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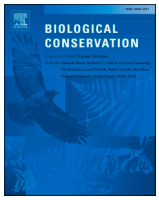

Perspective

Individuals in focus: Individuals as the ecological and ethical center of human-wildlife conflict

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ABSTRACT

The increased occurrence of human-wildlife interactions, due to climate change, land use change, habitat loss, and other anthropogenic impacts, necessitates better mitigation or adaptation. At the same time, developments in conservation ethics are converging on the need to recognize and value both human and non-human values within conservation practice. Better understanding of negative human-wildlife interactions can improve conservation management. In this paper, we interrogate what human-wildlife conflict is, who is involved, why it happens, and how we can better mitigate its occurrence. We describe how centering both human and non-human individuals allows wildlife management to leverage interdisciplinary tools for both better mitigation and ethical practices. We highlight existing interdisciplinary tools such as critical anthropomorphism, personhood, agency, and personality which can be used to conduct individual-based management strategies, as well as other tools that are already used to identify, understand, and monitor individuals. Ultimately, by centering the needs and perspectives of individuals, we assert that a more nuanced understanding of human-wildlife conflict can be achieved, leading to the development of effective and inclusive management strategies.

1. Introduction: The what and the who

Human-wildlife conflict (hereafter HWC) is a pressing conservation concern and rife with ethically challenging scenarios, including managing human and non-human stakeholder needs (Braczkowski et al., 2023), using limited funds to solve issues that arise from human and non-human encounters (Ravenelle and Nyhus, 2017), and managing conflict between humans and non-humans over natural resources (Treves, 2007). These situations often force practitioners and policymakers to make difficult decisions with little guidance (Braczkowski et al., 2023; Ferraro et al., 2021; Nyhus, 2016; Woodroffe et al., 2005a). Recently, the field of conservation ethics has developed to help navigate difficult questions in wildlife management (Ferraro et al., 2021; Nelson et al., 2021). As a subdiscipline of environmental ethics, conservation ethics integrates applied and moral philosophy to guide human interactions with wildlife (Batavia et al., 2021; Nelson et al., 2021; Wallach et al., 2020), interrogate underlying norms and assumptions within conservation (Ferraro et al., 2023; Karr et al., 2022), and provide guidance for the morally fraught decisions conservationists must make (Batavia et al., 2021; Sommer and Ferraro, 2022). This guidance includes the decisions that are made in managing HWC (Dubois et al., 2017).

HWC is an antagonism between people and wild animals, including actions, threats, or perceptions by either group that adversely affect the other (Woodroffe et al., 2005a). Within HWC, the intrinsic value and moral worth of individual humans is uncontentious. Yet the intrinsic value of non-human individuals or collectives is still debated. Work conducted by many conservation ethicists suggests that conservation should no longer abide by the historical norm of solely valuing ecological collectives (ecosystems, species, populations). Instead, it is scientifically and morally appropriate to recognize the intrinsic value of non-human individuals, too (Ferraro et al., 2023; Wallach et al., 2018). Conservation ethicists have shown that when all human and non-human individuals are intrinsically valued, they become the unit of scientific and moral focus, which is necessary for studying many ecological and conservation questions (Ferraro et al., 2023).

Recognizing and valuing the human and non-human individual is particularly beneficial in the study of HWC, where individual humans

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and non-humans' unique dispositions and environmental settings affect whether human-wildlife interaction results in conflict or coexistence. While HWC mitigation frameworks often recognize singular events involving individuals (i.e., Carter et al., 2019; Manfredo and Dayer, 2004), most research draws conclusions about any given event based on group- and community-level characteristics, and reporting is often aggregated (i.e., reported as frequency). Yet the physical act of conflict occurs at the individual level—meaning individual humans and individual animals participate in a unique interaction that results in conflict (e.g., a particular deer destroys a specific human's garden; Fig. 1). Conflict may be mediated by a particular landscape context, but conflict and non-conflict interactions are also driven by an individual's perceptions, behaviors, and actions (Fig. 1).

In this paper, we demonstrate that centering the individual in both research and practice provides the scaffolding necessary to better identify, understand, and ethically mitigate HWC. We show how individual differences among animals and humans can directly create or exacerbate HWC, meaning that the consideration of specific individuals is needed for effective mitigation. We then demonstrate emerging techniques and tools that can address individual-based HWC and may ultimately facilitate coexistence. We conclude by encouraging practitioners and scientists to prioritize individuals in HWC in conjunction with work conducted at the population-level. In doing so, practitioners can carefully interrogate the underlying norms guiding their field and make meaningful contributions to coexistence for both humans and wildlife.

2. Unit of focus.

2.1. Individual non-humans

Conservation Biology was established as a field that values ecological collectives (e.g., ecosystems, species, and populations) but not individual animals (Soule, 1985). Such dismissal of individual value has become dogmatic in conservation (Ferraro et al., 2023; Nelson et al., 2021), leading to a historical practice that not only ignored the extrinsic value of individual diversity and individuals themselves in ecosystem function, but also the intrinsic value of individual animals (Ferraro et al., 2023; Nelson et al., 2021; Wallach et al., 2018).

In the last two decades, there has been a renewed recognition of the ecological value of individual diversity and non-human individuals. Specifically, studies have begun to demonstrate non-human individuals vary along numerous trait axes, including personality, habitat use, reproductive success, stress responses, and responses to anthropogenic disturbances (Bejder et al., 2009; Buderman et al., 2018; Modlmeier et al., 2014; Sommer and Schmitz, 2020; Fig. 1). For example, lions (*Panthera leo*) that are the least-risk averse and thus potentially most prone to HWC tended to be sub-adult males who select for woodland compared to the optimal habitat use of shrubland and grassland (Elliot et al., 2014). Similarly, a study on the intraspecific differences of brown bears (*Ursus arctos*) in conflict behavior demonstrated that conflict individually varied within a population (Berezowska-Cnota et al., 2023). Simultaneously, there is growing work that demonstrates how a non-human individual organism can shape a community (Arroyo-Correa et al., 2023; Bolnick et al., 2003; Brehm and Mortelliti, 2022; Modlmeier et al., 2014) and how organismal variation has important conservation implications (Bolnick et al., 2011; Des Roches et al., 2018). Thus, many sub-fields of conservation biology, such as behavioral ecology, landscape ecology, and conservation genetics, now recognize the importance of variation among and within specific non-human individuals. For example, non-human individual diversity in temperament can lead to successful population reintroductions (Myles-Gonzalez et al., 2015), while a unique non-human individual's personality can influence ecological processes such as dispersal, social organization, and niche expansion (Modlmeier et al., 2014).

Simultaneous with the recognition of the ecological value of individual animals and individual diversity, work within conservation ethics has demonstrated a growing philosophical consensus around the intrinsic worth of non-human individuals (Ferraro et al., 2023; Vucetich and Nelson, 2007). Many ethical frameworks now recognize that non-human individuals have value in and of themselves, and this value requires that their individual needs and interests are taken into consideration. This growing consensus requires conservationists to incorporate this new norm within theory and practice. Recognizing and respecting the inherent value of non-human individuals involves not only acknowledging the intrinsic moral value of all individuals within HWC,

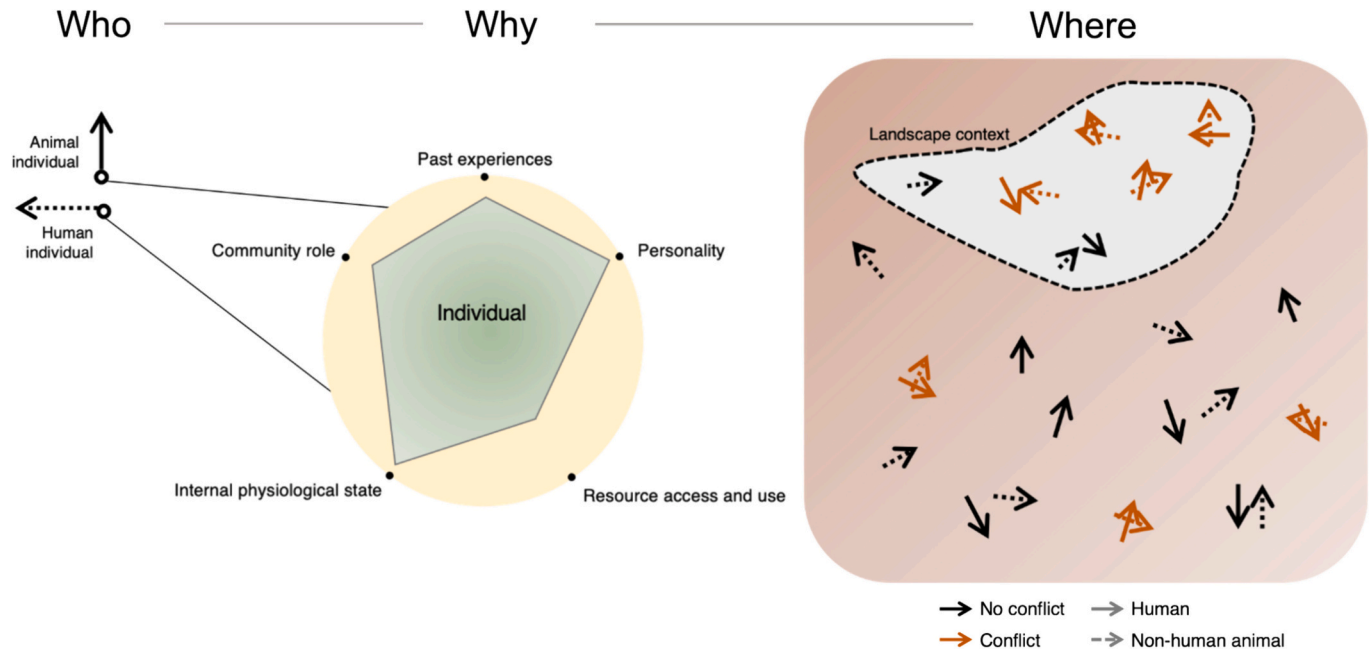

Fig. 1. The who, why, and where of HWC. "Who": Conflict can only occur when individual humans (dashed arrows) and animals (solid arrows) interact. "Why": Conflict is emergent from individual attributes and their role within their respective human or ecological communities. These can be static or flexible attributes, but their amalgamation at a given time and place can produce conflict. "Where": Conflict occurs when individuals interact at the same time and place on a landscape.

but also requires conservationists to shift the focus of resolution strategies from only managing populations to addressing individual animal behavior and motivations (Ferraro et al., 2023). As we will demonstrate below, this shift provides us with better insight into why HWC occurs and leads to best practices for conflict mitigation.

2.2. Individual humans

The importance of human social dimensions in conservation has advanced ideas of human-wildlife coexistence (Bennett et al., 2017; Dickman, 2010), but the discipline has struggled to fully centralize social dimensions as part of its theoretical and methodological canon. Not only do individual humans react differently to wildlife (Pooley et al., 2021) and differently to different types of wildlife (Gao et al., 2023), but human behavior is dynamic; it cannot be identically replicated, but it can be transformed across space and time by emerging practices, power structures, and personal experiences (Fig. 1; Leslie and McCabe, 2013; Orrick et al., 2024). It is shaped by degrees of social, economic, and ecological conditions (Fig. 1; Bennett et al., 2017; Dickman, 2010; Gao and Clark, 2023; Orrick et al., 2024; Wilkinson et al., 2019; Zimmermann et al., 2020). Thus, sustainable, long-term conservation can be achieved with a deeper and more meaningful understanding and capacity for the drivers and social conflicts at the local level (Zimmermann et al., 2020).

There are many cautionary warnings not to generalize how attitudes toward wildlife relate to personal experiences and socioeconomic status (i.e., Madden, 2004; Zimmermann et al., 2021). Even across a small landscape, humans are not a monolithic entity; human attitudes can vary at the individual- and the community-level (Dickman, 2010). At the individual level, attitudes are broadly shaped by an amalgamation of structure, culture, and agency (Lehnen et al., 2022). In conservation science, these are often measured by socio-demographic variables, such as age, education, gender, personal perceptions, economic benefits, socio-economic livelihoods, perceived risk, investment (e.g., money, time, effort), and location. At the community level (e.g., village, town, or city), attitudes can also be influenced by larger group variables, such as the size of the community, the number of resources, and group beliefs toward wildlife (Dickman and Hazzah, 2016; Suryawanshi et al., 2014). These socio-demographic characteristics also depend on time—individual people can have different responses within and across days, seasons, and lifetimes (Dickman, 2010; Yurco et al., 2017). This makes identifying correlations between socio-demographic variables and attitudes challenging. For example, an analysis of seventeen case studies of HWC across the range of jaguars (*Panthera onca*) found very few patterns among farm sizes and types within the range, the extent of livestock loss, economic dependence on livestock, and depredation concern (Zimmermann et al., 2021). Additionally, no patterns could be discerned among farmers' attitudes (Zimmermann et al., 2021). This inability to draw generalizable conclusions has substantial implications for designing mitigation strategies.

3. Better understanding the individual to address mitigation

The first challenge in an individual-approach to HWC is identifying the human and non-human individuals involved. Fortunately, previous challenges in identifying, studying, monitoring, and deterring individual non-human animals can now be addressed through a suite of technological advances (Fig. 2). Concomitantly, the subdiscipline of conservation social science demonstrates a broad suite of methodologies to study people within HWC at the community- and individual-level;

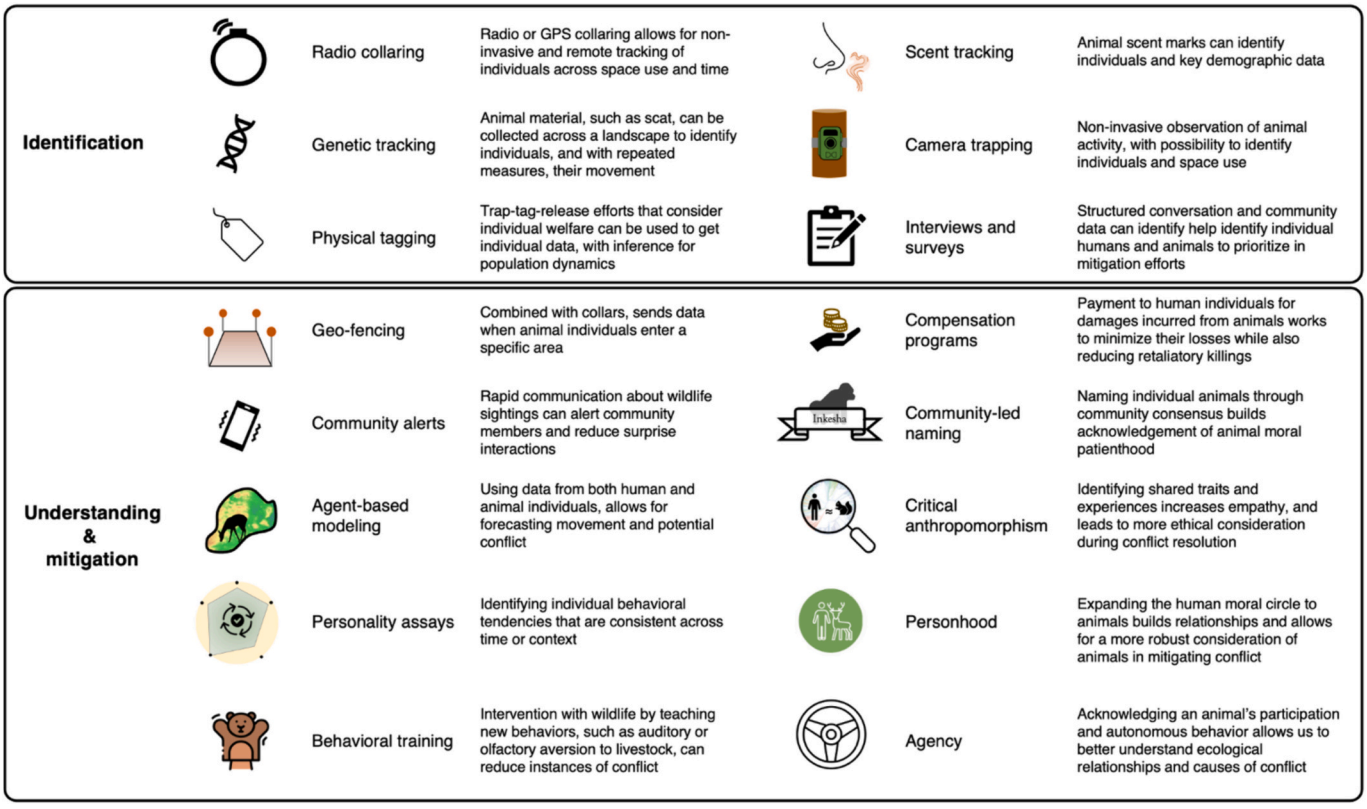

Fig. 2. Interdisciplinary tools for identifying, understanding, and mitigating HWC at the individual level. Tools predicated on philosophical recognition of non-human animals include critical anthropomorphism, personhood, and agency. Tools that already recognize the inherent value of human individuals include interviews and surveys, geo-fencing, community alerts, compensation programs, and community-led naming. While several of these tools are already employed in HWC identification and mitigation, there is considerable room to expand their use; in particular, personality assays and behavioral training. References of examples are contained in Table 2.

including qualitative, quantitative, spatial, evaluative, historical, meta-analytical, and participatory methods (Bennett, 2016). These approaches have been foundational in the study of HWC and instrumental in developing mitigation strategies.

When we prioritize and value individuals within the context of HWC, we unlock additional perspectives and academic resources. This includes tools and frameworks within the fields of animal behavior, ethology, social science, and philosophy. Valuing all individuals allows for the study of human and non-human personalities and agency, as well as more non-human animal-focused study of critical anthropomorphism and personhood. Together, these four approaches provide conservationists with better clarity about why HWC occurs and how to improve management and policy strategies. Below, we place individuals at the center of HWC to develop a framework that will help managers and practitioners to focus on the individual, ultimately allowing for unique and creative management plans that are both more effective and humane.

3.1.1. Recognizing individual personalities and attitudes

Conservation social science has demonstrated that individual human behavior and personality play an essential role in conservation (Dickman, 2010; Kvasova, 2015). HWC mitigation strategies must incorporate the needs, livelihoods, and behavior of local people. Fortunately, mitigation strategies that take an individualistic approach already exist, such as compensating an individual for wildlife damages or hiring former poachers as eco-guards (Lotter et al., 2016; Ravenelle and Nyhus, 2017). While not without faults, the tools and solutions that address the impact by and on individual people regarding HWC have been successful and can be appropriate depending on the context of the region (Fig. 2; Berezowska-Cnota et al., 2023).

The unique personalities of individual non-human animals also contribute to HWC. Non-human animal personality refers to consistent behavioral tendencies that differ from other individuals of the same species and remain consistent over time and context (Wolf and Weissing, 2012). Unsurprisingly, non-human animals with different personalities respond differently to interactions with humans (Blackwell et al., 2016). For example, shyer elk (*Cervus canadensis*) are more likely to migrate, while bolder elk are more likely to forgo migration and stay in human-dominated landscapes (Found and St. Clair, 2016). HWC mitigation strategies that incorporate non-human animal personality and behavior have been successful at identifying the individuals involved in, and ultimately resolving, the conflict. For instance, collaring particularly socially connected individuals helps managers know where populations interact frequently with humans (Melzheimer et al., 2020). Most commonly, this approach is used with large predators (Blackwell et al., 2016), yet animal personality can be used to mitigate HWC in many different animals and conflict scenarios. For example, it has been suggested that urban management of wildlife could select for shyer individuals, which may avoid human contact and reduce the spread of zoonotic disease (Honda et al., 2018). Mumby and Plotnik (2018) propose that by examining both the collective behaviors of elephant (*Loxodonta africana*, *Loxodonta cyclotis*, and *Elephas maximus*) populations and the unique characteristics of individual elephants, such as their personalities, life histories, and problem-solving skills, we can better infer why elephants choose to forage in risky areas where HWC might arise. This comprehensive understanding of personality can enhance the effectiveness of mitigation strategies.

Repeated events involving the same individuals provide strong evidence of how animal personality intersects with HWC. Individuals that cause repeated conflict events are termed "problem" or "nuisance" animals and are individuals "whose natural behavior, temperament or habits brings it into conflict with humans" (Woodroffe et al., 2005a). Evidence suggests that management strategies that target non-human individuals prone to HWC are often successful (Athreya et al., 2011; Swan et al., 2017). For example, management strategies that trap and translocate individuals particularly prone to HWC often reduce the instances of conflict (Athreya et al., 2011; Bauder et al., 2020). This can also be done while maintaining individual fitness or survival (Bauder et al., 2021), though it is not without its risks (Massei et al., 2010). However, the existence of the term "problem animals" elucidates a crucial point; not all individual animals are participants in HWC (Berezowska-Cnota et al., 2023; Treves, 2007).

We will not speculate about which labeled temperaments may be more prone to conflict but emphasize that any repeated behaviors of an animal that would bring it in frequent and close proximity to humans and their resources would inherently increase the likelihood of a conflict event. The labeling of a specific species or individual with value-laden language (such as a "problem", "pest", or even "charismatic") is often based on the perceived personality. These labels can play an important role in human perception and their likelihood of engaging in a conflict event or dismissing the value of that individual, based on whether the labeling is positive or negative. For example, "pest" species can be "disposed of" and species classified as "vermin" can be killed (Webber et al., 2017). Therefore, in HWC, and conservation more broadly, it is imperative to recognize the power of language in shaping human interactions with the natural world and strive for more objective discourse that acknowledges the inherent worth of all species and individuals.

Further consideration of individual non-human animal personalities will only result in more creative solutions that integrate current technological advances. For example, putting geofences on particularly bold individuals may help mitigate interactions with humans (Fig. 2; Table 2). The consideration of individual non-human personality can also inform both predictive models and direct management decisions. Namely, considering individual non-human personalities in HWC can draw attention to the underlying cause of conflict from the animal's perspective—providing insight into how and why animals make decisions (Mumby and Plotnik, 2018). However, the use of animal personality in conservation is still understudied and underutilized. Less than 2 % of work that considers animal personality within conservation efforts is related to HWC (Collins et al., 2023).

The incorporation of individual non-human personalities within HWC mitigation is currently easiest with large mammals, as these animals tend to cause a lot of HWC (Nyhus, 2016), and our understanding of the abilities and experiences of these species is relatively advanced (Poirier et al., 2020). Further, the majority of studies focus on mammals even though they often only measure limited personality traits (Collins et al., 2023). Yet a huge variety of animals exhibit personalities and cognitive abilities, from elephants (Mumby and Plotnik, 2018) to grasshoppers (Sommer and Schmitz, 2020), making the potential for the incorporation of the individual nearly limitless with proper resources and creativity.

3.1.2. Recognizing agency

A human's agency in itself is a combination of past experiences and internal imagined alternative possibilities (Emirbayer and Mische, 1998). The study of a human's attitudes toward wildlife is often measured by socio-demographic variables, such as age, sex, and socio-economic status, but it must also be complemented by the understanding of the human's agency. Agency also impacts willingness of individuals to participate in mitigation strategies; in Colorado, a study showed that humans are more compliant to bear-proof their residential garbage bins when they observe higher bear (*Ursus americanus*) conflict events on their block (Johnson et al., 2018). Thus, a human's behavior, and actions, toward a human-wildlife interaction and whether or not it results in conflict or coexistence is in part shaped by their agency as well as through their experiences of past conflict and socio-economic factors (Carter et al., 2014; Eklund et al., 2023; Kansky et al., 2016; Orrick et al., 2024).

Recent work has proposed recognizing animal agency within

conservation science and management (Edelblutte et al., 2023). Animal agency is "the ability of animals to actively influence wildlife and conservation management outcomes through their adaptive, context-specific, and complex behaviors that are predicated on their sentience, individuality, lived experiences, cognition, sociality, and cultures" (Edelblutte et al., 2023). Similar to human individuals, wildlife behavior during a single HWC event is shaped by past experiences and internal dispositions. A non-human individual uniquely responds to navigating perceived risks while accessing the resources associated with a human-wildlife encounter (Berezowska-Cnota et al., 2023; Orrick et al., 2024). The varying levels of risk that a species experiences require consideration of their individual perceptions and actions in relation to their surrounding landscape (Gaynor et al., 2019). Recognition of animal agency allows acknowledgment of an animal's active participation and autonomous behavior in landscape dynamics (Boonman-Berson et al., 2016; Sundberg, 2011). Specifically, acknowledging wildlife agencies can help center an animal's behavior in a specific conflict event. Indeed, recognizing non-human animals as active subjects in an interactive landscape has already led to a better understanding of HWC in agrarian landscapes (Orrick et al., 2024).

Incorporating the agency of human and non-human individuals in HWC mitigation acknowledges both their roles as active decision-makers in shaping their interactions with one another as well as their ability to shift behaviors and adapt to new contexts (Edelblutte et al., 2023). Recognizing the agency of humans invites local communities and stakeholders to participate in the planning and implementation of mitigation strategies. By recognizing the agency of non-human animals, we can capture the unique variation of wildlife behavior across a landscape which can change or shape over time and space. As such, valuing the agency of humans and of wildlife can lead to more sustainable outcomes for both humans and animals alike.

3.1.3. Critical anthropomorphism

As a way to better understand animal behavior and motivations, ethologists have long been advocating for the inclusion of critical anthropomorphism in ethology as it uses "natural history, … perceptions, intuitions, feelings, careful behavior descriptions, identifying with the animal, optimization models, previous studies … in order to generate ideas that may prove useful in gaining understanding" (Burghardt, 1991; Fig. 2, Table 2). Critical anthropomorphism recognizes how shared traits among species (including humans) may result in shared experiences. In this way, critical anthropomorphism is a useful tool for science and conservation (Fig. 2, Table 2; Ferraro et al., 2023).

In HWC, critical anthropomorphism can aid mitigation efforts by acknowledging that, just like humans, non-human animals have subjective experiences, needs, emotions, and motivations (Bekoff, 2010), which can shape their personalities and affect their behavior (Fig. 2, Table 2). It also allows for the ability to recognize, study, and incorporate other shared experiences between humans and non-humans, such as culture and community structures (Brakes et al., 2019). The combined recognition of individual personalities and critical anthropomorphism offers particular promise for HWC. For example, just as human societies have well-informed and well-connected individuals that lead to collective decision-making, some animal societies do as well (Bridges et al., 2023). HWC mitigation strategies, such as translocation, geofencing, and aversion training, may be most effective when applied to highly connected individuals (Fig. 2). Indeed, in southern California, translocating specific, socially-connected kangaroo rats (*Dipodmys stephensi*) resulted in more successful outcomes (Shier and Swaisgood, 2012).

Critical anthropomorphism encourages people to view non-human animals as individuals with their own unique experiences rather than just as objects or resources to be exploited. Yet it must be approached with caution and care, ensuring that tools from cognitive science, evolutionary ecology, and ethology are employed correctly. Otherwise, practitioners risk superficially applying human constructs to non-humans, which can be harmful to effective conservation and, ultimately HWC (Ferraro et al., 2023). Used correctly, critical anthropomorphism leads to a more ethical consideration of non-human individuals in conflict resolution (Manfredo et al., 2020). By recognizing these shared realities, researchers can develop strategies that address the root causes of conflict and promote coexistence (Fig. 2; Table 2).

3.1.4. Recognizing personhood

In valuing non-human individuals, we also gain the ability to recognize their personhood (Wallach et al., 2020). The concept of personhood recognizes that each individual deserves respect and should not be reduced to a mere tool for achieving other objectives (Midgley, 1985; Wallach et al., 2020). Like critical anthropomorphism and agency, recognizing non-human personhood allows conservationists to encourage empathetic relationships between human and non-human individuals and to recognize the moral status of non-human animals. In a HWC context, tools that recognize personhood can also help bolster public interest in wildlife conservation (Fig. 2, Table 2).

A useful entry point for recognizing personhood can be naming an individual (Fig. 2)—a practice in which the animal becomes individualized and valued. Naming builds a relationship between the animal itself, the public, and conservation activities as a whole (Wilkinson, 2023). Prime examples of named non-human animals that were valued by humans include P-22, the cougar (*Puma concolor*) from Los Angeles (Wilkinson, 2023), Flaco, the escaped Central Park Zoo Eurasian eagle-owl (*Bubo bubo*; Shanahan, 2024), or the contestants of the Katmai National Park Fat Bear week (Barber et al., 2023). Arguments have been made that naming individuals evokes an empathetic response that is an effective conservation tool (Benson, 2016) as well as an approach that also allows us to have a more compassionate approach to conservation (Manfredo et al., 2020).

4. Challenges in valuing the individual

Given the individual-based reality of HWC, strategies implemented at the collective level often do not work (Table 1). For example, in Washington State, the removal of cougars in an attempt to mitigate depredation ultimately led to an increase in depredation events (Peebles et al., 2013). Similarly, the introduction of mongoose (*Herpestes javanicus*) in Hawaii to manage rat (*Rattus rattus*) populations that were reducing crop yields ultimately led not only to the loss of many wildlife species but even more crop loss (Yamada and Sugimura, 2004). Importantly, the inefficacy of many collective-based human-wildlife management plans is often a direct result of ignoring the intraspecific variation within and among animal (Bejder et al., 2009; Buderman et al., 2018) and human populations (Zimmermann et al., 2021). For example, research seeking to develop population-level management plans for cougars discovered that such a high degree of individual variation in behavior meant that a "one size fits all" approach was unlikely to be successful (Buderman et al., 2018). Further, research seeking collective-level management plans can also cause drastic reductions in non-human animal populations and, at times, species extinctions and range collapse (Table 1). The introduction of cane toads (*Rhinella marina*) to mitigate the impact of insects on sugar cane is a canonical example of such unintended, but catastrophic consequences of collective-level HWC mitigation strategies for wildlife and ecosystem processes (Shine et al., 2020).

Yet, there is still sometimes a need to address HWC at the species or population level. For example, the use of repellents and deterrents are species-focused management approaches that deter specific behaviors and have had success in some cases (Bíl et al., 2018), though not in others (Shaffer et al., 2019). Elephants, for example, have learned to ignore acoustic deterrents (Moss, 1988). The use of critical anthropomorphism and agency are useful tools in helping to determine if deterrents may work for a given species, as well as diagnose why this collective strategy fails. Additionally, both human and non-humans can demonstrate collective behavior which differs from the action of an

Table 1
Evidence for non-human collective level strategies to mitigate HWC that have been unsuccessful.

Citation	Species	Management strategy	Conclusion
Lee et al., 2009	Cattle	Electric fence	Some individuals learn quickly, and others do not.
Hodgson et al., 2020		Physical barrier (aka fence)	While often successful in the short-term, often fails in the long term as costs and effort is high to maintain.
Snijders et al., 2021	Multiple species	Conditioned taste aversion	Context-dependent and field experiments utilizing this method have been often unsuccessful.
Ferretti et al., 2015	Shark	Culling	Mass cull campaigns of sharks in Australia after fatal shark bites are a common campaign that has a detrimental effect on already threatened species.
Rabinowitz, 1986; Hoogesteijn et al., 1993; Woodroffe et al., 2005a, 2005b, 2005c	Jaguars	Culling	Culling jaguars and their prey led to increased human-wildlife conflict; Jaguar autopsies showed that hunting often injured jaguars rather than actually killing them, which only made it more difficult for jaguars to hunt wild prey and led to an increased dependence on cattle.
Moss, 1988; Shaffer et al., 2018; Sukumar, 1992	Elephants	Acoustic or visual deterrent	Elephants have been shown to learn to tolerate the sound.
Fuller, 2000; Woodroffe et al., 2005b	Multiple species	Culling	Drastic and persistent ecological effects.
Distefano, 2005	Multiple species	Culling	Limited effectiveness in reducing crop raids and livestock losses.
Naughton-Treves, 1998	Lions and leopards	Culling	Ultimately caused an increase in the population of crop-raiding species.
Yamada and Sugimura, 2004	Rats	Introduction of a predator	The introduction of mongoose has led to the extinction or endangerment of wildlife and the damage of crops
Peebles et al., 2013	Cougars	Culling	Culling of cougars to mitigate depredation of livestock, led to a 200 % increase in livestock depredations.
Vanak et al., 2014	Dingoes	Culling	Removal of dingoes led to mesopredator release, increasing the number of feral cats.
Swanepoel et al., 2015	Leopards	Retaliatory killing	Retaliatory killing in response to HWC led to high level of leopard mortality, risking the viability of the population.
Shine et al., 2020	Insects	Introduction of predator	The introduction of cane toads ultimately has had direct and indirect consequences for wildlife and ecological processes.

Table 2
Citations for individual-based management strategies that either could be, or are, currently used in HWC mitigation.

Individual-based management strategy	Citation
Critical anthropomorphism	Bekoff, 2010; Bridges et al., 2023; Ferraro et al., 2023; Keeley, 2004; Rivas and Burghardt, 2002; Shier and Swaisgood, 2012
Personhood	Aaltola, 2008; Münster, 2016; Sundberg, 2011; Wallach et al., 2020
Naming individuals	Perry and Averka, 2020; Wilkinson, 2023
DNA tracking of individuals	Ernest et al., 2000; Avise, 2012
Physical tags	Rácz et al., 2021
GPS tracking	Long et al., 2015
Radio frequency identification	Bonter and Bridge, 2011
Scent tracking	Hagey and Macdonald, 2003
Camera Traps	Trolliet et al., 2014
GPS alert systems	Grinko, 2021
Compensation	Nyhus et al., 2005; McNutt et al., 2017
Behavioral training	St. Clair et al., 2019
Tracking highly connected individuals	Shier and Swaisgood, 2012
Agency	Lima, 2002; Hathaway, 2013; Boonman-Berson et al., 2016; Kiik, 2018; Edelblutte et al., 2023
Personality	Collins et al., 2023; Found and St. Clair, 2016; Honda et al., 2018; Sommer and Schmitz, 2020; Wolf and Weissing, 2012

individual acting alone. Within social species like elephants, younger members often emulate and gain knowledge from their elders during activities like crop raiding or moving through dangerous human-dominated landscapes (Chiyo et al., 2012). Likewise, individual humans can elicit the fear of damage in other humans, even if the others have never personally experienced it (Dickman, 2010). Therefore, there are times when strategies at the collective level can be productive in mitigating HWC. Still, we suggest that collective management strategies are most effective when they use the tools that recognize and value individuals, such as agency and critical anthropomorphism, to identify the root cause of the HWC.

One individual-based management strategy to mitigate HWC would be to remove problem individuals (Honda et al., 2018). However, even at the individual level, lethal control is not guaranteed to mitigate HWC. In some instances, if the target individual is killed, other individuals take their place (Farley et al., 2014; Naughton-Treves and Treves, 2005). Culling of individuals can also ultimately increase HWC. In the case of badger (*Meles meles*) culling, which presumably targeted bolder individuals, the culls shifted the behavior of other badgers, which ultimately made it harder to mitigate the transmission of *Mycobacterium bovis (TB)* to both other wildlife and livestock (Ham et al., 2019). The targeted removal of bolder, but more experienced, wolves left wolf packs (*Canis lupus*) without leadership and training for younger wolves, ultimately resulting in more HWC as younger wolves targeted easier prey, such as livestock and domesticated animals (Tshewang et al., 2021).

Further, lethal control at either the collective or individual level can have drastic unintended ecological consequences, is less cost-effective, and is socially contentious (Blackwell et al., 2016; McManus et al., 2015; Naughton-Treves and Treves, 2005; Woodroffe et al., 2005a). For instance, the removal of individuals can impact the fundamental ecological structure and demography of a population, as seen both with cougars in Yellowstone (Newby et al., 2013) and across the range of countries of Asian elephants (Vasudev et al., 2023). Simultaneously, attitudes toward wildlife culling by human stakeholders vary greatly, and even selective culling may cause contention because it is a reactive rather than proactive response to HWC (Naughton-Treves and Treves, 2005). In contrast, respect for the lives of individuals often results in more creative solutions for conservation that both meet the goals of the conservation scheme and do not unnecessarily take the lives of

individuals (Sommer and Ferraro, 2022).

5. Conclusion

The justification of centering individuals in the study and management of HWC species can also be applied to wildlife conservation more broadly. Many of these tools can be used to incorporate valuing individuals within broader conservation goals (Brakes et al., 2019; Collins et al., 2023; Edelblutte et al., 2023; Ferraro et al., 2023), such as restoration ecology, non-native species management, and rewilding. However, creating conservation solutions that account for the individual requires effort, patience, and a willingness to embrace complexity and context. Creative solutions must take into account the needs, values, and priorities of all parties involved in the conflict, and there is no one-all solution to solve this global challenge (Madden, 2004). Balancing these values and needs is not an easy task and requires compassion and considered thought. As such, there will be times of uncertainty and nonuniformity in the planning and implementation state (Edelblutte et al., 2023). However, we suggest that using a framework that values all individuals will help create effective and productive conflict mitigation strategies.

Many might suggest that such a scale is too specific and unachievable, or oppose this framing outright, claiming that individual animal welfare and conservation are fundamentally in conflict (Hayward et al., 2019). We recognize that management and policy plans that consider the individual require increased effort. However, as we have demonstrated, centering both human and non-human individuals in HWC will result in more effective outcomes (Swan et al., 2017). Others might assume that HWC creates dichotomous scenarios in which any resolution will result in winners and losers. We hold that, by centering both human and non-human individuals through the disciplines of ethics, ecology, and social science, we can be open and creative to find solutions that benefit both parties.

We show the current success and future potential of recognizing the intrinsic value of individuals—making individuals the unit of focus in mitigating HWC (Ferraro et al., 2023). The focus on individuals is not necessarily in conflict with the consequentialist goal to protect species; preserving biodiversity almost always begins with studying individuals and populations. At the same time, conservation is increasingly recognizing its responsibility to incorporate human culture, values, rights, and choices. By centering the individual—in ecological relevance, in environmental management, and in moral valuation—we could improve our understanding of HWC and the living world. Balancing these values and needs is not an easy task and requires compassion and considered thought. Embracing complexity, including the ethical, moral, and individual perceptions of human and non-human entities, promises to reveal more accurate and effective answers for HWC than conventional and siloed efforts.

CRediT authorship contribution statement

Kaggie D. Orrick: Conceptualization, Writing – original draft, Writing – review & editing. **Kristy M. Ferraro:** Conceptualization, Writing – original draft, Writing – review & editing. **Nathalie R. Sommer:** Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that the work presented in this manuscript is original research conducted by them. They confirm their agreement with the manuscript's content and its submission to the journal. No part of the research has been previously published unless fully acknowledged within the manuscript. The authors disclose any existing or pending manuscripts of a similar nature related to the research featured in this manuscript, whether published, in press, submitted, or soon to be submitted to Biological Conservation or any other publication. This manuscript is not under consideration for publication elsewhere during the review process for this journal. Any research not conducted by the authors is appropriately acknowledged within the manuscript. All sources of funding are acknowledged, and the authors have declared any potential financial benefits resulting from publication. The research described in this manuscript obtained all necessary ethics approvals and adheres to applicable ethical guidelines. The authors confirm that their research protocols have been approved by an authorized animal care or ethics committee and reference the adopted code of practice for the experimentation or methodology described.

Data availability

No data was used for the research described in the article.

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