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Coexistence beyond disciplinary silos: Five dimensions of analysis for more convivial human-predator interactions

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ABSTRACT

Understanding human-predator interactions has been a central goal of conservation for decades, yet many previous efforts have approached this challenge from disciplinary perspectives focused on single case studies. There is a need for more transdisciplinary and multi-sited research to enrich our understandings of the complexity of human-nonhuman interactions and to design ways to make them more convivial. The multi-year CONVIVA "convivial conservation" research project addressed this gap, involving scholars from natural sciences, social sciences and humanities to promote coexistence, biodiversity and justice in conservation across four diverse case studies of apex predators: jaguars in Brazil, wolves in Finland, lions in Tanzania, and brown bears in California, United States. In this article, we set out two key contributions. First, we highlight how our project created iterative, dialogue-based reflections amongst different disciplines and perspectives to inform research questions, methods and units of analysis, fulfilling what we see as a key need in the literature. Second, we operationalise our collaboration beyond disciplinary silos into a novel framework of five interconnected dimensions of analysis, that characterise human-predator interactions, drawing on a range of lenses and including a series of guiding questions. We also showcase empirical material from our cases across wildlife, environment, interactions, institutions and justice dimensions. We present our approach, framework and findings with collective reflections and an invitation for adaptation and further research on their suitability to other contexts and species.

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1. Introduction

Human-wildlife coexistence and conflict have inspired much research across natural sciences, social sciences and humanities (Bennett et al., 2017; Karanth et al., 2013; Vasudev et al., 2023; Woodroffe et al., 2005). While research on conflicts has dominated scholarship on human-wildlife interactions (Dickman et al., 2014; Madden and McQuinn, 2015), recent literature has emphasised the importance of shifting from a focus on conflict towards human-wildlife coexistence (Frank et al., 2019; Pooley et al., 2020). Arguably, this is all the more important for predators such as large carnivores, for whom conflicts with people are often more consequential (Dickman et al., 2014). A detailed understanding of coexistence requires thinking and action across disciplines (Jiren et al., 2021; König et al., 2020; Macdonald, 2019); however, what this means in practice needs to be unpacked. In this article, we share our insights from a multi-year research project on human-wildlife coexistence with four apex predators. The project brought together diverse geographical areas, disciplines, and fields of research, including history, anthropology, development studies, political ecology, conservation biology, and the human dimensions approach grounded in behavioural psychology and systems thinking. In this article, we share how we worked together across disciplines and perspectives and, based on this collaboration, propose a framework and empirical examples of five interconnected dimensions of analysis and a list of questions to facilitate understanding beyond disciplines in pursuit of humans and nonhumans thriving together.

This endeavour parallels McGinnis and Ostrom's (2014) social-ecological systems framework which explores how different forms of governance influence resource users and how they affect resource systems. In our project, we focused on clarifying human-nonhuman interactions through cases of human-predator relations by exploring empirical similarities and differences across political economy and environment to unearth and problematise underlying similar and diverging understandings between disciplines and contexts. We also draw on Ceauşu et al.'s (2019) social-ecological framework for ecosystem services and disservices and particularly their insight that such holistic analysis requires new ways of collecting and integrating data on human-wildlife systems. McGinnis and Ostrom (2014) and Ceauşu et al. (2019) focused on the wider socio-ecological systems or (dis)services of specific ecosystems of which our human-predator interactions are a part, respectively; in contrast, we identify animal, environmental, interactional, institutional and justice implications in human-nonhuman interactions, bearing in mind not only humans', but also predators' behaviours, needs, and actions. This focus is especially important because of the considerable consequences which human-predator relations often entail, and their highly diverse facets. This requires both a systemic approach, and one that moves beyond disciplinary lenses. Consequently, this article shares our collaboration and the dimensions of analysis and underlying questions focused on human-predator interactions, with empirical examples.

This framework addresses four shortcomings in much of the existing literature on human-wildlife interactions: (1) focusing on conflict, (2) omitting power and history, (3) working within disciplinary silos, and (4) sidelining non-western knowledges. Firstly, some scholars have warned against focusing too much on conflict, and called for exploring the full spectrum of human-wildlife interactions (Bhatia et al., 2020; Chapron and López-Bao, 2020). Human-wildlife conflict (HWC) has been extensively researched particularly by natural scientists, examining ecological variables of human-wildlife interactions in shared spaces, such as diet, habitat, and animal and human behaviours (Abade et al., 2020; Miller and Schmitz, 2019; Vasudev et al., 2023). Research committed to resolving human-wildlife conflict has tended to focus on managing wildlife to reduce humans' negative impacts on wildlife and vice versa, usually through socio-technical solutions such as fences, wildlife deterrents, and compensation programmes (Pooley et al., 2020). The assumption is that by addressing adverse impacts on local livelihoods and keeping wildlife and people separate, retaliatory killings of conflict-causing species will decrease, and local communities will support conservation (Nyhus, 2016). However, over time, research has shown the limitation of a sole focus on technical solutions (Ogada, 2015). While many conservation professionals agree on the challenges of coexisting with large carnivores, there is substantial disagreement on solutions, for instance on whether and how some conflicts arise from human-government relations (Lute et al., 2018). It is increasingly recognised that human-wildlife conflicts are the result of socioeconomic and political dynamics and historical intricacies (Dhee et al., 2019; Hussain, 2019; Redpath et al., 2013). Over the last two decades, studies have emphasised the numerous dimensions of decreasing human-animal conflicts, including different stakeholders' attitudes, beliefs, backgrounds and values (Baruch-Mordo et al., 2009; Oommen, 2021). A central theme has been to understand attitudes towards wildlife management and conservation initiatives, particularly near protected areas (Frank et al., 2015). Human dimension studies have shown a broad range of behaviours towards wildlife, meaning that focusing on conflict is a limited perspective (Peterson et al., 2010; Treves and Bruskotter, 2014). This scholarship has introduced concepts of tolerance, acceptance, and, significantly, coexistence (Carter and Linnell, 2016), which, despite an abiding high number of publications on conflict, is gaining ground (König et al., 2020). Despite a growing focus on coexistence, coexistence is not always defined explicitly; a proposed definition that we adopt here is that coexistence is dynamic, but sustainable co-adaptation between humans and large carnivores to live in shared landscapes involving effective institutions that safeguard social legitimacy, tolerable risk and carnivore populations long-term (Carter and Linnell, 2016).

Working towards coexistence involves exploring diverse human-wildlife interactions, understanding ecological, socio-cultural, and political factors that facilitate coexistence, and considering the interests of people and the needs of wildlife (Frank et al., 2019; Vasudev et al., 2023), although balancing these different foci can be challenging to implement in research. Most studies into coexistence have been conducted in biological and agricultural science, with fewer works emerging from social sciences and humanities (König et al., 2020). Among studies of coexistence rooted in social sciences and humanities, one approach has advanced a 'more-than-human' perspective to overcome the conceptual boundary between human and animal frames (Feinberg et al., 2013). This understanding of coexistence resonates with many Indigenous and local peoples' ways of interacting with wildlife and involves a relational approach that appreciates the agency and sentience of animals (Adams, 2019; Martinez et al., 2023). Nevertheless, there is a concern that this literature has not focussed sufficiently on conditions perpetuating exploitation and inequalities (Srinivasan, 2022). Addressing this somewhat, the second approach has largely focused on these structural conditions (economic, social and political) and power relations (Feinberg et al., 2013), albeit from a largely human-centred perspective (Silva and Srinivasan, 2019). This scholarship recognises that human-wildlife conflicts are driven by socio-economic and political landscape changes and the exclusion of local communities from conservation (Büscher and Fletcher, 2020; Silva and Srinivasan, 2019), with the same political-economic - capitalist - mechanisms which drive biodiversity loss also exacerbating social inequality (Büscher et al., 2017). Despite these existing bodies of knowledge, greater integration of social sciences and humanities would be needed (König et al., 2020), for instance regarding concepts such as power or historical legacies.

Human-wildlife relations are often studied within silos due to barriers to inter- and transdisciplinary understandings in existing knowledges (Setchell et al., 2017). Finding fruitful ways to integrate social and natural science perspectives, methods and insights is vital (Chua et al., 2020), as neither natural sciences, social sciences nor humanities on their own can offer answers to these complex questions. Coexistence has enabled and requires the synergy of diverse approaches, disciplines, sectors and worldviews (Pooley et al., 2017). While some

transdisciplinary analyses on coexistence have emphasised bridging the gap between academic knowledge and conservation practice (Jiren et al., 2021; König et al., 2020), we argue there is a necessary precursor of reflecting together on the expectations that inform what problems, research questions, methods or units of analysis are considered pertinent in different disciplines (Agrawal and Ostrom, 2006). Finally, this means challenging western science's abiding domination of coexistence thinking, as coexistence research continues to be conducted by mostly European and North American authors (Venumière-Lefebvre et al., 2022), and although the concept resonates with Indigenous and local communities' ways of knowing and valuing nature, the latter are commonly sidelined (Fiasco and Massarella, 2022).

To address these shortcomings of focusing on conflict, omitting power and history, working within disciplinary silos, and sidelining non-western knowledges, CONVIVA – the convivial conservation research project (2018–2022) involved investigators from natural sciences, social sciences and humanities in Europe, Africa and the Americas to explore shifting human-wildlife interactions (Massarella et al., 2021). The CONVIVA team conducted research in convivial conservation, 'a vision, a politics and a set of governance principles' that promotes 'radical equity, structural transformation and environmental justice' (Büscher and Fletcher, 2019: 283). It highlighted the importance of identifying dimensions of power (McInturff et al., 2021), political economy and history in the debate on conservation and coexistence (Fiasco and Massarella, 2022; Kiwango and Mabele, 2022). Furthermore, convivial conservation research brings together insights from diverse geographical areas, disciplines and knowledges with an emphasis on their interconnections, and interdependencies between and within humans and environments (Krauss, 2021; Massarella et al., 2022; Pandya, 2022; Sandroni et al., 2022). As such, it offers the potential to promote non-western knowledges (Ampumuza, 2022; Mabele et al., 2022), following Nyamnjoh's (2017) call for convivial scholarship, which works between and among disciplines, is critical and evidence-based, avoids overprescription and overstandardisation while connecting the local to the global. Finally, CONVIVA acknowledges the messiness, but also the importance of 'living with', and the need for shifting the focus beyond conflict towards coexistence and diverse human-predator interactions (Marchini et al., 2021; Sandroni et al., 2022).

Through the convivial conservation research lens described above, our research project problematised and brought together diverse disciplinary perspectives to work on human-predator interactions concerning brown bears in California, jaguars in Brazil, lions in Tanzania, and wolves in Finland, as explained in the next section. Our project team was comprised of both academic researchers and conservation practitioners from both government agencies and non-governmental organizations, all of whom have deeply engaged with surrounding communities. Through this multi-sited approach, our study operationalises our insights into an innovative framework intended for researchers, decision-makers and conservation practitioners. This framework is designed to advance our understanding of human-predator interactions beyond a focus on local conflicts or disciplinary specificities. Our novel approach proposes five interconnected dimensions of analysis, the 'what', and commensurate lenses (indicated in brackets, the 'how' or lens through which this is being analysed): 1) wildlife (animal behaviour), 2) environment (landscape), 3) interactions (relational), 4) institutions (policy) and 5) justice (political economy; see Table 1 in section 3 for details and academic groundings). We provide a list of questions to guide conservation research and planning and share some empirical findings from our project. We conclude by reflecting on the challenges of working across disciplines, and opportunities and limitations for further research.

2. Working together beyond disciplinary silos on coexistence: research design

To translate the above-highlighted principles into collaboration, multiple workshops of 20-30 participants were convened by the Brazilian (Laila Sandroni, Silvio Marchini) and US (Alex McInturff, Peter Alagona) teams of the CONVIVA project with researchers from the project and practitioners to develop shared understandings, to reflect on similarities and differences across contexts, cases and natural and social sciences and humanities (see Appendix A for details). In the first two workshops, organised by the Brazilian team, provocative questions were used to elicit different perspectives on coexistence:

- What are the differences you recognise between the perspectives of social and natural science approaches to coexistence?
- Do we need to have one definition for coexistence or should we embrace its plurality and/or vagueness?
- Does the concept of coexistence open opportunities for a transdisciplinary approach?

Rich discussions yielded, for instance, the conclusion that problem-focused perspectives from conservation biology could be complementarily addressed by political-economic analyses, including a focus on justice, power struggles, knowledge systems and political-economic structures shaping contexts for human-wildlife interactions. The first workshop involved sharing a first version of the dimensions of analysis (Marchini et al., 2021), which all four country teams populated with insights ahead of the second workshop. In the Brazilian team's second workshop, through an interactive game by Laila Sandroni (see Appendix A), the emphasis on both geographical and disciplinary diversity reflected aspirations for researchers from the Global South to be heard and better recognised (Chapron and López-Bao, 2020; Chaudhury and Colla, 2020; Kothari, 2021; Rodriguez et al., 2007; Tallis, Lubchenco, and 238 co-signatories, 2014).

Subsequent workshops, organised by the US team, further investigated whether there were mechanisms or conditions that determined the success or failure of predator-focused coexistence interventions. We derived over 200 statements from previous CONVIVA meetings and solicited project members to identify the most important issues facilitating or inhibiting co-existence in their case. We then further distilled this into 36 statements across four themes: social trust, political economy, material consequences, and predator characteristics, which colleagues ranked from strongly disagree to strongly agree. The exercise and further discussions yielded several cross-cutting themes. For example, the groups agreed that conservation can make people better off, but further discussions emphasised nuances and a need for more detailed research to articulate how this might occur. All groups also highlighted that the predators themselves alter their behaviours to avoid conflict with people. While all groups agreed on the importance of the material consequences of coexistence, the symbolic and cultural dimensions were also stressed. There was a wider range of responses on political-economy questions, emphasising that multifaceted local-global relations are vital to each case. This process further highlighted that analysis across diverse disciplines, dimensions, scales and stakeholder groups is integral to understanding human-wildlife interactions (Ceauşu et al., 2019; Dietsch et al., 2021; McGinnis and Ostrom, 2014; Young et al., 2010).

Building on this series of workshops and bearing in mind the above-identified shortcomings in the literature of being too western-focused, siloed, omitting power and history and focused on conflict, the idea of developing iteratively a series of questions drawing on our cases across five dimensions of analysis was established. The aim was to marshal convivial conservation's experience to make visible the different starting points, knowledges and values involved.

3. Dimensions of analysis and questions

Based on the above-explained collaboration among four cases and predators, we distinguished the following dimensions of analysis that characterise all human-predator interactions (the 'what'), which are

Table 1
Summary of dimensions of analysis of human-predator interactions and associated conceptual lenses, academic grounding and questions used to guide collaborative research in the CONVIVA research project.

Dimension of analysis ('what')	Lens ('how')	Academic grounding	Guiding question
Wildlife	Animal Behaviour	Animal behavioural ecology; ecology; more-than-human perspectives	What brings the predator into contact with humans?
Environment	Landscape Change	Geography; applied ecology; political ecology	How is the landscape changing?
Interactions	Relational	Anthropology; behavioural psychology; human dimensions of wildlife; more-than- human perspectives	How have humans and predators lived together in a particular context?
Institutions	Policy	Organisation studies; policy studies; management studies; law	What conservation policies and decision-making systems have governed this predator?
Justice	Political Economy	Political economy; political ecology	How does justice matter to landscape, humans and predators?

(Source: Kate Massarella)

interrogated through a commensurate 'lens' (the 'how'; see Table 1). These dimensions are dynamically interconnected, and meant to be used in iterative and inclusive research and planning processes for human-predator interactions (Marchini et al., 2021; Zimmermann et al., 2020). Equally, there are cross-cutting themes including justice (McInturff et al., 2021) and nonhumans' rights (Komi and Nygren, 2023; Srinivasan, 2022). Important caveats are that each label designating dimensions and lenses carries problems, yet is a shorthand to facilitate usability, and that the questions proposed require adaptation to each context and each type of predator. Due to space limitations, we illustrate the pertinence of each dimension, lens and questions with one concrete example from our project (for details from all cases, see Appendix B), though they also highlight the dimensions' interconnectedness.

3.1. *Wildlife dimension: animal behaviour lens*

This ecologically rooted dimension relates to non-human behaviours and action shaping interactions with humans, ranging from conflict to coexistence and conviviality (Bhatia et al., 2020; Hill et al., 2017; Van Bommel and Boonman-Berson, 2022, see Table 1). Here, ecological and biological data regarding diet, habitat, natality and mortality, movement, impact on crops or livestock and prey base are included.

Guiding question: What brings the predator into contact with humans?

- What is the predator's ecological role in relation to the ecosystem and other species?
- What do we know - from research and from local people - about the predator's behaviour, movement, natality and mortality? What does the predator eat (including domestic animals)?
- How often does the predator encounter humans? What interactions occur?
- How are natural and human-induced changes affecting the predator's movement patterns into human-dominated landscapes (connectivity issues, habitat, vital resources)?
- Where are the unknowns?

An example to illustrate this dimension and lens comes from CONVIVA's Brazilian team studying jaguars (*Panthera onca*), the Neotropical top predator (Sandroni et al., 2022), in the Brazilian Atlantic Forest where the team focuses on two sites (Foz do Iguaçu National Park and Carlos Botelho State Park). Jaguars are important to the ecosystem due to their ecological functions and cascade effects, as the remnants of the Brazilian Atlantic Forest are highly biodiverse (Morato et al., 2013) despite forests only occupying 28 % of their original cover (Rezende et al., 2018). Deforestation began with European colonisation, with successive plantation cycles (sugar cane, coffee etc.) and urbanisation (Joly et al., 2014). The jaguar is among the most critically endangered species in the Atlantic Forest, with fewer than 300 individuals in various sub-populations (Paviolo et al., 2016) as 85 % of the jaguar's habitat has been lost in the biome. The Jaguars of Iguaçu Project located in Foz do Iguaçu National Park aims to increase jaguar populations (estimated at 28, with some evidence of population recovery) and improve perceptions of jaguars among local populations, as jaguars are at risk due to fragmented habitats, reduced prey bases and human behaviour, namely intentional (retaliatory) killings of jaguars and prey, and unintentional killings through vehicle collisions (Marchini et al., 2021). Given small populations, human-jaguar encounter rates are low, with jaguars sometimes wrongly blamed for livestock or dogs being lost to pumas. Electric fencing can reduce livestock depredation by jaguars, which in turn increases acceptance and reduces persecution (Marchini et al., 2021). In sum, jaguar conservation is critical to the region's ecology amid drastic environmental change, but conservation is shaped by local perceptions and actions that are still poorly understood and rarely considered.

3.2. *Environment dimension: landscape change lens*

This dimension and lens, drawing on geography, applied ecology and political ecology, is related to anthropogenic and other environmental changes that affect predator conservation. These include desertification, environmental degradation, land use change, urban expansion, agricultural frontier vectors (Büscher and Fletcher, 2020; Pooley et al., 2017), and climate change.

Guiding question: How is the landscape changing?

- In what landscape does the predator occur, and how is the landscape demarcated (geographically, legally)? How has this changed over time?
- How is environmental and climatic change affecting the landscape? How is land use changing? How much is landscape change affecting the predator and human-predator interactions?
- How are perceptions of change (real or otherwise) affecting interactions?
- How likely is it that the landscape, and its uses, generate human-predator conflict?
- Where are the unknowns?

In the semi-arid to arid Ruaha-Rungwa ecosystem in Tanzania, the study site of CONVIVA Tanzania's research team, environmental, economic and social landscape changes have shaped human-lion interactions (Kiwango and Mabele, 2022) alongside advancing climate change. About 40 % of Tanzania is currently under nature protection (Noe et al., 2017); in some regions, more than 50 % of land is set aside without local resource use or residence permitted (Brockington et al., 2022). Overseas tourists visiting these spaces and their charismatic species such as the African lion (*Panthera leo*), produce important foreign exchange earnings (Kiwango and Mabele, 2022). The Ruaha

National Park is at the heart of the landscape, ensuring connectivity between protected areas given its relevance to migratory routes. Since colonial times, the landscape's uniqueness has been used to justify coercive conservation models (Kiwango and Mabele, 2022; Mabele et al., 2022), yet due to the absence of fences, lions move out to the surrounding diverse communities in search of food and are often killed to prevent or retaliate livestock depredation. Maintaining bases of large wild prey despite human behaviours and environmental changes in protected areas is vital given its role in determining lions' movements (Abade et al., 2020).

After independence, the Tanzanian government has continued to pursue protectionist conservation policies in the name of economic development, instituting changes in the landscape over time (Kiwango and Mabele, 2022). These are often driven by 'degradation narratives', which accuse local land users, especially pastoralists, of causing degradation through inappropriate land use, without good evidence to support these claims (Walsh, 2012). In sum, lion conservation has been shaped by economics, politics, environmental change, and international conservation efforts, with limited engagement or understanding of local land users.

3.3. Interactions dimension: relational lens

This dimension and lens, drawing on anthropology, ethnography, human behavioural psychology and human dimensions of wildlife, looks at how relations, attitudes and values towards wildlife affect human-predator interactions (Dickman et al., 2014; Hazzah et al., 2009) and interventions (Madden and McQuinn, 2015; Zimmermann et al., 2020), including feelings such as fear, admiration, and affection (Brenner and Metcalf, 2020; Rose and van Dooren, 2011). This dimension also encompasses diverse activities regarding the use, persecution or protection of focal species, killing or protection of related species such as prey, and destruction or improvement of species' habitat across the full spectrum of conflict to coexistence (Frank et al., 2019). Alternative ways of knowing, valuing and perceiving non-humans are vital (Ampumuza, 2022; Mabele et al., 2022), including more-than-human dimensions (Van Bommel and Boonman-Berson, 2022).

Guiding question: How have humans and predators lived together here?

- What are the problems from scientists' perspectives? What are the problems from local people's perspectives? What are the problems from the predators' perspectives? Have they changed over time?
- How do local people view this predator and their interactions with it? How do local people's views differ from each other and the scientists'?
- What alternative ways of knowing and valuing exist about this predator? To what extent are they recognised?
- Where are the unknowns?

The case of wolf (*Canis lupus*) conservation in Finland, a highly contested subject, illustrates this dimension and lens. CONVIVA's Finnish team explored attitudes and perceptions of wolves and wolf conservation in Lieksa, eastern Finland. Interviews and participant observation have demonstrated diverse viewpoints, yet also significant opposition towards wolf conservation despite economic damages from wolf depredation being relatively limited. Examining the social and psychological dimensions of wolf conservation, it becomes evident that wolves can be seen as symbols of conflicting ways of valuing nature (Komi and Nygren, 2023). Secondly, human-wolf interactions are shaped by collective and policy decisions (Komi and Kröger, 2022), such as livestock management, compensation being paid for electric fences, but not for the labour of upkeep in a challenging landscape, and free-roaming dogs used in recreational hunting. Coexistence habits can get lost, or disregarded: for instance, the importance of human scent around properties in keeping wolves away from them may be overlooked, with its present-day absence due to people moving less in their yards especially in winter. There is thus a need for a political ecology of responsibility, including examining power imbalances and questions of responsibility in human–wildlife interactions while attending to non-humans' intrinsic needs and patterns of behaviour (Komi and Nygren, 2023).

3.4. Institutions dimension: policy lens

This dimension, drawing on organisation, policy, management and legal lenses, relates to governmental policies and stakeholders' decision-making that influence conservation dynamics at different scales directly or indirectly, including non-governmental organisations or private institutions (König et al., 2020). Issues regarding governance, command and control approaches, incentives including environmentally harmful subsidies and engagement of different stakeholders (Mishra et al., 2017; Sandroni et al., 2022), are included here.

Guiding question: What conservation policies and decision-making systems have governed this predator?

- What is the protection status of the predator, prey and habitat?
- Are there any areas which are under different governments (e.g. Indigenous lands) or protected areas? If so, how are they governed?
- Who are the stakeholders in decision-making on predator conservation? What state, district, … policies are relevant to human-predator interactions?
- What policy measures have been taken to improve human-predator relations, and with what success?
- Where are the unknowns?

As discussed above, 40 % of Tanzania's lands are under nature protection (Noe et al., 2017), encompassing six types of protected areas ranging from national parks to wildlife management areas (Kiwango and Mabele, 2022). This is intended to protect species such as African lions, who are considered vulnerable. Four of the six types of protected areas are represented in the Ruaha-Rungwa ecosystem, subject to different governance arrangements in substance and authority. National Parks, allowing very limited use such as photographic tourism or wildlife research, are governed by Tanzanian National Parks (TANAPA). Game Reserves permit hunting by tourists and residents in specified 'hunting blocks' on top of photographic tourism, while Game Controlled Areas ban cultivation or grazing, with both under the Tanzania Wildlife Authority (TAWA). The fairly recent Wildlife Management Areas are governed by local and national governments, comprising village land with economically and ecologically viable resources (Kiwango and Mabele, 2022).

The abundance of wildlife habitat has likely contributed to larger predator populations; however, Tanzanian legislation makes living with such predators complicated. For reasons that remain obscure to many observers, wildlife damage in Tanzania is not compensated. A token 'consolation' is offered instead, in the form of minimal and insufficient cash payments depending on the damage type. Consequently, a conservation insurance scheme to compensate for social, economic and ecological consequences of wildlife tourism has been proposed (Kiwango and Mabele, 2022). Policies governing lion conservation are thus complex, and present particular challenges to those who must live alongside lions.

3.5. Justice dimension: political economy lens

This dimension, drawing on political economy and political ecology, concerns how historical and contemporary economic and power relations linking to class, gender, race/ethnicity, generation etc. intersect and affect conservation, human-wildlife and human-predator interactions (Frank et al., 2015; Pandya, 2022; Silva and Srinivasan, 2019; Turnhout et al., 2008). This equally encompasses the justice dimension

(McInturff et al., 2021; Massarella et al., 2022).

Guiding question: How does justice matter to landscape, humans and predators?

- Who lives here? How many people live here?
- What are their socio-economic and political living conditions/contexts? What are their main sources of income, and how precarious are they? What are the land ownership and access patterns?
- Who benefits or loses from the predator being here?
- How much has (in)justice shaped human-predator relations historically and currently, from human and more-than-human viewpoints?
- Where are the unknowns?

In the CONVIVA project, the California team explored potential reintroduction of brown bears (*Ursus arctos*), known locally as grizzly bears, in certain habitats in California, United States. They are estimated to have numbered 10,000 in the state before the 1849 gold rush, corresponding to eleven people for every brown bear. By 1924, brown bears were extinct in the state on account of quickly expanding human populations and new agricultural practices by European settlers. The brown bear is prominent on the state's flag and in its imagery, and there is an abiding perception that there continue to be brown bears in California. In discussions of any reintroduction, it will be essential to consider environmental justice, including multispecies, distributive, recognition and affective environmental justice (McInturff et al., 2021). These considerations are crucial to avoid legitimating or perpetuating human oppression; to identify what human agendas are being served; to evaluate material benefits and losses from reintroduction with a focus on justice and power; to understand whose voices, ways of knowing and valuing nonhumans are (not) considered in decision-making; and to question what roles are played by emotions especially regarding potential harms (McInturff et al., 2021).

4. Discussion & conclusion

This article sets out a blueprint for transdisciplinary collaboration and a framework to better understand human-predator interactions. The framework was developed in the multi-year CONVIVA – convivial conservation research project which brought together researchers from natural and social sciences and humanities to investigate four apex predators: jaguars in Brazil, wolves in Finland, lions in Tanzania and brown bears in California, U.S. Given our project's focus on charismatic predators, we continue the emphasis on charismatic megafauna inherent to much of conservation (Barua, 2016) and human-wildlife coexistence literature (Marchini, 2014). However, predators are considered keystone species, anchoring larger ecosystems, and posing particular challenges for humans.

Addressing shortcomings in existing literature, our approach focuses on power, political economy and history, overcomes disciplinary silos, celebrates plural knowledges beyond western science, and goes beyond conflict. We emphasised firstly the need to build into transdisciplinary projects collaborative, dialogue-based reflections, bringing together researchers and conservation practitioners from different disciplines, on the assumptions that inform what research questions, methods or units of analysis are considered pertinent (Agrawal and Ostrom, 2006). This iterative collaboration resulted in a framework of five interconnected dimensions of analysis (the 'what') with related lenses (the 'how' of exploring hese) with guiding questions to operationalise our insights on convivial conservation. The five dimensions of analysis – wildlife (animal behaviour lens), environment (landscape change lens), interactions (relational lens), institutions (policy lens), justice (political economy lens) – were populated with guiding questions drawing on examples from our four case studies. While our framework was designed for apex predators given their often more consequential interactions with humans, we propose that the framework may also be useful for smaller predators or other species at the centre of tense human-wildlife interactions such as elephants given their large home ranges.

In terms of key lessons, our dialogue-based process highlighted the advantages and challenges of working across disciplines. Building mutual understanding required rigour and nuanced engagement on multi-faceted terms such as 'communities' or 'coexistence' by negotiating different disciplines and researchers' understandings. Centring findings from the four case studies in collective workshops allowed us to develop an inductive understanding of coexistence. While some of our dimensions remain more focused on social science (justice and interactions) and some are more natural-science-driven (wildlife and environment), we aimed to include questions inspired by different disciplines in each dimension. Reflexivity was an important part of this process (Montana et al., 2020), through collaboration in groups encompassing different geographical areas and different disciplines. This inverted traditional modes of understanding and produced new collaborative insights (McInturff et al., 2021; Sandroni et al., 2022). However, as there are limits to our knowledge, we have included 'where are the unknowns' in each dimension.

In our approach, we also sought to incorporate diverse knowledges and knowledge holders particularly through our Tanzanian and Brazilian examples. Where, and by whom, different forms of knowledge and foci have been shaped is significant given the importance of overcoming dominant, yet inherently partial 'western' forms of knowledge (Mignolo, 2007; Quijano, 2000). This also means reflecting on how more-than-human viewpoints (Van Bommel and Boonman-Berson, 2022) and non-western epistemic worlds can be incorporated into research (Ampumuza, 2022; Kuokkanen, 2007; Sundberg, 2014). Our question-based approach has achieved this by drawing on diverse knowledges and acknowledging different knowledge holders (e.g. interactions dimension). However, the wider aspiration of convivial thought (Büscher and Fletcher, 2019, 2020) is not to cede knowledge production to elites, but support a convivial co-creation of knowledge which is accessible to and involves all. An opportunity for further research would be to test our framework in conversations with local residents in respectful, dignified, and partnership-oriented ways (Mishra et al., 2017; Wyborn and Evans, 2021).

Thirdly, our analysis operationalises a consistent attention to structural imbalances in justice and power across diverse scales and parties (Büscher and Fletcher, 2019, 2020; Dietsch et al., 2021) Therefore, we ask who is involved - and how - at different scales in policy and decision-making on these human-predator interactions (institutions dimension). Despite inherent difficulties in appropriately identifying, representing and incorporating more-than-human viewpoints (Madden, 2014), our framework includes a more-than-human dimension in terms of asking whether human and more-than-human responsibility, power and justice are considered systematically and fairly (Komi and Nygren, 2023; Srinivasan, 2022). Underlying norms and power asymmetries related to human-wildlife interactions shape knowledge production, but are rarely acknowledged (Lahsen and Turnhout, 2021). Thus, we recognise and engage critically with the ways that conservation interventions are shaped by human and more-than-human lives being disenfranchised, colonised or impoverished (McInturff et al., 2021; Sundberg, 2014). Consequently, our questions ask whose knowledges are considered or silenced (interactions dimension), and who benefits or loses from the predator's presence amid ongoing political-economic dynamics (socio-political dimension).

Finally, we shift focus from conflictual human-nonhuman connections to a continuum of interactions (Frank et al., 2019), while recognising that conflict can also be a part of coexistence (Pooley et al., 2020). We go beyond focusing on biological factors from predator to prey behaviour, societal factors ranging from values and identities, or economic losses inciting conflict (Madden and McQuinn, 2015; Zimmermann et al., 2020), towards allowing for the possibility of constructive, convivial human-predator relations and coexistence (Frank et al., 2019; Marchini et al., 2021). To promote a change in how these situations are framed and approached, we inquire about values and viewpoints of

predators (interactions dimension), while allowing for more convivial implications (environment dimension, justice dimension). Recognising the messiness of living together between and among humans and more-than-humans, our framework creates ways to acknowledge different disciplinary starting points while operationalising convivial conservation's focus on coexistence, biodiversity and justice into interconnected dimensions of analysis.

CRediT authorship contribution statement

Judith E. Krauss: Conceptualization, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Valentina Fiasco:** Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Silvio Marchini:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Methodology. **Alex McInturff:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Methodology. **Laila T. Sandroni:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Methodology. **Peter S. Alagona:** Data curation, Writing – review & editing, Funding acquisition. **Dan Brockington:** Data curation, Writing – review & editing, Funding acquisition. **Bram Büscher:** Funding acquisition, Writing – review & editing. **Rosaleen Duffy:** Funding acquisition, Writing – review & editing. **Katia Maria P M de Barros Ferraz:** Data curation, Funding acquisition, Writing – review & editing. **Rob Fletcher:** Funding acquisition, Writing – review & editing. **Wilhelm Andrew Kiwango:** Data curation, Writing – review & editing, Formal analysis. **Sanna Komi:** Data curation, Formal analysis, Writing – review & editing. **Mathew Bukhi Mabele:** Data curation, Formal analysis, Funding acquisition, Writing – review & editing. **Kate Massarella:** Visualization, Writing – review & editing. **Anja Nygren:** Data curation, Funding acquisition, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Details on collaborative workshops, interactive game & developing dimensions of analysis

Workshops 1&2 (Brazil: Laila Sandroni, Silvio Marchini)

- All CONVIVA team members (natural sciences, social sciences, humanities) plus partners/practitioners from government agencies, non-governmental organisations and conservation practice working on the four apex predators were invited.
- The main goal was to share pre-existing experience among CONVIVA teams to think about the coexistence conceptual framework and how it could help us move forward in terms of connecting social and natural sciences and humanities.
- The following provocative questions were used to incite discussion and elicit different perspectives from our diverse team of researchers:

● What are the differences you recognise between the perspectives of social and natural sciences' approaches to coexistence?
● Do we need to have one definition for coexistence or should we embrace its vagueness?
● Does the concept of coexistence open opportunities for a transdisciplinary approach? How?

- A well grounded and rich discussion followed about the general tendencies in terms of research and practice in conservation through a coexistence approach and how they relate to the different epistemic backgrounds encompassed by the CONVIVA network.
- Resulting consensus recognised that a single definition would not be possible and that while social sciences tend to incorporate the different meanings as part of the investigation, natural scientists tend to pick a more adequate single definition to move forward.
- A second consensus related to the fact that more problem-focused perspectives from conservation biology and practice could be complementarily addressed by political-economic analysis of conservation efforts, such as a focus on social justice, levels of power struggles at stake, and economic structures defining contexts for human-wildlife interactions.
- In a second round of discussions we focused on the case studies to deal with the challenges of comparative and multi-sited methodologies, given the diversity of situations and methodologies covered by the project. The initial proposal was to highlight aspects of each cases through a common coexistence framework that recognises 5 different levels on complex realities of human-wildlife interactions, namely: Ecological (e.g. damage to livestock, patterns of movement); Behavioural (e.g. use/persecution of focal species, killing of its prey); Individual/group (e.g. cognitions and feelings towards the species/management: knowledge, beliefs, attitudes, acceptance, perceived social norms, trust, motivations, fear); Institutions (e.g. governance, capacity, interventions in place: command & control, community engagement, incentives); and Societal (broader political, economic and societal structures).
- The case study teams completed a table with the main elements regarding each level (see discussion in Section 3; an early version of this table was the basis for Appendix B below).
- Based on this, the Brazilian team proposed an interactive game as an experimental form of engagement for workshop 2. The game consisted in a series of cards stating a sentence about one of the case studies, extracted from the above-mentioned table, but without stating what case it was from ('unrevealed card', cf. below for an example).

- People were divided in groups of 4–6 comprised of different country teams; the groups were invited to guess which case the card referred to and in which dimension of analysis.
- Finally the groups received 'revealed' cards and discussed what they found surprising or relevant regarding two main aspects: 1) acknowledgement of aspects of their own and the other case studies; 2) Relations to the collectively conceived notion of coexistence and proposed framework (cf. below for an example).
- The game served both as a tool to recognise cross-cutting themes, limits and possibilities of the suggested dimensions of analysis and to increase knowledge inside the project itself. By testing people's knowledge about their own and the other case studies, we opened space for the recognition of possible comparisons and collaborations, as well as refining our perspectives on a framework to address human-wildlife interactions through a coexistence focus.

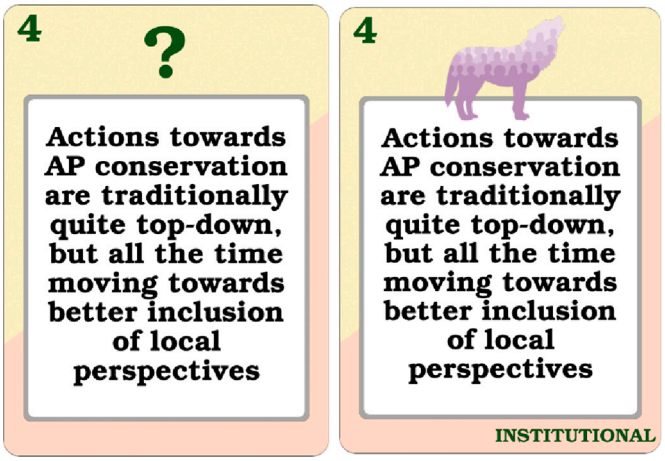

Fig. A.1. 'Unrevealed and revealed cards for interactive game. Unrevealed card says: 'Actions towards AP conservation are traditionally quite dtop-down, but all the time moving towards better inclusion of local perspectives.' Revealed card shows this to be from the 'institutional' dimension and applicable to the wolf/Finland case.

Workshops 3&4 (US: Alex McInturff, Peter Alagona)

- In terms of attendance, again all CONVIVA team members (natural sciences, social sciences, humanities) plus partners/practitioners from governmental agencies, non-governmental organisations and conservation practice working on the four apex predators were invited.
- In our CONVIVA meetings, we were struck by similarities in all the projects across continents. In particular, we were fascinated and excited to see that in the interactive game described above, it was often hard to tell which case study was being referred to, because many contexts could be described by the same statements.
- These similarities suggested that we might investigate whether there were underlying principles, mechanisms, or conditions that determined the success or failure of coexistence projects in multiple contexts.
- Our group is not the first to make this kind of inquiry, and existing scholarship tends to break into three domains: 1) Research on technical solutions to mitigate human-wildlife conflict that might apply broadly. Understanding how non-lethal tools work, for example, or how economic incentives work to limit conflict, and facilitate coexistence; 2) Research on the human-human conflicts underlying HWC. Studies of values, attitudes, morals, identities, beliefs, etc. These are generally conducted at the individual behavioural level, and might be considered a different kind of solutions-oriented approach, but derived more from the social than the natural sciences; and 3) Research on broad political, economic, and historical conditions and how these might set the stage for conflicts, though this domain remains an important site for future research.
- Rather than subscribe to one of these theoretical approaches, we turned to CONVIVA's empirical foundations in its four case studies. We conducted a self-examination of our four cases, which take place across a range of geographical, social, and ecological contexts. From this ground-up analysis of our empirical case studies, we aimed to identify common elements that might cut across disciplinary approaches to understanding coexistence.
- To put this approach into practice, we developed a list of over 200 statements derived from previous CONVIVA meetings or solicited from group members about the most important issues facilitating or inhibiting coexistence in their case study.
- We distilled this list into 36 statements that captured the diversity of responses and categorised these into four themes: social trust, political economics, material consequences, and predator characteristics.
- We asked members of the four case studies to rank each statement from 1 (strongly disagree) to 5 (strongly agree).
- We then summarised the results of this exercise as prompts for group discussion, which occurred in multiple formats, and which focused not only on interpreting the results but also emphasised developing new theses.
- This exercise provided important lessons in terms of both its content and its process.
- In terms of the content of the exercise and discussions, our analysis pointed to several cross-cutting themes. For example, all projects tended to share a scepticism about the role of private lands conservation in promoting coexistence, even as this approach has become an important cornerstone of global conservation movements like 30 × 30. All the projects also agreed that conservation has potential to make people better off, but group discussions emphasised important nuances to this point of agreement and a need for further transdisciplinary research to articulate how this might occur. While all groups agreed on the importance of the material consequences of coexistence, the symbolic and cultural importance of these species was also stressed, suggesting another important avenue for transdisciplinary research to contribute.
- When it came to questions of political economy, there was a wider range of responses, emphasizing that local context remains vital to understanding questions of coexistence.
- While these findings offered some clarity about a diverse range of important aspects to understanding coexistence, the process itself also taught important lessons about transdisciplinary practice. Centring the details of the four case studies and comparing their characteristics allowed our

group to avoid allegiance to a particular body of theory, and instead to develop an understanding of the elements of coexistence from the ground up.
- This approach was made possible by the diverse backgrounds of CONVIVA members, whose training in natural and social sciences and humanities provided a wide-ranging list of considerations that spanned existing theories and suggested new avenues of research.
- Reflexivity was an important part of this process as well, as our analysis did not end with the ranking of statements. Instead, in group discussions with members from distinct geographies and disciplinary backgrounds and perspectives, we made sense of these statements and developed new theses based on these findings.
- This approach, which begins with empirical details drawn from transdisciplinary groups rather than from an established theoretical approach to understanding coexistence, inverts traditional modes of understanding and produces new collaborative insights into this complex topic. The most challenging aspect is organisational, as without the established network of researchers involved in CONVIVA, convening this kind of multi-sited, collaborative, ground-up analysis of case studies would be a difficult challenge.

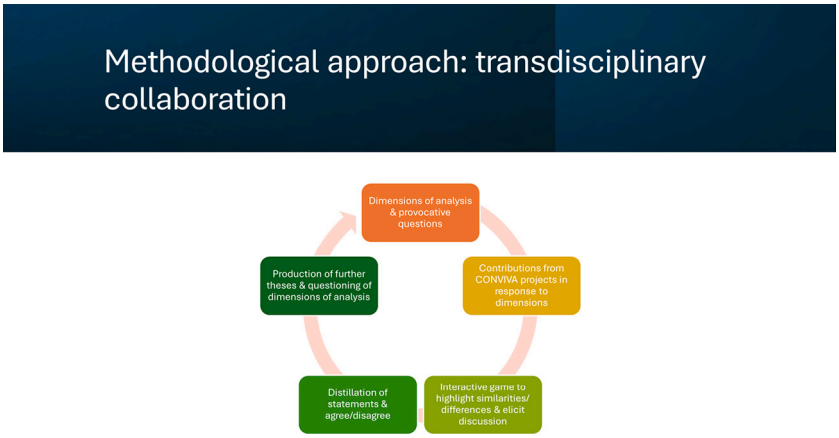

Fig. A.2. Methodological approach: transdisciplinary collaboration
Circular relationship between:

1) Dimensions of analysis & provocative questions
2) Contributions from CONVIVA projects in response to dimensions
3) Interactive game to highlight similarities/differences & elicit discussion
4) Distillation of statements & agree/disagree
5) Production of further theses & questioning of dimensions of analysis

Appendix B. Dimensions of analysis with further case study details

B.1. Wildlife Dimension: Animal Behaviour Lens

Guiding question: What brings the predator into contact with humans?

- What is the predator's ecological role in relation to the ecosystem and other species?
- What do we know - from research and from local people - about the predator's behaviour, movement, natality and mortality? What does the predator eat (including domestic animals)?
- How often does the predator encounter humans? What interactions occur?
- How are natural and human-induced changes affecting the predator's movement patterns into human-dominated landscapes (connectivity issues, habitat, vital resources)?
- Where are the unknowns?

Table B.1
Wildlife dimension (animal behaviour lens).

BR/jaguars (in detail in text): - jaguar: Neotropical top predator; important for conservation and ecosystem due to ecological functions & cascade effects - Critically endangered in Atlantic Forest; 85 % of jaguar's habitat lost - Ecological factors determine jaguar population size: natality, mortality, immigration, emigration. Shaped by changes in habitat quality/prey base and human behaviour (cf. below) - Jaguar abundance is generally very low in the Atlantic Forest: estimated population size of 51 individuals along the	Finland/wolves: - Livestock predation is not a huge issue, e.g. in comparison to monetary damages caused by large ungulate populations (which wolves predate) - Most of the packs keep within their territory, usually sightings closer to human habitations are young male individuals searching for mate and territory - Traditionally, local ecosystems, especially forests, were central for game, firewood, swidden cultivation - Humans traditionally seen as inseparable part of nature; wolves	Tanzania/lions: - Lions example of charismatic megafauna; important predators of herbivores and deemed keystone species - Estimated to now have largest lion population in the world - In the Ruaha-Rungwa ecosystem, human-wildlife interactions often result in livestock depredation (mainly by predators such as Lions, Hyaenas, wild dogs, Cheetah, Leopards etc.) - Ruaha-Rungwa ecosystem deemed critical for ensuring landscape connectivity between protected areas; Park bordered by villages and wildlife	US/grizzly bears: - Grizzly bears in California were driven to extinction in large part due to conflicts with livestock producers, but: agricultural employment has decreased significantly, to ca. 1–2 %, reducing likelihood of acute conflicts due to fewer livestock animals, a different set of cultural values, and protective laws - Vocal minority in California, especially rural California, will stress the importance of livestock depredation - Unknown: bear conflict over other prey species, e.g. game species like deer or elk (not important part of diet – mountain

(*continued on next page*)

Table B.1 (*continued*)

'Serra do Mar' mountain range corridor (SM) and 28 in Iguaçu National Park (INP), with evidence of a population recovery in this latter site - Human-jaguar encounter rates are consequently low - Few reported attacks on domestic dogs in SM in recent years. Attacks on livestock outside INP were an issue a few years ago - Problems involving pumas are far more common (including one fatal attack on a human in Southern Brazil, same region where INP is located): jaguars are sometimes wrongly blamed for livestock losses to pumas (e.g. sheep, calves) and sometimes even to domestic dogs - Efforts to improve perceptions in & around INP	hunted for pelts; changing in the 1960s (conservation institutionalised) - Encounters between humans & wolves happen, with numbers of wolves increasing the likelihood: e.g. wolves have learnt to use roads - many forests, but most of them industrial monocultures	management areas; elephants and large carnivores roam freely between protected areas and wildlife management areas	lions targets of scorn from local hunting groups because of the large number of deer that comprise their diets) - Direct and indirect conflicts with humans might be the most important interactions to consider. Direct attacks on humans rare, but always generate a lot of news coverage and have been known to rapidly change public opinion - Much more common would be indirect effects, like bears raiding trash or breaking into homes, especially empty vacation homes (common with black bears already; brown bears larger and more aggressive)

B.2. Environment Dimension: Landscape Change Lens

Guiding question: How is the landscape changing?

- In what landscape does the predator occur, and how is the landscape demarcated (geographically, legally)? How has this changed over time?
- How is environmental and climatic change affecting the landscape? How is land use changing?
- How much is landscape change affecting the predator and human-predator interactions?
- How are perceptions of change (real or otherwise) affecting interactions?
- How likely is it that the landscape, and its uses, generate human-predator conflict?
- Where are the unknowns?

Table B.2
Environment dimension (landscape change lens).

Brazil/jaguars: - Considerable ecosystem & landscape change; highly populated, intensively anthropogenic and fragmented landscapes - Killing of jaguars, for preventative and retaliatory reasons, and for reasons not related to conflict too, has always happened - Prevalence of this behaviour arguably in decline (in part due to the decline in jaguar population size). In INP, reports are mostly from the 90's (perhaps because cattle ranching was more common than today: cattle ranching has been replaced to some extent by soy growing) - Killing of jaguar prey species for various reasons is common throughout jaguar range; particularly acute in some areas of SM - Certain husbandry practices increase livestock vulnerability to jaguar predation (but also, and sometimes more importantly, to puma predation) - Illegal extraction of heart-of-the-palm by 'palmiteiros' may have direct (e.g. killing) and indirect (e.g. opening of new forest trails, constraints to the operation of park rangers) effects on jaguars	Finland/wolves: - Considerable ecosystem & landscape change - State owns large swaths of forest; 1970s & 1980s with clearcutting and peatland draining transformed landscapes - Heavily managed, monocultural forest landscapes mean wolves often encounter people, often inside machines - Wolves go where there is enough prey and territory that is not too fragmented - Illegal killings of wolves are the biggest cause for the stagnation of Finnish wolf population - Predation prevention with electric fences: materials are free, and volunteers often help erect fences. Maintaining the fences means extra work for livestock producers - Regulation of hunting permits for ungulates takes predators into account (at least on paper); there might be regionally specific difficulties related to volunteer-based research on different game populations, which form the foundations for population management and hunting permits	Tanzania/lions (details in text): - Considerable ecosystem & landscape change - Climate of Ruaha-Rungwa ecosystem (important, multiple protected areas): primarily semi arid to arid - In the ecosystem, the pastoralists (mainly the Maasai and Barbaig) have had cultural killings related to predators, particularly lions as a rite of passage to becoming Maasai warriors. In case of livestock depredation, retaliatory killings are often the norm. Programmes to reduce these killings are in place (e.g. Lion Landscapes, formerly Ruaha Carnivore Project), for example, educating the locals, improving livestock husbandry practices etc.	US/grizzly bears: - Considerable ecosystem & landscape change - In sum: abundant ecological subsidies available on the contemporary California landscape are likely to be important sites and drivers of brown bear conflicts. Minimising the availability of these subsidies would be one ecological means of promoting coexistence - With other reintroduced carnivores, like wolves, behaviours like poaching have in some cases represented major threats to the viability of reintroduction programmes - Currently, hypothetical bears enjoy pretty wide support from both urban and rural individuals - but that could all change with politicisation - Conflicts with analogous species like black bears are often the result of human behaviours within bear habitats (e.g. leaving aromatic foods in a car in Yosemite NP), which can lead to conflicts that have wider influence on public attitudes towards coexistence

B.3. Interactions Dimension: Relational Lens

Guiding question: How have humans and predators lived together here?

- What are the problems from scientists' perspectives? What are the problems from the local people's perspectives? What are the problems from the predators' perspectives? Have they changed over time?
- How do local people view these predators and their interactions with it? How do local people's views differ from each other and from the scientists'?
- What alternative ways of knowing and valuing exist about this predator, e.g. stories, lived experiences, …? To what extent are they recognised?
- Where are the unknowns?

Table B.3
Interactions dimension (Relational lens).

Brazil/jaguars:	Finland/wolves (details in text):	Tanzania/lions:	US/grizzly bears:
- Wicked problem of balance between protection and natural-resource use - Landscape & habitat quality & prey base changing - In fragmented landscape, very presence of jaguar can be challenging for local communities - Different knowledges present and needed - Despite the low rates of encounter, the jaguar is the 'top of mind' species among children, teenagers and adults in both study sites: it is the first species to be mentioned when local people are asked 'What species do you know to occur in this region?" - Fear is a prevalent feeling towards jaguars, even in some places where jaguars are not present anymore - Nonetheless, knowledge about the species (e.g. distinguishing between jaguar x puma x domestic dog predation on livestock) is generally low - Trust in the wildlife authority has been shown to affect the acceptability of jaguars (and pumas) in the Serra do Mar mountain range	- Highly contested: wolves seen as symbols of conflicting ways of viewing nature - Human-wolf interactions: shaped by collective/policy decisions, and loss of coexistence habits - Polarisation: most Finns have a neutral/positive stance towards wolf conservation, but there are very vocal proponents and critics - Proponents vilify critics. Critics do not trust authorities nor scientists, and amplify frustration and fear, while circulating alternative facts/full-blown conspiracy theories about wolves and their conservation - Understanding of wolf behaviour in general very low; coexistence habits are getting lost	- Usually the species that cause damage/livestock depredation/loss of people's lives are the most feared (e.g. Lions, Leopards, Elephants). - Loss of lives causes psychological trauma to communities, resentment, and the urge to retaliate. - This can happen collectively or at individual level depending on the extent of the conflict/damage - Alternative ways of knowing not always incorporated into conservation – western science often favoured, e.g. Indigenous knowledges or approaches such as Ubuntu not taken seriously in conservation implementation	- One of the strongest individual considerations is not really about the bears themselves at all, but rather about individual relationships and interactions with notions of or exertions of 'institutional' power. There are some famous (and maybe apocryphal) stories of people hanging confederate flags over the carcasses of poached wolves to symbolise their killing as a rejection of the perceived federal overreach involved in reintroducing wolves. This same potential could apply to grizzly bears. Grizzly bears also have really powerful but diverse symbolic power in California. They are on our state flag. They are the mascot of several state universities. For many, including some of the strongest advocates of reintroduction, they are symbols of wilderness, without which the state's wildlands aren't really wild

B.4. Institutions Dimension: Policy Lens

Guiding question: What conservation policies and decision-making systems have governed this predator?

- What is the protection status of the predator, prey and habitat?
- Are there any areas which are under different governments (e.g. Indigenous lands) or protected areas? If so, how are they governed?
- Who are the stakeholders in decision-making on predator conservation? What state, district, … policies are relevant to human-predator interactions?
- What policy measures have been taken to improve human-predator relations, and with what success?
- Where are the unknowns?

Table B.4
Institutions dimension (Policy lens).

Brazil/jaguars:	Finland/wolves:	Tanzania/lions (details in text):	US/grizzly bears:
- Diverse institutions (governmental, non-governmental, practitioners, academic community, private sector) play a role in shaping context; some supportive, some powerful opponents of jaguars - The National Center for Carnivore Research and Conservation (CENAP/ICMBio) and Jaguars of Iguaçu Project/	- Institutional decision-making has been conventionally quite top-down, but moving towards better inclusion of local perspectives - Early landscape protection: species conservation only one concern; game protection (concern for hunting conservationists) initially synonymous	- Institutionally, crop damage by elephants is consoled by the government (but not compensation in "like for like" or in real economic terms, but a token), and often this takes time to be implemented. It has been a source of debates at the community and national levels (debates in parliament)	- In last 50 years, changes in economies and value systems have promoted increasing legal protections for carnivores and some reintroductions of large carnivores - Indigenous groups have campaigned for legal rights of nature - If brown bears are successfully

(*continued on next page*)

Table B.4 (*continued*)

INP provide some assistance to the affected social groups, but with limited budget and coverage - Specialised education and communication interventions conducted by Jaguar of Iguaçu Project/INP - A number of institutions can affect human-jaguar interactions in the Atlantic Forest, but Jaguars of Iguaçu we believe is the only one dedicated exclusively to the species - CENAP/ICMBio has a National Action Plan for the Conservation of Big Cats (combining the previous separate plans for the conservation of the jaguar and the puma) and has produced a specific plan for the conservation of jaguars in the Atlantic Forest	with persecuting predators - New SusiLife project promotes dialogue and coexistence - Historical links to the hunting association within one of the governing institutions - Population management tends to react to local frustrations and controversies, but it does not seem to resonate with the critics at the local level - This reactiveness makes conservationists wary of governance. Within population management, and other similar activities, critical views often get multiple seats at tables (= multiple critical stakeholder groups invited), while conservation only gets one ⟶ lopsided representation of attitudes towards wolves - Wolf-critical populist politicians make things more difficult	- The current law in place prohibits wildlife killings except for self-defense purposes. The compensation policy is often debated in parliament, but the government always insists on its intent to compensate all affected parties. Conservation Programmes by NGOs, such as the RCP help in educating communities and devising incentives for communities to refrain from retaliatory or cultural killings of predators	reintroduced, it will likely be through an argument based on the federal and/or state Endangered Species Acts - The bears' very existence would come from an institutional mandate that they coexist with the people of California - However, the landscape of institutions in California is complex, and formed by multiple scales of governments, but also non-profits, business-oriented groups, associations of many kinds etc. - There would be a range of positions from opposition to indifference to support for grizzly bear reintroduction at every institutional scale

B.5. Justice Dimension: Political Economy Lens

Guiding question: How does justice matter to landscape, humans and predators?

- Who lives here? How many people live here?
- What are their socio-economic and political contexts? What are their main sources of income, and how precarious are they? What are the land ownership and access patterns?
- Who benefits or loses from the predator being here?
- How much has (in)justice been a factor in human-predator relations historically and currently, from a human and more-than-human viewpoint?
- Where are the unknowns?

Table B.5
Justice dimension (political economy lens).

Brazil/jaguars:	Finland/wolves:	Tanzania/lions:	US/bears (details in text):
- Convivial perspective centres inequalities/ political economy, which matter in saving jaguar in most anthropogenic landscape in Latin America - Magnitude of economic incentives relevant, as are sociopolitical factors (e.g. influence of ruralists/large farmers) - Livestock production important source of income and identity - High visitation rates to INP may have direct and indirect implications for human-jaguar interactions - The jaguar is heavily present in the INP promotional materials, but there is no jaguar-oriented tourist activity in place - There is no insurance/ compensation scheme in place	- Livestock production has some political significance and is economically partly relevant. However, economic losses due to wolf depredation are lower than in countries with strong sheep farming – still encounters can be sources of fear/anxiety - From 19th into 20th century, state divided animals into useful vs. harmful based on economic value and monetary profit; game hunting became nature economics - commodification of dead wolves - after World War II: forestry has been highly important in economic growth, especially in rural areas. 2021: 10 % of exports from forests; 70 % of Finnish lands under industrial forestry - eastern Finland: clearcuttings in lands owned by state, fund management companies, corporations partly critiqued; scepticism towards nonlocal ownership/ commodification. However, many believe they have personal right to profit from forest ownership. Forestry pervasive – often utilitarian attitudes - Peripheral rural regions: often feelings and experiences of political alienation and social marginalisation	- Livestock production is important livelihood - Conservation and related short-term tourism is a key source of economic income nationally, leading to tourists' interests being prioritised over those living with e.g. lions. Tourism revenue key financing for conservation; national parks directly funded through visitor fees - Conservation benefits not always felt locally by surrounding communities; local authorities can display rent-seeking behaviours - Conservation enforcement involves much more violence than in e.g. Brazil, US, Finland. State agencies can continue a colonial mindset towards surrounding communities	- Largest human population of any US states; different population density to where bears currently occur in the US - Global environmental and land-use changes have produced unhealthy environments and differential impacts on different groups, but disproportionate impacts on vulnerable humans ⟶ environmental justice important - Bears extinct after expanding human population and new European settlers' agricultural practices - Today: Livestock production is important, but overall change in employment/role of agriculture in economy (less important now than when bears lived in California) - However, where livestock predation would occur, considerable economic repercussions for subsistence livestock producers. Potential of human harm. Could potentially entail economic benefits, but would vary by occupation, location, gender etc. - Fear could be political issue

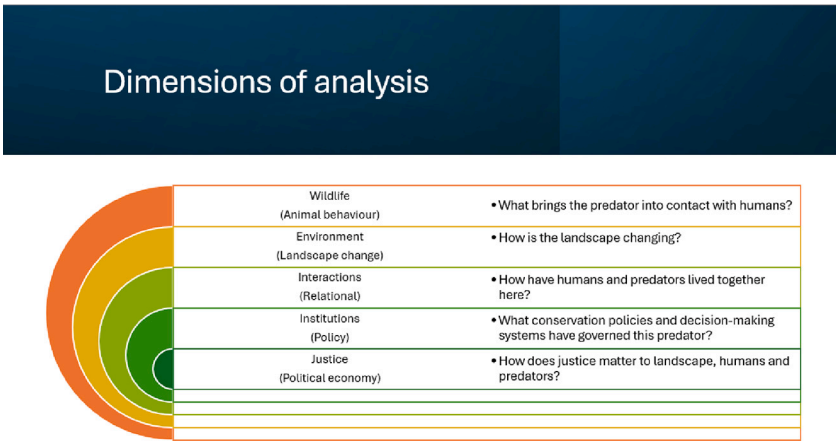

Fig. B.1. Dimensions of analysis

- Wildlife (Animal behaviour): What brings the predator into contact with humans?
- Environment (Landscape change): How is the landscape changing?
- Interactions (Relational): How have humans and predators lived together here?
- Institutions (Policy): What conservation policies and decision-making systems have governed this predator?
- Justice (Political economy): How does justice matter to landscape, humans and predators?

Data availability

Data will be made available on reasonable request.

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