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Review

Approaching human-animal relationships from multiple angles: A synthetic perspective

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1. Introduction

Non-human animals are ubiquitous in human lives: we dress with their fur and their skin, we eat their meat, and we visit them in zoos and aquaria (DeMello, 2012). Some of us construct our identities based on non-human animals (hereafter "animals", for simplicity; e.g., ornithologists, cattle farmers) (Myers & Russell, 2003). Meanwhile, some animals are cherished as part of our families, while others are vilified as pests and invaders (Dawkins, 2012) — even species of conservation concern, such as sea otters (*Enhydra lutris*) (Echeverri et al., 2017). From a conservation perspective, "human-animal interactions" are receiving increased attention as values towards nature and wildlife shift in an increasingly urbanized world (Manfredo et al., 2016). Via two examples, we illustrate how such interactions are fundamental to conservation. First, overharvesting remains one of the top threats facing endangered species (Dirzo et al., 2014; Wilcove & Master, 2005; Yiming & Wilcove, 2005), and it was likely a strong contributor to the extinction of many vertebrate species in the Holocene, an event with reverberating impacts on many species (Donlan, 2005; Janzen & Martin, 1982). Even without extinction, the overharvest and persecution of many species has structured many ecosystems, posing many conservation challenges and underlying recent regime shifts (Darimont et al., 2015; Estes et al., 2011; Jackson et al., 2001). On the flip side, our affinity for other species has yielded a spate of species introductions, some of which have had devastating ecological and social effects (Pejchar & Mooney, 2009). Second, in the Western world a growing social movement in favour of recognizing animals' rights is bumping up against traditional hunting and sustainable use interests in places such as rural North America and southern Africa (Angula et al., 2018; Paquet & Darimont, 2010). Both proponents and opponents of hunting claim to be motivated by concern with biodiversity loss (Di Minin et al., 2016). Proponents claim that human-animal interactions can be important for motivating conservation behaviors, as animals become ambassadors for all species: the emotional attachment between humans and other animals may trigger concern and care for the rest of nature (Amiot & Bastian, 2015; Kellert & Wilson, 1995; Vining, 2014). Conversely, hunters claim that the act of killing an animal hearkens back to primordial human-animal interactions, enhancing our spiritual connection with wildlife and serving to highlight the importance of conserving wilderness and the species that live within it for our own cultural heritage (Arnett & Southwick, 2015).

Deepening our understanding of such divergent views on human-animal interactions requires approaching such interactions from a variety of theoretical and applied perspectives. However, while human-animal interactions are an important domain of human activity, their study is highly scattered in the literature. In fact, a great diversity of academic fields addresses such interactions. Because the fields that study human-animal interactions have emerged from radically different intellectual traditions (ranging from psychology to literature and ecology), fields differ in terms of their research paradigms, methodologies, and research questions (DeMello, 2012). Several gaps currently impede conservationists and scholars working on people and animals from incorporating diverse insights into practice and research projects. This is particularly pertinent for people trained in the natural sciences

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and those rooted in the social sciences, arts, and humanities. Thus, this paper's overarching objective is to present a synthetic perspective on diverse academic literatures about human-animal interactions. In doing so, we aim to introduce researchers, students, and practitioners to the many kinds of research about human-animal interactions, to help them navigate appropriate methods, approaches and collaborations, and to better understand conservation and wildlife management problems and their possible solutions (e.g., for preventing illegal wildlife trafficking). We also make visible the differences and similarities across fields that study human-animal interactions and give examples on how different fields may aid to answer conservation-related questions and propose solutions. Reviewing this literature seems particularly relevant and timely given the increased interest to engage with the social sciences in conservation-related research (Bennett et al., 2017; Teel et al., 2018). Four main questions guided our research: (a) Many fields address the non-material relationships of humans with animals; what are the foci of each? (We focus on non-material relationships because they can motivate connections with the natural environment and promote conservation of biodiversity Chan et al., 2016) (b) In what contexts does each field operate, and what methods does it employ? (c) What intellectual traditions have spawned each, and how has each informed the others? And, (d) What opportunities present themselves for cross-fertilization across fields?

While the term "human-animal interactions" has been criticized for being paradoxical given that humans are animals too (Shapiro, 2008), it is nonetheless the most widely used academic term to refer to any encounter (physical or figurative) between humans and animals. We recognize that the delineation of boundaries between "animals" and "humans" is non-trivial and politically charged (Kemmerer, 2006). A coarse classification for human-animal interactions discerns between the *material* and the *non-material relationships* between humans and animals. Material relationships are defined by a physical nature (e.g., food, fiber, clothes), while non-material relationships constitute the intangible dimensions of human-animal interactions that are psychological, philosophical, social, and spiritual (Russell et al., 2013). According to Chan et al. (2012b), such non-material relationships yield benefits that can be categorized as: aesthetic, artistic inspiration, cultural heritage, spiritual connections, identity, knowledge, existence, and social capital. Animals also provide intangible benefits to humans when they help construct worldviews and languages; indeed, many language metaphors and similes are rich with animal references (e.g., "Lone wolf") (DeMello, 2012). Human thoughts often give us a glimpse on the non-material relationships humans have with other animals (Herzog, 2010).

To exemplify the material and the non-material relationships between humans and animals, we can think of the interactions between humans and the species *Gallus gallus*, commonly known as roosters, chickens, and hens. The material relationships between humans and this species are rather obvious, as human diets are highly reliant on chicken products, such as eggs and meat. The non-material relationships with this species are less obvious but still ubiquitous. For example, cockfighting is a traditional sport that originated in Southeast Asia and is still practiced in Asia, Middle East, Europe, North America, and South America. For Balinese men, cockfighting is a cultural practice by which roosters confirm the status hierarchy among men in rural villages (Geertz, 1994). For "cockers", their roosters contribute to not only societal structures and cultural practices but also their personal identities. They also develop emotional attachment with their animals through a caring relationship during the two years they spend training their roosters for the fight (Herzog, 2010). This species is also commonly represented in the arts via paintings, songs, and literary references. It is also used in everyday discourse in various languages (e.g., "Don't chicken out!" in English, or "En menos de lo que canta un gallo" a Spanish simile alluding to time). All these examples denote a variety of non-material relationships between humans and animals.

Because human and nonhuman worlds are inexorably bound, it is unsurprising that many academic disciplines, fields, and subfields (i.e., an area of research within an academic field) study human-animal relationships. Perhaps the overarching field that encompasses most of the scope of this scholarship is that of "human-animal studies", which DeMello (DeMello, 2012) defined as "the interdisciplinary field that explores the spaces that animals occupy in human social and cultural worlds, and the interactions humans have with them" (2012: 4). We amend this definition slightly, to refer to "the interdisciplinary *set of fields* …", given the persistent and pervasive barriers between the component fields (see Results). There appears to be a lack of consensus among scholars when defining this meta-field. Some use the terms of "anthrozoology" or "animal studies" interchangeably with that of "human-animal studies" (DeMello, 2012). However, we use "human-animal studies" as the fairest term in that it levels the positions of humans and animals (Hurn, 2010). Thus, condtradicting Hurn (2010), we consider anthrozoology and animal studies as fields within human-animal studies. But we do follow Hurn's differentiation of these two fields, in which anthrozoology prioritizes the human angle when studying human-animal interactions, whereas animal studies prioritize the animal angle by, for example, objectifying animals through giving them voices and deconstructing their subjugation to humans (Hurn, 2010).

What *is* and what *constitutes* human-animal studies? Human-animal studies are a set of interdisciplinary academic fields that emerged in the past 25 years and have experienced an unforeseen rise (Shapiro & DeMello, 2010). It now has formal academic institutions (e.g., Animals & Society Institute), as well as academic journals (e.g., Anthrozoös, Society & Animals) (Shapiro, 2008). Central to the meta-field of human-animal studies is the exploration of the ways in which animal lives intersect with those of humans. Human-animal studies encompass a suite of disciplines and fields that are mostly classified as social sciences (e.g., sociology, anthropology, psychology) or humanities (e.g., literature, history, human geography) (DeMello, 2012). To echo scholars, it is important to note that human-animal studies do not focus on studying animals per se. For instance, while zoology, ethology, and veterinary science focus on studying animals, these disciplines are not included in the overarching field of human-animal studies because they largely omit the "humans" as subjects of study when studying animals (DeMello, 2012; Shapiro, 2008). However, there are various fields within the natural sciences that pertain to human-animal studies, as they also characterize human-animal interactions. These fields include human ecology (Marten, 2001), human dimensions of wildlife (a subfield of wildlife management) (Manfredo, 2008), and ecosystem services (Daily, 1997), particularly cultural ecosystem services (Chan et al., 2012a).

2. Methods

Our review resembles an interdisciplinary review, which used a snowball technique to sample the literature. To identify the number fields that study the non-material relationships of humans with animals, we first selected 50 textbooks and journal articles that had reviewed the meta-field of human-animal studies (e.g., Shapiro & DeMello, 2010). From such readings, we obtained an initial list of fields, which we then reviewed one at a time by reading journal articles and books that either defined the field and explained the focus of the fields' enquiry (e.g., Hurn, 2010; Mullin, 2002; Thomas, 1996), or that were published under each field (e.g., papers with the subfield's name as a keyword, such as Clayton et al., 2013 in conservation psychology; Smith et al., 2012 in conservation marketing). From the initial list of fields, we then identified key references (e.g., well known articles or books from a subject that were cited over 100 times), and we subsequently searched the references cited in those initial references, and repeated the same procedure until saturation was achieved (e.g., new authors or new papers became uncommon in the search process) (Biernacki & Waldorf, 1981). In total, we reached saturation after reviewing 79 articles and 33 books.

We chose snowball sampling as the most appropriate methodology for this type of review because it gives equal importance to all fields, avoiding biases. Systematic reviews (e.g., which use keywords and search engines) are appropriate for fields closely related to each other, where authors are likely to publish their work in similar formats (e.g., journal articles, or books). Substantial differences between fields in publishing formats are likely to bias such systematic searches towards some fields over others. Instead, we attempted to include as many fields as possible ranging from those in the humanities (e.g., literature) to those in the natural sciences (e.g., ecology) that are rarely found in the same databases. While we acknowledge the existence of robust methodologies that allow quantitative analyses for scoping reviews (e.g., Westgate et al., 2015; Westgate et al., 2018), we believe such methodologies are not appropriate for our interdisciplinary review. First, the terminology for describing and characterizing human-animal relationships varies tremendously across fields. Thus, it would require a major interdisciplinary endeavour to identify the right keywords to use in search engines. Second, even if a representative body of literature could be compiled, many of the disciplines we examined resist quantitative approaches to describing human-animal relationships and we wanted to take a more inclusive approach. To our knowledge, our study is the first to expose such a diversity of fields that focus on human-animal relationships, and we encourage future studies to engage in more systematic reviews if there is interest.

Given that each field tries to define itself by differentiating itself from others (e.g., Clayton & Brook, 2005), we obtained a second list of fields, which we then added to our initial list until we had saturation in the names of fields that were mentioned in the readings and strong agreement across publications. In total, we reviewed 79 articles and 33 books. Since our goal was to identify the fields and their approaches, the references describing each field were informative enough for our purposes. We reiterate that we did not describe the fields ourselves, which would require a much larger sample size.

For each field, we collected information on five parameters: (1) focus of their enquiry; (2) contexts in which it operates; (3) examples of research questions, (4) theoretical perspectives; and (5) research methods. We selected these five parameters as basic characteristics intended to summarize the identity and purpose of the fields at a coarse scale. The foci of each field and the contexts in which it operates (i.e., parameters 1 and 2) were summarized in a table (Appendix A). This information was extracted from foundational readings that explained what the field does (e.g., Manfredo, 2008). The examples of research questions (i.e., parameter 3) were collected from empirical papers from each field. In addition, the theoretical perspectives and research methods (i.e., parameters 4 and 5) were characterized in a binary trait data base comprised of 33 traits. For each trait, each field got a score of 1 if the trait was present in that field, or a score of 0 if it was not. The traits were grouped into 4 broad categories: research paradigms (5 traits), epistemologies (7 traits), methodologies (17 traits), and unique traits (4 traits).

Five traits were related to research paradigms (1-positivism, 2-post-positivism, 3-constructivism, 4-critical theory, 5-pragmatism) that were used in each field. Research paradigms were defined following the typology of Guba and Lincoln (1996), which explained five opposing paradigms of investigation: positivism, post-positivism, pragmatism, constructivism, and critical theory. These paradigms differ on the position of truth, reality, and the role of the researcher in the research enquiry. Positivist and post-positivist researchers believe that the universe conforms to permanent laws and rules of causation and happenings. They believe that the world we observe is real and can be measured and quantified by testing hypotheses, which enables the generalizability of research findings. Positivist and post-positivist perspectives differ in the position of the researcher among other things. On the other hand, constructivists and critical theorists hold the view that reality or truth is created by the researcher and their interactions with the contexts. They believe that truth is subjective and that the world is experienced by every individual in a different way, challenging the idea of repeatability and generalization in research. While constructivists try to focus on understanding how the world around us gets constructed, critical scholars try to expose the problems associated with any fixed system of thought, being skeptical of traditions and absolute claims (Aliyu et al., 2014). Lastly, pragmatism sidesteps the contentious issues of truth and reality, and accepts that there are singular and multiple truths that are open to empirical enquiry. Pragmatists orient themselves towards solving issues in the real-world and choose methodologies and epistemologies that best serve their purpose (Feilzer, 2009).

Seven traits referred to epistemologies that were used for research in each subfield (1-phenomenology, 2-symbolic interactionism, 3-functionalism, 4-indigenous paradigm, 5-feminism, 6-queer theory, 7-Marxism). Epistemologies refer to the ways of knowing and understanding the truth. For example, phenomenology, functionalism and symbolism are all different epistemologies related to constructivism, while indigenous paradigm, feminism, queer theory, and Marxism are epistemologies related to critical theory (Aliyu et al., 2014).

Additionally, we collected information on 17 traits that referred to the methodologies used in every field as we identified them in our readings of empirical research or as they were described in the foundational readings of the fields (1-surveys, 2-fieldwork, 3-focus groups, 4-choice experiments, 5-interviews, 6-critical discourse analysis, 7-modeling, 8-manipulative experiments, 9-participant observation, 10-ethnography, 11-case study, 12-narrative enquiry, 13-ideological review, 14-archival studies, 15-content analysis, 16-methodic doubt, 17-dialectic method). Lastly, we identified four traits from the readings that referred to key characteristics of each field (1-The field studies human-animal interactions of people at present times, 2-the field studies human-animal interactions of people from the past, 3-the field uses evolutionary theory as a fundamental assumption, and 4-the field has an explicit political agenda).

To analyze the similarities between fields, we calculated a binary pairwise distance matrix for all fields using the statistical software R (R Development Core Team, 2008). We performed two different clustering analyses, based on different weightings. First, we calculated the dissimilarity using a binary distance method where each one of the 33 traits were given equal weight, which was the most parsimonious analysis. Second, we gave different weights to each category of traits: 30% to research paradigms, 30% to epistemologies, 30% to methodologies, and 10% to unique traits. These weightings were based on our opinion of the variables most important for structuring the similarity of the fields (recognizing the subjectivity of this task). We then used the Gower index to calculate dissimilarity between the fields. The results of the dissimilarity matrices were then visually represented in cluster dendrograms that were produced using the R package “dendextend” (Galili, 2015).

3. Results

We identified 27 fields that study the non-material relationships between humans and animals. The complete field summary is presented in Appendix A. The results of the first analysis (Fig. 1a) showed that the fields can be classified in three major groups, while the results of the second analysis showed that fields can be grouped in two major clusters with five subgroups (Fig. 1b). For the sake of simplicity, we structured this paper based on the results of the first analysis, while also discussing differences in the second analysis.

The first analysis showed a strong difference between the fields that exclusively study the interactions of humans with animals in the past, such as history and animals (Kalof, 2007) and zooarchaeology (Thomas, 1996), as opposed to the fields that study human-animal relationships in both present and past times. Moral philosophy is an interesting case because it groups with history and zooarchaeology. However, it also stands on its own since it utilizes methods that are unique to philosophy (i.e., methodic doubt and dialectic) (Maier, 2012). It is important to

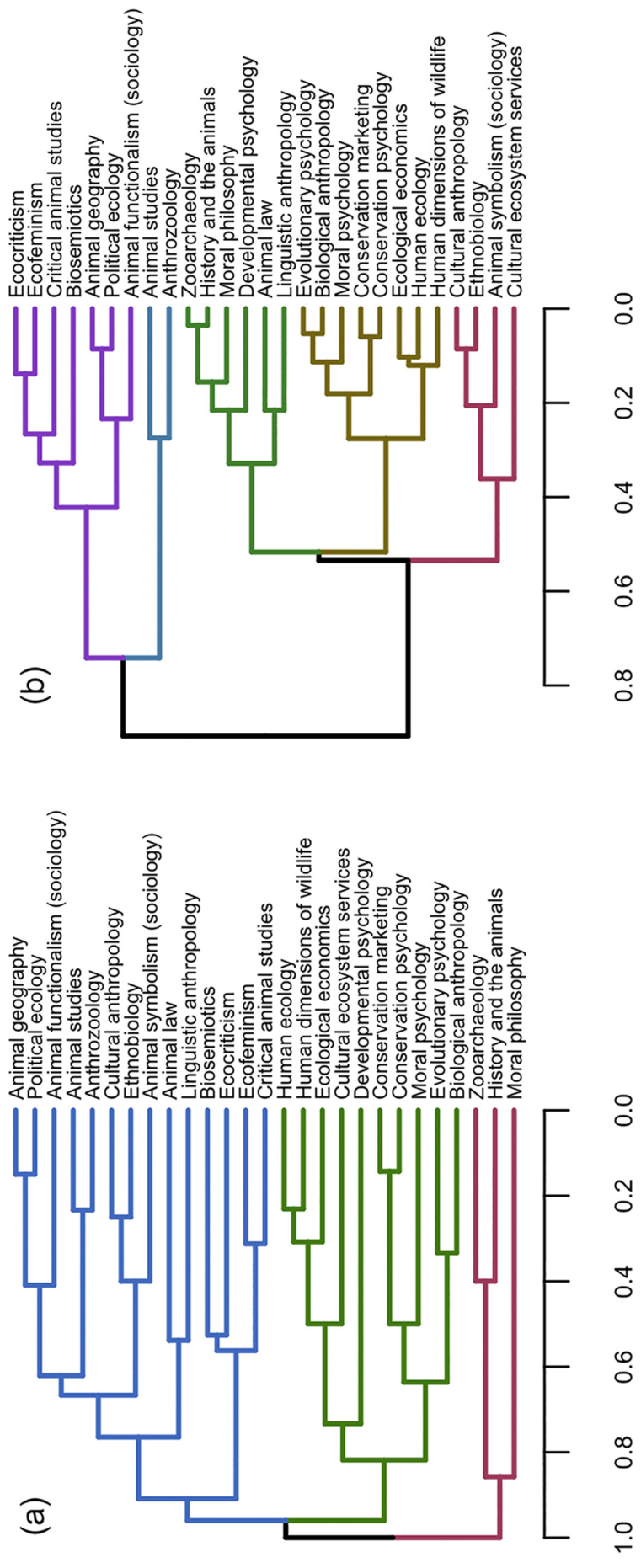

Fig. 1. Cluster dendrograms showing the dissimilarity between fields within human-animal studies. The left panel (a) shows the dendrogram obtained with a binary pairwise dissimilarity index. The second panel (b) shows the dendrogram obtained with a Gower distance dissimilarity index.

recognize that philosophy and particularly moral philosophy, have influenced the rest of the fields quite strongly (Shapiro & DeMello, 2010). For example, animal law and moral psychology operationalize ideas that were conceptualized by moral philosophers (e.g., should animals have rights?). A limitation of our research is that these influences are not captured by our analysis or shown in Fig. 1.

With respect to the fields that study the current non-material relationships of people with animals, our results showed that the 24 academic fields can be classified in two major clusters. The first cluster encompasses the various fields that focus on understanding how animals are socially constructed. Social constructions refer to the cultural constructs that are affected by language and discourse (upper branch in Fig. 1a). Examples of social constructions of animals are the names that humans give to different animals or the gender that we use to describe them. These social constructions relate to the ideas we have about different animals, which varies across social and cultural groups (DeMello, 2012). The second cluster encompasses fields that attempt to understand the non-material relationships between humans and animals by quantifying them in terms of attitudes, innate preferences or aversions, perceptions, emotional attachment, value orientations, behavioral intentions, and behaviors towards animals (middle branch in Fig. 1a). The next sections synthesize how the non-material relationships of humans with animals are studied and conceptualized under these two large clusters.

3.1. Animals are socially constructed: human-animal relationships are context dependent

Results showed that there are 14 fields that study how animals are socially constructed. These fields include: animal geography, political ecology, cultural anthropology, sociological animal functionalism, among others. Most of these fields operate within constructivist or critical research paradigms, which consider that reality is subjective (Aliyu et al., 2014). Thus, under the scope of these fields, the non-material relationships between humans and animals are context dependent and co-constructed between people and animals (DeMello, 2012). The methods used by these fields include, but are not limited to: ethnographies (e.g., Ingold, 2000), ideological reviews (e.g., Mullin, 2002), content analysis (e.g., Cosslett, 2002), interviews (e.g., Frommer & Arluke, 1999), and critical discourse analysis (e.g., Gruen, 1993). For the most part, these fields avoid quantitative methods because they challenge the idea that human-animal relationships can be generalized (Shapiro & DeMello, 2010).

A main starting point for the scholarship that evaluates how animals are socially constructed is the space in which animals exist. For example, animals exist in the wild, in the laboratory, in our workplaces, in our kitchen, and in the circus. The fields that study how animals are socially constructed do so by evaluating the influence of such spaces in shaping how people think about animals, and therefore how they treat them (DeMello, 2012). Arluke and Sanders (Arluke & Sanders, 1996) stated that humans classify animals in a sociozoologic scale, which is an arbitrary category system based on the roles animals play in our lives. This scale is socially constructed and is influenced by culture, individual worldviews, and constantly changes over time (Arluke & Sanders, 1996). For example, while most North Americans would classify dogs (*Canis lupus familiaris*) as "animals that we keep as pets" in their sociozoologic scale, Koreans would classify them as "animals that we eat" in their scale (Herzog, 2010). Arluke and Sanders (Arluke & Sanders, 1996) also pointed out that people who work closely with animals are unique in how they think about animals. For example, zoologists mostly classify animals, and therefore construct them, based on phylogenetic scales; other groups of people rely more on sociozoologic scales (Herzog, 2010).

Within the fields that study how animals are socially constructed, there are fields that deconstruct the labels that humans ascribe to animals. Animal geographers and political ecologists argue that sociozoological classifications are politically charged (Collard, 2015; Urbanik, 2012). It is important to note that here we use the term animal geographers to refer to the human geographers who study human-animal interactions within constructivist or critical research paradigms. We do not refer to physical geographers whose research resembles that of ecologists. Animal geographers and political ecologists may argue that such classifications benefit some animals at the expense of others. For example, gray wolves (*Canis lupus*) are managed each year to reduce livestock depredations and as a result, wolves are viewed disproportionately negatively relative to the actual damage they cause (Browne-Nuñez et al., 2015; Wielgus & Peebles, 2014). These classifications also determine whether animals get moral and therefore legal standing (Dawkins, 2012). Why do biologists working with certain taxonomic groups, such as birds and mammals, require ethical research permits, while those working with insects do not? This is an example of a research question that scholars in these fields attempt to answer. Lastly, these fields mostly operate in academic contexts.

Critical scholars within the meta-field of human-animal studies challenge the underlying assumptions for such sociozoological classifications. For example, ecofeminists (interpreted here as a subfield of gender studies), ecocriticists (a subfield of literature), and critical animal studies scholars draw parallels between speciesism, sexism, and racism (Adams, 1994; Cusack, 2013; Gaard, 2011). They study how the process of "othering" and assigning different characteristics to certain groups (e.g., women/men, animals/humans) helps justify the dominating behavior that people exert over animals (DeMello, 2012). Moreover, they question the moral implications of these assumptions. Many of these fields operate within academic contexts by bringing "animal voices" to the academic conversations, but some have explicit political agendas. For example, critical animal studies scholars advocate against animal oppression, exploitation, and domination in the animal rights movement (DeMello, 2012).

Animals also exist in languages, in folklore, and in various forms of artistic expression. Hence, a subset of academic fields looks at animal representations in these "spaces" (DeMello, 2012). For instance, sociologists studying animal symbolism evaluate how a species becomes a symbol and how these symbolic meanings get renegotiated over time (Arluke, 2002). For example, Jerolmack (2007) studied the change of the symbolic meaning of pigeons. The author explained how pigeons (doves) have served for many years as symbolic representations for deliverance and peace in Western societies, but how recently these birds are considered a symbol for uncleanliness, and are associated with health problems. In addition, other fields study the roles of animals in different cultures. For example, cultural anthropologists attempt to understand how animals become totemic cults, such as the sacred cows (*Bos taurus*) in Hinduism, or the Raven (*Corvus corax*) as the creator God of the people for some coastal Indigenous peoples in the Pacific Northwest of North America (Marzluff & Angell, 2005). Most of these fields operate within academic contexts by describing how animals are represented across cultures, and how animals take various forms in artistic and linguistic spaces. Biosemiotics in particular, bridges linguistics with biology by looking at the signs and codes that different species use to communicate with each other (Barbieri, 2008; Barbieri, 2009).

In summary, the academic fields that examine how animals are socially constructed do so by delving into the historical, political, and cultural contexts that inform the nature of human-animal relationships. While these fields mostly operate within academic contexts, some fields have explicit political agendas and practical applications (e.g., animal law, and critical animal studies).

3.2. The non-material relationships between humans and animals can be measured and quantified

Results also showed that 10 fields (middle branch in Fig. 1a) comprise the other stream of research within human-animal studies,

including human ecology, human dimensions of wildlife, conservation psychology, and cultural ecosystem services. These fields largely use positivist and post-positivist research paradigms (Guba & Lincoln, 1996) based on beliefs that the non-material relationships between humans and animals can be measured and quantified. These fields largely use quantitative methods such as surveys, longitudinal experiments, choice experiments, and modeling to capture and understand such relationships. Additionally, when these fields do employ qualitative methods, such as interviews, they often still quantitatively analyze the qualitative data. For example, by counting the number of times that predetermined themes are mentioned by interviewees (e.g., Gould et al., 2014a; Gould et al., 2014b; Klain et al., 2014).

Non-material relationships between humans and animals are measured in terms of peoples' attitudes (e.g., Browne-Nuñez et al., 2013; Serpell, 2004; Teel & Manfredo, 2010), innate preferences or aversions (e.g., Archer & Monton, 2011; Teachman et al., 2001), emotional attachment (e.g., Hills, 1993; Vining, 2014), perceptions (e.g., Belaire et al., 2015; Takahashi et al., 2012; Veríssimo et al., 2009), value orientations (e.g., Teel & Manfredo, 2010; Vaske & Donnelly, 1999), behavioral intentions (e.g., Browne-Nuñez et al., 2015; Vaske & Donnelly, 1999), and behaviors (e.g., Amiot & Bastian, 2017; Clucas & Marzluff, 2012; Drews, 2001) towards animals. These terms are often used to refer to similar aspects of the human-animal relationships, but different fields use some of them more frequently than others (Table 1). The fields that measure and quantify the non-material relationships between humans and animals are similar in research paradigms. The difference between them lies mostly in the contexts in which each operates, and the methods used. The next paragraphs elaborate mostly on the contextual differences, while the differences in methods are documented in Appendix A.

Some fields study animals with the purpose of better understanding humans, because we see animals as mirrors of ourselves (DeMello, 2012). For example, biological anthropology studies the interspecific behavior of primates to understand human relationships with other animals (Hausfater, 1984; Mullin, 2002). Similarly, evolutionary psychologists study the evolution of human-animal interactions, such as the origins of pet-keeping in primates (Herzog, 2014) or the innate preferences (i.e., Biophilia) or aversions (i.e., Biophobia) humans have towards specific animals (Kellert & Wilson, 1995). Scholars interested in these relationships evaluate whether these innate inclinations are also observed in other animals, such as the development of fear towards snakes among primates (Mineka & Cook, 1988). These fields use evolutionary theory as a starting point for formulating research questions and hypotheses.

Other fields study the non-material relationships between humans and animals throughout peoples' lifespans, and how previous interactions with animals shape our current views and actions towards animals. For example, developmental psychologists study how human-animal relationships in early childhood (e.g., violence towards animals in childhood) predict human behavior and attitudes towards animals and people in adulthood (e.g., violence towards people in adulthood) (Amiot & Bastian, 2015; Arluke et al., 1999; Serpell, 2004). In addition, moral psychologists study the moral rules that seem to guide how humans treat animals. For instance, when confronted with ethical dilemmas such as saving people vs. saving animals, why do humans almost always seem to save people over animals? Is this moral rule universal? (Herzog, 2010). Given that most of these research questions cross disciplinary boundaries, it is not surprising to notice that many scholars in these fields collaborate with each other. For example, moral psychologists often collaborate with developmental psychologists to determine not only the universality of the moral rules regarding animal treatment, but also how and when these rules are formed throughout a person's lifetime (Arluke et al., 1999).

Much of what we have stated so far echoes the synthetic views regarding the field of human-animal studies expressed in DeMello (2012) and Herzog (2010). To our knowledge, these are the two most comprehensive reviews on the scholarship studying human-animal interactions, and have helped define the fields of human-animal studies and anthrozoology. However, both DeMello (2012) and Herzog (2010) omitted some critical fields that also study the non-material relationships between humans and animals. Particularly, the fields that explicitly aim to inform biodiversity conservation and wildlife management have not yet been considered part of anthrozoology or human-animal studies. This may be because these fields are associated with the natural sciences, which might have caused a misconception regarding the focus of their enquiry (i.e., that they study only animals, instead of both animals and humans in human-animal interactions). Such fields include cultural ecosystem services, human dimensions of wildlife,

Table 1
Glossary of terms that defines the terminology used in the fields to measure and quantify the non-material relationships between humans and animals.

Term	Meaning
Attitudes	Learned predispositions to respond in a favorable or unfavorable manner with respect to a given object or situation (Fishbein & Ajzen, 1975). This term is widely used in psychology (various fields), and in the subfield of human dimensions of wildlife.
Behavior	One or more observable actions performed by an individual in a specific situation or under specific circumstances (Ajzen & Fishbein, 1977). Behavioral acts towards animals include installing bird feeders in the backyard, trapping or hunting animals, among others.
Behavioral intention	A person's intention to act in a particular way, which is a function of a person's attitude towards performing the behavior and the subjective norm about the behavior (Ajzen & Fishbein, 1977).
Innate preference or aversion	Inherent human predisposition to respond favorably or unfavorably with respect to an object or a situation. With respect to nature, sociobiological theory suggests that humans are born to like and dislike certain species and certain landscapes. For example, humans have an innate phobia for spiders, and a tendency to respond positive to savanna environments with water sources (Kellert & Wilson, 1995). Innate preferences or aversions are often used in fields like evolutionary psychology, developmental psychology, and biological anthropology.
Perception	The term “perception” has different meanings for different fields. In psychology and animal physiology, it refers to the neural organization of sensory information that allows humans and other animals to generate judgements towards situations or objects (Bruce et al., 2003). In conservation marketing, the term “perception” is used to describe “what people think” about animals, and it includes the conceptual meaning of attitudes, value orientations, and perceptions.
Sociozoologic scale	An arbitrary category system to classify animals based on the roles animals play in human lives. This scale is shaped by individual experiences, cultural beliefs, social norms, and changes over time (Arluke & Sanders, 1996).
Value orientations	Patterns of basic beliefs that capture cultural ideals and can be organized in dimensions with two opposite extremes. For example, *harmony* vs. *mastery* when referring to the orientation of beliefs regarding a person's relationship with nature. Other orientations are embeddedness vs. autonomy, hierarchy vs. egalitarianism (Manfredo, 2008; Schwartz, 2006). This term is mostly used in the field of human dimensions of wildlife.
Values	The term “values” is used in vastly different ways in a variety of academic fields and fields including psychology, sociology, anthropology, economics, moral philosophy, cultural ecosystem services, and human dimensions of wildlife (Jones et al., 2016; Tadaki et al., 2017). According to the psychological definition, values represent an enduring belief that a specific mode of conduct is personally or socially preferred over an opposite of converse mode of conduct. Values are the most abstract of the social cognitions and represent what is deemed important by individuals. They transcend objects, situations, and issues. Importantly they are hard to change during a person's adult life (Rokeach, 1973; Schwartz, 1994).

conservation psychology, conservation marketing, and human ecology. In the next sections, we summarize the differences and similarities between some of these fields. Moreover, we advocate for their inclusion to the meta-field of human-animal studies, as they have similar research questions to those posed by other fields within human-animal studies.

Cultural ecosystem services are defined as "ecosystems' contributions to the non-material benefits (e.g., capabilities and experiences) that arise from human-ecosystem relationships" (Chan et al., 2012b). This field emerged from the intellectual tradition of ecosystem services (Daily, 1997; Millenium Ecosystem Assessment, 2005). Scholars in this field conduct applied research with the intention of informing the conservation of ecosystems. Evidently, the study of human-ecosystem relationships also entails studying human-animal relationships. To date, most of the studies in the field of cultural ecosystem services have focused on ecosystems and characteristics of "place", rather than focusing on specific animals (e.g., Gould et al., 2014a; Gould et al., 2014b; Klain et al., 2014). But increasingly, studies are focusing on the relationships between humans and certain species (e.g., Belaire et al., 2015; Puhakka et al., 2011). The field of cultural ecosystem services has a special political agenda that aims to include the non-material relationships with nature, ecosystems, and animals into conservation decision-making, and natural resource management (Chan et al., 2012a). In addition, the field of human dimensions of wildlife emerged from the intellectual tradition of wildlife management (Manfredo, 2008). Manfredo stated that since its introduction, the human dimensions of wildlife field has been primarily applied and descriptive: "Its main focus is to provide information about public values that managers can consider while making wildlife decisions" (2008:12). Studies conducted in this field evaluate public opinion of endangered species and their management (e.g., wolves in Browne-Nuñez et al., 2015) or public attitudes towards species that are part of human-wildlife conflicts (e.g., elephants in Browne-Nuñez et al., 2013). Unlike other fields within human-animal studies, both fields are not only interested in advancing the scholarship and our theoretical understanding of human-animal relationships, but rather they are interested in applying research findings to inform conservation and wildlife management decisions.

Two academic fields are interested in influencing human behavior towards animals: conservation marketing and conservation psychology. Conservation marketing emerged from the combination of marketing ideas from business and commerce with ideas and needs from conservation biology (Smith et al., 2010). This field focuses on evaluating people's perceptions of animals with the purpose of increasing monetary donations to conservation, which can be done through the use of marketing techniques such as making people feel good about themselves when they engage in prosocial spending (Smith et al., 2010). Studies in this field quantify people's perceptions of animals with the purpose of identifying appropriate flagship species for marketing campaigns while considering the perceptions of different groups, such as tourists and local communities (Bowen-Jones & Entwistle, 2002; Veríssimo et al., 2009). Conservation marketing scholars also study the attributes that make animals appealing, which can later inform the design of conservation campaigns (Smith et al., 2012; Takahashi et al., 2012). Experiments in this field mostly use choice experiments and surveys as primary research methods.

Conservation psychology is a field similar to conservation marketing. As an interdisciplinary field, it has been informed by other fields in psychology (e.g., social, developmental, cognitive), human dimensions of wildlife, and human ecology (Saunders, 2003). Conservation psychology mainly studies the reciprocal relationships between humans and nature, by focusing on how to encourage conservation of the natural world (Saunders, 2003). For example, by analyzing how animals are depicted in popular media, conservation psychologists study people's perceptions and attitudes towards animals and make recommendations for designing more effective communications that avoid misrepresentations of animals, which can hinder their conservation (e.g., anthropomorphized chimpanzees: *Pan troglodytes*; Ross et al., 2011). Conservation psychologists also study attitude change and how to promote pro-wildlife behaviors such as responsible ecotourism, recycling, or reduced water consumption (Clayton & Brook, 2005; Clayton et al., 2013; Saunders, 2003). The main methods used in conservation psychology are experiments (including longitudinal and field-based experiments) and surveys.

These four relatively new fields deserve to be recognized by human-animal studies scholarship, as they also study human-animal interactions for academic purposes. Importantly, these fields conduct applied research with the hope of informing wildlife conservation or management, contributing substantially to the real-world applications of the human-animal studies field. Thus, the four represent an important subdivision of human-animal studies. Based on a narrow interpretation of human-animal studies without these four fields, the real-world application of human-animal studies has only been recognized to inform animal welfare policies, or animal-assisted therapy, not the conservation of biodiversity (DeMello, 2012).

In summary, of the 10 fields that measure and quantify the non-material relationships between humans and animals, some focus on advancing our theoretical understanding of such relationships. But others conduct applied research with the goal of informing conservation campaigns, wildlife management, and conservation decisions. They also aim to influence human behavior by encouraging people to adopt pro-wildlife behaviors. These fields study human-animal relationships by using a wide range of methods, but they agree on the fundamental assumption that human-animal relationships can be measured and quantified.

3.3. A weighted classification of the fields

Results from the second analysis showed that the fields can be grouped in two major clusters and five subgroups. This grouping showed some similarities with the results obtained from the first analysis. For instance, the fields that are highly similar to each other remain similar in the two analyses, such as anthrozoology and animal studies; zooarchaeology and history and the animals; cultural anthropology and ethnobiology. Moreover, the fields that approach human-animal relationships from post-positivist or positivist paradigms and use quantitative methods also cluster together in the second analysis. The main difference between the two analyses is that the fields studying the social construction of animals do not all form one large cluster, rather they are subdivided between those that often take critical approaches (e.g., ecocriticism, ecofeminism, critical animal studies, animal geography) vs. those that study the symbolic meaning of animals in different cultures (e.g., cultural anthropology, ethnobiology, sociological symbolism, cultural ecosystem services), and vs. those that describe human-animal relationships based on contextual differences (e.g., animal law, linguistic anthropology, zooarchaeology). Given the subjectivity of any weighting, the two classification results are equally valid.

4. Discussion

4.1. A conundrum: are cross-paradigmatic research collaborations possible?

The previous sections show that scholarship in the field of human-animal studies is highly interdisciplinary, and covers a wide range of topics. But how much cross-fertilization happens between the different fields of human-animal studies? This question remains open, and it is somewhat difficult to answer given that each field operates within disciplines that have conflicting norms. For example, researchers in psychology or human dimensions of wildlife tend to publish peer-reviewed articles with multiple coauthors (e.g., Amiot & Bastian, 2017; Browne-Nuñez et al., 2013) and often publish their work quite rapidly (e.g., several articles per year). In contrast, scholars in fields such as history or literature tend to communicate their research via single

authored books that are written over longer periods of time (e.g., Adams, 1994; Jepson, 2008; Kalof, 2007). Given this discrepancy in publication norms, what metric would allow us to objectively evaluate cross-fertilization across fields? Without answering this question, we seek to provide some tentative insight on the perceived cross-fertilization across fields.

Within the fields that study how animals are socially constructed, it appears that some fields have influenced others. For example, in the early 1990s, the environmental movement was strongly influenced by the feminist movement. Ecofeminist Carol J. Adams wrote about the control of women's bodies and the control of animal bodies, and showed how these two are intricately linked (Adams, 1994). Later, these ideas were echoed by ecocritics (Gaard, 2011), political ecologists (Lloro-Bidart, 2016), and critical animal studies scholars who advocated for animal rights in the meat production industry (Cusack, 2013). Moreover, with respect to the fields that quantify human-animal relationships, it is evident that attitudinal research and methods from social psychology have informed not only the formation of fields like human dimensions of wildlife (Manfredo, 2008), and conservation psychology (Clayton & Myers, 2011); but they have also been used in empirical studies, such as the anthrozoological study attempting to understand farmers' attitudes towards animals for improving animal welfare (Kauppinen et al., 2010), or the cultural ecosystem services study aiming to evaluate people's attitudes towards local birds for leveraging public support for their conservation (Belaire et al., 2015). Attitudes as measured via surveys seem to be a fundamental cornerstone of the scholarship that measures and quantifies human-animal relationships.

From the readings in the human-animal studies scholarship, it appears that research paradigms and their associated methodologies pose a major barrier that impedes cross-fertilization between fields. Our analysis suggests that the constructivists and critical scholars who study “animals-as-constructed” (i.e., animals as they exist in our minds with all the symbolisms and connotations that are ascribed through our lifetimes) conduct research independently of the positivists and post-positivists who study “animals-as-such” (i.e., animals as biological entities independent of human thought) (Shapiro, 2008). This has also been found by Shapiro and DeMello (2010), who summarized the history of human-animal studies and stated that: “[P]hilosophy raised the original question of the moral value of animals which led to the animal protection movement. Then the harder social sciences provided empirical data and identified the amazing array of human-animal relationships, their benefits to humans, and the exploitation typically involved. In response to these developments, in turn, the more interpretive social sciences and humanities delved into the issues on which these relationships rest” (2010: 311). This statement suggests two speculations about the cross-fertilization between the fields of human-animal studies. First, fields categorized under different academic categories (e.g., “hard social sciences”, “soft or interpretivist social sciences”, “humanities”) may inform each other only with a time delay. Second, the organizational paradigm of universities seems to facilitate some collaborations and hinder others, perhaps due to physical or organizational proximity associated with profound epistemological differences (e.g., many universities have separate faculties for sciences, social sciences, and humanities).

Since its origins, conservation biology was described as a crisis discipline aiming to protect nature for its own sake (Soulé, 1985). With many contributions such as the conceptualization of “ecosystem services” (Daily, 1997), and recent proposals to reorient conservation science in the Anthropocene (Kareiva & Marvier, 2012), the conservation movement has shifted partly towards also protecting nature for people. Most recently, the conservation movement has started to recognize the plurality of values that underpin people's motivations to care for the environment. Specifically, it has been stated that caring for the environment should go beyond its intrinsic or instrumental value, implicit in previous conservation discourses, and that we should also care for relational values that speak more broadly about people's interactions with nature (Chan et al., 2016). As part of the above trajectory, there have been a number of recent pushes to better integrate research from beyond the natural sciences in conservation (Bennett et al., 2017; Teel et al., 2018). Most recently Teel et al. (2018) advocate for increased social science research in conservation, recognizing that complex conservation problems transcend the purview of single disciplines or methods. They also note the need for methodological rigor (e.g., representativeness evaluations, triangulations of findings until theoretical saturation has been achieved) in quantitative and qualitative conservation social science studies. However, this invitation is biased towards the social sciences and entirely omits the arts and humanities. Here we build on Teel et al.'s call by also advocating for inclusion and collaboration with researchers trained in arts and humanities, as their methods and approaches delve into additional layers of complexity in conservation problems. In order to conduct meaningful and collaborative interdisciplinary research, overcoming epistemological and methodological barriers is imperative, yet from personal experience, many natural scientists are unaware of the methods and perspectives about knowledge and reality that are prevalent in many fields from the social sciences, arts, and humanities. Awareness of these crucial aspects may facilitate the integration of the many fields relevant to conservation, by enabling novel research questions, teams, and approaches to creatively explore and address local, regional and global conservation problems.

How can we effectively conduct cross-paradigmatic research? There are two possible avenues depending on the focus of the research (Robinson, 2008). For the academic advancement of theories and methods, we suggest four steps. First, we might raise awareness of the various fields within human-animal studies and foster a culture of respect for each other's fields. By challenging prejudice and “disciplinaryism” we might better form effective collaborations. Second, we might be explicit about our positionality as researchers, regardless of our training. It is easier to collaborate if we understand the fundamental assumptions that underpin how others approach human-animal relationships. Early conversations about fundamental assumptions regarding the position of truth, reality, and the role of researchers might help potential collaborators formulate a cohesive research project. Third, in research design, it might help to collectively choose one research paradigm, as paradigms guide the formulation of research questions, and methodological approaches (multiple implicit paradigms may work at cross-purposes, causing conflict among team members). However, in the analysis and the interpretation of the results, we might engage scholars from other fields that operate within different epistemological paradigms, to interpret the results more broadly. Alternatively, if the purpose of the research is to inform real-world issues, then a problem-based and solutions-oriented approach might be appropriate, which is consistent with the pragmatic research paradigm (Feilzer, 2009). Such an approach starts with real world issues and questions, and from there chooses research paradigms, research questions and methodologies that best addresses the conservation problem in question. A problem-based approach allows more flexibility at the stages of research design and data collection. In any case, a culture of respect for other ways of knowing is imperative for achieving fruitful collaborations.

4.2. Beyond the academic realm: real-world applications of human-animal studies to conservation and wildlife management

Studying the non-material relationships between humans and animals goes beyond theoretical understandings of how we construct animals and our attitudes towards them. In fact, human-animal studies have many practical applications. Increasingly, the conservation community understands that conservation issues go well beyond our biological understanding of endangered species, and that while people can create conservation problems, they also must be a key part of the solution (Chan et al., 2016; Díaz et al., 2018; Pascual et al., 2017). Below

Fig. 2. Four examples of conservation cases that could benefit from interdisciplinary collaborations with human-animal studies scholars and practitioners. (a) An example of a predator conflict, is the jaguar-farmer conflict across the Americas. Jaguars pose threats to livestock farmers across their distribution range. (b) An example of reintroduction efforts that would benefit from some understanding of the human-animal relationships between people and animals is the sea otter reintroduction and population recovery in the West Coast of Vancouver Island. Conservation groups talk about their benefits to eco-tourism, but coastal First Nations are concerned with the rapid losses of shellfish fisheries. (c) An example of ex-situ conservation is the conservation of amphibians in zoos. Many zoos currently lack a representation of amphibians as they are often perceived negatively and lack visitor support, more research and endeavours are needed to change public perceptions of amphibians. (d) An example of wildlife crime is ivory trade. Some ivory trade is illegal and agencies confiscate it. Ivory trade is posing great threats to elephant populations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

we consider four classical cases from wildlife management and conservation, and illustrate how each one would benefit from engaging with human-animal studies (Fig. 2). In Table 2 we summarize some research questions for each example and how they fall in the domain of different fields.

4.2.1. Predator conflict

Conflicts between people and predators (e.g., large carnivores), particularly those that threaten livestock, are commonplace around the world (Pooley et al., 2017). Local perceptions of predators influence how they are threated and which institutions are responsible for their management (Pooley et al., 2017). For example, conflict between livestock farmers and jaguars (*Panthera onca*) in the Americas is the most serious threat to the survival of the jaguar across its 19-country range (Zimmermann, 2014) (Fig. 2a). A recent study evaluated 17 case studies across 7 countries within the jaguar range and found a great diversity of farmer perceptions of and norms towards jaguars (Zimmermann, 2014). For instance, in Colombia and Brazil jaguars represented power and war for pre-Hispanic people (Gómez García-Reyes & Payán Garrido, 2017; Zimmermann et al., 2005). In contrast, across the Mayan territory jaguars were perceived as the alter ego for the “chamanes” (traditional healers). Thus, jaguars and “chamanes” were a single entity (e.g., a common Mayan figure is the “chilam balam” or jaguar priest) with special healing powers and worthy of respect. Understanding and incorporating these differences in cultural perceptions of jaguars can inform more effective conservation efforts that better target the appropriate cultural symbolism, via leveraging the jaguar as a symbol of power and as a healer (Gómez García-Reyes & Payán Garrido, 2017). To better leverage the diverse perceptions and symbolism of jaguars and other wide-ranging and conflict-prone predator species (e.g., sharks, tigers), we need to engage with a wide variety of human-animal studies scholars who understand the local meanings of such culturally-important species (see Table 2 for specific interdisciplinary collaborations).

4.2.2. Reintroduction

An important conservation strategy for recovering populations of species at risk is to reintroduce them to their former range (Corlett, 2016). These reintroductions are contingent on the successful co-existence of the newly introduced individuals with the local people already living there (Browne-Nuñez et al., 2015). For example, sea otters were reintroduced to the West Coast of Vancouver Island in British Columbia, Canada in the 1970s. Although the recovery of sea otter populations reflects successful biological conservation, the social and economic impacts have induced socio-ecological conflicts that have triggered negative attitudes among local coastal communities, resulting in retaliatory killings of otters (Hume, 2014). Otters compete with shellfish fisheries, but they are also a charismatic species that attracts tourists (Fisheries and Oceans Canada, 2007) (Fig. 2b). Interdisciplinary research conducted by ecologists and zooarchaeologists can give insights into how First Nations coexisted with otters in the past to promote future coexistence. Moving forward, management strategies may depend on strategies on reconciliation, education, and new paradigms for co-governance of shellfish fisheries between First Nations and the provincial government that clearly outline harvest regulations and delimit spatial boundaries for harvest vs. no harvest areas (Salomon et al., 2015). These actions fall well beyond the scope of biology, and require interdisciplinary teams of research and practitioners that are willing to work together (see Table 2).

4.2.3. Ex-situ conservation

Ex situ programs have contributed to the conservation of many

Table 2
Examples of research questions that could help us solve some of the classical problems in conservation, such as predator conflicts, reintroductions, ex-situ conservation and wildlife crime.

Conservation case	Example	Examples of research questions	Fields
Predator conflicts	Jaguar conflicts across the Americas	Which symbolisms do jaguars carry across the 19 countries of their range? Are they often perceived as positive or negative characters?	Cultural anthropology, ecocriticism, zooarchaeology, animal functionalism, critical animal studies
		How can educational and conservation campaigns be designed to incorporate the cultural and the ecological roles of jaguars and be tailored to different populations?	Conservation marketing, conservation psychology, human ecology, ecology, cultural anthropology
		How much monetary harm do jaguars cause to livestock farmers and how can we design effective conservation mechanisms that mitigate or compensate them for their loses? Can we design co-management strategies for the territories that jaguars cross to ensure local stewardship from farmers and following the local legislations?	Environmental economics, Animal law, human dimensions of wildlife
Reintroduction	Sea otter reintroduction in the West Coast of Vancouver Island, Canada	How can sea otter conservation join other reconciliation and decolonizing efforts in British Columbia that are happening now in natural resource management and human rights?	Critical animal studies, political ecology, eco-feminism, animal geography, moral philosophy
		Which roles did sea otters have in First Nations cultures before the fur trade? Can we leverage from such roles to create co-existing strategies?	Ethnobiology, history and the animals, zooarchaeology, biological anthropology, animal functionalism
Ex-situ conservation	Conserving globally endangered amphibians in zoos worldwide	How can we change the social construction of amphibians so that they do not hold negative views?	Animal studies, anthrozoology, cultural anthropology, animal geography, animal symbolism, cultural ecosystem services
		Can we make successful conservation campaigns for amphibians that are going to get public attention and motivate donations to their conservation? If so, how?	Conservation marketing, conservation psychology, developmental psychology, evolutionary psychology
Wildlife crime	Elephant ivory trade between Africa and Asia	Are there any substitutes for ivory that also represent wealth and social status for ivory consumers? Historically, how did ivory get its symbolic meaning?	Animal symbolism (sociology), animal geography, political ecology, animal functionalism (sociology), history and the animals
		How can we reduce supply (e.g., by diminishing interest in poaching) and demand (e.g., by changing societal preferences) to mitigate the impact of ivory trade on elephant populations? Are there any alternative economic benefits that people can get from elephants other than revenues from selling ivory?	Environmental economics, conservation psychology, anthrozoology, cultural ecosystem services

species and have helped the recovery of heavily diminished populations (e.g., California Condor: *Gymnogyps californianus*, Whooping Crane: *Grus americana*) (McGowan et al., 2017). Zoos and aquaria play significant roles in ex-situ conservation, but it has been documented that zoos disproportionately conserve more birds and mammals, giving little attention to globally endangered amphibians (Conde et al., 2013). A recent survey on amphibian curators at 107 institutions worldwide showed that one of the main barriers to having amphibians in ex situ collections is the difficulty of displaying them due to their cryptic behavior and coloration, and the difficulty in attracting visitor interest (Brady et al., 2017) (Fig. 2c). In general, people hold very negative attitudes towards amphibians (Ceríaco, 2012). However, there is much scope for constructing positive images and narratives of these animals through storytelling, oral histories, movies, documentaries, and games (Clayton et al., 2013; Silk et al., 2018). This would require some ambitious interdisciplinary collaborations between conservation psychologists, conservation marketing experts, artists, and biologists to ensure that the stories have biological foundations but are told in ways that are persuasive and attractive to people (see Table 2).

4.2.4. Wildlife crime

The illegal and/or unsustainable exploitation of wildlife continues to pose a substantial threat to biodiversity (Kurland et al., 2017). Wildlife crime continues to intensify, and strong preferences for certain animals or their products can accelerate species' extinction risk. For instance, rhinos and tigers have been decimated across their range due to the increased demand for their horns and bones, which are thought to cure cancer, rheumatism or are symbolic of social status in certain cultures (Graham-Rowe, 2011). Similarly, African elephants (*Loxodonta* spp.) have declined by 72% over the past 40 years (Robson et al., 2017), in large part due to the demand for carved ivory products, since possessing ivory is symbolic of wealth and position in China and other countries (Fig. 2d). Insights from political ecologists, critical animal studies scholars, cultural anthropologists, and ecocritics might help us understand how wildlife products become viewed as effective treatments or symbols of wealth and position, and how these views and meanings change over time. With these insights, conservationists can then more effectively design societal interventions that aim to deconstruct such symbolisms and renegotiate the meanings of wildlife products, by reducing demand and/or finding culturally appropriate substitutes that will not threaten biodiversity in similar ways. These ideas are outside the realm of expertise of many conservation biologists or criminologists currently engaged on these topics, so unless we enlist a diverse group of human-animal studies scholars and practitioners, we may continue to overlook effective solution (see Table 2).

4.3. Concluding remarks

Many fields study the non-material relationships between humans and animals under the broader interdisciplinary field of human-animal studies. There appears to be a disconnect between the fields that study "animals-as-constructed", and "animals-as-such" (Shapiro, 2008). This apparent disconnect seems to be caused by profound epistemological differences, and perhaps by the differences in the specialized language of each field. Innovative interdisciplinary research in wildlife management and conservation will require overcoming such epistemological barriers.

The world is facing complex conservation problems that transcend the purview of single disciplines or methods. Interdisciplinary innovation is key to solving many pressing issues. Unless conservationists engage with academics and practitioners trained in other fields, such as the multitude of fields comprising human-animal studies, we will likely miss effective solutions to the worlds' problems. We have found that interdisciplinary research in human-animal studies seems to be "disciplinary-based" (Robinson, 2008). The nature of this research might be hindering the discovery of new research areas that might advance our understanding of human-animal interactions. Importantly, by analyzing questions from a single perspective, certain aspects of human-animal relationships might be overlooked, obviating opportunities to unleash human concern for wildlife. Just as popular concern for only a few charismatic animals hinders conservation, so too does conservation's engagement with only a few select fields of human-animal studies.

Since each has its own unique roots, concepts, theories and methods, each has an important contribution to make.

Future research might productively integrate diverse social sciences and humanities' theories and methods in conservation contexts, which have much to contribute to our understanding of why people value animals. Likewise, research in human-animal studies might benefit from integrating the natural sciences, particularly the fields that also study human-animal interactions, as they can help us understand more broadly our connections with other species, particularly with wildlife. Effective interdisciplinary and cross-paradigmatic research collaborations might require that we be explicit about our positionality as researchers. All research approaches entail advantages as well as limitations; recognizing this might allow us to better understand and review each other's contributions to the field. Thus, valuing the analysis of human-animal relationships from multiple angles is imperative for advancing the field. The various approaches inherent in different fields are likely complementary rather than conflicting ways of knowing.

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Supplementary data

The complete summary of all the fields and the rest of the results are available online (Appendix A). The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author. Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2018.05.015.

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