

RESEARCH



Beyond saving lives: Political ecology, animal welfare, and the challenges of wildlife rehabilitation in Costa Rica

Sarah Coose^{1,*}, Bastian Thomsen^{2,3,4,5}, Tamsin Dodsworth², Florian Eckl^{2,3}, Jennifer Thomsen⁶, Roger Such⁷, Sebastian Guardia-Uribe⁸, Daniel A. Villar^{1,9} and Andrew Gosler¹

Abstract

Wildlife rehabilitation in Costa Rica is a deeply complex and often precarious endeavor, shaped by the intersection of local socio-political realities, environmental pressures, and the inherent limitations of the centers themselves. These factors not only challenge the governance of wildlife conservation but also profoundly affect the daily lives of the staff and the nonhuman animals they care for (hereafter animals for simplicity). This ethnobiology study is a doctoral pilot study but is also an extension of a longitudinal study led by the second and fifth authors that commenced in 2021. This pilot study explores the lived experiences of veterinarians, staff, and animals in two prominent wildlife rehabilitation centers in Costa Rica. Findings provide insights into the ways external socio-political-ecological forces intertwine with the everyday practices of animal care in wildlife rehabilitation centers. This research was conducted over 2-weeks in late 2024, with approximately 65 hours of participant observation and 39 in-depth interviews with veterinarians, volunteers, and staff. Through immersive ethnographic fieldwork, data were gathered through participant observation, semi-structured and unstructured interviews, and archival data. Data were recorded daily using field notes, which were later coded and analyzed. The primary focus of this pilot study was to understand the quotidian realities of resource constraints, emotional labor, ethical dilemmas, and team dynamics, while also considering the broader cultural, political, ecological, and environmental factors that shape the rehabilitation process. Three key thematic findings emerged from this ethnographic pilot study: (1) operational challenges due to resource restraints and the complexities of communication and teamwork within the centers, (2) ethical tensions practitioners face when balancing compassionate care with institutional limitations, and (3) effects of sociopolitical forces and how well-intentioned policies, while aimed at protecting wildlife, often result in unintended negative consequences for individual animal welfare. This research underscores the layered complexities of wildlife rehabilitation and suggests the need for a more integrated approach from an ethnobiology lens that accounts for institutional goals and individualized care. This study demonstrates how ethnographic findings can inform biological research in a positive methodological feedback loop, where the logical next steps should be to carry out biological research that focuses on animal behavior (ethology) and measurable indicators of stress (e.g., through cortisol analysis) to better assess animal welfare conditions at each phase of the wildlife rehabilitation process.

Keywords: ethnobiology, ethno-ornithology, multispecies relations, political ecology, veterinary medicine, ecosystem governance, conservation, animal welfare, One Health, One Welfare

Introduction

As you walk through the tropical property, gated fences clearly separate the long-term enclosures dedicated to the animals that cannot be released and those in hospital isolation. Once in the private hospital space, multiple secluded cages hold patients in need of medical care. These cages include animals eligible for release and those that are unable to be ethically released back

into the wild but will survive their injuries yet are not ready to be moved into long-term enclosures.

One of the animals in the care of the sanctuary was a young spider monkey (*Ateles geoffroyi*) who had sustained electrical burns to both of her front hands, a common injury due to exposed electrical wires within the forest. One of her hands was so badly affected that although the skin had healed, she had lost dexterity and partial

Author Affiliations: ¹Department of Biology, University of Oxford, Oxford, UK; ²Strategy, Innovation, & Entrepreneurship Discipline, The University of Sydney Business School, Sydney, Australia; ³The Sydney Environment Institute, University of Sydney, Sydney, Australia; ⁴School of Anthropology & Museum Ethnography, University of Oxford, Oxford, UK; ⁵Emerging Scholar Research Fellow, The University of Sydney Business School, Sydney, Australia; ⁶College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO, USA; ⁷Jaguar Rescue Center, Punta Cocles, Costa Rica; ⁸Centro de Rescate Animal Costa Rica, Turrúcares, Costa Rica; ⁹Department of Anthropology, Durham University, Durham, UK

*Corresponding Author: Sarah Coose. Email: sarah.coose@biology.ox.ac.uk

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ability to maneuver normally. From a medical and rehabilitation perspective, it was a logical decision to keep her in an isolated cage temporarily as she recovered due to her limited ability to defend herself or escape harm, even in the long-term spider monkey enclosure. However, anytime someone would approach her cage she would extend her arm through the iron until someone connected with her. When I passed her for the first time, I could not resist and instinctually extended my hand simultaneously.

We sat there for a few moments as I stroked her arm and admired her. The first time I tried to pull away so that I could continue with the daily tasks of taking care of the many animals, she vocalized loudly and reached out as far as the bars would allow. This time when I took her hand, she also extended her prehensile tail, wrapping it tightly around my forearm. Before I knew it, so much time had passed that another worker brought me a chair. We sat touching, but in complete silence for over an hour. At one point, she reached out with her free hand and touched my hair and face. Out of curiosity, I brought my face closer to her enclosure and as I did, she began “grooming” me with both her hands while her tail stayed securely wrapped around my forearm.

It became clear to me then that although this isolation was likely the best practice for her medically, she was craving contact and companionship. Tears swelled in my eyes as I was unsure of how to provide her the ongoing intimacy she needed. It is common practice to limit human contact to these wild animals as it can impede their survival rates once released back into the wild. However, this monkey could not ethically be released due to her extensive injuries. This raises the question, what more can be improved from a mental health approach for these individuals?

The vignette opening by the author and veterinarian JT highlights a central challenge in wildlife rehabilitation, namely, the intersection of conservation goals and animal welfare. Therein lies an apparent dichotomy. Conservation efforts typically prioritize safeguarding species and ecosystems, often at the cost of individual animals (Clay and Visseren-Hamakers, 2022), whereas animal welfare focuses on the needs of individual animals, which frequently conflicts with the broader ecological goals of biodiversity conservation (Paquet and Darimont, 2010). The case of the spider monkey highlights this dilemma within wildlife rehabilitation centers, where rehabilitation “best practices” require temporary isolation, but the monkey’s evident psychological distress prompts the need to reassess ethical care at each phase of the wildlife rehabilitation process (Willette *et al.*, 2023).

This study examined the effects of external constraints (social, political, economic, and ecological) on wildlife rehabilitation and its role in conservation and animal welfare. This doctoral pilot study is an extension of a longitudinal study that began in 2021 and focuses on wildlife rehabilitation centers in Costa Rica from the perspective of ethnobiological and veterinary medicine. Costa Rica was chosen as the focal point for the study because of its perceived reputation of pro-wildlife laws and policies, shifting social attitudes that consider wildlife intrinsically valuable, and its focus on ecotourism, which combines conservation and socio-economic factors (Thomsen *et al.*, 2023). However, in practice, socio-political and socio-ecological dynamics manifest differently than laws or policies suggest. This underscores the importance of evaluating the efficacy of wildlife rehabilitation and release practices and how macro-level factors, such as bureaucratic requirements for release, influence how wildlife veterinarians operate.

To evaluate the efficacy of wildlife rehabilitation practices and the welfare of long-term animal residents, it is critical to consider what “success” means in a wildlife rehabilitation setting. Rather than measuring success through the popular live-release metric, which is calculated by the number of individuals treated and released compared to the number who died of their wounds or were humanely euthanized (Molina-López *et al.*, 2017), wildlife rehabilitation must balance operational, ethical, and sociopolitical challenges while ensuring that released and long-term care animals experience

the highest quality of life. Moving beyond anthropocentric ideals of success that primarily measure live release rates, this study ethnographically demonstrates how social findings can inform biological questions and hypotheses, such as the need to study animal welfare biologically at each stage of the rehabilitation process. The following sections place this ethnobiological study within the conservation and animal welfare literature, before turning to how these methods informed key thematic findings and future research directions. It suggests biological questions and methods for wildlife rehabilitation researchers and practitioners to engage with post-ethnography, including the logical next steps of SC’s doctoral fieldwork.

CONSERVATION AND ANIMAL WELFARE

Animal welfare concerns and conservation goals frequently collide to create difficult moral conundrums. Ironically, conservation management often involves killing individuals of one species, usually predators or competitors, for the benefit of another species (Fulton and Ford, 2002). For example, in Australia, the widespread killing of feral species (e.g., rabbits and foxes) is generally accepted because of their significant effects on agriculture and native ecosystems. However, growing evidence suggests that some native species can pose threats to endangered or declining species (Fulton and Ford, 2002). These practices are not limited to fauna but extend to flora. For example, in 1983, the Food and Agriculture Organization (FAO) of the United Nations introduced *Prosopis juliflora* in Kenya to fight deforestation and desertification and to provide fodder and livelihood support (Mwangi and Swallow, 2008; Tabe-Ojong, 2023). However, plants spread uncontrollably and destroy wetlands, encroach on farmlands and rangelands, decrease pasture productivity, and cause flooding and livestock deaths (Alvarez *et al.*, 2019; Mbaabu *et al.*, 2020; Choge *et al.*, 2022). Satellite data have shown that its coverage has expanded rapidly, resulting in over 30% land cover change (Mbaabu *et al.*, 2019). This invasive spread led to conflicts between conservationists and local rural communities, some of whom sued the government in 2005 over lost grazing land (Little, 2019; Tabe-Ojong *et al.*, 2021). A well-intentioned conservation strategy has devastating consequences for both biodiversity and human livelihood.

Management of invasive alien species (IAS) is one of the most contentious areas of conservation-justified killing. IAS are frequently implicated in the decline of native species. For instance, invasive European Starlings (*Sturnus vulgaris*) outcompete native cavity-nesting birds in North America, contributing to their population decline (Koenig, 2003). Similarly, invasive lionfish (*Pterois volitans* and *Pterois miles*) in the Florida Keys have caused significant damage to coral reef ecosystems and native fish populations (Ruttenberg *et al.*, 2012). However, the classification of a species as invasive is not always straightforward.

Some species, initially labeled as invasive, have even grown to become ecologically significant in their introduced environments. For example, *Lantana camara*, an invasive plant in India, was originally introduced to provide firewood and protect native scrub vegetation. Over time, it has become a critical food source for insectivorous and frugivorous birds during the dry season, demonstrating its ecological role in supporting native avian communities (Deshwal, 2019; Deshwal *et al.*, 2022). The case of the Nine-banded Armadillo (*Dasypus novemcinctus*) further illustrates the complexity of species classification. This neo-native species is naturally expanding its range northward, a process accelerated by climate change. Different US states classify it variably – as invasive, a pest, or a nuisance – while others struggle to determine its appropriate designation. Despite lacking formal legal protections, research suggests that Nine-banded Armadillos provide ecological benefits to local wildlife (DeGregorio *et al.*, 2022; DeGregorio and Deshwal, 2025). These examples highlight the nuanced nature of invasive species management, underscoring the need for context-specific approaches that consider both conservation priorities and the evolving ecological roles of introduced species. Bliss *et al.* (2023)

state that “invasive alien species (IAS) contribute to biodiversity loss, yet animals deemed invasive are both part of biodiversity and individuals themselves.” (p. 26).

This creates a fundamental tension for global environmental politics, where biodiversity conservation goals that focus on species and ecosystem protection clash with ethical animal welfare considerations for the individual animals involved (Bliss *et al.*, 2023). These dilemmas extend to conservation breeding programs, zoo management, and wildlife rehabilitation, where interventions designed to achieve broader ecological objectives may come at the expense of individual welfare (Clay and Visseren-Hamakers, 2022). Escobar-Ibarra *et al.* (2021) emphasize that integrating welfare considerations into conservation efforts is essential for ethical and effective outcomes. Their research highlights the importance of behavioral research, enriched environments, and multispecies interactions in improving conservation results. For example, captive breeding, which prioritizes naturalistic enclosures and social integration, leads to higher breeding success and prepares individuals for potential reintroduction into the wild. To achieve both conservation and welfare objectives, institutions should adopt a holistic approach that integrates ecological principles, behavioral science, and veterinary care (Escobar-Ibarra *et al.*, 2021).

Resolving the tension between conservation priorities and animal welfare requires a fundamental shift in measuring conservation success. Future efforts must embrace interdisciplinary approaches that incorporate scientific, ethical, and social perspectives to ensure that conservation is not “successful” if it comes at the expense of unnecessary suffering. To develop a pluralistic approach to biodiversity conservation and animal welfare (see Thomsen *et al.*, 2022), the fields of political ecology, health, and welfare should provide interdisciplinary insights into theoretical ground ethnobiological studies of wildlife rehabilitation.

POLITICAL ECOLOGY, ONE HEALTH, AND ONE WELFARE

Political ecology is an interdisciplinary field that examines the relationship between environmental changes and social, political, and economic factors. It provides a critical lens for examining the bio-cultural-political complexities of human-environment relationships, recognizing nature as a deeply humanized construct (Blaikie and Brookfield, 2015; Watts, 2017). Watts (2017) identified two primary theoretical streams that have shaped the evolution of political ecology: political economy, which links power distribution to capitalist production, and ecological analysis, which deepens the understanding of bio-environmental relationships (Watts, 2017). However, biopower imbalances frequently manifest in multispecies relations, particularly between local wildlife and humans, as particular human groups are often favored over marginalized individuals and groups in environmental politics (Neumann, 1992; Thomsen, 2022).

Despite the large number of wildlife rehabilitation centers worldwide and the crucial role they play in wildlife conservation, especially for threatened or declining species, they have been largely overlooked by the political ecology literature. Thus, rehabilitation centers often have poor funding or political support (Deem, 2024). This disparity reflects a broader misalignment between conservation policies and the tangible ecological and public health benefits provided by wildlife, which One Health perspective has addressed.

The One Health framework as we know it today, was originally developed in 2004 in response to the risk of zoonotic disease transmission to humans but has since expanded to encompass the broader interdependence of human, animal, and environmental health, proposing that health issues in one domain often reverberate across others (Zinsstag *et al.*, 2011; Evans and Leighton, 2014). One Welfare, a broader ethical framework that emerged as a critique of One Health’s anthropocentric roots, explicitly integrates animal and human well-being, beyond simply seeing animal well-being as a means of improving human health (Colonius and

Earley, 2013; Pinillos *et al.*, 2016). For example, the mental and physical health of veterinarians and their staff directly influence the quality of care provided to animals (Platt *et al.*, 2010). This holistic perspective is especially relevant in settings where human and animal lives are closely linked, such as wildlife rehabilitation, ecotourism, and agriculture (Mattson, 2020; Broz *et al.*, 2023).

Wildlife is essential for maintaining ecological balance, and species loss can disrupt vital ecosystem processes (Miller 2012). However, human activities and climate change continue to threaten wildlife populations (Miller *et al.*, 2023). Miller *et al.* (2023) reported that, on average, only approximately one-third of rehabilitated animals are successfully released into the wild. This indicates an inherent difficulty in wildlife rehabilitation. The World Health Organization’s One Health Initiative acknowledges the interdependence of environmental, animal, and human health (WHO, n.d.), reinforcing the need to incorporate wildlife rehabilitation into comprehensive conservation and public health strategies. One health and welfare study suggested that wildlife health is fundamental to both human and environmental well-being, necessitating greater public engagement and policy support (Deem, 2024). This aligns well with the work of Coolman *et al.* (2020) and Louv (2008), who emphasized the positive psychological and physical effects of human interaction with nature. Framing wildlife rehabilitation as a public health and ecological priority could enhance its political legitimacy, increase financial support, and improve wildlife rehabilitation outcomes.

WILDLIFE REHABILITATION AND RELEASE

Wildlife rehabilitation serves as a critical interface between conservation and animal welfare, embodying the ongoing tension between species-level preservation and well-being of individual animals. Traditionally, the success of rehabilitation efforts has been assessed using a binary lens: whether an animal survives or dies post-release (Wimberger *et al.*, 2010; Cope *et al.*, 2022; Willette *et al.*, 2023). However, this reductionist metric fails to account for the quality of life of animals both in captivity and after release (Speiran, 2025). Mellor’s (2016) concept of *A Life Worth Living* challenges traditional ideas about what constitutes animal welfare by advocating for welfare assessments that go beyond mere survival, emphasizing positive experiences and opportunities for animals to engage in natural behaviors so that they can not only live but thrive (Mellor, 2016). Rehabilitation programs that incorporate this approach strive to minimize distress, enhance environmental enrichment, and facilitate smoother transitions to the wild, ensuring that the released animals have the skills and resilience needed to navigate their natural habitats (Cope *et al.*, 2022; Speiran, 2025).

As this paradigm evolves, there is growing recognition of the need for animal-led welfare indicators rather than ethical frameworks solely rooted in humanist philosophy (Cope *et al.*, 2022; Speiran, 2025). Traditionally, animals have been viewed as passive subjects in conservation efforts, while the human stakeholders, such as governments, ecotourism operators, and conservationists, have been at the forefront of decision making processes (Sheppard and Fennell, 2019; Thomsen *et al.*, 2021; Thomsen *et al.*, 2022). However, emerging research calls for the assessment of animal well-being through physiological and behavioral cues, such as what animals *themselves* indicate through their stress responses, engagement with their environment, and social behaviors (Korte *et al.*, 2007). This field of study is known as ethology, and lies within the domain of biology.

For instance, measuring cortisol levels as an indicator of chronic stress; monitoring behavioral patterns that suggest psychological well-being or distress; and observing feeding, mating, and exploratory behaviors post-release may provide a more nuanced understanding of rehabilitation outcomes (Korte *et al.*, 2007). These metrics shift the focus from human-imposed standards of success to an evidence-based understanding of well-being from an animal’s perspective, at least scientifically, while still recognizing the paradox of not *yet* being able to fully understand an animal’s emotions, feelings, and thoughts through more

advanced interspecies communication. By integrating ethological assessments, rehabilitation programs can make informed, ethical, and effective decisions about when and how animals should be released, ultimately uniting conservation goals with animal welfare.

STUDY BACKGROUND

JRC

The JRC (acronym used for anonymity) is a wildlife rehabilitation center located on the Caribbean coast in a lush tropical rainforest. However, the jungle surrounding the center is increasingly being degraded by human development and tourist infrastructure (Adamson, 2024). This trend has increased significantly post-COVID driven in part by the rise in remote work (Adamson, 2024). As a result, veterinarians and staff at JRC have observed a marked increase in wildlife-human interactions, leading to a growing number of injuries among wild animals. This has resulted in a higher number of patients being brought into the center and has placed significant strain on staff and volunteers. Many long-time staff members, including the lead vet RS, have been forced to relocate further from the center because of the tripling of local housing prices.

Despite these challenges, JRC remains unwavering in their commitment to animal care. Walking through a tiny wooden gate, still damp from the previous tropical rainstorm, meets with smiles and positivity. Every volunteer and staff member inside has chosen to be there, united by the shared purpose of saving wildlife. The center cares for over 90 non-releasable animals, from flightless birds to confiscated exotic pets and victims of the illegal wildlife trade. Perhaps the most eerie addition to the center's collection is the humanized birds-parrots taught to speak English or Spanish. While some tourists are delighted and amused with their chatter from a biological standpoint, this highlights the deep and often unsettling impact that humans have on wildlife.

JRC is financially sustained by donations from approximately 30,000 tourists who visit annually alongside compulsory donations from volunteers before they start working. The government is also involved with the JRC, dropping off confiscated animals from the local area but providing no financial support to the frustration of the JRC's management. The JRC was founded decades ago by a pair of biologists, and the center has prioritized the development of its veterinary hospital, gradually accumulating advanced equipment such as an X-ray machine, surgery room, and sophisticated microscopes to become one of Costa Rica's most well-equipped wildlife hospitals. However, the organic growth of the hospital has left it cramped, forcing staff to constantly squeeze past one another while crossing paths to treat their numerous patients, which now exceeds 1000 annually.

At the time of observation, RS was the only paid veterinarian, but he was also responsible for training three European volunteer vets. With no permanent nursing staff, the RS has found himself performing multiple roles – hospital manager, head veterinarian, and primary consultant – for every issue, from misplaced supplies to emergency wildlife care. His workload was relentless, stretching from dawn until dusk, and he went straight for 2 years during COVID-19 without a holiday break. Despite its reputation as a well-established center, the JRC veterinary hospital operates under immense strain. Staff work tirelessly to ensure that every patient receives care, often improvising solutions because of the limited resources. Some standard Western veterinary protocols, such as maintaining fully sterile environments, performing operations in a dedicated operating theatre, or replacing broken anesthesia masks, are compromised due to resource constraints. Nevertheless, the large number of animals that were successfully saved and released into the wild is a testimony to the resilience and ingenuity of RS and his team.

CRARC

CRARC (acronym used for anonymity) is located in the center of Costa Rica, close to San José, and it follows a different operating

model. As a smaller volunteer-driven facility, CRARC maintains a more relaxed atmosphere and limits public access by offering only private tours. This results in a quieter, more intimate environment, embodying more of the “pura vida” lifestyle of Costa Ricans. Volunteers, primarily young Europeans and US Americans aged 18–35, pay to live onsite and contribute a few hours of work each day in exchange for food and accommodation. This model fosters a strong sense of community with volunteers bonding over social activities, such as playing cards or painting murals on the center's walls.

CRARC's veterinary hospital, although run by a single veterinarian, has an average of approximately 500 patients annually. With the support of a permanent vet nurse and a fraction of the caseload seeing maybe 2–3 new animals per day, the team could spend more time with each patient. However, the center's limited financial resources meant that advanced medical interventions were challenging. For instance, the team had to drive an hour in the car to a local small-animal veterinary clinic because they lacked appropriate equipment. The stark contrast between the JRC and CRARC underscores the diversity of wildlife rehabilitation approaches in Costa Rica. Both models contribute to conservation efforts, yet each faces unique challenges in balancing resources, staff well-being, and the ultimate goal of wildlife rehabilitation.

Methods

CONTEXT OF THE RESEARCH

This pilot study is a component of a larger longitudinal ethnobiological study that commenced in 2021. The overarching longitudinal, multi-sited, and multispecies ethnographic studies have focused on wildlife rehabilitation and release centers across Costa Rica because of its perceived reputation as a global leader in ecotourism and pro-wildlife attitudes and policies (Thomsen *et al.*, 2023). The primary aims of this study are summarized in Table 1.

In contrast, this article is the result of a doctoral pilot study that seeks to leverage the social components of bird rehabilitation and release to validate the need for (ethno) ethno-biological research on the topic and engender key hypotheses to be tested as part of an interactive feedback loop that is gaining traction in the ethnobiology literature (see Thomsen *et al.*, 2025). Subsequently, the biological results are anticipated to generate further social inquiries. Thus, this study employed an inductive, emic (perspective-taking), bottom-up approach to understand the context in which wildlife rehabilitation practitioners operate (see Creswell and Creswell, 2017; Thomsen *et al.*, 2023).

DATA COLLECTION AND ANALYSIS

This research used an ethnographic approach, a qualitative method in anthropology that studies cultures and social interactions through immersive observation and direct engagement (Howell, 2018). By spending extended time in a setting, conducting interviews, and recording detailed observations, ethnography prioritizes context, lived experience, and insider perspectives over numerical data (Howell, 2018). In this case, it also sheds light on animal welfare by capturing the firsthand experiences of caregivers, veterinarians, and volunteers in rescue centers rather than relying on abstract theories or standardized metrics.

Ethnographic data were collected at six wildlife rehabilitation centres through interviews, participant observation, and archival research. The overarching longitudinal study has now amassed more than 200 interviews over 3-plus years and obtained the required university ethics approval. For this sub-study, TD served as the SC's research assistant in the field, and SGU and RS were wildlife veterinarians and key collaborators based on the study's primary sites. Approximately 65 hours of participant observation was conducted over 2 weeks. SC and TD conducted 39 interviews and had additional 41 interactions with interlocutors. Five formal interviews were conducted (recorded) with veterinarians

and the center management. The remaining interviews were informally conducted using a mix of semi-structured questions and unstructured formats. Informal interviews were conducted during participant observation or with other volunteers and staff during the breaks. The use of unrecorded interviews is popular in ethnography, as interlocutors often provide more open and honest answers when they are not recorded through more natural conversations (see Burgess, 2003).

Data saturation occurred prior to the completion of the pilot study as the findings reaffirmed previous data collection in a longitudinal study (Guest *et al.*, 2006). SC and TD also use a popular ethnographic method to write highly detailed field notes. This allowed them to compare the findings and analyze their notes using thematic analysis and interpretation of the participant observation data (Creswell and Creswell, 2017). The thematic analysis produced three key themes.

1. Operational challenges and communication barriers
2. The effects of ethical dilemmas and compassion fatigue on care and welfare
3. Biocultural and sociopolitical effects on wildlife rehabilitation

The key findings of this pilot study are summarized in Table 2 and distinguished through a comparison of how each center's lead veterinarian operated. The three key thematic findings are presented after the table, followed by a discussion that includes a reflexive analysis of this pilot study as well as how these ethnographic findings inform the biological hypothesis of SC's doctoral thesis. This approach provides ethnobiologists with a methodological example of how ethnography and biology can serve as feedback loops without sacrificing the rigor of either method or discipline.

Results

KEY THEMATIC FINDING #1: OPERATIONAL CHALLENGES AND COMMUNICATION BARRIERS.

In wildlife rescue centers, caretakers constantly navigate the intersection of limited infrastructure and financial resources, which profoundly shapes day-to-day operations. For the RS, one of the most significant challenges was the lack of space, which disrupted the sanctuary's ability to function efficiently. "It's very difficult to get things done in such a tiny room...sometimes it's almost impossible to send an email because there are people constantly rushing in

Table 1. Overarching aims of the longitudinal study.

Aim	Description
Multispecies relations in wildlife rehabilitation	Examine how wildlife rehabilitation and release influence human attitudes toward wildlife (social aspects) and improve survival rates post-release (biological aspects).
Socio-economic dynamics and wildlife veterinary medicine	Investigate how economic factors impact wildlife veterinary care, including the balance between tourism revenue improving veterinary services versus overwhelming facilities due to excessive tourism operations.
Environmental governance and rehabilitation practices	Analyze how policies and governance structures shape wildlife rehabilitation and release efforts at local, regional, and national levels.
Cultural attitudes and their practical implications	Explore how shifts in cultural perspectives toward wildlife translate into tangible rehabilitation and release practices.
Socio-economic and socioenvironmental influences on rehabilitation outcomes	Assess how contextual factors, such as local economic and environmental conditions, affect the success of wildlife rehabilitation and release programs.

Table 2. Overview of the pilot study's key findings.

Key finding	Description	Examples from data
Operational challenges	Both SGU and RS face resource constraints, yet consistently work closely with their team to develop innovative solutions for animal care	<ul style="list-style-type: none"> • SGU pokes holes in a plastic tub and adds a heat lamp to create a makeshift nursery for baby birds. • RS uses an oxygen mask made from a 2-l Coke bottle top. • SGU and RS work closely with volunteers but wish communication were better. They also struggle with high turnover and the constant need to retrain new volunteers.
Ethical challenges	SGU and RS engage in emotional labor while making ethical decisions that balance animals' needs with available resources and medical options.	<ul style="list-style-type: none"> • SGU expresses excitement when his treatment method works and he is able to stimulate an iguana's appetite • RS expresses a resigned sadness at the death of a baby agouti after doing all he can to save it. • SGU decides against operating on a parrot's tumor after carefully considering the risks. • RS chooses to release a sloth early to make room for new arrivals in the clinic.
Sociopolitical challenges	Local cultural political factors cause increases in animal injuries and delays in providing timely animal care.	<ul style="list-style-type: none"> • SGU talks about delays waiting for animal release approval. • RS expresses frustration with the government's slow action on powerline insulation. • SGU criticizes the government for seeming to be pro-conservation while ignoring real sustainability issues. • RS is frustrated by gentrification increasing animal injuries due to infrastructure and tourists who claim to love the jungle but complain about its wildlife.

and out, with animals waiting everywhere”, he explained. His words convey the frantic pace of life in an overcrowded space where every task becomes a balancing act between caring for animals and working within the confines of the environment.

Under these constrained conditions, the absence of sufficient resources forced the staff and volunteers to continuously adapt and improvise. One example of this resourcefulness was the creation of a makeshift oxygen mask from the top of a 2-liter Coke bottle. Another example is a temporary nursery for orphaned birds fashioned from a perforated plastic tub using a heat lamp. These innovative solutions highlight the ongoing struggle to provide adequate care, despite the lack of conventional tools and funding. The experiences of both SGU and RS reflect the resourcefulness needed to meet the needs of animals despite these constraints. In this environment, necessity drives innovation; however, each solution is a temporary fix to the deeper systemic issue of underfunding. As SGU succinctly put it, “the reality of many rescue centers is we are very underfunded.” This paradox – the gap between the ideal care sought and the limited resources available – echoes findings from Thomsen *et al.* (2021), which also revealed that wildlife rescue centers in Costa Rica often face severe financial constraints. These limitations force caretakers to make difficult decisions about resource allocation, treatment, and rehabilitation priorities, shaping both the ethical dilemmas and practical challenges they face. This underscores the tension between the aspirations of wildlife rehabilitation and the economic and institutional realities that constrain it.

This scarcity was exacerbated by the high turnover rates and challenges in communication within the centers. As noted by SGU, “one of the challenges of working in such a place is that people are not usually trained”. He reflected on a time a volunteer contaminated a tub of disinfectant with a dirty cotton swab.

Once, I asked a guy to help me clean a wound, and he put the cotton swab into the wound and then mimicked the sound of a swab hitting liquid, “in the tub... like a double-dip, but much worse”.

This highlights the ongoing need for training and oversight as new volunteers often have little medical experience. This turnover leads to a time-consuming process that slows down operations and increases the potential for miscommunication during animal care. Even RS, who worked with an intern team of handpicked veterinary students from Europe, expressed the challenge of constantly training new interns. Since these interns typically stay for only 6 months, the most experienced person in the clinic can never have more than 6 months of experience, making it difficult to rely on them for consistency.

This cycle of constant training and repetition underscores the broader issue of internal communication in wildlife rescue centers, where the high turnover of volunteers creates a fragile operational environment.

The scarcity of permanent staff only intensified these challenges within the sanctuaries and placed a further burden on existing staff, who were forced to juggle multiple roles in an unpredictable and often chaotic environment. RS’s frustration with this was palpable, “everything is so disorganized...I do not have the time,” he confided, offering a glimpse into the exhaustion and stress that permeated the center’s daily routines. SGU echoed this sentiment, “things disappear, and it’s a nightmare, or they break...but if they break, at least someone tells me, so I am not counting on something that does not exist”.

With too few permanent staff members and a continuous flow of injured or orphaned animals, a high-traffic sanctuary must operate in a constant state of urgency. Despite these overwhelming challenges, caretakers continued to persevere, expressing both their frustrations and their resilience as one permanent non-veterinarian staff expressed, “we do the best we can with what we have”. This sentiment captures the spirit of endurance that defines

life in a rescue center, where passion and commitment are tested daily by the realities of under-resourcing and disorganization.

KEY THEMATIC FINDING #2: THE EFFECTS OF ETHICAL DILEMMAS AND COMPASSION FATIGUE ON CARE AND WELFARE

The ethical challenges encountered in wildlife rescue centers are intricately linked to the moral imperatives of conservation, rehabilitation, and the profound impact of human activity on the natural world. Sanctuary staff grapple with a paradox, celebrating each life saved while confronting the seeming futility in the face of widespread environmental destruction. This tension was powerfully articulated by RS after receiving a dead sloth showing visible signs of electrocution,

For every animal I save, four more die... This happens every day. We got this one, but imagine all the animals that die and are never reported... “Here, people worry about the mammals—the monkeys, the sloths—but worldwide, thousands of birds die...”

His words underscore the existential crisis facing wildlife rescuers: despite their tireless efforts, human-driven threats, deforestation, urbanization, and infrastructure expansion, continue to claim the lives of countless animals. Power lines, roads, and development projects carve through the jungle, leaving destruction in their wake.

This relentless life and death-cycle reflects deeper systemic issues within a country. RS critiqued wealthier expatriates who flocked to the region and were often unaware of the consequences of their lifestyles on the local ecosystems. He stated,

They want to live in the jungle but complain about the animals. They build houses with big windows, and birds fly into them. They report animals like they’re pests.

RS’s frustration reveals a fundamental contradiction, while many outsiders are drawn to the region’s natural beauty, their actions frequently disrupt the very ecosystems they so admire. This ethical contradiction raises significant questions about the role of human desires in shaping environmental outcomes and the capacity of rescue centers to advocate for both wildlife and local communities that depend on these ecosystems. The JRC exemplifies such a commitment to advocacy. Every animal that arrives dead from electrocution undergoes a thorough examination, with photos and necropsy reports documenting the cause of death. They gather evidence and report these deaths to the government in part of an ongoing effort to push for insulated powerlines, demonstrating how rescue centers can work not only to save individual animals but also to drive systemic change.

The ongoing environmental threats posed by human activity provide a stark backdrop for the ethical landscape of wildlife rescue. RS trailed off when commenting on the impact of power lines on birds of prey, “birds of prey, they open their wings, touch the wires, and then....” This captured the devastating consequences of the human-made infrastructure. His unfinished thought, trailing off into an unspoken sorrow, evoked the inevitability of death for many of these animals regardless of the sanctuary’s intervention.

Wildlife rehabilitation is emotionally taxing, as caretakers navigate a range of feelings from joy and fulfillment to grief and frustration. One participant shared,

The veterinary profession is often isolating, and people close to me sometimes struggle to understand what I’m dealing with. I think it’s because unless they are in the medical field, they do not understand the overwhelming responsibility of having a life in your hands. If I mess up in surgery, it can mean death. And that’s what keeps me up at night.

The emotional bonds formed with animals, particularly those requiring extended care, can lead to success and loss. SGU experienced a profound sense of relief when iguana (*Ctenosaura*

similis) began to eat after a long illness. RS expressed quiet sadness over the death of a baby agouti (*Dasyprocta punctata*) despite having done everything possible to save it. These emotional highs and lows underscored the psychological toll of rehabilitation and highlighted the need for institutional support to prevent caregiver burnout.

Human-animal bonds often complicate rehabilitation efforts. Confiscated pet birds, especially those with strong attachments to their previous “owners,” often vocalize or seek human attention when separated and cannot be released into the wild as they will not survive. For instance, at one of the smaller wildlife sanctuaries, one parrot, observed by author SC, would repeatedly say “Hola” whenever caretakers passed by, hoping for belly scratches, and would scream when workers walked away. This attachment can hinder rehabilitation, as these animals struggle to adapt to environments with limited human interaction or socialization with other birds. In some cases, imprinting on rehabilitators occurs, as seen with a tayra (*Eira barbara*) at a different medium sized sanctuary which became too aggressive toward humans and could not be released because of behavioral issues. This type of imprinting can significantly affect animal welfare and the broader conservation goals of release. However, from a post-humanist animal welfare perspective (Thomsen *et al.*, 2023), if an animal cannot be released, its goal shifts from conservation to animal welfare. In the case of spider monkeys and parrots, their lives can be enriched through socialization and the ethological behaviors they exhibit, which they actively seek out.

Caretakers are frequently confronted with ethical dilemmas that balance the well-being of individual animals with their broader conservation goals and limited resources. These decisions involved careful consideration of medical options, available space, and long-term welfare of animals in captivity. For example, SGU decided against operating on a parrot tumor after determining that the risks outweighed the potential benefits. RS, faced with a limited space in the clinic, makes it difficult to release a sloth earlier than planned to accommodate new arrivals. These decisions reflect the weight of ethical responsibility in wildlife care, in which caretakers must prioritize some animals over others, based on shifting circumstances.

This theme highlights the tension between conservation laws and animal welfare. Many animals, particularly confiscated pets, are unable to transition to life in the wild because of their attachment to humans or past experiences in captivity. The challenges associated with rehabilitating confiscated pets, such as parrots, exemplify how legislation can unintentionally complicate rehabilitation efforts, making it difficult to release animals into their natural habitats.

KEY THEMATIC FINDING #3: BIOCULTURAL AND SOCIOPOLITICAL EFFECTS ON WILDLIFE REHABILITATION

The sociopolitical landscape in which wildlife rescue centers operate is inextricably linked to broader challenges such as underfunding, governmental neglect, and the intersection of global tourism with local conservation efforts. SGU highlighted the disconnect between government regulations and financial sanctuary constraints.

The reality of many rescue centers is that we are very underfunded. We do the best we can with what we have. The government comes in and is quite strict, saying you have to change this, you have to change that, but they don't give us any money—and they still want us to take all their animals.

This sentiment reflected the gap between the idealized support promised by the government and the reality that, without adequate funding, sanctuaries are left to rely on volunteers, donations, and limited tourism revenue.

Despite caretaker dedication, bureaucratic delays often hinder efficient animal care and conservation. SGU shared his dismay over long wait times for animal release approvals, which forced

rehabilitated animals to remain in captivity for longer than necessary. Similarly, RS described his frustration with the government's delayed response to insulating power lines—a failure that continued to result in preventable wildlife electrocutions. These inefficiencies underscored the disconnect between policy and practice and raised important questions about how regulatory frameworks can be improved to better support conservation goals, a critical area of focus for another researcher in this longitudinal study.

The biocultural context surrounding these rescue centers has significantly shaped the challenges that caretakers face in their daily work. Local attitudes toward wildlife, conservation policies, and pressures from tourism and development have influenced both opportunities and obstacles for caretakers. SGU criticized the government for promoting a pro-conservation image while failing to address sustainability issues in any meaningful way. RS similarly expressed frustration with the effects of gentrification, noting that rising infrastructure development led to more animal injuries, whereas tourists who professed to love the jungle often complained about wildlife. These perspectives demonstrate the complex relationship between conservation, economic development, and public engagement and now pose critical questions about how communities can be better integrated into ethical conservation efforts.

Cultural factors also influence how animals are treated in the context of wildlife rehabilitation. Increased urban and tourism-driven development pressures have placed additional stress on wildlife populations. For example, the effect of gentrification on infrastructure has resulted in more wildlife injuries and increased challenges for centers such as the JRC to advocate the government for stronger wildlife protection. The intersection between the local culture and environmental changes must be considered when developing rehabilitation and conservation strategies. For instance, regional differences in rehabilitation practices were apparent between the two centers. At the JRC, a closer relationship with regulatory authorities and proximity to protected lands allowed for faster response times and smoother bureaucratic processes, aiding animal release. In contrast, the CRARC's stricter regional oversight and greater distance from approved release sites created obstacles, which made releases more complicated and increased the risk of animals habituating to human care.

Socio-economic pressures on workers and sanctuary staff were also compounded by gentrification, which increased the cost of living in regions once considered affordable. RS's personal story of being forced to leave his rented home after the landlord increased his rent provided a poignant example of the financial burden wildlife rehabilitators faced in an increasingly expensive environment.

I used to pay \$500/month to live in that house, then the landlord increased the rent to \$1500/month. I couldn't afford it. Now I live in a tiny house with one little room – mostly open air.

This shift illustrates the broader impacts of gentrification, as wealthier expatriates and tourists have driven up living costs in once-affordable areas and created a divide between those working to protect the land and wildlife and those whose lifestyles have contributed to their degradation.

The role of volunteers, many of whom pay for the privilege of working at sanctuaries, adds another layer of complexity to the socio-economic fabric of wildlife conservation. One volunteer stated the following.

Volunteers pay to come work here. They also pay for their food and lodging...we pay to work, we pay for food, we pay for the locale...we pay with our soul [jokingly]...

This paradox of volunteerism, in which individuals financed their stay while simultaneously contributing to labor, raised important questions about the sustainability of this model. The emotional

and financial costs borne by the staff, volunteers, and animals they cared for underscored the challenges of balancing the needs of conservation with the limitations of the sanctuaries' resources. Financial dependence on tourism provides insight into the precariousness of these sanctuaries. When asked whether the sanctuary made most of its money from volunteers or tourists, one group of volunteers replied that the sanctuary received most of their money from cruise tourists, who paid US\$20 each in groups of over 800 people at a time.

This finding reveals the major vulnerability of the funding model. While tourism is vital for sustaining operations, it also presents ethical questions about capitalizing on human fascination with wildlife, which may have contributed to the destruction of habitats on which these animals rely. These findings reveal the intricate challenges, ethical dilemmas, and emotional investments that have shaped wildlife rehabilitation. They underscored the need for greater institutional support, efficient regulatory processes, enhanced training programs, and culturally informed conservation strategies. The experiences of SGU and RS provide valuable insights into how the field can evolve to ensure the well-being of rehabilitated animals and the sustainability of caretakers who have dedicated their lives to this work.

Discussion

This study reveals the intricate balance required to navigate the challenges, ethics, and emotional complexities of wildlife rehabilitation. The three key thematic findings emphasize the interconnected nature of wildlife care and the tensions between institutional policies, conservation priorities, and lived experiences of both animals and caretakers. These findings generated several critical research questions that warrant further exploration, which this larger study will address over time.

One of the most pressing concerns is how operational challenges, such as resource limitations, shape rehabilitation practices, and, in turn, influence animal welfare. Caretakers regularly face shortages in funding, materials, and staff but develop innovative solutions to meet the needs of animals. Team dynamics and communication have emerged as crucial factors that shape rehabilitation success. Effective collaboration between veterinarians, caretakers, volunteers, and administrators determines the quality of the care provided. However, miscommunications and conflicting priorities can lead to friction. Future research should explore the role of leadership, training, and institutional culture in fostering stronger interdisciplinary collaboration within wildlife care teams, how resource-constrained environments affect rehabilitation outcomes, and what creative strategies can be scaled or standardized to improve care, despite financial and material limitations.

Returning for a moment to the opening vignette, the young spider monkey unveiled poignant tensions in wildlife rehabilitation: the balance between saving a particular life and ensuring that a rescued animal can lead a life worth living. The burden of this decision was that wildlife veterinarians grappled with it daily. Some studies have demonstrated the importance of ethology in examining the relationship between welfare and behavior in captivity for potential release and long-term care (see Swaisgood, 2010; Ross and Leinwand, 2020). Although "gold-standard" veterinary care and meticulous best practices are usually offered to animals at these rehabilitation centers, the emotional and social needs of these individuals remain underexplored from an interdisciplinary animal welfare perspective (Speiran, 2025). Despite the abundance of enrichment and other material resources that the sanctuary could provide, this monkey's longing for connection was unmistakable: extending her hand, wrapping her tail around JT's arm, and engaging in grooming behavior in a quiet plea for touch and companionship. These gestures indicate a need that is as profound as any medical or nutritional intervention. Overlooking this fact would neglect the fundamental truth that welfare is more than survival. Rehabilitators must frequently

navigate through the ethical complexities of caring for individuals who cannot be released. When an animal's life is saved, but its autonomy is permanently limited due to physical impairments, behavioral challenges, or legal restrictions, rehabilitators are often left with difficult decisions about long-term welfare.

A poignant example of this challenge is the tayra observed by SC, who developed a deep attachment to one of her human caregivers. While she displayed playful, affectionate behavior in his presence, she became visibly distressed (paced and agitated) whenever he left. Despite being provided with enrichment items, this did not seem to address her core need for socialization. This raises a crucial concern as to whether her current enrichment strategies, despite the center's best intentions, support her psychological well-being. Because of the center's efforts, her life was saved as a baby, but now, what kind of life does she truly have? From a more acute perspective, how can her quality of life be improved through enhanced socialization, given the limited resources of the center?

Similar issues have emerged in rehabilitation and long-term care of confiscated pet parrots. As demonstrated earlier, these birds often display human-directed behaviors, such as vocalizing attention or mimicking speech, and many struggle to integrate into new social groups of their own species, such as the parrot who would beg for belly scratches and screams when the author SC withdrew her attention to return to the clinic. While often unintended, imprinting and habituation shape the fate of these animals in ways that cannot be undone. Examples of spider monkeys, tayra, and parrots also highlight the broader tension between priorities in rehabilitation governance and individual animal welfare. This issue is further exacerbated by the limited financial and material resources at these centers. While legislation is designed to protect animals by regulating release criteria and minimizing human interaction during rehabilitation, policies often overlook the psychological toll of the abrupt loss of social connections.

Costa Rica's current legislation mandates the removal of pet parrots from private homes regardless of the quality of care they receive. This allowed the government to showcase a conservation victory by banning exotic pet ownership. However, this policy often results in unnecessary suffering. Many confiscated parrots are deeply bonded to their caretakers, and experience severe stress and maladaptation in sanctuaries. Despite dedicated efforts by underfunded and overburdened sanctuaries expected to house, feed, and care for an influx of confiscated birds without financial support from the government, many parrots struggled to adjust. Rather than prioritizing the well-being of these animals, the law appears to serve as a political tool, presenting an appearance of ethical responsibility while serving broader political agendas. Future research should investigate whether case-by-case welfare assessments can lead to more ethical and effective rehabilitation strategies than blanket confiscation policies can.

The ethical challenges of animal care and the emotional labor involved in facing such choices are closely tied to operational challenges. This study illustrates the deep emotional connections that caretakers form with animals, particularly in cases in which animals cannot be released. The psychological burden of making life and death decisions, managing grief, and navigating ethical dilemmas is profound. Future studies should examine the long-term mental health effects of working in rehabilitation settings and the effectiveness of institutional support systems in preventing burnout and compassion fatigue. While limiting human interactions with animals is the best practice for release success, animals that cannot be reintroduced into the wild often experience psychological distress in isolation. Future studies should investigate whether alternative care approaches such as increased socialization or customized enrichment can enhance the well-being of non-releasable animals without compromising ethical and conservation goals.

Sociocultural and environmental influences serve as contexts for the operational and ethical challenges. They shape public perception of wildlife and institutional approaches to rehabilitation.

Local traditions, tourism, and historical attitudes toward certain species impact how wildlife is treated and valued. Future research should examine how cultural narratives influence conservation and rehabilitation practices, and how community engagement can be leveraged to support wildlife protection efforts. At the institutional level, bureaucratic inefficiencies present significant obstacles to providing effective care. Delays in decision making, rigid policies, and slow permit processes can hinder treatment and rehabilitation efforts. A critical question for future research is how regulatory frameworks can be optimized to balance oversight with the flexibility required for individualized animal care. Examining successful models in other rehabilitation centers or conservation programs could provide insights into potential policy improvements.

Taken together, these themes call for a more nuanced and interdisciplinary approach to wildlife rehabilitation that balances scientific, ethical, emotional and logistical considerations. By addressing these critical research questions, future studies can contribute to refining best practices, improving animal welfare, and supporting the well-being of those who dedicate their lives to care for injured and displaced wildlife. The following section details how ethnographic findings can inform and validate the need for the biological components of ethnobiology studies. Specific biological research questions are then provided to show how the ethnographic pilot study shaped the future direction of SC's doctoral thesis.

THE VALUE OF ETHNOGRAPHY AS A MECHANISM TO GENERATE BIOLOGICAL RESEARCH QUESTIONS

Ethnography contributes to biology in two ways: The first is the application of ethnographic approaches to the study of animal behavior. In recent years, there has been increasing emphasis on how non-unique human cognitive and behavioral responses can be (Whiten, 2024). This includes the study of animal culture and how the dual inheritance of genes and culture applies to non-humans (Whiten, 2021), in fields such as animal cognition and cognitive ecology (Shettleworth, 2009). More prosaically, it has been understood for decades that the study of animal behavior is incomplete without understanding the behavior from the animals' own subjective perspective, whether that is referred to as understanding their *umwelt* (von Uexküll 1934), receiver psychology (Guilford and Dawkins, 1991), or cognitive ecology (Shettleworth, 2009). The study of animals' subjective understanding of the world has already been highlighted as important by conservationists (Greggor *et al.*, 2014; Candolin and Wong, 2012). Ethnography is a useful addition to the toolkit of biologists interested in studying the subjective life of animals and the role that subjective life plays in conservation efforts. The emergence of multispecies ethnography has begun to not only consider the more-than-human worlds (i.e., our relationship with animals, plants, etc.) but has even begun to combine ethnography and ethology (see Thomsen *et al.*, 2025). This approach may have provided additional benefits to ethnobiologists at the beginning of this study.

The second way that ethnography can contribute to conservation biology is to allow us to understand the biological questions that are relevant to conservationists. Conservation biology is, at least in theory, an applied discipline that ought to be measured by the species saved rather than by published papers (Soulé, 1985). However, from the inception of the discipline, some have accused it of being an academic displacement activity (Whitten *et al.*, 2001), a way for academics to try to justify their own interest as being of greater use. While such criticism can be unfair, and there is evidence that conservation biology is becoming better at directly addressing the concerns of wildlife managers (Pressey *et al.*, 2017), there is no denying that the growth of conservation biology as an academic discipline has not been followed by a decline in the rate of species extinction and endangerment. By understanding both the subjective world of animals and the interactions between animals and humans, ethnography can shed light on the biological questions that are most relevant to the conservation of this

species. Crucially, these questions need not be universalized but are expected to be context-specific. In this study, the ethnographic findings directly inform the next steps of the SC study.

NEXT STEPS IN THE STUDY: ETHNOGRAPHICALLY INFORMED BIOLOGICAL RESEARCH QUESTIONS

As SC's doctoral thesis focuses specifically on parrot rehabilitation, these questions are tailored to extend this line of inquiry. However, they also suggested that those interested in studying the tension between conservation and animal welfare at wildlife rehabilitation sites could develop their work from an interdisciplinary perspective. However, the impact of wildlife rehabilitation and release on individual animals remains unclear (Pyke and Szabo, 2018; Cope *et al.*, 2022). Future studies should examine how variations in care protocols, enclosure design, and socialization enrichment influence stress reduction and adaptability in rehabilitated animals. In addition, studies should consider the cognitive and emotional consequences of prolonged captivity, particularly in species with high intelligence and complex social structures. Potential biological hypotheses to study include the following.

- Biological Research Hypothesis #1: In wild Red-Fronted Parrots (*Touit costaricensis*), feather corticosterone levels increase with both the duration of captivity during rehabilitation and frequency of human exposure.
- Biological Research Hypothesis #2: In wild Red-Fronted Parrots (*Touit costaricensis*), the frequency of stereotypical behaviors increases with both the duration of captivity during rehabilitation and the frequency of human exposure.
- Biological Research Hypothesis #3: In wild Red-Fronted Parrots (*Touit costaricensis*), feather corticosterone levels decrease with increased financial resources available to the rehabilitation center, greater frequency and variety of enrichment opportunities, larger enclosure size, and proximity to conspecifics.
- Biological Research Hypothesis #4: In wild Red-Fronted Parrots (*Touit costaricensis*), the frequency of stereotypical behaviors decreases with the increased financial resources available to the rehabilitation center, greater frequency and variety of enrichment opportunities, larger enclosure sizes, and proximity to conspecifics.

By assessing animal well-being using physiological and behavioral indicators from a biological perspective, a new ethnobiology-informed animal welfare framework can be developed to center on individual animal ethology in captive settings. Biological research could include the analysis of stress responses, engagement with the environment, and social behaviors (Korte *et al.*, 2007). A valuable ethological approach would also involve measuring glucocorticoid levels (e.g., cortisol levels) and using cameras to monitor behavioral stress indicators (e.g., stereotypies) to assess chronic stress in animals undergoing rehabilitation. These hypotheses demonstrate how ethnography and biology can serve as positive feedback loops in ethnobiological wildlife rehabilitation studies.

CONCLUSION

This study contributes to the field of wildlife rehabilitation by illuminating the complex interplay between political ecology in Costa Rica and how its trickle-down effects impact rehabilitation governance and, ultimately, the welfare of individual animals. The key findings from the 2-week ethnographic fieldwork period are a continuation of a previous study by Thomsen *et al.* (2023). Key findings: Resource Constraints and Creativity, Emotional Labor of Animal Care, Bureaucratic Inefficiency, Team Dynamics and Communication, Ethical Dilemmas and Compassionate care, and cultural and environmental influences underscore the challenges inherent in navigating the rehabilitation process. Notably, this study highlights how well-intentioned laws, such as Costa Rica's pet parrot confiscation law, may compromise animal well-being.

While this study provides valuable insights, its limitations include the qualitative nature of ethnographic research, which, while rich in detail, may not fully capture broader trends across rehabilitation centers across the whole country. Future research should expand upon these findings by further fleshing out ethnographic data across a larger sample size of rehabilitation centers and incorporating quantitative welfare assessments, such as the measurement of corticosteroids and the frequency of stress-related behaviors, in a comparative analysis across different rehabilitation facilities across the country. These questions formed the foundation for continuing this research into a doctoral project.

Recommendations for further study emerging from this line of inquiry include the following: (1) assessing the impact of wildlife rehabilitation on individual animals, (2) measuring physiological stress; and (3) integrating the sociocultural dimensions of veterinary practice. Moving beyond survival and release metrics, successful wildlife rehabilitation must also prioritize the emotional and physical well-being of animals, whether released or housed, over the long term. Future ethnographic work should expand across more centers and integrate quantitative welfare assessments to enrich our understanding of rehabilitation practices in Costa Rica and beyond. This study emphasizes the importance of integrating broader rehabilitation goals with individualized animal welfare approaches for wildlife rehabilitation practitioners. Practitioners may want to consider the following: 1) enrichment designed to simulate social experiences through sensory engagement in such a way that minimizes risk of imprinting on humans, (2) evidence-based advocacy, and (3) enhanced communication. Ultimately, successful wildlife rehabilitation must extend beyond mere survival and release metrics and must also ensure that animals, whether released or housed long-term, experience the highest possible quality of life.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare but note that two of the authors worked at two wildlife rehabilitation and release centers where this study was conducted.

ETHICS STATEMENT

This study obtained university IRB ethics approval from a large R1 US university and was authorized from 2021 to 2027. All ethical guidelines were followed in this study.

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AUTHOR CONTRIBUTIONS

All authors contributed equally to the development of this article.

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DATA AVAILABILITY

The data were anonymized to protect the identities of the interlocutors, according to the ethics protocol. A limited amount of data that was coded and analyzed may be available upon request but will not be located in a specific repository.

References

Adamson, E.M. (2024) *The Social Economy of Escaping to the Beach: The Impact of Privileged Lifestyle Migrants on a Local Community in Caribbean Costa Rica (Doctoral Dissertation)*. University of Kansas.

Alvarez, M., Heller, G., Malombe, I., Matheka, K.W., Choge, S. and Becker, M. (2019) Classification of *Prosopis juliflora* invasion in the Lake Baringo basin and environmental correlations. *African Journal of Ecology* 57(3), 296–303. DOI: 10.1111/aje.12601.

Blaikie, P. and Brookfield, H. (2015) *Land Degradation and Society*. Routledge, Abingdon, UK and New York.

Bliss, C., Visseren-Hamakers, I.J. et al. (2023) Most (un)wanted: Explaining emerging relationships between “invasive alien” species and animal governance. *Global Environmental Change*. DOI: 10.1016/j.gloenvcha.2023.103984.

Broz, L., Keck, F. and Weich, K. (2023) Veterinary anthropology: Samples from an emerging field. *Frontiers in Veterinary Science* 10, 1053256.

Burgess, R.G. (2003) The unstructured interview as a conversation. In: *Field Research*. Routledge, London, pp. 177–182.

Candolin, U. and Wong, B.B. (eds.) (2012) *Behavioural Responses to a Changing World: Mechanisms and Consequences*. Oxford University Press, Oxford, UK.

Choge, S., Mbaabu, P.R. and Muturi, G.M. (2022) Management and control of the invasive *Prosopis juliflora* tree species in Africa with a focus on Kenya. In: *Prosopis as a Heat Tolerant Nitrogen Fixing Desert Food Legume*. Elsevier, London, pp. 67–81.

Clay, A.S. and Visseren-Hamakers, I.J. (2022) Individuals matter: Dilemmas and solutions in conservation and animal welfare practices in zoos. *Animals (Basel)* 12(3), 398. DOI: 10.3390/ani12030398.

Colonijs, T.J. and Earley, R.W. (2013) One welfare: A call to develop a broader framework of thought and action. *Journal of the American Veterinary Medical Association* 242(3), 309–310.

Coolman, A.A., Niedbalski, A., Powell, D.M., Kozłowski, C.P., Franklin, A.D. and Deem, S.L. (2020) Changes in human health parameters associated with an immersive exhibit experience at a zoological institution. *PLoS One* 15(4), e0231383. DOI: 10.1371/journal.pone.0231383.

Cope, H.R., McArthur, C., Dickman, C.R., Newsome, T.M., Gray, R. and Herbert, C.A. (2022) A systematic review of factors affecting wildlife survival during rehabilitation and release. *PLoS One* 17(3), e0265514.

Creswell, J.W. and Creswell, J.D. (2017) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications, Thousand Oaks, CA.

Deem, S.L. (2024) One health and the wildlife rehabilitator. *Wildlife Rehabilitation Bulletin* 42(1), 1–5. DOI: 10.53607/wrb.v42.272.

DeGregorio, B.A. and Deshwal, A. (2025) Current distribution of the nine-banded armadillo (*Dasyus novemcinctus*) in the United States. *Diversity* 17(2), 138.

DeGregorio, B.A., Veon, J.T. and Massey, A. (2022) Wildlife associates of nine-banded armadillo (*Dasyus novemcinctus*) burrows in Arkansas. *Ecology and Evolution* 12(5), e8858.

Deshwal, A. (2019) *Ecology and Conservation of Shrubland Bird Communities in the Eastern Ghats of India*. University of Arkansas, Fayetteville, AR.

Deshwal, A., Stephenson, S.L., Panwar, P., DeGregorio, B.A., Kannan, R. and Willson, J.D. (2022) Foraging habitat selection of shrubland bird community in tropical dry forest. *Ecology and Evolution* 12(8).

Escobar-Ibarra, I., Mota-Rojas, D. and Gual-Sill, F. (2021) Conservation, animal behaviour, and human-animal relationship in zoos: Why is animal welfare so important? *Journal of Animal Behaviour and Biometeorology* 9(1), 12–20.

Evans, B.R. and Leighton, F.A. (2014) A history of One Health. *Revue Scientifique et Technique* 33(2), 413–420.

Fulton, G.R. and Ford, H.A. (2002) The conflict between animal welfare and conservation. *Pacific Conservation Biology* 7(3), 152–153. DOI: 10.1071/PC010152.

Greggor, A.L., Clayton, N.S., Phalan, B. and Thornton, A. (2014) Comparative cognition for conservationists. *Trends in Ecology & Evolution* 29(9), 489–495.

Guest, G., Bunce, A. and Johnson, L. (2006) How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 18(1), 59–82. DOI: 10.1177/1525822X05279903.

- Guilford, T. and Dawkins, M.S. (1991) Receiver psychology and the evolution of animal signals. *Animal Behaviour* 42(1), 1–14. DOI: 10.1016/S0003-3472(05)80600-1.
- Howell, S. (2018) 2023. "Ethnography". In the open encyclopedia of anthropology. In: Stein, F. (ed) *Facsimile of the first edition in The Cambridge Encyclopedia of Anthropology*. DOI: <http://doi.org/10.29164/18ethn>.
- Koenig, W.D. (2003) European Starlings and their effect on native cavity-nesting birds. *Conservation Biology* 17(4), 1134–1140.
- Korte, S.M., Olivier, B. and Koolhaas, J.M. (2007) A new animal welfare concept based on allostasis. *Physiology & Behavior* 92(3), 422–428.
- Little, P.D. (2019) When "green" equals thorny and mean: The politics and costs of an environmental experiment in East Africa. *African Studies Review* 62(3), 132–163. DOI: 10.1017/asr.2019.41.
- Louv, R. (2008) *Last Child in the Woods*. Algonquin Books of Chapel, Chapel Hill, NC, pp. 1–390.
- Mattson, K. (2020) *Veterinary Educational Debt Continues to Rise*. AVMA Association. Available at: <https://www.avma.org/javma-news/2020-12-15/veterinary-educational-debt-continues-rise> (accessed 12 March 2025).
- Mbaabu, P.R., Ng, W.-T., Schaffner, U., Gichaba, M., Olago, D., Choge, S. et al. (2019) Spatial evolution of *Prosopis* invasion and its effects on LULC and livelihoods in Baringo, Kenya. *Remote Sensing* 11(10), 1217. DOI: 10.3390/rs11101217.
- Mbaabu, P.R., Olago, D., Gichaba, M., Eckert, S., Eschen, R., Oriaso, S. et al. (2020) Restoration of degraded grasslands, but not invasion by *Prosopis juliflora*, avoids trade-offs between climate change mitigation and other ecosystem services. *Scientific Reports* 10(1), 20391. DOI: 10.1038/s41598-020-77126-7.
- Mellor, D.J. (2016) Updating animal welfare thinking: Moving beyond the "Five Freedoms" towards "a Life Worth Living". *Animals* 6(3), 21.
- Miller, E.A. (2012) *Minimum Standards for Wildlife Rehabilitation*. 4th edn, National Wildlife Rehabilitators Association, St. Cloud, MN.
- Miller, T.K., Pierce, K., Clark, E.E. and Primack, R.B. (2023) Wildlife rehabilitation records reveal impacts of anthropogenic activities on wildlife health. *Biological Conservation* 286, 110295. DOI: 10.1016/j.biocon.2023.110295.
- Molina-López, R.A., Mañosa, S., Torres-Riera, A., Pomarol, M. and Darwich, L. (2017) Morbidity, outcomes and cost-benefit analysis of wildlife rehabilitation in Catalonia (Spain). *PLoS One* 12(7), e0181331.
- Mwangi, E. and Swallow, B. (2008) *Prosopis juliflora* invasion and rural livelihoods in the Lake Baringo area of Kenya. *Conservation and Society* 6(2), 130–140. <https://www.jstor.org/stable/26392921>.
- Neumann, R.P. (1992) Political ecology of wildlife conservation in the Mt. Meru area of Northeast Tanzania. *Land Degradation & Development* 3(2), 121–138. DOI: 10.1002/ldr.3400030203.
- Paquet, P.C. and Darimont, C.T. (2010) Wildlife conservation and animal welfare: Two sides of the same coin? *Animal Welfare* 19(2), 177–190.
- Pinillos, R.G., Appleby, M.C., Manteca, X., Scott-Park, F., Smith, C. and Velarde, A. (2016) One Welfare—a platform for improving human and animal welfare. *Veterinary Record* 179(16), 412–413.
- Platt, B., Hawton, K., Simkin, S. and Mellanby, R.J. (2010) Systematic review of the prevalence of suicide in veterinary surgeons. *Occupational Medicine* 60(6), 436–446.
- Pressey, R.L., Weeks, R. and Gurney, G.G. (2017) From displacement activities to evidence-informed decisions in conservation. *Biological Conservation* 212, 337–348.
- Pyke, G.H. and Szabo, J.K. (2018) Conservation and the 4 Rs, which are rescue, rehabilitation, release, and research. *Conservation Biology* 32(1), 50–59.
- Ross, S.R. and Leinwand, J.G. (2020) A review of research in primate sanctuaries. *Biology Letters* 16(4), 20200033.
- Ruttenberg, B.I., Schofield, P.J., Akins, J.L., Acosta, A., Feeley, M.W. et al. (2012) Rapid invasion of Indo-Pacific lionfishes (Pterois volitans and Pterois miles) in the Florida Keys, USA: Evidence from multiple pre- and post-invasion data sets. *Bulletin of Marine Science* 88(4), 1051–1059.
- Sheppard, V.A. and Fennell, D.A. (2019) Progress in tourism public sector policy: Toward an ethic for non-human animals. *Tourism Management* 73, 134–142. DOI: 10.1016/j.tourman.2018.11.017.
- Shettleworth, S.J. (2009) *Cognition, Evolution, and Behavior*. Oxford University Press, New York.
- Soulé, M.E. (1985) What is conservation biology? *BioScience* 35(11), 727–734. DOI: 10.2307/1310054.
- Speiran, S.I. (2025) The 'Sanctuary Gap': Reviewing the research on captive wildlife sanctuary tourism. *Animals* 15(4), 496.
- Swaisgood, R.R. (2010) The conservation-welfare nexus in reintroduction programmes: A role for sensory ecology. *Animal Welfare* 19(2), 125–137.
- Tabe-Ojong, M.P.J. (2023) Action against invasive species: Charcoal production, beekeeping, and *Prosopis* eradication in Kenya. *Ecological Economics* 203, 107614. DOI: 10.1016/j.ecolecon.2022.107614.
- Tabe-Ojong, M.P., Heckeley, T. and Baylis, K. (2021) Aspiration formation and ecological shocks in rural Kenya. *European Journal of Development Research* 33(4), 833–860. DOI: 10.1057/s41287-021-00411-2.
- Thomsen, T.B. (2022) *The Precarity of Nonhuman Livelihoods: Rethinking Speciesism in a Genocidal State (Doctoral Dissertation)*. University of Oxford, Oxford, UK.
- Thomsen, B., Thomsen, J., Copeland, K., Coose, S., Arnold, E. et al. (2021) Multispecies livelihoods: A posthumanist approach to wildlife ecotourism that promotes animal ethics. *Journal of Sustainable Tourism* 31(5), 1195–1213.
- Thomsen, B., Cousins, T., Copeland, K., Thomsen, J., Coose, S. et al. (2022) Posthumanist pluralities: Advocating for nonhuman animals' rights, agency, and welfare in ecosystem governance. *Advances in Ecological Research: Pluralism in Ecosystem Governance* 66, 117–146. DOI: 10.1016/bs.aecr.2022.04.004.
- Thomsen, B., Copeland, K., Fennell, S.R., Thomsen, J., Harte, M. et al. (2023) The promise of posthumanism in wildlife ecotourism: A set of case studies of veterinarians' role at wildlife rehabilitation centers in Costa Rica. *Journal of Ecotourism* 4, 1–19.
- Thomsen, B., Villar, D., Muurlink, O., Siegeman, C., Deshwal, A. et al. (2025) *Multispecies Ethnography as a Pathway for Translational Ecology: A Methodological Approach to Foregrounding Nonhumans' Interests in Applied Ecology*. Working Paper, Sydney, Australia.
- Von Uexküll, J. (1934) *Streifzüge Durch Die Umwelten Von Tieren und Menschen ein Bilderbuch Unsichtbarer Welten: Einundzwanzigster Band*. Springer, Berlin, Heidelberg.
- Watts, M. (2017) Political ecology. *A Companion to Economic Geography* 257–274, 1.
- Whiten, A. (2021) The burgeoning reach of animal culture. *Science* 372(6537), eabe6514.
- Whiten, A. (2024) Frans de Waal (1948–2024), primateologist who questioned the uniqueness of human minds. *Nature* 628(8008), 497–497.
- Whitten, T., Holmes, D. and MacKinnon, K. (2001) Conservation biology: A displacement behavior for academia? *Conservation Biology*, 1–3.
- Willette, M., Rosenhagen, N., Buhl, G., Innis, C. and Boehm, J. (2023) Interrupted lives: Welfare considerations in wildlife rehabilitation. *Animals* 13(11), 1836.
- Wimberger, K., Downs, C.T. and Boyes, R.S. (2010) A survey of wildlife rehabilitation in South Africa: Is there a need for improved management? *Animal Welfare* 19(4), 481–499.
- World Health Organization (n.d.) *One Health*. Available at: https://www.who.int/health-topics/one-health#tab=tab_1 (accessed 12 March 2025).
- Zinsstag, J., Schelling, E., Waltner-Toews, D. and Tanner, M. (2011) From "one medicine" to "one health" and systemic approaches to health and well-being. *Preventive Veterinary Medicine* 101(3-4), 148–156.