

Advancing the science of environmental justice in the international wildlife trade

Edited by

Jamie K. Reaser, Nicholas King, Gunārs Hauff Platais,
Ines Arroyo-Quiroz and Meredith L. Gore

Coordinated by

Isla Kirkey

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Advancing the science of environmental justice in the international wildlife trade

Topic editors

Jamie K. Reaser — Smithsonian Conservation Biology Institute (SI), United States

Nicholas King — North-West University, South Africa

Gunārs Hauff Platais — University of Colorado Boulder, United States

Ines Arroyo-Quiroz — National Autonomous University of Mexico, Mexico

Meredith L. Gore — University of Maryland, College Park, United States

Topic coordinator

Isla Kirkey — Smithsonian Conservation Biology Institute (SI), United States

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EDITED AND REVIEWED BY
Shankar Aswani
Rhodes University, South Africa

*CORRESPONDENCE
Jamie K. Reaser
✉ Reaserjk@asi.edu

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Editorial: Advancing the science of environmental justice in the international wildlife trade

Jamie K. Reaser^{1,2*}, Meredith L. Gore³, Ines Arroyo-Quiroz⁴,
Isla M. Kirkey¹, Nicholas King⁵ and Gunars Platais⁶

¹Smithsonian National Zoo and Conservation Biology Institute, Front Royal, VA, United States,
²Smithsonian-Mason School of Conservation, Front Royal, VA, United States, ³Department of
Geographical Sciences, University of Maryland College Park, College Park, MD, United States,
⁴Programa de Estudios Socioambientales, Centro Regional de Investigaciones Multidisciplinarias,
Universidad Nacional Autónoma de México, Cuernavaca, Morelos, Mexico, ⁵Research Unit for
Environmental Science & Management, North-West University, Potchefstroom, South Africa,
⁶Mortenson Center in Global Engineering & Resilience, University of Colorado Boulder, Boulder,
CO, United States

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Editorial on the Research Topic

Advancing the science of environmental justice in the international
wildlife trade

Introduction

This Research Topic is dedicated to advancing the science of environmental justice in the international wildlife trade, examining diverse perspectives on both problems posed and potential solutions. We invited contributors to frame environmental justice in the context of social, species, and ecological justice, prioritizing papers that employed social science approaches. International wildlife trade, whether legal or illegal, is recognized as one of the greatest threats to biodiversity (Balvanera et al., 2019; Hughes, 2021; Hughes et al., 2023), as well as a facilitator of zoonotic disease transmission with epidemic and pandemic potential (Pavlin et al., 2009; Borsky et al., 2020). This has led to a call from human health and wildlife conservation sectors for more effective and efficient monitoring and regulation of the live animals, animal parts, and animal products that comprise this mega-industry (Borzée et al., 2020).

Nearly every aspect of wildlife-related commerce and risk mitigation measures has implications for environmental justice, yet environmental justice has not been mainstreamed in the scientific inquiry, policy, nor planning processes relative to the international wildlife trade (Arroyo-Quiroz et al.). Because international wildlife trade has diverse drivers and purposes, as well as different levels of legality, social legitimacy, regulatory authorities, and enforcement requirements, there remains an unmet need to more directly understand the complex, inter-acting environmental justice issues along the whole of the trade pathway. This includes exploring how consumer demand versus supply provision along trade chains are influenced by economic, cultural, and geographic biases

with environmental justice implications. This Research Topic helps elucidate these issues by centralizing novel and contemporary research, case studies, and perspectives. Understanding environmental justice patterns and trends is necessary for the design and support of effective regulatory frameworks that manage risks in practice, rather than merely in concept. Differentiating where and how to facilitate legal, sustainable wildlife trade from where tighter regulatory controls are warranted requires understanding both the socio-cultural drivers of human behavior and the ecological vulnerabilities of the traded species.

There also remains an unmet need to conceptualize an environmental justice framework that informs regulations of the international wildlife trade to minimize ecological deterioration, biodiversity loss and infectious disease risks while also affording justice to human communities and nations entwined in the commerce pathway. The papers in the Research Topic contribute to developing such a framework, offering conceptual models, original research, case studies, and unique perspectives. Likewise, building the capacity of more diverse individuals, organizations, and nations to share their voice in building recognition about how, when, where and why to address environmental justice issues along international wildlife trade pathways. For many of our authors, the opportunity to publish under this Research Topic created a means to share their insights, observations, and recommendations in scientific literature for the first time. We are honored to host their contributions, and we learned a lot from all of them.

Publication of all the manuscripts in this Research Topic was sponsored by a grant from the Smithsonian Life on a Sustainable Planet initiative. The Smithsonian National Zoo & Conservation Institute partnered with the International Alliance Against Health Risks in Wildlife Trade, and IUCN, to promote, coordinate, and implement the Research Topic.

The articles

Arroyo-Quiroz et al. provide a framework for advancing environmental justice inquiry in their Perspective, “A framework for advancing the science of environmental justice along the international wildlife trade pathway”. The framework is organized via three interrelated domains (social justice, wildlife species justice, and ecological justice) and intended to catalyze transparent, mutually respectful discussions about justice between conservation researchers, practitioners, and the vast array of wildlife trade stakeholders.

In “A critical environmental justice framework for the illegal wildlife trade”, Green provides a Perspective at the intersection of environmental justice and wildlife crime prevention, specifically focusing on the illegal wildlife trade. By applying critical environmental justice principles, the paper explores how issues of inequality, social dynamics, and state power can inform more equitable and effective interventions along the international wildlife trade pathway. The author goes beyond normative environmental justice to propose a transformative framework rooted in sociopolitical critique, which is especially useful in the Global South.

In their Community Case Study, “Global youth as catalysts for legal and sustainable wildlife trade solutions”, Anagnostou et al. recognize that the voices of youth have been underrepresented in wildlife-trade decision making. They explore how youth may contribute to achieving the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) Strategic Vision and offer ideas of how youth can be best supported in their efforts. The case study showcases youth-led innovation, including AI and digital surveillance tools for trade detection and network mapping.

In the Perspective, “Implementation biases in wildlife trade regulation foster unscientific and inequitable intervention strategies”, Kolby and Goodman examine the science underpinning wildlife trade interventions. To enable healthier approaches to effective conservation and wildlife resource-use strategies, they call for greater transparency in the wildlife trade decision-making processes, as well as the scientific evidence underpinning policy frameworks. This manuscript makes the case that wildlife trade interventions may reinforce bias and injustice, particularly when “unscientific” or “racist conservation” narratives are left unchecked.

Saito conducted Original Research that explores environmental justice issues associated with illegal wildlife seizures, providing insights into animal welfare and ethical concerns post-seizure. The manuscript “Where the wild things are...stored? The management and return of seized wildlife” points to the need to better understand how wildlife seizures are dealt with on the ground, particularly given the potential of seizure management and repatriation to raise environmental and restorative justice concerns. The article draws on concrete examples from East Africa and Central Europe, exploring how both live animal seizures and wildlife contraband are managed respectively.

In “Wildlife trade dynamics: exploring bushmeat market with a view toward social and ecological justice in Ibadan Metropolis Nigeria” Olunusi focuses on the dynamics of the bushmeat trade in Ibadan Metropolis, Nigeria, exploring its economic, social, and ecological dimensions. The Original Research examines the roles of bushmeat marketers (primarily women) and highlights income gaps, the need for alternate sources of livelihood, the sustainability of wildlife use, and declining species availability. The research aims to advance environmental justice by balancing economic livelihood options with conservation efforts.

Mukanganwa et al. explore environmental justice in the context of game-meat trade in their Original Research paper, “Zoonosis and the law: a case study of legal game meat regulation and control in Zambia”. To understand the game-meat trade in an environmental justice context, they conducted a literature review and surveyed subject matter experts. Ultimately, this work led to the development of recommendations for strengthening bushmeat governance in Zambia, as well as regarding Zambia’s international trade engagement.

The Original Research conducted by Carpio-Dominguez et al., “Policing wildlife trafficking in northeastern Mexico: the case of Tamaulipas in 2023-2024”, provides important insight into the factors that influence police response and capacity to identify wildlife trafficking in the state of Tamaulipas in northeastern Mexico. The study explores phenomena such as public insecurity,

corruption, and the lack of interest and training of the police on environmental crimes, including their impact on environmental justice processes. The authors identify factors that promote environmental justice, such as citizen collaboration and legal frameworks, and make recommendations for raising the capacity of the police to enforce environmental justice.

Zanvo et al. address environmental justice issues in the traditional medicine context in their Original Research, “Wildlife trade at the interface between deeply-rooted animal-based traditional medicine and unregulated harvesting of wild animals in West Africa”. The authors use a methodological approach borrowed from the social sciences to highlight the geographical extent of the wildlife trade network in traditional medicine markets, and the diversity and conservation status of species affected by this trade in three major taxonomic groups: mammals, birds and reptiles. They also identify factors influencing the spatial distribution of traditional medicine and bushmeat markets. This study fills the gaps in scientific data on local and regional wildlife trade as is essential to understanding of the trade network.

Adebowale et al. investigate the use of traditional medicines derived from wildlife in their Original Research paper, “Utilization of fauna resources for therapeutic purposes as a barrier to species justice advocacy in Nigeria”. Using a quantitative research design, they collected data through a semi-structured questionnaire distributed randomly to 165 traditional medicinal vendors. They found that animal parts are often traded in the markets for spiritual empowerment and disease treatment, which could negatively impact species justice if not properly regulated. The trade negatively impacts conservation efforts and undermines the collective endeavors of all stakeholders to promote species justice in Nigeria.

In “Delineating the environmental justice implications of an experimental cheetah introduction project in India”, Joshi et al. employ Project Cheetah as a case study to explore species and social justice issues in the rewilding and restoration context, especially projects that necessitate attention by proponents and authorities responsible for issuing CITES import and export permits. They emphasize that conservation practices that prioritize respect, inclusivity, and justice are more likely to have positive outcomes for people and nature.

A way forward

Combined and standing alone, the articles in this Research Topic make an unequivocal case for growing attentiveness to the many facets of environmental justice along international wildlife trade pathways. They also identify, each in their own way, opportunities for enhanced action addressing these injustices at local, regional, national, and international levels. They provide groundbreaking science to be built upon. The case studies demonstrate both the unique features of environmental injustice, as well as the common drivers and implications of risks, threats and loss to vulnerable persons, places, and species. Fundamentally, the authors call for and point the way toward increased vigilance, shared responsibility,

and collective problem solving – advancing the science of environmental justice along the international wildlife trade pathway.

Author contributions

JR: Conceptualization, Funding acquisition, Project administration, Supervision, Writing – original draft, Writing – review & editing. MG: Writing – original draft, Writing – review & editing. IA-Q: Writing – original draft, Writing – review & editing. IK: Writing – original draft, Writing – review & editing. NK: Writing – original draft, Writing – review & editing. GP: Writing – original draft, Writing – review & editing.

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EDITED BY

Chiara Bragagnolo,
Federal University of Alagoas, Brazil

REVIEWED BY

Bright Olunusi,
Cornell University, United States

*CORRESPONDENCE

Jamie K. Reaser
✉ Reaserjk@si.edu

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A framework for advancing the science of environmental justice along the international wildlife trade pathway

Inés Arroyo-Quiroz¹, Meredith L. Gore² and Jamie K. Reaser^{3,4*}

¹Programa de Estudios Socioambientales, Centro Regional de Investigaciones Multidisciplinarias, Universidad Nacional Autónoma de México, Chamilpa, Cuernavaca, Morelos, Mexico, ²Department of Geographical Sciences, University of Maryland College Park, College Park, MD, United States,

³Smithsonian National Zoo & Conservation Biology Institute, Front Royal, VA, United States,

⁴Smithsonian Mason School of Conservation, Front Royal, VA, United States

The international wildlife trade can be a significant driver of biodiversity loss, as well as a facilitator of zoonotic disease transmission with pandemic potential. Environmental justice has never been more relevant to the wildlife trade as it is today. Yet, environmental justice has not been sufficiently mainstreamed into conservation science, nor practice. Here, we propose a framework for advancing the transdisciplinary science of environmental justice in the international wildlife trade context. The framework is organized via three interrelated domains: a) social justice, b) wildlife species justice, c) ecological justice. Each of these domains is described in terms of transdisciplinary questions that are intended to foster the translation of science of environmental justice for wildlife trade and should be tailored to cultural and historical contexts. It is our hope that the framework stirs open, transparent, mutually respectful discussions about justice between conservation researchers, practitioners, and the vast array of wildlife trade stakeholders.

KEYWORDS

conservation policy, ecological justice, social justice, species justice, research agenda, Wildlife trade

1 Introduction

The trade in live wildlife, wildlife parts, and wildlife products—whether legal or illegal—can be a significant driver of biodiversity loss (Hughes et al., 2023), as well as a facilitator of zoonotic disease transmission with pandemic potential (Pavlin et al., 2009). This has led to increased calls for industry regulation—ranging from comprehensive bans to risk-based strategies that are species, product, and/or geography specific (Borzée et al., 2020). Yet, at the local level, the wildlife trade may support vital sustenance, livelihood, and cultural needs (Rao et al., 2011; Robinson et al., 2018; IPBES, 2019; Future Earth and GEO BON, 2022) and, at the global scale, it comprises a mega billion dollars/year industry (UNODC (United

Nations Office on Drugs and Crime), 2016, 2020, 2024). Those with a strong desire to maximize the socio-economic benefits of the wildlife trade, while simultaneously minimizing adverse impacts, have thus pointed to the need for more balanced oversight and regulation of this globally distributed industry (Borzée et al., 2020). To achieve effective regulatory outcomes that mutually benefit wildlife and people along the trade pathway, there is a need for a discussion of justice (Spapens et al., 2016; Brockett and Woolaston, 2022; Sollund, 2022).

Environmental justice is commonly regarded as the human right to a safe, healthy, productive, and sustainable environment for all peoples, where “environment” is considered holistically to include ecological (biological), physical (natural and built), social, political, aesthetic, and economic contexts (Chowkwanyun, 2023). For the purposes of this paper, we regard environmental justice broadly to include the assignment of these rights as inclusive of a) social justice (all people have equal, protected, rights and opportunities; Montgomery et al., 2024), b) species justice (all non-human wild species are to be protected against discrimination, abuse, or exploitation by humans; Fitz-Henry, 2022), and c) ecological justice (all beings are part of an integrated Earth system and warrant the protection of equal rights and respects, including the ability to access sufficient natural resources for survival; Washington et al., 2018).

Environmental justice has never been more relevant to conservation, or wildlife trade in particular, as it is today. Issues of equity, gender, fairness, legitimacy, and inclusion are widely diffused across the social and ecological systems touched by wildlife trade (Agu and Gore, 2022; Milne et al., 2023; Sovacool et al., 2023). Yet, environmental justice has not been sufficiently mainstreamed into conservation science, nor practice. Specifically, environmental justice is lacking in scientific inquiry, policy, and planning processes relating to the wildlife trade. When environmental justice is not taken into consideration, the sustainability and efficacy of these efforts is likely to fail at best (McGregor et al., 2020); at worst, interventions may reinforce, as well as introduce, new injustices and contribute to biodiversity loss (Sovacool et al., 2023).

The opportunity exists for scientists working for society to conceptualize an environmental justice framework that better informs regulation of the international wildlife trade to help minimize biodiversity loss, harmful practices and infectious disease risks while also affording sustainable justice outcomes. Here, we propose a framework for advancing the transdisciplinary science of environmental justice in the international wildlife trade context. The framework arises as a synthesis of biological and social sciences, insights from conservation and social justice practitioners, and lessons drawn from case studies. It is organized via three interrelated domains: a) social justice, b) wildlife species justice, c) ecological justice. Each of these domains is described in terms of transdisciplinary questions that are intended to foster translation of the science of environmental justice to society, specifically for wildlife trade. The framework does not offer rigid authority for considering major types of justice with touchpoints to wildlife trade (e.g., distributive, corrective, commutative; Kuehn, 2000). Rather, our goal is to help

better facilitate transdisciplinary scientific analysis and inclusion of environmental justice into legal and illegal wildlife trade policies and practices.

Every aspect of international wildlife trade and every proposed risk reduction measure has implications for environmental justice (Sollund, 2019, 2022). Amongst a range of factors driving global biodiversity loss (e.g., Hald-Mortensen, 2023), wildlife trade stands apart in its diversity of influencing factors and functions, socio-cultural roles and impacts, levels of legality, and enforcement (Fukushima et al., 2021). The need to improve understanding of the environmental justice issues tied to wildlife trade is readily apparent. This is particularly true for consumer demand versus supply provision along the trade pathways, as well as how the supply chain is influenced by, and impacts, economic, cultural, and geographic biases. Deeper understanding of environmental justice patterns and trends can enable the design and evaluation of more effective regulatory and control frameworks that help manage risks and harms in actuality—rather than merely in concept. For example, improved insight about environmental justice can facilitate efforts to determine where and how to support legal and sustainable wildlife trade, versus where the trade should be more tightly regulated. A better understanding of environmental justice can also elucidate the societal implications of restrictive regulation and point to opportunities for proactively mitigating potential adverse impacts on affected stakeholders. For example, it would be useful to assess the potential of trade bans to drive historically legal wildlife trade into black markets. Likewise, in instances in which wildlife trade bans could undermine the security of local peoples and whole cultures, it would be wise to support these communities in developing alternative livelihoods consistent with their socio-cultural norms, use and conservation goals. Some scholars also recognize opportunities for environmental justice studies in the wildlife trade context to help advance green criminological concepts of ecological citizenship and institutionalized harm (e.g., Sollund, 2021) as well as rights-based approaches, which are scant in wildlife trade activities (Osorio and Bernaz, 2024).

2 Characterization of the international wildlife trade pathway

For the purposes of this paper, the international wildlife trade is defined as the intentional translocation of wild animals (wildlife), wildlife parts, or wildlife products across national borders in exchange for currency or other goods. The term “international wildlife trade” covers legal (regulated and unregulated) and illegal activities that, at a minimum, includes wildlife provisioning (harvesting, ranching, or farming), containment, preparation to meet consumer needs, transportation, and exchange (trade) to fulfill a wide range of consumer end uses (e.g., pets, food, décor, research). We recognize that, when appropriately managed, the trade in wild animals, parts, and products can provide livelihood benefits to local and rural communities, as well as contribute to species conservation

(Cooney et al., 2015; IPBES, 2019). It is also clear that the opposite can be true; poorly managed trade, including illegal trade, can put people, cultures and wildlife at risk of harm as a direct and indirect consequence (Baker et al., 2013; Maher and Sollund, 2016; Van Uhm, 2016). Environmental justice is of particular concern in poorly managed trade contexts but warrants consideration under even the most well managed wildlife trade circumstances.

Trade is often discussed in terms of the “supply side” versus “demand side” of a commerce pathway equation, given the impression that trade is a simple binary. In actuality, the

international wildlife trade is interconnected, spatio-temporally complex, constantly transforming and in flux. For this reason, the framework proposed herein should be regarded as a generalized model. The structure and details of an environmental justice framework will need to be specified (fit-to-context) on a case-by-case basis.

These diagrams (Figures 1A, B) draw partial ontological components from green criminology, geography, law, economics, logistics, and conservation science. They are intended to be flexible in application across geographical, political, and cultural contexts,

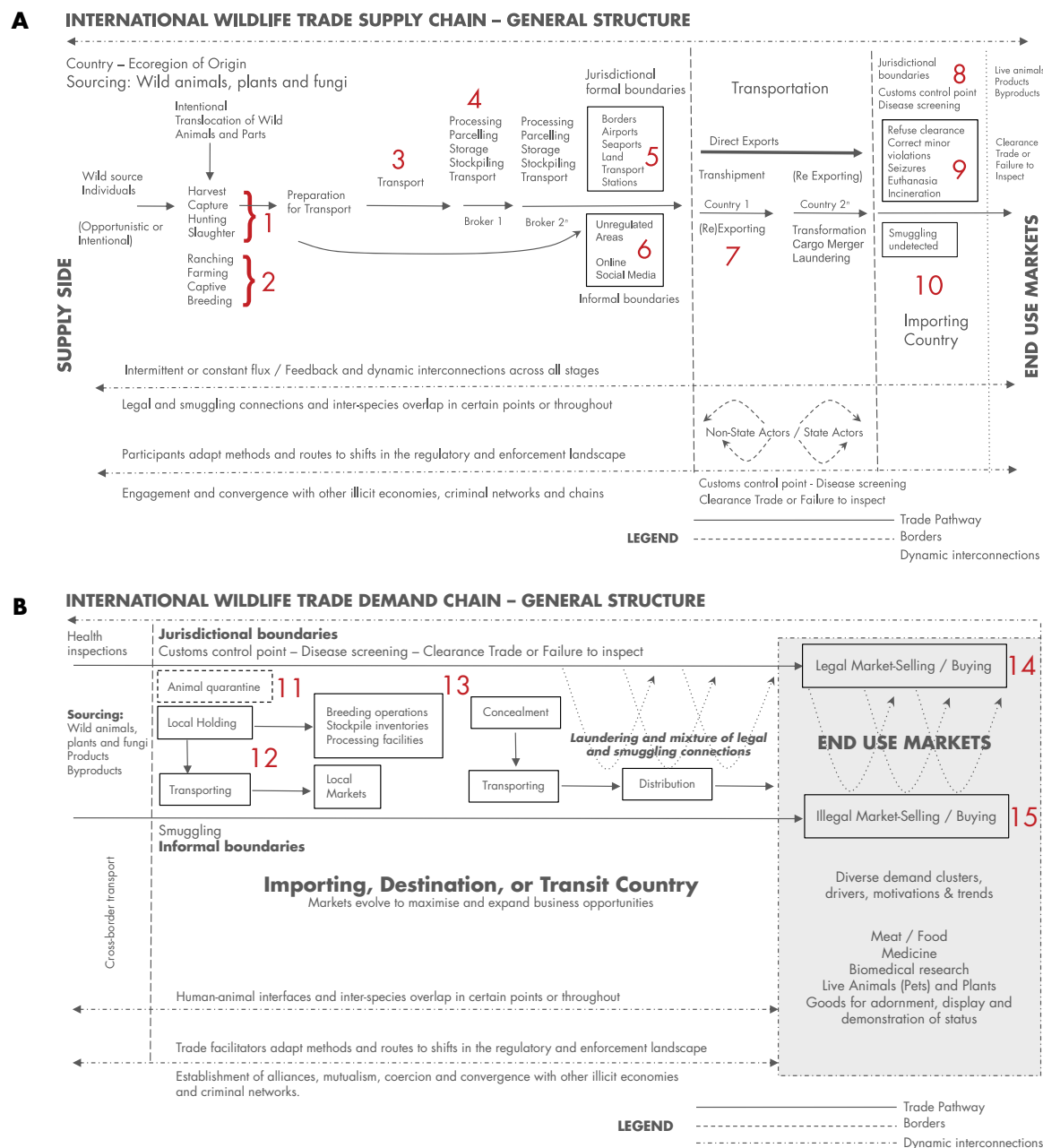


FIGURE 1

Diagrams depicting the general structure of the international wildlife trade pathway with numbers corresponding to social, wildlife species and ecological justice inquiry topics (Table 1). (A) The export pathway. (B) The import pathway.

as well as the market(s) and taxonomic groups involved. They should be adapted and fit-to-context on a case-by-case basis corresponding with issues to be analyzed. The diagram details will differ, for example, among inquiries taken from ecological justice, animal welfare, and species at risk perspectives. These diagrams are linked to [Table 1](#). The numbers correspond to the proposed environmental justice framework, emphasizing the significance of environmental justice inquiry at these stages.

The major difference between illegal and legal wildlife trade pathways is that illegal wildlife shipments are not, by definition, subject to regulatory scrutiny unless intercepted by enforcement officers. Live animals are thus more vulnerable to animal welfare injustices such as poor-quality transport conditions (e.g., overcrowding, inhumane containment). It is also likely that illegal wildlife shipments bypass all pre-export pathogen testing and vaccinations, thereby facilitating the risk of disease transmission

TABLE 1 Science-based environmental justice questions to investigate along the international wildlife trade (IWT) pathway.

Pathway Stage	Social Justice	Wildlife Species Justice	Ecological Justice
1	How, when and/or why are indigenous people and local communities engaged by outsiders to hunt local species for IWT? How can authorities ensure that access and benefits sharing policies are in place to support local peoples?	How do we determine and enforce sustainable removal rates for particular species in specific contexts? How can we guarantee animal welfare conditions during capture/hunting?	How do we assess and address the systemic and structural impact of wildlife removal in biodiversity and ecosystems? (loss of biodiversity at the level of genes, species, alteration of food webs, etc.) How can we ensure rights of nature are recognized and enforced from local to global scales?
2	How can occupational conditions and safeguards for managing large and/or risk wildlife species (e.g., venomous species) be gender sensitive?	How can we prevent the laundering of species from the wild and their introduction into captive breeding schemes? How can we guarantee animal welfare conditions in captivity? How can we work with users to inform, support and increase their awareness and capacity for species-specific animal care?	How do we ensure facility biosecurity to prevent wildlife escape and/or disease transmission from the facility to wild populations?
3	How is the physical, psychological, and economic safety of environmental defenders, local guardians, law enforcement officers and their families ensured?	How do we ensure handling and transportation standards meet species-specific welfare needs and are enforced? This should include regulations that limit multi-species co-housing to prevent pathogen/parasite spread.	How do we ensure transport biosecurity to prevent wildlife escape and/or disease transmission to wild populations and vice versa?
4	How do we support a fair distribution of income and other benefits along value chains? e.g. in the stages of transportation, storage, inventory and pre-processing.	How do we ensure handling and holding facilities meet species-specific welfare needs and are enforced? This should include regulations that limit multi-species co-housing to prevent pathogen/parasite spread. Especially those shipments that are abandoned, animals suffer from a lack of basic resources and hygiene.	What is the ecological footprint of wildlife trade processing and packaging? How can the practices become more sustainable? How do we ensure waste products and packaging do not become environmental contaminants and/or a source of disease for wild populations?
5	How comprehensive are security and sanitary conditions guaranteed for workers handling wild specimens (plants and animals) and by-products? How can they be improved? How are compliance obligations monitored and are educational entry points identified and used in noncompliant situations? How can they be improved?	What capacity do inspectors have to verify species identity? How can this capacity be improved to aid enforcement activity and accuracy of trade data? This is especially important for those shipments that take a long time to leave the fiscal precincts due to administrative problems or that are abandoned by customs agents. While these procedures are resolved, animals may suffer from a lack of basic resources and hygiene.	How do we ensure points of entry biosecurity to prevent wildlife escape and/or disease transmission to wild populations? How can wildlife inspectors be incentivized by and rewarded for their roles in ecological stewardship?
6	Internet wildlife sales, legal and illegal, may be associated with dark web activities. How can surveillance of wildlife sales improve detection of other crimes, such as drug and sex trafficking?	How can regulations and platform terms of use be established that require accurate and transparent statements of species identification for marketed items? What tools and technologies can be employed to assess the species identity of wildlife and wildlife-derived products online to aid enforcement activity? How can we infiltrate certain illegal distribution chains to work with users mainly to inform, support and increase their awareness and capacity for species-specific animal care?	How can internet consumers be effectively educated about the adverse ecological consequences of purchasing wildlife and wildlife-derived products? What approaches and incentives are needed to inspire the behavior changes (e.g., purchasing decisions) necessary to protect ecological systems from IWT impacts?
7	How do we guarantee a fair distribution of income and other benefits along value chains where not	How do we ensure handling and transportation standards meet species-specific welfare needs and are enforced? This should include regulations that limit multi-species co-housing to prevent	What are the various impacts of the wildlife transport pathway(s) on ecological systems?

(Continued)

TABLE 1 Continued

Pathway Stage	Social Justice	Wildlife Species Justice	Ecological Justice
	only the large companies or extreme end users are the beneficiaries of the added value of what is marketed? How can we ensure gender is considered as an aspect of fair distribution?	pathogen/parasite spread. This is especially important for those shipments that take a long time to leave the fiscal precincts due to administrative problems or that are abandoned by customs agents. While these procedures are resolved, animals may suffer from a lack of basic resources and hygiene.	How can we minimize the impact from local to global scales and vice versa?
8	How are security and sanitary conditions guaranteed for workers while screening for diseases in animal specimens (and by products)?	What pathogens and parasites warrant routine screening for particular wildlife species? What regulatory frameworks, tools, and technologies need to be put in place to enable rapid disease screening, data collection, and risk mitigation at ports of entry for legal and illegal wildlife imports?	How can we ensure biosecurity at points of entry to prevent the escape of imported wildlife into local environments? How can we prevent native wildlife from frequenting points of entry where they might come into contact with pathogens or parasites contaminating shipping conveyances/containers?
9	How can we improve the working conditions of the personnel in charge of receiving, protecting and guarding wildlife shipments? A lack of adequate resources (financial, human, infrastructure and training) is common, leading to morale issues and high rates of staff turnover. The capacity and attitude of these workers impacts animal welfare and the wildlife in transit is dependent upon their decisions and actions.	How can we ensure that these actions are consistent with species-specific welfare standards (e.g., humane euthanasia varies among species) and that those standards are enforced? These issues are particularly concerning for shipments that take a long time to leave the fiscal precincts due to administrative problems or that are abandoned by customs agents. While these procedures are resolved, animals may suffer from a lack of basic resources, and hygiene. How can any seized wildlife or wildlife-derived products serve conservation goals for the species?	How can financial penalties for illegal wildlife importation be directed to biodiversity conservation programs in the country of origin? How can we improve waste practices so that there is little or no impact on the environment? Ideally, a zero waste scheme would be a requisite business practice. Biological waste is linked to euthanasia and cremation practices while transport containers and associated materials may be incinerated or landfilled.
10	How can we prevent public health risks for workers and their families, e.g., exposure to infections, zoonotic diseases, while handling specimens for sale.	What approaches can be used to end the illegal (black) market demand for particular species? What tools and technologies can be used to detect specimens, products and by-products in black market circulation? How can we infiltrate certain illegal distribution chains to inform, support and increase their awareness and capacity for species-specific animal care?	How can we infiltrate illegal distribution chains to inform, support, and increase their biosecurity capacities, preventing wildlife escapes, as well as zoonotic disease outbreaks?
11	How are security and sanitary conditions guaranteed for workers handling live specimens and by products? Do gender biases need to be addressed? If so, how?	What species warrant quarantine holding? Why and for how long? How can quarantine standards be established and enforced to meet species-specific needs? This is especially important for countries with very limited resources and hygiene conditions. How can disease testing results obtained during quarantine be collected and publicly reported in a standardized manner to aid wildlife health and conservation measures?	How can we ensure quarantine facility biosecurity? Imported wildlife needs to be contained and prevention measures need to be in place to keep local wildlife from coming into direct or indirect contact with imported wildlife (e.g., via waste disposal).
12	How can we guarantee a fair distribution of income along value chains so that large companies are not the only (or primary) beneficiaries of the added value of what is marketed? How can we ensure gender is considered as an aspect of fair distribution?	How can we ensure housing and transportation standards meet species-specific welfare needs and are enforced? This should include regulations that limit multi-species co-housing to prevent pathogen/parasite spread. How can we infiltrate certain illegal distribution chains to inform, support and increase people's awareness and capacity for species-specific animal care?	How can we ensure biosecurity to protect against facility escapes? How can early detection and rapid response measures be put in place to respond to wildlife escapes? How can we eradicate and/or control imported wildlife species that become invasive, especially if they are highly charismatic species? Who is held accountable for ecological impacts and how?
13	How can security and sanitary conditions be guaranteed for workers handling animal specimens? Do gender biases need to be addressed? If so, how? How can we ensure public health and safety if animals escape or are released	How can we ensure animal welfare that meets species-specific needs?	See 12

(Continued)

TABLE 1 Continued

Pathway Stage	Social Justice	Wildlife Species Justice	Ecological Justice
	from the facilities? Rural communities may be particularly at risk. What is the decision process for determining facility locations and analyzing risk? How can environmental justice be improved?		
14	How can we counteract the legacy (culture) of violence, abuse, and mistreatment to animals displayed in legal markets? Intervention is needed for both animal welfare and establishing healthy societal norms for youth values and behavior.	How can we inform, support and increase user's awareness and capacity for species-specific animal care? How can we foster species-specific rescues for imported wildlife that is no longer wanted by the consumer?	See 12 How can we track what happens when wildlife is not sold and address ecological consequences? While there is speculation that links exist between trade distribution chains and illegal landfills in natural or semi-disturbed environments, the issue is poorly assessed.
15	How does the end use for illegal wildlife correspond to other illegal markets? Will successful IWT interventions result in increased wildlife populations which then increases human-wildlife conflict which can create burdens for local people? How can we counteract the legacy (culture) of violence, abuse, and mistreatment to animals displayed in illegal markets? Intervention is needed for both animal welfare and establishing healthy societal norms for youth values and behavior.	How can we infiltrate illegal distribution and selling chains to work with users, mainly in urban areas, to improve species-specific animal welfare? See 14 How can we foster amnesty programs that enable people to turn in illegal wildlife without penalty?	See 12, 14

to other animals and people. This presents social, species (domestic animals and wildlife), and ecological injustices. We offer the following points to emphasize and clarify environmental justice concerns across the pathway. These points underpin the inquiries offered in Table 1.

A. **Illegal trade.** What constitutes illegal trade can range from a wildlife shipment with an unintended error in accompanying documents (which is correctable) to intentional wildlife smuggling. Which acts constitute crimes depends on the applicable national legislation, which vary within countries, among countries, and over time. Illegal trade undermines the rule of law, leads to losses in revenue, and increases health risks to wildlife and people. Illegal wildlife trade may be intermingled with other criminal activity, such as drug and human trafficking. However, the evidence base for specific points of vulnerability to corruption in the wildlife trafficking chain, how those points vary over time and by context, and on the effectiveness of risk mitigation responses remains weak.

B. **Pathogens (including parasites)** can be present anywhere along the chain; they may enter and exit via secondary interactions. There are relatively few requirements for wildlife, or their parts, to be quarantined, tested, and/or vaccinated for pathogens at any point along the pathway. Pathogen transmission among animals in transit should be of the greatest concern when a) multiple species are held in close quarters and/or b) shipping conveyances or containers are reused without sterilization. Transmission risk to people is a function of human exposure to wildlife and/or the bodily materials (e.g., blood, excrement).

C. **Gender** shapes the engagement in and roles of people involved in all stages of the international wildlife trade supply chain. Across the trade chain from source to end market gender undoubtedly influences trade patterns and processes, including criminality and efforts to mitigate harm. For example, on the supply side, gender likely influences roles in wildlife extraction. Gender is known to influence wildlife poaching prevention efforts (e.g., ranger employment). On the consumer side, gender likely influences what wildlife species and products are in

demand. However, the gender dimensions of wildlife trade have been poorly studied and thus warrant environmental justice research (Agu and Gore, 2020, 2022; Seager, 2021).

3 Proposed environmental justice framework

Advancing the science of environmental justice is an act of expanded, deepened, and better integrated inquiry. Table 1 is a transdisciplinary framework for advancing environmental justice research along the international wildlife trade pathway. The framework is intended to facilitate the ability of environmental justice researchers to identify broad questions that can then be refined for application to specific international wildlife trade contexts (wildlife species, geographies, players, purposes, victims, etc.). We also hope the framework will help funding agencies identify granting targets, needs, and priorities. The framework is not exhaustive; the questions are exemplary, and the invitation exists for researchers to identify other relevant inquiries fit-to-context.

Rather than function as an authoritative structure for the application of major types of justice (e.g., distributive, corrective, commutative, restorative), the framework is intended to facilitate transdisciplinary scientific inquiry into environmental justice in the wildlife trade context—from both legal and illegal perspectives—with the hope of better informing decision making across the whole trade pathway. For example, it is intended to promulgate the science that will enable decision makers who have a desire to regulate the importation of potential harmful species to consider the various ramifications of proposed regulatory actions on the suite of affected parties and systems involved in trade export activity (Martin et al., 2013).

Questions in Table 1 are largely framed from a “how can we...” perspective. The “we” refers to all those who self-identify as interested in improving environmental justice along the international wildlife trade pathway, with a particular emphasis on the conservation research community. The “how to” frame is intended to place the focus on capacity building rather than simply the identification of environmental justice challenges. The framework is, thus, a scholarly tool for addressing environmental injustices. Although actionability of the framework elements is critical, we have intentionally provided broad questions in multiple instances to catalyze innovation, a wide range of possible response narratives, and stakeholder inclusivity. We recognize that these justice issues are inter-related and may overlap. In some situations, it may be challenging to distinguish between Wildlife Species Justice (focused on species conservation, ethical treatment, and welfare) and Ecological Justice (focused on all biota and the processes among them). However, the inquiries can be framed differently according to the scale of impact (species vs. ecosystem).

4 Discussion

The international wildlife trade is a multi-billion dollar, cross-border, globally-distributed, socio-environmental phenomenon that is ecosystem, species, and socially agnostic (Gore and Bennett, 2022; Gore et al., 2023a, b). The complexities of trade pathways, particularly supply–demand dynamics, help highlight the need for context-specific solutions to risk mitigation. The international wildlife trade is not decreasing in scope or scale (UNODC (United Nations Office on Drugs and Crime), 2016, 2020, 2024); it is reasonable to assume that the legacy of [social and ecological] injustice(s) will continue alongside a range of escalating and emergent burdens (see Levy and Hernández, 2022). It is our hope that the framework herein offers a rendezvous point of sorts for conservation scholars and practitioners to accommodate the interconnectedness of human rights, animal welfare, and ecological health when seeking fair and sustainable outcomes responsive to international wildlife trade related risks. These interconnections may produce cumulative exposures and differential vulnerabilities; they may be generated via community engagement, empowerment, capacity building (Levy and Hernández, 2022), as well as creating awareness and involving all sectors of society.

The environmental justice framework herein is also intended to enhance extant, mainstream solutions that are broadly discussed in the conservation literature, such as prevention measures, trade bans (Challender et al., 2024), biosecurity measures (Pienaar et al., 2022), species-specific welfare standards (Pienaar et al., 2022; Wyatt et al., 2022) and global health governance (Willettts et al., 2024). In particular, the framework can be applied to community-engaged research and/or efforts to integrate environmental justice principles into wildlife management, regulation and controls, simultaneously mitigating biodiversity loss; reducing abuse; and, supporting socio-economic benefits with a particular focus on those local communities reliant on trade for their livelihoods (Schroeder, 2008). When adapting the framework across geographical, political, and cultural contexts, we encourage practitioners to consider how to shape inquiries relative to such factors as legal frameworks (e.g. strict vs. weak enforcement, socio-cultural traditions (e.g., focal species, harvest purpose, harvest demand patterns), user groups (e.g., local consumption vs commercial exportation), and ecological condition (e.g., human dominated, highly impacted system vs. relatively intact system with low anthropogenic pressures).

We offer three broad observations, reflections, and implications that emerge from the framework.

- A. Justice issues along the international wildlife trade pathway are driven by internal and external attributes and factors, which in turn, have internal and external impacts. The pathway is not an isolated distribution and commerce chain. To advance the science of socio environmental justice, the pathway must be

regarded as a complex system full of dynamic human-to-human and human-to-wildlife interactions.

- B. There is broad opportunity for multi-dimensional policy innovations at individual, neighborhood, and community levels that foster justice and sustainability (Esmail et al., 2020). By more deliberately integrating social, species, and ecological justice into wildlife trade policies, policy makers may address ecological harms and mistreatment of wildlife while supporting the socio-economic needs of communities. Beyond the technological innovations to confront the international wildlife trade (Kretser et al., 2017), neighborhood, community, and regional policy innovations can equally help ensure that international wildlife trade interventions are effective, just and less harmful.
- C. If risk prevention and mitigation strategies stemming from biosecurity, health and animal welfare are enhanced, a focus on the entire wildlife trade pathway—rather than specific points—may enable justice in a more holistic way (Adeeso, 2024). There are clear opportunities to mitigate risky public health issues and uphold ethical practices in wildlife management at discrete points along the wildlife trade pathway. However, because justice issues have so many intricate trade pathway touch points, narrowly focused strategies may simply displace injustices to other locations along the pathway. Justice in IWT spaces may not always emerge from adding innovations or strategies; de-adoption, de-implementation or discontinuance of practices that are known to be harmful or unjust (Ashcraft et al., 2024) are also possible paths to follow.

Some environmental justice scholars acknowledge that frameworks are ideally centered on the communities they seek to serve (Van Horne et al., 2023). We acknowledge our lived experiences and expertise as academics/scientists and recognize our framework is investigator led. We also point out that the framework is intended to serve the investigator community, particularly those practicing in the field of conservation from biological and/or social science perspectives. We encourage these investigators to collaborate with trade pathway stakeholders on data collection and ownership, communication and results dissemination, and project leadership—in the spirit of justice and equity both social and ecological.

5 Conclusion

The international wildlife trade impacts social, species, and ecological justice through the buying and selling of wild animals and plants and wildlife-derived products. We have provided a general socio environmental justice inquiry framework to support scholars and practitioners, but especially conservation scientists, in their efforts to understand and mitigate injustices along this type of trade pathways worldwide. The framework is to be regarded as a catalyst for the identification of additional real world research questions and

challenges, as well as the tailoring of investigations by cultural and historical contexts. It is our hope that the framework stirs open, transparent, mutually respectful discussions about justice between researchers, practitioners, and the vast array of wildlife trade stakeholders. We trust that the findings generated by the application of this framework will point the way to greater justice in international wildlife trade policies and practices. Yet, we underscore the need to recognize that achieving justice is not a one-off, single step task. Achieving environmental justice throughout all the various international wildlife trade pathways that are constantly evolving requires the substantial and sustained will of every nation and of all those who inform national decision making, but also the responsibility and the commitment of users themselves.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

IA-Q: Visualization, Writing – original draft, Writing – review & editing. MG: Visualization, Writing – original draft, Writing – review & editing. JR: Conceptualization, Funding acquisition, Project administration, Visualization, Writing – original draft, Writing – review & editing.

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Timothy C Haas,
University of Wisconsin–Milwaukee,
United States

*CORRESPONDENCE

Aalayna R. Green
✉ arg267@cornell.edu

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A critical environmental justice framework for the illegal wildlife trade

Aalayna R. Green*

Department of Natural Resources & the Environment, Cornell University, Ithaca, NY, United States

Rapidly, scholars and practitioners are recognizing the need for the radical incorporation of justice into conservation interventions. Critical environmental justice is an attractive avenue for integrating justice and wildlife crime prevention within the illegal wildlife trade. As coined by David Pellow, critical environmental justice delineates dynamics of inequality related to intersecting social categories, multi-scalarity, racial expendability, and state power. Within IWT, these pillars of critical environmental justice offer opportunities to contend with futures otherwise and to pursue IWT intervention with a grounded understanding of communities, wildlife, and each other. This article demystifies the critical EJ literature and analyzes IWT through a critical EJ lens. Grounding IWT prevention and study in a critical EJ approach can facilitate a more seamless, radical, and transformative integration of justice principles into IWT intervention.

KEYWORDS

environmental justice (EJ), conservation social science, wildlife crime, wildlife trade, imagination, social inequalities

1 Introduction

“If you ask me, ‘What is the most important, enduring success of the environmental justice movement?’ I would say it’s not some law, it’s not some policy that we got passed...

It is, in fact, a change in the way we think about the environment and its relationship to human beings, and the question of inequality – and it’s a change in the way we even define the environment.”

– David Pellow in Dean’s Lecture Series at the Stanford Doerr School of Sustainability

Illegal wildlife trade (IWT) is one of the fastest-growing criminal markets despite pro-conservation rhetoric (Keskin et al., 2023) and poses considerable risks to both biodiversity (e.g., Garber et al., 2024; Wyatt et al., 2022) and local communities (e.g., Arroyave et al., 2023;

Rush et al., 2021). IWT's implications reflect contextual dynamics regarding gendered (Seager et al., 2021; Agu and Gore, 2020), socioeconomic (Tolbert et al., 2023; Prasad et al., 2022), and cultural (Feddemma et al., 2020; Donovan, 2004) underpinnings—all of which can contribute to the systemic marginalization of local communities through conservation. IWT, when considered a form of wildlife or conservation crime, delineates the complexities associated with people's care for the environment and the preexisting social conditions that push them to engage with IWT in the first place (Duffy, 2022, p. 43). Indeed, Duffy (2022) proceeds to argue that IWT can shape and impact livelihoods in two ways: (1) by depriving communities of food and income sources and (2) by serving as an income-generating endeavor (p. 43–44). IWT is thus complicated by broader conceptions of identity, space, and environmental relations, requiring approaches grounded in a justice model that accounts for these dynamics. Given its application within other conservation practice sectors (e.g., Ciornei, 2023; Guibrunet et al., 2021; He et al., 2021), environmental justice (EJ) posits a suitable method of integrating such principles into IWT.

There is a gap in our understanding of applying EJ to IWT analysis, critique, and solutions. Defined by Bullard (1996), EJ “embraces the principle that all people and communities are entitled to equal protection of environmental and public health laws and regulations” (p. 493). Rooted in the experiences of African Americans protesting against hazardous waste sitings in Warren County, NC, in the 1980s (Eady, 2007; McGurty, 2000), EJ has evolved as a social movement to more adequately reflect global realities of environmental racism and environmental inequality (Sze and London, 2008). Environmental inequality pertains to environmental conditions that further preexisting social disparities, such as the magnification of systemic violence experienced by houseless people forcibly relocated into toxic neighborhoods (Goodling, 2020). Environmental racism, as defined by Bullard (1993), “refers to any policy, practice, or directive that differentially affects or disadvantages (whether intended or unintended) individuals, groups, or communities based on race or color” (p. 1037). One example of environmental racism is policies that site toxic waste sites in predominantly racially marginalized communities (Mascarenhas et al., 2021). As a theoretical praxis, EJ lends itself to understanding the dynamics between environmentally-induced social inequality and environmental racism (Steady, 2009), influencing how an individual will be impacted by environmental injustice.

However, in application, EJ is often divorced from deeper understandings of racialized production of spatial-induced social inequality (Pulido, 2000). Some argue that EJ is limited by a purely Western scope (e.g., Roy and Hanaček, 2023; Álvarez and Coolsaet, 2020), thereby restricting the theory's application in non-Western contexts. Within conservation, EJ has been deployed as a tool to unsettle dichotomies of conservation projects in perpetuating and alleviating environmental injustices (Bontempi et al., 2023; Domínguez and Luoma, 2020); modes of organized resistance against social injustices in areas of conservation interest (Fanari, 2022; Wang and Lo, 2022); and evaluating distributions of conservation harms and benefits (Gurney et al., 2021; Martin et al., 2015). Applying an EJ framework to IWT requires more

critical integration that accounts for the interlocked roles of the state, security, and criminalization as they relate to human–environment relationships.

Critical environmental justice (critical EJ) studies posit an evolution of environmental justice theory to account for a deeper understanding of the entrenched and embedded character of social inequality as it is reinforced by state power (Pellow, 2017). As opposed to EJ, which aids in our collective understanding of how environmental injustice develops and impacts communities, critical EJ pushes us further by linking theory and practice to pursue an environmentally just society (Pellow and Brulle, 2005). Critical EJ argues that inequalities are sustained through intersecting social categories, multi-scalarity, racial expendability, and state power (Carrillo and Pellow, 2021). Given the global expansion of IWT and global biodiversity decline, a critical EJ approach is necessary if solutions to IWT are to be long-term and sustainable. A critical EJ perspective of IWT can allow interventions to address the drivers of social marginalization and illicit natural resources through broader geopolitical understandings of conservation-induced inequality. In this way, critical EJ enables a more holistic solution to IWT grounded in respect for globalized local contexts, species, and communities. This paper seeks to guide IWT scholars and practitioners in implementing critical EJ principles within their research. I first provide an overview of the critical EJ framework. Second, I disentangle the elements of IWT according to the four pillars of critical EJ. I then suggest avenues for scholars and practitioners wishing to implement a critical EJ perspective.

2 A critical environmental justice framework

Critical environmental justice (EJ) studies is interdisciplinary, multi-methodological, and scholar-activist inspired within a praxis-oriented EJ approach (Pellow, 2016). Critical EJ studies attest to how intersecting and overlapping social categories of difference work to position individuals at increased risk of exclusion, marginalization, erasure, discrimination, violence, and stigmatizing social differences (or Othering) (Pellow, 2016). Resting on four pillars, critical EJ draws attention to intersectionality, multiscalarity, horizontality (anarchism), and indispensability (Murphy et al., 2021). These pillars constitute a commitment to understanding the social and geopolitical dimensions of environmental (in)justice, with emphasis on how IWT prevention has the potential to both alleviate or exacerbate preexisting environmental inequities. Critical EJ refocuses the conception of human–environment relationships by paying attention to individuals and scales through an awareness of intersecting modes of difference.

Critical EJ allows for assessing the intersecting modes of difference that make an individual more likely to engage in IWT and be affected by IWT interventions. For instance, a common wildlife crime intervention is increased militarized security or policing, which has the potential to further marginalize communities that were participating in IWT or other wildlife crimes for subsistence motives (e.g., Lynch and Turner, 2022;

Peterson et al., 2017). Through this perspective, critical EJ can lend itself to the evaluation of IWT study and intervention in ways that account for the varied motivations for why a person chooses to engage in the industry and to develop solutions that are reflective of the spatiotemporal and identify dynamics that undergird conservation crimes. The integration of EJ to IWT and other conservation crimes has faltered, and perhaps the reason for its limited uptake is how we consider when justice for biodiversity can take precedence over justice for communities (see Davies, 2014). For example, expanding protected areas may be a massive success for species protection. Still, it could undermine local communities if they are denied access to natural resources or are displaced. Integrating EJ principles within criminology has proven successful throughout the green and critical criminology literature, such as through studies evaluating the siting of correctional institutions (Opsal et al., 2022; Bradshaw, 2019); murders of environmental defenders (Hasler et al., 2020; Lynch et al., 2018); and victims of environmental crimes (Natali et al., 2023; Hall, 2016), among others. In symmetry with conservation criminology, critical EJ makes it feasible to mitigate or adapt to global events and their impacts across varied groups of people and geopolitical contexts (Gore, 2011, p. 659).

From a conservation criminology perspective, a critical EJ analysis of IWT aids in understanding the victimology of IWT offenders, given that environmental harms disproportionately impact many offenders from underprivileged social backgrounds (see Wolf, 2011). In countries with high biodiversity and social inequality, IWT motivators are often influenced by the local socio-economic characteristics (Regueira and Bernard, 2012). Dynamics related to conservation-induced social disparities, such as dispossession (e.g., Gurung, 2023; Hoefle, 2020) or criminalization of traditional hunting or foraging practices (Molnár et al., 2023; Snook et al., 2020) are dynamics that are also correlated to environmental injustices such as resource extraction (Dunlap, 2022; Youdelis et al., 2021) or food insecurity (Safari et al., 2022; Kamat, 2014). Within the mix of IWT, we see how anti-IWT measures and some conservation measures result in the persecution of already marginalized communities despite their limited authority within the IWT industry. Understanding IWT from a critical EJ perspective requires us to reorient how we view struggles of race, class, and gender in their grounded socio-political and socio-ecological contexts. In the proceeding section, I examine IWT through a critical environmental justice lens and organize the section according to the four pillars of critical EJ:

- I. Attention to social categories of difference in (re)producing environmental injustice
- II. The role of the state in perpetuating environmental racism
- III. The spatial and temporal dynamics of environmental injustice
- IV. Identifying and countering indispensability

In doing so, I show how critical EJ framework has much to offer to the unique challenges posed by IWT. Applying a critical EJ lens can allow scholars and practitioners to better account for the intimacies between sociocultural, geopolitical, and environmental factors shaping IWT and demonstrate overlooked forms of

(in)justice related to the IWT. While I illuminate how IWT prevention strategies have integrated justice principles, I deepen the conversation by engaging with the critical EJ literature and its capacity to expand our understanding of IWT and conservation justice. By considering the pillars of critical EJ, my analysis reveals the potential for IWT solutions to support an agenda of justice while supporting biodiversity protection.

3 Critical EJ applications and principles for IWT

3.1 Pillar 1: Attention to social categories of difference in (re)producing environmental injustice

Today, much of conservation's application and use of intersecting social categories comes from the Black feminist theory of intersectionality (e.g., Ruano-Chamorro et al., 2024; Pandya, 2023; Lau, 2020). The deviation of intersectionality from Black feminism, and specifically the theory's uptake in non-Black feminist disciplines, has often resulted in a narrow deployment of the theory into a strict gender/race binary (Nash, 2011). In this regard, the first pillar of critical EJ challenges us to focus beyond multiple forms of inequality and question the degree of emphasis one should place on one or more social categories of difference (Pellow, 2016). EJ and IWT scholars often focus only on singular forms of inequality rather than how multiple systems of identity and inequality overlap (e.g., Olunusi, 2024; Massé et al., 2021). Here, we understand the social interventions determining whether a person is more likely to participate in IWT and receive disproportionate harm from conservation interventions such as through the expansion of protected areas (Mahalwal and Kabra, 2023; Bathija and Sylvander, 2023) or increased conservation security efforts (Millner et al., 2024; Massé and Lunstrum, 2016). This facilitates our understanding of the intersectional dynamics of multiple social differences that (re)produce environmental injustice and enable IWT participation.

These dynamics in IWT policies and interventions also tend to perpetuate existing inequalities. Indeed, Indigenous peoples' environmental rights have often been criminalized or challenged by Western environmental justice perspectives (Nurse, 2020). Critical EJ avenues thus force conservation practitioners to reckon with the degree of flexibility of legal wildlife use and trade per the rights of Indigenous peoples and local communities. Expanding the categories of differences between IWT offenders, victims, and associates allows for a more comprehensive view of the intersectional processes that (re)produce and maintain oppression. van Uhm (2020) notes the geopolitical and socioeconomic factors that facilitate IWT asymmetries, where powerful Western actors exploit poverty and inequality to encourage the IWT. Indeed, the people most vulnerable to the social and ecological ramifications of the illegal wildlife trade are most likely to be prosecuted for these crimes. For instance, Paudel et al. (2019) found that, of the individuals incarcerated for IWT in Nepal, 56% were poor, and 75% were from Indigenous communities.

Racialized enforcement dynamics and recognition of these biases are necessary to consider if enforcement will be used equitably. Thus, a partial component of understanding the critical EJ dimensions of the IWT is understanding the mechanisms of IWT, through both engagement and enforcement, that take advantage of discriminatory social conditions. Many IWT laws and policies lack coordination across sectors, such as between wildlife conservation and rural development, whereby sectors lack continuity (Osorio and Bernaz, 2024). Ensuring consistency will aid in modes of enforcement that are accessible and just, as well as increase compliance with policies (Osorio and Bernaz, 2024).

Here, we must understand the way that anti-IWT policies and practices reproduce inequalities based on the social identities of Indigenous and local communities. These socio-economic implications of environmental injustice and IWT prevention require a commitment to valuing socio-cultural livelihoods (see Peterson, 2015). The matrix of social identities that individuals involved in IWT possess is often exacerbated by the environmental injustices that they face, such as having to live in proximity to dangerous predators (Doubleday and Adams, 2020; Chowdhurym et al., 2016); rights violations (Mujetahid et al., 2023; Ndoinyo, 2021); or conservation-induced displacement (Kokunda et al., 2023; Shahabuddin and Bhamidipati, 2014), among others. For example, women mangrove harvesters receive limited recognition as stakeholders in environmental governance as they are denied the right to practice their traditional livelihoods, which are a result of broader systemic issues of patriarchy, imperialism, and neo-liberalism (Cormier-Salem, 2017). Within the context of IWT, the expansiveness of environmental injustice reverberates through socio-systemic processes that marginalize those most at risk in society and position them to engage in illicit industries such as the IWT.

3.2 Pillar 2: The role of the state in perpetuating environmental racism

The state, particularly in conservation interest areas, has a considerable geopolitical and social influence on adjacent communities (e.g., LaRocco, 2024; Ramutsindela, 2017; Peluso, 1993). The state's role in furthering divisions along social categories of difference (Marx, 1996) is reflected within protected areas and other areas of conservation interest (Moulton, 2024; Loperena, 2016; Kepe, 2009). Environmental racism is a form of structural violence where the systems creating, perpetuating, and allowing environmental harm are also bolstered and supporting white supremacy (Sample, 2020). The perpetuation of environmental racism within areas of conservation interest significantly impacts the success of IWT interventions and individuals' categorization within the IWT industry. Understanding these complexities can aid in identifying more targeted and race-aware approaches to IWT prevention by delineating how the state (re)produces the conditions that allow for environmental racism to ensue.

Drawing upon preexisting biases related to local and Indigenous peoples' social identities, environmental racism aids in the creation of a conservation enemy, thus justifying the use of violence as a conservation strategy (e.g., Day et al., 2023; Duffy, 2016). This dual

process of criminalization and dehumanization aids in the reproduction of marginalizing social systems that force communities to participate in the IWT in the first place. The state plays a pivotal role in combining racial ideology and anti-environmental rhetoric (Carrillo, 2022), processes that perpetuate environmental racism within the conservation sector. Environmental racism in conservation indicates that some conservation acts distribute harms and benefits in ways that validate racial dynamics (Torres, 1992, p. 840). The linkages between environmental harms and environmental racism are sensitive to the racial orderings produced by the state and the perceived acceptability of anti-IWT or conservation policies. Environmental harms, such as through retaliatory illegal wildlife hunting, therefore, will continue to increase as the legitimacy of conservation policies declines (Witter, 2021). This relationship is shaped by the cultural, political, and socioeconomic aspects of local communities (van Uhm and Moreto, 2018) and their perception of the justness of conservation policies.

Furthermore, the state also directly influences the accessibility of the legal wildlife trade. This lack of accessibility to legal markets thus makes it easier for people to engage in IWT and be at further risk of persecution for these illicit activities. Although there is considerable critique of the legal wildlife trade as an IWT prevention strategy due to the difficulty of LWT regulation enforcement and corruption (Rizzolo, 2021), the legal wildlife trade is also a livelihood potential for many local communities (Obasi and Vivan, 2016). Indeed, mischaracterizing IWT threats can cast assumptions that a species' use or legal trade harms wild populations when that might not be the case (Challender et al., 2021). The blanket characterization of the wildlife trade thereby threatens to continue the global legacies of Western ideologies of wildlife use, with some arguing that a ban on all wildlife trade may further exacerbate localized inequalities (e.g., Zhu and Zhu, 2024). Indeed, altering consumer behavior is difficult to achieve, with interventions having adverse consequences if they fail to address systemic, cultural, and environmental drivers (Thomas-Walters et al., 2020). Curbing the legal and illegal wildlife trade requires understanding the historical and systemic roots of biases related to people's relationships with the environment.

To responsibly address environmental racism in IWT policies and interventions, an equity lens must be prominent and guide implementation (Bullard, 2019, p. 241). Equity, in this case, involves merging the interests of marginalized communities into mainstream IWT policy and intervention (Willard, 1992). Vu (2023) argues that anti-IWT campaigns can overlook positive cultural attributes related to non-Western environmental relations and instead resort to negative perceptions of non-Western consumers guided by racial biases. The use of problematic historical stereotypes in some anti-IWT campaigns, therefore, aids in reproducing and reinforcing the stereotypes (Marguiles et al., 2019) in ways that perpetuate environmental racism. For instance, Asian consumers are typically the target for IWT demand reduction, despite the consumption rates of illegal wildlife products in North America and Europe and those continents' roles in IWT transit. This also involves creating legal cooperation between countries to better manage the legal trade of wildlife (e.g., Jiao

et al., 2021). Acknowledging and addressing environmental racism in the IWT requires constant negotiation with the state and its social and environmental governance structure.

3.3 Pillar 3: The spatial and temporal dynamics of environmental injustice

With the rise of environmental conflicts, the contest of unjust political and scientific structures and practices is infiltrating broader spatial and symbolic spaces (Temper et al., 2015). Specifically, communities subject to environmental injustice are also shaped by historical trajectories of oppression, colonialism, and disempowerment, shaped by evolving geographies (see Karmakar, 2023). Inequalities can form and operate simultaneously in the same location (Ahmed and Eklund, 2021), which can aid in creating the conditions necessary for environmental injustice and IWT participation. These patterns are illuminated through the processes that have facilitated the global expansion of IWT, which are predicated on extractive legacies of injustice and affirmation of violent, militarized state power (see Marguiles et al., 2023). Attention to the spatiotemporal dynamics of environmental injustice, as seen through IWT, requires a multiscale consideration of how environmental (in)justice and space are co-constituted (Ducre, 2018; Walker, 2009).

The creation of conservation space, such as through protected areas, has also served as a site of creation for environmental injustice at the expense of biodiversity and local communities (Dominguez and Luoma, 2020). For instance, the legal frameworks of the US *Endangered Species Act* (ESA) and the Canadian *Species at Risk Act* (SARA) infringe on the environmental rights of Native American and First Nation tribal lands partly because of the distribution of benefits and burdens (Olive and Rabe, 2016). With the expansion of the global IWT market, dynamics of power that are highly sensitive to global-local geographies are introduced. Liew et al. (2021) cite the economic advantage of wealth importers contributing to their control over poor exporting nations and territories, drawing connections between IWT and international wealth inequality. In conjunction with geographic characteristics and biodiversity distribution, Ni et al. (2022) argue that these socioeconomic disparities may be the reason for spatial variations in wildlife crime patterns. These variations require regional and group-specific prevention strategies (Ni et al., 2022). The metrics of vulnerability that shape environmental (in)justice and the conditions where these vulnerabilities arise can aid in understanding how IWT is sensitive to and permeates the expansion of IWT globally.

Broadening understanding of IWT geographies, which more adequately accounts for social difference and the spatiotemporal mechanisms contributing to environmental (in)justice, can allow for a deeper integration of critical EJ in IWT prevention. IWT is a global issue, and some of the shortcomings related to its prevention's long-term implementation can be linked to a lack of congruency between IWT policy and local communities' multifaceted interests. The cultivation of critical EJ geographies for IWT here borrows from Black geographies, whereby the production of space and the assessment of violence are shaped by the interconnections of race, domination practices, and geography (McKittrick, 2011). Within

IWT, this process translates to the connections of social differences (i.e., race, economic status, gender), domination practices, geography, and human-environment relationships that dictate the social spatiotemporal impacts of IWT. Indigenous geographies, too, offer an understanding that breaks away from the conflation of Indigenous and local by rooting the work in modern and future politics, which recognize the continuation of settler colonialism in the present day (de Leeuw and Hunt, 2018). Drawing parallels between histories of colonial extraction and juxtaposing those histories with the modern expansion of IWT can allow for a more critical integration of justice into IWT prevention and study. These dynamics of affirming the social, cultural, and historical geographies have been achieved through scholars' pursuit of work that (re)affirms concepts of embodiment (Gay-Antaki, 2023; Seamon, 2013); activism (Apostolopoulou et al., 2022; Pulido and De Lara, 2018); and human-environment relationships (Wolverton et al., 2023; Brown et al., 2019), to facilitate a grounded practice of addressing socio-spatial and temporal dynamics of environmental inequality.

3.4 Pillar 4: Identifying and countering indispensability

Indispensability involves grappling with how entire populations are deemed expendable and what strategies these populations use to resist. Metrics of indispensability within critical EJ scholarship are drawn along the perceived expendability of marginalized social identities, which aim to justify a group's exposure to environmental harms (e.g., Privitera et al., 2024; Rice et al., 2022). Expendability is thus intimately rooted in the principles that guide environmental racism (Kolers, 2024). Within conservation, the expendability of local and Indigenous populations is related to the justification of violence as a conservation strategy (de Jong and Butt, 2023). Specifically, the processes that make communities expendable also make them invisible (e.g., Rubis and Theriault, 2020; Massé, 2019; Andersson et al., 2017), ultimately increasing a community's risk of environmental harm and IWT engagement. Techniques to counter IWT, particularly aligned with the dynamics of conservation security, is the most notable space wherein indispensability is visible. The use of enforcement-heavy or militarized security as an IWT prevention measure, such as through the use of drones (Sauls et al., 2023; Sanbrook, 2015) or heightened policing (Mushonga, 2021; Chaudhuri, 2013), can undermine conservation efforts while furthering local communities' social expendability.

The politics of recognition has become a necessary component of environmental justice within conservation policy and practice (Martin et al., 2013). Attention to avenues of recognition justice, which requires interventions to meet standards that fairly consider and represent the cultures, values, and lived experiences of all affected parties (Whyte, 2011), involves framing conservation interventions within the context of histories, communities, and ecosystems influenced by broader social and political processes (Asiyanbi and Massarella, 2020). Positioning conservation within this frame allows for an understanding of how social conditions can enable or serve to remedy environmental harm and conflict (Lunstrum et al., 2023). The conditions that make a community indispensable to IWT can aid in dismantling oppressive

institutions by co-creating forms of research and praxis. The process of co-creation involves bringing together affected parties, including people who commit IWT offenses and community members, to foster collaboration that addresses the synergies and differentials related to power, privilege, knowledge, and resource access which have the potential to undermine IWT interventions if they are not addressed (Jolles et al., 2022). Critical EJ concepts of indispensability thus are premised on a practice that brings those from the “margins to center” (Hooks, 2000) by grounding diverse lived experiences within conservation governance and IWT prevention.

4 A framework for applying critical environmental justice by IWT practitioners

I propose a framework for IWT practitioners to foreground critical EJ. This framework builds upon Pellow (2016) and works to reject the boundaries of what justice *should* look like. This framework emphasizes what environmental justice *could* look like when emboldened by the lived realities and experiences of the affected communities through recognition of our differences and symmetries. EJ sits at a crossroads wherein the spillover of research into praxis and advocacy is evolving (Sze and London, 2008). IWT interventions, in light of an expansion of justice within the conservation sector, are positioned to answer the call by critical EJ scholars and conservation practitioners to pursue models rooted in the interconnected futures of biodiversity, local communities, and Indigenous peoples. Integrating critical EJ in IWT policies and interventions requires a commitment to multiscale justice, whereby the systems and structures that permit social inequality and IWT participation are challenged.

Importantly, Indigenous peoples and local communities can only determine the contours of what is truly a just IWT or critical EJ intervention. As IWT scholars and practitioners, we are challenged to consider how IWT solutions can be positioned to safeguard Indigenous and local peoples' livelihoods while also facilitating processes that aid in restoring traditional models of EJ (Rodriguez, 2022). Reorienting our thinking towards IWT intervention that recognizes local communities and Indigenous peoples' indispensability to conservation efforts involves an account of the histories, processes, and relationships that make specific communities expendable. Recognition also involves a commitment to reducing socioecological harm (Hübschle and Marguiles, 2024), whereby IWT researchers are tasked with cultivating meaningful collaborations and expanding definitions of harm. Guibrunet et al. (2021) remind us that just because communities are engaged does not mean that the interventions are just if communities' value systems are not incorporated within conservation governance. Committing to a mode of justice that builds upon and celebrates the inherent value of communities is necessary for long-term, sustainable, and equitable IWT solutions. This process involves going beyond the boundaries of environmental justice and instead embracing the integrative nature of environmentally just solutions (Sze and London, 2008) while still working towards addressing the sources and impacts of IWT.

Critical EJ application within IWT thus begins with a commitment to recognizing and minimizing harm. Environmental harms that stem from IWT, as perpetuated against wildlife and communities, threaten to absolve any conversation of justice. Here, conceptions of environmental harm, as shaped by environmental values and ecological sciences, arise (see White, 2008). The effort here lies within IWT interventions grounded in the realities of the individuals who are most likely to engage in IWT out of need *and* are most likely to harbor a disproportionate degree of environmental harm. A more fluid integration of justice into IWT prevention also necessitates respect for Indigenous sovereignty, right to self-determination, and consent (Dominguez and Luoma, 2020). To begin taking steps toward the weaving of critical EJ and IWT intervention, you must challenge yourself, your research teams, and your collaborators to pay attention to the multiple systems of oppression and axes of social difference that encompass your study system. Which systems are/are not being accounted for? Why are they absent? What steps can be taken to bring these systems forward?

5 Discussion

IWT is an arena that is ripe for a critical EJ intervention. Justice, particularly regarding anti-IWT interventions, necessitates a commitment to political representation that reflects social and environmental justice (see Arroyo-Quiroz et al., 2022). Grounding IWT interventions in local communities' lived realities without sacrificing our unique identities as IWT scholars and practitioners can provide the tools to uncover alternative and potentially transformative understandings of just intervention (Massarella et al., 2020). Critical EJ as a framework for IWT prevention thus requires deliberate engagement with transformative processes by imagining, creating, and working towards alternative conservation futures (see Moore and Molkoreit, 2020). As such, I urge IWT scholars and practitioners to delve deeper into collaborations, studies, and interventions that serve as places of radical thinking and justice (Gutierrez et al., 2021). In this, I ask to what extent critical EJ may enhance IWT interventions in cultivating a conservation future cognizant of care, relationships, and empowerment while simultaneously dismantling global oppressive forces.

This article serves as a starting point for integrating a critical EJ perspective into IWT intervention and study. Pursuing EJ in IWT can only be achieved if we broaden our scope of what it means to be EJ researchers. Here, critical EJ challenges us to examine how we can integrate the framework into our field of study and practice and how we show up within our own lives and communities. Princeton professor Ruha Benjamin (2024) encourages her readers to think through the creation of a world in which everyone can thrive, for “radical imagination can inspire us to push beyond the constraints of what we think, and are told, is politically possible” (p. 22). Thinking and creating anti-IWT futures require a reorientation towards justice and care for wildlife, communities, and each other. To tackle the IWT, we must explore alternatives and pursue justice that reflects our vision of the future.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

AG: Conceptualization, Writing – original draft, Writing – review & editing.

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EDITED BY

Meredith L. Gore,
University of Maryland, College Park,
United States

REVIEWED BY

Benjamin Michael Marshall,
Suranaree University of Technology, Thailand
Samantha S. Sithole,
Leadership for Conservation in Africa,
South Africa

*CORRESPONDENCE

Michelle Anagnostou

✉ michelle.anagnostou@biology.ox.ac.uk

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Global youth as catalysts for legal and sustainable wildlife trade solutions

Michelle Anagnostou^{1*}, Celine Boon Yuan Ng², Robin Cepeda³,
Jessica Grace Huiyi Lee⁴, Adrian Hock Beng Loo⁵,
Peng Xiong Keith Ng⁵, Keanu Sitjar⁶, Hui Min Steffi Tan²,
Yong Jen Tang⁷ and Wai Kit Ting⁴

¹Department of Biology, University of Oxford, Oxford, United Kingdom, ²CITES Global Youth Network, Singapore, Singapore, ³Ministry of Environment and Natural Resources of the Dominican Republic, Santo Domingo, Dominican Republic, ⁴Mandai Nature, Singapore, Singapore, ⁵Department of Geography, National University of Singapore, Singapore, Singapore, ⁶Haribon Foundation, Quezon City, Philippines, ⁷Conservation Science, S.E.A. Aquarium, Resorts World at Sentosa, Singapore, Singapore

Despite gaining traction in international forums, such as in global climate action spheres, the potential of youth in contributing to a legal and sustainable international wildlife trade remains under-tapped, overlooked and underexplored. This is an emerging topic of discussion, as Parties to the Convention on International Trade in Endangered Species (CITES) were first encouraged to explore opportunities to engage youth during the seventeenth meeting of the Conference of the Parties in 2016. In April 2024, the first meeting of the CITES Global Youth Network was held in Singapore, where concrete actions were collaboratively identified by youth from around the world. This paper aims to answer the following question: how may youth contribute to achieving the goals of the CITES Strategic Vision by 2030? As a first step in answering this question, this community case study collates the diverse voices of members of the CITES Global Youth Network. Using a backcasting perspective, and the CITES Strategic Vision as our desired future by 2030, we outline how youth may contribute to achieving the Vision, and offer ideas of how youth can be supported. We argue that youth are underrepresented voices in wildlife trade decision-making, and that their deeper and more meaningful engagement in CITES processes has significant potential to improve outcomes for a legal and sustainable wildlife trade in the long-term and fundamental to achieving intergenerational equity as envisioned by the Sustainable Development Goals.

KEYWORDS

biodiversity, global governance, illegal wildlife trade, sustainability, sustainable development, youth

Introduction

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement that aims to ensure that the trade in wild animals and plants is not harmful to their survival. Established in 1975, CITES has grown to a membership of 185 Parties and provides a framework for regulating the trade of over 40,000 species. The Convention remains critically important, with recent reports indicating that illegal wildlife trade threatens over 4,000 species and occurs in at least 162 countries (UNODC, 2024). Of the 4,000 trafficked species, an estimated 3,250 are listed in the CITES Appendices (UNODC, 2024). By setting wildlife permitting and management guidelines and encouraging global cooperation, CITES safeguards endangered species from overexploitation while promoting sustainable trade practices that benefit biodiversity and local economies. There are massive challenges to achieving the goals of CITES, as it requires balancing the protection of wildlife with the demands of global trade, economic development, diverging cultural values, and sometimes organised crime involvement in CITES noncompliance.

Power imbalances in broader global governance are also prevalent in the realms of conservation and wildlife trade governance, influencing decision-making processes, resource allocation, and the enforcement of regulations. Many marginalised voices are not adequately represented in wildlife trade decision-making, which affects the efficacy and fairness of these decisions. For example, CITES has been criticised as being structurally dominated by Parties and organisations that are “Western, wealthy, and urbanized” (t-Sas-Rolfes et al., 2024). One type of marginalised voice is that of youth. Youth are thought to be essential for achieving sustainability goals, as they are creative, optimistic, dynamic, and innovative (including technologically) (Ekka et al., 2022). Youth-driven initiatives are a powerful force for a greener future. Youth can be effective agents of change for spreading awareness of complex sustainability and justice issues, and for mobilising communities (Kumar, 2023). Actively involving youth in sustainability efforts may instill a sense of responsibility and leadership in young individuals (Kumar, 2023). Challenges to youth involvement include a lack of: comprehensive education; resources and funding; representation and inclusion; support and mentorship; and political and policy support (Kumar, 2023). As the generation that will bear the long-term consequences of today’s actions, finding ways to meaningfully involve youth in wildlife trade decision-making will help ensure that efforts are forward-looking and inclusive of future needs.

In the field of future-oriented studies, forecasting is a commonly used approach. However, forecasting predicts *likely* futures based on dominant past and existing trends. This means that it uses trends which may be part of the problem, and therefore insufficient in terms of the level of disruption required to achieve a desired scenario. Backcasting, on the other hand, first identifies *desirable* futures and then works backwards to determine the feasibility of that future and the steps required to reach it. Backcasting is valuable for studying ways to overcome long-term complex sustainability issues. According to seminal work by Dreborg (1996), backcasting is

favorable when: (1) the problem is complex, affecting many sectors and levels of society; (2) there is a need for major change; (3) dominant trends are part of the problem; (4) the problem is largely a matter of externalities; and (5) the time horizon is long enough to allow considerable scope for deliberate choice. Therefore, backcasting is a useful approach to understanding a future with a legal and sustainable international wildlife trade.

Context

CITES Parties were first encouraged to explore opportunities to engage youth during the seventeenth meeting of the Conference of the Parties in 2016 (see Conf. 17.5 Rev. CoP18 on Youth Engagemen; CITES, 2016). Parties and the CITES Secretariat were invited to work with universities, youth groups, and other relevant associations and organisations, to create educated, engaged, incentivised, and empowered youth that can inform CITES decision-making processes. Parties and observer organisations were also invited to include youth delegates on official delegations and provide learning opportunities at CITES meetings. At the 77th meeting of the CITES Standing Committee in Geneva, Switzerland, in November 2023, the Committee supported Singapore’s efforts in establishing the CITES Global Youth Network (CGYN). In February 2024, CITES sent a Notification to the Parties concerning the Establishment of the CITES Global Youth Network, published at the request of Singapore. Parties and observers were encouraged to nominate youths affiliated with their organisations to attend the CITES Youth Leadership Programme 2024.

Key programmatic elements

From April 22 to 25, 2024, the CITES Global Youth Network held its inaugural Youth Leadership Programme (CYLP) in Singapore. Forty-one youths between the ages of 18 to 30 attended the symposium in person, traveling from 31 unique countries to participate and help shape the future of the Network (see Table 1; Figure 1). External donor funding enabled in-person representation from low- and middle-income countries. The Programme established diverse sub-groups within the broader Network during the four-day in-person programme to take the lead on priority actions under each of these pillars. The five pillars are: Research and Innovation, Governance, Communications, Education and Public Awareness (CEPA), Networking and Collaboration, and Capacity Building. The Research & Innovation team (i.e., the authorship team) co-developed this study through in-person and virtual brainstorming and discussion sessions.

The programme included presentations from CITES leaders, training on a mock Conference of the Parties (CoP), field trips to the Centre for Wildlife Forensics and Centre for Wildlife Rehabilitation, an illegal wildlife trade “Amazing Race” at the Singapore Zoo, a mock CoP, and multiple collaborative sessions dedicated to facilitated discussions and reflections. CYLP provided multiple opportunities

TABLE 1 List of countries represented by youth at the 2024 CITES Youth Leadership Programme in Singapore.

Name of Member State	Number of Participants
Australia	1
Austria	1
Bahrain	1
Bolivia (Plurinational State of)	1
Burkina Faso	1
Cambodia	1
Canada	1
China	1
Costa Rica	1
Cuba	1
Denmark	2
Dominican Republic	1
India	2
Italy	1
Japan	1
Kenya	2
Lao People's Democratic Republic	1
Malaysia	2
Morocco	1
Philippines	2
Rwanda	1
Singapore	1
South Africa	2
Sri Lanka	1
Thailand	2
Togo	1
Tonga	2
Uganda	1
United States of America	1
Zambia	3
Zimbabwe	1

for youth to connect, collaborate, and collectively shape the Network's mission, vision, and strategic roadmap across the five pillars. Youth were divided into four groups, each with multiple regional representatives to cultivate the sharing of diverse perspectives. Each group had a facilitator to foster active participation and offer constructive feedback, and all ideas were noted down by independent scribes. A final report was prepared based on the points discussed throughout CYLP, which was reviewed and approved by CGYN advisors and members.

A key feature of CGYN is the composition of the youth who were already working in CITES Management Authorities upon joining, or in related vocations that address wildlife trade legality and sustainability, such as regulatory, enforcement, research, education/awareness, or policy-related professions. Since its inception, there has been a close working relationship between CGYN and the CITES Secretariat, CITES Management Authorities, and relevant non-governmental organisations. This cooperative approach maximises collective impact for sustainable wildlife trade by aligning joint efforts with CITES principles and resolutions. This paper sets a path not only for future leaders but also the current leaders to better understand the need for an equitable and shared future. Lastly, as a collective output by a team of youths, this paper exemplifies the promises of youth involvement and engagement in wildlife trade issues.

Engagement and empowerment of youth have been gaining traction in other international forums, such as YOUNGO, the official youth constituency of the United Nations Framework Convention on Climate Change (UNFCCC), and the Global Youth Biodiversity Network (GYBN), the official group for the Convention on Biological Diversity (CBD). However, the role that youth can play in supporting efforts to achieve a legal and sustainable international wildlife trade remains an under-discussed and understudied topic. This community case study seeks to address this knowledge gap. Specifically, this study uses a “backcasting” approach to outline the necessary steps for realising the CITES Strategic Vision by 2030, with a particular focus on the contributions of youth toward achieving this Vision. The key research question that this paper addresses is: how can youth contribute to achieving the goals of the CITES Strategic Vision by 2030? The future scenario we used for the present study was centered around the CITES Strategic Vision 2021–2030 (CITES, 2021), as it already has the support of CITES member states and global leaders in wildlife trade governance. We also highlight the challenges for youth empowerment in CITES processes, and the importance of overcoming the challenges to achieve intergenerational equity. As this study serves as an initial step in understanding the role of youth in achieving a legal and sustainable wildlife trade, we have developed actionable strategies to bridge the gap between the present and our desired outcome (i.e., the goals of the CITES Strategic Vision). However, while we recognize the importance of establishing time intervals for each milestone, this remains a crucial next step for future research.

Discussion

CITES' Vision Statement is: “By 2030, all international trade in wild fauna and flora is legal and sustainable, consistent with the long-term conservation of species, and thereby contributing to halting biodiversity loss, to ensuring its sustainable use, and to achieving the 2030 Agenda for Sustainable Development (CITES, 2021).” The CITES Strategic Vision 2021–2030 includes a number of goals, objectives, and indicators. The indicators in the Vision are the responsibility of CITES parties. However, CGYN has envisioned clear actionable objectives for youth to support achieving the goals

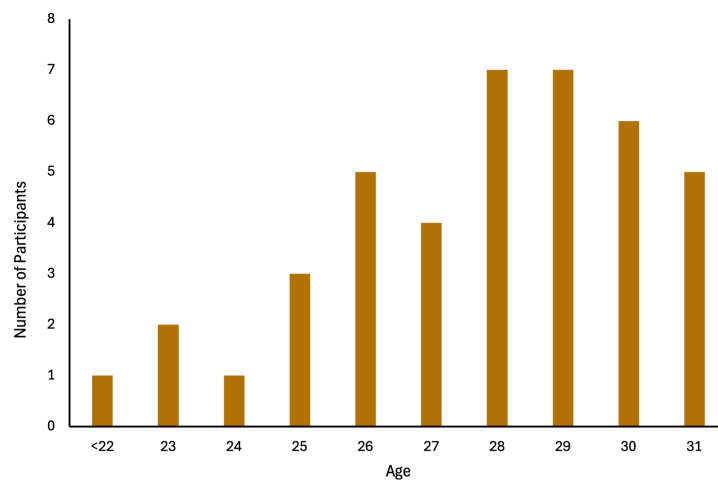


FIGURE 1
Ages of youth participants at the 2024 CITES Youth Leadership Programme in Singapore.

of the Vision. The results first outline the values of the Network and how they align with the CITES Strategic Vision, followed by outlining the various ways in which youth can contribute to legal and sustainable wildlife trade, using the Convention's strategic goals and objectives as a guiding framework. While the discussion

highlights ideas from current CGYN members, youth contributions to the goals of the CITES Strategic Vision extend far beyond the Network's membership. Young people worldwide can take on leadership roles in promoting a legal and sustainable wildlife trade (Figure 2).

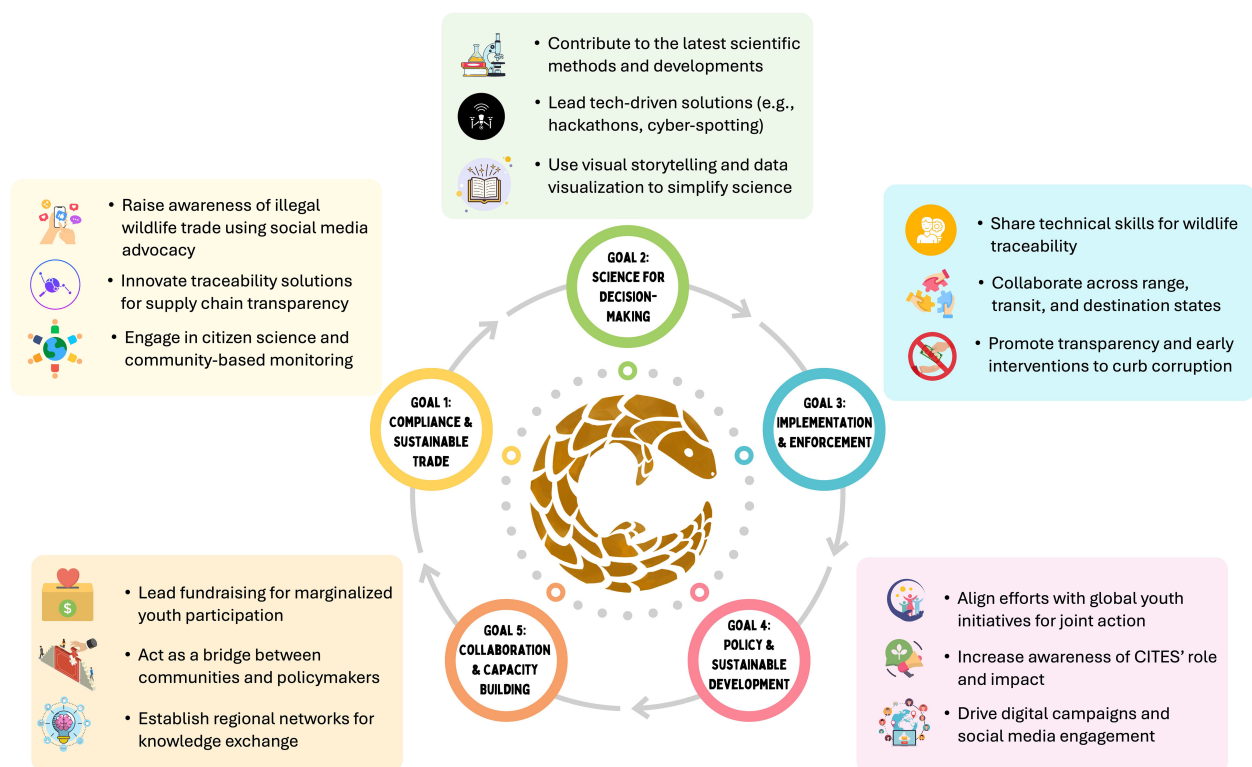


FIGURE 2
Visual Representation of youth contributions to the five pillars of the CITES Strategic Vision.

Goal 1: Trade in CITES-listed species is conducted in full compliance with the Convention in order to achieve their conservation and sustainable use.

To achieve Goal 1, in their roles across sectors of society, including public, private, non-governmental, and inter-governmental organisations, youth can support Parties in compliance with their obligations under the Convention through the adoption and implementation of appropriate legislation, policies, and procedures. Achieving compliance with the Convention necessitates that wildlife traders and users have a thorough understanding of relevant laws and policies. Engaging youth is widely recognised as a critical step in wildlife conservation (Sithole et al., 2024). However, many young people remain unaware that the illegal wildlife trade is occurring in their own countries or regions, and the vital role of CITES in combating it. This lack of awareness allows the issue to grow unchecked, especially as smaller, everyday seizures often go unreported or are deemed unnewsworthy. This in turn hinders youth capacities to innovate and drive meaningful change. CGYN can address this gap by educating and raising awareness about illegal wildlife trade at local, regional, and global levels, empowering youth to curb its growth. By fostering awareness, the Network has the potential to reduce demand for illegal wildlife products within a generation and inspire future leaders to champion sustainable trade practices.

Young people's digital literacy enhances their connectivity and amplifies the voices of youth from low- and middle-income countries, and/or historically marginalised communities, empowering them as credible advocates for policy change (McPherson, 2007). This capability can assist CITES Parties in advancing their agendas, leveraging social media for advocacy, and addressing misinformation about wildlife conservation and sustainable use. Youth-led innovation occurs when young people, "instigate potential solutions to a problem, often one that they have identified or defined themselves, and take responsibility for developing and implementing a solution" (Sebba et al., 2009). Youth can directly support supply chain transparency both by developing innovative solutions to traceability (see Goal 3) and by increasing consumer awareness. Youth can lead creative and innovative legal awareness and public education campaigns by sharing information about CITES-listed species, promoting their conservation, explaining how wildlife products are sourced, and advocating for sustainable fashion trends. Youth's mastery of social media and technology offers a transformative platform to inspire global action, rally support, and promote awareness in addressing wildlife trade issues. Social media campaigns led by youth have the potential to amplify voices, expose illegal activities, and educate the public on the importance of sustainable trade practices. For instance, social media platforms such as, Instagram and TikTok can be leveraged to create compelling narratives and visually engaging content that highlights the plight of CITES-listed species, fostering a sense of urgency and collective responsibility

among diverse audiences (PwC, 2023; GITOC, 2024). The active engagement, content sharing, and widespread adoption of social media by young users play a crucial role in driving an online platform's growth and viral success. Establishing a strong stance against wildlife exploitation can significantly enhance an online platform's ethical integrity. Social media shapes the formation of young people's identities (Pérez-Torres, 2024), and therefore in turn, may be a powerful tool to instill long-term values of wildlife protection among users, and set the tone for zero tolerance of wildlife exploitation.

Citizen science

Beyond awareness, public engagement in citizen science initiatives has proven to be a proactive approach to combating illegal wildlife trade. By harnessing the power of crowdsourced data, young volunteers can participate in passive surveillance efforts, reporting suspicious activities such as the sale of endangered species or products derived from them on digital marketplaces. A notable example is the use of mobile applications that allow users to upload geotagged photographs of suspected wildlife crimes, which are then analysed by experts to support law enforcement actions (Padma, 2022). While engaging in wildlife photography to document illegal trade is a commendable endeavour that can significantly contribute to conservation efforts, it is essential to recognize and address the personal risks involved. These risks include potential confrontations with traffickers, legal implications, and exposure to hazardous environments. Youth must ensure that their safety is not compromised prior to taking any action by themselves. Before embarking on any assignment, a risk assessment and thorough research is crucial, such as understanding the area, species involved, and the nature of the illegal activities to anticipate potential dangers. Additionally, there is a need to understand local laws and regulations related to wildlife trade and photography. This knowledge can prevent unintentional legal violations and inform them about their rights. Furthermore, ensuring anonymity and maintaining a well-structured safety plan is critical for wildlife photographers documenting illegal trade. Operating discreetly by blending into the environment, using inconspicuous equipment, and avoiding overt documentation in high-risk areas can minimize personal exposure. Additionally, safeguarding personal information, such as obscuring metadata from images and limiting identifiable online traces, reduces risks of retaliation. Collaboration with established conservation organizations such as TRAFFIC and WWF could help enhance security by providing legal and logistical support, ensuring that the evidence collected is properly handled and acted upon.

Additionally, youth must be aware of legal protections under international and national frameworks designed to safeguard young environmental defenders. The United Nations Convention on the Rights of the Child (CRC) recognizes the right of youth to participate in environmental advocacy while ensuring their safety from threats and retaliation (UNGA, 1989; UNEP, 2021). Similarly,

the Escazú Agreement, a regional treaty in Latin America and the Caribbean, establishes legal protections for environmental defenders, emphasizing access to justice and safety mechanisms (ECLAC, 2018). At the 16th meeting of the CoP of the CBD in Colombia (2024), discussions on strengthening protections for environmental defenders, including young conservationists, highlighted the urgent need for legal frameworks that ensure their safety in biodiversity activism (Ministry of Environment and Sustainable Development of Colombia, 2024). While not all countries have specific laws protecting young conservationists, organizations such as the Environmental Justice Foundation and Amnesty International also provide legal assistance, and publicly available risk assessment tools to support advocacy for environmental defenders. Youth can also benefit from initiatives such as the National Geographic Young Explorers program, which equips emerging conservationists with the skills and resources needed for fieldwork in challenging environments. Additionally, maintaining a structured safety protocol (e.g., emergency contacts with trusted individuals, regular check-ins, and contingency plans) enhances protection while reinforcing responsible investigative practices. These proactive measures, combined with legal awareness and institutional support, empower youth to contribute meaningfully to conservation while ensuring their security in the field.

Moreover, youth-driven innovation can extend to creating educational tools and community-based programs that align with CITES Goal 1. For instance, university-led hackathons focusing on wildlife conservation can generate novel solutions to address gaps in monitoring and enforcement. Partnerships between youth organisations and conservation bodies can also facilitate training programs, equipping young individuals with the skills needed to engage effectively in sustainable trade advocacy and policy development. Through initiatives that combine technology, community engagement, and policy advocacy, youth can drive progress toward ensuring trade in CITES-listed species is conducted in full compliance with the Convention, safeguarding their conservation and sustainable use.

Support needed

To be most effective in contributing to Goal 1, youth will need to be supported through gaining relevant knowledge and expertise on CITES regulations, including non-detriment findings (NDFs) and how they implicate trade and domestic contexts for wildlife trade law and policy. Indicators of this include that: youth are employed in CITES Management and Scientific Authorities and enforcement focal points; youth voices are heard regarding amendments to the Appendices that correctly reflect the conservation status and needs of species; and that youth are involved in multiple stages of efforts to improve the conservation status of CITES-listed specimens, develop national conservation actions, and support their sustainable use and promote cooperation in managing shared wildlife resources.

Goal 2: Parties' decisions are supported by the best available science and information

Goal 2 states that Parties' NDFs must be based on the best available scientific information and their determination of legal acquisition is based on the best available technical and legal information. Youth can support this objective when young staff are involved in the writing of NDFs that are submitted by Parties; and educated on legal acquisition findings as per their national regulatory framework, as recommended by Resolution Conf. 18.7 (Rev. CoP19). Young researchers can often contribute the latest methods and developments in their fields and an understanding of the perspectives of diverse communities due to the increasing internationalisation of research careers (Jørgensen et al., 2019). Goal 2 requires that Parties have sufficient information to make listing decisions that are reflective of species conservation needs. To this end, youth can conduct collaborative and interdisciplinary research, including leading and participating in population surveys or other analyses in exporting countries to better understand the population status of Appendix-I and -II species, including trends and impacts of trade and recovery efforts. Youth can actively contribute to scientific efforts by reporting wildlife populations and trade data, monitoring online marketplaces for illegal wildlife trade (i.e., "cyber spotters"), and tracking wildlife sightings, trafficking, and habitat disturbances. Empowering youth-driven innovation is key to advancing sustainability goals, while simultaneously building the skills and leadership capacities of young people to inspire and guide future generations (Bastien and Holmarsdottir, 2017). Youth can pilot and introduce new technologies for species monitoring and data collection. Hackathons for technology-related solutions for illegal and unsustainable wildlife trade may be valuable examples of harnessing youth capacities.

For youth engaged in documenting suspected illegal wildlife trade (such as on iNaturalist) and/or cyber-sleuthing efforts, prioritizing content-sharing protocols is essential to prevent misinformation and protect themselves from potential legal or digital threats. Ensuring that findings are reported through credible channels, using encrypted communication, and verifying authenticity before dissemination strengthens the impact of their work. While social media platforms play a powerful role in amplifying awareness, the ultimate goal is not merely virality but fostering meaningful action against illegal wildlife trade. Raising public consciousness must align with tangible efforts to safeguard biodiversity, reinforcing the urgency of combating trafficking networks and preserving ecological integrity. While cyber-sleuthing can enhance wildlife trade monitoring, it is crucial to ensure that efforts do not inadvertently make species more vulnerable to exploitation. Cyber spotters must work discreetly alongside ecologists and adhere to ethical wildlife photography practices to prevent unintentionally exposing species locations to poachers or traffickers. The principle of "do no harm" should guide all investigative efforts, prioritizing the protection of wildlife and social equity over publicizing findings (see Roe et al., 2020). By integrating ethical guidelines with conservation science, cyber-sleuths can contribute valuable intelligence while safeguarding the very species they aim to protect.

Advanced technologies

The integration of advanced technologies, such as artificial intelligence (AI) and machine learning (ML), further enhances the capacity to detect and disrupt illegal wildlife trade. Youth with coding and data science skills can contribute significantly to these efforts by developing or improving AI models that mine data from online platforms, identify wildlife trafficking networks, and classify illegal wildlife products. Recent advancements include the use of image recognition software to differentiate between legal and illegal wildlife goods, as well as predictive modelling to identify trafficking hotspots (Xu et al., 2019; Kulkarni and Di Minin, 2023; Zhang, 2024). Youth can contribute more efficiently by developing or enhancing these AI technologies, leveraging their expertise in coding, data science, and user-centered design to create tools that are not only precise but also accessible to a broader range of users. For instance, young technology enthusiasts can collaborate with conservation organisations to optimise image recognition algorithms for accuracy or to design user-friendly interfaces for reporting wildlife crimes. Initiatives like the AI Guardian of Endangered Species further highlight opportunities for youth to participate in the deployment and improvement of automated systems that screen vast amounts of online content, flagging potential violations for investigation by authorities (Zhang, 2024).

Information and resources sharing

Goal 2 also incorporates objectives that Parties will cooperate in sharing information and tools relevant to the implementation of CITES. Youth can be powerful vessels to break down political barriers to information sharing between Parties within CGYN

(see Figure 3). Countries are often restricted from sharing information due to political barriers, limiting opportunities for cooperation on illegal wildlife trade issues (Anagnostou, 2024). However, youth (depending on their roles) are often not bound by the same diplomatic restrictions and can freely exchange ideas, support, knowledge, and solutions. Through their international networking, online platforms, and collaborative initiatives, youth may leverage their unique positions to promote dialogue and understanding as a global community. Youth can establish networks of contacts across borders, including source, transit, and destination locations, and sectors to have cross-cutting, inclusive discussions and facilitate the creation of partnerships. Youth can develop channels for sharing information amongst each other that are relevant to the implementation of CITES, such as reports, scientific papers, shared databases, and data analysis/visualisation software. This paper is in itself a prime example of the above.

Communication, education, and public awareness

In addition, CGYN has identified Communication, Education, and Public Awareness (CEPA) as one of its main pillars for empowering youth to address wildlife trade challenges. CEPA is a widely recognised tool endorsed by international conservation frameworks, such as the Convention on Biological Diversity and the International Union for Conservation of Nature (IUCN), to bridge the gap between complex scientific data and actionable conservation strategies (Hesselink et al., 2007; Convention on Biological Diversity (CBD), 2022). Youth are uniquely positioned to leverage CEPA principles through innovative and adaptive approaches to science communication. Recent studies highlight

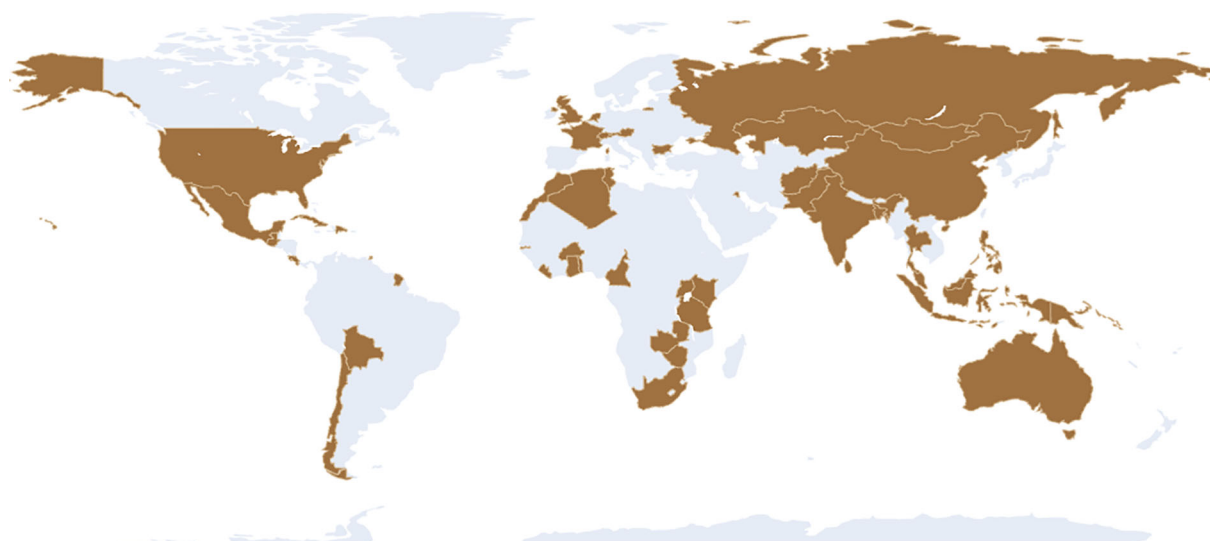


FIGURE 3
Geographic distribution of countries with youth delegates that have been formally nominated and invited to the 2025 CITES Global Youth Summit.

the importance of visual storytelling and data visualisation in making scientific information accessible and actionable. Youth can harness this potential by creating infographics, interactive dashboards, and multimedia content that distill critical conservation data into compelling formats.

Building youth capacity

Exposure to wildlife and protected areas through targeted ecotourism opportunities for youth is important to instill a balanced view of wildlife, especially with increasing urbanisation (Seddon and Khoja, 2003). In addition, formal education of wildlife and conservation in school and participation in environmental clubs are critical, including supporting access for girls (Kioko and Kiringe, 2010; Nadeson and Barton, 2014). Youth in wildlife conservation volunteering and educational programs can also share their knowledge with parents/older adults and contribute to community-wide change (Kaukonen, 2014). However, youth engaging in political activities for broader-scale social change may be more challenging (Rendell and Kantamaturapoj, 2021).

To be most effective in their contributions to Goal 2, youth could be supported through facilitating access to research opportunities, and capacity building of how to generate relevant data for NDFs, and relevant scientific data analysis software (e.g., NVivo; Geographic Information System (GIS); Open source intelligence (OSINT); crime analysis techniques). Research training opportunities can be provided by research institutions through specialized modules and certificate programs, or pursued independently by youth through self-driven learning initiatives. Institutions, such as universities, think tanks, non-governmental organisations, inter-governmental organisations, and public sector and enforcement agencies, can all be involved in providing credible, structured curricula online and in-person. However, access to these learning resources may be limited by affiliation and location. Therefore, a complimentary approach is to expand the development and use of freely accessible, remote, high-quality online resources recognised by leading organisations (e.g., self-paced virtual courses, live-streamed workshops, webinars, briefs, toolkits, and other digestible formats). Youth-led initiatives, such as CGYN and other networks, can bridge the gap between formal institutional guidance and self-motivated learning. Youth may benefit from workshops to learn data analysis and ecological modelling techniques, and participatory methods for social research on livelihoods, empowering young people to support decision-making with scientifically sound recommendations. In addition, creating mentorship opportunities within CITES Authorities and related institutions where experienced scientists can guide young people in conducting and presenting research to impact CITES decisions would be valuable. Youth could also be supported with guidance on understanding relevant political contexts and possible information-sharing barriers, and how to navigate them. Finally, youth could also be present at future CoPs and able to participate in side events where Parties present information and tools relevant to the implementation of CITES.

Goal 3: Parties (individually and collectively) have the tools, resources and capacity to effectively implement and enforce the Convention, contributing to the conservation, sustainable use and the reduction of illegal trade in CITES-listed wildlife species

Youth can help ensure that Parties have in place administrative procedures that are transparent, practical, coherent and user-friendly, and reduce unnecessary administrative burdens. Young staff in CITES Authorities could be trained to make use of the simplified procedures provided for in Resolution Conf. 12.3 (Rev. CoP19), and to use an electronic system for the issuance of permits. Youth with technical skills can share their skills with other youth around the world and develop innovative tools that would aid in the traceability of wildlife trade supply chains. For example, youth can be involved in the rapid detection of illegal wildlife online, and the development of mobile applications and online platforms where youth can anonymously report sightings of illegal wildlife trade, aiding enforcement agencies. Youth can also participate in community-based surveillance for illegal trade, such as through programs to train volunteers.

Youth could be presented with opportunities to attend training and capacity-building programmes, and to access information resources to implement CITES, including the making of non-detriment and legal acquisition findings, and issuance of permits and enforcement strategies. Additionally, CITES Authorities can facilitate these supports by providing internships or volunteer opportunities for youth interested in conservation enforcement, building capacity at the grassroots level. Sufficient resources are required at national and international levels to support these efforts. Youth can identify avenues to obtain funding that will advance their activities in alignment with the Convention. They can also be involved in organising fundraisers aimed at acquiring resources, such as anti-poaching patrol equipment. In addition, while changes to the legal system are likely to be in the hands of senior government officials, youth can play an advocacy role in ensuring parties recognise criminal offences relating to illegal trade in wildlife as serious crimes.

Objective 3.5 states that Parties should work collaboratively across range, transit and destination states to address entire illegal trade chains, including through strategies to reduce both the supply of and demand for illegal products. This is an area where CGYN has significant potential. Even in the Network's early stages, ideas are being exchanged, and collaborations are being established between youth across range, transit and destination states, to address entire illegal trade chains.

Transparency

Corruption is a commonly recognised driver of illegal and unsustainable wildlife trade globally (OECD, 2018). To achieve Goal

3, Parties are expected to take measures to prohibit, prevent, detect and sanction corruption. Engaging youth in integrity management, anti-corruption interventions, and proactive preventative action will likely lead to disruptive changes to global wildlife trade governance. Parties could actively engage in measures to prevent corruption, including early intervention with young staff to discourage corrupt behaviours from the outset. With guidance and support from trusted mentors, youth can also be advocates for greater transparency within their organisations. An awareness of potential risks and legal protections is crucial. Youth could be empowered to raise concerns in appropriate forums, such as ethics committees or secure anonymous reporting systems to protect privacy. Young staff could educate themselves on the organisation's policies, relevant laws, and best practices for transparency.

To ensure youth remain safe when confronting corruption, we recommend using encrypted digital reporting tools and secure platforms (e.g., Crimestoppers), and leveraging whistleblower hotlines from reputable organizations with strong security measures, including independent anti-corruption bodies. Sensitive information on illegal wildlife trade and corruption should only be shared with trusted entities known for their integrity. Additionally, we encourage advocating for systems and technologies that minimize opportunities for corruption and misconduct in wildlife trade decision-making. Building a support network with trusted colleagues, both locally and internationally, can provide added protection, especially in environments where corruption is deeply entrenched. In such cases, youth may also be able to engage international watchdogs to apply external pressure. Finally, conducting thorough risk assessments and developing mitigation strategies is essential for ensuring safety while taking action against corruption.

Goal 4: CITES policy development also contributes to and learns from international efforts to achieve sustainable development

In alignment with Goal 4, Parties could co-develop or otherwise support the capacity of young members of Indigenous and local communities to pursue sustainable livelihoods. CGYN members could seek to increase the number of CITES-listed species for which youth have designed/implemented relevant sustainable wildlife management policies. Youth that are cross-appointed or seconded to other multilateral youth initiatives, such as the Global Youth Biodiversity Network, can identify synergies, streamline efforts, avoid duplication, and find opportunities for joint action to achieve both the United Nations Sustainable Development Goals and the CITES Strategic Vision.

Furthermore, youth can lead efforts to raise global awareness of CITES' role, purpose, and achievements. An indicator of this is an increased number of applicants to join the Youth Network due to increased interest in CITES among youth from around the world. Youth can easily and comfortably share content and information,

and connect and engage on social media. As such, young leaders can spearhead communications efforts, including creating and encouraging the use of identified hashtags (e.g., #cites, #citescop19 #worldwildlifeday, etc.) on social media platforms. In this regard, young professionals may be assets as they will have a deeper understanding of trends in younger generations which could be a reason for an increase or reduction in trade demands.

Knowledge creation and dissemination

Youth can be heavily involved in producing scientific research, data collection, and innovation towards the Sustainable Development Goals which can help in the crafting of policies, including providing feedback on research and policy documents from a fresh perspective (Lim et al., 2017). In addition, CITES youth could seek to increase the number of events held by the Network independent of official CITES meetings. Youth could establish a communication platform to stay on top of events, documents, learning opportunities, presentations, and Notifications to the Parties issued by the CITES Secretariat that may have a bearing on achieving the goal of CITES. To best provide these contributions, youth could be supported through invited participation in policy consultations, including for multilateral agreements that are relevant to the Convention.

Goal 5: Delivery of the CITES strategic vision is improved through collaboration

Goal 5 requires that Parties and the Secretariat support and enhance existing cooperative partnerships to achieve their identified objectives. This can be achieved when youth involvement in an increasing number of intergovernmental and non-governmental organisations participate in and/or fund CITES workshops and other training and capacity-building activities where youth attendance is encouraged. This can be supported by youth-led fundraising, with guidance from the Secretariat, prioritising financial aid to youth from Indigenous and historically marginalised communities.

Fostering meaningful relationships

An additional measure of success is an increased number of cooperative actions taken by youth to prevent species from being unsustainably exploited through international trade. Youth involved in the Network and other informal connections could include alliances between CITES and other relevant international partners to advance CITES objective and mainstream conservation and sustainable use of biodiversity. This can start at the grassroots level, with youth serving as a vital, accessible link to communities,

helping countries engage with those living near wildlife or relying on CITES-listed species. CGYN can form regional youth chapters that work on regional conservation issues and share their work globally. There, lessons could be shared, ideas exchanged and blended, then tested and refined through ongoing improvement. CGYN will host regular webinars where youth and experts can discuss challenges, solutions, and share knowledge and resources to progress on CITES goals. Further, they can create a shared library of resources, studies, and success stories accessible to anyone working on CITES-related projects.

Through CGYN, young people can promote new and existing partnerships and collaborations, including participating in cross-sector projects such as linking the goals of CITES with other sectors such as green finance, ecotourism, or sustainable fashion, airlines, shipping companies, and logistics companies, etc. Parties and non-state organisations could develop youth activities that include CITES-related conservation and sustainable development elements. One key approach is for more countries and institutions to establish mentorship opportunities, communication platforms, and to bring youth in their delegations to official CITES meetings.

Challenges

While advocating for increased youth engagement, it is important to recognise the potential limitations of this approach. Youth-led innovation can be inhibited by negative attitudes towards youth, risk aversion, low tolerance for new and innovative ideas, resource constraints, and power dynamics, such as a reluctance to 'hand over' (Bastien and Holmarsdottir, 2017; Jørgensen et al., 2019). Additional challenges and concerns identified by youth during the CGYN brainstorming sessions include: resistance from senior policymakers to increasing youth participation; lack of institutionalised pathways for youth engagement; limited resources and/or lack of strategic foresight in developing youth capacity within organisations; underrepresentation of youth from countries with weaker CITES implementation frameworks; Parties not responding to notifications or calls for youth nominations; limited access to relevant education and training; perceptions of inexperience; tokenism; resource and funding constraints, especially with other CITES initiatives that require funding for immediate issues; cultural and generational barriers, and the digital divide (i.e., unequal access to digital technology). Another challenge is the retention and succession planning of staff within CITES authorities and related organisations operating in this field, creating a long-term gap in skilled and empowered personnel. While engaging youth is vital to achieving the goals outlined in the CITES Strategic Vision, the numerous challenges highlight the pressing need for external support and developing meaningful collaborations. It is important to find ways to overcome these challenges to facilitate the development of the next generation of conservation professionals across governmental and non-governmental sectors.

Shared values are crucial to international sustainability agendas, as they serve as the foundation for decision-making in pursuit of

goals, foster a sense of common purpose among diverse stakeholders, ensure that initiatives are culturally sensitive, and underpin long-term commitments. The values for the CITES Strategic Vision include "a shared commitment to fairness, impartiality, geographic and gender balance, and to transparency." CGYN's values align closely. The Network believes in equal opportunity regardless of youths' identifying factors. Decision-making processes aim to be clear, balanced, open, and collaborative, and conflicts of interest and personal biases and prejudices are to be minimised where possible. For example, gender is increasingly acknowledged as an essential consideration in the design of anti-illegal wildlife trade measures, yet it remains largely overlooked (Green et al., 2023). CGYN fosters diversity through collaboration and inclusivity across regions and genders, actively engaging with the global youth community to ensure every voice is heard and respected. Additional values that are embodied by CGYN include empowerment, optimism, and openness to innovation.

Intergenerational equity

The growing environmental consciousness of the 1990s corresponded to the reflection of intergenerational equity in international treaties (Bertram, 2023). Intergenerational equity and duties of justice are often expressed in terms of fairness to young people and future generations for their rights to healthy and sustainable environmental heritage to be protected (Summers and Smith, 2014). This concept is widely discussed in international policy, particularly in relation to the depletion of natural resources and biodiversity, the deterioration of environmental quality, and the heightened challenges of anthropogenic climate change. Young people may not only be beneficiaries of measures to achieve intergenerational equity, but also harbingers of it (Lim et al., 2017). Modes for collaborating with youth to address intergenerational issues in global sustainability initiatives may include: (1) participation by invitation only; (2) open application recruitment; (3) knowledge-sharing through early career bodies; (4) strategic decision making to secure intergenerational perspectives at highest levels; and (5) maintaining partnerships (Jørgensen et al., 2019). We advocate for further integration of all five modes in CITES processes.

Conclusions

As discussed, this journey will not be without its challenges. However, we outline that supporting youth in wildlife trade governance may facilitate a number of unique contributions to a legal and sustainable international wildlife trade, including clear pathways for driving awareness raising, cross-border collaboration, information sharing, and innovation. With intergenerational collaboration, and the proactive support and mentorship from wildlife trade policy leaders, youth will ensure they are not just recipients of intergenerational equity but leaders in its realization. Overall, it is evident that youth can play important and varied roles in achieving the CITES Strategic Vision by 2030. Future studies by

young researchers could include undertaking an analysis to identify knowledge and policy gaps, and where youths' assistance is needed to address them to support the implementation of the Convention.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

MA: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. CN: Writing – original draft, Writing – review & editing. RC: Writing – original draft, Writing – review & editing. JL: Writing – original draft, Writing – review & editing. AL: Writing – original draft, Writing – review & editing. PN: Writing – original draft, Writing – review & editing. KS: Writing – original draft, Writing – review & editing. HT: Writing – original draft, Writing – review & editing. YT: Writing – original draft, Writing – review & editing. WT: Writing – original draft, Writing – review & editing.

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Conflict of interest

Author YT was employed by S.E.A. Aquarium

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The author(s) declare that no Generative AI was used in the creation of this manuscript.

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EDITED BY

Nicholas King,
North-West University, South Africa

REVIEWED BY

Ines Arroyo-Quiroz,
National Autonomous University of Mexico,
Mexico

*CORRESPONDENCE

Jonathan E. Kolby
✉ KolbyJE@si.edu

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Implementation biases in wildlife trade regulation foster unscientific and inequitable intervention strategies

Jonathan E. Kolby* and Orion L. B. Goodman

Smithsonian's National Zoo & Conservation Biology Institute, Front Royal, VA, United States

International conservation initiatives such as international wildlife trade regulation are important for species conservation efforts, but many current implementation models lend themselves to an environment that promotes biased values and inequitable distribution of benefits and responsibilities. This Perspective article aims to highlight prevailing sentiments observed among the international conservation community that contribute to asymmetrical discourse, policy development, and enforcement. These biases can limit the positive biodiversity impacts of interventions, preventing them from accomplishing species or landscape conservation goals. They can also contribute to mistrust between stakeholders, therefore adversely affecting relationships that are crucial to maintaining biodiversity and ecosystem services. Additionally, interventions and policies can be shaped more by subjective judgments of value than by science. The regulation of foreign bushmeat in the United States and the discourse surrounding it demonstrates the presence of value judgments in conservation policy. It also demonstrates how these value judgments appear to supplant evidence-based policy development and promote a landscape of wildlife resource use where some species and usages are permitted and others are considered unacceptable. The ramifications of these inequities can be seen in protected area and species management strategies globally but are particularly prevalent in African and Asian regions, where militarization and shoot-to-kill policies are in place. We argue that fostering sustainable wildlife resource use is enormously complex and requires a scientific, evidence-based approach to develop and implement initiatives that are both fair and effective. These arguments are supported through the use of select quotations from notable public authorities.

KEYWORDS

bushmeat, environmental justice, equity, poaching, wildlife crime, zoonoses

Introduction

Regulating international wildlife trade is crucial to species conservation and maintaining public health security, but without a thoughtful and science-based approach the resulting regulatory frameworks can produce inequitable policies that perpetuate harmful strategies. Biased perspectives contribute to mistrust among stakeholders, inefficient or ineffective programming, and policy strategies with unintended negative overall impacts on human societies and ecosystems (United Nations, 2024). Examples of policy misdirection include purportedly simple solutions to complex conservation issues, such as excluding local communities from accessing resources in protected areas, fortifying private land to discourage unwanted wildlife harvest, and instituting trade bans supported by limited evidence. Furthermore, misperceptions about wildlife trade can stimulate biases and misinformation within institutions, causing them to conflate risks posed by the commercialization of wildlife in ways that may be counterproductive to its protection (Immigration and Customs Enforcement, 2024; Fed Agent, 2023).

Risk mitigation policies crafted to reduce harms are more likely to be successful when they are specifically designed to address the nexus of the most threatening factors (Challender et al., 2015; Sonter et al., 2018). In academic and political discourse on the wildlife trade, the harvest of wildlife is typically highlighted as a primary contributor to species extinction, yet additional factors contribute to species endangerment (t Sas-Rolfes et al., 2019; Devenish et al., 2023). These factors include disease, climate change, and reduced welfare as well as habitat destruction, degradation, and fragmentation resulting from infrastructure development and industrial operations such as logging, mining, or refining. Noise, chemical, and light pollution are also contributing factors.

Failure to acknowledge the nuances of wildlife trade and the diverse ways in which wildlife resources are used and valued can foster policies that undermine human rights, species conservation, public health security, and economic sectors that depend on sustainable relationships with wildlife and wildlife products. This lack of healthy discourse creates a false dichotomy between those who value wildlife as a resource available for consumption and those who believe that wildlife has entirely intrinsic value and should never be treated as a commodity (Table 1). Regardless of moral arguments, this binary value schema exacerbates issues over community and land rights by promoting notions that management frameworks largely originating from institutions based in the Global North are the ones best suited for governing land and wildlife resources globally (Duffy, 2022).

In this Perspective article, we describe how wild meat consumption and poaching elicit prejudices that inhibit equitable access to wildlife and wildlife products. We use a selection of statements quoted from notable, public authorities to highlight the existence of these prejudices across policy, science, and communication strategies. The viewpoint we present herein is relative to our investigation into Advancing the Science of Environmental Justice in the International Wildlife Trade. By

questioning the status quo and looking toward the science underpinning wildlife trade interventions, we aim to catalyze constructive dialogues that often appear absent from this emotionally charged landscape.

Bushmeat: terminology and regulation

The United States (US) Centers for Disease Control and Prevention (CDC) defines bushmeat as “...raw or minimally processed meat that comes from wild animals in certain regions of the world, including Africa and other areas, and may pose a communicable disease risk” (CDC, 2024). Per this definition, bushmeat could consist of a variety of species including fish, bats, monkeys, and pangolins as well as meat from feral cattle and pigs (Kolby et al., 2023). The importation of bushmeat into the United States is illegal according to CDC regulations and subject to a maximum financial penalty of \$250,000 (CDC, 2024). US Fish and Wildlife Service (USFWS) Law Enforcement Management Information System (LEMIS) import data reveals that significant volumes of raw and minimally processed wild animal meat imported by trophy hunters or by US-based companies are cleared to enter US commerce. These food items include deer meat from New Zealand, guinea pig from Peru, and ostrich and other plains game from southern Africa (Eskew et al., 2020; USFWS, n.d.; J. Kolby and O. Goodman, pers. obs.). These types of commercial shipments appear to meet the CDC’s definition of bushmeat, but regulatory officers and media reporters frequently choose to treat them as if they do not. As a result, some bushmeat traders are punished while others are provided exceptions without clear rationale.

Personal values appear to comele with policy implementation, separating species that are “acceptable” to consume as food from those that are not. For instance, a US law enacted in 2018 prohibits the trade in and slaughter of dogs and cats for human consumption (7 USC 2160, 2018), while it remains legal in many states for those same animals to be euthanized at animal shelters.

Public health risk perceptions associated with bushmeat trade

A core criticism of modern bushmeat trade and consumption is that it introduces heightened risks of exposure to zoonotic pathogens that spread from animals to people (Karesh et al., 2007; Milbank and Vira, 2022). This perception also arguably justifies the CDC’s steep financial penalty for importing bushmeat from Africa, Asia, and Latin America. Bushmeat intercepted at the US border is typically seized and destroyed without routine pathogen testing by the CDC or another US agency (USCBP, 2024). Seemingly, no coordinated effort exists to build a rigorous scientific foundation which could help justify the total import prohibition. It should be noted that thousands of pounds of prohibited bushmeat are still illegally imported into the United States annually (Walz et al., 2017). Yet, CDC staff are “...unaware of

any documented cases of such disease being spread through consumer bushmeat” (Dr. Galland, as quoted in [Donnelly, 2007](#)), a disclaimer also stated on the CDC website ([Table 1](#); [CDC, 2024](#)). Meanwhile, hunters returning to the United States from Canada transporting coolers of raw black bear (*Ursus americanus*) meat are allowed to import their hunted meat with relatively few administrative barriers despite several confirmed outbreaks of freeze-resistant human trichinellosis directly attributed to the consumption of hunted bear meat ([Cash-Goldwasser et al., 2024](#)).

The term “bushmeat” legitimizes a system of inequity and prejudice-enabling attitudes, presumptions, and policies governing wildlife trade regulation to develop independently of scientific approaches to risk analyses and pathogen surveillance ([Challender et al., 2022](#); [Hughes A. et al., 2023](#)). While the detection of genetic sequences of zoonotic pathogens in bushmeat imported from parts of Africa is certainly concerning, pathogens must also be viable and infectious to pose a zoonotic threat ([Smith et al., 2012](#); [Chaix et al., 2022](#)). It is plausible that the risk of infection posed by imported bushmeat is greater than what has been scientifically demonstrated through genetic sequencing. However, the absence of investigations of viability has resulted in trade policies that are decoupled from rigorous scientific evidence.

Any human-animal interface presents risks of zoonotic exposure, and it is imperative that policymakers and researchers avoid misattributing elevated risks to wildlife when surveillance data suggests that human-livestock interfaces may be much more frequent sources of zoonotic transmission ([Kock and Caceres-Escobar, 2022](#)). Research demonstrates that pigs, cows, and poultry, as well as common pets such as dogs and cats, present an abundance of opportunities for zoonoses emergence in humans ([Klous et al., 2016](#); [Desvars-Larrive et al., 2024](#)). In the post-COVID-19 environment, states and international development initiatives incentivize interventions that target wildlife harvest and “wet markets” over domesticated animal production systems. However, policies and interventions that are designed to pander to donor trends and political interests are not serving the public if they eschew standards of scientific rigor. Considering the negative impacts of industrial livestock operations on the environment and human health, a well-regulated trade in meat from wild animals could contribute to an alternative, or complementary system of food production. Such a system might prove beneficial to affected communities, cause less habitat degradation, incentivize less land-use change, and facilitate the emergence of fewer zoonoses, such as the highly pathogenic avian flu ([Nasi et al., 2011](#)).

TABLE 1 Quotations extracted from a variety of sources which express or describe sentiments that portray unequitable perspectives of wildlife consumption.

Affiliation	Quote	Citation
National Institute of Allergy and Infections Diseases	“I think we should shut down those things [wildlife markets] right away ... It boggles my mind how when we have so many diseases that emanate out of that unusual human-animal interface, that we don’t just shut it down.”	Samuel, 2020
Center for Biological Diversity	“Immediately ban the import and export of all live wildlife, permanently close all domestic live-wildlife markets, and urge all nations to take similar actions.”	Center for Biological Diversity, 2020
MCRS	“When people say hunting is a livelihood issue but it’s illegal - like ‘Oh the hunter is really poor and he has five children’ - I can’t get on board ... If you’re going to make an exception for hunting then why not let them sell two of their kids, as well? Or deal in cocaine?”	Nuwer, 2018
African Parks	“We receive EU funding to put poor poachers in jail, while in Europe a hunter who kills a wolf will only get a small fine.”	Pilling, 2024
United Nations	“It would be good to ban the live animal markets ... The message we are getting is if we don’t take care of nature, it will take care of us.”	Samuel, 2020
CDC	“Dr. Glenda Gale Galland, a veterinarian and animal-disease expert with the CDC, testified there was concern about the potential for the spread, from primates to humans, of diseases to include Ebola, measles, tuberculosis, monkeypox, and retroviruses similar to HIV. However, she also admitted she was not aware of any documented cases of such diseases being spread through consumer bushmeat.”	Donnelly, 2007
WildAid	“Some people call this a souvenir. I call this criminal.”	WildAid, 2008a
WildAid	“Connect the dots and you discover a thin line separates a buyer from a killer.”	WildAid, 2008
Northumbria University	“During the Voices From the Frontlines: Communities and Rangers session, the panelist from Tajikistan ironically asked their fellow panelists and audience why the same actors promoting militarized approaches are not using guns and their own military to protect critically endangered European species such as bats and butterflies.”	Massé et al., 2020
John Jay College	“If species are beautiful enough to carry as a handbag, they should be beautiful enough to let live sustainably and fulfill their ecological roles in the wild.”	Sosnowski and Petrossian, 2020
Australian Minister for the Environment and Water	“I think anybody who’s involved in animal trafficking is a despicable human being.”	Hartley, 2024
Wildlife Conservation Society	“Governmental authorities should stop the sale of wildlife for human consumption, especially birds and mammals, either presented as live animals or fresh meat, in cities, towns, and peri-urban settings, and their supply and trade, whether from wildlife farms or directly from the wild.”	Wildlife Conservation Society, 2021

Geographical biases

Common reasons people hunt wild animals are to access affordable protein or diversify their protein intake (Cawthorn and Hoffman, 2015). In many parts of the world, hunted meat is cheaper and more accessible than meat from livestock (Ingram et al., 2021; Gaubert et al., 2024). This demand for wild meat provides a foundation for an informal economy built around bushmeat, whereby hunters can sell their animals further down the supply chain, thus increasing marginal profits (Davies, 2002; Lescuyer and Nasi, 2016). Studies in West Africa suggest that bushmeat vendors enjoy long, relatively stable careers (Gaubert et al., 2024). Studies also suggest that these bushmeat markets show evidence of “post-depletion sustainability,” whereby deforestation and other land-use changes unrelated to bushmeat hunting activities have transformed local ecosystems to favor small and mid-size mammals, such as antelope and rodents (Cowlishaw et al., 2005). Similar species are targeted for hunting in the United States, namely whitetail deer (*Odocoileus virginianus*), and gray squirrel (*Sciurus carolinensis*) (Sowers, 2020). While these species generally cannot be lawfully sold commercially in the United States, meat from similar wild animals is commercialized in the United Kingdom and across Europe as game (Marescotti et al., 2019; USDA, 2024).

Regulations and dialogues surrounding the consumption of bushmeat are also frequently characterized by concerns over species offtake and commercialization (Stansell, 2002; Hinsley et al., 2023). Bushmeat is consumed globally, but in the United States, the United Kingdom, and Europe it is commonly referred to as “game” (Goguen and Riley, 2020; Booth et al., 2021). In these regions, trade and consumption of “game” meat tends to be supported while trade and consumption of “bushmeat” is vilified – even though either term could describe the same or similar species (Hoffman and Wiklund, 2006). Conversations about bushmeat that take place in the international policy environment rarely acknowledge the widescale consumption of wild cervids, fowl, and rodents that occurs across North America and Europe despite their zoonotic potential (Han et al., 2016). These conversations broadly categorize bushmeat from areas in the Global South as inherently illegal and threatening species with extinction. Risks should be measured against scientific evidence of harm and decoupled from biased attitudes in the Global North that presume that the consumption of game and even domestic animals is safer and more ecologically friendly than that of wild animals (Cawthorn and Hoffman, 2015).

Poaching is one of the most common wildlife issues leveraged to support conservation interventions by non-governmental organizations (NGOs) and government agencies (Massé and Lunstrum, 2016; Massé, 2019). Poaching, a term used to describe the illegal killing or collection of plants and animals from the wild, is an emotionally charged topic that regularly appears to elicit public disapproval of all forms of wildlife commodification, conflating legal and illegal trade (Montgomery, 2020; Maxson, 2024). This activity is often discussed in the context of illegally harvested elephant tusks and rhinoceros horns in African parks, perpetuating a narrative that critically endangered species are primarily affected and that the people performing such acts are solely interested in amassing wealth (de Jong, 2019). Across the entire spectrum of poaching,

from orchids to eels, the legal status of an event that leads to the death or removal of wildlife from nature does not inherently denote the extent to which populations and ecosystems are impacted by poaching activity. This presents notable challenges when using seizure data, such as those maintained by TRAFFIC, to evaluate legal or illegal wildlife trade and its impacts (TRAFFIC International, 2024). Legality and sustainability are not always positively associated. For many species affected by trade, the absence of population-level scientific information necessary to define “sustainable use” and quantify the actual impact of trade pressures, whether legal or illegal, poses a significant barrier to objective discussions about when and why trade becomes harmful (Hughes A. et al., 2023; Hughes L. J. et al., 2023). Despite a consistent lack of scientific data to accurately describe species population estimates and trends for most species traded globally, anti-poaching efforts across Africa and many parts of Asia are often referred to as “conservation wars” or part of the “war against poaching” conducted to save species from extinction (Simlai, 2015). Although trade-driven pressure is a proximate cause of decline for certain species, the ultimate cause is often multifaceted. The absence or minimization of such acknowledgement in conservation narratives and interventions tends to result in a diminished perception of the negative environmental impacts fueled by resource extraction and infrastructural development. This lack of nuance can be weaponized to justify the acquisition and use of military-grade hardware against suspected trespassers or would-be poachers by portraying a paucity of alternative strategies for preventing extinction (Duffy, 2022).

David Pilling (2024) of The Financial Times described the “real business” of African Parks Network (APN) as, “defending wildlife, often with guns, on the frontline of the conservation wars.” Millecamps and Toulemonde (2022) similarly stated in the Africa Report that, “One of the main features of the APN is the use of rangers, armed eco-guards equipped with the latest equipment.” The protection of conservation areas is inarguably dangerous business, but there is a stark contrast between the type of violence deemed permissible against the poor in the Global South and that allowed against malefactors in the Global North. For example, in 2016 a group of US extremists seized the Malheur Wildlife Refuge in Harney County, Oregon for over a month (Robbins, 2016; United States Attorney’s Office, 2018). While they eventually capitulated, only seven out of twenty-seven militants received time in prison and all surviving members of the group were granted a fair trial, despite seizing control of federal property. Further evidence of this dichotomy can be seen in the work of such organizations as the Environmental Investigation Agency and the Wildlife Justice Commission, two NGOs that employ the expertise of former law enforcement and intelligence officers to carry out extrajudicial field investigations in the Global South (Environmental Investigation Agency, 2024; Wildlife Justice Commission, 2024a). These organizations use their findings to develop detailed and compelling intelligence reports for use by the public and state authorities. However, it remains unknown whether their donors, which include the National Geographic Society, US Agency for International Development, Deutsche Gesellschaft für Internationale Zusammenarbeit, and the United Kingdom’s Department for Environment Food and Rural Affairs, among others, would be

equally supportive of the same kinds of extrajudicial investigations if they were instead performed within the US, Germany, or the United Kingdom (Environmental Investigation Agency, 2024a; Wildlife Justice Commission, 2024b).

Differential enforcement

State-sanctioned militarized strategies visible across Africa, India, and elsewhere in the Global South are notably absent from the Global North (Duffy, 2022). Poachers and wildlife traffickers in North America face financial penalties, asset forfeiture, deportation, and potential jailtime, meanwhile authorities in protected areas across Kenya, Tanzania, Botswana, and India have been known to enforce shoot-on-sight policies (Messer, 2010; Maxson, 2024). This dichotomy is so prevalent it incited sardonic commentary at the 2018 London Illegal Wildlife Trade Conference questioning why European militaries were not being deployed to protect wildlife and ecosystems in their own jurisdiction (Table 1). Notably, this comment followed days after speakers praised the British military's deployment to support APN rangers in Liwonde National Park, Malawi (Massé et al., 2020).

In their evaluation of the 2018 London Illegal Wildlife Trade (IWT) Conference, Massé et al. (2020) concluded that, "Notwithstanding that many engage in illicit hunting and extraction of flora and fauna and other aspects of IWT as a way out of poverty and as a calculated livelihood strategy, this discourse overshadows much-needed discussion about investment in sustainable livelihoods as a long-term preventative approach to address IWT." Nearly six years later, the same conclusion can be drawn from institutional responses to the joint zoonotic and conservation risks posed by both legal and illegal harvest and commercialization of wildlife resources wherein total or near-total trade bans have been loudly advocated without equivalent calls for the development of infrastructure and education needed to make existing trade safer.

When prominent policymakers deny the possibility of finding common ground with wildlife resource stakeholders, it creates an environment of hostility and conflict that constrains the emergence of solutions to facilitate legal and sustainable trade (Harrison and Loring, 2020). Policymakers have frequently denounced wildlife use, sometimes expressing their own biased views or broadcasting what they believe to resonate best with their audiences and constituents (Table 1). Like the inequities caused by the vague and inconsistent application of the term "bushmeat," the broad operational definition of "wildlife trafficking" is likewise troublesome for painting all perpetrators as criminals. For instance, wildlife trafficking includes relatively innocuous events such as the hypothetical import of a shipment of captive-bred turtles into the United States that would have been legal, except that it was accidentally cleared by US Customs prior to clearance by the USFWS. Picking a single blue jay (*Cyanocitta cristata*) feather up off the ground and carrying it from the United States across an international border, for instance as a bookmark or on a keychain, also constitutes wildlife trafficking (Migratory Bird Treaty Act of 1918, 1918).

Recommendations

We believe that transparent scientific research should underpin the development and implementation of wildlife resource use policies. For instance, we recommend that policies designed to reduce the risk of disease emergence from bushmeat trade should be crafted from scientifically driven risk analyses. Data produced through these analyses should then be used to help inform whether all wild animal meat carries equivalent public health risks. If the trade in certain species and/or commodities is found to introduce negligible risk, then it may become more effective, efficient and equitable to target trade restrictions only where the greatest known risks have been identified. One such approach to achieve this output would be to implement a system of surveillance whereby imported wild animal meat is methodically tested for zoonotic pathogens prior to confiscation and destruction of bushmeat or clearance of game meat to enter the United States. The data generated could be applied to determine whether current perceptions of threat to public health are scientifically substantiated and if not, to adjust policies accordingly.

Conclusion

Biases and prejudices are part of human nature, but they can perpetuate injustice and violence when inserted into the legal frameworks of wildlife trade and resource regulation. Policies that are sometimes established through a precautionary approach in the absence of optimal scientific evidence should be communicated as such to mitigate perceptions of bias and should be continually scrutinized, reevaluated, and adapted to mitigate negative and inequitable impacts. Implanting greater equity into the highly emotive landscape of wildlife commodification will require policymakers to embrace the scientific method as standard practice and acknowledge prejudices that exacerbate systemic violence toward those who engage in the wildlife trade. It will also require practitioners to evaluate the design and intention behind the tools and interventions used to gather information for intervention and policy development.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

JK: Conceptualization, Writing – original draft, Writing – review & editing. OG: Conceptualization, Writing – original draft, Writing – review & editing.

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Jessica Bell Rizzolo,
Oregon State University, United States
Orion Goodman,
National Zoo and Conservation Biology
Institute, United States

*CORRESPONDENCE

Anna Saito
✉ annaxsaito@gmail.com

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Where the wild things are...stored? The management and return of seized wildlife

Anna Saito*

Department of Social Sciences, University of Hamburg, Hamburg, Germany

As more and more wildlife is seized across the globe due to the unlawful possession, handling and trading of protected wildlife species, the wildlife which needs to be managed by enforcement agencies keeps expanding. While seizure data alone is deemed insufficient to measure the illegal wildlife trade, given the complexity of the many drivers and pressures associated, the elevated numbers of wildlife seized provide nevertheless evidence of a global illicit trade that is in progress and seemingly prospering. Disentangling what happens to seized wildlife can be difficult. By using multiple methods including documentary analysis, seizure data analysis and key informant interviews, this study examines seizure management in four countries: Kenya and Uganda in East Africa and Germany and Czech Republic in Central Europe. Wildlife continues to be treated in many instances even after seizure on the basis of continued commodification, or enters a transient state of simultaneous commodification and decommodification, which influences seizure management framing and implementation. Dismissed as the unfortunate collateral of the illegal wildlife trade, live animals, dead animals and derivatives pass in the background. While seizure management processes are underdeveloped, patchy, neglected or burdened by resource constraints, responsible authorities, institutions and individuals struggle to find adequate solutions. By laying this much-needed groundwork for understanding seizure management in practice, opportunities to build on this work to investigate more substantive questions around conservation, environmental and restorative justice are created.

KEYWORDS

wildlife trafficking, IWT, wildlife seizure, seizure management, commodification, repatriation, environmental justice, green criminology

1 Introduction

While much of the wildlife trade is legal or unregulated, illegal wildlife trade (IWT) refers to the taking, trading and exploitation of wild flora and fauna in violation of domestic and/or international laws (Wyatt et al., 2022). Wide-scale poaching and IWT are attributed to be key drivers of the present unprecedented rate of species extinction and biodiversity loss. They may undermine local economies, imperil people's livelihoods, be a vector for transmitting zoonotic diseases and endanger public health (Biggs et al., 2023; Rush et al., 2021; Felbab-Brown, 2017). Seizures have become a popular approach to disrupt wildlife

crime (EIA, 2022; IUCN, 2019). Wildlife seizures may consist of dead animals, parts and derivatives in the form of trophies, food, cosmetics, fashion, ornamental or medicinal products, but they may also involve live animals (IUCN, 2019; UNODC, 2016). Although the size and frequency of seizures is higher in some regions than in others, an overall increase in wildlife seizures across the globe has been registered and the number of wildlife managed by enforcement agencies therefore keeps expanding (CITES, 2022c; Rivera et al., 2021). This yet raises two vital questions: (a) what happens with the seized and confiscated “wildlife” (hereafter live animals, dead animals and derivatives)¹ and how are they managed; and (b) is the repatriation of confiscated wildlife practised and if so, under what circumstances?

Only a few previous studies address the question of live animal seizure management and repatriation (see for example Wyatt et al., 2022; Rivera et al., 2021; Gomes Destro et al., 2019; Collard, 2014). Seizure management usually entails a lengthy process, starting from the interception and control of the animal, over to its immediate care, transfer and transportation to short-term and long-term arrangements, and the provision of veterinary screening (Pascual and Wingard, 2023). Rehabilitation and long-term care are often key to survival as the violence these animals have been subjected to often proves dire to their existence (IUCN, 2019; Wyatt, 2013; Wyatt et al., 2022; Collard and Dempsey, 2013). Unfortunately, seizure management remains overlooked in enforcement and there seems to be a continuing lack of debate on the overall management and return of seized wildlife from a criminological perspective.

The framing of seizures and the value attached to wildlife can have its impact on post-seizure management. On some occasions, seized wildlife may be dismissed as “doomed” collateral of IWT, without exploring the full potential that seizure management could, on a case-by-case basis, perhaps provide (Eudey, 1995; Koontz, 1995). Dead specimens and derivatives are afforded even less consideration, and repatriation is seldom mentioned (de Vries and Anderson, 2022). Given that derivatives represent the bulk of seizures (CITES, 2022a), the question of management merits further scrutiny as we are arguably talking about commodities of great value (Lopes et al., 2017; UNODC, 2010), often linked to questions of resource governance and justice.

Taking examples from Central Europe and East Africa, this study deliberates on the present state and challenges of seizure management, by exploring where seizure management practices of selected countries currently stand, and how they intertwine with national and regional wildlife security concerns. This groundwork is necessary to further explore the potential of seizure management

and repatriation in the context of environmental and restorative justice concerns. After all, despite the augmenting pressure to address wildlife crime, and the valiant efforts in recent years to establish some initial structure and guidance to seizure management (Pascual and Wingard, 2023; AZA, 2023; IUCN, 2019), ensuring proper handling of confiscated wildlife remains to this day an invisible aspect in the global response to IWT. This study is therefore both timely and necessary, as it is becoming ever more pressing to take measures to effectively deal with confiscated live animals and wildlife contraband, and contribute to the conservation of endangered wild animal populations.

2 Green criminology, commodification and conservation

Even as wildlife species are declining, some are fetching more than their equivalent in gold or platinum on the black market (East African Community, 2018; UNODC, 2010). The monetary value attached to wildlife, be it dead or alive, entices people around the globe to engage in the illegal sourcing and trade of wildlife (Mrosso et al., 2022). Increasing buyer power, population growth and globalisation have moreover led to the global proliferation of wildlife markets, whether legal or illegal (Felbab-Brown, 2017). Global awareness on the magnitude and associated harm of IWT has at the same time only been slowly developing. As Nurse and Wyatt (2020) point out, despite all advances, a limited notion of wildlife crime currently exists and remains perpetuated in criminological and political discourse. Wildlife continues to be treated in many instances primarily on the basis of the sustainable use of wild flora and fauna, which allows for their continued commodification and exploitation, seeking only to regulate the most excessive and violent of human activities.

Distinctions exist, however, in the commodification of live animals and in the commodification of dead animals (including body parts and derivatives). According to Collard (2014), live animals are put together into new animal subjects that derive their value from the very fact of being alive. Through the exoticisation of their wild identity, their former life linked to their native habitat serves to enhance their value as lively commodities through their association with faraway places. But it can also form part of local and regional cultural practice, as in many countries keeping wild animals in captivity builds on notions of tradition, popularity and aesthetic appeal (Souito et al., 2017; Alves et al., 2016). In the case of dead animals and derivatives, the process of commodification ultimately places a value on the dead state of wildlife, to their bodies and their parts. Through the physical separation of the to-be-commodity from the animal (for instance, when skins are removed from the bodies of wild animals) and the moral separation of the animal from its function and place in its respective ecosystem, wildlife is isolated as a resource to be “harvested” for commercial use (Castree, 2003). Wildlife thus ceases to be seen as a victim through the commodification process, since the final commodity stands separated from its former animal existence.

¹ It should be acknowledged in this context that the illegal trade in wild flora constitutes another significant wildlife market and that enforcement actions in this regard remain just as crucial. Seizures of wild plants, timber and plant derivatives can even surpass those of wild animals and animal derivatives (TRAFFIC, 2024; Plesnik et al., 2023a). But as this form of IWT and its management post-confiscation receives in many instances even less attention than their animal counterparts, it presents another striking hole in our understanding.

By negating all but their economic value, wildlife suffering receives little or no significance, presumably because it is not regarded as a “real” crime, but rather as a minor offence against property², and therefore without victims to speak of (Beirne, 2007). Yet the question of harm is eminent as the impacts of illegal capture, transport and captivity are often detrimental to animals physically, psychologically and emotionally (IUCN, 2019; Wyatt, 2013). Many do not survive trafficking and die during the act of poaching, handling, transporting, at their destination, at the point of and during seizures (Wyatt et al., 2022; Collard and Dempsey, 2013). This is without counting the harm sustained by wildlife that are killed and transformed for the purpose of trophies and other commodity forms. For this reason, Beirne and South (2007) posited that green criminology should be a harm-based discourse that addresses any animal abuse that leads to animal suffering. After all, animals, whether construed as wild, domestic or commercial, should be considered beings that have intrinsic value and an interest in living unharmed.

Seizures and confiscations as part of the criminal justice response to wildlife crime are in this regard important practices to review, as the question of harm may also be of concern in relation to seized and confiscated animals. Seizures designate a temporary custody placed on the wildlife by authorities, during which the owner retains their legal ownership over the wildlife, although authorities may have temporarily deprived them of the actual wildlife itself (Pascual and Wingard, 2023; IUCN, 2019). Reasons for seizure can vary and may include missing, incomplete or fraudulent paperwork, violations of welfare standards during transport, as well as the unrightful possession, transfer or handling of protected species (TRAFFIC, 2024; D’Cruze and MacDonald, 2016; Wyatt, 2013). Confiscations, on the other hand, designate the point at which the wildlife is placed in the permanent custody of the authorities, usually after the court has ruled that the legal ownership of the respective wildlife should be ceded to the state due to illegalities that cannot be overcome. It is therefore only after confiscation that responsible authorities can decide upon the long-term management of wildlife. This separation between seizure and confiscation is crucial since different management protocols apply, which delimit the scope of actions authorities are permitted to take (Pascual and Wingard, 2023; IUCN, 2019). Enforcement priorities commonly focus on the need to minimise harm and preserve the life of seized and confiscated wildlife, securing and preserving criminal evidence, while at the same time preventing the transmission of zoonotic diseases (Pascual and Wingard, 2023).

² Speciesist language remains problematic to this day, even in debates about wildlife crime, as it is often laced with implicit assertions that deny animal sentience and their right to live a life harmfree. In an effort to be inclusive, some green criminologists have resorted to the use of the term “non-human animals”, to move beyond the artificial dyad between “humans” and “animals”. Yet this solution seems hardly satisfactory given that, as Beirne (2007) notes, it entails the same offence as referring to (human) women as non-male humans. In absence of a convincing terminology, the objective therefore remains to at least reflect on the use of language, as it has a significant impact on the way we approach, conceptualise and deal with wildlife and wildlife crime.

On an international level, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides a number of guidelines on how countries can handle wildlife seizures, in particular live specimens. The three recommended management³ options for live specimens are euthanasia, long-term captivity and repatriation to the source country/country of export. While the convention requires that repatriation of confiscated CITES-listed animals to the country of export is to be considered, the return of the animal to the wild is not obligatory. Release to the wild is recommended only under certain circumstances, with reference to IUCN guidelines on confiscated live specimens (CITES, 2022b). Euthanasia, as the CITES guidelines state, being in many cases ‘the simplest and most humane option available’ (CITES, 2022b, 10) for live specimens. The recommended action for dead specimens and wildlife contraband, on the other hand, is currently sidelined under the disposal of ‘confiscated specimens other than live animals and plants’, namely that of confiscated and accumulated dead specimens (CITES, n.d.). A distinction in recommended disposal options is made between Appendix I (species listed as most endangered where commercial trade is prohibited) and Appendix II and III species (species listed where trade is permitted but regulated). Confiscated dead specimens from Appendix I may only be re-used for scientific or educational purposes and must be otherwise stockpiled or destroyed. Confiscated dead specimens from Appendix II and III species may be disposed of in a manner consistent with the convention (CITES, 2022b).

But even though the vast majority of countries are members to the convention, practical implementation is not guaranteed as countries are left to harmonise and enforce the convention within their national legislation (Arroyo-Quiroz and Wyatt, 2019; Maher and Sollund, 2016). When it comes to seizure management in particular, insights into the practice on the ground are hard to obtain (CITES, 2019). Poor reporting compliance, along with non-standardised, low-quality and missing data remain an on-going area of concern (Plesník et al., 2023a; D’Cruze and MacDonald, 2016).

What characterises the complexity of seizure management among other things, is the inherent competition between conservation and animal welfare agendas, two perspectives that are not necessarily opposed, but which should not be confused. Frequently they function and think in parallel, but where conservationists focus broadly on the restoration and health of the biotic community as a whole, animal welfareists focus on defending the rights and well-being of individual animals (Beirne, 2007; Jimenez and Cadena, 2004). From a conservation point of view, the long-term welfare of wild populations should be given priority over the welfare of individual animals. As such, concern for the protection of individual animals arises solely when the population of animals representing a species becomes so small that the death of any individual may lead to its extinction (Cuarón,

³ CITES uses the term “disposal” when describing the management of illegally traded and confiscated wildlife, indiscriminate of whether it concerns dead specimens, derivatives or live animals. Although this terminology draws on general customs parlance for inanimate goods, the adoption of the terminology by CITES has since come under heavy criticism for objectifying sentient wild animals (Pascual and Wingard, 2023; Rivera et al., 2021).

2005; Hargrove, 1995). This can also have its bearing on how the management of confiscated animals is approached. There may be disagreements as to what interests animals have and what management should look like.

From an animal welfare perspective, there is a moral predisposition against captivity as the deprivation from liberty is considered presumptively wrong (Jimenez and Cadena, 2004; Jamieson, 1995). Yet, biodiversity loss is a risk when confiscated animals are released back to the wild inappropriately. The loss can come from the spread of pathogens from the released animals but also from the introduction of animals to non-native areas. It is difficult to establish with certainty that a specimen is pathogen-free. Nor is it easy to determine the provenance of confiscated wildlife with certainty as many species naturally occur in many sites. But as each population has a unique evolutionary history, their pathogen resistance and genetic make-up may diverge from other populations. This can pose a risk as much to the to be released specimen as to the population and ecosystem in question (Pascual and Wingard, 2023; IUCN, 2019; Jimenez and Cadena, 2004). Record-keeping on releases and reintroductions of confiscated animals are notoriously poor, and according to the IUCN, releases remain rare (Rivera et al., 2021; Zhou et al., 2016). Even so, successful and failed attempts at release of confiscated wildlife have been documented (Oliveira et al., 2020; Gray et al., 2017; Beck, 1995; Jamieson, 1995).

Sadly, confiscated animals are rarely in a suitable condition to be released in the first place (Felbab-Brown, 2017). In many cases, it so becomes that releases are actually undesirable from both an animal welfare perspective as well as from a conservation perspective. Another divisive topic can be the question of euthanasia. From a conservation perspective, euthanasia may be an option to consider, the underlying principle being that a humane death may be in the animal's best interest (Jimenez and Cadena, 2004). From an animal welfare point of view, however, the taking of an animal's life for reasons other than relieving suffering seems hardly acceptable and not in the wildlife's interest (Wyatt et al., 2022). The management of confiscated wildlife thus clearly rests on a fine balance between what can be quite distinct priorities. The context in which such efforts are carried out is important, as the rights, protection and position of wildlife are contingent on social geographies.

3 Methods

3.1 Geographic focus and regional considerations

This study examined seizure management in four countries across two regions: Kenya and Uganda in East Africa and Germany and Czech Republic in Central Europe. Kenya and Uganda are long recognised as hotspots for IWT. While elephant and rhinoceros poaching has dropped in recent years, the two countries remain important source, transit and destination⁴ points for IWT (KWS,

2021; EIA, 2018; MTWA, 2020). Borders are porous and large volumes of ivory and rhino horn leaking from stockpiles and transiting from other countries continue to be illegally exported (EIA, 2018; Weru, 2016; Rossi, 2018).

Nowadays, Kenya and Uganda are part of a variety of bilateral, multilateral and regional frameworks targeting IWT, including the Lusaka Agreement, the regional strategies of the African Union (AU) and the East African Community (EAC), as well as regional wildlife enforcement networks. The majority of the regional frameworks yet make no mention of measures relating to managing seizures. Alone the Lusaka Agreement makes reference to the possibility of repatriating seized wildlife to the country of original (re)-export (Lusaka Agreement, 1994).

The EU is one of the world's largest markets for wildlife and although European countries have become less important consumers of African wildlife themselves, they remain a vital conduit for further transit to Asia (Rihova, 2023; Arroyo-Quiroz and Wyatt, 2019; Sina et al., 2016). The Czech Republic is considered to be one of four countries in the world most involved in the illegal trade in rhino horn (MV CR, 2018). Enforcement measures therefore focus on trophies for which it has received international recognition by CITES as the only country so far (Plesnik et al., 2023b). Although rhino horn trafficking has since decreased, it is believed that wildlife trafficking networks continue to operate in the country (Rademeyer, 2016). Germany is the leading EU destination country for IWT and one of the main buyers involved in the legal and illegal trade in exotic pets worldwide (WWF, 2023; Altherr et al., 2020). Demand is particularly high for reptiles, amphibians and, to a lesser extent, small mammals (WWF, 2023; Altherr et al., 2020). For an overview of the most frequently seized wildlife in the four countries see Table 1.

When considering the Czech Republic and Germany, it is necessary to examine their practices also in the broader context of the European Union, since both countries are regionally harmonised through EU frameworks and directives issued. EC Regulation No 338/97 Art. 16 stipulates among other things the seizure, and where appropriate (Council Regulation (EC) No 338/97, 1996), the confiscation of specimens that do not meet required standards of documentation and/or transportation. As Member States are not required to record or publish steps taken after the seizure and confiscation of wildlife, an overview of seizure management practices across the EU does not exist (Altherr et al., 2020). Common measures include that derivatives⁵ labelled as containing annex-listed wildlife may be seized without prior verification or testing. For live animals that have been introduced into the EU, repatriation may be considered an option. Although the new EU action plan to combat illegal wildlife trade (2022) aims

⁴ It should be borne in mind that IWT supplies not only international markets but also local ones in source countries and nearby areas (Mrosso et al., 2022).

⁵ Foods, medicines and cosmetics are of particular note. The most prominent examples thereof are Traditional Asian Medicine (TAM) and Traditional Chinese Medicine (TCM). These derivatives have gained increasing notoriety due to concerns that their increased use will exacerbate pressure on endangered species, including saiga antelope, pangolins, tigers and black bears, owing to increased domestic and international demand (Esmail et al., 2020).

TABLE 1 Most frequently seized wildlife mentioned by key informants according to country⁶

Seizures	Kenya	Uganda	Czech Republic	Germany
Dead animals, parts and derivatives	Ivory, rhino horn pangolin scales, abalone, bushmeat, animal skins	Ivory, rhino horn, pangolin scales, bushmeat, animal skins	TAM/TCM products, corals, reptile leather products, ivory antiques, furs	TAM/TCM products, corals, ivory, animal skins, furs, reptile leather, turtles, snails
Live animals	Pangolins, tortoises, leopards, African grey parrots	Pangolins, parrots and exotic birds, primates, reptiles	Reptiles, turtles, amphibians Incidences of eel smuggling, trade in lynx, tiger cubs and parrots were recorded.	Amphibians, turtles and reptiles

to improve enforcement, the management of seized and confiscated wildlife remains to this date only marginally addressed.

This cross-regional and cross-cultural focus was chosen because of the transboundary nature of IWT and the need to consolidate insights along trafficking routes (Pascual and Wingard, 2023; Milner-Gulland et al., 2018). Understanding local and regional differences is important when looking at enforcement and criminal justice approaches, in order to reflect on needs and successes on a more equal footing. Central Europe and East Africa were chosen to investigate certain IWT patterns identified by previous research (TRAFFIC, 2023; UNODC, 2020; Sina et al., 2016). African experiences still remain underrepresented in governance literature (Iroulo and Tappe Ortiz, 2022) and even when it comes to seizures and confiscation management, data is limited despite its obvious IWT relevance. An emphasis was therefore placed in this research on integrating cross-cultural perspectives, while being reflective to produce knowledge with and guided by practitioners on the ground. All the more so, since Arroyo-Quiroz and Wyatt (2019) raise in relation to enforcement responses, ‘trying to uncover the smuggling of a live bird is very different from uncovering the smuggling of a cactus seed’ (p.33). In other words, based on the nature of enforcement and IWT, seizure management activities are experienced, perceived, and understood differently.

3.2 Data collection and analysis

To obtain insights into the countries and overall thematic, multiple methods were combined including documentary analysis, seizure data analysis and, above all, semi-structured interviews with key informants experienced in seizure recovery, management and/or repatriation processes related to wildlife trafficking. Since the focus was on how seizure management takes place in practice, the interviews provided the means of probing the situation, offering privileged complementary insights into the operationalisation of seizure management policies and structures. Interviewees were selected using purposive sampling and snowball sampling. Purposive sampling consists of recruiting people that fit a specific profile (in this case renown expertise with the topic under study), thereby ensuring the most relevant sample possible. Snowball sampling refers to the method of identifying future

respondents based on the recommendations of an initial informant sample. Particularly for sensitive criminological research that implicates hard-to-reach actor groups and institutions, snowball sampling has been recognised as a means of overcoming barriers to accessing information (Heap and Waters, 2019).

Interviews were conducted from the end of October 2023 to April 2024. In total, 31 interviews were conducted with 37 key informants. Contributing participants were drawn from wildlife management authorities, government departments, international organisations and regional bodies, customs authorities, zoos/museums, academia, animal welfare NGOs and enforcement networks (see Table 2). 25 interviews were held via phone or an online meeting platform. 3 interviews were conducted in-person on institutional premises. For 3 interviews, responses were received in written form. Interviews lasted between 30 to 201 minutes, with an average length of 60 minutes. Four interviews were conducted in pairs, one interview was held with three key informants and the rest was held with one person at a time. 19 interviews were held in English, nine interviews were held in German and three interviews were held in Czech.

A participant information sheet and consent form were provided to each participant in advance via email. Interview participant contributions were anonymised (P#1-37) unless stated otherwise. In the spirit of Ned et al. (2022), interview participants were given the choice to give permission to have their real names used and disclosed, as to acknowledge their valuable contribution made to this study (see annex). Given the cross-cultural aspect of this study, the measure was all the more important to ensure that epistemic vulnerability is not perpetuated by cancelling out voices from research participants as knowledge producers. Bearing in mind that, for this study, professionals with long-standing experience and expertise in the field were consulted, their consent and willingness to have their name made explicit for this study was deemed to outweigh any risk of association. ‘One could ask, is there a way we can be accountable to our relations, if we hide the people we worked with, if their knowledges are deprived of names and de-identified?’ (Ned et al., 2022, 47-48).

Two separate interview rounds were conducted. The first interview round sought to consolidate the available body of existing knowledge on seizure management and the international governance mechanisms related thereto, in order to gain a better understanding of current implementation and identified best practices. In this manner, the objective was to build on existing practical knowledge on what is deemed important, missing and worthy of further scrutiny. Independent experts were consulted representing a variety of positions, geographic locations, and professional agencies. One risk of this initial expert consultation was that based on the informant

⁶ Dead wildlife, parts and derivatives are prevalently seized. Live animal seizures are perceived as rare in all the countries examined.

TABLE 2 Key informants consulted according to their professional background (multiple affiliations included).

Key informant profile	No. of interviewees
Ministerial wildlife/environmental authority	3
(Wildlife) law enforcement authorities	10
Customs authorities	3
Zoos/sanctuaries/rescue centres	4
Museums	2
International organisations/regional bodies	2
Judicial authorities/prosecution	4
Research/forensic laboratories	4
Animal welfare/conservation NGOs	7
Wildlife trade and enforcement NGOs	5

selection, certain experiences or questions may not have been raised or may have received less attention. With this in mind, the interview round tried to comprehend a diverse set of experiences to offer a starting point for reflection on this subject. In total, 11 experts were consulted. Their responses were coded to identify initial themes relevant to seizure management, upon which further issues for consideration were added to the country study questionnaires.

The second interview round was specific to the countries and professionals were consulted, who either are directly implicated in one or all steps of the seizure recovery and management process on the national level, or collaborate on its aspects on the regional level. 15 key informants were consulted for Germany and for the Czech Republic. 11 key informants were consulted for Kenya and for Uganda. Responses were coded according to whether the seizure management referred to live animals or dead specimens and derivatives. The process was also broken down according to the countries. In a subsequent step, connections were traced between the different codes, examining how they are (inter)related, with a particular focus on comparing the saliency of categories.

Next to this, a documentary analysis was conducted of existing legislative and policy documents; grey and scientific literature and accessible seizure databases and reports; published local and specialist press stories; as well as written correspondences collected throughout the research process from actors, responsible authorities and gatekeeper institutions. The collected information was in the final step collated and triangulated with the results from the interview analysis to identify current needs and challenges, best practices and opportunities for change.

4 Findings

4.1 Kenya

In Kenya, all matters relating to wildlife law enforcement and trade are laid down in the [Wildlife Conservation and Management](#)

[Act \(WCMA\) Cap. 376 \(2013\)](#). The Kenya Wildlife Service (KWS) bears the main responsibility for enforcement and has the mandate to seize wildlife, keep seized trophies and audit them on behalf of the government. Seizures made by other enforcement agencies are handed over to KWS. This can happen regularly as particularly at borders, multi-agency teams are present. But as P#29 notes ‘[Seizure management] It’s a subject that, I think, a lot of actors who are trying to do interventions do not consider’. Steps to be taken with regard to seizures are not prescribed beyond mandates and that seized wildlife subject to speedy and natural decay are to be destroyed without needing to await the court’s orders. More recently, standard operating procedures (SOPs) were drawn up in collaboration with the Uganda Wildlife Authority (UWA) on the management of wildlife exhibits (P#28-29).

Initially, seized wildlife are stored in so-called “exhibit rooms”, which are usually secured custodial rooms of KWS. They can also be in a restricted zone of a court under the prosecutor, under the registry, or at the police station (P#27-29). However, KWS usually tries to avoid storage outside its premises. Storage facilities of other authorities are neither always well-administered nor equipped, which not only poses security risks but also can impede the prosecution of cases (P#28). While WCMA (2013) does not specifically stipulate that offenders are to pay for the costs associated with the management of seized wildlife, section 105 stipulates that a court may order that the cost of disposing of livestock or any other thing provided for in the subsection be borne by the person convicted there-under, which may or may not include the cost of disposing of wildlife trophies. According to key informants, however, costs of disposal or management are never factored in final court orders.

When it comes to live animal seizures, authorities usually try to produce them in court at the first arraignment to ask for disposal orders at the earliest opportunity. Admissibility of criminal evidence still constitutes a barrier to conscientious seizure management as presenting digital evidence can pose challenges. Although a new section (Section 78A) was passed into the Security Laws (Amendment) Act of 2014, which henceforth allows the admissibility of digital evidence at trial, it is not applied consistently across the country and cases remain often contingent on wildlife being produced in court ([Weru, 2016](#); P#29). Seized live animals may thus be held in limbo for the duration of the case. Very few enforcement authorities furthermore possess the necessary expertise and equipment to take care of wildlife. Training on live seizure management is often missing and there is a perpetual risk that wildlife experience further harm because they are not being handled or fed appropriately (P#28-30).

You find some of the species are going to be dying in that process. And I always find that very problematic because it [is] why you are actually even prosecuting these people in the first place (...) the issue is ensuring that species actually survive and are not killed through the criminal justice process (P#29).

After confiscation, when the animal is healthy, release into their natural habitat is preferred. Confiscated animals that cannot be released back into the wild due to health issues or other reasons are

placed in wildlife sanctuaries and rescue centres. The main facility is the KWS-run Nairobi Animal Orphanage (KWS, 2021; P#30). Confiscated animals may also be transferred to zoos and accredited wildlife institutions to participate in breeding programmes, research initiatives, or conservation education efforts. According to Kenya's most recent CITES implementation report (2021), the majority of confiscated animals are in fact placed in designated rescue centres and private facilities.

Dead wildlife, in particular trophies, constitute the main focus of management efforts in Kenya. When the case is concluded, the court gives an order for the wildlife to be handed over to KWS. Management options comprise mainly stockpile management and destruction (P#27-30). Further sale of confiscated wildlife or trade is prohibited under WCMA (2013). Stockpile management is handled by a distinct department of KWS that alone has access to the strong room as a security measure. The cabinet secretary is informed of the amount and provenance of trophies stored and may, when the storage is full, issue a process of destruction (P#28). When it comes to trophies, Kenya has pioneered the burning of ivory as the first country in the world (Nadal and Aguayo, 2016). Destruction includes first the crushing of ivory or rhino horn and then its burning to prevent it from re-entering the illegal market (P#29). Yet, not all wildlife is being destroyed and as has been remarked, storage facilities of the KWS are becoming full, which poses a risk to proper management and disposal. Destruction remains controversial and public support for destruction has been considered waning. It is publicly debated as whether the confiscated trophies should not rather be preserved for other purposes or used to raise conservation funding (P#27-29). The official government stance however remains set on destruction due to concerns over instigating a new poaching crisis.

We just need to move from this false dichotomy of choice of should you burn or should you keep until CITES allows you to sell (...) Countries should be encouraged to find different ways of commoditising or finding value out of their stockpiles. We should truly innovate solutions around how we make these seized items valuable. Without selling them, without trading them' (P#29).

A third management option for dead wildlife, although less applied, is the reuse of seized wildlife for research and education purposes. Some wildlife products are used for example by law enforcement authorities for training or to train detection dogs. Confiscated animal skins may moreover be repurposed by museums for stuffing and education (P#28; P#30). Alternative public uses for highly valued wildlife such as ivory or rhino horn in museums or education facilities have been however ruled out, as the security risks are deemed too high.

Under WMCA (2013), repatriation is not an option. Seizures are according to the key informants regularly communicated to other countries, when identified as such (P#27-29). Kenya itself has filed several requests for repatriation with regard to the large ivory seizures made in Vietnam, Thailand and China (EIA, 2018; P#28-29). But despite established international cooperation frameworks

and MLA requests filed, they were unsuccessful. Nevertheless, the repatriation of wildlife to the country of origin was generally deemed important and key informants made reference to principles of *in-situ* conservation, restorative justice, and national sovereignty. While cost has been noted as a constraining factor, key informants nevertheless highlighted that in the case of Kenya's own requests, Kenya was prepared to bear the costs (P#28-30). The failure to reach repatriation was mostly attributed to the unwillingness of confiscating countries to repatriate the wildlife back (P#28-29). Repatriation was mostly mentioned in relation to dead wildlife and only when it was considered valuable (P#27-30). In the context of Europe, trafficked wildlife is not deemed valuable enough to warrant a repatriation request.

It's very rare. You're seeing cases rerouting through it, it's often transiting, not as a final destination as such. And not for the kind of species that a lot of African countries are so bothered about. So it's mostly birds, pet-like, you know, wildlife (P#29).

Species identification to determine the type and provenance of wildlife proves to be a reoccurring challenge (KWS, 2021). There are very few forensic experts in the country able to provide expert evidence. Ivory and rhino are usually taken to the National Museums of Kenya for identification purposes, even though KWS established a new laboratory for forensic and genetic analysis. The capability for analysis still remains limited, however, as DNA databases continue to be built (KWS, 2021; P#29). Other challenges that have been raised in reference to seizure management overall include interagency conflicts that may arise due to competing mandates on one hand, and the insufficient understanding of existing legislative frameworks, policies and procedures, on the other hand. This has resulted in some cases in "turf wars" between various law enforcement agencies, as well as between wildlife management authorities when they are operating in the same place (P#28-29). But above all, stockpile management issues the greatest challenge. Discrepancies in management standards prevail, with many storage facilities away from the centre not being up to par (P#29-30). Corruption is pervasive, facilitated by weak accountability mechanisms at all stages from crime scene to confiscation management (MTWA, 2020; EIA, 2018). 'Sometimes they leak information to the smugglers (...) Sometimes, like I said, this ivory tends to disappear within the strong rooms.' (P#27).

4.2 Uganda

In Uganda, measures to be taken with regard to wildlife seizures are prescribed by the Uganda Wildlife Act (2019). The main authority on wildlife law enforcement is UWA, who is the custodian of all wildlife and has the mandate to conduct seizures. Certain aspects of enforcement are moreover done in collaboration with other enforcement agencies. When wildlife is seized by authorities other than UWA, they are required to notify UWA within two days. Wildlife are then usually taken to the nearest UWA facility or otherwise to a nearby police facility for safe custody,

where they are marked, numbered, and recorded as exhibits. When the hearing starts in court, the magistrate requires the wildlife to be brought physically on-site. One prevailing challenge in this respect is the storage capacity available for the temporary storage of wildlife (P#31-33).

The Chief Magistrate's office, it's actually operating as an exhibit store. Why? Because the police stores are full. The wildlife agencies are full. Now some of them are being kept in court precincts. And it's a security risk (P#29).

The seized wildlife usually therefore remains in court until the case is disposed of, at which point it is transferred back to UWA (P#31-32). While the Uganda Wildlife Act (2019) does not stipulate that offenders are to pay for the costs associated with management, compensations are in some cases requested by prosecutors for the incurred cost that the enforcement authority has gone through to investigate and prosecute this case. But as P#31 remarks, this is a new practice that has really developed in the last four years.

The management of confiscated specimens falls to the Executive Director of UWA. When it comes to live animals, the preferred management option is to return the animal to its natural habitat, when deemed capable to survive on its own. When deemed incapable of surviving in the wild, management options include (1) the donation of the specimen to a recognised educational, zoological or scientific institution, either for payment or free of charge; (2) keeping the specimen in captive management in own custody and (3) the "destruction" of the specimen (Uganda Wildlife Act, 2019). In practice, confiscated live animals are brought to the Uganda Wildlife Education Centre (UWEC) zoo in Entebbe, which is the mandated facility to conduct the rescue, rehabilitation and release of wild animals (Rossi, 2018; P#30; MTWA, 2021). According to the 2019-2020 implementation report (MTWA, 2021), the majority of confiscated specimens are placed there. Time is considered crucial in the management of confiscated specimens. Management decisions are usually expedited to ensure that animals stay alive and to prevent any further harm and stress. Yet, since UWEC is the only available facility for confiscated wildlife, challenges can arise as to getting the confiscated animals there (Rossi, 2018).

We had to struggle trying to know what kind of food these birds could be fed as they were quickly being moved to UWEC. But of course, we lost, I think, three or four birds in that process of handling. You had to mobilise transport to ensure that the birds are moved around 400 kilometres. So, it really takes a bit of arranging (P#32).

Dead wildlife constitutes the main focus of management efforts also in Uganda. When confiscated, UWA decides on the management of the wildlife in consultation with the Ministry of Tourism, Wildlife and Antiquities. Management options include (1) destruction; (2) donation to a scientific or educational institution; (3) sale of the wildlife either in its entirety or in part; or (4) stockpile management (Uganda Wildlife Act, 2019). But in practice, wildlife

is mostly kept in safe custody and stored away (P#27-30). Destruction is practised only with regard to bushmeat or other perishable foods and derivatives (P#29; P#31). Although sometimes enforcement authorities may also take advantage of confiscated meat to feast on it (P#32). Trophies are stockpiled as their sale is prohibited and the government opposes destruction.

It's a political discussion. Ivory is a high price product (...) UWA has found itself stuck with huge piles of ivory and other specimens or trophies, mainly because the government has not made a strategic decision (P#31).

Destruction remains a contentious issue on the national level, as well as on the broader regional level. The challenge therefore is the provision of adequate storage facilities. A new ivory strong room was built in 2016 and available resources strengthened, including the establishment of a wildlife crime task force and a specialised wildlife crime court, the development of SOP guidelines for exhibit management and the expanded use of forensic analysis (MTWA, 2021; EIA, 2018). But as P#33 notes, there is only so much these measures can do. 'You can't fight corruption with capacity-building; What you need to have is to completely remove it from the equation. Our problem is corruption. It's not about capacity'. Corruption remains pervasive and stockpile thefts and leakages have been recorded since 2000 (EIA, 2018).

Alternative uses for research or education purposes through donation are not practised to the knowledge of those interviewed. Repatriation is not considered a management option under the Uganda Wildlife Act (2019) and also according to key informants, it is not practised. While the majority of the bigger past ivory seizures have been identified as not coming from Uganda, no repatriation took place as to these particular countries. Nor have any of the interviewees heard of any demands for repatriation by other countries for any of the wildlife seized in Uganda. Similarly, some of the ivory that has been seized in Kenya and Tanzania, have been identified as coming from Uganda in the past. But also there, repatriation has not been enacted (P#31-32).

Possible barriers to repatriation raised by key informants included the lack of resources of some countries to lay claim on wildlife confiscated in other countries, the lack of established frameworks to facilitate international cooperation, as well as the missing capacities by many to conduct proper forensic analysis (P#29-33). In the case of Uganda, key informants felt that many seizures, even when the source country has been identified, are not necessarily disseminated. Uganda's own framework was also noted to be old and in need of review to facilitate international cooperation (P#31). But generally, no great interest to engage in repatriation for its own wildlife was expressed.

The absence of a forensic lab and incapacity to use forensic technology to support investigations was raised as a big shortcoming (MTWA, 2021; EIA, 2018). While large ivory seizures have been sent to the US for DNA analysis, smaller seizures are usually left be as they are believed to stem from Uganda (EIA, 2018; P#32). For other seized wildlife, local experts are consulted to provide species identification at court. In this

regard, the pioneering of mobile scene of crime kits for testing seizures was noted as instrumental in supporting national casework. But generally, forensic analysis was deemed to fall short, impacting the prosecution of wildlife crimes (P#32).

While interagency cooperation has been stepped up, especially between the different wildlife and security authorities, still more needs to be done also to raise awareness (P#30; P#32-33). 'I put emphasis on awareness, on training and on strengthening intelligence proactively to deal with these things. I don't want to always do post mortems' (P#32).

4.3 Czech Republic

In the Czech Republic, steps to be taken with regard to seizures are prescribed by Law 100/2004 Sb. (*Zakon o ochrane druhu volne zijicich zivocichu a plane rostoucich rostlin regulovanim obchodu s nimi a dalsich opatrenich k ochrane techto druhu a o zmene nekterych zakonu (zakon o obchodovani s ohrozenymi druhy)*, 2009), which gives instructions as to which actions are to be taken by which actors, procedural deadlines and contingency plans. The Ministry of Environment acts as the main executive body and is responsible for overseeing the management of confiscated wildlife. The Czech Environmental Inspectorate (CEI) meanwhile conducts enforcement on the ground with CEI wildlife inspectors having the competency to do inspections, impose fines, seize and confiscate specimens (Law 100/2004). When other enforcement authorities intercept wildlife, they inform the CEI to determine measures to be taken.

Some tensions and discrepancies can nevertheless be observed when it comes to the operationalisation. As far as exports are concerned, the situation tends to be more complicated as the infrastructure does not allow for easy inspection. It is also foreseen by law that seizure management costs are to be recovered, but this is not enforced. 'I don't know if the amendment may not be removed, because it is impossible to implement in practice (...) It just seems unnecessarily bureaucratic an effort' (P#12).

When it comes to live animal seizures, the CEI must report the case to the appropriate veterinary authority and transfer the wildlife to a rescue centre (Law 100/2004). The Czech Republic has designated CITES rescue centres specialised by taxon. They are licensed by the Ministry of Environment, and in most cases belong to the zoo. One major challenge is that rescue centres are not obliged to receive seized wildlife. As many are overloaded, it happens fairly often that they refuse to take care of new animals.

They simply do not want to. There can be a number of reasons, the specimen may require to be quarantined, or spoken again bluntly, the animal simply may not be interesting (P#12).

It becomes therefore often necessary to consider alternative placement options including 'any other rescue centre that is willing to take the specimen in. Even if the rescue centre is not directly approved for the respective species' (P#12). Zoos may be contacted but institutional unwillingness is also there a barrier to placement. Private animal keepers and breeders are occasionally also considered, especially when large quantities of animals are seized, as rescue

centres and zoos often do not have the capacities to accommodate them all. It may even be that when an animal should be seized and removed from the owner by law, it is left there for want of a more suitable placement (P#12; P#14). Given that rescue centres are specialised by taxon, the placement of certain species also presents difficulties, in particular large carnivores such as big cats and bears, as well as aquatic specimens (MZP, 2023, 2021; P#12-13).

In the case of birds from outside the EU, it is compulsory to place them in rescue centres with approved quarantine facilities (MZP, 2020). But according to key informants, there is no such facility, or at most one, that meets this requirement. To overcome this situation, it has become common practice to call veterinarians ahead to the rescue centre that has no such quarantine facilities, so that they can inspect the wildlife and decide whether or not they can be placed inside. In view of the risk of infection, however, a number of zoos have ceased their activities as rescue centres and have withdrawn from their charge (Potucek, 2013; P#12-13).

When confiscated, their management falls to the Ministry of Environment (Law 100/2004). According to the ministerial directive MZP 08/2018, a tender process is organised to redistribute all confiscated specimens, dead and alive. A valuation commission determines an estimate price for this purpose. Since redistribution is free of charge, the valuation is intended to serve only as a record price, to be stipulated in the donation contract. Live animals are recommended for transfer to zoos, rescue centres or other approved private facilities. For native wildlife which also falls under Law 114/1992 Sb., release to the wild is to be considered in priority. Releases to the wild remain rare, however. Confiscated animals are usually donated to a zoo or even kept by the rescue centre where the animal was placed initially (P#12-14). Euthanasia is not considered a management option. Although the national action plan on IWT formally allows the preventive culling of imported birds from outside the EU, when approved by the State Veterinary Authority, due to missing quarantine facilities (MZP, 2020).

Dead wildlife, parts and derivatives are at first stored at CEI for safekeeping. When a certain level of storage has been reached, the wildlife is transferred to the Ministry of Environment, whose storage capacity is even more limited (P#12-13). For dead specimens, the Ministry may recommend the transfer to facilities where they can be used for scientific research, environmental education and/or awareness-raising. Priority is in this regard given to ministerial departments, CEI, the CITES Scientific Authority and customs authorities. Only if these state authorities do not express an interest, are other public institutions considered, such as research institutes, museums, schools, and zoos. Further redistribution to others in return for payment is prohibited.

We put to use some of the more interesting commodities we seize (...) Environmental education, that is the buzzword. That's what we use the confiscated specimens for. Not only the dead specimens, also the live specimens are used for environmental education, as they are in zoos (P#12).

Repurposing wildlife often evoked a dichotomy where value, especially reparative value, was attributed while at the same time

any association with value was being removed. This was particularly visible in relation to dead wildlife and the underlying demand for purpose. If the wildlife cannot be redistributed due to poor condition, biosecurity risks or if no one expresses an interest in the confiscated specimen, destruction may also be considered (MZIP, 2018). In the past, seized rhino horn was thus burned in a coordinated manner with other countries in an attempt to signal that it has no value and should not be commodified. Similarly, a public burning was initiated for dead snakes contained in tonics and liquids after tender processes were unsuccessful.

Repatriation is generally not considered a management option. 'Our national legislation does allow for that option, we just don't implement it (...) I cannot even imagine how we would be able to repatriate a specimen that we seized at the border' (P#12). Practical challenges were stressed to outweigh the possibility to consider repatriation and interest in repatriation by other countries has not really been registered. Putting confiscated animals, when suitable, into rescue programmes was considered more promising. A further barrier was also the lack of trust with regard to some countries' intentions. 'You need a contact whom you trust that the animals really will end up in nature and won't reenter the illicit market. So, it really almost never comes to repatriation' (P#13). Key informants were doubtful that seizures are regularly communicated to source countries, even if identified. Barriers to formal international cooperation and difficulties in obtaining information from other countries were also noted (MZIP, 2020).

Overall, some leniency and flexibility were emphasised to accommodate more uncommon cases. One such example presented the seizure of a white tiger in 2022 and in 2023, which gave way to new collaborations, including between the Czech Ministry of Environment and the animal welfare organisation FOUR PAWS for finding a suitable placement. While temporarily placed in Zoo Hodonín, the tiger was transported in the end to the wildlife animal sanctuary TIERART in Germany that is specialised in wild cats (P#22-23). Another case in point was the seizure of 70,000 glass eels in 2019, which were in the end released into the Czech river system in cooperation with a fishermen's association (MZIP, 2021).

4.4 Germany

In Germany, the Federal Nature Conservation Act (BNatSchG) and the Federal Species Protection Ordinance (BartSchV) are the main instruments of wildlife trade regulation. Enforcement presents a particular case given the federal structure of Germany. The Federal Agency for Nature Conservation (BfN) is the central enforcement authority on the national level, mandated to oversee all authorisations relating to the import and export of protected specimens, and responsible for the management of confiscated wildlife. Federal state authorities share some responsibilities on dealing with wildlife and trade, including monitoring and the prosecution of violations. The responsible structures vary from federal state to federal state. In total, there are 238 enforcement authorities within Germany (Gehrmeyer, 2021; Sina et al., 2016). The fragmentation of national enforcement approaches constitutes

a major challenge for seizure management. Data is often not centralised nor collected uniformly across the federal states and some authorities do not have the appropriate tools to even do so (TRAFFIC, 2023).

Standard practices for short-term management and the temporary placement of seized wildlife differ from authority to authority (P#18; P#26). Management options cited in legislation include the in custody taking of wildlife by customs authorities, entrusting the specimen to a third party or leaving it in the possession of the owner under prohibition of further disposal. At the airport Frankfurt, which has the highest wildlife seizure records in Germany, seized live animals are brought first to the animal lounge, a private service company which facilitates the transport of live animals, as they also have quarantine facilities on-site (Hessisches Landeslabor, n.d.; P#18). The placement there is generally followed by a transfer to a nearby rescue centre or zoo. Other airports meanwhile place seized wildlife directly in zoos or facilities with quarantine facilities. Placement can however pose significant challenges as rescue centres and zoos are often overloaded and quarantine facilities remain rare. Animals may thus also be placed with private breeders, but this is mostly seen as a last resort, as is the placement of animals with the owner (P#16-19; P#22-25).

It has always been the question of finding a suitable final home for the animal, in order to even go through with the seizure. In many cases it also plays into the decision-making because, after all, what shall the authorities do if they do not manage to find a placement for it after seizing it? (P#23)

It's the most common reason why seizures do not work out. Because there is a lack of placement options. The demand surpasses the available places by a large margin unfortunately (P#22).

Dead wildlife are often temporarily stored in customs storage facilities or in facilities that provide expert consultations, in museums and research institutions. 'Fortunately, more products get confiscated than live animals. It would be harder if more live animals were confiscated. Products can just be put on the shelf' (P#16). It is important to note that under BNatSchG (2009), it is stipulated that the owner has to bear the costs for seizure management. To what extent this is enforced is however unclear. According to some key informants, customs authorities rarely request cost reimbursements for the management of dead wildlife (P#16-18). With regard to live animals, when brought to zoos or rescue centres for temporary placement, the costs are in some cases reimbursed. Experiences varied however, with some facilities issuing invoices for caretaking provided, while other facilities mentioned that authorities provide no financial support (P#19; P#22-23).

When wildlife is confiscated, the responsibility for management is transferred to the BfN or to the federal authorities of the state concerned. Post-confiscation management is not prescribed by legislation. In practice, live animals are almost always placed in captivity, preferably in scientifically managed zoos. There are no state-organised facilities and the authorities are therefore dependent on zoos. According to Germany's latest implementation report

(BfN, 2021), the majority of confiscated animals were either returned to the country of export or placed in public zoos, designated rescue centres or approved private facilities. In particular, with very rare species, zoos are prepared to take them in to see if they could not be included in a breeding programme (P#18-19; P#25).

Some success stories have thus been recorded, for example in the case of confiscated lizards and tortoises that had been smuggled into Germany from the Philippines, and were rehabilitated in Cologne Zoo, where they were able to reproduce successfully (Koelner Zoo n.d.; Hauser, 2023; P#24). Finding a permanent home can be difficult as many zoos, rescue centres and sanctuaries are already full and do not have the capacity to take in more wildlife. Authorities may therefore also contact private breeders or facilities abroad. But as several informants noted, animals are at times kept for too long in temporary shelters under conditions that are not adequate for long-term care (P#18-19; P#25). Euthanasia is not considered a management option.

Dead wildlife, parts and derivatives are generally stored or redistributed between facilities for research, education or training purposes. For some wildlife, immediate destruction is practised for health and biosecurity reasons, particularly when food such as bushmeat is involved. With regard to redistribution, in the event of transfer, the BfN or the federal authority concerned retains ownership of the specimen for five years. The loan is recorded in a contract, together with the purpose of the loan. During this period, the specimen may not be redistributed or used for any other purpose. It is only after five years on loan that the specimens become part of the facility's exhibition reservoirs (P#20). This can be especially frustrating for museums, which are also not allowed to exhibit the specimens during this period, as it is strictly forbidden to make any commercial profit from the wildlife. Other issues raised in relation to storage included the lack of adequate, available and secure facilities. Many storage facilities do not have the necessary conditions to prevent damage to stored wildlife, nor are specimens kept and recorded to standards that would allow quick location (P#15; P#20-21; P#25).

Repatriation is generally not seen as a viable management option and no records are kept as it happens too rarely (P#15-25). On one occasion, repatriation was initiated following the seizure of Karo turtle eggs, a highly endangered species. Frankfurt Zoo managed to hatch them and, as the turtles are highly endemic to a small area, and on the initiative of one biologist in particular, the turtles were repatriated and reintroduced into their original habitat (P#18-19). Key informants noted that often only seizures of critically endangered or highly endemic species are communicated to the country of origin, when identified. However, here too, contacts are often lacking and it is not always clear who best to contact (P#16-18). Practical challenges were stressed, such as difficulties to ascertain the provenance of wildlife, the suitability of the animals to be released and funding. Interest in repatriation by other countries has been registered only regarding live animals (P#12-13). For dead wildlife and derivatives, repatriation was denounced as serving no purpose unless the wildlife is of cultural importance (P#15; P#20).

The first question would be, if the country of origin has any sensible purpose for this animal or any sensible placement facility. If the animals would just end up being thrown into a bush somewhere, then this would not constitute any useful contribution to species preservation. That would not be a good deed, even though it might appear so on the first glance. Repatriation can be the best option in certain circumstances but it is often not the best option (P#19).

A number of challenges and areas of tension were also raised in relation to species identification and available forensic analysis capacities (BfN, 2021). It was noted that customs authorities often are assumed to have the expertise to be able to identify protected wildlife species, with any shortcomings seen as a criticism and limiting the opportunity for further specialist training (P#18; P#21). Another limiting factor often cited was the cost of forensic analysis or even consultation, in particular when more than one type of wildlife is apprehended (P#15; P#20-21; P#25). 'I said that I cannot do this species identification and that another expert would be needed. So, they just left it there. It would have been too much, in reality they just can't do everything' (P#15). In most cases, it is dependent on the individual networks of the authorities themselves which experts are consulted. A general lack of experts and forensic laboratories available to provide expert advice on wildlife has been noted, with some species not even being able to be identified (P#15; P#18-21; P#26). As several informants pointed out, the central database provided by the BfN to help authorities find a suitable expert for species identification is not up to date and therefore, to some extent, obsolete.

5 Discussion

The management of seized and confiscated wildlife is as can be seen nuanced and links to many factors. In order to deliberate on the present state and barriers to efficient implementation, it is necessary to understand the legal and administrative framework underpinning national practices and the specific context in which such practices are implemented. Since seizure management is primarily a national enforcement issue and very much embedded in situational contexts, comparisons are useful only to some degree for a better understanding of wildlife crime responses. Differences are visible in relation to seizure recovery, regulatory frameworks, the actor landscape and management options provided, as well as implementation. As foremost a source and transit region, seizure recoveries are often not only related to border management in East Africa, but also to poaching incidents, while Central Europe as foremost a transit and destination region, is rather concerned with border management and wildlife ownership. The emphasis placed thus differs as much to the context in which the activities are conducted but also to the wildlife itself. But parallels are also visible, in the case of Central Europe and East Africa, accountability and transparency in wildlife seizure and confiscation management remain an issue, as low prioritisation, resource allocation and

infrastructure remain wanting, and international cooperation mechanisms continue to operate in a disjointed manner. While regional cooperation initiatives have strengthened joint international enforcement and communication on IWT, collaboration on seizure management remains weak, with some success registered in East Africa with regard to developing best practices and forensic analysis, and in Central Europe, with regard to finding an appropriate home for seized live animals. Recent studies have begun to disentangle the processes of commodification, victimisation and exploitation inherent to IWT (Nurse and Wyatt, 2020). Yet, as made visible by the results, in exploring these kinds of social processes, it becomes clear very quickly that commodification arguably remains a central aspect in the handling of wildlife also upon and following confiscation as its value properties become renegotiated. Value is not necessarily monetary, even though it represents the most common form of valuation with far-reaching consequences also on other forms of value (Castree, 2003). The commodity value, similar to conservation value, is constructed, among other things, in relation to the animal species themselves, which in turn also has its bearing on management. Animals are valued by humans in very disparate ways with attractive species on the verge of extinction often placed at the top (White, 2011). The language and selectiveness behind seizure management can in some instances cast doubt on the claim that wildlife are fully decommodified once they are confiscated. While confiscated wildlife may generally not be traded as commodities any longer, their management remains often connected to the notion of (commodity) value or even to economic cost-benefit analyses.

When it comes to the management of dead specimens, Central Europe seems to place a value on repurposing confiscated specimens for education, research or training purposes. As many informants have pointed out in this regard, even if the specimen cannot be brought back to life, there is a reparative value in using them to train law enforcement and raise awareness on the harms of wildlife crime. At the same time, from the responses and constant references to valuation made, it is clear that the commodification process has not halted with the seizure of wildlife. In fact, a kind of schizophrenia prevails when talking about dead wildlife, as on one hand, authorities are adamant about dead specimens having “no value”, with measures taken to negate their black market price and to prevent their laundering back into the illicit market, while, on the other hand, management options are often contingent on the relative “value” the specimens in questions have, with certain specimens being prioritised and even in the case of the Czech Republic, price estimations made. This dissonance is even more visible with regard to East Africa, where the management of dead specimens, in particular trophies, is the central focus of attention when dealing with seizure management, with management options often halting at the value attributed to the wildlife.

Overall, transparency and accountability in seizure management needs to be improved in both regions. The lack of adequate infrastructure and shortcoming to available resources have been raised by all countries respectively, with many pointing to the repercussions these have with regard to animal welfare, and

meeting conservation and security needs. Indeed, as seizure management is not prioritised, management of confiscated wildlife often falls back to pragmatism and choosing the most appropriate option under constraints. Seizures, in particular of live animals, may not even be conducted out of fear that no appropriate management can be provided. While some innovative solutions have been found to cope with certain shortcomings, it is clear that more needs to be done if management is to be effective. Likewise, it is evident that in many cases it is also a question of case-specific and situated measures, as one-size-fits-all solutions can have their drawbacks. On the other hand, the lack of uniformity in enforcement responses also has its shortcomings and thus interagency and international cooperation is essential to overcome silos.

While all the countries have frameworks to guide at least part of the seizure and confiscation process, gaps were nevertheless to be found in all of them. Indeed, even though Europe is often hailed as having more developed structures and regulations in place, guidelines, whether in form of regulations or SOPs, for how to manage specimens once confiscated were glaringly missing. In contrast, the Uganda Wildlife Act provided a rather detailed framework and contingency planning for different stages ranging from the seizure of wildlife through to its management post-confiscation. But as evident from all the data, there is no need to develop further frameworks and streamline measures when the basic infrastructure is missing as the best meaning frameworks are of no use when they cannot be operationalised. ‘If you’re not giving the resources to do confiscations, then there’s no use in a confiscation strategy. It just doesn’t have any impact at all’ (P#7). Or, put even more bluntly, ‘No amount of new international law will change the fact that this store is crap’ (P#29).

5.1 Repatriation put into perspective

In general, repatriation is not practised by any of the countries examined. As a management option, it is only mentioned explicitly in the frameworks of Germany, the EU and partially, the Lusaka Agreement. Even so, what has become apparent is that even for the actors involved, there seems to be minimal awareness of any efforts or demands made in this regard. Repatriation is not considered a practicable option by most, even though the emphasis placed by the different regions differs to some extent. Commonly raised was the fact that cases for which repatriation would be viable are rare in themselves. Records of repatriations are therefore also not kept, which hinders further understanding of the matter.

One major barrier hindering repatriation that was consistently raised was the difficulty to establish the provenance of seized wildlife. This was raised as much on the international level by the experts consulted, as on the national level across all case studies respectively. Forensic analysis is not standardised and resources and capacities to do so are not always given. This has been identified as a major limitation in East Africa, as it impedes crime scene management and above all, the prosecution of wildlife crime. Available capacities to conduct such analyses are limited, with

centralised operating laboratories overstretched or missing. Even for non-DNA analysis, experts are not necessarily readily available for species identification. Similarly, in Central Europe, capacity and resource issues have also been raised, with the cost of analysis often being prohibitive to analyse all wildlife seized. Depending on the wildlife seized, few experts may be available. Even when resources are available, it was raised that the information on service providers is often not centralised or up-to-date for enforcement authorities to easily identify whom to contact. As a result, species identification often falls back to individual contacts and relies in most cases to morphological identification, with phyloforensic analysis left to particularly “valuable” cases.

Resources were also commonly raised as impeding countries to even attempt repatriation, although some key informants also mentioned that repatriation requests were denied due to fear of costs in the confiscating country. This seems to indicate that the understanding of the procedures surrounding international repatriation may be in some cases limited, since exporting countries are in principle not obliged to pay. Unwillingness to pay thus certainly figures as a main barrier, although as can be seen in the case of Kenya, repatriation may still falter even if the country requesting repatriation is willing to pay and has put everything in place for transport. Commonly raised in relation to resources was also the value of the animal in question. Repatriation was generally not deemed as interesting or viable for all animals and many therefore underlined the need to conduct such processes only for wildlife species of high (conservation) value. Indeed, particularly key informants in Germany and Czech Republic dismissed the idea of repatriation for all but the most endangered species. While most informants raised animal welfare as well as conservation concerns in relation to repatriation, the latter was perceived as the more pressing and excluding therefore many animals from being considered for repatriation.

Many also raised in this regard their doubts about the source country being able to provide adequate care to the wildlife, if repatriated. Indeed, the lack of trust toward source countries was echoed by many informants in Germany and Czech Republic, sometimes in relation to the lack of available facilities, and other times, in relation to the lack of trust that these specimens will not be laundered back into the illicit wildlife market once repatriated. The lack of good relations and trust was also highlighted by the interviewees in East Africa. While corruption was also perceived as a problem in ensuring orderly repatriation, some also expressed their doubts if the confiscating countries were not keeping the wildlife for their own interests. Unwillingness to repatriate was therefore perceived as the bigger challenge, even when frameworks to cooperate internationally are in place.

While several key informants and consulted experts made reference to the need of established mechanisms to facilitate international cooperation, a point also highlighted by Liu (2023) and de Vries and Anderson (2022), when questioned specifically about Kenya and Uganda, interviewees generally concurred that mechanisms are in place. International communication and cooperation on repatriation should in theory therefore be possible. The fact that in

practice this is not the case therefore suggests that other factors are more salient. Finally, individual championing was highlighted as essential for repatriation but also for seizure management overall to work. Since repatriation is not considered a viable management option per se, with many countries not automatically communicating on seizures, any effort committed to go this “extra mile”, therefore, goes back to individuals pushing for repatriation to happen.

Individual decision-making is probably more powerful than any process. Because a lot of the countries you’re dealing with in the illegal wildlife trade do not have that level of resources to deal with these things in a process. They tend to be done by subjective decision-making (P#7).

6 Limitations and paths forward

While the study was from the beginning led by practitioners’ perspectives, it unfortunately also set clear limitations on how far this study could research given realities and underlying dynamics. The need to trace wildlife post-confiscation management already from the point of seizure, an important distinction that remains invisible in the general treatment of wildlife law enforcement, meant that the centre of attention shifted forward placing the emphasis on management practices and challenges rather than revolving around a profounder treatment of repatriation. This was further reinforced by the many barriers to information and access, which surround this area of study. Repatriation remains rare, with many actors in positions relevant to such undertaking either not being informed or not willing to share too many details on the process itself. The former was particularly noticeable and suggests short institutional memory and lack of transparency, which, after all, seems to pervade all aspects related to wildlife seizure management. Consequently, this study deliberated in the end mostly conceptually on repatriation and further research is necessary to unravel the many dimensions and complexities of this particular criminal justice response.

Data representativeness remains another important limitation. While the utmost was tried to complement any data gaps and shortages in interviews, with information obtained from written correspondences, this variability of data collected and also of data sources needs to be acknowledged for each country study. There is also a limitation with regard to the national and regional aggregation of findings. First, while seizure management remains a national enforcement issue, the implementation remains in many cases fragmented due to the number of enforcement authorities involved, the site of seizure or simply, given by territorial fragmentation (as for instance in Germany, where enforcement is also a matter of federal states). Any conclusions on implementation on a national level are therefore limited in their representativeness. Secondly, given the nature of wildlife crime and increasing regional cooperation on this matter, it is necessary to examine regional

experiences. Nevertheless, for a more comprehensive regional overview all countries in the region should be included for further study as experiences may differ substantially. A case in point is East Africa, where even SOPs were developed together between Kenya and Uganda for exhibit management but which have entirely opposing policies as to the management of trophies.

As illustrated, seizure management represents a unique field of research that is rich in information, tension points and inconsistencies. The research objective was to collect insights into seizure management practices on the ground, taking into account extant enforcement and conservation needs, the efficiency of applied mechanisms, the barriers encountered in their use and resulting opportunities and implications. By laying this much-needed groundwork for understanding seizure management in practice, opportunities to build on this work to investigate more substantive questions around conservation, environmental and restorative justice are created. Furthermore, the characteristics of how and whether (de)commodification comes into play in the management of seized and confiscated wildlife vary and therefore deserve to be studied in greater detail. It is however clear that substantial changes need to be put in motion in order to ensure that wildlife seizure and confiscation management operates effectively as a criminal and environmental justice response to IWT, and does not in fact add to the violence and injustices committed against wildlife.

It is important to consider both the potential benefits and ethical considerations associated with each approach. There are always concerns about these [wildlife] ending up back in the illegal markets. Any use of confiscated wildlife should [yet] be carefully evaluated to ensure that it aligns with conservation goals (P#30).

Data availability statement

Generated datasets include interviews which have been collected confidentially. According to the participant agreement sheet, they cannot be shared with third parties. Requests to access the datasets should be directed to annaxsaito@gmail.com.

Ethics statement

Ethical approval for the studies involving humans was not required by the Department of Social Sciences of the University of Hamburg. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AS: Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcosc.2024.1489314/full#supplementary-material>

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Jason Kirkey,
Smithsonian Conservation Biology Institute
(SI), United States
Dauda Ayomide Onawola,
Independent Researcher, Kaduna, Nigeria

*CORRESPONDENCE

Bright O. Olunusi
✉ brightolunusi@gmail.com

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Wildlife trade dynamics: exploring bushmeat market with a view toward social and ecological justice in Ibadan Metropolis Nigeria

Bright O. Olunusi^{1,2*}

¹Department of Earth and Environment, Boston University, Boston, MA, United States, ²Department of
Wildlife and Ecotourism Management, University of Ibadan, Ibadan, Nigeria

This study examines the bushmeat trade in Ibadan Metropolis, Nigeria, through the lens of environmental justice, focusing on sustainable livelihoods and wildlife conservation. Environmental justice in this context seeks to ensure fair economic opportunities for bushmeat marketers, predominantly women (93%), while protecting vulnerable wildlife species. The surveyed marketers—90% of whom were married—face social inequalities, with only 50% having secondary education and 10% lacking formal education. Most marketers sell bushmeat to household consumers and travelers, raising concerns about the potential spillover of wildlife products beyond Nigeria's borders, with implications for conservation and zoonotic disease risks. ANOVA results show that greater experience leads to higher profits from species like grasscutter (*Thryonomys swinderianus*; $P = 0.005$) and Nile monitor lizard (*Varanus niloticus*; $P = 0.001$). As key species such as West African crocodile (*Crocodylus suchus*), African leopard (*Panthera pardus*), and ground pangolin (*Manis temminckii*) decline in availability in traditional hunting grounds, this study emphasizes the urgent need for conservation policies that promote sustainable trade practices and provide alternative livelihoods. These strategies would advance the science of environmental justice by reducing pressure on wildlife (ecological justice) while ensuring stable incomes for marketers (social justice).

KEYWORDS

biodiversity loss, bushmeat trade, conservation policy, environmental justice, market dynamics, sustainable livelihood

Introduction

Bushmeat is defined as the meat of wild animals stemming from the hunting of wildlife (Olunusi et al., 2022). The bushmeat trade is a complex phenomenon that intersects various aspects of socioeconomics, market dynamics, and environmental conservation. A major focus of existing studies revolves around the diversity of bushmeat species traded and the market values, with particular attention to the dominance of certain species such as the grasscutter, also known as the greater cane rat (*Thryonomys swinderianus*; Malik et al., 2019). These studies suggest that correlation between the availability and demand for specific wildlife species influences the economic dynamics of the market (Oduntan et al., 2018).

The concept of environmental justice is relatively new in the context of the wildlife trade in Nigeria, particularly regarding the bushmeat trade. While this research did not explicitly investigate environmental justice as a formalized field of work or use specific terms traditionally associated with the concept, it explores the practical indications of environmental justice within the specific context studied. Environmental justice generally refers to the equitable treatment and meaningful involvement of all people, regardless of income, gender, race, or other factors, in environmental decision-making processes that affect their lives and health (United States Environmental Protection Agency, 2024). In this study, environmental justice is understood in practice, particularly as it relates to the vulnerabilities of bushmeat traders, the sustainability of natural resources, and the socio-economic factors that shape the trade.

The bushmeat trade in Nigeria presents several layers of justice concerns, including social justice and ecological justice. Social justice refers to the gender dynamics and economic inequalities that affect traders, especially women who dominate the marketing side of the trade but are often excluded from the higher-profit roles such as hunting (Babalola, 2023). On the other hand, ecological justice is the ethical responsibility to protect ecosystems and species. It involves ensuring that wildlife species are not overexploited to the point of endangerment or extinction, thus maintaining ecosystem balance (Gaubert et al., 2023). The overharvesting of certain species, such as ground pangolins (*Manis temminckii*) and chimpanzees (*Pan troglodytes*), in the bushmeat trade is a direct violation of ecological justice, as it threatens the biodiversity and sustainability of natural habitats.

The economic viability of the bushmeat trade is another focus of research inquiry. Oduntan et al. (2017) highlighted income differentials among various classes of bushmeat, with mammals contributing significantly to total income of bushmeat trade in Oyo State. Profitability rates, as estimated by Soaga et al. (2014), demonstrate the economic viability of the trade, providing traders with substantial returns on investment. Recent study by Olunusi et al. (2023) highlights that consumer preferences for bushmeat, are driven by its nutritional value, taste, and affordability. As a result, despite efforts to reduce the trade, it continues due to ongoing consumer demand.

Although the bushmeat trade provides economic benefits, it faces some challenges such as seasonal fluctuations in supply and environmental concerns. Halidu (2019) discusses the potential negative impact of unsustainable bushmeat trade on biodiversity

conservation and recommends measures such as awareness programs and law enforcement. The depletion of wildlife in national parks due to unregulated trading activities is also of significant concern in Nigeria (Malik et al., 2019).

The specter of zoonotic diseases transforms regional bushmeat harvest and trading into an activity of global concern, due to the potential for disease spillover from wildlife to humans. For instance, a study by Olunusi et al. (2023) emphasizes the importance of implementing hygiene measures and ensuring proper cooking practices to mitigate the risk of zoonotic disease transmission from bushmeat consumption. Jagadesh et al. (2023) further explains the link between bushmeat trade and the potential for zoonotic pathogen spillover, as exemplified by the global emergence of diseases like Deltaretrovirus, Spumavirus (foamy viruses), Ebolavirus, and Henipavirus (Nipah virus). These pathogens, originating from fruit bats and nonhuman primates, pose significant health risks that could lead to endemic outbreaks in the Global South (Peros et al., 2021). Even with these well-documented risks, the bushmeat trade persists, often driven by economic necessity. Recent research has suggested that bushmeat traders may not fully recognize or prioritize these health risks, as economic pressures and the need to support their families often overshadow the potential consequences (Peros et al., 2021; Olunusi et al., 2022).

Against this backdrop of bushmeat investigation, I explored the trade of bushmeat in the Asejire and Odo Ona Kekere markets in Oyo Metropolis, Nigeria, with the goal of examining the socioeconomic, health, and environmental implications, placing a critical focus on environmental justice. While previous studies have significantly contributed to understanding bushmeat trade dynamics, there has been limited integration of these findings into policy frameworks. I bridge this gap by providing actionable recommendations that align with existing legal frameworks and policies. If implemented, these recommendations will improve biodiversity conservation and the livelihoods of these bushmeat traders in Nigeria.

Materials and methods

Study area

This study was conducted in Egbeda local Government and Oluyole local Government within the Ibadan metropolis due to the significant prevalence of bushmeat trade in these areas. Egbeda local Government, situated at longitude 3°58' and 2°0'88'E and latitude 7°22' and 46.55'N, was established in 1989 and shares borders with Osun, Lagelu, Ibadan Northeast, and Ona Ara local Governments. With eleven wards, Asejire market, a prominent bushmeat trading hub, is located within this local Government. Oluyole local Government, positioned at latitude 7°13'59.99" N and longitude 3°52'0.01" E, is one of the oldest councils in Oyo State, sharing boundaries with Ibadan South-West, Ibadan South-East, Ona-Ara, and Ido local Governments. Notably, Odo Ona Kekere, one of the major bushmeat markets in Ibadan, is situated within Oluyole local Government.

Data collection

I employed a total sampling methodology to survey all active bushmeat market traders in two key markets, Asejire and Odo Ona kekere bushmeat markets, due to their high intensity of bushmeat trade, as noted by Oduntan et al. (2017). A total of 30 traders (20 from Asejire and 10 from Odo Ona) were surveyed, representing the entire population of bushmeat traders at these markets during the study period. The structure of the bushmeat market across both sites consists of roadside sellers, allowing for easy access to traders, with most stalls situated approximately 0.2 miles apart from each other. At the Odo Ona Kekere bushmeat market, two bushmeat marketers were located behind the main market sections and slightly separated from the main cluster of stalls to avoid direct market competition.

Prior to the formal data collection, a preliminary survey was conducted to familiarize myself with the bushmeat market dynamics and observe the traders. This initial step was necessary to ensure that the final survey questions were contextually appropriate and relevant to the traders' experiences. While this early interaction could potentially introduce bias, the preliminary survey was mainly observational, focusing on understanding market interactions rather than directly questioning participants, to avoid influencing their responses during the formal data collection. To further minimize bias and capture a broad range of perspectives, the final survey included mostly open-ended questions, giving traders the freedom to express their experiences and raise issues that may not have been anticipated by the researcher (Supplementary Data Sheet 1). This approach ensured that the data collected reflected the complexity of the traders' realities and was not constrained by preliminary assumptions.

During the data collection, two research assistants supported administration of the survey at Asejire bushmeat market and one research assistant supported the project at Odo Ona Kekere bushmeat market. All surveys were conducted one-on-one, with questions asked in the local dialect (Yoruba language) as most participants did not speak English. To facilitate easy data collection, surveys were executed on weekdays when trade was not at its peak (Monday at Asejire and Wednesday at Odo Ona Kekere). We gathered data related to the demographic and occupational characteristics of bushmeat market traders, their sex, age, marital status, educational background, primary and secondary occupations, and years of experience in the bushmeat trade. Additionally, the surveys collected information on the traders' perceptions, practices, and experiences related to bushmeat marketing, such as their opinions on wildlife conservation and domestication.

I conducted descriptive statistical analyses, including frequency and percentage calculations, as well as inferential statistics such as ANOVA, with a significance level set at $\alpha=0.05$.

Results

Demographic characteristics of respondents

Table 1 provides a comprehensive overview of the demographic and occupational profile of bushmeat marketers within the study site.

TABLE 1 The table summarizes demographic and occupational information of survey respondents, including their sex, age, marital status, educational background, and primary and secondary occupations.

Variables	Label	Frequency	Percentage
Sex	Male	2	7
	Female	28	93
Age	20–30	3	10
	31–40	7	23
	41–50	11	37
	>50	9	30
Status	Single	3	10
	Married	27	90
Educational background	Primary Education	12	40
	Secondary Education	15	50
	No formal Education	3	10
Primary occupation	Marketer	30	100
Secondary occupation	None	30	100
Years of experience	<6	3	10
	6–15	3	10
	16–25	7	23
	26–35	12	40
	>35	5	17

It also details the respondents' years of experience in their primary occupation. Data is presented in terms of frequency counts and corresponding percentages for each category.

A total of 30 bushmeat marketers were surveyed. Of these, 28 (93.3%) were women, and 27 (90%) were married, highlighting their significant presence in this occupation. Most marketers fell within the age brackets of 41–50 years (11 respondents, 36.7%) and over 50 years (9 respondents, 30%), indicating a mature workforce. Educational backgrounds varied, with 15 respondents (50.0%) having secondary education, 12 respondents (40.0%) primary education, and 3 respondents (10%) reporting no formal education. This points to the diverse educational levels of the bushmeat marketers. Notably, all 30 respondents identify bushmeat marketing as their primary occupation, with no reported secondary occupations. In terms of experience, 12 respondents (40%) had between 26 and 35 years of experience, while 3 respondents (10%) had less than six years' experience, indicating a mix of both seasoned and relatively new bushmeat marketers.

Frequency distribution on sources and supply of bushmeat

Table 2 provides insights into the bushmeat trade, revealing its sources, target consumers, and the marketers' reflections on wildlife

TABLE 2 The table presents survey data on the sources of bushmeat, typical buyers, and wildlife species that have become less available over time.

Variables	Response	Frequency	Percentage
Sources of Bushmeat	Common bush	5	17
	Hunters	25	83
Buyers of bushmeat	Restaurants, Household and Travelers	19	63
	Restaurants, Household, and Taxi drivers	5	17
	Travelers only	6	20
Wild animals encountered less frequently or reduced supply by hunters over time	Roan antelope	3	10
	Chimpanzee	5	17
	West African crocodile	8	26
	African leopard	7	23
	Ground pangolin	2	7
	Grey parrot	5	17
Perception on Wildlife Domestication as a Conservation Strategy (e.g., Grasscutter)	Yes, domestication could help prevent extinction	23	77
	No, domestication is not a viable solution	7	23
Reasons for response	Past experience with similar efforts	5	17
	Current practices in rearing species like grasscutters	9	30
	Uncertainty about the feasibility without concrete reasons	5	17
	Inability to provide appropriate habitat conditions	2	6

It also includes respondents' perceptions of domestication as a strategy to prevent wildlife extinction and their reasons for these views. Data is shown with frequencies and percentages for each category.

conservation. Hunters remain the primary suppliers of bushmeat, providing most of the stock to marketers who then cater mainly to restaurants, households, and travelers. However, the bushmeat marketers have reported a noticeable decline in the availability and supply of various wildlife species over time (e.g., Roan antelope (*Hippotragus equinus*), ground pangolin (*Manis temminckii*), grey parrot (*Psittacus erithacus*)). This decline is often attributed to hunters encountering these animals less frequently in their traditional hunting grounds, indicating a reduction in their local populations. These species, while not necessarily legally protected, have become less common in usual hunting areas, likely due to decreased population densities or movement into more remote or protected areas. As these species become rarer, hunters' ability to supply them diminishes, leading to a lower supply of such bushmeat to the market.

This reduced availability led to the discussions around wildlife domestication as a potential conservation strategy. Wildlife domestication, in this context, refers to the process of breeding and managing certain wild animal species in controlled environments, such as farms or reserves. The aim is to make them more suitable for human use or conservation purposes, which could reduce the pressure on wild populations and the need to hunt them in their natural habitats, thereby helping to prevent their extinction. During interviews with bushmeat marketers, the possibility of domesticating certain wildlife species like grasscutters (a rodent heavily hunted in Nigeria) was discussed. According to [WildAid Africa \(2021\)](#), the grasscutter is known for its adaptability to controlled breeding, making their domestication a potential source of alternate income. However, the respondents expressed mixed views on the effectiveness of wildlife domestication as a conservation strategy. Some saw it as viable, based on their own experiences or observations of others successfully breeding grasscutter, while others questioned its feasibility.

Furthermore, the study revealed the profitability of various bushmeat types sold by marketers. Grasscutter (*Thryonomys swinderianus*), the most sold and preferred bushmeat, yielded profits ranging from ₦1,000 to ₦3,000 per unit sold, equivalent to approximately US\$1.30 to US\$3.90. Kob antelope, the second most preferred, generated profits between ₦2,000 and ₦4,000 per unit sold (around US\$2.60 to US\$5.20). In contrast, the Gambian pouch rat (*Cricetomys gambianus*) provided the lowest profits, typically ranging from ₦300 to ₦400 per unit sold (approximately US\$0.39 to US\$0.52). The highest profits were from also known as red river hog (*Potamochoerus porcus*), with earnings between ₦3,000 and ₦5,000 per unit sold, equivalent to US\$3.90 to US\$6.50. It is worth noting that these profit margins per unit are quite substantial in the Nigerian context, where a university professor earns an average of ₦500,000 (around US\$650) per month. This comparison highlights the significant financial incentive for traders in the bushmeat market.

As seen in [Table 3](#), inferential statistics, specifically one-way ANOVA, were conducted to examine the association between marketers' years of experience and the profits made from different types of bushmeat. The results revealed significant differences in experience affecting profit levels for grasscutter (F2,

TABLE 3 The table presents the Analysis of Variance (ANOVA) results examining the relationship between marketers' years of experience and their profit from selling various bushmeat species.

		Sum of squares	df	Mean square	F	Sig.
Grasscutter profits	Between Groups	14.210	4	3.552	4.803	.005
	Within Groups	18.490	25	.740		
	Total	32.700	29			
Kob antelope profits	Between Groups	4.063	4	1.016	2.591	.061
	Within Groups	9.803	25	.392		
	Total	13.867	29			
Ground pangolin profits	Between Groups	.833	2	.417	2.647	.125
	Within Groups	1.417	9	.157		
	Total	2.250	11			
African bush-tailed porcupine profits	Between Groups	.308	2	.154	.769	.489
	Within Groups	2.000	10	.200		
	Total	2.308	12			
Nile monitor lizard profits	Between Groups	9.250	3	3.083	9.088	.001
	Within Groups	4.750	14	.339		
	Total	14.000	17			
Bush pig profits	Between Groups	.075	1	.075	.562	.482
	Within Groups	.800	6	.133		
	Total	.875	7			

The analysis covers six bushmeat types: grasscutter also known as greater cane rat (*Thryonomys swinderianus*), Nile monitor lizard (*Varanus niloticus*), kob antelope (*Kobus kob*), ground pangolin (*Manis temminckii*), African bush-tailed porcupine (*Atherurus africanus*), and bush pig also known as red river hog (*Potamochoerus porcus*). The table includes values for sum of squares, degrees of freedom, mean square, F-value, and significance level, indicating whether the variation in profits is significantly influenced by marketers' experience.

29 = 4.803, $P = 0.005$) and Nile monitor lizard (*Varanus niloticus*; $F_{3, 7} = 9.088$, $P = 0.001$). Similarly, significant differences were found for kob antelope ($F_{2, 29} = 2.591$, $P = 0.061$) and ground pangolin ($F_{2, 9} = 2.647$, $P = 0.125$). However, there were no significant differences observed for African bush-tailed porcupine (*Atherurus africanus*; $F_{2, 10} = 0.767$, $P = 0.489$) and bush pig ($F_{1, 6} = 0.562$, $P = 0.482$), indicating that experience did not significantly impact profit levels for these bushmeat types.

Moreover, the study identified key associations governing the activities of bushmeat marketers. Seventy percent of respondents reported paying a levy imposed by the association of bushmeat

marketers for their sales, while 30% indicated they were not subject to this levy. The levy is not a government tax, but an internal fee collected by the marketers' association to support the operational and administrative functions within the markets. There are no regulations set by the association regarding the quantity of bushmeat sold per day, and the scale of the levy varies depending on the amount of bushmeat traded.

Discussion

Demographic characteristics of respondents

The gender dynamics within the bushmeat trade in Oyo State, Nigeria reveals a notable predominance of women comprising 93.3% (28 respondents), highlighting their substantial involvement in the sector, consistent with previous studies by Oduntan et al. (2018) and Babatunde et al. (2020). This contrasts with earlier reports by Oduntan et al. (2017), which indicated a male majority in similar settings. This suggests a shifting gender dynamic within the trade which may be due to distinct roles assumed by men and women, as highlighted by Babalola (2023), with men primarily engaged in hunting activities and women taking on marketing roles (Ijose, 2018).

While both genders can benefit economically from the trade, disparities exist in access to roles, benefits, and risks. Men typically dominate hunting roles, exposing them to physical labor and inherent risks, but they also enjoy the highest profit margin possible within the bushmeat market structure (Olunusi et al., 2022; Babalola, 2023). Conversely, women, who primarily act as market traders, face economic challenges. They purchase bushmeat from hunters at a fixed rate and resell it for a lower profit margin, as documented by Olunusi et al. (2022) and Cowlishaw et al. (2004). This market structure restricts women to intermediary roles, offering less opportunity for substantial financial gain compared to their male counterparts. The gender-based division coupled with other gendered barriers such as limited access to financial capital, reduced market opportunities, and mobility constraints, further restrict their ability to negotiate prices and expand their businesses (Alliance for Financial Inclusion, 2016). This structural inequality worsens the income gap, reducing the potential benefits women could derive from the trade.

Furthermore, in alignment with the work of Babatunde et al. (2020) and Oduntan et al. (2017), my findings revealed that a significant proportion of individuals engaged in bushmeat marketing are middle-aged, with 43.3% (13 respondents) falling within the 31–40 age range, 30% (9 respondents) within the 41–50 age range, and 6.7% (2 respondents) above 50 years old. This proves that majority of the marketers are in their active age. Additionally, this study reveals that 10% (3 respondents) of respondents were single, while the vast majority (27 respondents, 90%) were married. This suggests that many women engaged in the bushmeat trade have familial responsibilities, which may serve as a motivating factor to continue their involvement in the trade, especially in the absence of viable alternative livelihood options. This emphasizes the social

justice aspect, as the lack of other opportunities can perpetuate economic reliance on bushmeat marketing for the traders.

The educational profile of bushmeat market traders reveals a significant proportion with only secondary education (15 respondents, 50%), followed by those with primary education (12 respondents, 40%), and 10% (3 respondents) lacking any formal education. These findings align with previous research by Babalola (2023), Malik et al. (2019), and Oduntan et al. (2017), indicating a prevalent lack of substantial formal education among market traders. This educational deficit contributes to their predominance in the informal sector, as they are often ill-equipped for formal employment opportunities. In Nigeria, where only 17% of workers have wage jobs capable of lifting them out of poverty, according to a World Bank (2022) report, even individuals with higher education struggle to secure formal employment. The dearth of formal education places bushmeat traders at a further disadvantage in accessing profitable job opportunities. Consequently, emphasis in the society tends to prioritize extractive industries (Akakuru et al., 2022) like agriculture and the bushmeat trade for sustained livelihoods. Additionally, the overwhelming reliance of bushmeat traders on this market activity evident, as indicated by their lack of alternative income sources. Notably, all respondents in our study were found to be full-time bushmeat traders with no other means of income, reinforcing social inequities in access to sustainable livelihood options.

Moreover, the results reveal that a significant majority (17 respondents, 56.7%) of traders have amassed over 25 years of experience in the bushmeat industry, indicating a sustained presence and dependence on this trade. Soaga et al. (2014) corroborated this finding by stating that most of the traders inherited the bushmeat business and started with little or no capital. Conversely, 10% (3 respondents) of traders have fewer than six years of experience, suggesting a continual influx of newcomers into the trade. This points to the level of reliance of these traders on the bushmeat marketing sector for their livelihoods. Interestingly, our findings contrast with those of Malik et al. (2019) who conducted a study in the northern Nigerian state of Benue, where most respondents (57.1%) had only 1–5 years of experience. This disparity suggests that the bushmeat trade as a livelihood avenue is not only enduring but also expanding, with new individuals entering the market across different regions of the country.

Sources and supply of bushmeat

Table 2 provides valuable insights into the sources and supply of bushmeat, shedding light on the operational aspects of the trade and its potential ecological ramifications. The results indicate that the majority of bushmeat is sourced from hunters (25 respondents, 83.3%), with a smaller proportion obtained directly from common bushes (5 respondents, 16.7%). The term “common bush” generally refers to areas of wild, undeveloped land or forests that are not privately owned or intensively managed, often found on the outskirts of rural communities (Nasi et al., 2008). In these regions, natural resources, including wildlife, may be commonly accessed or perceived as communal property by local populations. This finding

aligns with the research of Babalola (2023), emphasizing the reliance of bushmeat marketers on hunters as their primary suppliers. Furthermore, the results highlight the intermediary role of bushmeat marketers, who predominantly supply bushmeat to restaurants, travelers, and households. This demand-driven trade, as emphasized by Olunusi et al. (2023) and Malik et al. (2019), contributes to the pressure on wildlife populations. While our results highlight that travelers are one of the major buyers of bushmeat, we did not capture explicit evidence of international transport. However, the WildAid Africa (2021) report suggests that bushmeat purchased by travelers may reach international markets. Ground pangolins, for example, are frequently traded from Nigeria to countries such as China, Vietnam, and Singapore. This report also highlights how local consumption is linked with illegal global wildlife trade networks, as bushmeat and wildlife parts move across borders to meet international demand.

The structure of the bushmeat market, as earlier stated, predominantly involves hunters, marketers, and consumers, all of whom are exposed to potential risk of zoonotic diseases. Jagadesh et al. (2023) highlighted a strong correlation between bushmeat consumption and the spillover of zoonotic pathogens, with over 60% of emerging infectious diseases originating from animals. Examples include SARS, MERS, Ebola, HIV, and COVID-19, with over two-thirds originating from wild species (Max Planck Society, 2020). Despite these health risks, bushmeat marketers often underestimate the associated hazards, citing their own experiences and knowledge as justification (Peros et al., 2021). Interestingly, during interviews, some bushmeat marketers mentioned the Ebola outbreak as a reason for past declines in sales but noted that sales had recovered, and they do not believe that bushmeat posed a disease risk. This demonstrates a gap in understanding, where the fear of zoonotic diseases impacts livelihoods during outbreaks as consumers desist from patronizing the traders, but the long-term recognition of ongoing risks is underestimated. Gaubert et al. (2023) observed that bushmeat vendors in Central and West Africa primarily rely on health-related information from television channels and social networks, often subscribing to the belief that if a species has never been a disease vector, it will never become one. Unfortunately, zoonotic diseases present an ongoing vulnerability for individuals involved in the trade of wildlife, and misconceptions about disease risks could exacerbate future outbreaks.

Bushmeat profitability

On a more positive note, the bushmeat trade has been reported to be highly profitable for those involved. The profitability of various bushmeat types varies; for example, as revealed by this study, the sale of mammals yields higher profits compared to wild birds, highlighting the commercial appeal of certain bushmeat species (Oduntan et al., 2017; Soaga et al., 2014). The disparity in profit levels among different bushmeat types suggests varying market demand and pricing dynamics, which may be influenced by cultural preferences and consumer behavior (Oduntan et al., 2018). The findings also illuminate the role of experience in shaping profit levels within the bushmeat trade. While experience was found

to significantly influence profits for certain bushmeat types, such as grasscutter and nile monitor lizard, no significant impact was observed for other bushmeat types. However, it is important to note that while bushmeat trade may seem lucrative in the short term, its long-term sustainability is questionable (Malik et al., 2019; Soaga et al., 2014).

Sustainable wildlife utilization

In addition to the socio-economic and zoonotic disease vulnerabilities mentioned previously, there is also an ecological justice aspect of the bushmeat trade to consider, where advocating for a more sustainable approach to bushmeat trade is crucial. The results in Table 2 highlights the decline in the supply and availability of certain wildlife species which could be due to unsustainable trade practices, as evidenced by the threatened status of the reported species. Wildlife species such as chimpanzee, african leopard, ground pangolin, and grey parrot are all listed as threatened according to the IUCN Red List (2023). This highlights the pressing ecological consequences of unchecked bushmeat trade, as noted by Soaga et al. (2014) and Ijose (2018), who also emphasized the strain on biodiversity conservation efforts. The loss of these species not only disrupts ecosystem functioning but also erodes the cultural and ecological significance of biodiversity-rich habitats (Gupta et al., 2023). Additionally, it means that future generations would not get to see or experience certain types of wildlife that have gone extinct.

Despite this, a significant proportion (23 respondents, 76.7%) of bushmeat traders expressed that domestication of certain wildlife species, like the grasscutter, could prevent extinction, reflecting their recognition of the potential for sustainable alternatives. Other 7 respondents (23.3%) voiced skepticism about the feasibility of domestication, with majority citing concerns about providing adequate conditions for wildlife. Until the concept of wildlife domestication to supply meat markets is supported by effective implementation strategies, including access to resources, training programs, and supportive policies, a transition from wild harvesting is not likely (Hilderink and de Winter, 2021). Additionally, addressing concerns about providing adequate conditions for wildlife requires collaboration among stakeholders, such as government agencies, conservation organizations, and local communities. By combining knowledge with practical support and collaborative efforts, there is greater potential for the successful adoption of sustainable alternatives in the bushmeat trade, leading to improved conservation outcomes (ecological justice) and livelihood opportunities.

Recommendations to policy makers

According to the Government of Nigeria et al. (2022), legal frameworks exist to ensure compliance with national and international commitments to legal trade and combating wildlife crime. These frameworks aim to raise awareness of wildlife crime, generate social and political will among stakeholders regarding the value of nature, and provide alternative livelihoods by empowering local communities through the development of wildlife crime

prevention initiatives and alternative livelihoods for the period 2022–2026. However, I propose two additional policies that emerge from my findings. These recommendations will further social and ecological justice.

1) Enlightenment and empowerment

It is the responsibility of the state and federal government, along with all wildlife stakeholders to spread the knowledge of wildlife conservation around us. For example, the Department of Wildlife at the University of Ibadan, while celebrating World Wildlife Day on March 3rd, 2024, invited hunters in Oyo State to learn about domestication, sustainable resource use, and the consequences of species extinction. The communication was delivered in Yoruba to ensure understanding among the local population. In this context, conservation experts must take up the task of public outreach. Hilderink and de Winter (2021) highlighted that there is often partial knowledge, misinformation, or even a complete lack of awareness regarding the risks associated with the bushmeat trade. Gaubert et al. (2023) also stressed the importance of closely monitoring the media to ensure accurate information is disseminated, as opposed to misinformation. By raising awareness about the effect of overexploitation of bushmeat and the zoonotic risks associated with its trade and consumption, it is possible that bushmeat market traders and other involved actors will reduce their hunting activities. However, this increased awareness must be paired with efforts to empower communities to adopt sustainable alternatives.

Empower people. Given the high dependence of bushmeat marketers on bushmeat trade, there is a need to provide alternative sources of income to these people. Otherwise, combating wildlife trade will be useless as people will look for non-transparent means to continue trading. (Hilderink and de Winter, 2021). According to Van Velden et al. (2020), survey results in Malawi showed that local communities preferred alternative sources of livelihood that would guarantee long-term empowerment opportunities over gaining access to park-based products like bushmeat. The authors stated that the alternative source of livelihood option was for households to receive three goats and be trained in livestock management. Similarly, such a test could be implemented in Nigeria to ascertain peoples' alternative livelihood preferences. Both the local and national governments need to commit to training these marketers as they have little or no formal education nor any alternate employment.

2) Tighten existing conservation policies

Enforce conservation. There is a need to tighten existing wildlife conservation policies. This involves bolstering the legal framework and regulations governing wildlife protection and conservation to deter illicit activities and safeguard vulnerable species. This may include measures such as increasing patrols in protected areas, strengthening surveillance and monitoring mechanisms, and imposing stricter penalties for wildlife-related offenses.

A community-based approach can be instrumental in enhancing policy enforcement by incentivizing residents to report instances of wrongdoing and illegal activities (Sollund, 2022). This strategy entails engaging and empowering communities residing in and around areas susceptible to wildlife trade, encouraging them to

actively participate in conservation endeavors. By offering rewards or benefits for providing information leading to the apprehension of offenders, communities are motivated to take ownership of wildlife preservation efforts. This approach has shown promise in similar contexts, as demonstrated by Heermans et al. (2021) in northern Botswana. It not only strengthens law enforcement effectiveness but also cultivates a sense of ownership and stewardship among community members toward their natural heritage.

Conclusively, this study highlights the need for social and ecological justice by promoting sustained alternative livelihoods to reduce reliance on declining wildlife, hereby addressing the key environmental justice concerns of bushmeat trade. Additionally, the bushmeat trade is not isolated; its links to international markets and the potential for zoonotic disease spillovers emphasize its global significance. Effective interventions must align local sustainability efforts with global wildlife trade policies to ensure both ecological integrity and economic stability.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because it lies in the institutional guidelines of the University of Ibadan, which does not mandate ethical approval for all research endeavors unless specific circumstances such as involvement of vulnerable groups, collection of blood samples, or biomedical research necessitate it. However, research methods are still subjected to scrutiny by departmental professors to ensure adherence to ethical standards. Furthermore, the study exclusively involved roadside sellers aged 18 and above who openly identified themselves and willingly participated in the research. Given the nature of the participants and the voluntary nature of their involvement, formal ethical approval was deemed unnecessary. Nonetheless, ethical considerations were upheld throughout the research process, with participants being informed of the study's purpose and the voluntary nature of their participation, and measures were taken to ensure data anonymization and confidentiality. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements because as for written informed consent, it was not required for this study due to the practical considerations of the research context. The participants, being roadside sellers, engaged in face-to-face interactions with the researchers and were briefed on the study's objectives and procedures. Their willingness to participate was ascertained verbally, and they were assured of their anonymity and confidentiality. Given the informal setting and the nature of the interactions, obtaining written consent would have been logistically challenging and potentially intrusive. However, verbal consent was obtained from each participant before their involvement in the study,

ensuring that they were adequately informed and willing to participate. This approach maintained ethical integrity while respecting the practical constraints of the research environment.

Author contributions

BO: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcsc.2024.1401308/full#supplementary-material>

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Timothy C. Haas,
University of Wisconsin–Milwaukee,
United States
Dauda Ayomide Onawola,
One Health in Action Initiative, Nigeria

*CORRESPONDENCE

Batsirai Alexander Mukanganwa
✉ alexmukanganwa@gmail.com

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Zoonosis and the law: a case study of legal game meat regulation and control in Zambia

Batsirai Alexander Mukanganwa^{1*}, Farah Aisyah Sukmawati²
and Sara Wilhelmina Erasmus²

¹Department of Food Science and Nutrition, University of Zambia, Lusaka, Zambia, ²Food Quality and Design, Wageningen University & Research, Wageningen, Netherlands

Globally, game meat production is increasing. Yet, in many countries, game meat supply chains are not formally regulated and traceability issues have also been raised. As a consequence, there is an increased risk of zoonotic disease outbreaks. Thus, there is a growing call for a greater role of law and policy (environmental justice) in game animal and game meat products to secure animal and human health. Zambia is one of the countries where game meat production is increasing and legally traded. There is a paucity of information on Zambian laws, regulations, and policies governing the game meat trade. To understand this phenomenon in light of environmental justice concerns, we conducted a case study analyzing the Zambian regulatory framework and policies related to the game meat supply chain. The study included a review of Zambian laws and policies that address the game meat chain, focused on game meat zoonosis risks, and interviews with stakeholders in the game meat supply chain. This was followed by a zoonoses vulnerability assessment of the chain prompted by the absence of specific game meat regulations. The policy analysis revealed a lack of specific regulations governing game meat safety, with limited control over game meat along the supply chain. Several gaps in the law and policy frameworks were identified. To enhance game meat safety and reduce zoonotic disease transmission along the game meat supply chain, the use of a zoonotic control framework is recommended. We conclude with a discussion of the international implications of this Zambian use case.

KEYWORDS

environmental justice, food safety, policy, risk analysis, regulations

1 Introduction

1.1 Environmental justice

The sustainability of natural resources is a key principle of environmental justice. According to [Matsumoto \(2023\)](#), environmental justice “mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things ... Affirms the right of all workers

to a safe and healthy work environment...” Game meat is meat from wild animals that are typically hunted for food. Legal game meat production is a multifaceted environmental justice issue. For example, regulations regarding legal game meat production place controls on hunting in national parks (NPs), community partnership parks, and bird and wildlife sanctuaries. This helps to protect these habitats from disturbances and degradation, ensuring that ecosystems remain intact and healthy. It provides alternatives to illegal game meat trade through game farming (Tensen, 2016; Wang et al., 2019), which can lead to a decline in the illicit game meat trade (Murray et al., 2016; Fukushima et al., 2021). By doing so, it prevents environmental injustices associated with the illicit trade, which impacts both animals and people. White and Belant (2015) highlighted that game meat production not only provides game meat as a communal benefit but also contributes revenue to communities through hunting fees and licenses. This sustains marginalized communities where hunting typically occurs. Game farming through community conservancies also benefits the communities through income generation. This is important because these communities struggle to farm or raise livestock due to wildlife interference (Pant et al., 2025). There are also ecological benefits associated with game farming (Pienaar et al., 2017), such as counterbalancing the impacts of wild animals due to overhunting (Lindsey et al., 2009).

To ensure social and ecological justice in the game meat supply chain, it is imperative to understand the stakeholders, operations, regulations, and regulatory constraints (FAO, 2011). Such knowledge enables the development of an effective regulatory framework, thereby protecting habitats, wild species, and people. Therefore, we analyzed Zambian game meat regulations and policies and conducted in-depth stakeholder interviews. Based on our findings, we propose a zoonotic control framework that can be used to enhance game meat safety and reduce zoonotic disease transmission from wildlife to humans along the game meat supply chain. Our paper concludes with a discussion of the international implications of this Zambian use case.

1.2 Game meat production

Humans have always engaged in game hunting in Africa as a life necessity (Muposhi et al., 2016). Until the 20th century, game hunting proceeded according to tribal customs. However, when European settlers became established on the continent and started overharvesting native wildlife, the need arose to introduce conservation laws (Munro, 2021). The emergent regulations delineated legal and illegal game meat. In theory, these regulations resolved the environmental (species) injustices brought on by the overexploitation of game species, fostering the sustainable use of this natural resource. Since then, game meat production (UNECE and FAO, 2018) and marketing (Green et al., 2023) have been rising; not only in Africa but also globally. Although there is a dearth of available data, the global production of game meat is estimated to have reached approximately 2 million tons in 2016 (Rawal et al., 2019), with Africa and Europe being the

highest producers. The United Nations Economic Commission for Europe (UNECE) region almost doubled its export value in the space of a decade, from US\$190 million in 2001 to US\$365 million in 2011 (UNECE and FAO, 2018). In 2013, UNECE reached a production of 400,000 tons of game meat valued at approximately \$850 million (Rawal et al., 2019). South Africa is the largest exporter in the Southern African Development Community (SADC) region, exporting approximately 3,010 tons of game meat per year (Department of Forestry, Fisheries and the Environment, South Africa, 2023). Namibia is another major SADC game meat producer, with an annual output of approximately 17,637–28,660 tons.

Ranucci and colleagues (Ranucci et al., 2021) highlighted that game meat production differs significantly from that of domestic meats, as factors present in the field and the steps taken before transferring carcasses to a game-handling establishment affect game meat and handler safety. These factors, including poor hygiene, handling practices, and occupational exposure, increase zoonotic risks to the consumer (Paige et al., 2014; D’Cruze et al., 2020) and the hunter/processor. The risk of contracting zoonoses is largely due to human exposure to body fluids and feces of game animals during handling and butchering. Considering that zoonotic risk exposure results from a contaminated environment or inadequate biosecurity measures, zoonotic risk needs to be viewed through social justice and environmental justice lenses.

According to the World Health Organization (WHO, 2020), zoonotic diseases are any diseases or infections that are naturally transmissible from vertebrate animals to humans. It has been reported that 60.3% of emerging human infectious diseases are animal-borne, of which 71.8% have originated from wildlife (Chai et al., 2023). These diseases are considered a social justice issue because people from lower socioeconomic backgrounds are often disproportionately affected due to factors such as limited access to healthcare, poor sanitation, close contact with animals due to livelihood needs, and inadequate knowledge about disease prevention, leading to higher exposure and vulnerability to zoonotic diseases. This highlights inequalities in health outcomes across different communities (van Der Westhuizen et al., 2023).

Recently, game meat regulation, control, and policy have gained attention as a result of zoonotic disease outbreaks (van Vliet et al., 2022; Wegner et al., 2022; Gallo-Cajiao et al., 2023). Examples include severe acute respiratory syndrome (SARS) in China (Can et al., 2019), Ebola in West Africa (Bonwitt et al., 2018), and mpox in the Democratic Republic of Congo (Lâm et al., 2024). In addition, concerns have been raised that food safety regulations are failing to prevent hazards in the food chain and that food safety standards do not apply to game meat (OECD, 2021). Still, as a matter of policy, efforts have been made to ban both legal and illegal game meat as a public health protection strategy (Eskew and Carlson, 2020). Banning the game meat trade could constitute an environmental injustice since indigenous and marginalized people are the ones who largely benefit from this resource as a necessity (Green, 2025). Booth and colleagues (Booth et al., 2021) pointed out that there is no justice in banning the game meat trade because it would adversely impact the people reliant on game meat for their lives

and livelihoods. Instead, they suggest risk-based regulation. To develop and implement risk-based regulatory frameworks, there is a need to understand the existing regulatory structures and perform a vulnerability assessment of both the public and the product to determine where risk mitigation can be achieved.

Because game farms can provide a higher degree of sanitary conditions (Broad, 2020), farmed game meat has been shown to carry less zoonosis risk than wild game (Magwedere et al., 2015; OECD, 2021). Farmed game is confined to farms, where the animals are protected from predation, and more importantly, disease control measures can be applied to them. In contrast, free-ranging game are prone to predation, and disease control measures are difficult to apply (Magwedere et al., 2015; OECD, 2021). The importance of biosecurity (preventing harm by biological agents) as a measure of controlling zoonotic diseases in game and game products has been recognized by the WHO, World Organization of Animal Health (WOAH), and the Food and Agricultural Organization of the United Nations (FAO). Their interim guidance emphasizes that the regulations should include strict on-farm biosecurity measures to prevent the introduction and/or spread of zoonotic diseases (WHO, WOAH, UNEP, 2021).

The farming of game animals for game meat is a common practice in many parts of the world (Needham et al., 2023). However, despite increased game meat production in many countries, particularly developing nations, the game meat supply chain is still not formally regulated due to a lack of legal instruments (WHO, WOAH, UNEP, 2021). Game meat traceability concerns have been raised for the product supply chain (Campbell et al., 2022). The biggest regulatory and traceability challenges are in Asia and Africa (World Bank, FAO, 2022a), as countries in these regions have a large informal food sector that is not regulated and does not adhere to central government legislation on hygiene (Oloo et al., 2018). In many countries, the major animal-based food laws, such as the Animal Health Acts, Meat Industry Acts, and Food Safety Acts, that regulate the domestic meat supply chain do not cover game meat chains. Game and game meat should have specific hygiene regulations requirements for its production, processing, and marketing in all national food regulations (WHO, WOAH, FAO, 2021).

1.3 The Zambian situation

Zambia has an abundance of natural resources and a rich biodiversity. The majority of Zambians, particularly those residing in rural areas, are highly dependent on the ecological services for their livelihoods (FAO, 2013). The network of Zambia's statutory protected areas (PA) is composed of over 63,580 km² in 20 NPs, about 167,557 km² in 36 Game Management Areas (GMAs), 5,981 km² game ranches, and 74,361 km² in 490 Forest Reserves (United Nations Convention on Biological Diversity, 2015). For this case study, understanding mammal diversity in Zambia is particularly important. Researchers estimate the country hosts 224 mammal species. Of these, 43 large mammals are vital to the country's

economy due to the potential income that can be produced from their use in photographic and consumptive tourism, and the protein they contribute to local households through game meat hunting (United Nations Convention on Biological Diversity, 2015). In 2023, as part of National One Health Strategic Plan 2022–2026, Zambia produced a list of zoonotic priority diseases, including African trypanosomiasis, anthrax, enteric diseases (salmonellosis), viral hemorrhagic fevers (Ebola), rabies, plague, influenza-like illnesses (zoonotic avian influenza), zoonotic tuberculosis, cysticercosis, and brucellosis (WHO, 2023). Of these, anthrax (Hang'ombe et al., 2012), salmonellosis (Altissimi et al., 2024), zoonotic tuberculosis (van der Merwe and Michel, 2010), and viral hemorrhagic fevers (Altissimi et al., 2024) have been associated with game meat.

We selected Zambia for our investigation of regulatory structures as a step toward risk-based regulatory framework development because it is one of the few countries in Africa that has a formalized game meat system (FAO et al., 2024). In Zambia, legal game meat comes from GMAs (Phiri et al., 2011) and game ranches (Lindsey et al., 2013). GMAs are considered buffer zones immediately surrounding national parks, where human settlement, limited agricultural activity, and legal game hunting are allowed (Phiri et al., 2011). Ranches produce an estimated 295,000 kg (325 tons) of game meat each year, with 37.2% coming from trophy hunting. Most of the game meat is sold to butcher shops or individual customers (48.8%), followed by ranch workers (20.7%), ranch guests/families, (12.2%), and local communities (12.2%) (Lindsey et al., 2013). In Zambia, legal game is categorized into wild game meat and farmed game meat depending on the source. Wild game meat is the meat that is found in either controlled or wild populations (national parks or reserves), while farmed game is intentionally reared to produce meat and hides (Whyte et al., 2011).

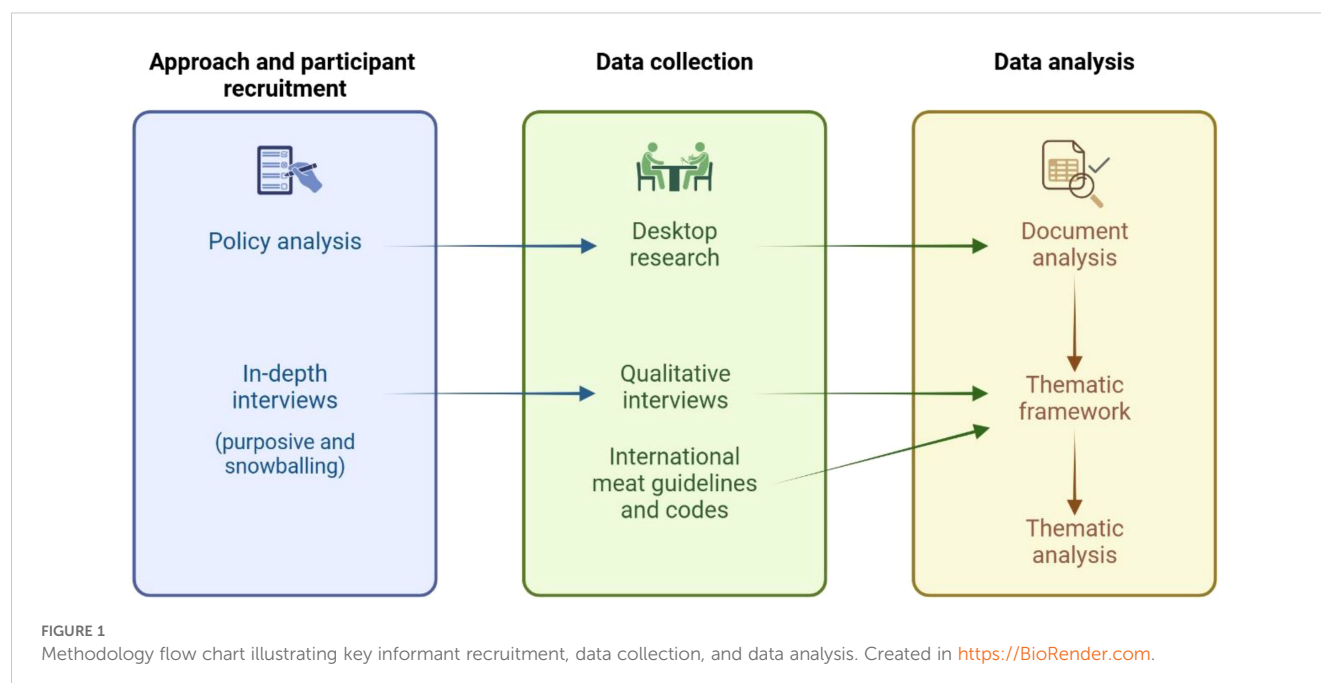
2 Methodology

2.1 Study area

The study was undertaken in the Lusaka district, one of the six districts of Lusaka province and the capital city of Zambia. Most of the legal game meat is traded in this area. It has an estimated population of approximately 3 million (Zambia Statistics Agency, 2023). Lusaka is located at -15.41 latitude and 28.29 longitude and is situated at an elevation of 1,277 meters above sea level (as obtained by Google Earth).

2.2 Approach and design

This cross-sectional qualitative study (Figure 1) was conducted in two parts (policy analysis and interviews) to answer the following research questions: Does the country have specific game meat regulations? What stages of the supply chain are covered? Which laws and agencies are responsible? What mandates do they have?



Does the law cover the marketing of products? Do the laws cover zoonotic diseases? What control mechanisms are in place? Are there adequate monitoring and enforcement powers?

The policy analysis focused on a literature search of regulations and policies associated with game, livestock, and the meat industry to address the following questions: Are there specific game meat regulations? Do they cover game safety and zoonosis?

The in-depth interviews focused on answering the following questions: If the regulations cover game meat, what are the implementing mechanisms? Are there adequate monitoring and enforcement powers? If they do not cover game meat, then how is the game meat being controlled?

2.3 Policy analysis

2.3.1 Data collection

The literature search was conducted from February 2024 to March 2024. In many countries, meat regulations, both for domestic livestock meat and game meat, are in a single document [(EC) No 853/2004; CAC/RCP 58-2005]. Hence, policy analysis focused on relevant policies and regulations of the meat industry for domestic livestock meat and game meat. This is particularly important since the creation of game meat regulations is guided by domestic livestock meat regulations.

Relevant documents are not limited to scholarly databases. Therefore, the Google search engine was used to gather information on acts, regulations, and policies that are relevant to the game meat industry. These documents were searched using the keywords *game meat regulation*, *animal regulations*, *wildlife regulations*, *conservation acts*, *animal health*, *disease act*, *meat regulations*, *meat act*, *meat standards*, *food safety act*, *food standards*, and *livestock policy* in combination with the term

Zambia. The following relevant documents were identified in response: The Wildlife Act of 2015, the Animal Health Act of 2010, the Public Health Act (Meat, Abattoir, and Butcherries Regulations), the Food Safety Act of 2019, and the National Livestock Development Policy of 2020. The list was sent to two Zambian food safety experts with experience in both food safety consultancy and academia for validation and to identify any relevant gaps.

2.3.2 Data analysis

Document analysis is a systematic procedure for reviewing or evaluating documents, both printed and electronic (Bowen, 2009). Following standard guidance (WHO, WOA and FAO, 2021), the analysis was based on the presence or absence of key terms (i.e., *game meat*, *game*, *wild game*, *wild meat*, *zoonosis*, *animal*, *trade/selling*) and several aspects of game meat production (i.e., farm biosecurity; specific hygienic requirements for the production, processing, and marketing of foods of animal origin; ante- and post-mortem inspection; hygiene and sanitation requirements, traceability requirements; farm registration; inspections; and supervision of the slaughtering process).

2.4 In-depth interviews

The interviews followed the human subjects research requirements. Ethical clearance was obtained from the Tropical Disease Research Centre (TDRC/124/09/23). Research permits were obtained from government agencies and departments. Consent was obtained from the interviewees prior to conducting the interviews. In-depth interviews and structured questionnaires were conducted from March 2024 to April 2024. These in-depth interviews provided the contextual data necessary to fully understand how exactly the

game meat is being controlled and regulated along the supply chain, which would not have been possible to capture by only using questionnaires.

2.4.1 Participant selection

A purposive sampling method was used (Palinkas et al., 2015). In total, 17 in-depth interviews were conducted with chief inspectors, directors, national focal officers, academicians, consultants, senior specialists from regulatory agencies, inspectorates, and butchers/traders. The interview guide is provided in the Supplementary Material. Of the 17 interviews, six were personnel from government institutions that are responsible for regulation and control, and the other 11 were experts in food safety and the game meat industry. Since data collection and analysis were conducted concurrently as the benchmark for grounded theory, each interview was deemed complete when new information was no longer being conveyed.

2.4.2 Data collection and transcription

For data collection and transcription, we followed an approach used by Goodall (2022). Interviews ranged between 25 minutes to 1 hour and 40 minutes and took place in offices, over phone calls, Microsoft Teams, Zoom, and Google Meet. In-person interviews were recorded using a recording device. Since an in-depth interview approach was used, some individuals were inclined to share more than others. We refrained from interrupting interviewees so that the maximum data could be collected. Variation in the electronic

platform use approach was for the convenience of the interviewees as access to standardized platforms can be limited in Zambia. Standardizing platform use would have hindered data capture.

Phone interviews were recorded on the phone. Zoom/Microsoft Teams and Google Meet interviews were recorded on the computer. In all these interviews, consent was sought first. In-person and phone-recorded interviews were transferred to a computer for transcription. Artificial intelligence (AI) Whisper, a function embedded in the Python software, was used for data transcription. Recorded audio files were input into the application, and Microsoft text transcripts were generated. Interviews were transcribed in English and the outputs were uploaded to NVivo 12 for coding and data analysis.

2.5 Data analysis

2.5.1 Thematic framework

The transcripts were analyzed in two parts. Firstly, a general understanding was sought of the regulatory control mechanisms for game meat. This understanding combined with, the *Codex, Code of Hygienic Practice for Meat (CAC/RCP 58-2005)*, *Technical Guidance Principles of Risk-Based Meat Inspection and Their Application (FAO, 2021)* and standard guidelines (WHO, WOA, UNEP, 2021) were then used to formulate a zoonotic control framework as presented in Figure 2. The framework is made up of three

ZOONOTIC DISEASE CONTROL IN THE GAME MEAT SUPPLY CHAIN

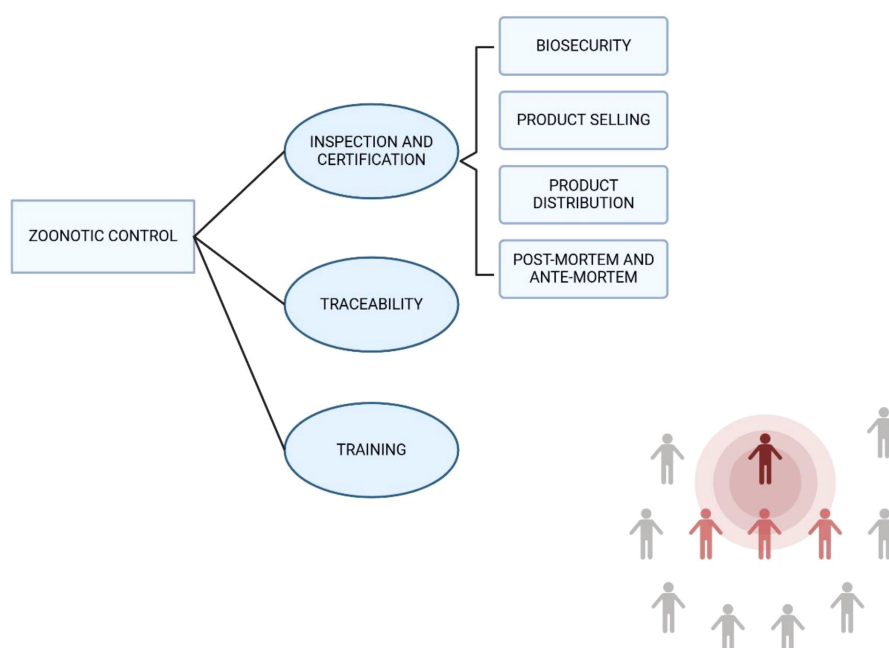


FIGURE 2

The thematic framework used to understand points of zoonotic disease control along the game meat supply chain. Created in <https://BioRender.com>.

components: inspections (which are subdivided into four elements: biosecurity, post-mortem and ante-mortem, product distribution and selling), traceability, and training. This zoonotic control framework can be used to understand points of zoonotic disease control along the game meat supply chain. The thematic framework was used for thematic coding (data analysis). For the second aspect of the data analysis, inspection, selling, traceability, and training were used as coding themes.

2.5.2 Thematic analysis

For part two of the data analysis, grounded theory was used for coding as previously conducted by Goodall (2022) and Milstein et al. (2020). This approach is used when little is known regarding the phenomena being studied (Glaser and Strauss, 2017; Chun Tie et al., 2019). For initial coding, transcribed data was broken and categorized into themes followed by theoretical coding, which wove the broken data back together into an organized theory (Charmaz, 2012). Finally, advanced coding was used to facilitate the integration of the final theory (Chun Tie et al., 2019).

3 Results

A summary of the meat (domestic and game) regulations and guidelines identified during the desktop study, along with the responsible authorities, is shown in Figure 3.

3.1 Policy analysis

Five Zambian laws were identified that are relevant to game meat, each with varying environmental justice implications. The Wildlife Act of 2015 relates to the sustainability of natural resources. The Animal Health Act of 2010 and the National Livestock Development Policy of 2020 cover equity in health prioritization between domestic and game animals. The Animal Health Act of 2010, the Public Health Act (Meat, Abattoir, and Butcheries Regulations), and the Food Safety Act of 2019 protect consumer safety.

3.1.1 Zambia Wildlife Act of 2015

The Zambia Wildlife Act of 2015 is the primary regulation establishing conditions for the game meat trade, both farmed and wild, in Zambia. The Department of National Parks and Wildlife (DNPW) under the Ministry of Tourism and Arts (Figure 3) is responsible for executing its responsibilities. The Act defines animals as all wild species. Game meat is defined under the topic of trophies together with other game products such as horns, tusks, and skins. The Act empowers the Minister, on the advice of the Director, to regulate the trade or movement of meat, game, or protected wildlife. In addition, the Act criminalizes the hunting of game animals for game meat without a license and possession to sell and the purchase of game animals or meat without certification. Furthermore, the Act accords an authorized officer to apply or order

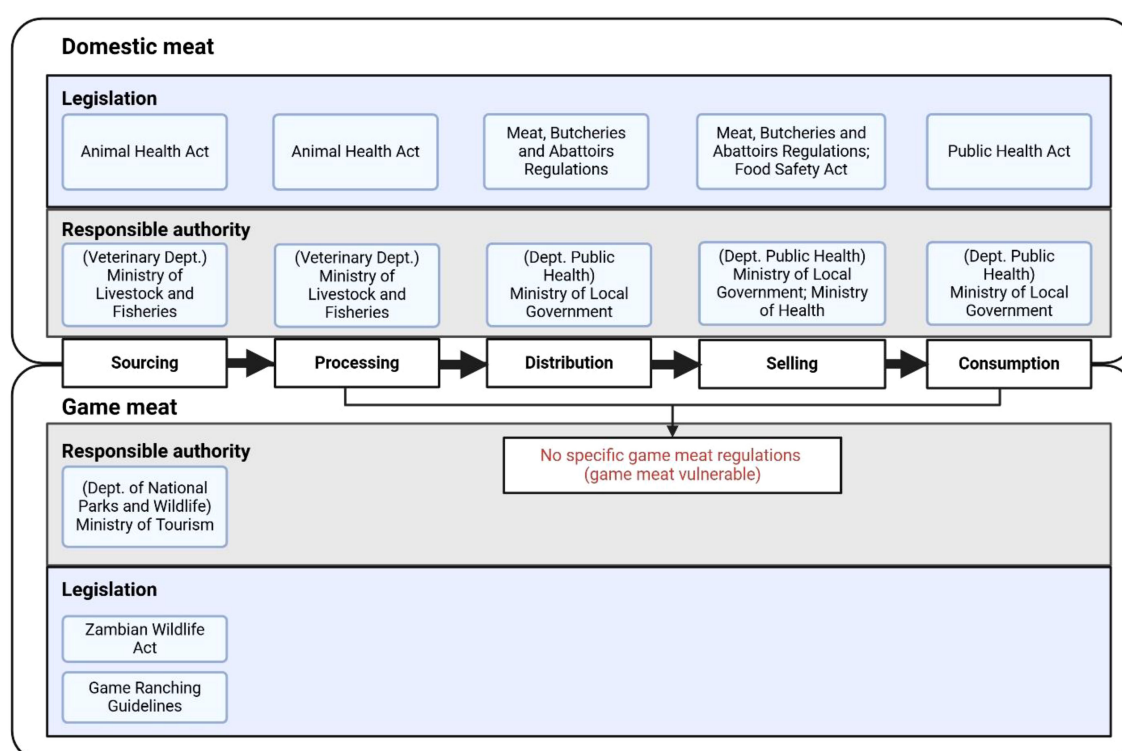


FIGURE 3

Summary of meat regulations and guidelines in Zambia, responsible authorities, and their scope according to policy analysis. Dept., Department. Created in <https://BioRender.com>.

measures necessary or prescribed for disease control and animal infection. The Act further empowers the officer the power to destroy or order the destruction, recall, destroy, detain or dispose of, obtain a sample for testing, suspend, temporarily partially, or completely close premises. The Act does not include specific regulations that regulate game meat safety and zoonosis.

3.1.2 Animal Health Act of 2010

The mandate of the Animal Health Act of 2010 is to “provide for the prevention and control of animal diseases; provide for the quarantine of animals, regulate animal products and animal by-products.” In the meat supply chain, it regulates the sourcing and processing of animal meat in Zambia. The custodian of the Act is the Ministry of Livestock and Fisheries, and it is enforced by the Department of Veterinary Services (Figure 3). The Act defines an animal as “any vertebrate, other than a human being, which is a member of the *Phylum Chordata* and includes a bee, butterfly, and other insects used in the production of animal products, including the carcass of such animals.” The Act defines an animal product as “a meat product or product of animal origin for human consumption, for use in animal feeding, or for pharmaceutical or agricultural use, and includes an embryo, ova, semen, blood, bone or bone meal, hide, skin, horn, fat, honey, unprocessed wool, and feathers.” Livestock is defined as “any breed or population of animal kept by a human being for a useful or commercial purpose and includes domestic animals, semi-domestic animals, and captive wild animals.” Considering that the Act does not specifically define game or wildlife, the coverage of these subjects is left to interpretation. It can be concluded that the Act does not have specific regulations governing game and game meat.

3.1.3 Public Health Act (Meat, Abattoir, and Butcheries Regulations) and the Food Safety Act of 2019

This Act regulates the operations of abattoirs and butcheries in Zambia. The regulations are enforced by the Public Health Department, under the Ministry of Health (Figure 3). In the meat industry, they cover processing and selling. The Public Health Act (Meat, Abattoirs, and Butcheries regulations) defines an animal as “ox, bullock, cow, heifer, steer, calf, sheep, lamb, goat, or other quadrupeds commonly used for the food of man.” Meat is defined as “the flesh, or offal or other parts used or intended for the food of man derived from any animal as defined above but does not include canned meat, potted meat, bacon, or ham.”

The Food Safety Act of 2019 mandate is to “provide for the protection of the public against health hazards and fraud in the manufacture, sale, and use of food; provide for a streamlined process for regulatory clearances for regulatory health requirements for food premises.” The Ministry of Health is the custodian of the Act, and it is enforced by the Department of Public Health (Figure 3). In the Food Safety Act of 2019, animal and animal products have the same meaning as assigned in the Animal Health Act of 2010. The Act gives provisions for regulations, standards, and statutory instruments.

3.1.4 National Livestock Development Policy of 2020

This policy document is relevant to this analysis because game is defined under livestock according to the Animal Health Act of 2010. The policy covers game as non-conventional livestock. The coverage is viewed from an investment perspective. Disease control and quality control standards focus on domestic livestock. The policy, however, states that there is a lack of clear policy on game as indicated by this direct quote: “The key constraints limiting non-conventional livestock include poaching, high startup costs, lack of a clear policy on non-conventional livestock, difficulty of accessing land for game ranching, and limited research and extension.”

3.2 In-depth interviews

The main goals of the in-depth interviews were to verify the findings of policy analysis with respect to the availability of specific game meat regulations and to clarify if there are any control mechanisms or practices that are being employed to manage game meat safety and zoonosis. Figure 4 illustrates the summary of game meat control mechanisms concerning regulations, codes, or standards along the supply chain, as revealed by the key informants.

3.2.1 Inspection

3.2.1.1 Game movement

To illustrate game movement control concerning zoonosis, we provide an illustration of a typical game movement process as coded from the key informants' interviews (Figure 4). If farmers or ranchers want to move the game, the head of the veterinary department is contacted. For example, if farmers want to move buffaloes, they must contact the wildlife veterinary department, which will advise them that testing is mandatory for buffaloes. Hence, field officers are instructed to go and test for diseases of national importance (e.g., foot-and-mouth disease for buffalo). At a private ranch or farm, a practicing wildlife veterinarian visits the ranch. This is because field veterinarian staff lack the competencies to perform certain tests. In some circumstances, a team from the central national laboratory can conduct the tests. After the animals have been cleared, both the selling and receiving districts are advised to proceed or not, depending on the outcome of the tests. According to interviewees, since there are no game regulations pertaining to game movement, livestock regulations are used.

“So, on regulations, we are still working on them. The regulations that we are currently using are the livestock regulations, so considering that the individual who is advising has the knowledge of both livestock and game, they provide good advice.”

Interviewees revealed that the trade of game and game meat falls under the Ministry of Tourism and Natural Resources by law. Animal diseases and game meat safety fall under the veterinary

REGULATION AND CONTROL OF GAME MEAT SUPPLY CHAIN

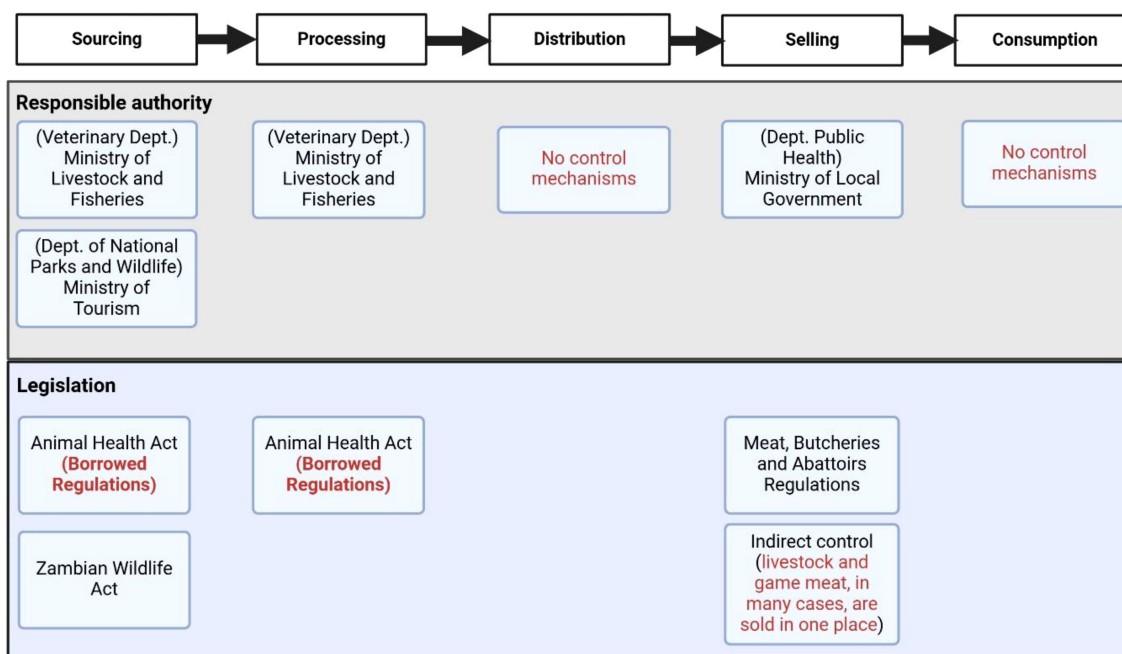


FIGURE 4

An illustration of the regulation and control of game meat along the supply chain as revealed by key informants. Borrowed regulations: regulations meant for domestic animals and meat trade that are being used for game meat in that particular supply chain stage. Dept., Department. Created in <https://BioRender.com>.

provision of the Ministry of Livestock and Fisheries. This was reported to cause challenges regarding regulation.

control measures are put in place to ensure the food safety of game meat.

“The challenge with the management and regulation implementation is we have the veterinary provision that falls by law under the Ministry of Tourism, Environment, and Natural Resources, but the authority for animal diseases, which includes wildlife, is under the Ministry of Fisheries and Livestock.”

Interviewees reported that veterinary surgeons in the Ministry of Tourism and Natural Resources are primarily there to support conservation activities, and secondarily, to address food safety and zoonotic needs.

3.2.1.2 Farmed game meat (ante-mortem and postmortem)

Interviewees reported that there are no farmed game meat regulations. Hence, for control, the Animal Health Act of 2010 (which is more biased towards livestock) is used. It was pointed out that regulations governing game and game products have since been drafted to be part of the Animal Health Act but not yet assented to be a legal body by the time this paper was written. Interviewees highlighted that even in the absence of game meat regulations, some

“Now, coming to your case when we are dealing with game products. What we are doing is still using the Animal Health Act of 2010, which is more biased towards livestock. We have to put measures in place to ensure that the product coming out of wildlife is wholesome and fit for human consumption.”

To understand zoonosis control mechanisms implemented by the authorities for farmed game meat, the practices that are put in place, from hunting to when the meat leaves the farm, were coded. The study revealed that, similar to livestock, an ante-mortem inspection is done before the animals are slaughtered. Most of the time, the department does a health assessment in private wildlife estates or game ranches. A health clearance certificate is provided to the game ranch. Officers visit the game ranch and inspect it. The inspection requires knowing the farmed species, the management of the ranch, and the biosecurity measures implemented by the game ranch, starting with fencing, the location, and then other facilities that are present. A standard questionnaire is used for the assessment. Another factor that is considered is whether the farm has a private veterinarian who attends to injured animals or attends to any diseases. During the assessment, much attention is given to

animal species that host diseases of national economic importance, which are derived mainly from livestock. Species of interest are mainly buffaloes and warthogs. For buffaloes, the focus is foot-and-mouth disease, while for warthogs it is African swine fever. Depending on the management system or what is found during the game ranch assessment, a certificate is given to the ranch. The maximum validity is 1 year, whereas the minimum validity will depend on the outcome of the assessment based on the management system and the presence of species that are hosts to diseases of national economic importance. After the certificate has been issued, the ranch is advised that the assessment acts as an ante-mortem tool. This means they can directly cull the animals after they are farmed. Officers will then perform the routine meat inspection after harvest.

The veterinary department agreed that a significant amount of work needs to be done to fully regulate the game meat industry in terms of ensuring game meat safety for human consumption. Interviewees reported that efforts regarding regulations are being made.

“We drafted the regulations governing wildlife and wildlife products in 2021 so that they can be part of the Animal Health Act of 2010, which is the law that governs the service of veterinary service provision in the country. But they are still at the consultative phase.”

3.2.1.3 Wild game meat (post-mortem)

To understand if any zoonosis control mechanisms are implemented by the authorities regarding wild game meat, the practices that are used were coded from the typical place from hunting to when the meat leaves the forest. According to interviewees, animals are shot in a GMA.

“Now in the natural protected areas, which are our game management areas, where cropping is allowed, since the law stipulates that you do not shoot animals from a national park, but rather from a game management area, which is part of the park, but where cropping is allowed.”

The hunters and the wildlife veterinary department liaise with national parks. The national parks will notify the veterinary department that they have issued hunting licenses during hunting seasons from September to December. The department knows that the main disease of concern in the Luangwa ecosystem is anthrax, and the species that are mainly of concern are hippos and buffaloes. Hunters pass through specific GMA exit points where veterinarian officers are present. The officers inspect the carcasses to determine if the minimum health requirements are met and if the meat is fit for human consumption. Reportedly, hunters also enter the GMA during the non-hunting season when no veterinary officers are at

the exit points. In this scenario, the animal is shot, processed, and delivered to butcheries or taken home without inspection.

It was pointed out that inspections are sometimes not undertaken due to the remoteness of some of the GMA areas. The example of Nyika National Park was given. In these circumstances, the hunter must make a judgment regarding meat safety. Another challenge that was reported is the lack of laboratory equipment to perform advanced tests. Game meat that should go under microscopic screening is being screened via visual observation.

3.2.2 Selling

It was reported that three ministries are involved in game meat selling: the Ministry of Tourism, the Ministry of Local Government, and the Ministry of Health. Their involvement concerns the provision of certifications and permits. The Ministry of Tourism, through the DNPW, issues permits to hunters (as mentioned under policy analysis). This permit allows them to sell to individuals or butchers. However, butchers should obtain two permits: certification of ownership of a trophy, which allows the trader to possess game meat, and a permit that allows them to sell game meat. Both are issued by the DNPW. The selling permit contains the species that is being sold and the kilograms received from the supplier hunter or rancher. If a butcher is selling the meat, the butcher requires a health permit from the local government (city council), which is renewed annually. The permit is not specifically for game meat but for any premises that are selling meat.

The Ministry of Health, which is the custodian of the Food Safety Act of 2019, and the Ministry of Local Government, which together are the custodians and enforcers of the Meat, Abattoir and Butcheries Regulations, reported that the selling of game meat is not regulated. The Ministry of Health pointed out that it does not recognize the game meat trade as formal. This is regardless of it being legalized by the Zambia Wildlife Act of 2014. However, the Ministry of Health indicated that due to increases in zoonotic outbreaks, there is a need to have game meat regulations. The Ministry of Local Government was not aware that game meat is being traded legally in Lusaka Town, which is concerning considering that they are the ones responsible for inspections. It was reported that game meat is being sold in the same butchery as domestic meat, and these butcheries are occasionally inspected by meat inspectors. Yet when the local government was interviewed, they reported that they were not aware that game meat is being traded legally in Lusaka Town, regardless of having butcheries that are selling game meat legally in Lusaka City. It was also noted that butcheries do not differentiate whether the game meat they sell is farmed or wild.

3.2.3 Traceability

Regarding traceability, one of the informants reported that:

“So, for traceability, on the license, there is a section that is signed by the hunter and one of the officers who escorted the hunter; this section needs to be verified by the local officers who are

either the area warden or the ranger. So the area warden or the ranger will verify and they will check how many heads and hooves are there and allow the hunter to proceed.”

All the information gathered by the warden and rangers is reported to wildlife headquarters. It was reported that the challenge is that the DNPW gives out permits to everyone who wants a permit to sell and does not follow up to check the source of meat. When someone wants to start selling game meat, one of the requirements is to put the supplier’s name, i.e., who is going to be supplying the game meat. It was reported that several prospective sellers use the contact details of legal suppliers during the application to satisfy the requirements. Once they obtain their permit, they will then never report to the offices again and do not update the supplier’s details in case of changes. This makes traceability a huge challenge.

3.2.4 Training

Interviewees indicated that hunter training is done by the DNPW and that the training does not involve game meat handling. The study revealed that in GMAs, there are two prerequisites for hunting: possessing a licensed gun and being a professional hunter. The study revealed that there is an association called the Professional Hunters Association (PHS). In most of the game ranches, the clientele might not be trained hunters, but the owners of the game ranches are either trained hunters or they are the ones who employ trained hunters. Interviewees mentioned that if the clients want to shoot the animal themselves, they will be accompanied by a trained hunter. There are also freelance hunters who may have served in the military, and in some rare circumstances, wildlife police officers can also assist with shooting.

4 Discussion

4.1 Policy analysis

4.1.1 Zambia Wildlife Act of 2015

To determine if the Zambia Wildlife Act of 2015 covers the game meat trade, it is a matter of the presence of certain terms in the Act, i.e., game meat and wild meat, and how they are defined. How an animal is defined is also important as it establishes which species are covered by the Act. Defining game meat as a trophy makes the interpretation unclear. The lack of clarity has consequences for the general population in interpreting the law, and this may bring challenges in enforcement. The Minister has the power to regulate trade or movement of meat or game animals or protected wildlife. The Act criminalizes hunting without a license, possession to sell without a license, and the buying of game animals or meat to sell without certification. These measures control zoonotic risk as hunting permits are issued by the DNPW, and the department does not issue permits to hunt in high-risk areas (e.g., areas experiencing disease outbreaks). The power to recall a product and test and destroy it also increases game meat safety and reduces zoonotic transmission. It is important to note that the Act regulates sourcing and selling mainly from a conservation vantage point.

Other countries’ conservation Acts, for instance, the South African National Environmental Management: Biodiversity Act of 2004, have a section of professional hunting courses. This section encompasses how to conduct training, reassessments, and examinations of hunters. This is important because proper training enhances game meat safety and reduces zoonosis spillage (Branciarri et al., 2020; Gaviglio et al., 2018).

Interviewees reported that the Zambian regulation allows hunting provided that the hunter holds a permit. When hunting is done, the surrounding rural and marginalized communities are also given a share of the game meat (Lindsey et al., 2013). This practice allows these marginalized groups to have access to wildlife resources (Treves et al., 2019), which is a much-needed source of protein. This means the law and the practice both serve environmental justice as there is a certain balance in resource use, especially if a comparison is made with countries that do not allow hunting (Damm, 2008). In addition, regulated hunting ensures sustainable management of game species, which can also lead to a reduction in animal-wildlife-human interactions (Baskin, 2016). All these factors contribute to environmental justice.

4.1.2 Animal Health Act of 2010

The scope of the Animal Health Act of 2010 regarding game and game meat is a function of how the term animal is defined. The Act does not clearly state game or wildlife; it only mentions the word vertebrate. It can reasonably be said that it does include game animals. The problem is that, when the law is left to interpretation, it can have ramifications in enforcement. The inclusion of game in the definition would have made things clear considering that game animals are usually not covered by regulations that cover domestic animals (World Bank, FAO, 2022a; Broad, 2020). This lack of clarity may create an enforcement loophole. The FAO (1983) points out that a lack of clear terms and certainty in laws deprives the public of protections. The definition of game animals under livestock shows how domestic livestock is prioritized in regulations over game animals. In addition, by only mentioning captured game animals, non-captured game animals are not covered by the Act. The lack of specific regulations for the mentioned captive game shows that the game is included by definition. This means that game meat is vulnerable to contamination by zoonotic pathogens during sourcing and processing. This reflects both the history and primary purpose of animal health laws, which is to protect domestic animals and not the health of wild animals (World Bank, FAO, 2022a, 2022).

4.1.3 Public Health Act (Meat, Abattoir and Butcheries Regulations) and the Food Safety Act of 2019

How the Public Health Act (Meat, Abattoir, and Butcheries Regulations) covers game and game meat is a matter of how the animal is defined in the Act. The Act defines ‘animal’ as a quadruped (meaning four-legged animal), thus not providing clarity as to the specific species covered under the Act. This makes application and enforcement challenging. The regulations

do not have specific game meat regulations that cover the game meat chain in the same way that the Meat Inspection and Control of Red Meat Abattoir Regulations of Botswana do (Botswana, Livestock and Meat Industries Act of 2007). The lack of specific regulations or guidelines that control the supply chain may increase zoonosis risks. Game meat should conform to hygiene regulations if it is entering the commercial market (Needham et al., 2023). To determine if the Food Safety Act of 2019 covers game meat, how animal and animal products are defined in the Act needs to be considered. ‘Animal’ and ‘animal products’ in the Food Safety Act of 2019 have the same meaning assigned to the definitions in the Animal Health Act of 2010. These definitions reference the Animal Act without further clarification, leaving the application of the term game meat open to interpretation. The Act provides provisions for regulations, standards, and statutory instruments. However, currently, there are no regulations or standards that regulate game meat. The lack of game meat standards or specific regulations that regulate the selling and marketing of game meat increases zoonotic risks. Looking at Southern Africa, only South Africa has game meat standards. These are the Standards for the Microbiological Monitoring of Meat, Process Hygiene, and Cleaning (VPN/15/2010-01), which are for exported game meat. Namibia, in their Guidelines for the Harvesting and Processing of Wild Game in Namibia of 2016, has microbiological limits.

4.1.4 National Livestock Development Policy of 2020

The National Livestock Development Policy covers game, defining it under non-conventional livestock. Its coverage is from an investment point of view. Disease control and quality control standards focus on domestic livestock. This indicates that it is biased towards domestic livestock. The production of game and game products cannot be compared with the production of domestic animals in terms of numbers but considering the frequency of zoonotic outbreaks; strategies must also cover game and game products for the safety of public health.

4.2 In-depth interviews

4.2.1 Inspection

4.2.1.1 Game movement

As reported, the lack of competence of field officers is common in developing countries. Nkosi et al. (2023) highlighted that in many developing countries, there are not enough trained staff to undertake inspections of game, whilst laboratories to help with the diagnosis of possible hazards are even more scarce. The lack of competence and resources likely increases the zoonotic risks, especially if veterinarians are unable to detect diseases of importance in time. Furthermore, the focus of veterinary surgeons is mostly on conservation, and less on food safety and zoonosis. This indicates a bias and low level of priority towards food safety issues. Wei (2020) pointed out that governments should start to pay more attention to food safety issues related to the game.

4.2.1.2 Farmed game meat (ante-mortem and postmortem)

The lack of specific game meat regulations likely increases zoonotic risks, as regulations, (together with proper enforcement) prevent the distribution of contaminated meat products. The effort to draft game regulations is an important step towards controlling zoonotic risks in game meat and increasing its safety. The realization that there is a considerable amount of work that needs to be done to normalize the game meat industry in terms of game meat safety for human consumption is a good step in the right direction. However, a realization of the need to increase game meat safety and the drafting of specific game meat regulations is not enough. There is a need for commitment from relevant stakeholders so that the regulations come into force. If these regulations are not prioritized, they may take a long time to be approved. For instance, in South Africa, game meat regulations were drafted in 2004 (van Der Merwe et al., 2011), and at the time our paper was written, they had not yet been approved.

4.2.1.3 Wild game meat (post-mortem)

The practice of introducing game meat without inspections was reported by key informants. This practice likely increases zoonosis risk. The same practice was also highlighted in Abrantes et al. (2023). Philavong et al. (2020) pointed out that part of the game trade operates outside the official distribution chains and therefore bypasses slaughterhouses where inspections and testing for potential infectious agents would normally be carried out, which is the same for Zambia. The practice of telling hunters where they can find veterinarian staff who can perform inspections after hunting (as found in this study) was also mentioned by Gaviglio and colleagues (Gaviglio et al., 2018). Regarding the situations where game meat is not inspected at the exit, Casoli et al. (2005) reported that in many cases, wild game does not undergo any official examination. A study that was done by Olivastri and colleagues (Olivastri et al., 2021) showed the importance of post-mortem inspections and the central role of the competent authority in ensuring the food safety of game meat. A lack of resources increases game meat risks and decreases game meat safety as game meat will gain entry into the market without proper inspection. The lack of resources was also pointed out by Mendelson et al. (2003) as an impediment to compliance associated with state regulation in the Ghana Wildlife Department.

4.2.2 Selling

The lack of awareness among inspectors regarding the sale of game meat by butchers is probably because inspections are guided by regulations. Hence, the absence of specific regulations addressing game meat leads to the assumption that game meat is not being sold. Failure to distinguish between farmed and wild game during selling can mislead customers, as well as make it difficult to track the source of zoonotic origin. An interim guideline published by the WHO, WOA, and FAO in 2021 highlighted the need to distinguish farmed game from wild game as a traceability measure to reduce zoonotic risks (WHO, WOA, UNEP, 2021).

4.2.3 Traceability

The informants revealed that the current game traceability system is mainly focused on conservation to allow passage at roadblocks. It does not focus on zoonosis or game meat safety. It also does not record the health status of the killed animal back to the farm, the same way the South African system does for exported game meat (Hoffman and Wiklund, 2006). The lack of a traceability system that is zoonotic and game meat safety-oriented makes it difficult to manage zoonotic outbreaks if they occur. The WHO, WOA, and FAO in 2019 stressed the importance of traceability systems in game meat supply chain systems as a mechanism to manage zoonotic diseases (WHO, WOA, UNEP, 2021). The same was suggested by Petrovan and colleagues (Petrovan et al., 2021) in a review. Poor traceability systems make it difficult to track and trace the origin of a zoonotic outbreak (Campbell et al., 2021), which in turn makes it challenging to protect public health.

4.2.4 Training

The study found that hunters are not trained to handle game meat. This practice likely increases zoonotic risks through occupational exposure. Incorporating training limits exposure, which protects the workers from the working environment. Korkmaz et al. (2022) recommended that the training of hunters should include both shooting training and game meat safety training. According to the European Regulation (EC) No. 853/2004 for food derived from animals, at least one person from a team must know the normal anatomy, physiology, and behavior of game animals as well as be able to ascertain abnormal behavior and pathological changes caused by disease, environmental contamination, or other factors, which may affect human health after consumption. Gaviglio and colleagues (Gaviglio et al., 2018) emphasized that, in any supply chain, the chain of game meat should start with a trained hunter. A trained person has juridical responsibility, which is required to transmit and make people aware of food safety preventive measures and the unhygienic handling of meat (Abrantes et al., 2023). The same is also mandated in South Africa by the National Environment Management Biodiversity Act of 2004. A study that evaluated the contamination of roe deer carcasses during animal control in central Italy (Branciarini et al., 2020) concluded that training hunters who carry out procedures, such as bleeding and evisceration, is necessary to prevent carcass contamination. Zottola and colleagues (Zottola et al., 2013) pointed out that the choice of a well-trained hunter for the season and the hunting method are important. Ranucci and colleagues (Ranucci et al., 2021) reported that proper training of hunted wild boars influenced the lower average microbial loads. Training in good hygiene practices while handling and dressing game meat resulted in low *Enterobacteriaceae* counts in a study conducted by Mirceta and colleagues (Mirceta et al., 2017).

4.3 International perspective in this Zambian case study

Zambia is only one of many countries contributing to the international trade in game meat through importation from

South Africa and Namibia (FAO, 2024). In this section, we provide a brief overview of the policy perspective for international trade. The environmental justice issues discussed as applicable at the national level are magnified across the extent of the complex international trade pathways.

Regarding the regulation and control of game meat safety from an international perspective, the Codex Alimentarius Commission (CAC) (an organization operated by the WHO and FAO to create and maintain international food standards to protect public health and ensure fair trade practices) published the *Code of hygienic practice for meat CAC/RCP 58-2005*, which covers game meat safety along all the supply chain stages. However, it does not specifically cover zoonosis. Countries that do not have the game meat regulations/guidelines can adopt the code into law; once adopted, it can be used as it is or adjusted to fit the local context; if it is adopted, it can only work at a national scale. The FAO has established technical guidance principles for risk-based meat inspection and their application. The technical document mentions the game in passing under elements that should be incorporated in meat inspection legislation, stating that “when applicable, there should also be a provision for the hunted game” (FAO, 2021). The guidelines do not explain how the principles work in the context of game meat. Specific game regulations and guidelines at the international level are lacking. Hence, the international game meat trade is regulated through bilateral agreements (Department of Forestry, Fisheries and the Environment, South Africa, 2023). The bilateral agreements include the game meat safety criterion that the exporting country should meet. If they do not meet the specific criterion, the arrangement is canceled. For example, Russia banned importation of kangaroo meat due to high *Escherichia bacteria* (Ben-Ami et al., 2010).

The World Trade Organization (WTO) mandates the WOA within its Sanitary and Phytosanitary Agreement (SPS Agreement), as the international reference organization for setting standards for the international trade in animals and animal products (Brückner, 2009). Trade between countries is through bilateral agreements that are guided by this SPS Agreement. (Figure 5). As a result of these measures, the risk of zoonotic spillover along the game meat supply chain can be minimized, considering that all the ministries and departments (Figure 5) have control measures in place. However, it is important to point out that risk minimization depends on whether the measures are being implemented and the necessary resources for the implementation are available.

When game meat that is sourced legally in countries that allow hunting and trading of game meat (this case study) or sourced from countries where regulations are unclear (van Vliet et al., 2019) is smuggled via airports or borders (Morrison-Lanjouw et al., 2023), it likely increases zoonotic risks because border control measures are avoided. When this game meat, despite being sourced legally, crosses the borders, it becomes illegal. To prevent this kind of trade, the focus needs to be placed on the regulation and control of sourcing and customs (Figure 5). A study conducted by Chaber and colleagues (Chaber et al., 2023) focused on international wild meat traffic into Belgium. The researcher found that Nigeria and Uganda were some of the key countries from which the meat originated. By investigating the regulations of wild meat in Nigeria, Akpan and

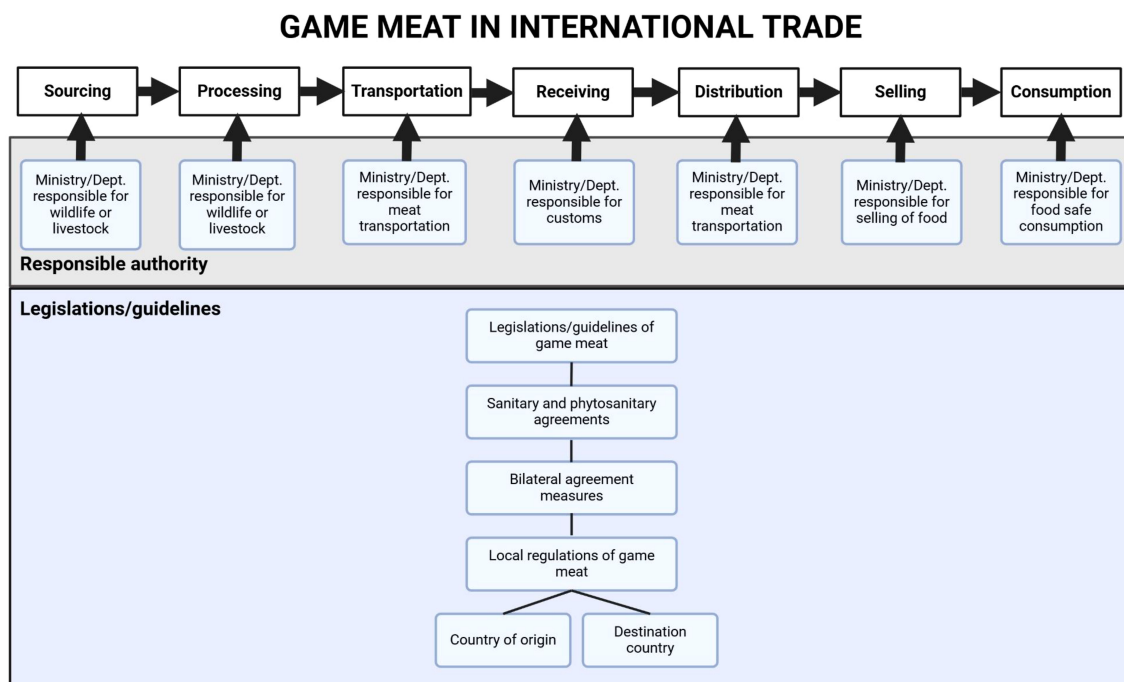


FIGURE 5

An illustration of game meat in international trade, including possible ministries or departments (depending on the country) and current international legislations or guidelines. Dept., Department. The arrows indicate the movement of the meat from the source. Created in <https://BioRender.com>.

colleagues (Akpan et al., 2025) revealed a lack of regulations in the wild meat supply chain. Hence, this could be one of the contributing factors to its international trade and trafficking. Conversely, Uganda has hunting and game meat trading regulations (The Uganda Wildlife Statute of 1996), yet it was also reported as a source. This could be a result of enforcement or lack of knowledge regarding the illegality of import of personal consignments of meat from third countries into the European Union (Chaber et al., 2023). Hence, on top of regulations and enforcement, it is important to educate people regarding these trafficking practices.

4.4 General recommendations

Based on the findings of this study, the use of the zoonotic control framework (Figure 2) is proposed as the basis for developing regulations for game safety and zoonosis prevention along the game meat supply chain in Zambia. All the components in the framework can increase game meat safety and mitigate zoonotic transmission, thereby improving environmental justice. The framework is made up of three components: inspections (which are subdivided into four elements: (biosecurity, post-mortem and ante-mortem, product distribution and selling), traceability, and training.

Biosecurity protects animal and human health. Ante-mortem inspections help in identifying diseased animals so that they are not slaughtered. Post-mortem inspections, distribution, and selling of game meat-specific regulations prevent the distribution of

contaminated meat products that could give rise to zoonotic disease in humans (FAO, 2021). In addition, the regulations should cover traceability through the monitoring of critical points in the supply chain to gather data on where, how, and under what conditions the game meat is being produced and traded (Campbell et al., 2022). Furthermore, they should also include personnel training. Ideally, the training should encompass game pathology, the production and handling of game meat after hunting, and the undertaking of a first examination of wild game on the spot (EC No 853/2004). All these are important in preventing zoonotic spillover. Creating regulations alone is not enough. The government should allocate more resources to responsible ministries. These resources should support infrastructure, financial needs, and personnel needs, ultimately benefiting enforcement.

The One Health concept that integrates human, animal, and environmental health should be practiced by all the ministries involved in the supply chain to improve game meat safety and prevent zoonosis. If this concept is adopted by the Ministry of Tourism and Natural Resources and the Ministry of Livestock and Fisheries, this can avoid delays and expedite the approval of the game and game regulations that can address the concerns raised in this study.

5 Conclusion

There are no specific regulations governing game meat safety in Zambia. Domestic livestock and meat regulations are being borrowed

from other regulatory frameworks and used to control game meat safety along the domestic supply chain. Game meat control is only occurring at the first stage (i.e., sourcing) of the supply chain, while the rest of the chain remains uncontrolled. Game meat is being sold in the same butcheries that also sell domestic livestock. From the lens of environmental justice, the Wildlife Act of 2015 is serving environmental justice. The Animal Health Act of 2010 and the National Livestock Development are biased towards domestic livestock; hence, there is no equity in health prioritization between domestic and game animals. Consumers are not fully protected by the Public Health Act (Meat, Abattoir, and Butcheries Regulations) and the Food Safety Act of 2019. This study offers key insights into the regulation and control of farmed and wild game meat in Zambia. We recommend utilizing the zoonotic control framework to draft specific game meat regulations for the government and increase resources for responsible ministries. The framework can also be adopted by other countries in similar situations. In addition, the policy analysis methods employed in this study can contribute to a deeper understanding of game meat safety and, thus, environmental justice in other countries.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Tropical Disease Research Centre (TDRC) Research Ethics Committee, Ndola, Zambia. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

BM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. FS: Writing – review & editing, Visualization, Validation. SE: Writing – review & editing, Visualization, Validation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcsc.2025.1541179/full#supplementary-material>

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Jonathan Kolby,
Smithsonian Conservation Biology Institute
(SI), United States
Jason Kirkey,
Smithsonian Conservation Biology Institute
(SI), United States
Bienvenu Takem Mbi,
University of Maryland, College Park,
United States

*CORRESPONDENCE

José Luis Carpio-Domínguez
✉ jlcarpiodominguez@outlook.com

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Policing wildlife trafficking in northeastern Mexico: the case of Tamaulipas in 2023–2024

José Luis Carpio-Domínguez^{1*}, José Juan Cervantes-Niño²,
Jesús Ignacio Castro-Salazar³ and Violeta Mendezcarlo-Silva⁴

¹Criminology Department, Faculty of Law, Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico, ²Instituto de Investigaciones Sociales, Universidad Autónoma de Nuevo León, Nuevo León, Mexico, ³Tecnologico Nacional de Mexico (TecNM), Instituto Tecnológico Superior de Abasolo, Abasolo, Guanajuato, Mexico, ⁴Law Department, Faculty of Law, Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico

Illegal wildlife trade is an environmental, economic, and social problem that threatens global public health and the security of countries. It is one of the main drivers of biodiversity loss on a global scale. Mexico is a source and transit nation for trafficked wildlife, so the timely detection by Mexico's governmental institutions is of fundamental importance for combating wildlife trafficking. The present study aims to analyze the factors that facilitate or constrain the police actions taken as first responders to wildlife trafficking in the state of Tamaulipas during the period 2023–2024. Through interviews with police officers, we determined that the prioritization of crimes related to public security has limited police attention to other forms of crime, such as wildlife trafficking. as the outcome is that wildlife trafficking is a largely uninvestigated, unquantified, and unaddressed crime. Further, most police officers are unaware that environmental crimes fall under their jurisdiction, which limits law enforcement and environmental justice in the state.

KEYWORDS

wildlife trafficking, policing, environmental crime, police, green criminology

Introduction

Illegal wildlife trade is an environmental, economic, and social problem that threatens global public health and national security. It is one of the main causes of biodiversity loss on a global scale (UNODC, 2020; Bezerra-Santos et al., 2021; UNODC, 2024). Wildlife trafficking, like other environmental crimes, is socially neglected and economically exploitative, generating global insecurity with widespread consequences for human development (International Police [INTERPOL], 2020). Consequently, human lives and livelihoods, as well as all other life of the planet (Agnew, 1998; White et al., 2013; Brisman, 2014; Carpio-Domínguez, 2023a). Environmental crime exacerbates poverty and weakens society's resilience (INTERPOL, 2020) leading to the reduction of a healthy environment.

Scholars have thus called for an adaptive governance model which should emphasize key law enforcement solutions to wildlife crime (Castro-Salazar et al., 2022).

Environmental justice considers the just treatment and meaningful involvement of all people regardless of income, race, color, national origin, Tribal affiliation, or disability. In agency decision-making and other Federal activities affecting human health and the environment (Environmental Protection Agency, 2024), environmental justice incorporates the ways in which the governments respond to environmental issues, including environmental crimes (Bass, 1998).

Environmental criminal threats are complex and constantly evolving and emerging (Ayling, 2017; Carpio-Domínguez et al., 2022; Duffy, 2022). Among the crimes with a high adaptive capacity to government regulations, wildlife trafficking has been highlighted due to the heterogeneity of its contributing factors (social, environmental, geographic, political, economic and cultural), as well as the creation of social networks that confer permeability to government institutions (Sas-Rolfes et al., 2019; Wyatt et al., 2020; Anagnoustou, 2021). Key forces addressing wildlife trafficking include government environmental institutions (e.g., environmental agencies, police, experts, universities and research centers, international agreements) and members of civil society (e.g., non-governmental organizations and volunteers) who have collectively joined forces to understand, measure, and prevent wildlife trafficking in different parts of the world (UNODC, 2024).

Police represent the first line of government attention in attending crimes, including cases of wildlife trafficking because, primarily, they are first responders, this refers to an authority with public security functions that first arrives at the scene of a criminal act or where evidence, objects or instruments related to a criminal act were found (Protocolo Nacional de Actuación Primeros Respondientes, 2017). Their capability to identify wildlife trafficking and the forms in which it occurs is strategic in identifying and combating this crime.

Wildlife trafficking in Mexico occurs as organized crime, subsistence activity, and as an activity promoted by cultural tradition (see Sosa-Escalante, 2011; Arroyo-Quiroz and Wyatt, 2019; Alvarado-Martínez and Ibañez-Alonso, 2021; Arroyo-Quiroz et al., 2023; Carpio-Domínguez et al., 2023). It therefore requires a comprehensive and coordinated response from the government and its institutions (Castro-Salazar et al., 2023; Carpio-Domínguez, 2023a), including actions to strengthen the capacities of government officials responsible for the identification, attention, management, and prevention of wildlife crimes (Castro-Salazar and Camacho-García, 2020).

In Mexico, wildlife trafficking is a crime under federal jurisdiction (Art. 420 of Código Penal Federal, 2024). Responsive actions fall to the national Attorney General's Office (Fiscalía General de la República) (FGR) and each State Attorney General's Office in criminal jurisdiction, as well as the Secretariat of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales) (SEMARNAT) and the Federal Attorney General's Office for Environmental Protection (Procuraduría Federal de Protección al Ambiente) (PROFEPA) for administrative jurisdiction.

However, constant social and security problems in Mexico have diminished environmental crimes, including wildlife trafficking, from public interest relative to crimes considered "of high social impact" (e.g., homicides, drug trafficking, kidnappings, theft, extortion). As a result, environmental crime does not occupy an adequate place on government agendas (Moreto et al., 2015; Carpio-Domínguez, 2023a) despite the fact that wildlife trafficking often occurs in conjunction with other crimes, such as drug trafficking, kidnapping, human trafficking, and arms trafficking (Carpio-Domínguez et al., 2022, 2023).

The neglect of environmental crimes is particularly apparent in the state of Tamaulipas where, due to its border location with Texas in the United States, phenomena such as human migration, drug trafficking, and organized crime are present and are considered high-impact phenomena (Coss-Nogueda, 2012; Moloesnik and Suárez de Garay, 2012; Correa-Cabrera, 2016; Izcarra-Palacios, 2016; París-Pombo, 2016). Government attention and resources are focused on addressing these problems.

Environmental crime in the state of Tamaulipas has not been studied in depth despite the fact that it is located between the Sierra Madre Oriental and the coast on the Gulf of Mexico, making it the northern state of Mexico with the greatest biodiversity (Correa-Sandoval et al., 2014; Gobierno de Tamaulipas, 2024). Nonetheless, wildlife trafficking is documented Tamaulipas and is related to other forms of criminality originating from criminal groups, government officials, and the civilian population (Sosa-Escalante, 2011; Carpio-Domínguez et al., 2018a, b, 2022; 2023b). The factors that facilitate and constrain police action as a first response to wildlife trafficking in the state of Tamaulipas have not previously been investigated.

The state of Tamaulipas has 4,543 police officers, most of whom are preventive police (n=4,307, 94.8%), followed by community police (n=184, 4.1%), reaction police (n=45, 1.0%), and investigation police (n=7, 0.2%) (INEGI, 2023a). To cover the security needs of the state, studies have estimated the need to increase the number of new police officers to 8,400 (Oficina de las Naciones Unidas contra la Droga y el Delito [UNODC], 2020). Tamaulipas ranks thirteenth nationally in the number of police per state, below Mexico City (n=95 161), Estado de México (n= 20 613), Veracruz (n= 11 957), Oaxaca (n= 8 094), Nuevo León (n=7 669), Tabasco (n= 7 617), Chiapas (n= 7 393), Guerrero (n= 7 372), Puebla (n= 6 291), Jalisco (n=6 195), Yucatan (n= 5 398), and Hidalgo (n=5 165).

According to the Secretariat of Public Security of the state of Tamaulipas (Secretaría de Seguridad Pública del estado de Tamaulipas) (SSPT), the mission of the state police is to "prevent the commission of crimes in the state territory, guarantee and maintain public order and peace, protect the integrity of people, their human rights and individual guarantees, governed by the principles of legality, efficiency, professionalism and honesty." Guidelines also envision that police officers are "professional ... with optimal training in various disciplines of police work, supported by modern equipment and technology, to provide an efficient service of quality and warmth to society" (SSPT, 2023). Although the main objective of police is to guarantee peace through the pursuit of justice (Willy, 2023), they are typically the first responders in criminal cases, including environmental crimes.

The aim of our study was to analyze the factors that constrain and facilitate the police actions as first responders to wildlife trafficking in the state of Tamaulipas during the period 2023–2024. In particular, we sought to ascertain how the security, political, social, cultural, and environmental context influences the identification, response, and prevention of environmental crimes such as wildlife trafficking. Ultimately, it is our hope that the project findings will be used to increase the priority for police actions to address wildlife crimes in Tamaulipas and elsewhere, consequently improving policy force capacity for enforcement. Biodiversity conservation is contingent on these improvements in environmental justice.

Methods

Theoretical framework

This study adapts the institutional capacity framework proposed by Rosas-Huerta (2008) which was in turn adapted from Grindle and Hildebrand (1995); Grindle (1997) and Forss and Venson (2002). The framework enables the elucidation of factors that facilitate or constrain police actions as first responders to wildlife trafficking. Capacity is defined as the “ability to perform functions, solve problems and set and achieve objectives” (Fukuda-Parr et al., 2002). Institutional capacity is composed of administrative capacity

and political capacity, and through its processes and organization it seeks to ensure compliance with the public agenda.

Following Grindle's (1997) framework, institutional capacity has five levels: the individual; the institution; the network of institutions; public governance; and social norms, values and practices. These levels can be regrouped into three levels: micro (the individual), meso (the institution) and macro (the institutional context) (Rosas-Huerta, 2008). Analyzing institutional capacity through these levels provides an understanding of how different factors influence the capacity to perform functions, solve problems and set and meet objectives in the field of public service.

At the micro level are the attitudes and aptitudes, skills, incentives, objectives, and adequacy of the institutions' staff. Although they are the basis of success for any public policy, individual actions are not sufficient to achieve institutional capacity and are therefore related to the other levels of institutional capacity. The meso level is focused on the institution and considers the clear objectives and goals in the functions and policies implemented, the financial resources to develop its functions, the organizational capacity (organizational culture), the leadership of the institution, as well as the inter-institutional coordination and cooperation to meet objectives. Finally, the macro level refers to the economic, political, and social environment in which the institution performs its functions, and is subject to changes in legislation, political regimes and political and legal changes (Willems, 2004; Rosas-Huerta, 2008) (Figure 1).

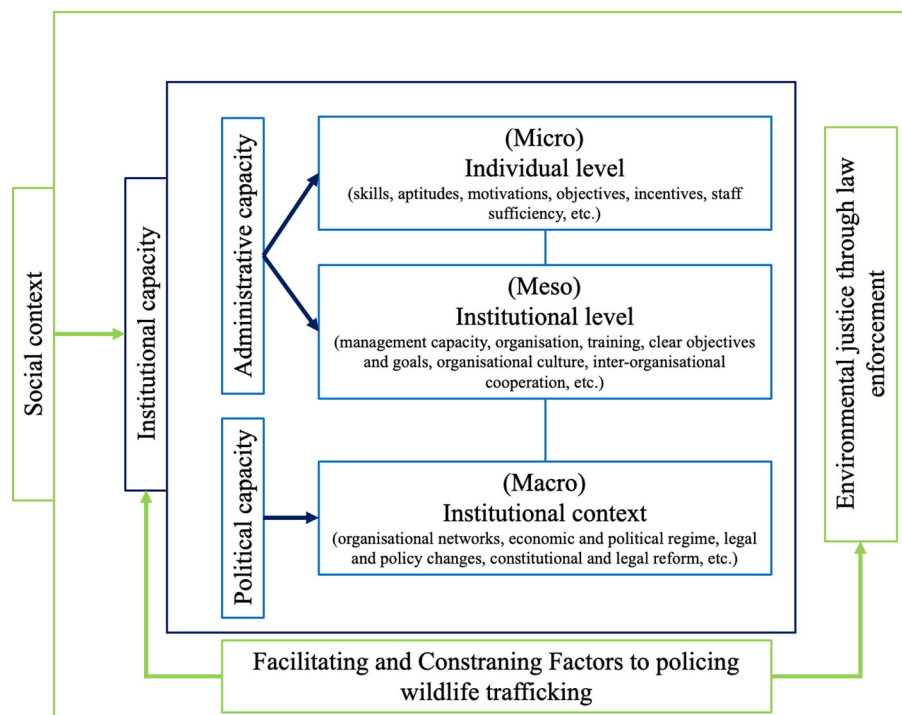


FIGURE 1

The theoretical framework examines institutional capacity for public service. The framework is adapted from Grindle and Hildebrand's (1995), Grindle's (1997), Forss and Venson's (2002), Willems' (2004) and Rosas-Huerta's (2008) proposals about institutional capacity. Source: Modified from Rosas-Huerta (2008).

The main objective of adapting this theoretical framework is to understand those factors that not only depend on the self-management and self-organization of institutional capacity to respond to social problems, but also those originated in the social context. In particular, the factors that facilitate and constrain police action in responding to wildlife trafficking as a preliminary study of the police and their relationship in the institutional response to environmental crime in the Mexican context.

This framework incorporates environmental law enforcement from the role of police as first responders in wildlife trafficking as part of the government's role in achieving environmental justice. It focuses on making visible the government response and the challenges and advantages of achieving environmental justice, considering the social context in which the police institutions operate (Tomkins, 2005).

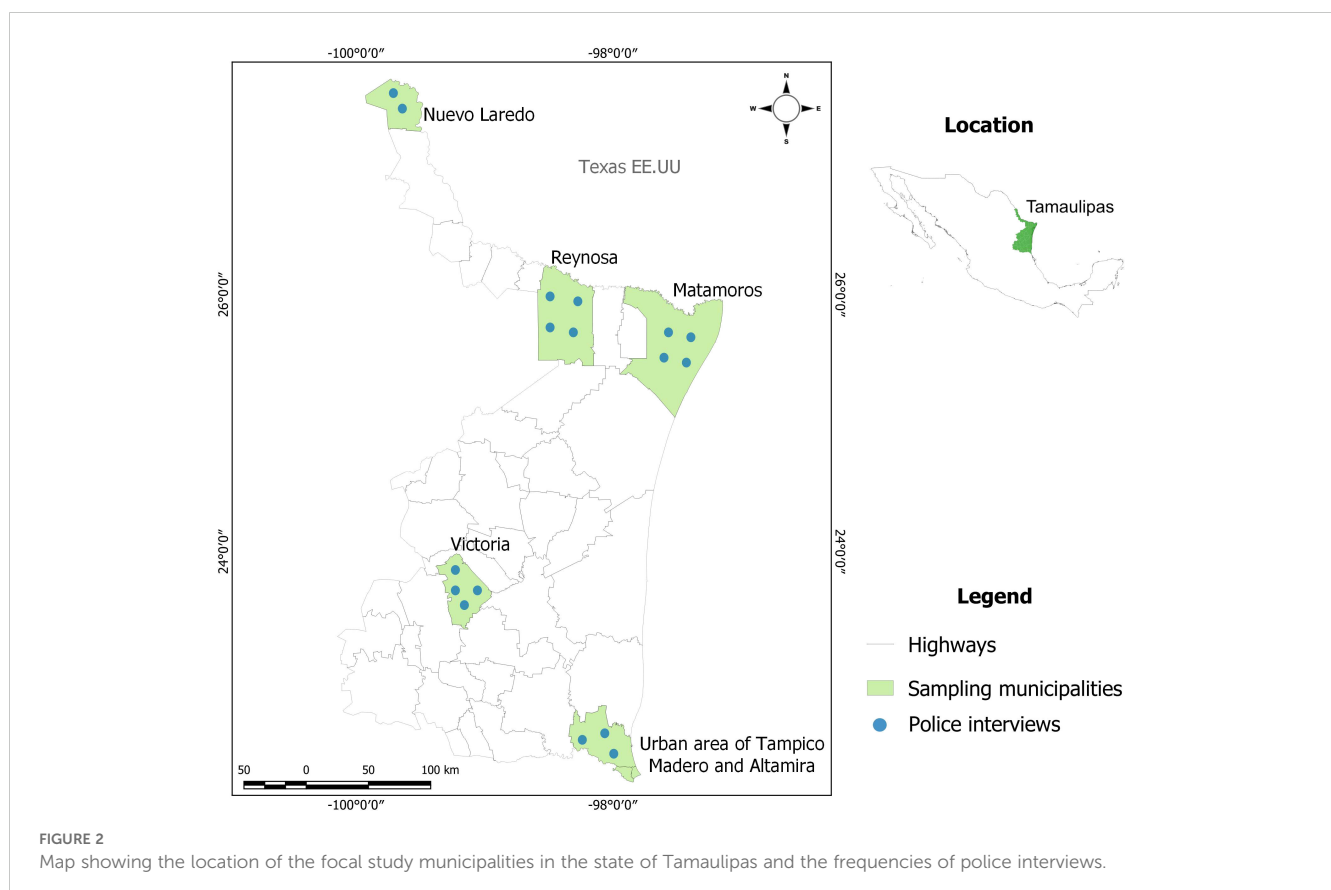
Study area

This study was conducted in seven municipalities within the state of Tamaulipas in northeastern Mexico. The study municipalities were intentionally selected because these municipalities have the largest cities in the state, with the largest populations and with State Guard detachments. To obtain a broader geographical perspective of police response in cases of wildlife trafficking, police from the three regions of the state of Tamaulipas were considered: north, central, and south. This

approach provided insight into the diverse of security, economic, social, and environmental contexts that facilitate or constrain the police activities as first responders in wildlife trafficking in the three regions of the state of Tamaulipas (Figure 2). The distribution of the municipalities in the northern region were Nuevo Laredo (n=2), Reynosa (n=4) and Matamoros (n=4); in the central region the municipality of Victoria (n=4), the capital of the state, was considered, and in the southern region the urban area of the municipalities of Tampico (n=1), Altamira (n=1) and Madero (n=1) was considered.

Research participants

For data collection we requested access to public security offices of the municipalities to conduct interviews with preventive police officers for this study and once authorization was obtained, we proceeded to explain the objective, informed consent process, and scope of this study to the police officers who initially agreed to participate, after which they referred other colleagues who could participate and provide information. This data collection technique, known as snowball sampling, involves identifying potential informants and leading to other informants with the same inclusion criteria (Bernard, 2006) until saturation of the sample is reached. Saturation of the sample was conducted when no new or additional information or issues of interest to the research emerge from the interviews (Krueger and Casey, 2000), thus investigating



the phenomenon and subsequently allowing new research from other angles (Martínez-Salgado, 2012).

Seventeen interviews to preventive police officers were conducted during the period August 2023 to January 2024, achieving sample saturation. Each interview lasted between 30 and 40 minutes and was conducted in person. Regarding the gender of the interviewees, 23.5% (n=4) were women, while 76.5% (n=13) were men; with an average age of 36.6 years and an average of 6.9 years in police service. The police officers interviewed represent four police ranks: Sub-officer (n=4, 23.5%), Police Officer 1° (n=1, 5.9%), Police Officer 2° (n=1, 5.9%) and Police Officer 3° (n=11, 64.7%).

Each police rank develops prevention activities established by the Regulations of the Professional Police Career Service of the Secretariat of Public Security of the state of Tamaulipas (*Reglamento del Servicio Profesional de Carrera Policial de la Secretaría de Seguridad Pública del Estado de Tamaulipas, 2021*) and these ranks are categorized as follows: (a) Officers and Sub-officers and (b) Basic Scale. The persons interviewed were Sub-officers (higher police rank in this study) engaged in supervisory and liaison activities. While Basic Scale, the police officers (1st, 2nd and 3rd) engaged in law enforcement operations. In addition, each rank is determined by the level of education of each police officer at the time of entry to police institution or the last degree obtained while in the institution (professionalization). The police officers interviewed were from the three regions of the state of Tamaulipas

(see Figure 1): north (n=10, 58.8%), central (n=4, 23.5%) and south (n=3, 17.6%) (Table 1).

Informed consent

Prior to each interview, the written informed consent for this study was read and shared with the participants, and each participant signed it in agreement. In addition, the data collection instrument contains a consent section that participants signed at the end of each interview (see *Supplementary Material*).

Data collection instrument

An interview guide was designed and applied to preventive police officers in the state of Tamaulipas (see *Supplementary Material* for detailed interview guide). The interview guide were structured in two categories: (1) the first category explores the factors constraining police response in cases of wildlife trafficking as a first responder, (2) the second category explores the factors facilitating police response in cases of wildlife trafficking, both considering the institutional and instructional perspective (*Protocolo Nacional de Actuación Primeros Respondientes, 2017; Código Nacional de Procedimientos Penales, 2024*) (National First Responders Protocol and National Code for Criminal Procedures).

TABLE 1 Police officers interviewed to analyze factors constraining and facilitating policing as a first response to wildlife trafficking in Tamaulipas during 2023–2024.

ID Code	Gender	Age (years)	Years in police service	Grade of education	Municipality	Region
POLICETAM01	Male	46	12	Bachelor	Nuevo Laredo	North
POLICETAM02	Male	35	9	High school	Nuevo Laredo	
POLICETAM03	Male	48	10	Bachelor	Reynosa	
POLICETAM04	Female	29	5	High school	Reynosa	
POLICETAM05	Female	33	5	High school	Reynosa	
POLICETAM06	Male	37	6	High school	Reynosa	
POLICETAM07	Male	40	8	High school	Matamoros	
POLICETAM08	Male	39	5	High school	Matamoros	
POLICETAM09	Male	38	7	High school	Matamoros	
POLICETAM10	Male	34	6	High school	Matamoros	
POLICETAM11	Male	47	12	Bachelor	Victoria	Central
POLICETAM12	Male	35	5	High school	Victoria	
POLICETAM13	Female	28	3	High school	Victoria	
POLICETAM14	Male	30	4	High school	Victoria	
POLICETAM15	Male	39	11	Bachelor	Tampico	South
POLICETAM16	Male	32	6	High school	Altamira	
POLICETAM17	Female	33	4	High school	Madero	

The interview guide included sixteen questions on the legal competencies of the police to respond to environmental crimes, knowledge of wildlife trafficking, the country's environmental legislation, procedures and protocols for document review, seizure and confiscation of specimens and products, the connection between wildlife trafficking and other crimes in the state, as well as the ways in which society participates to prevent and report cases of wildlife trafficking.

Interview analyses

The data obtained from the interviews were systematized and coded using ATLAS.ti software (v.8). The information was selected considering the objective of the study, this process of abstraction of the information involves selecting the information that allows to understand the phenomenon based on the research objective (Miles and Huberman, 1984). The primary axes were the previous categories, allowing the subcategorization of the information, this process involves discovering and identifying connections between concepts following an inductive reasoning (González, 2010) and has an important practical significance, because from this discovery the whole explanatory model is presented in the form of a theory, integrating the secondary categories that appear related to the main categories (Strauss and Corbin, 2002; Penalva-Verdú et al., 2015).

Preliminary coding followed the previous categories for the interview guide: factors that constrain and facilitate policing. In

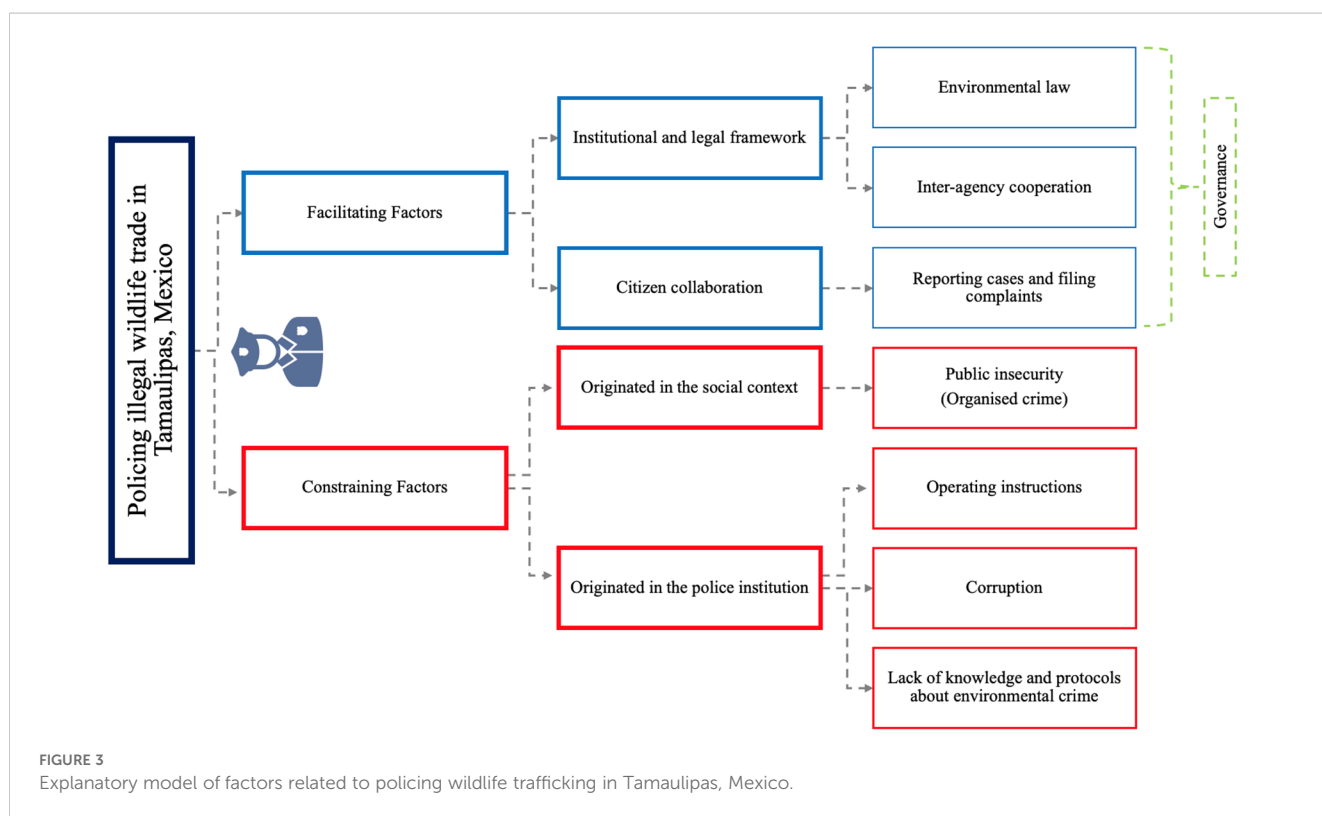
addition, codes were created to identify relevant information and create subcategories of analysis to identify more specifically the elements that structure each of the previous categories and to understand the phenomenon integrally.

Once the subcategories were obtained from the processing of the interviews, the results were drafted based on the explanatory model obtained and served to thread the structure and syntax of the results based on the previous categories and the subcategories that emerged from the analysis of the interviews.

Incorporating textual quotations in the writing of the results serves to give consistency and support the arguments (see Lingard and Watling, 2021) and make visible the perspective of the police officers interviewed in relation to the policing of wildlife trafficking in the state of Tamaulipas.

Findings

To analyze police actions in the identification and response to wildlife trafficking in Tamaulipas, two main categories were generated to understand the phenomenon: 1) factors that facilitate the identification and response to wildlife trafficking and 2) factors that constrain the identification and response to wildlife trafficking. The analysis of the interviews provided an explanatory model of the phenomenon based on the experiences of the police in the state that considers the social, security, institutional and environmental context of the state of Tamaulipas during 2023-2024 (Figure 3).



Facilitating factors

Three main factors were identified as facilitating the policing of wildlife trafficking: 1) the institutional and legal framework (through environmental law and inter-agency cooperation) and 2) citizen collaboration (through reporting cases and filing complaints) (see [Figure 3](#)).

Institutional and legal framework

Mexico's environmental legislation and its institutions are the core structure of law enforcement. Environmental conservation and protection depend on their functioning and coordination. Mexico has an extensive environmental legislation that includes the regulation of most of the factors that can cause environmental harm (see [Revuelta-Vaquero, 2022](#); [Anglés-Hernández et al., 2023](#)), including wildlife trafficking. This environmental legislation establishes and determines the different forms of participation and cooperation between criminal and administrative institutions in environmental issues ([Noyola-Rodríguez et al., 2024](#)), including the participation of the police.

Environmental law

Environmental legislation in Mexico can be understood from two jurisdictions: criminal and administrative (in other countries it is considered a civil jurisdiction). In the criminal jurisdiction are the crimes contained in the Penal Codes (Federal, in charge of the federal administration and State in charge of each state administration) and violations to these codes are considered crimes and include a punishment (such as imprisonment, reparation of environmental damages and fines) and are judicialized, which means that governmental attention is attended to as criminal acts, due to their social and environmental consequences.

In the administrative jurisdiction are those laws and regulations that regulate the use of natural resources and violations to the laws and regulations are considered administrative offences and are punishable by fines and reparation of social and environmental damage and do not include imprisonment, except in cases where an environmental crime is committed with an administrative offence.

In addition, Mexico is party to various international environmental agreements and treaties (e.g. CITES, Convention on Biological Diversity), which, together with its own legal and institutional system, protect and preserve the environment.

Cases of wildlife trafficking is considered a federal crime punishable under Article 420 bis IV of the Federal Criminal Code ([Código Penal Federal, 2024](#)) and defined as: whoever illicitly captures, possesses, transports, collects, importing into or exporting from the country, any specimen, its products or derivatives and other genetic resources, of a species of wild flora or fauna, terrestrial or aquatic, considered endemic, threatened, in danger of extinction, subject to special protection, or regulated by any international treaty to which Mexico is party. In addition, wildlife trafficking is punishable by one to nine years' imprisonment

plus a financial fine, and the police as first responders can attend to cases of wildlife trafficking in the verification of documentation and for the precautionary confiscation of specimens or products suspected of illegality, and report to the Prosecutor's Office and PROFEPA for specialized attention.

The environmental regulatory framework, in addition to the Penal Codes, also includes two important laws: the General Law on Ecological Equilibrium ([Ley General de Equilibrio Ecológico](#)) ([LGEEPA, 2024](#)) and the General Law on Wildlife ([Ley General de Vida Silvestre](#)) ([LGV, 2021](#)). Regarding wildlife trafficking, these two laws establish the legal and administrative criteria for keeping specimens of fauna and flora in captivity and under express authorization (provided they have been legally acquired), as well as preventive activities for wildlife trafficking such as surveillance, monitoring, inspection, the development of alternative productive activities for rural communities and environmental education.

The environmental legal framework is further reinforced by other official instruments such as the National First Responders Protocol ([Protocolo Nacional de Actuación de Primeros Respondientes, 2017](#)) and the National Code for Criminal Procedures (articles 132 and 238, [Código Nacional de Procedimientos Penales, 2024](#)), which establish the faculties and procedures to be followed by public government officials in prosecuting crimes in Mexico, including wildlife trafficking.

Identifying whether conduct is criminal or not is one of the main attributes and responsibilities of the police as first responders. The National First Responders Protocol and the National Code for Criminal Procedures establishes that the police have the obligation to attend to complaints, identify and report possibly criminal conduct to their superior and to the Public Prosecutor's Office, document through the Homologated Police Report with the support of photographs or video recordings. Subsequently police must deliver the scene and seized or confiscated wildlife or products through the Chain of Custody to the Environmental expert (Forensic Sciences Department). Under indication of the Public Prosecutor's Office the specimens must be destined to the competent authority (PROFEPA) for their respective management (e.g. to be sent to zoos, Wildlife Conservation and Research Centre or consult them for referral to Wildlife Conservation Management Units, institutions or persons that fulfil the best conditions for the safety and care of wildlife) (Article 120, [LGEEPA, 2024](#)) ([Figure 4](#)).

The police, as first responders, have the legal authority to investigate the legality of flora and fauna specimens in operations or when attending to complaints, as well as to inform PROFEPA (through Public Prosecutor's Office) about seizures or confiscations of trafficked flora and fauna. In confiscation, specimens or products may be recovered if legal provenance is demonstrated by the possessor, while confiscation is not possible to return specimens or products, because legal provenance is not proven and therefore it is a crime. In the latter scenario, the specimens are placed in the care of an authorized institution (e.g., zoos, environmental management units, wildlife research centers) ([Castro-Salazar et al., 2024](#)), while the products are either stored or destroyed.

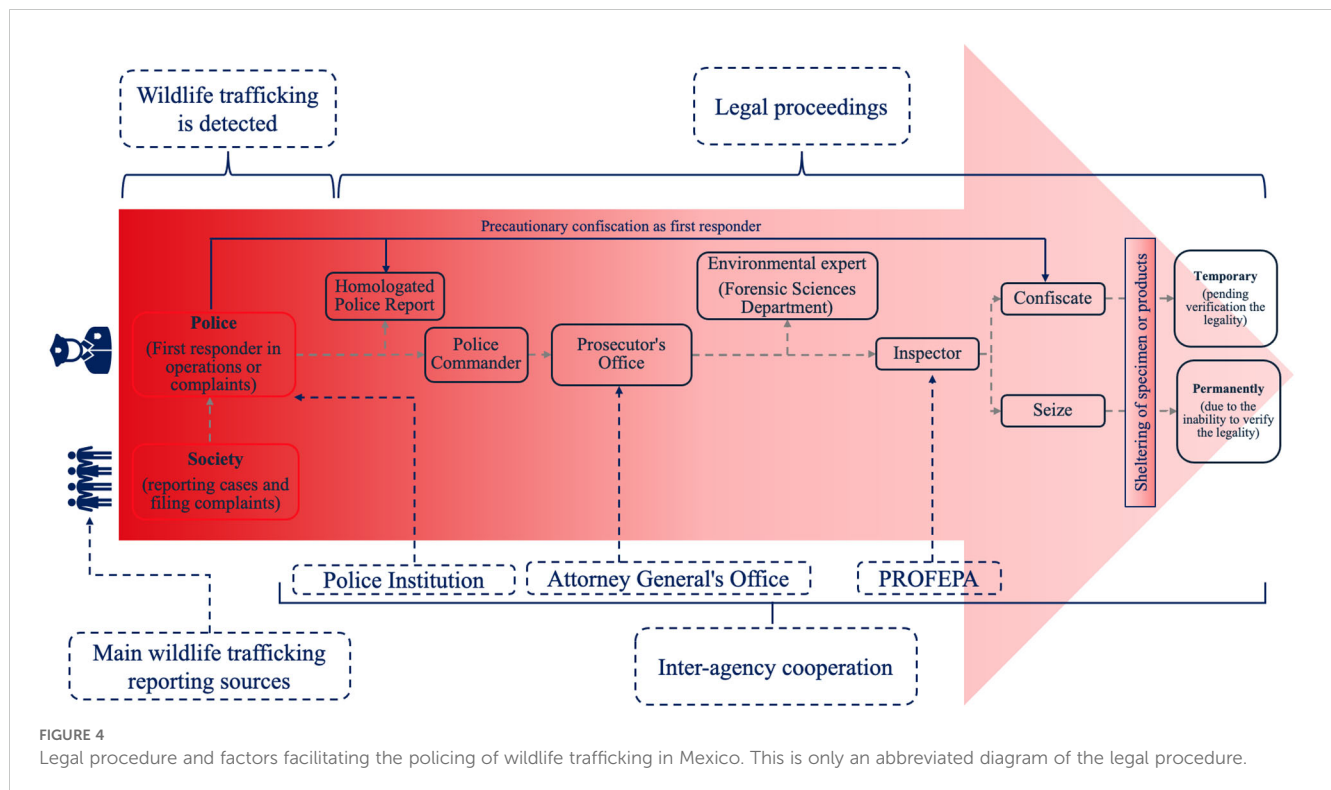


FIGURE 4

Legal procedure and factors facilitating the policing of wildlife trafficking in Mexico. This is only an abbreviated diagram of the legal procedure.

Inter-agency cooperation

One of the primary factors facilitating law enforcement against wildlife trafficking is inter-agency co-operation. When police officers identify cases of wildlife trafficking, they notify the Attorney General's Office or the State Attorney General's Office to initiate the criminal investigation, and PROFEPA to secure the specimens (see Figure 4).

When we find animals or things like that where we go on operations, what we do is notify PROFEPA because we do not have jurisdiction over the animals [...] they arrive and check the animal and prepare a form that we attach to our report, obviously with the corresponding photographs (POLICETAM01).

As a commander, I have the duty to inform the Public Prosecutor's Office about anything related to the environment, I think they supervise that (POLICETAM11).

We always have good communication with other security institutions such as the Army and the Navy, when we are in an armed confrontation, they always come to the call for help to support us [...] we also coordinate with them in the operations (POLICETAM15).

Although some lack of awareness of their specific responsibilities to deal with wildlife trafficking is evident, inter-institutional cooperation partially compensates for this lack of awareness. The

National Code for Criminal Procedures, the National First Responders Protocol, the General Law of Ecological Balance and the General Wildlife Law all promote and encourage collaboration between government agencies and other facilities such as the Wildlife Conservation and Research Centre and Wildlife Conservation Management Units. This is consistent with other studies that establish that collaboration between government institutions, training between institutions and communication can lead to good results in environmental law enforcement (Pink, 2016; Barrett and White, 2017; White and Pink, 2017; Faroque and South, 2022).

When some police colleagues found the tigers [possibly *Panthera tigris*] in the garage of a drug trafficker, they called us to help with a possible armed confrontation, but when the situation calmed down, the commander called PROFEPA, and they came very quickly and seized the tigers (POLICETAM06).

As observed in the interviews and depicted in Figure 4, the police alone are not able to enforce the law against wildlife trafficking –the participation of public security institutions and other governmental entities in environmental issues is necessary. This reflects a strength at the macro level of institutional capacity to consolidate organizational and inter-institutional networks to address social problems (Willems, 2004; Rosas-Huerta, 2008). Strengthening capacities of collaboration between institutions represents the first line of action against wildlife trafficking in Tamaulipas and Mexico.

LGEEPA (2024) establishes that SEMARNAT, as the main environmental authority in Mexico, must provide training and

environmental education to public education institutions (schools of all educational levels) and other facilities. However, it does not consider public security institutions, such as the police, despite being first responders at crime scenes and for the attention of complaints.

Citizen collaboration

Reporting cases and filing complaints

Citizen collaboration through complaints plays a key role in facilitating the policing of wildlife trafficking in Tamaulipas because it incorporates society in response to environmental crimes and, as documented in other studies, environmental complaints are a source of information and an indicator to develop effective public policies (Salgado and Fidélis, 2011; Zeng et al., 2019; Jiao et al., 2021). This is particularly important, as the relationship between citizen participation in denouncing environmental crimes and police reaction has not previously been academically documented in Tamaulipas or Mexico.

The environmental law framework considers different ways to make complaints directly to PROFEPA: 1) by going to the offices, by email, on the website and by phone call (requesting its ratification in writing within three days) (LGVS, 2021; CNPP, 2024; LGEEPA, 2024). Although environmental complaints made directly to PROFEPA belong to the administrative jurisdiction, citizens also report directly to 911 when they identify criminal conduct such as wildlife trafficking, and police officers attend to the complaints to take the necessary steps to enforce the law or to turn the case over to PROFEPA (see Figure 3).

When we have been called about the trade of animals at the flea market, it has been because people report it to 911 and from there they inform us about the location and what the people described in the complaint [...] when we arrive at the place and if we see something strange, for example exotic animals being sold or animals that are not domestic or farm animals, we report it to the Prosecutor's Office so they can check and talk to PROFEPA (POLICETAM03).

In addition, it is necessary to highlight that a greater participation and concern of society for environmental issues is observed, which is evident in the increase of complaints at the national level attended by PROFEPA (see PROFEPA, 2023). The figures on environmental crimes that are judicialized in Mexico are only partially publicly available, as the open access data only show the total number of criminal cases, without specifying the type of crime (wildlife trafficking, deforestation, pollution, etc.), which is particularly problematic for measuring specific environmental crimes at the national or local level (see Castro-Salazar et al., 2023).

The police, as first responders, are one of the primary government officials dealing with complaints, including those related to wildlife trafficking, so effective interaction between the complainant, the 911 service and the police ensures an effective governance and environmental justice (Tomkins, 2005).

When we were informed about people kidnapped in a “safe house” [a place where drugs, weapons, migrants and kidnapped people are illegally kept by criminal groups] the people who made the report told us that there were also exotic animals such as tigers [possibly *Panthera tigris*] and jaguars [possibly *Panthera onca*] in the backyard of the house, this information is as it helps ensure our safety and prepares us to handle such scenarios (POLICETAM10).

About two years ago we received a report through 911 about a person who was selling parakeets [possibly *Amazona oratrix*] on the street, we went and when we arrived we carried out an inspection, we secured the parakeets and we contact to PROFEPA, when they came and checked it was indeed wildlife trafficking [...] we have noticed that more and more people are getting involved in denouncing criminal activities (POLICETAM13).

Considering the importance of the police as first responders to crime, it should be noted that the factors favoring police intervention against wildlife trafficking are based on the legal authority to enforce environmental law, but also on the participation of society in the prevention of wildlife trafficking through the filing of complaints. Although few cases have been identified by police officers who know the protocol for enforcing environmental law, a first step, in addition to training police officers on their faculties, is to promote citizen collaboration through environmental education.

Constraining factors

Policing wildlife trafficking in Tamaulipas is influenced by factors originating in the social and public security context (see Figure 3), such as the fragmentation and consolidation of criminal groups dedicated to trafficking in drugs, arms and migrants; and those originating in the police institution, such as strategies in operations, corruption and lack of knowledge about protocols for law enforcement in environmental crimes (National First Responders Protocol, Homologated Police Report, etc.). All these factors influence how the police operate against wildlife trafficking as first responders.

Originated in the social context in Tamaulipas

Public security conditions in the state of Tamaulipas are historically related to its geographic location. Its proximity to the state of Texas in the United States, and for being the southernmost border of northern Mexico, is a strategic point for different forms of trafficking such as drugs, people and firearms between the two countries, and criminal groups have strengthened and ruled over

many social factors such as politics, the economy and social life, but also determine the state's public security conditions (Coss-Noguera, 2012; Moloesnik and Suárez de Garay, 2012; Correa-Cabrera, 2016; Izcarra-Palacios, 2016; París-Pombo, 2016) and the ways in which the law is enforced by police and government institutions.

Public insecurity

The main cause of public insecurity in the state of Tamaulipas is organized crime linked to drug trafficking. Criminal groups operating in the region often outgun police forces, hindering effective law enforcement, and due to the weapons equipment of these criminal groups exceeds that of the police forces. This situation stems from the tendency of members of criminal groups to keep exotic animals in captivity in their homes or ranches (farms) as "luxury possessions," mainly felines (*Panthera tigris*, *P. leo* and *P. onca*). Although this phenomenon has been documented in previous studies in the state (Carpio-Domínguez et al., 2018b, 2022; 2023a, b), how the police respond to cases of wildlife trafficking by criminal groups has not been documented and is a factor that originates in the social context of institutional capacity and influences the policing response to wildlife trafficking (Willems, 2004; Rosas-Huerta, 2008).

The conditions of public insecurity in the state have resulted in the police being unable to enforce the law or initiate a criminal investigation even when the crime is committed in flagrante delicto because the organizational structure of response and coordination of criminal groups in armed confrontations outweighs the daily police patrols that are generally manned by 2 or 4 police officers, two in the cab and two in the truck bed.

6 years ago, we stopped a truck on a street in Rio Bravo, when we approached the first thing we saw was a tiger cub [possibly *Panthera tigris*] leaning out of the window and the driver got out of the vehicle with a long gun and asked us [offensively] what was being offered to us and we let him continue, my partner and I could do nothing (POLICETAM08).

This imposition of organized crime on public security institutions has been a historical phenomenon, not only in the state of Tamaulipas, but throughout the country, and it intensified during and after the "war against drugs" in Mexico during the Calderon administration (2006-2012) (Williams, 2010; Buscaglia, 2012; Olinger, 2013; Carpio-Domínguez, 2021). The policy of direct action against drug trafficking was characterized among other things by armed confrontations between state forces (police, Secretaría de la Defensa Nacional [Ministry of National Defense]) and the big drug cartels (e.g. Cartel del Golfo, Cartel del Pacífico, Cartel de Juárez), but also by armed confrontations between the cartels.

This situation led to the fragmentation of the cartels into smaller criminal groups characterized by extreme violence and the diversification of economic activities in addition to drug trafficking, such as kidnapping, extortion, fuel theft, trafficking of

migrants, extortion, among others, and which have remained more than eighty criminal groups in the country (Muedano, 2018; Carpio-Domínguez, 2021).

In the 43 municipalities of Tamaulipas, eleven criminal groups operate: the Cártel del Golfo, Los Zetas Vieja Escuela, Cártel del Noreste, Tropa del Infierno, Los Ciclonos, Los Escorpiones, Los Metros, Los Panteras, Los Rojos, Operativo Gama 16, Columna Armada Pedro J. Méndez and Cartel de Jalisco Nueva Generación (Infobae, 2023) (Figure 5). These criminal groups are characterized by activities such as extortion, kidnapping, migrant trafficking, and drug sales, and during police operations to confront them, cases of possession of exotic animals from wildlife trafficking have been identified, such as felines (*Panthera tigris*, *Panthera leo* and *Panthera onca*), oryx (*Oryx dammah*), bears (*Ursus americanus*), deer (*Odocoileus virginianus*), spider monkeys (*Ateles geoffroyi*), also in conservation risk categories (see Carpio-Domínguez et al., 2018b, 2022; Carpio-Domínguez, 2023a, b).

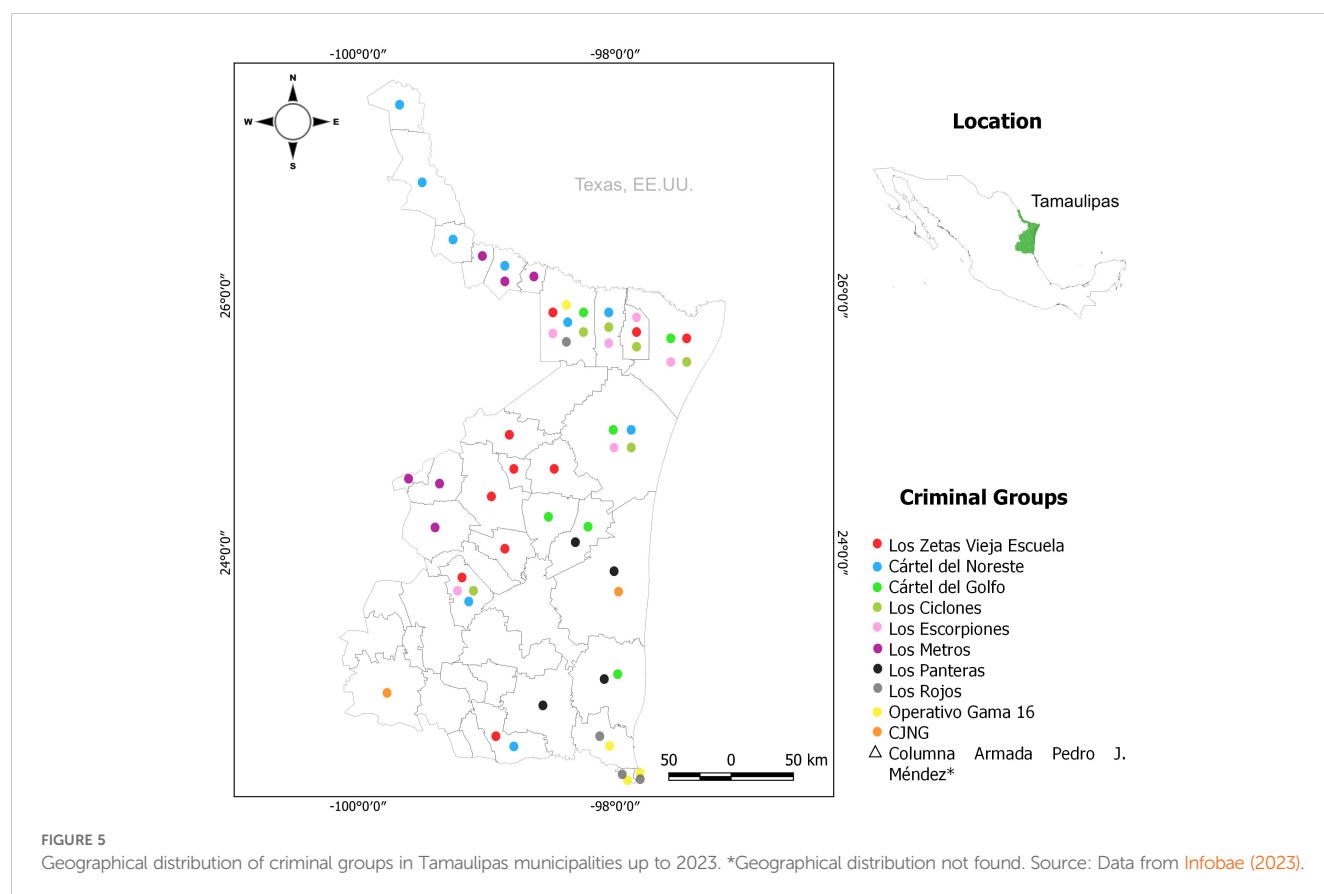
In the logic of police operations against drug trafficking, little attention is paid to other crimes, such as wildlife trafficking, as it is not categorized by the state as a crime of high social impact and are the main target of police operations, so the real rates of wildlife trafficking in the state are unknown (Carpio-Domínguez et al., 2018b, 2022, 2023).

If we see exotic animals in captivity, we cannot do anything, we only go to support the SEDENA (Ministry of National Defense) and in the cases that we have seen crocodiles [possibly *Crocodylus moreletii*], lions [possibly *Panthera leo*] or some other animal, the Commander decides whether to report it to the Prosecutor's Office but this has only happened a few times (POLICETAM12).

Public insecurity negatively influences the implementation of environmental legislation in the country. In Tamaulipas, wildlife trafficking is a crime subordinated to the "big social problems" and has not received adequate attention by the police as first responders at the crime scene, not only due to lack of interest and knowledge in identifying environmental crimes, but also due to the forms of direct and structural violence to which the police are exposed and which have been made visible in other studies on police enforcement in Mexico and other Latin American countries (e.g. Malone and Dammert, 2020; Quintero-Cordero, 2020; Cortés-Fuentes et al., 2023; Monroy-Ojeda, 2023).

Originated in the police institution

The neglect (intentional or unintentional) of environmental crime and harms by the government and its institutions has been documented in other studies at global and national levels (see Tomkins, 2005; Moreto et al., 2015; Castro-Salazar and Luyando-Cuevas, 2020). In Mexico it is exemplified by the reduction of the budget for environmental institutions, which results in a shortage of



staff to attend to environmental complaints (Castro-Salazar and Camacho-García, 2020) but also because of government prioritization of some crimes over others, which means prioritizing attention and resources to crimes of high social impact over environmental crimes, consequently receive less governmental attention and environmental law enforcement institutions receive fewer public resources for hiring personnel and equipment to attend to complaints or conduct inspections. This represents a constraint factor not only for tackling wildlife trafficking, but a constraint for institutional capacity to respond to social problems at the macro level of institutional capacity (Willems, 2004; Rosas-Huerta, 2008). It is also a constraint to accessing environmental justice due to governmental neglect of social and environmental problems (Tomkins, 2005).

Among the factors constraining police action to effectively address wildlife trafficking in Tamaulipas are those originating within the police institution. These factors include operating instructions, corruption and lack of knowledge and protocols on environmental crime.

As police officers we receive frequent training and updates, mostly on protocols, human rights, firearms training and self-defense, but not on environmental crimes. Actually, we have never been lectured about that, if you ask me for a protocol on environmental crimes, I wouldn't know what to answer (POLICETAM04).

Operating instructions

The context of public insecurity, corruption and working conditions such as the high turnover rate of personnel has caused the police to act in a "practical" manner without generating investigative or intelligence activities, limiting them only to responding to instructions from the command center, which is known as "reactive activities" and which, in turn, is determined by the context of public insecurity in the state, therefore police interactions with organized crime are generally sporadic, numerically disadvantaged and often require support from SEDENA or the Navy.

In the raid of a "safe house" we found a panther cub [possibly *Panthera onca*], There was no one present, and no drugs or weapons were found and the Commander instructed us to go and leave the animal there, because there were 8 of us police, if the traffickers returned with reinforcements, we wouldn't have been able to handle it (POLICETAM02).

In Mexico, wildlife trafficking as a federal crime is prosecuted by complaint, so that the police can only act in response to a complaint or when they are involved in special police operations, mainly against drug trafficking. As evidenced in the interviews and as has been reported in other studies in this region (Carpio-Domínguez

et al., 2018b; 2022; 2023) wildlife trafficking is identified within anti-drug trafficking operations, while from the interviews conducted, only two police officer has been commissioned to respond to a citizen complaint about wildlife trafficking.

Only once I had to deal with a 911 report to go to the flea market to check because there was a lady selling those talking parrots (possibly *Amazona oratrix*), but as I did not know what to do, I spoke to my superior and he told me not to do anything, that it was not in our jurisdiction and that I should leave (POLICETAM16).

When we have found animals like lions and so on, we almost always notify our superior, if he tells us to notify PROFEPA we do, otherwise we just report what we came for [weapons, drugs, migrants, etc.] (POLICETAM17).

The only thing I know is that if I see that if we find illegal exotic animals in an operation I have to call to my Commander, he is in charge of that [...] but I personally don't know, I wouldn't even know who to talk to besides the Commander (POLICETAM09).

The police face two critical, interdependent limitations: 1) instructions from superiors not to prosecute environmental crimes, such as wildlife trafficking, have greater weight in the decision not to attend to these crimes than the obligations attributed in the National Code for Criminal Procedures (article 221, *Código Nacional de Procedimientos Penales*, 2024) and 2) the lack of knowledge regarding procedures for addressing environmental crimes, both by the police and their superiors.

Although it seems to be a local phenomenon, other studies have reported that in transnational environmental crime, police cooperation and the lack of homologation of environmental legal frameworks represent a challenge for police enforcement (Spapens, 2013). In addition, the police currently perform a variety of functions spanning administrative, regulatory, social welfare, and law enforcement that are variable depending on the context (Tomkins, 2005). When responding to or identifying environmental crime the workload increases, which is consistent with a lack of knowledge and interest in addressing environmental crime.

Corruption

Corruption also limits the policing of wildlife trafficking, which is related to the widespread public insecurity in the state of Tamaulipas. In Mexico, the levels of perception of corruption are high, according to *Transparency International* (2023) it is 31/100, which places the country in 126/180th place in corruption; while in the state of Tamaulipas 77.4% of the population considers that there is corruption in government institutions (INEGI, 2023b).

To understand how corruption affects the processes of attention, registration, law enforcement, and accounting of environmental crimes in the state, it is necessary to consider that there are relationships between government officials and different criminal associations, or corrupt practices among government officials. Other studies on wildlife trafficking in the state have shown the interrelation government officials and members of criminal groups (see Carpio-Domínguez et al., 2023; 2023b), as well as bribes to allow the smuggling of wildlife across the country (see Carpio-Domínguez et al., 2022).

The relationships of government officials and members of criminal groups are also subject to processes of adjustment and pact-breaking, which has been reported in other studies in Mexico (Pérez-Velazco, 2013; Valencia-Londoño, 2018). This provides insights into the processes of intimidation of government forces towards members of criminal groups and that, in some cases, it is related to wildlife trafficking.

When we handle to the case of a private [illegal] zoo, we were deployed to seize drugs and weapons because the owner was with organized crime, but when we arrived to carry out the raid on the property there was nothing [...] and curiously it wasn't until the third day of guarding the private zoo that three little bags of marihuana, cocaine and a .45 caliber pistol appeared [...] and during the eight days we were guarding the place, the animals were not fed and several tigers [*Panthera tigris*] and a baboon [*Papio hamadryas*] died [...] all this was done to intimidate the malandro [drug trafficker] [...] (POLICETAM05).

Relations between security forces or politicians and members of criminal groups determine how the law is enforced also in cases of wildlife trafficking. If the police deal with complaints or are on operations, the targets are usually known, which means that they know whose house, ranch, or farm it is, and as instructions from superiors are given, police actions are carried out.

During an operation, the commander instructed us not to touch anything in the house such as jewelry, animals from the private zoo (including ostriches (*Struthio camelus*), deer (possibly *Odocoileus virginianus*), parrots (possibly yellow-headed parrots-*Amazona oratrix*), peacocks (possibly *Pavo cristatus*), a tiger cub [possibly *Panthera tigris*] or the luxury vehicles that the malandro [drug trafficker] had [...] we only carried out the operation to comply with Commander's instructions (POLICETAM09).

Corruption not only limits environmental law enforcement, but it also constrains cases of wildlife trafficking from being registered and documented and remaining in unreported figures. According to the UNODC (2020; 2024) corruption is an essential factor in all processes of wildlife trafficking (sourcing, transit and export),

however, as observed in this study also in law enforcement. It has been documented that for environmental law enforcement, police officers are the government officials with the highest percentage of corrupt practices (UNODC, 2020) and in environmental crimes, government officials are rarely prosecuted for corruption.

Lack of knowledge and protocols about environmental crime

The context of public insecurity in the state of Tamaulipas and in Mexico more broadly has compelled public security institutions to prioritize prevention and reaction against “traditional” crimes, which can be delimited as human-to-human violence. This implies that professionalization, law education, training, and police enforcement are focused on easily identifying crimes and human-to-human violence, and therefore have not been educated or trained to identify other forms of crime such as environmental crimes, this includes human to non-animal violence and/or harms against biodiversity.

When I was in the police academy, they never talked to us about environmental crimes, I don't think these crimes are not even in our jurisdiction, only the crimes that the Penal Code establishes (POLICETAM07).

I know that there are environmental crimes, but those are handled by PROFEPA, if I wanted to take any case the Commander would scold me, or my colleagues would mock me (POLICETAM04).

We are trained for the worst in society, the violence, the homicides, the shootings, that's what we are prepared for, not to know if a parakeet is legal or not [...] and if I were to handle something involving exotic animals or similar issues, I would just call PROFEPA and that's it. I honestly don't think that the police should deal with environmental crimes because it has nothing to do with people's safety (POLICETAM15).

Although, in practice, not all police officers are aware of their environmental law enforcement role, the National First Responders Protocol (*Protocolo Nacional de Actuación de Primeros Respondientes*, 2017) and the National Code for Criminal Procedures (articles 132 and 238, *Código Nacional de Procedimientos Penales*, 2024) authorized them to report and take custody of wildlife specimens or products until they are collected by PROFEPA. The actions of the police are fundamental to detect wildlife trafficking before any other institution, however, it is still a pending issue in police training in Tamaulipas.

The truth is I don't know much about environmental crimes or wildlife trafficking, we didn't learn about it at the academy, but I know that if I have any doubts, I can ask my Commander [...] in the operations we have seen several exotic animals, but I couldn't say if they are legal or not (POLICETAM14).

Discussion

In general, the police response to wildlife trafficking is influenced by institutional factors, training, and the social context in which police activity is carried out. For example, in the northern region of the state, due to its border location, the influence of organized crime largely determines that police training is focused on combating organized crime, mainly drug trafficking. In addition, preventive patrolling and police operations have identified wildlife trafficking and several police officers have an awareness of what wildlife trafficking in concept, as well as the importance given to the chain of command to resolve procedural doubts on environmental issues (Table 2).

A key starting point is to encourage and promote citizen collaboration in reporting cases of wildlife trafficking, but also to focus efforts on training police (including Commanders) on the procedures and legal competences of the police in environmental issues through the inter-institutional cooperation that already exists between the police and environmental institutions and the Public Prosecutor's Offices. Further, it is essential to create protocols for police attention to wildlife trafficking to guide police response.

In the central and southern regions of the state, factors such as unawareness of environmental law, insufficient training, absence of protocols on environmental crime, and even lack of interest in environmental crime are identified as influencing the police response to wildlife trafficking. However, considering the facilitating factors for policing in these regions (see Table 2), strategies can be implemented at both the societal and institutional levels. At the social level, citizen collaboration should be promoted and encouraged through the reporting of wildlife trafficking cases, while at the institutional level, courses and training should be implemented for the police on the importance of detection and the importance of the police in detecting environmental crimes such as wildlife trafficking, with the aim of raising awareness of the role of the police as the first line of attention for environmental crimes.

Police training academies and universities that offer academic degrees in areas of public security (e.g., criminology, criminalistics, public security), from which people join the police forces in the country, should incorporate subjects related to green criminology and environmental law enforcement (see Carpio-Domínguez et al., 2020). In addition, specialized police environmental manuals and protocols (see Uribe and Ibáñez, 2020) could be developed with the aim of enhance awareness of police capacities to respond to wildlife trafficking that are being denied and made invisible in the police law enforcement in Tamaulipas.

It is necessary to raise awareness across all levels of government of the importance of the police as first responders to environmental crime, not only by faculties conferred by the legal framework, but also the proximity they have with society and what happens on the streets every day (McKenna, 1993; Spapens, 2013). This is an urgently needed strategy that will ensure environmental justice and the prevention of wildlife trafficking.

TABLE 2 Summary of factors facilitating and limiting police intervention as first responders in wildlife trafficking by region in the state of Tamaulipas during 2023–2024.

Municipality	Region	Facilitating	Constraining
Nuevo Laredo Reynosa Matamoros	North	- Preventive patrolling and identification of wildlife trafficking - Interinstitutional cooperation with environmental institutions - Citizen collaboration through complaints - Attending to complaints related to wildlife trafficking - Continuous training by the police institution - Awareness of animal abuse in wildlife trade - Request instructions from the Commander	- Public insecurity caused by criminal groups - Unaware about environmental laws - Lack of training and protocols on environmental crime - Subject to the Commander's instructions
Victoria	Centre	- Citizen collaboration through complaints - Attending to complaints related to wildlife trafficking - Interinstitutional cooperation with Prosecutor's Office - Interinstitutional cooperation with environmental institutions - Request instructions from the Commander	- Unaware about environmental laws - Public insecurity caused by criminal groups - Lack of training and protocols on environmental crime - Subject to the Commander's instructions
Tampico Altamira Madero	South	- Attending to complaints related to wildlife trafficking - Preventive patrolling and identification of wildlife trafficking - Interinstitutional cooperation - Request instructions from the Commander	- Unaware about environmental law - Lack of interest about environmental crime - Subject to the Commander's instructions

Considering the institutional capacity framework (Grindle and Hildebrand, 1995; Grindle, 1997; Forss and Venson, 2002; Willems, 2004; Rosas-Huerta, 2008), it is evident that police as first responders in wildlife trafficking have several limitations at all levels of institutional capacity. At the micro level it is identified that, although they have the legal authority to respond to wildlife trafficking, they are not aware of this competence and even have an attitude of little interest in wildlife trafficking. This is related to other meso-level phenomena such as the lack of training and education on environmental crimes, changes in the administration of the institution and the prioritization of public insecurity crimes, which in turn depend on macro-level factors such as instructions at the federal and state levels to reduce the figures of crimes related to public security.

The factors behind these levels are framed in a social context in which public insecurity derived from organized crime causes environmental crimes to be subordinated to crimes related to public security and, on the other hand, a greater increase in the interest of the civilian population in reporting environmental crimes to which public agencies such as the police must respond.

Conclusions

This study highlights police's capacity to address wildlife trafficking in Tamaulipas in northeastern Mexico. Environmental crimes such as wildlife trafficking are subordinated to those considered as "of high social impact," such as drug trafficking. Police officers erroneously consider that other forms of crime, such as wildlife trafficking, are all outside their jurisdiction, limiting the ability to achieve environmental justice.

The study reveals that the police are unaware of the procedures to deal with wildlife trafficking cases. Therefore, the capacities of the

Tamaulipas police must be complemented with legal and technical-scientific knowledge to be able to identify environmental crimes, including illegal wildlife trafficking and to respond efficiently as a first responder in support of environmental law enforcement. It is important to highlight that citizen collaboration is a fundamental part of wildlife trafficking law enforcement, since it is evident that there is a growing social commitment regarding environmental harms and crimes such as wildlife trafficking.

To improve response capacity to wildlife trafficking, there is a need for inter-institutional collaboration based on training and the elaboration of protocols of attention between the police, the Public Prosecutor's Office, and PROFEPA. These should be oriented towards strengthening the knowledge of environmental crimes of the police as first responders to facilitate the application of environmental justice with the collaboration of the entire institutional system.

Drawing on institutional capacity framework to address these limitations, integral strategies can be implemented to reach all levels of the police institution by: 1) training for the police on environmental crimes; 2) promoting and strengthening inter-institutional cooperation with PROFEPA; 3) implementing policies to improve the institutional management processes of the police; 4) knowledge of all forms of crime that fall under their jurisdiction; 5) establish law enforcement protocols on environmental issues, and clarify the role of the police in the Code of Criminal Procedures in attending to environmental crimes such as wildlife trafficking, and 6) implementing environmental education policies for civil society.

Finally, this study highlights wildlife trafficking as a hidden criminal phenomenon among the crime figures in the state of Tamaulipas and underscores the police's pivotal role in detection, prevention, and law enforcement of wildlife trafficking to achieve environmental justice in Tamaulipas and northeastern Mexico.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Material](#). Further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants.

Author contributions

JC-D: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JC-N: Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – review & editing. JC-S: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. VM-S: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcsc.2025.1488500/full#supplementary-material>

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

L. Jen Shaffer,
University of Maryland, College Park,
United States
Dauda Ayomide Onawola,
One Health in Action Initiative, Nigeria

*CORRESPONDENCE

Stanislas Zanvo
✉ zanvostanislas@yahoo.fr

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Wildlife trade at the interface between deeply-rooted animal-based traditional medicine and unregulated harvesting of wild animals in West Africa

Stanislas Zanvo^{1*}, Samson Dognimon¹, Chabi A. M. S. Djagoun¹,
Jiroux Akpachémè¹, Akomian Fortuné Azihou¹, Bruno Djossa^{1,2},
Etotépé A. Sogbohossou¹ and Brice Sinsin¹

¹Laboratory of Applied Ecology, University of Abomey-Calavi, Faculty of Agronomic Sciences,
University of Abomey-Calavi, Cotonou, Benin, ²Laboratoire de Foresterie et de Conservation des
Bioressources (LaFCBio), Ecole de Foresterie Tropicale, Université Nationale d'Agriculture,
Kétou, Benin

Local trade remains a data poor component of wildlife crime that must be better understood for more effective combat against the illegal wildlife trade. We assessed the distribution of wildlife markets, diversity of species traded and the extent of the trade chain through spatial analysis of wildlife sale sites and semi-structured interviews with 75 vendors in the 10 largest traditional medicine markets of Benin. GPS coordinates of wildlife markets were used to map their geographic distribution and assess their spatial patterns. We used a generalized linear model to determine the drivers underlying the spatial patterns of wildlife markets. A circular layout was designed to delineate the geographic extent of wildlife trade in terms of supplying sources. We found that wildlife was traded at 121 sale sites in Benin, highly dominated by traditional medicine markets (106 sites). The spatial analysis of markets exhibited an aggregative distribution pattern, and the type of market, the number of stalls in the markets and the municipality status influence significantly the spatial temporality of market distribution. Wildlife trade for traditional medicine affected 268, 96 and 61 bird, mammal and reptile species, respectively, and included species of both high national and global conservation concern. We also found that the national wildlife trade in Benin was supplied from 80% (12/15) West African Economic and Monetary countries, and all the Economic Community of West African States (except Guinea-Bissau) in violation of national laws, CITES, and regional commitments to combat wildlife trafficking (e.g., the West African Strategy for Combatting Wildlife Crime). Our study in Benin is a big step to revealing trade throughout in West Africa. It provides much needed information on wildlife trade structure and driving forces that could help to inform decision-making for better trade regulation and for effective wildlife law enforcement in West Africa. Other studies should do the same to help paint a more complete picture of wildlife trade in West Africa.

KEYWORDS

birds, law enforcement, mammals, reptiles, spatial distribution, wildlife crime, wildlife markets

Introduction

Biodiversity is a traditionally valued resource used to meet fundamental needs, particularly in the tropics where conservation and poverty alleviation represent two major challenges (Robinson and Bennett, 2002; Lee et al., 2020; Ingram et al., 2021). Throughout the tropics, people depend on wildlife to varying degrees for their food, traditional medicine, cultural practices and income (Robinson and Bennett, 2002; Brashares et al., 2011; Lee et al., 2020; Ingram et al., 2021; Booth et al., 2021). However, the use and trade are not governed effectively by either formal or informal means. Human populations and their needs have been steadily growing, leading to overexploitation being a major driver of decline and consequently biodiversity loss (Alves and Rosa, 2007; Joppa et al., 2016; Maxwell et al., 2016; Benítez-López et al., 2017; Ripple et al., 2017).

Wildlife trade, comprising local, domestic and international, generally includes species of both protected and unprotected status under national and international legislation (Nikolaus, 2011; Djagoun et al., 2013; Buij et al., 2016; Petrozzi, 2018; D'Cruze et al., 2020; Zanvo et al., 2021a, 2022). International trade has been shown to affect > 6,000 species, including a diversity of birds (8.5%), mammals (23%) and reptiles (21.3%) and, over the last two decades (UNODC, 2020). Domestically, especially in sub-Saharan Africa, wildlife trade is deep-rooted and manifests through bushmeat markets (BM) and traditional medicine markets (TMM). Trade in BM is largely in native (either nationally or regionally), wild species and largely for consumption (Lee et al., 2020; Booth et al., 2021; Ingram et al., 2021), while TMM trade a more diverse set of body parts of both wild and domestic species, including native and non-native, for medicinal and spiritual (religious and occult) purposes (Nikolaus, 2011; Djagoun et al., 2013; Lee et al., 2020). Though these markets play important roles in local community livelihoods, traditional medicine and the maintenance of endogenous religions (*Vodùn*) throughout West Africa (Alexander et al., 2015), they also represent a major driver of defaunation and biodiversity erosion in the region (Djagoun et al., 2013; Petrozzi et al., 2016; Petrozzi, 2018; D'Cruze et al., 2020). Previous authors have estimated that the bushmeat trade affects c. 500 species with extraction volumes that reached c. 4.9M tons per year in Africa and suggested it is very likely unsustainable (Fa et al., 2002; Redmond, 2006). Similarly, TMM affect as many as 100 mammal (Djagoun et al., 2013; Petrozzi et al., 2016) and 302 bird species (Petrozzi, 2018) across West Africa. Recent studies in West Africa revealed that TMM affects 15 bird species, 16 mammal species and 8 reptile species in Ghana (Gbogbo and Daniels, 2019) and 2 bird species, 22 mammal species and 2 reptile species in Togo (Sonhaye-Ouyé et al., 2022). This taxonomic diversity of wild species traded in TMM included endangered species such as vultures, pangolins, elephants etc. that their loss could have devastating impacts on African's ecosystems (Chao et al., 2020; Carucci et al., 2022; van de Water et al., 2022) and a consequently on climate change (see Bello et al., 2015). Though mostly domestic in nature, transboundary regional trade represents a violation of the CITES treaty, and 79% (11,645/14,741) of species having a biological resource use recorded in the CITES trade database are listed on the IUCN Red List with local trade as a threat (Challender et al., 2023). In spite of this, local trade

of wildlife via BM and TMM remains the poorly studied components of wildlife crime, particularly in West Africa (UNODC, 2020) and specially when compared to Central Africa (Taylor et al., 2015).

In West Africa, the little data available on wildlife trade at the local/national scale is mainly focused on internationally protected species (Zanvo et al., 2021a, 2022), single taxonomic groups (e.g., birds, mammals or reptiles), and mostly with restricted spatial scope (e.g., to a single market or city) (Nikolaus, 2011; Djagoun et al., 2013; Williams et al., 2014; Buij et al., 2016; Petrozzi, 2018). To our knowledge, no field-based study has thus far addressed local/or domestic wildlife trade at a national scale for any country in the region but also in Africa. This lack of data renders understanding of the interplay between national and international trade impossible, in spite of recommendations to do so (Ingram et al., 2021). Such an increased understanding will improve law enforcement efforts by significantly reducing the risk of targeting wrong places and wrong species (see UNODC, 2020).

Even though Benin has been identified as one of the West African countries most involved in the regional wildlife trade (Williams et al., 2014; Buij et al., 2016) including some high concern species, the local trade had never been deciphered at a country-wide scale using the three animal taxonomic groups (birds, mammals and reptiles) most threatened by international trade (UNODC, 2020) simultaneously. The number of wildlife markets, their spatial distribution and the drivers underlying their spatial pattern are still largely unknown. The sources of bird, mammal and reptile specimens sold openly in these markets remains understudied. Such data are prerequisites for effective regulation of hunting activities, regional coordination of efforts to tackle wildlife crime, effective law enforcement at the national scale, and enlightened combat against transnational organised crime. They could help to better understand the geographic and functional connectivity of local/national trade and regional wildlife trade, and are essential for international cooperation.

This study constitutes the first country-wide field-based investigations of local trade in wildlife using the three most targeted animal groups by international trade. We provide details on wildlife trade at a national scale through the distribution of wildlife markets, the diversity of species traded and the extent of the trafficking chain in Benin. Here we aimed to: (i) investigate the spatial distribution pattern of wildlife markets and factors underpinning the pattern, (ii) assess the diversity and conservation profiles of mammals, reptiles and birds openly traded in the wildlife markets, and (iii) assess the sources of these taxa traded in the wildlife markets.

Methods

Study area

We conducted the study from July 2019 to December 2021 in the Republic of Benin, a West African country that covers the largest landscape in the Dahomey Gap. It is located between latitudes 6°25'–12°25' N and longitudes 0°45'–3°55' E, including 77 districts and

shares its terrestrial borders with Nigeria, Togo, Niger and Burkina Faso to the east, west, north and northwest, respectively. Benin is subdivided into three ecological regions (White, 1983): the Guineo-Congolian zone between 6°25'-7°15' N and under bimodal rainfalls, the Soudano-Guinean zone extending 7°15'-9°45' N and the Sudanian zone between 9°45'-12°25', both characterized by unimodal rainfalls. An estimated human population of c. 12 M inhabitants (INSAE, 2013) is distributed across a landscape of 114,673 km² with the highest population density in southern Benin. The country counts 56 protected areas unequally distributed following the latitudinal gradient and representing 26% of total land area. Benin scores second highest on the global religious diversity index (Lin et al., 2022), including the native, widespread, and dominant religion 'Vodun'. This traditional religion is animal-consuming and commonly practiced by all the ethnic groups in Benin. It has persisted despite the rapid uptake and growth of foreign expansionist religions (Christianity and Islam) driven by colonization and globalization (Lin et al., 2022). Apart from the endogenous 'Vodun' religion, Christianity and Islam are the most widely practiced religions in the south-central and northern regions respectively. Of the 42 ethnic groups in Benin, the Fon, Adja, Gun, Nago and Yoruba are the largest in southern and central Benin, while the Bariba, Dendi, Otamari and Yoa Lokpa are the dominant ethnic groups in northern Benin (INSAE, 2013). The precarious healthcare system (850 private and public hospitals, 1.2 doctors per 10,000 inhabitants) is officially oriented towards western medicine (Sylvest, 2013) less accessible to impoverished population alongside an affordable traditional medicine.

Data collection

To conduct our investigations in the TMM, we obtained the written consent from authorities of the animal-based traditional medicine Association [*Association des Guérisseurs et Prêtes Endogènes de la Collectivité Awinon* (AGPECA)] including vendors in both Benin and Togo, and verbal consents of all the participants included in this study. Although the vendors have never been harassed (repression) by the wildlife trade enforcement services due to the cultural aspect of traditional medicine markets, all participants were guaranteed confidentiality and anonymity due to sensitive information collected in the framework of the study. This was necessary to motivate participants to provide reliable information.

We started our data collection by georeferencing of all the wildlife markets across Benin using the snowball technique (Berg, 2001) and districts as sampling units. Within Benin's 77 districts, we georeferenced all the wildlife markets, categorized each by type (BM/TMM), temporality (permanent/periodic), and quantified the number of all stalls. The permanent markets operate every day while the periodic markets operate every 4 or 5 days. BM are dedicated to the fresh or smoked wild meat trade for consumption whereas TMM are dedicated to the trade of dry specimens including both whole individuals and animal body parts processed by traditional and/or modern techniques for long-term preservation (Zanvo et al., 2021b). The latter makes identification of specimens in TMM in particularly challenging.

Prior to entering markets, we generated a list of potential species (birds, mammals and reptiles) we might observe within each of the three target taxonomic groups, including both local and scientific names. We generated these lists using the Red List for Benin (Neuenschwander et al., 2011), the Biodiversity Atlas of Benin (Sinsin and Kampmann, 2010), and other published taxonomic references for the region (e.g., Ullenbruch et al., 2010; Djagoun et al., 2013; Petrozzi, 2018). Local names were listed in the Fon language because most of our targeted markets were located in southern and central Benin and that almost all the stakeholders in these TMM belong to Fon ethnic group (Zanvo et al., 2021a). We recorded additional local names through pilot investigations using posters and focus groups in three larger markets from Atlantic and Littoral districts.

We then carried out individual semi-structured interviews with 75 vendors in 10 TMM, including markets in the southern (6), central (3) and northern (1) regions. These markets were those comprising a great number of stalls (≥ 15 stalls), except in the northern part where we were not able to conduct the wildlife species inventory and any other activities in the largest market of Manlanville, because vendors did not give us their agreement through verbal consents. The interviewees were all adult men, randomly selected without controlling for stall size and education level. We conducted each interview after we had explained the objectives of the study and then obtaining verbal consent to participate. We asked each interviewee to confirm the presence or absence of each species on our list in his stall at the time of the interview. For any species not present at the time of the interview, we asked the vendor to confirm if they had previously sold at least one specimen of that species during the last two years. We further allowed each interviewee to add species not on our list that were present at the time of interview and/or had been traded during the last two years. We limited the time period to up two years to avoid the bias related to the Local Ecological Knowledge (LEK) degradation over time (Aswani et al., 2018). We finally asked the vendors to indicate the country of origin of specimens observed in the stalls at the time of the interview. The three lists of potential species for the three taxonomic groups were administrated at different time periods and according to the interviewees' availability in order to allow each respondent to remain lucid during the surveys. In addition, we swapped the order of implementation of our three lists from one interviewee to another one. This strategy was used to get the same data quality for the different taxonomic groups.

Data analysis

In order to assess the spatial pattern of wildlife sales, we mapped the different types of markets using ArcGis 10.8.1 (Esri France) and analyzed the randomness of their distribution under point process theory (Ripley, 1981) using the PCF function of the *spatstat* package in R.4.2.1. This function provides the probability density of the *g* function under the Complete Spatial Randomness null hypothesis. We delineated the spatial distribution pattern through the univariate *g(r)* function, where *r* is the spatial scale and the *g(r)* function, the

ratio of the expected number of markets to the density of sample markets in a circle with any markets across Benin. We computed the function $g_{obs}(r)$ using 10,000 simulations at the 5% confidence interval and compared it to the theoretical function $g_{theo}(r)$ under the null hypothesis [$g(r) = 1$]. Rejection limits for the test are estimated as the envelopes of simulations and in the event that $g(r)$ was, for a given scale r , outside the simulation envelopes, the null hypothesis was rejected at this scale. So, $g(r) = 1$ indicates randomness, while $g(r) > 1$ and $g(r) < 1$ indicate clumping and regularity, respectively. We calculated the mean number of stalls for BM and TMM, and estimated the density of markets for each ecological zone (Guineo-Congolian, Soudano-Guinean and Soudanian).

To identify the relevant factors underlying the spatial distribution pattern of wildlife markets, we used a generalized linear model with binomial error and logit link to explain the temporality of wildlife markets (permanent vs. periodic) in response to the status of the municipality in which each market occurs (special, intermediate and ordinary), the ecological zone in which each market occurs (Guineo-Congolian, Soudano-Guinean and Soudanian), the number of stalls recorded market, the type of wildlife market (BM/TMM), and the Euclidian distance from wildlife markets to the nearest protected area under the management of government officials. We used the Pearson correlation coefficient to first assess collinearity among the predictor variables. The status of the municipality in which each market occurs was determined following the ordinance categorizing the municipalities in Benin (*DÉCRET N° 2022-319 DU 1er JUIN 2022 fixant les critères de catégorisation des communes and DÉCRET N° 2022- 320 DU 1er JUIN 2022 portant catégorisation*). According to the ordinance “*DÉCRET N° 2022-319 DU 1er JUIN 2022 fixant les critères de catégorisation des communes*”, the status of municipalities was defined as followed: (i) “special status,” scored (3), is a municipality with at least 200,000 inhabitants and that has mobilized over a period of at least three years preceding the year of evaluation of the municipalities’ categorization of budgetary resource amounting to one billion FCFA (1 Euro = 655 FCFA; the local currency) at least every year, (ii) “intermediate status,” scored (2), is a capital of a district that played a leading role in the history of Benin, having a population of at least 100 000 inhabitants and mobilized in a period of at least three years preceding the year of evaluation its own budgetary resource amounting to five hundred million FCFA at least each year, and (iii) “ordinary status,” scored (1), includes all other municipalities that do not belong to categories (i) and (ii).

To understand the amplitude of threats related to the wildlife trade, we visualized the percentage of recorded bird, mammal and reptile species in the 10 TMM in each of the following “protected” classifications. To understand the prevalence of threatened taxa, we annotated each recorded species with its IUCN Red List of Threatened Species (IUCN, 2022; <https://www.iucnredlist.org>) status, as well as its national Red List status for Benin (Neuenschwander et al., 2011). We also used the IUCN Red List to annotate each species as native or non-native to Benin. To understand the prevalence of protected species, we annotated each recorded species by its national status under Law N° 2002-16 of 18 October 2004 on wildlife protection in Benin and ordinance N° 2011-394 of 28 May 2011, which define the

modalities for species and habitat conservation and sustainable management in Benin. Each species was recorded as either Integrally Protected (category A), which cannot be hunted; Partially Protected (category B), which may be hunted outside protected areas; or not listed (category C), which generally are not protected or managed under Benin law. Finally, to understand the prevalence of species who’s transboundary trade should be managed under the terms of the Convention on International Trade in Endangered Species (CITES), we also annotated each recorded species by its CITES appendix (UNEP-WCMC (Comps.), 2022; <http://checklist.cites>). For each of these “protected” classifications, we visualized the proportions using histograms in Excel.

To decipher the trade network related to local trade, the source countries (origins of specimens as indicated by traders) collected from 590, 609, and 609 birds, mammals and reptiles specimens respectively in the stalls at the time of interviews were used to delineate the geographic extent of the trade and the contribution of each country to the local trade using a circular layout designed from ChordDiagram function in the package *circlize* (Gu, 2021). We used Pearson’s Chi-squared test to compare the frequency of citation between taxonomic groups.

Results

Wildlife market spatial temporality

We recorded 121 wildlife markets in Benin, including 106 TMM and 15 BM (Figure 1). The mean number of stalls in the TMM and BM were 5.83 and 1.2, respectively. Among TMM, the biggest wildlife markets were Dantokpa (56 stalls, Southern Benin), Avogbannan (36 stalls, Southern Benin), Gbèdagba (34 stalls, Southern Benin), Malanville (30 stalls, Northern Benin) and Azovè (26, Southern Benin). We observed a latitudinal trend in the density of wildlife markets, with the higher wildlife market density (1 wildlife market/267km²) in the Guineo-Congolian zone in the south and lower wildlife market density in the Soudanian zone (1 wildlife market/1877km²) of the north. The univariate spatial distribution of all wildlife markets (BM and TMM) exhibited aggregative distribution patterns across Benin (Figure 2).

We found that the municipality status (e.g., special, intermediary and ordinary), number of stalls and the type of market (BM and TMM) were all significant predictors of wildlife market temporality (permanent vs. periodic) in Benin (Table 1). In other words, permanent markets mostly occurred in biggest municipalities (special status) and had the highest numbers of stalls. There was also a higher probability that BM were permanent compared to TMM.

Diversity and conservation status of traded species

We observed and/or detected through interviews 268, 96 and 59 species of birds, mammals and reptiles, respectively (Supplementary Tables S1–S3, Supplementary Material). The species diversity recorded in TMM comprised 27, 5 and 8 non-native bird, mammal and reptile

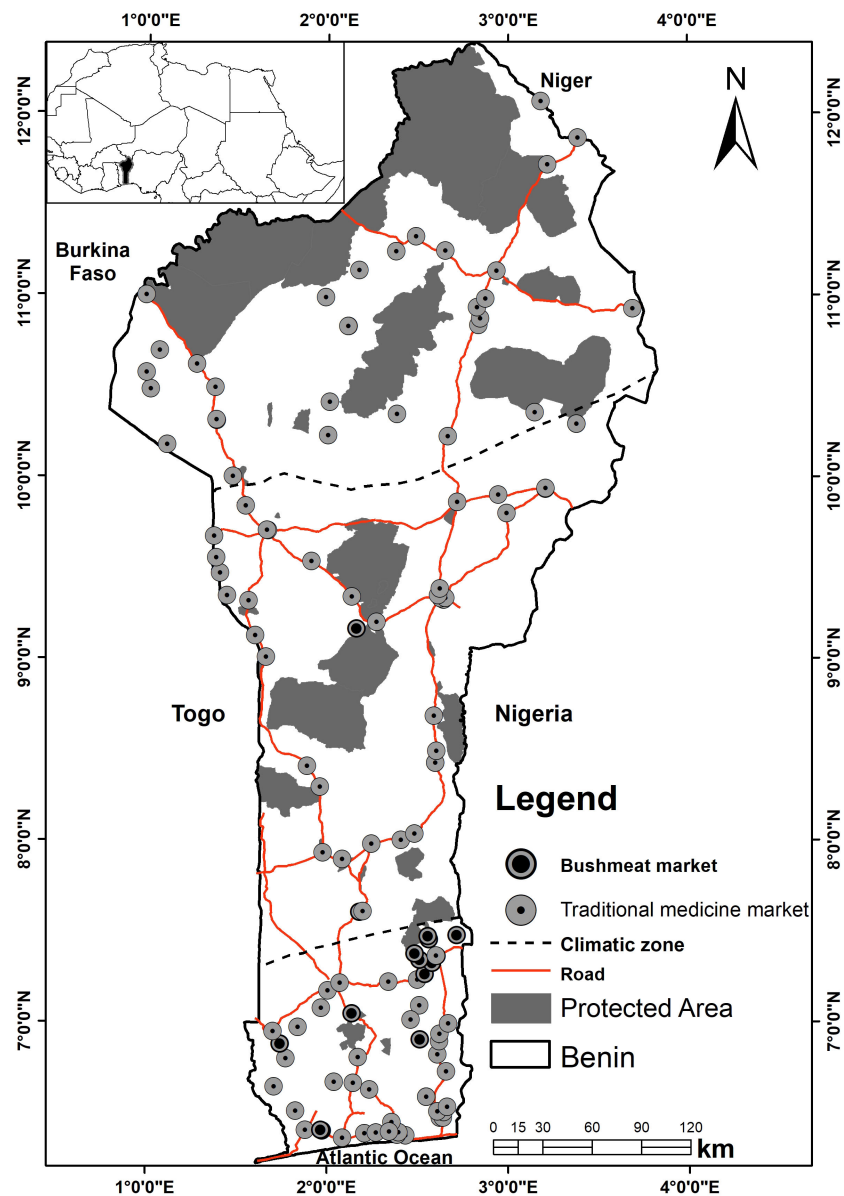


FIGURE 1
Geographic distribution of wildlife markets in Benin.

species respectively. The mammals belonged to 12 Orders, including Carnivora (27%), Rodentia (21%), Cetartiodactyla (20%) and Primates (12%). Birds belonged to 22 Orders, predominantly including Passeriformes (26%) and Accipitriformes (18%). The reptile group included only two Orders, Squamata (81%) and Testudines (19%).

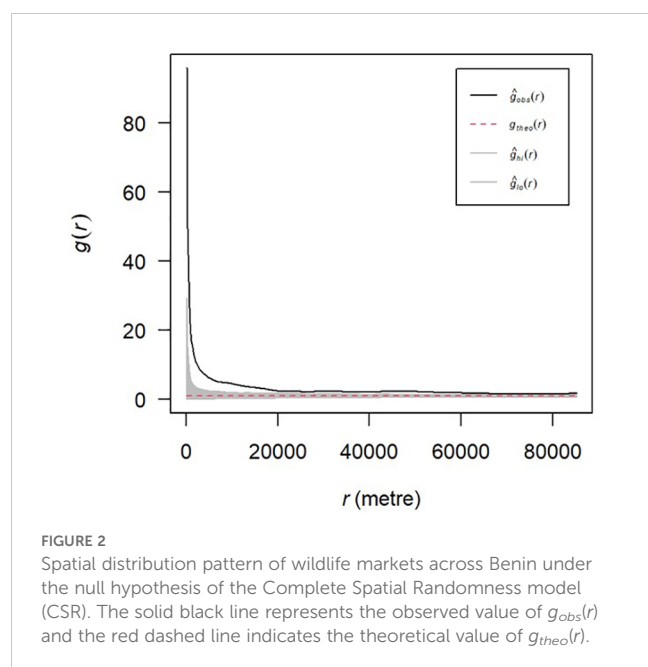
At the global scale, few bird, mammal, and reptile species traded in TMM are listed as threatened on the IUCN Red List (Figure 3A). Among mammals, 75% are listed as Least Concern (LC), compared to 2%, 5%, 7% and 7% listed as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT), respectively. A similar trend was observed for birds, for which 91% of species are Least Concern (LC), compared to 1%, 3%, 3% and 2% as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT), respectively. Reptiles were dominated by Least Concern (LC, 69%) species, followed by vulnerable (VU,

10%), Not Evaluated (NE, 7%), Critically Endangered (CR, 3%), Endangered (EN, 3%), and (NT, 3%).

At the national scale, most birds (75%) and reptiles (68%) were unevaluated, while 61% of mammal species are evaluated as nationally threatened (CR=2%, EN=14%, VU=30% and NT=15%; Figure 3B). However, 21% of birds (CR=1%, EN=4%, VU=10% and NT=6%) and 25% of reptiles (EN=2%, VU=8% and NT=15%) were also listed as nationally threatened.

Around one third of birds (29%), mammals (34%) and reptiles (32%) are CITES-listed species, including mostly in Appendix II (28% of birds, 18% of mammals and 27% of reptiles; Figure 3C).

Referring to the national legislation, 28%, 33%, and 14% of birds, mammals and reptiles, respectively, are Integrally Protected (A), compared to 11%, 25% and 8% listed as Partially Protected (B) birds, mammals and reptiles respectively (Figure 3D).



Scale of the wildlife trade supply chain

Traders in the TMM reported their specimens coming from across West Africa, with some rare specimens also coming from Central African range states (Figure 4). Specimens were reported as most frequently sourced from Benin and its border countries (Burkina Faso, Niger, Nigeria, Togo), though traders reported specimens coming from Cameroon, Côte d'Ivoire, Gabon, Ghana, Equatorial Guinea, Mali and Senegal (in alphabetical order) as well. Mammals were reported as more likely to be coming from countries outside of Benin, including predominantly Burkina Faso and Niger, while reptiles were most likely sourced in Benin. Frequency of citation of supplying sources varied highly significantly ($X^2 = 40.655$, $df = 21$, $p\text{-value} = 0.006185$) from a taxonomic group to another one.

Discussion

International recognition of wildlife trade as one of the major drivers of biodiversity loss is mainly based on international wildlife crime-based data and evidence illustrated in the UNODC's World

WISE database. However, local/domestic (National) component of wildlife crime remains underrepresented and almost heedless due to the great lack of relevant data even though evidence of local trade are recorded across tropics in particular. Understanding wildlife trade in and around Benin is a big step to revealing trade throughout the West African region and others should do the same to help paint a more complete picture. The study has the merit of filling the data gap by characterizing the spatial pattern of wildlife trade and driving forces, the geographic extent of the trade and the diversity of wild animals traded in these wildlife markets in West Africa.

We identified through national georeferencing 121 wildlife markets in Benin including 15 BM and 106 TMM, with relatively high densities of TMM in all the ecological zones compared to BM, restricted to the Guineo-Congolian Zone. There is evidence that wildlife trade is among one of key economic activities widely operated in Benin as throughout the tropics (Coad et al., 2010; Brashares et al., 2011; Nielsen et al., 2014; Price, 2017; Lee et al., 2020; Ingram et al., 2021). The high density in TMM (7 times higher than BM) is inverse to the common situation in Central Africa where the wildlife trade is predominantly operated in BM (Edderai and Dame, 2006; Fa et al., 2014; Taylor et al., 2015), highlighting the use of wild animals in traditional medicine and religious practices as one of the major threat to wildlife conservation in West Africa. This uncommon dominance of TMM in Benin is likely related to the religious singularity of country (see Lin et al., 2022) due to its animal-consuming endogenous religions *Vodùn* that remains deeply-rooted among ethnic groups despite the uptake and growth development of foreign religions. Benin remains one of the countries in West Africa where the public healthcare system, mainly based on the Western model, is precarious and difficult to access for impoverished populations (Sylvest, 2013). The proliferation of traditional medicine markets is certainly driven by the strong demand for this affordable and culturally-rooted traditional medicine by impoverished populations. In 2023, the total number of TMM represents one third of the total number of pharmacies in Benin (337; <https://www.abrp.bj/officine.php>). The TMM, support of the cultural identity of Beninese remains resilient to the ongoing transformation of health system by the government. Undoubtedly, wildlife trade in Benin is mainly oriented towards public health and religious practices, although no national law or policy allows and encourages animal-based traditional medicine as opposed to plant-based traditional medicine. Nevertheless, the few number of BM does not mean necessary that low volumes of wild meat are extracted from forest habitats to feed this category of market for consumption, given that the main consumers of wild meat (clients of BM) remain the larger populations in urban areas (Fargeot et al., 2017; Luiselli et al., 2018). A comparative analysis of volume of wild animals extracted from the forests to supply each category of market on a daily basis could make it possible to deeply appreciate the relative amplitude of the impacts induced by each market.

The spatial analysis of wildlife markets across Benin's landscape exhibited an aggregative distribution pattern with wildlife market temporality (permanent vs. periodic) significantly explained by the type of market ($P < 0.001$), the number of stalls in the wildlife

TABLE 1 Factors influencing the temporality (permanent vs. periodic) of wildlife markets in Benin.

Variables	Estimate	$p\text{-value}$
Municipal status	1.547e+00	3.12e-05 ***
Number of stalls	2.270e-01	0.007641 **
Type of market	-3.159e+00	0.000253 **
Distance to protected areas (m)	-5.020e-07	0.795485
Ecological zone	-5.413e-02	0.881888

Significance: '***' 0.001 '**' 0.01 '*' 0.05.

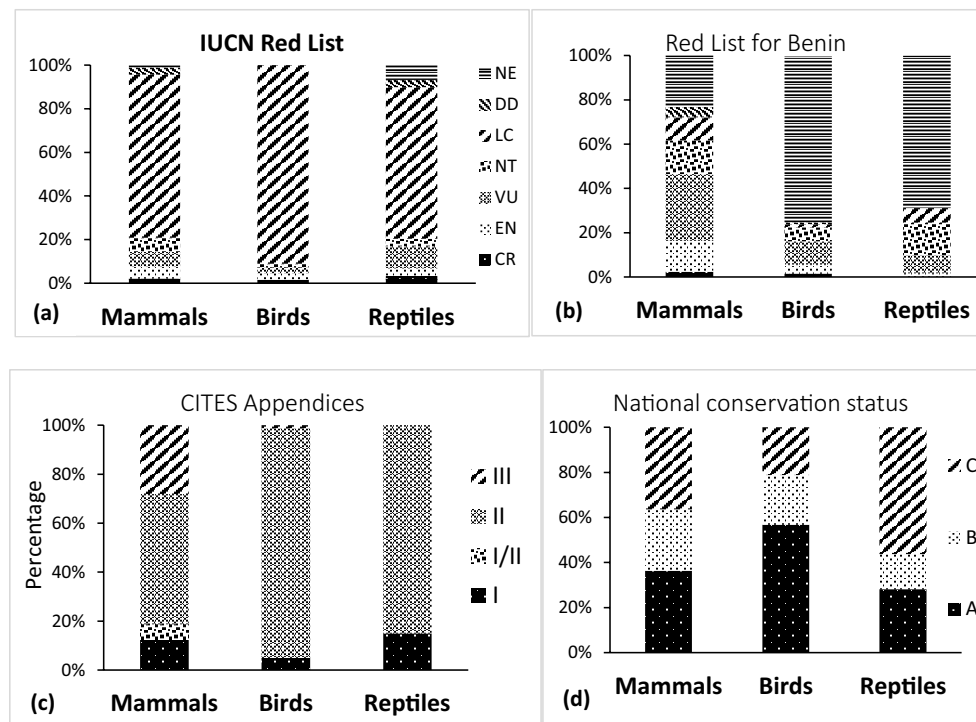


FIGURE 3

Proportion of species traded in TMM: (A) threatened at the global scale, (B) threatened at national scale, (C) threatened by the international trade and (D) protected by national law in Benin. CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; DD, Data Deficient; EN, Not Evaluated; A = Fully protected, B = Partially protected, C = Not protected.

markets ($P < 0.01$) and the municipality status ($P < 0.001$). These results mean that wildlife markets generally and permanent markets in particular mostly occurred in demographically and economically biggest municipalities (special status) and had the highest numbers of stalls. This leads to a high concentration of wildlife markets in large municipalities to the detriment of smaller ones from southern to northern Benin. These findings corroborate the fundamental law of supply and demand in economy (here, increasing consumers' demand correspond to growing number of wild specimens stalls) but also support previous studies that pointed out the economic chain related to the wildlife trade and its importance as an income source for local people (Fa et al., 2014; Nielsen et al., 2014; Price, 2017; Lee et al., 2020; Ingram et al., 2021). The Guineo-Congolian ecological zone where the higher density of wildlife markets has been recorded overlaps the southern Benin that encompasses most of larger cities (including both economic and administrative capitals) and more than 50% of the human population (INSAE, 2013). These results are in line with previous studies that underpinned the strong incentives of large urban human populations on wildlife harvesting in West and Central Africa (Fargeot et al., 2017; Luiselli et al., 2018). They support aforementioned demographic and economic factors underlying the spatial distribution and temporality of markets across Benin.

TMM-based surveys revealed a high species richness in birds (268 species), mammals (96 species) and reptiles (59 species) with species richness in birds 4 and 6 times higher than mammals and reptiles respectively. Contrary to previous studies that pointed out

mammals as the most affected taxonomic group by the wildlife trade (Whiting et al., 2011; Petrozzi et al., 2016; Gbogbo and Daniels, 2019), birds were dominant taxonomic group in terms of the number of species on TMM in Benin. Species recorded on TMM represents 20% (268/1371), 14% (96/663) and 10% (59/601) of bird, mammal and reptile richness respectively in West and Central Africa (Mallon et al., 2015). Referring to the country-level data (Benin), the diversity recorded on TMM represents 45% (268/590), 61% (96/157) and 58% (59/103) of bird, mammal and reptile richness respectively (Sinsin and Kampmann, 2010; Dowset-Lemaire and Dowset, 2019). The trade in wild animals on TMM affects relatively more species in Benin than South Africa (53 bird species, 60 mammal species and 33 reptiles; Whiting et al., 2011); Ghana (15 bird species, 16 mammal species and 8 reptiles; Gbogbo and Daniels, 2019) and in Togo (2 bird species, 22 mammal species and 2 reptiles; Sonhaye-Ouyé et al., 2022). However, a single sale site was surveyed in South Africa whereas surveys were restricted to the eight largest TMM in Accra (Ghana), contrary to our study that investigated a large area including several cities and 10 TMM. A comparison of our findings with those of BM in West and Central Africa shows a high species richness of TMM in Benin compared to BM from Cameroon, Ghana, Nigeria, Equatorial Guinea and Democratic Republic of Congo together (14 bird species, 91 mammal species and 19 reptiles; Petrozzi et al., 2016). Another relatively lower species richness was obtained for surveys conducted on 89 BM in Nigeria and Cameroon (Fa et al., 2014). The high numbers of species than those we obtained were reported for birds

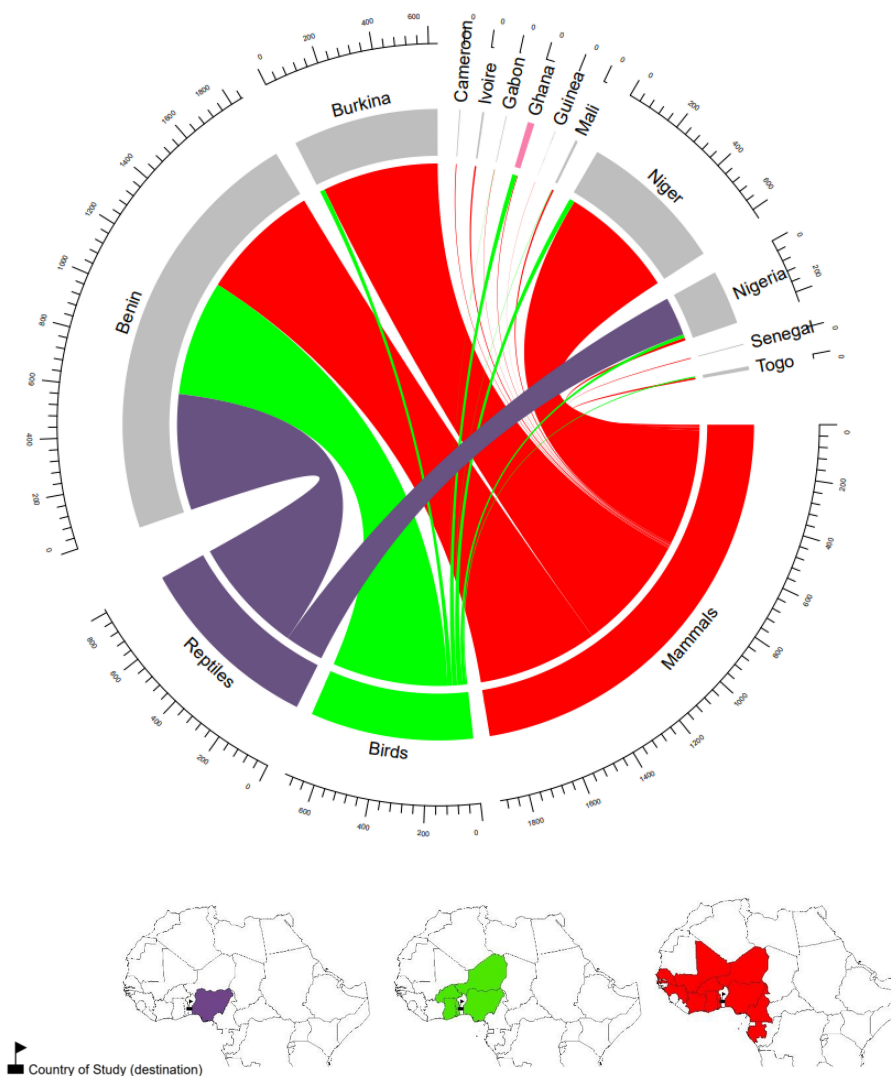


FIGURE 4

Diversity of supplying sources in wildlife of the traditional medicine markets in Benin. Ivoire= Côte d'Ivoire, Guinea = Equatorial Guinea, Burkina = Burkina Faso. The color on the maps represent each taxonomic group of the circular layout.

through systematic literature reviews involving 25 African countries (354 bird species; Williams et al., 2014), and 10 West and Central countries (354 bird species; Petrozzi, 2018). Moshoeu (2017) estimated a relatively high species richness in reptiles (101 species) across 30 African countries. Our study supports the important contribution of TMM in Benin to the regional estimations of the trade in bird species for the traditional medicine, counting for more than 50% of bird species (Petrozzi, 2018). The same trends could be observed for other non-focal taxonomic groups.

Our surveys ranked Carnivora (27%), Rodentia (21%), Cetartiodactyla (20%) and Primates (12%) as the main mammal orders available on TMM; Passeriformes (26%) and Accipitriformes (18%) for birds and the Squamata (81%) as the most represented order for reptiles. For mammals and birds, our findings are in line with previous studies that had already reported dominance of these different orders in the wildlife trade across West and Central Africa (Djagoun et al., 2013; Williams et al., 2014; Petrozzi, 2018; Djagoun

et al., 2023) but across Africa for reptiles (Moshoeu, 2017). We identified during interviews, Charadriiformes (03 species) and Psittaciformes (04 species) that had only been found on TMM in Benin (see Petrozzi, 2018).

On TMM occurs all the conservation profiles even if the high numbers of non-threatened (*NT*, *LC*, and *DD*) and Not Evaluated (*NE*) species on the IUCN Red List of Threatened Species and on the Red List for Benin were reported for all the focal taxonomic groups. Some comparisons based on the number of threatened species in Benin according to the IUCN (2020) shows that all the threatened birds (12/12), reptiles (7/7) and almost all the high concern mammal species (13/16) are affected by the local trade on TMM. These findings are a further evidence of harmful impacts of wildlife trade on local and regional biodiversity. Similar results were reported for all the surveys relative to wildlife trade across Africa (Djagoun et al., 2013; Williams et al., 2014; Petrozzi et al., 2016; Moshoeu, 2017; Petrozzi, 2018; Sackey et al., 2023; Djagoun et al., 2023). The large spectrum of species (a total of 426 species for both

three groups) affected by the trade including many large-bodied seed dispersers (i.e. primates, antelopes, bats etc.) and high concern species would lead to severe defaunation, a decreasing of the carbon balance and consequently will emphasize climate change (see Bello et al., 2015).

Our inventory on TMM revealed that one third of recorded species, were CITES-listed species including a high number of species listed on the Appendix II. Among CITES-listed species, four mammals (*Acinonyx jubatus*, *Panthera pardus*, *Phataginus tricuspidis*, *Gorilla gorilla*) and three reptiles (*Boa constrictor*, *Chelonia mydas*, *Lepidochelys olivacea*) were listed on the Appendix I. The trade affects not only the IUCN high concern species but also some species threatened by international trade (Williams et al., 2014; Petrozzi et al., 2016; Moshoeu, 2017; Petrozzi, 2018; Djagoun et al., 2023). In West Africa, 99 mammals and 113 birds were listed on the CITES Appendices (Cormier-Salem et al., 2018) whereas 44 out of 101 reptiles reported across Africa were listed on Appendix I or II (Moshoeu, 2017). Using the above-mentioned reference frameworks, 69% (79/113) of bird species, 32% (32/99) of mammal species and 45% of (20/44) reptiles species listed on CITES Appendices were openly sold on TMM. Out of species under international reference frameworks (IUCN Red List of Threatened Species and CITES Appendices), it was recorded on TMM some fully protected species (75 bird species, 32 mammal species and 8 reptile species) by the National legislations ((see, Supplementary Tables S1–S3, Supplementary information). These findings underpin the ineffectiveness of law enforcement at national level and call for urgent regulation of wildlife trade, in particular on TMM. It is quite clear that there is an illegal dimension of the local trade.

Out of the distribution pattern of wildlife markets, the diversity of bird, mammal and reptile species traded on TMM and their conservation profiles at national and international scales, our investigations delineated a regional trade including all the countries of the West African Economic and Monetary Union (WAEMU) except (Guinea-Bissau) and 12/15 of the Economic Community of West African States (ECOWAS). This means that almost all the West African countries supply TMM in wild animals in Benin. These results support the long-distance trade underpinned recently in the Dahomey Gap (Zanvo et al., 2022). The trade in wildlife follows probably the same routes as the goods between the states of WAEMU and ECOWAS that established strong economic ties several decades ago. This raises the problem of porous borders and weak enforcement at borders, which facilitate this regional trafficking. According to IUCN (2020), it occurs 7 and 12 threatened reptile and bird species respectively in Benin, but our inventory identified on TMM 8 and 19 threatened reptile and bird species respectively on the IUCN Red List (Supplementary Tables S2, S3, Supplementary Material). Moreover, some species recorded on TMM were non-native species to Benin but native species to the West and Central Africa (Supplementary Tables S1–S3; Supplementary Material). There is no doubt that TMM in Benin are supplied in wildlife from the states belonging to WAEMU and ECOWAS. Whatever the taxonomic group considered, the most cited supplying sources were Benin and its border countries (Burkina Faso, Niger, Nigeria). These results show a wildlife trade

mainly centered on the available wildlife resources in Benin and its neighboring countries (Burkina Faso, Niger and Nigeria) with some remote connection with Western and Central Africa countries. LEK-based surveys revealed a lower diversity of supplying sources in reptiles contrary to mammals and birds. Given Benin is recognized as one of most prolific reptile-exporting country in the world (Harwood, 2003; Auliya et al., 2016), may be the availability of sizeable populations of reptiles could explain the limited number supplying sources contrary to mammals and birds. Moreover, Benin has several captive breeding farms across the country on which large quantities of reptiles (turtles, python, lizards) are bred every year (SZ, pers. obs.). However, the fact that one fourth of reptile specimens sold in markets come from Nigeria, points out that this country participates to the international trafficking via Benin. In view of Benin's place in the illegal wildlife (native and non-native) trade at regional level, the challenges linked to securing borders, the weakness of law enforcement in the country and the growing dynamic of cases of seizures of animal specimens from Nigeria in particular (SZ, pers. obs.), we hypothesize that Benin is probably becoming a hub of international illegal wildlife trafficking. An in-depth study of the wildlife trade chain involving a wide range of actors (TMM and BM vendors, consumers, forest officers, customs officers and border populations, etc.) and national seizure data is needed to shed light on the links between local/regional trade and international trafficking, the extra-continental drivers and Benin's level of involvement for informed interventions against wildlife crime.

Implications for conservation

Sustainable development, the fight against accelerating biodiversity loss and degradation, as well as climate change inexorably requires rational management of biodiversity at the level of each country and the implementation of more structured and inclusive strategies at regional and international level against the illegal trade in wildlife. This can only be effective in a context where each nation has up-to-date and reliable information. Our study has the merit of deciphering wildlife trade in its current form in West Africa. Data relating to the number of markets, the spatial configuration of markets, their spatial temporality, then their weight (number of stalls) and the factors influencing this temporality constitute an important source of information for developing a national strategy to regulate the local wildlife trade and combat the illegal trade. These data could be used for spatial prioritization of actions against the illegal wildlife trade. Data on species of major conservation concern, cross-referenced with the occurrence areas of the different species in Benin, will make it possible to identify the habitats on which it will be necessary to concentrate more conservation efforts to avoid local extinction of these species. Our investigations revealed the presence in the stalls of TMM some species fully protected by national legislation. This evidence should raise awareness of public forest services for rigorous law enforcement, even in TMM which carry the cultural identity of Beninese and which until now have remained free of all regulations. In addition, religious leaders/community need to be actively brought into the different conservation efforts using a top-down approach. Using the

species diversity obtained from our investigations, the Beninese Government could update the list of protected species in Benin. Thus, certain species, given the level of threat and the scientific data available on their abundance, could change category. Our results clearly suggest that the sources of animals that supply TMM go beyond Beninese borders, and it occurs a regional wildlife trade violating the regional commitments to combat wildlife trafficking such as West African Strategy for Combatting Wildlife Crime. Our data could help update the regional strategy. These data will allow a targeted fight against animal trafficking and are of paramount importance for planning a regional fight against wildlife crimes through transnational cooperation.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Material**. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Research Ethics Committee of the University of Abomey-Calavi (#4613). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their informed consent to participate in this study.

Author contributions

SZ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft. SD: Data curation, Formal analysis, Funding acquisition, Investigation, Visualization, Writing – original draft. JA: Data curation, Investigation, Methodology, Visualization, Writing – original draft. AA: Software, Validation, Visualization, Writing – review & editing. BD: Supervision, Validation, Writing – review & editing. ES: Conceptualization, Supervision, Validation, Writing – review & editing. BS: Conceptualization, Project administration, Supervision, Validation, Writing – review & editing. CD: Software, Supervision, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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EDITED BY

Ines Arroyo-Quiroz,
National Autonomous University of Mexico,
Mexico

REVIEWED BY

Dauda Ayomide Onawola,
One Health in Action Initiative, Nigeria
Xavier López Medellín,
Centro de Investigación en Biodiversidad y
Conservación (CIByC), Mexico

*CORRESPONDENCE

Opemipo Alaba Ijose
✉ oai0004@auburn.edu

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Utilization of fauna resources for therapeutic purposes as a barrier to species justice advocacy in Nigeria

Taiwo Kabiru Adebowale¹, Opemipo Alaba Ijose^{2*},
Bolade Bosede Ibiyomi¹, Oluyinka O. Akintunde¹,
Oladapo O. Oduntan¹, Israel Oluyinka Oloyede Osunsina¹
and Aishah Adeola Shobowale¹

¹Department of Forestry and Wildlife Management, College of Environmental Resources Management, Federal University of Agriculture, Abeokuta, Ogun, Nigeria, ²Horst Schulze School of Hospitality Management, Tony and Libba Rane Culinary Science Center, College of Human Science, Auburn University, Auburn, AL, United States

Efforts to reduce the irrational exploitation of wildlife, aimed at achieving species justice, continue to be challenged by the persistent demand for animal parts and derivatives in formulating alternative medicines in certain regions of Nigeria. This study focuses on the Kuto, Iberekodo, Itoku, and Lafenwa markets in Ogun State, known for the many traditional medical practitioners relying on these markets for alternative remedies. Data were collected through a semi-structured questionnaire distributed randomly to 165 traditional medicinal vendors. The survey identified 49 animal species of conservation concern; these are categorized as follows: two molluscs, two amphibians, two insects, five fish, eight reptiles, nine birds, and 21 mammals. Various animal parts are traded for spiritual empowerment and disease treatment in these markets. This trade negatively impacts conservation efforts and undermines the collective endeavors of all stakeholders to promote species justice in Nigeria.

KEYWORDS

traditional medicine, illegal wildlife trade, species justice, wet market, biodiversity conservation

Introduction

The practice of utilizing wildlife for therapeutic purposes has a long history and is sometimes categorized as “complementary” and “alternative” medicine in certain countries according to [Alves and Alves \(2011\)](#). Medicinal items (plants and animals) are mostly traded in local and traditional city markets, particularly as raw materials ([Monteiro et al., 2010](#); [Alves and Alves, 2011](#)). According to [Alves et al. \(2012a\)](#), local markets typically feature separate areas dedicated to selling medicinal plants and animals. Ethnobotanists

have shown a growing interest in the markets for medicinal plants (Monteiro et al., 2010; Mati and de Boer, 2011). Until recently, however, the trade in animals for medicinal purposes has largely been overlooked. Recent research shows that this area is attracting attention due to a growing market for traditional medicine, mostly operated by herbalists in different marketplaces (Oliveira et al., 2010; Ferreira et al., 2012).

Traditional medicinal practitioners, traders, hunters, poachers, and, occasionally, middlemen are among the many people who make their living from traditional medicine. Many of these individuals rely only on hunting, processing, and trading wildlife as their primary source of income because of their economic and social backgrounds (Soewu, 2008). However, Simmonds (1998) hypothesized that individual species will suffer, and regional or perhaps global conservation may be in jeopardy if enough money is generated from the trade in wild animals. Unfortunately, there is no question that the trade in animals as traditional medicinal recipes will continue to thrive because human ailments will always need to be addressed (Soewu, 2008). This would directly lead to the ongoing loss of these wildlife resources in the wild since most wildlife traded for use in traditional medicine formulations are sourced from the wild (Marshall, 1998). The number of these wild resources is decreasing quite drastically (Anon, 1999).

Traditional medicine formulations remain a crucial source for preventative and curative healthcare, catering to a significant portion of the global population, with approximately 80% still relying on traditional medicine for their primary healthcare needs (Ajagun et al., 2017). Traditional medicine encompasses diverse therapies and practices that vary across countries and regions, sometimes in conjunction with Western medicine (Herman et al., 2018). Animal species are essential ingredients in traditional medicine formulations, including their parts and by-products, such as skin, head, excreta, fur, feathers, bones, glands, etc. These formulations have demonstrated effectiveness in preventing, curing, and managing various diseases like hypertension, diabetes, epilepsy, cancer, convulsions, and mental illness (Friant et al., 2022). Numerous wild species face local or regional extinction due to the increasing demand for wildlife derivatives used in traditional medicine across developing countries (Alves and Rosa, 2007). Some researchers suggest that this demand is closely linked to poverty, urbanization, and associated social challenges (Alves and Rosa, 2010). Additionally, it is important to recognize that many individuals in these countries often lack adequate healthcare services (Fronterias, 2001).

Although unjustifiable, traditional medicine is crucial in healthcare delivery systems, particularly in Nigeria and the southwestern region (Erinoso and Aworinde, 2012). Historically, using animals in traditional medicine was more prevalent in rural areas where healthcare facilities were lacking (Soewu et al., 2012). However, the reliance on wildlife products, often sourced from threatened or endangered species, has placed increased pressure on the wildlife population and, in turn, dwindled the advocacy for species justice. This potentially negatively impacts conservation efforts, especially considering the popularity of wildlife derivatives as an ingredient in many Nigerian dishes and for medicinal purposes (Adebowale et al., 2024; Alarape et al., 2017).

According to recent studies, several animal species are trafficked for therapeutic use in urban areas around the world, particularly in Latin American, Asian, and African nations. Studies reveal both parallels and discrepancies among the chosen animals. El-Kamali (2000), for instance, found 23 species utilized in Central Sudanese traditional medicine, while Sodeinde and Soewu (1999) found 45 species in Nigeria. A total of 44 species were reportedly marketed in herbalist stores in the Eastern Cape region of South Africa by Simelane and Kerley (1998). Additionally, excluding domestic animals, diverse marine invertebrates, and fish, Cunningham and Zondi (1991) reported no less than 79 species of vertebrates in KwaZulu-Natal Province, comprising birds of about 16 species, 18 reptiles, and 45 mammals.

Ngwenya (2001) reported that 132 vertebrate species, including 79 mammals, 32 birds, and 21 reptiles, were traded in KwaZulu-Natal Province. Of them, 50 species, including baboons and mambas, with a few others, were highly sought after. Whiting et al. (2012) found 147 vertebrate species in South Africa, which accounted for roughly 9% of all vertebrate species in the country and 63% of those traded there. Although Ashwell and Walston (2008) reported 47 species in Cambodia, investigations conducted in Brazil found approximately 180 animal species marketed for medical purposes (Alves, 2010). Most of the 100 therapeutics sourced from 68 animals that Nguyen and Nguyen (2008) reported were available in Ho Chi Minh City as gels or dried portions prepared by boiling animal carcasses.

The ongoing use of wildlife for traditional medicine often overlooks the conservation status of the species involved (Alves et al., 2021). Traders and farmers hunt these species without recognizing the importance of wildlife conservation (Damania and Bulte, 2007). The demand stemming from traditional medicine constitutes a significant factor contributing to the overexploitation of various wildlife species populations (Soewu and Adekanola, 2011). Scott et al. (2010) observed that many species used in traditional medicine are at risk of becoming threatened or endangered, with the possibility of extinction if appropriate conservation policies and a demand for species justice are not taken seriously by the relevant authorities.

According to Nurse (2013), wildlife laws are essential to promote species justice because they enable the modern criminal justice system to extend beyond traditional human-centered notions of justice, which often focus on punishment or rehabilitation. These laws incorporate both restorative and reparative principles for humans and non-human animals. However, the legal protection of wildlife is often primarily driven by their economic or property value. As a result, these legal safeguards are generally limited to situations where the use of animals aligns with human interests, such as when animals are utilized for food or subjected to other forms of commercial exploitation, like the trade in skins, body parts, or derivatives.

Despite the efforts of federal and state governments and NGOs to combat wildlife and forest crimes through the establishment of agencies and the utilization of the legal system, Nigeria continues to face significant challenges in curbing wildlife trafficking across its borders. NGOs in Nigeria have made several efforts to establish a

sustainable species justice system by ensuring that the national government takes its various laws, frameworks, and policies on wildlife matters seriously. These measures are allegedly enforced by the National Environmental Standards and Regulations Enforcement Agency (NESREA). They are guided by international agreements like CITES to control wildlife exploitation. The duties assigned to NESREA in Nigeria include biodiversity preservation, environmental protection, and the advancement of sustainable natural resource management. The agency works with stakeholders domestically and abroad to enforce environmental norms and laws. Protecting Nigeria's land, water, air, forests, and wildlife is part of its goal. As stated in Sections 7(a), (c), and (e) of its Act, one of its primary duties is to prevent wildlife crime. While Section 7(c) focuses on respecting international agreements on a range of environmental challenges, such as incorporating the culture of the species justice system, Section 7(a) requires the implementation of environmental legislation. Guidelines governing biodiversity protection, sustainable ecosystem management, and the utilization of natural resources are enforced by Section 7(e) (Gbadegegin, 2023).

Nigeria's primary wildlife protection law is the Endangered Species (Control of International Trade and Traffic) Act (ESA), established in 1985 and revised in 2016. The ESA aims to protect endangered species by regulating hunting, capturing, and trading activities. Species classified as threatened require special permission for exceptions. Section 6 bans harmful practices, including the use of toxic substances and explosives. Violators face heavy fines: ₦5,000,000 for first-category species and ₦1,000,000 for second-category animals, with repeat offenders risking jail time. Despite these measures, illegal exploitation of protected species, such as pangolins, remains a significant problem (Gbadegegin, 2023).

According to Gbadegegin (2023), Nigeria adheres to the Protection of Endangered Species in International Trade Regulation 2011 (PESITR) in line with CITES, regulating the trade of live specimens, leather, jewelry, and medicinal products to protect endangered species. Trade involving Appendix II species requires permits, while Appendix I species are prohibited except under special circumstances. Enforcement is handled by the Nigerian Customs Service and the National Wildlife Enforcement Monitoring Unit, with penalties including fines of up to ₦5 million and imprisonment for 3 years for individuals and up to ₦21 million for companies, with senior executives facing up to 7 years in prison for violations. Section 7(3) criminalizes possessing, selling, or displaying unlawfully obtained specimens.

Despite the various measures taken to address the issue of illegal wildlife exploitation and trade, Nigeria has been a major source and transit nation for wildlife products that have been illegally traded in the last 10 years. In its World Wildlife Crime Report (WWCR) 2020, the United Nations Office on Drugs and Crime (UNODC) stated that the quantity of pangolin scales seized at Nigerian ports increased dramatically from 2 tons in 2015 to 51 tons in 2019. Nigeria is a major player in the illicit ivory trade, as Nigerian ports handle about 25% of all seized ivory globally. Nigeria confronts major obstacles in strengthening its ability to handle wildlife

trafficking and sustain species justice, even though national and state governments have tried to address wildlife and forest criminality by creating specialized agencies and legal frameworks (Gbadegegin, 2023). Considering the conservation status of numerous animal species involved in the illegal wildlife trade and the subsequent utilization for medical purposes (Alves et al., 2010), it is imperative to conduct more comprehensive inventories of the species involved, along with an analysis of the ecological and health impacts of their use which drive the illegal exploitation (Ferreira et al., 2009). This study examines the unjustifiable therapeutic use of wildlife derivatives and proposes a framework for a species justice system to address the ongoing exploitation of these species in southwestern Nigeria.

Methodology

Study area

The research was conducted in Abeokuta, the capital of Ogun state, positioned between longitude 3°30' north and 3°37' east and latitude 7° and 7°5' north. Situated on the east bank of the Ogun River, Abeokuta is located 77 km north of Lagos by railway or 130 km by water (Oluremi et al., 2021). The town is characterized by two significant rivers, the Ogun and Oyan rivers, which converge north of Abeokuta. The altitude of Abeokuta ranges between 0 and 200 m above sea level within the lowland area (Soaga et al., 2014). Abeokuta is recognized for its trade in palm oil, lumber, natural rubber, yams, rice, cassava, maize, cotton, fruits, and shea butter. It is a crucial export hub for cocoa, palm products, fruit, and kola nuts. Positioned beneath the Olumo Rock, housing caves and shrines, the town relies on Oyan River Dam for water supply, although its reliability is inconsistent. The dam is situated in Ogun State's Abeokuta North local government area, approximately 20 km northwest of the state capital (Aluko, 2018). Abeokuta serves as the headquarters of the Federal Ogun-Oshun River Basin Authority, overseeing the development of land and water resources for Lagos, Ogun, and Oyo states. Responsibilities include irrigation, food processing, and electrification. Local industries in Abeokuta encompass fruit canning plants, plastics, breweries, sawmills, and an aluminum products factory. South of the town are the Aro granite quarries (Aderogba et al., 2012).

Research design

The study employed a survey approach similar to those used by Adeola (1992), Soewu et al. (2012), and Adebowale et al. (2024) to gather relevant data from the appropriate participants. Before initiating the study, the researchers conducted a pilot survey to identify and establish the rationale for selecting the study area. The research drew on findings from Soewu et al. (2012) and Adebowale et al. (2024), who reported significant wildlife trade transactions occurring in various markets within Ogun State. However, their

studies did not address some critical markets located near viable forest ecosystems, as they primarily focused on markets close to human habitation. Given that the proximity of wet markets to forested areas could increase wildlife hunting, potentially leading to quick sales in these markets, as suggested by [Ijose \(2018\)](#), we determined that such locations would be ideal for our study.

By employing a stratified sampling method, we identified several markets with potential wildlife trade. We then spent 2 weeks monitoring market transactions in our pilot study. After consistently observing wildlife and its derivatives being traded, we identified four markets where these activities are most prevalent: Kuto, Iberekodo, Itoku, and Lafenwa. At these markets, we noted the presence of traditional medicinal vendors who facilitate the illicit trade of wildlife. They were arranged in stalls where they sold wildlife derivatives and other processing ingredients. To gather accurate data, we conducted a population census of these vendors to determine their number. This helped us to establish the quantity of samples we needed to collect. Our focus was specifically on vendors selling wild animals, whether whole or in parts.

We prepared a questionnaire for the main survey based on the information gathered from the pilot study. This questionnaire was designed and tested to determine the time required to collect data from vendors and assess the inventory of wildlife derivatives available at each market stall. The results from this trial provided us with an estimate of the time needed to collect data from each market. The questionnaire was designed to gather information about the participants' socio-demographic characteristics, including age, gender, and marital status. Additionally, it covered topics related to using animals in traditional medicine, specifically focusing on the types of animals used, the specific parts of the animals utilized, and the therapeutic purposes for which they are employed.

Data collection

The study was conducted over a 3-month period, from February 2022 to April 2022. The Kuto, Iberekodo, Itoku, and Lafenwa markets in Abeokuta were purposefully selected as they represent the four major markets frequented by artisans and vendors specializing in traditional remedies, as shown in [Figure 1](#). These markets were chosen for their proximity to significant forest ecosystems. Based on information from our pilot study, a purposive and convenient sampling technique was used to identify market vendors who primarily trade in wildlife parts and derivatives for traditional medicine and other uses within the selected stalls. The markets typically operate 5 days a week. We approached the vendors in the morning when hunters brought fresh wildlife carcasses, as emphasized by [Alarape et al. \(2017\)](#). This timing is ideal, as transactions peak during this period, making monitoring inventories and the scale of transactions easier.

Before administering the survey questionnaire, the vendors received a comprehensive overview of the study's objectives and potential implications. A translator was provided to ensure that all vendors fully understood the information in the form of consent. Those who expressed discomfort with the nature of the study were excluded from the data collection process. Primary data was collected through a semi-structured survey questionnaire conveniently administered to traditional medicinal market sellers willing to participate in the research. A total of 165 questionnaires were distributed among the respondents. Additionally, the scale of their stocks was assessed through open-ended questions.

During our visits to the selected markets for this study, we conducted a thorough inventory of every item found at each stall to compare it with information provided by the vendors. We recorded every species observed in the market, including its local name. We

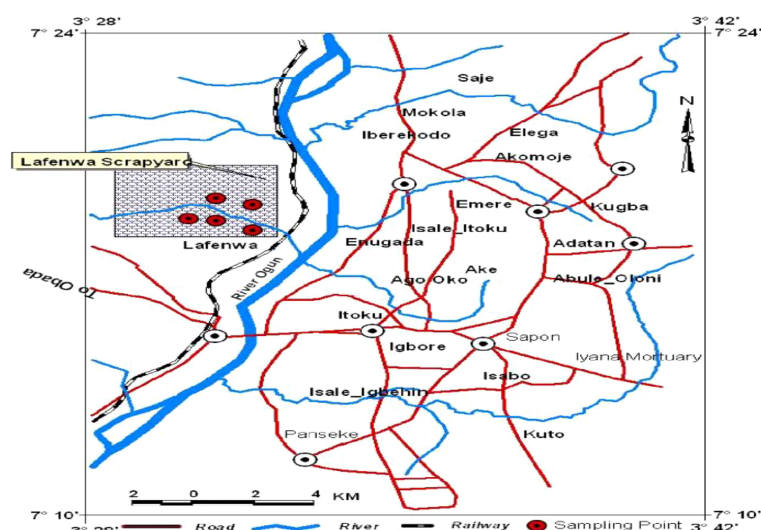


FIGURE 1

Map showing the geographical coordinates of the markets in Abeokuta, Ogun State, Nigeria. Source: field survey, 2022.

consulted scientific publications to align the indigenous names with the accepted English and scientific names. Additionally, we employed the Village Contact Survey (VCS) approach to help identify some species. To assist the traditional medicine vendors in recognizing animals by their local names where animal parts are paraded without proper identification, we provided published identification guides and encyclopedias, which included photographs and distinguishing characteristics of the species. Once a local name was established, we compared it with scientific and common English names (Soewu et al., 2012).

The study focused on animals identified by at least three respondents. In the questionnaire, we asked questions to explore key issues related to the trade of wildlife used in traditional medicine. The vendors were requested to identify the most traded species and the ailments for which these species are believed to provide remedies. Additionally, they were asked about the impact of traditional medicine on wildlife conservation. The questionnaire also included a section aimed at gathering insights into the vendors' attitudes and perceptions regarding the use of traditional medicine. This criterion was established to ensure consistency and significance in the information provided. We referred to the CITES appendices for global listings to assess the status of trade and conservation for the species observed during the survey. We also reviewed the Endangered Species (Control of International Trade and Traffic) Decree No. 11 of 1985 to understand the current conservation status of these species within Nigeria (Soewu et al., 2012).

We employed a two-stage approach for data presentation, utilizing fundamental methods such as cross-tabulations and descriptive statistics. A data presentation technique established by Field (2000) guided this study. Section A of the questionnaire focuses on the socio-demographic characteristics of the participants. Section B provides information about the animal species and their derivatives commonly traded for alternative medicine purposes as well as the illnesses associated with these animal parts sold in markets. Section C examines the implications of traditional medicine on conservation, while Section D includes questions about the respondents' attitudes and perceptions toward the use of traditional medicine. The results were organized and tabulated for visual presentation. One effective way to clearly and succinctly illustrate the main conclusions from the statistical study was by using tables to present the data.

Results

Table 1 displays the demographic information of the study participants. The findings reveal that 32.7% of the respondents were male, while 67.3% were female. Regarding age distribution, 39.4% of participants were within the 21–40 age bracket, 44.2% fell within the 41–60 range, and 16.4% were over 60. Regarding marital status, 1.8% of the respondents identified themselves as single, 67.9% were married, 20.2% were widowed, and 10.3% were separated. On the educational front, most respondents completed primary education (38.2%) and secondary education (37.0%). Furthermore, 16.4%

obtained a post-secondary diploma or NCE, while 2.4% held a bachelor's degree. Notably, only 6.1% of the population reported no formal education.

In terms of religion, Islam was the predominant faith among the respondents with 51.5%, followed by Christianity at 29.7%, and

TABLE 1 Demographic characteristics of the respondents.

Variable	Frequency	Percentage
Gender		
Male	54	32.7
Female	111	67.3
Age		
21–40	65	39.4
41–60	73	44.2
Above 60	27	16.4
Marital status		
Single	3	1.8
Married	112	67.9
Widower	33	20.2
Separated	17	10.3
Education		
No formal	10	6.1
Primary	63	38.2
Secondary	61	37.0
Post-secondary/NCE	27	16.4
Bachelor	4	2.4
Religion		
Christianity	49	29.7
Islam	85	51.5
Traditional	31	18.8
Income		
≥₦30,000	24	14.5
₦31,000–₦60,000	66	40.0
₦61,000–₦90,000	55	33.3
₦91,000–₦120,000	14	8.5
₦121,000	6	3.6
Market		
Itoku	70	42.5
Lafenwa	35	21.2
Kuto	30	18.2
Iberekodo	30	18.2

18.8% identified themselves as traditional worshipers. In terms of income derived from the sales of animals used for medicinal purposes, 40.0% of the respondents reported earning between ₦31,000 and ₦60,000 (\$21–\$40) monthly, 33.3% earned between ₦61,000 and ₦90,000 (\$41–\$60), 8.5% earned between ₦91,000 and ₦120,000 (\$61–\$80), and 3.6% earned ₦121,000 (\$81) or more each month.

Molluscs species and parts used for therapeutic purposes

Table 2 presents the molluscs utilized in traditional medicine within the study area, revealing the presence of two species. The participants identified the entire freshwater snail (*Pila ovata*) as an ingredient in preparations to treat strokes. Furthermore, the African giant snail (*Achatina achatina*) is recognized for its diverse beneficial components, including its meat, shell, and mucus, which are employed to address various health concerns. These concerns encompass weak bones, measles, stroke, fibroids, complications during childbirth, diabetes, hypertension, convulsions, and fertility issues.

Amphibian species and parts used for therapeutic purposes

Table 3 highlights the amphibians used in traditional medicine in the study area, focusing on two species. The findings reveal that the entire European common frog (*Rana temporaria*) is a crucial ingredient in remedies aimed at promoting strong bones. The African common toad (*Amietophrynus regularis*) is likewise recognized for enhancing bone strength. This toad is also employed as an anti-poison agent and is believed to be effective in preventing bedwetting.

Insect species and parts used for therapeutic purposes

Table 4 presents information on the insect species employed in traditional medicine, focusing on two species available for purchase in the study area. The respondents indicated that the honeybee (*Apis mellifera*), including its sting and feces, is a key component in remedies for pain, cough, cold, and rheumatism. Additionally, the entire common wasp (*Vespula vulgaris*) treats skin infections.

Fish species and parts used for therapeutic purposes

Table 5 details the use of various fish species in traditional medicine and highlights five species that can be purchased in the study area. The electric fish (*Malapterurus electricus*), snakehead (*Parachanna obscura*), African knife fish (*Xenomystus nigri*), and redbelly tilapia (*Tilapia zillii*) are commonly employed for the treatment of infertility in both men and women, utilizing therapeutic components such as the entire body, bones, and fins of the fish. In contrast, the African catfish (*Clarias gariepinus*) is specifically valued for its bones and fins to address infertility in both genders and to alleviate rheumatism.

Reptilian species and parts used for therapeutic purposes

A range of reptiles and their body parts are employed in traditional medicine to address various physical ailments and spiritual concerns, as outlined in Table 6. The complete body of the common green iguana (*Iguana iguana*) is utilized for treating fever, pain, and ulcers as well as for protective purposes and enhancing business success. Similarly, the entire body of the agama lizard (*Agama agama*) is used to alleviate epilepsy, cough, sore throat, and convulsions. Furthermore, the whole body of the Senegal chameleon (*Chamaeleo senegalensis*) is sought after for its reputed magical properties, anti-poison attributes, and effectiveness in relieving pain and tumors.

Various parts of the Gaboon viper (*Bitis gabonica*), including its entire body, head, fat, shed skin, tail, and flesh, are utilized in traditional medicine to address a range of conditions such as paralysis, stroke, skin infections, complications during labor, pain, convulsions, eye infections, and cancer. The African rock python (*Python sebae*) is thought to offer protection against malevolent forces, promote wealth, and assist in the healing of broken bones. The Nile monitor (*Varanus niloticus*), particularly its whole body and skin, is employed to treat tumors and liver diseases and is also considered an antidote for poisoning.

There is a belief that certain creatures offer protection against malevolent influences and manipulation—for instance, the Nile crocodile (*Crocodylus niloticus*), including its entire body, head, and tail, is utilized to alleviate weakness and rheumatism and ward off evil. Similarly, the African spurred tortoise (*Centrochelys sulcata*), encompassing its entire body, head, and shell, is

TABLE 2 Molluscs species and parts used for therapeutic purposes.

S/N	Common Name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	African giant snail	<i>Archachatina marginata</i>	Meat, shell, mucus	Weak bone, measles, stroke, fibroid, easy delivery, diabetes, hypertension, stroke, convulsion, fertility	Not evaluated
2.	Freshwater snail	<i>Bithynia tentaculata</i>	Whole body	Stroke	Least concerned

TABLE 3 Amphibian species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part used	Traditional uses	IUCN status
1.	European common frog	<i>Rana temporaria</i>	Whole body	For strong bones	Least concerned
2.	African common toad	<i>Bufo regularis</i>	Whole body	For strong bones, anti-poison, to stop bed wetting	Least concerned

TABLE 4 Insect species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	Honeybee	<i>Apis mellifera</i>	Whole, sting, feces	To treat pain, cough, cold, and rheumatism	Data deficient
2.	Common wasp	<i>Vespula vulgaris</i>	Whole, skin	To treat skin infections	Least concerned

employed as a remedy for poisoning and convulsions. Additionally, it is sought after for favor, protection, and even perceived enhancement of sexual vitality.

Avian species and parts used for therapeutic purposes

In traditional medicine, various birds and their components are employed for various health-related purposes, as outlined in Table 7. The complete body of the Senegal lark-heeled cuckoo (*Centropus senegalensis*) is utilized for stroke treatment. Different parts of the gray parrot (*Psittacus erithacus*), including its eggs, feathers, head, and entire body, address infertility in women, appease malevolent spirits, and reduce inflammation. The domestic pigeon (*Columba livia*), encompassing its flesh, feathers, and whole body, is incorporated in love potions and for treating paralysis. The spotted eagle owl's fresh head and complete body (*Bubo africanus*) alleviate dizziness, prevent accidents, and attract good fortune.

The flesh of the house sparrow (*Passer domesticus*) is thought to relieve weakness and fever, while the blood and flesh of the cattle egret (*Bubulcus ibis*) are utilized to treat dysentery. The quail (*Coturnix coturnix*), particularly its legs, head, and meat, is utilized in various traditional treatments to promote early walking in children, enhance memory, and improve sexual potency. Similarly, different parts of the common ostrich (*Struthio camelus*), including feathers, meat, head, legs, and eggs, address fertility issues, protect children against negative spiritual influences,

and alleviate asthma symptoms. The hooded vulture (*Necrosyrtes monachus*) is used in its entirety for a range of purposes, including the treatment of insanity and poor vision, protection against malevolent influences, enhancement of fertility in women, appeasing witches, and assisting in the search for marital partners.

Mammalian species and parts used for therapeutic purposes

Table 8 presents the mammals utilized in traditional medicine within the study area, illustrating species diversity with 21 identified for sale. The respondents reported that the whole straw-colored fruit bat (*Eidolon helvum*) and the striped mouse (*Lemniscomys striatus*) are used in treatments for stroke and to promote business success. Additionally, the complete bodies of the house mouse (*Mus musculus*), giant rat (*Cricetomys gambianus*), and cane rat (*Thryonomys swinderianus*) are believed to enhance fertility. Various parts of the pangolin (*Phataginus tricuspis*), including the head, scales, bones, tail, and female internal organs, are associated with various applications. These include spiritual protection and treating conditions such as rheumatism, financial rituals, convulsions, bleeding, male aphrodisiac effects, anemia, healing old wounds, managing strokes, and providing pain relief.

The entire body and meat of the squirrel (*Xerus erythropus*) are utilized to treat convulsions. At the same time, the African grass rat (*Arvicanthis niloticus*) is known for its effectiveness in alleviating stomach pain. The skin of the crested porcupine (*Hystrix cristata*),

TABLE 5 Fish species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	Electric fish	<i>Malapterurus electricus</i>	Whole, bones, fins	To treat infertility in both men and women, retentive memory	Least concerned
2.	African catfish	<i>Clarias gariepinus</i>	Whole, bones, fins	To treat infertility in both men and women, rituals and rheumatism	Least concerned
3.	Snakehead	<i>Parachanna obscura</i>	Whole, bones, fins	To treat infertility in both men and women	Least concerned
4.	African knife fish	<i>Xenomystus nigri</i>	Whole, bones, fins	To treat infertility in both men and women	Least concerned
5.	Redbelly tilapia	<i>Tilapia zilli</i>	Whole, bones, fins	To treat infertility in both men and women	Least concerned

TABLE 6 Reptilian species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	African spurred tortoise	<i>Centrochelys sulcata</i>	Whole body, head, back	Used as an anti-poison, also used to treat convulsion, for protection, to seek favor, and for sexual enhancement	Endangered
2.	Nile monitor	<i>Varanus niloticus</i>	Whole body, skin	To treat tumors and liver diseases, anti-poison, to treat pain, and protection against evil influences and manipulation	Least concerned
3.	Common green iguana	<i>Varanus varus</i>	Whole body	Used to treat fever, pain, and ulcer, for protection, to boost business	Least concerned
4.	Nile crocodile	<i>Crocodylus niloticus</i>	Whole body, head, tail	Weakness and rheumatism, preventing evil	Vulnerable
5.	Agama lizard	<i>Agama</i>	Whole body	Epilepsy, cough, sore throat, convulsions	Least concerned
6.	Gaboon viper	<i>Bitis gabonica</i>	Whole body, head, fat, shed skin, tail, flesh	To treat paralysis, stroke, skin infection, easy delivery, pain, convulsion eye infection, and cancer	Least concerned
7.	African rock python	<i>Python sabae</i>	Whole, head, fat, tail	Protection against evil, wealth, broken bone	Near threatened
8.	Senegal chameleon	<i>Chamaeleo chamaeleon</i>	Whole body	Used for magic power, anti-poison, to cure pain and tumor	Least concerned

when combined with other herbs, serves as a fortifying agent. Various parts of the common fox (*Vulpes pallida*), spotted hyena (*Crocuta crocuta*), African civet (*Civettictis civetta*), and bushbuck (*Tragelaphus scriptus*) are employed to address ear diseases, fulfill spiritual needs, provide protection, and treat strokes, respectively. Furthermore, the penis, skull, and head of the gorilla (*Gorilla gorilla*) are esteemed as potent sex enhancers and antidotes. Lastly, the serval cat (*Leptailurus serval*) is believed to be effective in treating skin diseases, warding off evil influences, serving as an aphrodisiac, and attracting good fortune.

The African buffalo (*Syncerus caffer*) head and lion (*Panthera leo*) fat and skin are reported to be employed in traditional medicine

for treating conditions such as strokes, keloids, pain, and tumors, respectively. As observed in Figure 3, the skull, head, and forearm of Sclater's monkey (*Cercopithecus sclateri*) are utilized for their protective qualities against accidents, aiding in the treatment of bone fractures and assisting in the pursuit of marital partners. Similarly, the patas monkey's head, forelimbs, and hind limbs (*Erythrocebus patas*) are believed to offer protection against mishaps and are thought to enhance good fortune. Additionally, the bones and horn of the African savanna elephant (*Loxodonta africana*) are used to promote growth and treat skin infections, while fat derived from wild boars (*Sus scrofa*) is applied in the treatment of paralysis, joint pain, burns, and fractures.

TABLE 7 Avian species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	Senegal lark-heeled cuckoo	<i>Eremophila alpestris</i>	Whole body	To treat stroke	Least concerned
2.	Gray parrot	<i>Psittacus erithacus</i>	Egg, feathers, head, whole body	To treat infertility in women, to appease witches, to treat inflammation	Endangered
3.	Domestic pigeon	<i>Columba livia</i>	Flesh, feather, whole body	For making love concoctions and treating paralysis	Least concerned
4.	Spotted eagle-owl	<i>Bubo africanus</i>	Fresh head, whole body	To cure dizziness, for the prevention of accidents, and for fortune rousing	Least concerned
5.	House sparrow	<i>Passer domesticus</i>	Flesh	To cure weakness and fever	Least concerned
6.	Cattle egret	<i>Ardeola ibis</i>	Blood, flesh	To cure dysentery	
7.	Quail	<i>Coturnix</i>	Leg, head, flesh	To make treatment for a child to walk early, to enhance memory, and to improve sexual power	Least concerned
8.	Common ostrich	<i>Struthio camelus</i>	Feather, flesh, head, leg, egg	To treat fertility, to protect children from bad spirits, to treat asthma	Least concerned
9.	Hooded vulture	<i>Necrosyrtes monachus</i>	Whole body	To cure insanity, and poor vision, to protect against evil influences, fertility for women, for appeasing witches, seeking marital partners	Critically endangered

Discussion

Demographic characteristics of traditional medicine vendors

The research reveals that most participants involved in this trade were female, accounting for 67.3% of the sample. This finding is consistent with a study conducted in Ogun State, which found that 95% of traditional medicine traders were women (Soewu and Ayodele, 2009). Similarly, a research by Adebowale et al. (2021) in Ikire, Osun State, Nigeria, indicated that 55.9% of the respondents were female. This highlights the gender roles in the illegal trade of wildlife derivatives in Nigeria. Typically, men are solely responsible for hunting wildlife in the forest at night due to the effort required. They then bring the hunted animals out for women to sell during the daytime (Ijose, 2018). Regarding age distribution, the largest group of respondents (43.7%)

fell within the 41–60 age range, while 39.4% were in the 21–40 age range. This pattern indicates that the traditional medicine vendors in the study area comprise various age groups, with a significant number in their productive years. This raises concerns, as their active age status could lead to continuing this behavior over time. It aligns with Soewu's (2008) observation that using wild animals in traditional medicine is prevalent across all ages and genders.

A notable percentage of the respondents were married (67.9%), with a majority adhering to the Muslim faith (51.5%). The high proportion of married traders suggests that many serve as heads of households or bear financial responsibilities that may influence their involvement in the wildlife trade. This observation is consistent with findings from Osunsina et al. (2022), who identified similar trends. The educational background of the respondents varied, with 38.2% having completed primary education and 37% having attained secondary education. Literacy levels may affect the respondents' perspectives on natural

TABLE 8 Mammalian species and parts used for therapeutic purposes.

S/N	Common name	Scientific name	Part/product used	Traditional uses	IUCN status
1.	Straw-colored fruit bat	<i>Eidolon helvum</i>	Whole body	To treat stroke	Near threatened
2.	Striped mouse	<i>Hybomys trivigatus</i>	Whole body	To boost business	
3.	Pangolin	<i>Manis tricuspis</i>	Head, scale, bones, tail, internal female organs	For the treatment of spiritual protection, rheumatism, financial rituals, convulsions, bleeding, aphrodisiac for men, anemia, healing of old wounds, fertility for women, stroke, and pain	Vulnerable
4.	Giant rat	<i>Cricetomys gambianus</i>	Whole body	Used for fertility	Least concerned
5.	Squirrel	<i>Funisciurus pyrrhopus</i>	Whole body, meat	To treat convulsion	Least concerned
6.	House mouse	<i>Mus musculus</i>	Whole body	Used for fertility.	Least concerned
7.	Cane rat	<i>Thryonomys swinderianus</i>	Whole body	Used for fertility	Least concerned
8.	Crested porcupine	<i>Hystrix cristata</i>	Skin	Used for fortification	Least concerned
9.	African grass rat	<i>Arvicanthis niloticus</i>	Whole body, meat	To treat stomach pain	Least concerned
10.	Common fox	<i>Canis spp.</i>	Whole body, bone, meat	Treatment of ear diseases	Least concerned
11.	Spotted hyena	<i>Crocuta</i>	Whole body, leg, head, bone	Spiritual purpose, To fight witches	Least concerned
12.	Gorilla	<i>Gorilla</i>	Penis, skull, head	Sexual enhancement, anti-poison	Critically endangered
13.	Serval cat	<i>Leptailurus serval</i>	Skin, carcass, male organs, head	Skin diseases, protection against evil influence, aphrodisiacs, fortune rousers	Least concerned
14.	African buffalo	<i>Synecerus caffer</i>	Head	To treat stroke	Near threatened
15.	Lion	<i>Panthera leo</i>	Fat, skin	Keloids, pain, tumor	Vulnerable
16.	Sclater's monkey	<i>Cercopithecus sclateri</i>	Skull, head, forearm	Prevention of accidents, bone fractures, and seeking marital partners	Endangered
17.	Patas monkey	<i>Erythrocebus patas</i>	Head, fore and hind limbs	For the prevention of accidents, fortune rousers	Near threatened
18.	African savanna elephant	<i>Loxodonta africana</i>	Bone, horn	Stunted growth, skin infection	Endangered
19.	African civet	<i>Civettictis civetta</i>	Whole, leg, head, meat	Protection	Least concerned
20.	Bushbuck	<i>Tragelaphus scriptus</i>	Whole, leg, head	Stroke	Least concerned
21.	Wild boar	<i>Sus scrofa</i>	Fat	Used to treat paralysis, joint pain, burns, and fractures	Least concerned

resource conservation. In this situation, the ongoing involvement in the illegal wildlife trade for traditional medicine persists mainly because most vendors lack access to advanced education. This educational gap deprives them of vital information about the serious consequences of the continuous exploitation and trade of wildlife on the environment. This reinforces Osunsina's (2010) argument that individuals with higher educational attainment are more likely to support and engage in conservation efforts and species justice endeavors.

The variety of fauna species found in the study area

Figure 2 showcases examples of wildlife products available for purchase in the market. Much like this study, numerous investigations have underscored the importance of zootherapy in various rural communities throughout Nigeria. The trade in traditional medicinal mixtures is widely embraced among the Yoruba population in Ogun State, as evidenced by this research. Traditional medicine vendors identified 49 animal species in their day-to-day trading activities, surpassing the figures reported in similar studies by Abubakar et al. (2015). In comparison, research conducted in Puna and the semi-arid region of northeastern Brazil recorded approximately 17 and 25 species, respectively (Hernandez et al., 2015).

A study conducted in Ethiopia found that approximately 23 animals and/or their parts are utilized in traditional medicines by the Degu tribes in the Tigray region (Kendie et al., 2018). A similar investigation at the Bode Wildlife Market also documented 33 different species (Adebowale et al., 2024). The species identified in this survey comprise two molluscs,

two amphibians, two insects, five fish, eight reptiles, nine birds, and 21 mammals. This showcases a remarkable diversity of wild animals employed in unjustifiable traditional medicine, underscoring the strong cultural significance of these practices in the region and prompting the vendors to intensify their hunting and sourcing activities to satisfy this growing need. This trend aligns with the findings of Ijose (2018), who observed that the rising commercial demand for wildlife products has led to excessive harvesting, further endangering already threatened species. However, the increasing demand for such products substantially threatens vulnerable wildlife species and weakens species' justice advocacy.

Traditional utilization of molluscs and its conservation implications

The research underscores the potential of snails in addressing various health issues, including hypertension, facilitating smoother childbirth, managing convulsions, and enhancing fertility. Bonnemain (2005) points out that snails are often linked to femininity and fertility, with traditional beliefs suggesting that they can expedite delivery, combat female scrofula, and, when prepared appropriately with milk, offer therapeutic benefits for conditions such as spasms associated with spitting blood in tuberculosis and the burning sensation linked to nephritis. Furthermore, snails play a crucial ecological role in nutrient cycling and the maintenance of soil health. However, excessive harvesting from their natural environments disrupts ecosystem balance, adversely affecting soil fertility and biodiversity. The slow reproductive rate of certain snail species renders them particularly vulnerable to overexploitation.



FIGURE 2
Body parts of birds displayed for sale in the study area. Source: field survey, 2022.



FIGURE 3

Body parts of mammals displayed for sale in the study area. Source: field survey, 2022.

Utilization of fish in traditional medicine and its conservation implications

The presence of fish as a less prominent species in the study area can be attributed to its inland location, with a notable absence of large bodies of water such as rivers, lakes, or coastlines. As a result, fishing does not play a significant role in the region's economy. However, the literature highlights the importance of utilizing fish and their by-products in medicinal formulations, as [Ehinmore and Ogunode \(2013\)](#) noted. The study revealed that several fish species are recognized for their effectiveness in treating various illnesses within traditional medicine—for example, all the bodies, bones, and fins of *Parachanna obscura*, *Xenomystus nigri*, and *Tilapia zilli* are employed to address infertility issues in both men and women. *Clarias gariepinus* is particularly significant in treating infertility for both genders, and it is also utilized in rituals and to alleviate rheumatism. According to [Orilogbon and Adewole \(2011\)](#), practitioners of traditional medicine, fish farmers, and herbal vendors widely acknowledge the varied applications of *Clarias* in traditional healing. This includes its role in treating numerous ailments and its involvement in sacrifices, rituals, festivals, and ceremonies.

The *Malapterurus electricus* fish is thought to play a role in enhancing memory and promoting mental well-being. Incorporating fish into traditional medicine significantly influences healthcare delivery systems within communities. This

underscores the heavy reliance on traditional therapies during illness, especially in the absence of Western medical treatments ([Zhang and World Health Organization, 2000](#)). However, despite their recognized medicinal value, the overexploitation of certain fish species raises serious conservation concerns. Issues such as overfishing, habitat destruction, and pollution have led to declining freshwater fish populations, with some already classified as vulnerable or near threatened. Species like *Parachanna obscura* and *Xenomystus nigri* are increasingly at risk due to habitat degradation and unsustainable harvesting practices for both consumption and traditional medicine use.

Reported uses of amphibians in traditional medicine and conservation concerns

Using animals and their body parts for medicinal purposes dates to ancient times ([Mishra et al., 2011](#)). Anurans, including frogs and toads, have played a significant role in materia medica ([Satiro et al., 2024](#)). The chemical secretions produced by these amphibians benefit human health, exhibiting antibacterial, antiprotazoal, and various therapeutic properties ([Zahari et al., 2017](#)). The skin secretions of many anurans, including frogs and toads, contain peptides known for their antibacterial effects ([Gupta et al., 2017](#)). Research indicates that *Rana temporaria* is recognized as a vital component in formulating remedies to improve bone strength. Similarly, *Bufo regularis* is acknowledged to contribute to bone health and is used as an anti-poison remedy believed to prevent bedwetting effectively.

According to [Govender et al. \(2012\)](#), extracts obtained from the scraped skin secretions of the giant leaf frog (*Phyllomedusa bicolor*) are utilized in Chinese folk medicine to treat conditions such as depression, stroke, seizures, and cognitive decline related to diseases like Alzheimer's. While frogs and toads possess significant medicinal properties, overharvesting these species for traditional medicine poses a significant threat to their survival. This observation is supported by [Phaka et al. \(2025\)](#), who highlighted that amphibians are among the most endangered vertebrate groups globally, with their populations declining due to habitat loss, climate change, pollution, and diseases such as chytridiomycosis. The unregulated collection of these species exacerbates the situation, pushing some closer to extinction.

Utilization of insects in traditional medicine and associated conservation concerns

The extensive use of honeybees, specifically *Apis mellifera*, to treat coughs and colds is a widespread tradition among Nigerian tribes. Individuals willingly undergo bee stings annually, believing that it contributes to maintaining good health ([Carpena et al., 2020](#)). Furthermore, the venom extracted from bees is sometimes injected into individuals dealing with rheumatic pain and arthritis. Bees and their by-products are undeniably among the most utilized insects for therapeutic purposes ([Kwon et al., 2021](#)). Due to their extensive

use, a chemical analysis of bees' composition and venom has been conducted to assess their antibacterial and anti-arthritis properties (Meyer-Rochow, 2017).

Similarly, the common wasp (*Vespula vulgaris*) addresses skin infections. These practices align with the findings of Jugli et al. (2020), who reported the utilization of honey from bees and wasps for treating coughs and colds and remedies for spider bites and allergies among the Wancho and Tangsa tribes, respectively. Flanjak et al. (2024) reported that excessive collection of honey, beeswax, and venom can weaken bee colonies, making it harder for them to reproduce and maintain healthy populations. Since bees play a crucial role in pollinating wild and cultivated plants, their decline has a ripple effect on biodiversity. If these threats continue, the loss of bees could reduce crop yields and harm the overall health of ecosystems.

Traditional utilization of reptiles: implications for wildlife conservation

The research uncovered the utilization of eight reptile species in traditional medicine, with these species occasionally being sold in their entirety but more commonly being dissected into various parts such as flesh, skin, tail, eyes, head, tooth, cloaca, fat, rattle, and carapace. Notably, a single reptile can provide a diverse array of raw materials. The harder components, including bones, snake rattles, and skin, are typically sun-dried, grated, and crushed to form a powder. This powder is often consumed as a tea or incorporated into meals. Alternatively, the fat and oil derived from these reptiles can be ingested or applied topically as ointments, depending on the ailment being treated (da Nóbrega Alves et al., 2008).

In Nigeria, animal products play a significant role in cultural ceremonies, traditional rituals, and pharmacopeia, as elucidated by Leo Neto et al. (2009). Animals and their various parts are employed as charms to ameliorate or address various conditions—for instance, the Senegal chameleon (*Chamaeleo senegalensis*) is highly sought after for its believed magical properties, anti-poison attributes, and its alleged ability to alleviate pain and tumors. This aligns with the research conducted by Alves et al. (2012c), affirming that the entire Senegal chameleon is used to confer invincibility upon the recipient, protecting against adversaries or enchantments. However, the overharvesting of *Chamaeleo senegalensis* for traditional medicine and rituals has caused a decline in its population, putting it at risk of disappearing from local areas. Because chameleons depend on their camouflage and slow movements to stay safe, they are especially vulnerable to overexploiting (Stuart-Fox et al., 2006).

Additionally, reptiles and their components serve as offerings to appease and invoke spirits and ancestral deities—for example, the head of the African python (*Python sebae*) is employed for invocation and safeguarding against witches. These findings resonate with the work of Alves et al. (2012b). According to Muhammad et al. (2022), fats derived from pythons are predominantly used to address issues such as scars, rheumatism, back pain, burns, and waist pain. However, *Python sebae* is already

classified as “near threatened” by the IUCN due to habitat destruction and overhunting for its skin and meat. The continued use of its body parts in traditional medicine exacerbates its population decline, further threatening its survival in the wild. The excessive harvesting of reptiles for traditional medicine decreases their population and disrupts their important roles in nature—for example, snakes help control rodent populations, while chameleons are key in keeping insect numbers in check. If overexploitation continues, it could trigger a chain reaction in the ecosystem, harming biodiversity and destabilizing the environment (Dufour et al., 2022; Morton et al., 2021).

Conservation challenges in the use of birds for traditional medicine

Nine bird species are currently available in the markets, with offerings including various body parts like the whole body, flesh, head, leg, and eggs for therapeutic purposes. Notably, the procurement of vital organs from specific species involves the sacrifice of the entire animal. This practice places immense pressure on avian populations, leading to substantial declines in their numbers and disrupting the ecological balance. The prevailing socio-cultural practices among the indigenous people have contributed to a pronounced decrease in the population of avian species, irrespective of their body organs and therapeutic value. Continuous harvesting of these birds for traditional medicine exacerbates the decline of already vulnerable species, potentially pushing some toward local or even global extinction (Adegbola et al., 2024).

It is imperative to underscore that some of the identified bird species fall into categories such as least concerned, endangered, and critically endangered according to the IUCN Conservation Status Classification. Harvesting endangered or critically endangered species speeds up their decline, making recovery more difficult and risking biodiversity and species endeavors. Removing birds from their natural habitats can also disrupt food chains, hinder seed dispersal, and disturb ecosystem balance, further threatening their survival. Promoting species justice advocacy at all levels is essential to address these challenges and reduce overdependence on excessive wildlife harvesting for traditional medicinal practices.

Reported uses of mammals in traditional medicine and conservation concerns

All of the mammalian species identified for sale in this region are indigenous. Interestingly, mammals appear to be more prominently utilized compared to other species. This preference might stem from the shared characteristics between humans and mammals, suggesting that certain traits can be replenished in humans when deficient due to illness. This discovery underscores the significance of local biodiversity in traditional medicine, aligning with the observations of Alves and Rosa (2006), who noted that the faunal composition, accessibility, and availability

directly shape the types of zootherapeutic products traded in a particular region.

However, procuring animals from the wild and markets poses a serious conservation concern, as excessive and unregulated harvesting can lead to population declines and local extinctions. Poorly regulated collection practices can potentially contribute to the extinction of endangered species, as highlighted by El Hajj and Holst (2020). Many species mentioned exhibit multiple uses and are employed in treating various ailments—for instance, different body parts of *Bitis gabonica* are utilized to address paralysis, stroke, and skin infections, facilitate easy delivery, alleviate pain, manage convulsions, treat eye infections, and combat cancer. *Python sebae*, specifically the whole body, head, fat, and tail, protects against evil and wealth and mends broken bones. *Chamaeleo chamaeleon*, when used as a whole body, is believed to confer magical powers and anti-poison properties and is utilized in treating pain and tumors. *Varanus varus* is employed to treat fever, pain, and ulcers as well as for protective purposes and to enhance business prospects.

Conclusion

This study highlights the incessant overexploitation of wildlife species in traditional medicine across southwestern Nigeria and its significant negative effect on species justice advocacies. The findings show that various animal species, including some that are classified as vulnerable or endangered, are actively traded for their perceived medicinal benefits. However, the unregulated nature of this trade poses a serious threat to conservation, as continuous exploitation could lead to population declines and even extinction. To address this issue, species justice advocacy and effective policy development are urgently needed to regulate wildlife harvesting, trade, and use in traditional medicine.

The government should prioritize the enforcement of existing wildlife protection laws by providing the necessary resources and authority to the agencies responsible for their implementation. This includes equipping these agencies with advanced technologies, training personnel adequately, and increasing funding for conservation efforts. Non-governmental organizations (NGOs) should mobilize several species justice movements nationwide. By doing so, it would rest assured that these regulations are not merely words on paper but are actively enforced to combat the threats facing wildlife. Strengthening collaboration between governmental bodies, local communities, and conservation organizations will also be crucial in fostering a comprehensive approach to wildlife conservation, ultimately leading to a significant and positive impact on biodiversity preservation and ecosystem health. Public awareness, species justice campaigns, and educational programs should also be introduced to inform traditional medicine practitioners, traders, and consumers about the environmental consequences of unsustainable wildlife use. These initiatives should also promote ethical and scientifically backed alternatives to ensure biodiversity conservation and the rational continuity of traditional healing practices.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The animal study was approved by the Department of Forestry and Wildlife Management at the College of Environmental Resources Management, Federal University of Agriculture, Abeokuta, Nigeria. The study did not involve the handling or use of live animals. The research methodology focused on conducting interviews and surveys with vendors and traditional practitioners to gather insights into the fauna species commonly used in medicinal practices. All data collection was carried out with full respect for participants' privacy and cultural beliefs. Participation in the study was entirely voluntary, and informed consent was administered and obtained from each participant before their involvement. Each participant signed a consent form confirming that they understood the study's purpose, agreed to participate voluntarily, and acknowledged their right to withdraw from the study at any time without any consequences. The study was conducted in accordance with the local legislation and institutional requirements.

Author contributions

TA: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. OI: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. BI: Conceptualization, Methodology, Project administration, Resources, Visualization, Writing – original draft. OA: Conceptualization, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. OO: Conceptualization, Methodology, Supervision, Validation, Visualization, Writing – review & editing. IO: Conceptualization, Resources, Supervision, Validation, Visualization, Writing – review & editing. AS: Data curation, Formal Analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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EDITED BY

Jamie K. Reaser,
Smithsonian Conservation Biology Institute
(SI), United States

REVIEWED BY

Timothy C. Haas,
University of Wisconsin–Milwaukee,
United States

*CORRESPONDENCE

Stephanie E. Klarmann
✉ steph.klarmann@live.co.za

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Delineating the environmental justice implications of an experimental cheetah introduction project in India

Yashendu C. Joshi¹, Stephanie E. Klarmann^{2,3*}
and Louise C. de Waal²

¹Department of Conservation Science, Centre for Wildlife Studies (CWS-India), Bengaluru, Karnataka, India, ²Blood Lions Non Profit Company (NPC), Gansbaai, South Africa, ³Department of Psychology, University of Johannesburg, Johannesburg, South Africa

Project Cheetah in Kuno National Park was initiated to establish a population of African cheetahs in India due to the Asiatic subspecies' extinction in the country since the 1950s. The project has received criticism from international conservationists for lacking conservation and scientific merit. Conservationists, particularly from India and South Africa, have raised concerns regarding the ecological criteria guiding its decision-making and concerns regarding a lack of scientific evidence in addition to potential political motivations. The concerns raised by the international community suggest that the project may not solely focus on conserving the African cheetah, which is classified as "Vulnerable" by the International Union for Conservation of Nature (IUCN), but could be guided by other agendas outside of conservation. Several cheetahs have died in the project's couple of years, raising ethical concerns regarding the cheetahs' welfare and high mortality rates demonstrated thus far, in addition to the perceived unjust social impacts on local stakeholders. In this perspective piece, we use Project Cheetah as a case study to exemplify broader issues applicable to rewilding and restoration projects that necessitate attention by proponents and authorities responsible for issuing the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) import and export permits.

KEYWORDS

cheetah relocations, environmental justice, ecological justice, legal wildlife trade, evidence-based decision-making, African cheetah, India

Introduction

Project Cheetah has so far introduced 20 African cheetahs (*Acinonyx jubatus*), eight from Namibia in September 2022 and 12 from South Africa in February 2023, into Kuno National Park (KNP), Madhya Pradesh, India (Chellam, 2023; Qureshi et al., 2024). The project aims to establish a viable population of African cheetahs since the Asiatic subspecies went extinct in India in the 1950s (Rai et al., 2020). Most cheetahs were released into free-

ranging habitats, except for six adults remaining in soft-release bomas (SRBs). However, in July–August 2023, all free-roaming cheetahs were returned to the SRBs for health reasons (Qureshi et al., 2024). To date, 17 cubs have been born in SRBs; however, the project has experienced high mortality rates (40.0% adult mortality and 29.4% cub mortality) (Qureshi et al., 2024). The remaining 12 adult cheetahs and 12 cubs live in captivity, and currently, no cheetahs exist in KNP's extensive wild systems (Chellam, 2024). However, in December 2024 Indian media reported the release of a male coalition of two cheetahs (<https://theprint.in/india/multiple-sightings-of-cheetah-vayu-roaming-the-streets-in-mps-sheopur-days-after-release-from-kuno/2418973/>). It is projected that establishing a viable cheetah population could take 30–40 years, with an average of 12 cheetahs imported from southern Africa every year to support population growth and account for high mortality (Marnewick et al., 2023; Ranjitsinh and Jhala, 2010).

The project has been criticized for lacking conservation and scientific merit specifically regarding the ecological criteria guiding its decision-making (Gopalaswamy et al., 2022; Singh, 2022; Wachter et al., 2023) and doubts about its scientific evidence and potential political motivations (Gopalaswamy et al., 2022; Shahabuddin, 2015). Criticisms suggest the project may not solely focus on the conservation of an International Union for Conservation of Nature (IUCN) “Vulnerable” classified species but could involve other agendas (Shahabuddin, 2015), including an alleged request from Namibia that India withdraw its ban on ivory trade (Perinchery, 2022). Furthermore, ethical concerns have been raised regarding the cheetahs' welfare and high mortality rates (Chellam, 2023; Marnewick et al., 2023) and the perceived unjust social impacts on local stakeholders (Kabra, 2003; Mahalwal and Kabra, 2023), including a lack of consultation and transparency (Chellam, 2023). We argue that Project Cheetah exemplifies broader issues applicable to rewilding and restoration projects that necessitate attention by proponents and authorities responsible for issuing the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) import and export permits. The high costs of this experimental project are estimated between USD 50 and 60 million, which arguably may be utilized for *in situ* conservation (Marnewick et al., 2023) or social upliftment.

Since the Kunming-Montreal Global Biodiversity Framework was established, there has been a global push toward equity and justice in protecting biodiversity. The framework refers to the disproportionate effects of conservation initiatives and biodiversity loss on marginalized communities and indigenous people. Additionally, there is a significant movement to recognize injustices committed against non-human species (Winter and Schlosberg, 2023), including animals in the global wildlife trade (Afana, 2022; Collard, 2013; Wyatt et al., 2021). It is well-established that the illegal trade is detrimental to animals' welfare (Sollund, 2013; Wyatt et al., 2021), but more attention is required to recognizing injustices in the legal trade (Baker et al., 2013) along the full supply chain from source to destination. In the case of Project Cheetah, alarms have been raised that animals exported from Southern Africa to India have experienced unjust treatment, bringing attention to compromised animal welfare, in addition to the unjust social implications for local and indigenous communities surrounding KNP.

We demonstrate that translocations of African cheetahs to India for restoration purposes have not adequately accounted for ethical considerations and face several social and species justice concerns. The lack of research on animal welfare in the legal trade of wild animals needs to be addressed (Wyatt et al., 2021), and we call on conservationists to give comprehensive consideration to the social and animal welfare implications of translocation work. The cheetah translocations to India present further challenges, including differences in climate, prey species, and habitat that African cheetahs need to adapt to (Marnewick et al., 2023; Singh, 2022) and the potential human–wildlife conflict for communities not accustomed to the presence of cheetahs (Gopalaswamy et al., 2022; Marnewick et al., 2023). We, therefore, assess the social and species justice considerations in not only relocating human communities from KNP to accommodate cheetahs in an experimental relocation attempt but also intercontinental species translocation.

We analyze these considerations through distributive, procedural, and recognition justice lenses (Schlosberg, 2007; Lenzi et al., 2023; Schaafsma et al., 2023), which have been applied to marginalized people but may also be applied to non-human species (Martin et al., 2016; Schlosberg, 2007, 2014), with the inclusion of recognizing dignity, values, and identities (Martin et al., 2016). We reviewed reports prepared for the translocation of Asiatic lions and African cheetahs to KNP. We discuss the implications of relocating local communities and social justice issues in conservation work, both generally and specific to KNP's local communities. We use these inputs to consider ethical and justice implications for translocated animals and relocated peoples in terms of 1) methodological considerations for decision-making and 2) normative considerations regarding the project's justification. We conclude by relating this case to the broader issue of rewilding and restoration work, which have become important conservation strategies globally.

Justice and methodological concerns

KNP is a biodiverse region of 784 km² situated in the Central Indian Vindhyan Hills and was initially selected for the reintroduction of Asiatic lions, a long-term translocation program that was due to commence in 2008 (Johnsingh et al., 2007) and, more recently, as the relocation site for African cheetahs. Between 1999 and 2001, 5,000 people from 24 villages were displaced for planned Asiatic lion reintroductions (Sharma, 2003), which did not occur as the Gujarat state government was reluctant to release lions to another state (Shahabuddin, 2015; Chellam, 2023; Gopalaswamy et al., 2022). Subsequent discussions among Indian government officials, state forest departments, and researchers led to the decision to introduce African cheetahs instead, pending a report on potential introduction sites, including KNP, requested by the Ministry of Environment and Forests (Ranjitsinh and Jhala, 2010).

Evaluating the 2010 report's methodology, justice shortcomings become evident. Surveys were conducted at prospective sites to assess factors including “economic well-being”, “sources of livelihood”, and “perceptions about wildlife”. No questions were posed to respondents; instead, a well-being index was calculated using visual assessments of interviewees' age, sex, attire condition,

quality/quantity of ornaments/wristwatches, and transportation (Ranjitsinh and Jhala, 2010). These subjective assessments were weighted to calculate an index determining which populations may accept compensation. This disparity led to distributive injustice where socio-economic impacts, distribution of benefits, and burdens of conservation efforts are markedly unequal (Bennett et al., 2017; Mkono, 2019). This could have been mitigated by recognizing diverse values, understanding potential inequitable impacts, and focusing on historically burdened groups.

The report neglected social issues like attitudes toward relocation, exotic species introduction, project acceptance, and perceived risks and benefits. Instead, it focused on identifying economically and socially disadvantaged targets for monetary incentives. Statements like, “The people residing in the forested areas outside KNP are poor and backward and a good compensation package ... would be irresistible” (p. 96) suggest that they were deemed susceptible to one-off compensation. This lack of community engagement can lead to disenfranchisement and exacerbate existing power imbalances (Kashwan, 2016; Anderson et al., 2022). Such language raises concerns regarding the ethics and motivations of research potentially tailored to support displacing local communities, leading to unjust outcomes, such as “conservation refugees” (Hoeftle, 2020; Snodgrass et al., 2016). These practices highlight procedural injustice, as the representation and inclusion of relevant actors are overlooked during the valuation and execution phases. Addressing this issue involves meticulous assessment of the degree to which affected communities and stakeholders with diverse worldviews, especially marginalized groups, are engaged in the planning, execution, and monitoring of relocation projects (McLean and Stræde, 2003). It is crucial to establish institutionalized mechanisms for community feedback and grievance redressal, fostering equitable and sustainable relocation processes.

Background studies regarding the human costs/benefits could draw upon established tools, such as Living Standards Measurement Study, encompassing the dependence on natural resources (Burdge, 1987; Grosh and Glewwe, 1995) to have a holistic understanding of what was at stake in these decisions. Furthermore, greater emphasis could be placed on non-marketed products and contextual information (Angelsen et al., 2012) and on examining livelihood resilience post-relocations (Quandt, 2018). Contextual information can be determined by understanding cultural, religious, traditional, demographic, socio-political, and governmental aspects of a landscape (Agrawal and Angelsen, 2009; Cundill et al., 2012) that go beyond relying on quantitative surveys alone (Milton, 1985; Cundill et al., 2012).

A recent report used in a case adjudicated by the Indian Supreme Court failed to conduct any social surveys (Centre for Environmental Law vs Union of India & Ors, 1995; Supreme Court allows introduction of African Cheetah in India, 2020; Jhala et al., 2021). The report suggested a “rapid assessment” of potential sites surveyed in 2010 within a few days; the methodology for assessing “Anthropogenic Activities” was unclear; some sites discussed only linear infrastructures and industrial pressures without mentioning local communities, while others ignored industrial impacts (Jhala et al., 2021). The Cheetah Action Plan deemed KNP the most suitable site, noting previous village relocations for Asiatic lion

reintroductions; however, it lacked mention of preparing remaining communities for the arrival of cheetahs (Jhala et al., 2021).

Equally, concerns have been raised regarding ecological considerations prior to the arrival of the cheetahs in KNP (Wachter et al., 2023). Since the project’s inception, eight adults and five cubs have died due to kidney failure, fighting injuries, extreme heat and humidity, and skin infections due to fly strike (PTI, 2024; Naveen, 2023), highlighting the difficulties in adapting to their new environment.

Problematic social justifications

An argument presented by Van Der Merwe (2023) is that the predominantly Hindu culture advocates tolerance toward animals and reduces the risk of human–wildlife conflict. However, there are fundamental flaws in this argument, and conservation researchers should exercise caution when employing culture-specific terminology and generalizations without well-grounded research (Sheil and Wunder, 2002). It is essential to understand the underlying reasons why individuals in certain regions may tolerate negative wildlife encounters. We need to challenge the assumption that only Hindu communities reside around KNP and understand that other communities may experience human–wildlife conflict. Even within Hindu communities, attributing tolerance exclusively to religion would be simplistic.

Local traditions and beliefs may influence people’s willingness to coexist with wildlife. Local communities often have deep connections to indigenous wild animals, viewing them through the lens of their multigenerational cultural belief systems (Henning, 1998; Torri and Herrmann, 2011; Kreye et al., 2017) and traditionally acquired ecological knowledge (Agnihotri et al., 2021), which form the basis of their understanding of avoiding or rationalizing negative encounters.

Human–animal relationships in a diverse country like India are based on complex webs of socio-ecological systems (Barua et al., 2013; Margulies and Karanth, 2018). It is unfounded to assume people would tolerate potential human–wildlife conflict with cheetahs. Hence, researchers must apply more forethought and avoid generalizations regarding this intricate web of relationships.

Relying on generalizations to justify translocations and delineate protected land demonstrates little appreciation of the human dimension of conservation, often resulting in recognition or epistemic injustice (Bennett et al., 2017; Brittain et al., 2020; Lenzi et al., 2023). This risks overlooking diverse knowledge systems and values, the complex relationships people have with nature, their perceptions of wildlife, and consent to bear the consequences of such initiatives. This oversight could be addressed by identifying and formally recognizing all relevant actors representing different knowledge systems, worldviews, and values and granting them institutional rights and structures to articulate their perspectives in inclusive, sensitive, unbiased, and intersectional dialogues (Pretty et al., 2009; Martin et al., 2016). Engaging in intersectional dialogue has the potential to recognize and acknowledge the ways in which those in power and those without intersect with relational contexts to promote human rights,

plurality, and diversity (Adami, 2013), which we argue is a necessary condition in relocations of local and indigenous communities when implementing conservation projects.

Problematic species injustices

African cheetah populations are under significant pressure with approximately 6,500 mature individuals remaining in the wild. The translocation of a “Vulnerable” species to India raises concerns about ecological and species injustices, particularly regarding welfare, mortality, and risks associated with their intercontinental translocation.

As part of Project Cheetah, all cheetahs were initially released into nine SRBs ranging in size from 0.5 km² to 1.5 km². SRBs are frequently restocked with live prey, mostly captive-bred chital, and are predator-free. Four cheetahs died in an SRB within 6 months of arrival, and two females have never left the SRBs, as they had cubs (National Tiger Conservation Authority et al., 2023). All other pregnant females have been returned to the SRBs, and since July–August 2023, all remaining free-roaming cheetahs were also returned to these bomas (Qureshi et al., 2024). The SRB conditions are far from the KNP free-ranging conditions, where cheetahs roam on average 4.3 km per day, in home ranges up to 5,441 km² (National Tiger Conservation Authority et al., 2023). Cheetahs are generally susceptible to stress, in particular, associated with the capture of free-ranging animals (Braud et al., 2019). The KNP cheetahs have not only been transported intercontinentally, but they are regularly subjected to veterinarian interventions, including more than 90 chemical immobilizations (Qureshi et al., 2024). Hence, one can question the long-term impact on their physical and mental welfare, especially considering their long-term existence in captive conditions. Furthermore, live prey is released in what may be classed as “unnatural confinement and exposed to the danger of immediate attack with no recourse”, as was ruled in a case by the Supreme Court of Appeal of South Africa (National Council of Societies for the Prevention of Cruelty to Animals (NSPCA) v Openshaw, 2008).

The translocation of African cheetahs to KNP has shown several welfare-associated risks, including stress, trauma, and adaptation failures (Qureshi et al., 2024), leading to adult survival rates of 60%, which falls far below the average 85% survival rate for reintroductions in South Africa’s metapopulation (Marnewick et al., 2023). The KNP survival rates are likely to decrease further when all cheetahs are free-ranging and encounter other large indigenous predators. We challenge conservationists to identify an ethically acceptable mortality rate for cheetah reintroductions and refrain from phrases like “successful reintroductions” when 40%–50% of the animals die. Project Cheetah’s shifting “acceptable” mortality rates reveal the lack of ethical considerations and accountability for species management failures (Jhala et al., 2021; Tiwari, 2022; Sehgal, 2023).

Furthermore, anecdotal reports of cheetahs being stoned by local villagers and harassment during sedation reveal the risks faced by cheetahs struggling to adapt or thrive post-release (Navajyoti, 2024; Marnewick et al., 2023; Saxena, 2023), highlighting the interplay of welfare, human–wildlife conflict, and conservation priorities. In December 2024, one of the males released into KPN was sighted multiple times in residential areas of Sheopur city, about 50 km from

his release site, demonstrating the real risks of human–wildlife conflict (<https://theprint.in/india/multiple-sightings-of-cheetah-vayu-roaming-the-streets-in-mps-sheopur-days-after-release-from-kuno/2418973/>).

Prioritizing justice-informed and evidence-based decision-making

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) highlights that environmental knowledge is produced through cultural frames of reference, and local and indigenous knowledge systems are fundamental to understanding the diverse ways people relate to the natural environment (Díaz et al., 2018). We argue displacements and relocations disregard the three dimensions of justice, namely, distribution (who bears the costs and benefits), procedure (participation in decision-making), and recognition (respecting cultural differences and identities) (Martin et al., 2016; Schlosberg, 2007), and the importance of indigenous knowledge systems and relationships with nature, prioritizing external knowledge over that of local inhabitants.

The consequences of species relocation projects that lack ecological and social dimensions demonstrate the need for robust, scientifically grounded, and locally accepted conservation strategies. Poorly planned community relocations present several issues, including disruption of societal structures, akin to forced land reform (Kabra, 2003). Attention has grown to understanding enduring mental and emotional challenges and place attachment (Bott et al., 2003; Cundill et al., 2017; Rangarajan and Shahabuddin, 2006; Tuck and McKenzie, 2015). Communities within forests hold sentimental connections to land and non-human inhabitants. Beliefs and traditions intertwine with their experiences in nature. Over time, relocations exert repercussions on the mental health of those who closely identify with their culture and surrounding land and animals (Schmidt-Soltau, 2003; Ratnam, 2017; Mathew, 2019).

Fundamental problems may affect those relocated from places like KNP, including inadequate land quality, lack of irrigation water, and insufficient livestock fodder (Kabra, 2003; Sharma, 2003). Importantly, these problems are differentiated by class, caste, age, and sex (Kabra, 2020). Many people in KNP abandoned larger livestock in the forest due to resource scarcity during the initial Asiatic lion reintroduction attempts (Kabra, 2003). The research underscores the profound bond between rural residents and livestock (Vignesh, 2022), making abandonment traumatic, with no mitigating efforts from project managers.

Community relocation may on occasion be deemed necessary for medical, educational, law enforcement, or conservation reasons (Kabra, 2003; Karanth and Bhargav, 2005), but we argue for a justice-informed execution. Through justice-informed engagement, relocation may not always be necessary, depending on residents’ preferences and needs. Such decisions should not rely on surveys that fail to capture complex human attachments to place. Short- and long-term consequences of relocations demand meticulous consideration, necessitating well-planned community engagement. It is imperative to acknowledge people’s profound connections to land and relationships with the forest and non-human species.

Literature increasingly reflects on injustices extending to non-human species (Kotzé, 2019; Meijer, 2023). The cheetah translocations to KNP present ethical concerns by experimenting with a “Vulnerable” species and knowingly subjecting animals to substantial stress, existential risks, and mortality (Marnewick et al., 2023) by disregarding their spatial ecology (Wachter et al., 2023). The injustice to wild animals involved in the wider legal wildlife trade, including for conservation purposes, necessitates critical reflection and cost–benefit analysis for individual animals, the species and on the ecosystem level. We need to challenge the way in which we measure conservation successes that go beyond measuring ecological processes of birth and death but also gauge impacts on an animal’s physical, physiological, and mental health.

To achieve transformative and effective conservation outcomes, it is necessary to incorporate diverse values of nature (Lenzi et al., 2023). Schaafsma et al. (2023) provided a useful set of recommendations embracing justice in the design of studies that assess people’s values of nature. Furthermore, the IPBES Values Assessment provides practitioners and decision-makers with a comprehensive understanding of the pluralistic ways in which people conceptualize and value nature to inform sustainable and just means of protecting biodiversity. Conservation practices that prioritize respect, inclusivity, and justice are more likely to have positive outcomes for people and nature (Pascual et al., 2022). Such practices also prevent conflict among stakeholders and loss of scientific credibility (Lenzi et al., 2023).

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

YJ: Conceptualization, Data curation, Investigation, Project administration, Resources, Writing – original draft, Writing – review & editing. SK: Conceptualization, Data curation, Investigation, Project administration, Writing – original draft, Writing – review & editing. LdW: Data curation, Investigation, Writing – original draft, Writing – review & editing.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY

Jean Hugé,
Open University of the Netherlands,
Netherlands

REVIEWED BY

Helen Uchenna Agu,
University of Nigeria, Nsukka, Nigeria
Michael Gilek,
Södertörn University, Sweden

*CORRESPONDENCE

Jamie K. Reaser
✉ Reaserjk@asi.edu

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Advancing the science of environmental justice in the international wildlife trade pathway: summary for CITES policy makers

Nicholas King¹, Gunārs Platais² and Jamie K. Reaser^{3,4*}

¹Research Unit for Environmental Science & Management, North-West University, Potchefstroom, South Africa, ²University of Colorado Boulder, Mortenson Center in Global Engineering & Resilience, Boulder, CO, United States, ³Smithsonian National Zoo and Conservation Biology Institute, Front Royal, VA, United States, ⁴Smithsonian-Mason School of Conservation, Front Royal, VA, United States

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Context and significance

One of the primary aims of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is to foster environmental justice by regulating international wildlife trade. The agreement aims to protect species vulnerable to extinction, peoples reliant on wildlife for their lives and livelihoods, and ecological systems worldwide (CITES n.d). Thus, CITES provides a framework for its 183 member states to jointly implement a comprehensive approach to environmental justice, which we define to include social justice, species justice, and ecosystem justice. This article serves as a summary for CITES policy makers, highlighting key findings, observations, and recommendations arising from the Frontiers in Conservation Science's Research Topic, Advancing the Science of Environmental Justice Along the International Wildlife Trade Pathway. The summary is intended to empower CITES parties to more deliberately and strategically mainstream environmental justice in CITES policies and procedures.

For the first time, conservation scientists were invited to contribute to a collection of transdisciplinary research, perspectives, and case studies meant to inform development of an environmental justice framework serving international wildlife trade scientific inquiry, policy, and planning. In the spirit of environmental justice, manuscript publication fees were sponsored through a grant from the Smithsonian Institution's Life on a Sustainable Planet initiative. This facilitated a unique wealth of contributions from scientists, veterinarians, and natural resource managers typically hindered by publication costs. It brought the conceptual conversation to the ground and the frontlines of environmental justice challenges in international wildlife trade. The voices in the collection primarily arise from scholar-practitioners in Africa, Asia, and Latin America (Reaser et al., 2025). The key findings and recommendations offered here are informed and inspired by the Research Topic manuscripts but have been generalized to support policy decision making across a

wide range of socio-ecological norms. We strongly encourage review of the entire Research Topic to gain an understanding and examples of context-specific priorities, points of view, and issue nuances.

Key findings and observations

Globally, wildlife trade is increasing, both within countries and across borders. This appears to be especially true of illegal wildlife trade, with growing quantities of wildlife and wildlife derivatives seized by authorities due to the unlawful possession and trading of protected species (Arroyo-Quiroz et al., 2025; Saito, 2025). However, the regulatory regime is not keeping pace with the growth in the sector, both legal and illegal (Green, 2025; Mukanganwa, 2025). Lack of international coordination, as well as data standards and data sharing frameworks (Arroyo-Quiroz et al., 2025; Carpio-Domínguez et al., 2025), hinder the vastly more comprehensive controls required (Kolby and Goodman, 2025). Post-seizure management practices are hopelessly *ad hoc*, uncoordinated, and lack conservation and welfare considerations. This is especially a concern for countries of origin, which generally lack the resources to effectively implement whatever regulatory frameworks do exist at national and subnational levels (Saito, 2025). The subnational movement of wildlife is often unregulated and occurring outside of surveillance frameworks, making assessment and intervention particularly challenging (Adebowale et al., 2025; Carpio-Domínguez et al., 2025; Mukanganwa, 2025; Zanzo, 2024). The gaps and weaknesses in international wildlife trade regulation foster readily apparent injustices at the species level that extend to the ecosystems from which the wildlife has been derived (Arroyo-Quiroz et al., 2025; Joshi et al., 2025). Social justice implications are more complex and include such issues as the impacts of corruption on societal dynamics, increases in the risk of zoonotic disease outbreaks, and disparities in access and benefit sharing (Carpio-Domínguez et al., 2025; Green, 2025; Joshi et al., 2025; Mukanganwa, 2025; Olunusi, 2024).

To date, wildlife trade has been viewed as an economic endeavor. Regulatory frameworks have thus had a 'commodities' lens, being focused generally on aspects of production and consumption, on the sustainability of supply and demand in terms of impacts on the conservation of traded species (Arroyo-Quiroz et al., 2025). However, the international wildlife trade is fundamentally a network of interacting people and non-human animals. Regulatory effectiveness needs to place value on human lives and livelihoods, as well as the health of individual animals and the ecological systems to which they belong. As demonstrated by the case studies herein focusing on bushmeat (Olunusi, 2024) and game meat trades (Mukanganwa, 2025), the trade dynamics for wildlife-derived meat are complex and attentiveness to context-specific socio-ecological factors is key to fostering fair, equitable, sustainable, humane, and just wildlife trade practices. Yet, thus far, CITES largely operates from the perspective of business transactions; it has demonstrated little cognizance of environmental justice concerns. This is especially true of the illegal wildlife trade, where CITES primarily seeks to

curtail the negative economic externalities, rather than frontline environmental justice. Whilst it is acknowledged that effectively managing sustainable wildlife use is enormously challenging, the awareness, resources allocation, and enforcement to date - across all jurisdictional levels - lags far behind what is required for the scientific, evidence-based approach needed to develop and implement regulatory regimes that are both fair and effective (Carpio-Domínguez et al., 2025; Mukanganwa, 2025; Saito, 2025).

Opportunities to improve environmental justice along the international wildlife trade pathway are many (Arroyo-Quiroz et al., 2025). For example, youth are a critical stakeholder group underrepresented in wildlife trade decision-making. Despite some progress to date, youth engagement falls well behind both the recognition of the need for, and growing engagement in, other key policy sectors such as climate change. More meaningful youth engagement has significant potential to improve understanding and incorporation of environmental justice for a legal and sustainable wildlife trade (Anagnostou et al., 2025). Likewise, there is a need to more explicitly consider gender-based social injustices in the international wildlife trade (Arroyo-Quiroz et al., 2025; Olunusi, 2024). The case studies from these articles underscore how environmental justice requires attention to both procedural fairness and outcomes for people, species, and ecosystems. For example, enforcement strategies that overlook community voices (Carpio-Domínguez et al., 2025), benefit-sharing schemes that exclude traditional users (Adebowale et al., 2025; Green, 2025; Zanzo et al., 2024), and post-seizure animal handling that ignores welfare concerns (Saito, 2025) reflect injustices at multiple levels. Likewise, the work of Green (2025) highlights how colonial legacies persist in the dominance of Western scientific norms over local knowledge systems.

Illegal wildlife trade is an environmental, economic, and social problem that threatens global public health and is one of the main drivers of biodiversity loss on a global to local scale (Arroyo-Quiroz et al., 2025; Green, 2025; Mukanganwa, 2025). The international wildlife trade regulatory regime, currently led by CITES, would benefit from philosophical, moral, and practical updating. The authors in this Research Topic point the way for the framework to be re-envisioned through a multi-faceted environmental justice, conservation, and sustainable use lens, evolving beyond the dominant economic supply-and-demand lens. This resetting of values is especially needed to address the growing volumes of seizures of live animals when considering how to address animal welfare, zoonotic disease risks, and conservation imperatives. It is also urgently required for rewilding and restoration projects involving live animals, where utilization of CITES import and export trading permits can prove to be logistical barriers to achieving wildlife conservation aims.

Practical recommendations

There is an urgent need to build national capacities across several environmental justice dimensions. The following recommendations are intended to provide a way forward for CITES Parties to constructively advance the science and practice

of social justice, species justice, and ecological justice in the international wildlife trade context.

A. Actionable recommendations for CITES Parties:

- Codify environmental justice principles in CITES procedures, including stakeholder consultation and community impact assessments for listing decisions and enforcement.
- Improve the coordination, data standards, and data sharing serving wildlife trade regulatory frameworks. Rapid adoption of digital technologies is essential to keep pace with the sector's scale.
- Promote and support more meaningful youth engagement and gender equity, especially within wildlife trade governance processes.
- Establish ethical standards for post-seizure care of live animals, including options for rehabilitation, repatriation, or sanctuary, with species and ecosystem justice top of mind.
- Develop justice-sensitive enforcement training modules that incorporate procedural and distributive justice.
- Integrate environmental justice indicators in national reporting, including outreach on the role of CITES in fostering environmental justice.
- Support co-production of knowledge, considering both traditional ecological knowledge and science in regulatory processes.
- Facilitate the sharing of original research and case studies in scientific, peer-reviewed literature by scientist-practitioners working at the frontlines of environmental justice challenges associated with the wildlife trade.
- Continue exploring the role of CITES in zoonoses risk mitigation with the intent of safeguarding lives and livelihoods, thereby fostering environmental justice.

B. Motivators for implementation of the recommendations

Motivating the implementation of these recommendations will require a mix of conventional and innovative incentives. Traditional levers include:

- Financial incentives: Donor funding, climate or biodiversity finance mechanisms, and economic aid packages can be tied to measurable progress on justice-oriented wildlife trade governance.
- Reputational benefits: CITES Parties may be motivated by international recognition, improved credibility, or leadership in conservation diplomacy.
- Legal compliance and risk mitigation: Stronger environmental justice provisions help reduce the risk of social conflict, legal challenges, and non-compliance penalties.
- Combatting corruption and organized crime: more stringent regulatory frameworks together with improved collaborative multi-party data and information sharing help reduce corruption and curtail organized crime activities within the illegal wildlife trade pathway.

In addition, innovative approaches can offer complementary motivations:

- Empowerment through education and capacity-building: As seen in protected area contexts, awareness campaigns and participatory training programs can shift perceptions and foster community stewardship.
- Alternative livelihood development: Offering viable economic pathways aligned with conservation goals can foster behavioral change and reduce dependence on illegal or unjust trade practices.
- Youth and community engagement platforms: Platforms for co-design and dialogue—especially with marginalized or underrepresented groups—can generate ownership and co-benefits across social and ecological dimensions.
- Integrating justice outcomes into performance metrics: Embedding justice-related indicators into monitoring and evaluation systems can drive sustained institutional commitment.
- Cross-sectoral coalitions: Linking environmental justice with broader agendas—such as public health, indigenous rights, combatting corruption and organized crime networks, and sustainable development—can open new pathways for advocacy and resource mobilization.

These motivators, taken together, offer a robust strategy for overcoming inertia and enabling transformative change toward environmental justice in the governance of international wildlife trade.

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NK: Writing – review & editing, Writing – original draft. GP: Writing – original draft, Writing – review & editing. JR: Conceptualization, Funding acquisition, Project administration, Writing - original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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