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Perspective

Species nativeness as a cultural paradigm in conservation

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ABSTRACT

Conservation entails cultural practices shaped by our worldviews, values, beliefs, and priorities for our interactions with nature. These inform how we categorize which species we want to occur in which landscapes. In Western conservation organizations, conceptualizations of species 'belonging' typically align with a dichotomy of native versus introduced species. This is a cultural paradigm, informed by biological considerations, and it is not uniformly shared across different cultures, resulting in varied conceptualizations of species belonging. These conceptualizations may continue to evolve as socio-ecological systems change over time. Thus, misalignment in perceptions of species belonging can manifest in seemingly intractable conflicts. We apply a cultural evolutionary lens to: (1) consider the social history of the native-introduced dichotomy; (2) describe social and ecological factors causing friction around the dichotomy; (3) explore how conservation can integrate diverse and changing values about species belonging, and (4) make predictions about future socio-ecological change that may shape conservation governance and our categorization of species. In doing so, we encourage conservation scientists and practitioners to practice reflexivity about the cultural nature of conservation and management of introduced species. This application of cultural evolution presents a unique lens for recognizing the inevitability of both social and ecological change and inspires critical consideration of how diverse and changing values might be integrated into, and shape, the future of conservation.

1. Introduction

Conservation is about people and our efforts to manage relations with nonhuman natures (hereafter 'nature'; Sandbrook, 2015). It entails cultural practices governed by human values, attitudes, beliefs, and worldviews pertaining to social constructions of and desired interactions with nature (Clifford et al., 2021). Society categorizes which organisms 'belong' or are priorities for conservation based on socio-ecological contexts, and problematize them when they become 'out of place' by crossing socially constructed boundaries (Jerolmack, 2008; Leong, 2009; Philo and Wilbert, 2000). These mental models in turn inform policy and management (Clifford et al., 2021). However, society (and

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therefore conservation paradigms) is comprised of diverse cultural groups that hold differing values and worldviews. Different perceptions of species belonging can manifest in conflict, in turn hindering nature conservation (Hill et al., 2017). Understanding the character of these conflicts – including differing values and conceptualizations of conservation – can better equip managers and policy makers to address them, optimizing outcomes for people and biodiversity.

Management organizations (e.g., governments, non-governmental) are cultural products that reflect the dominant values of the people who established and lead them (Fisk et al., 2025). These organizations and the management actions they pursue may also be dynamic and reflect conflicting values. Culture thus shapes the decisions, policies, and practices that such organizations undertake on behalf of the people for whom they manage relations with nature (Crawford and Ostrom, 1995; Currie et al., 2016). However, friction can occur because organizational cultures do not represent all public values, worldviews, knowledge systems, and norms; rather, they tend to serve a limited subset of their constituencies' cultural values and fail to adapt to changes in those cultural systems over time (Berl et al., 2022; Gavin et al., 2015; Sullivan et al., 2022). For example, governance institutions in some Western countries are rooted in ideologies and processes that resulted in dispossession and erasure of Indigenous communities and histories (Colchester, 2004; Fisk et al., 2025), and extractivism and preservationism promoting human disconnection from the natural environment based on 'nature as other' ideologies (Büscher and Fletcher, 2020).

Given that conservation approaches are culturally constructed, they also change over time as the multiple cultures they reflect continue to evolve (Fisk et al., 2025; Knudson et al., 2018). In this paper, we draw on *cultural evolutionary theory* to examine the dynamic social and ecological factors shaping conservation governance and practice. The transdisciplinary field of cultural evolution views culture as socially transmitted information that is 'inherited' through processes that parallel those of genetic information, and thus evolves over time in ways that are similar to Darwinian biological evolution, with some critical mechanistic distinctions (Mesoudi, 2016). Importantly, this intellectual tradition is distinct from and rejects outdated concepts of unilineal cultural 'progress' associated with 'social Darwinist' movements, which imply that all cultures develop along a set path of development and thus that some cultures are more 'advanced' and therefore superior to others. Rather, modern cultural evolutionary thinking supports a broader understanding of the adaptive value of cultural diversity and the processes that generate it (Frost and Richerson, 2014). Applying a cultural evolutionary lens can be helpful for understanding the dynamic processes by which cultural traits such as values and institutions change over time, together with the consequences of these changes on other species and ecosystems, and vice versa through coevolutionary relationships (Currie et al., 2016; Mesoudi, 2016; Ellis, 2015).

Specifically, the lens of cultural evolution allows individuals and organizations implementing conservation to recognize their work as culturally-embedded, historically-situated, and future-oriented, facilitating critical reflexivity around the values, beliefs, and cultural systems that shape their actions and the impacts of those actions on a dynamic system (Boyce et al., 2022). Cultural evolutionary approaches have been previously applied to sustainability policy (Schimmelpfennig and Muthukrishna, 2023; Waring et al., 2015), emphasizing how policy could: (i) be informed by understanding of the emergence of socio-ecological states; (ii) adapt to integrate cultural change; (iii) incorporate an understanding of the conditions that drive cooperation; and (iv) address complex socio-ecological dimensions at multiple scales (van Riper et al., 2018; Ellis, 2015). Cultural evolution has less frequently been applied to the ethics and practice of nature conservation and management (but refer to initial framing work by Kaaronen et al., 2023).

One highly influential paradigm within conservation is the *native-introduced dichotomy*, which has had a profound influence on generations of science and policy around species management (Hettinger, 2001). According to this paradigm, species are understood as 'alien' or 'exotic' to a place if they were introduced as a consequence of human activity (refer to Lane-Clark et al. (2024) for discussion of why these terms can be harmful and why we used 'introduced'). Every other species is considered native and belongs because it is known–or presumed–to exist there without human assistance or influence (Gilroy et al., 2017). In cultures adopting this 'biotic nativeness' paradigm, species labeled as native are largely considered to be inherently 'good' (i.e., valued), whereas non-native species may be inherently 'bad' because they do not belong (Goodenough, 2010; Warren, 2007). By labeling a species non-native to a place, and therefore not belonging, this paradigm moralizes and justifies the removal of these species (van Eeden et al., 2020). The native-introduced paradigm is informed by the negative effects that some introduced species have had on conservation objectives, including contributing to species extinctions, which have been particularly apparent where predators are introduced to islands (Davis, 2009; Bellard et al., 2016). However, the paradigm has become entwined with cultural judgements about value that may go beyond stated conservation objectives and species may be targeted or ignored based on their assumed, rather than evidenced, characteristics or effects as members of the culturally-determined native or introduced categories (Guiaşu and Tindale, 2018; Robbins and Moore, 2013).

Additionally, species that some people might consider native can be labeled as non-native by other people seeking to justify their removal. For example, gray wolves (*Canis lupus*) in the United States (Martin et al., 2021), Australian dingoes (*Canis lupus dingo;* van Eeden et al., 2021), and Hawaiian monk seals (*Neomonachus schauinslandi*; Konrad et al., 2024) are framed as non-native by some local communities who perceive that these animals negatively affect their livelihoods. Debates about management of free-roaming horses (*Equus caballus*) in North America are also tied to conflicting beliefs about whether they are native (Bhattacharyya et al., 2011). While prevalent in both conservation discourse and broader society, this native-introduced dichotomy is neither accepted nor considered relevant by all cultures.

We explore the cultural nature of the native-introduced dichotomy and consider how conservation practice and governance interacts with and may be evolving to respond to conflict over species belonging. We draw on political ecology, environmental history, invasion biology, and Indigenous scholarship to explore how social, ecological, and temporal dimensions shape contemporary conservation cultures. As authors working in industrialized countries that are either European or have histories of European colonization, our analysis pertains primarily to the dominant management regimes in these contexts (refer to author positionality statement in Addendum). Notably, the cultures dominating conservation governance and management in these places tend to be dominated by worldviews (e.g., Western, technocratic, Judeo-Christian) that may not reflect local cultural diversity. The cultures and practices in these locations, however, have historically influenced management in other contexts, and continue to do so through globalization and colonial conservation practices; therefore, they have relevance in informing cultural evolutionary thinking for conservation generally.

Our analysis is not an argument for ending all introduced species control and is compatible with many existing efforts. We instead seek to equip conservationists with a more nuanced understanding of the nature of conflicts around introduced species management, with an awareness of how cultural values drive decision making and how changing values could shape the trajectory of conservation into the future. In doing so, this paper intends to inform governance and management efforts to better achieve both ecological and social objectives, acknowledging that difficulties exist as a result of uncertainty and conflicts that force trade-offs.

2. A short history of the native-introduced dichotomy in conservation

History reveals how our desired relationships with wildlife evolve to shape contemporary conservation paradigms, and prompts recognition

that they will continue to change into the future as part of a dynamic system. Here, we focus on conservation and conservation science as fields within Western cultures, acknowledging that sustainable management of the natural environment has been practiced for millennia by diverse cultural groups who may not refer to their practices as 'conservation'.

As Western science established conservation biology as a field, Michael Soulé (1985) described a set of shared ethical norms that he perceived to inform conservation objectives and practices, which are now variously held by organizations in the conservation field. These norms included that the introduction of generalist species posed a threat to biotic diversity. A subfield of conservation termed 'invasion biology' developed concurrently (Richardson, 2011) that explores the arrival, establishment, and spread of species. The native-introduced dichotomy is largely attributed to this subfield (Sagoff, 2018). The label of 'invasive' is most commonly applied to introduced species that are perceived to negatively affect environmentally, economically, or other socially valued components, although native species are regarded as 'invasive' in some contexts, too. There is no universally accepted definition for invasiveness and the term is used inconsistently (Pereyra, 2016; Soto et al., 2024). Further, 'introduced' and 'invasive' are sometimes used synonymously in cultural understandings of species value. This blurring of boundaries between the biologically inherent and culturally assigned aspects of species is a key motivation for this paper.

The roots of invasion biology are often attributed to a book written by Charles Elton in 1958, however, variably defining species as native or introduced is a practice that has occurred for centuries (Chew, 2006; Richardson, 2011). 'Native' has been variously applied to describe humans, with the term deriving from 15th century Old French 'natif' meaning a person born into bondage, like a lord's servant or serf, or someone entitled to a place or membership of a community by right of birth. Birthrights were superior to the rights afforded outsiders. The term thus divided people - and nature - into those that have rights and those that do not (refer to Wehi et al., 2023, Chew, 2006). That many conservationists simplify animals and plants to binary categories, as native or alien (although with some subcategorizations, discussed below), is a direct product of Europeans categorizing people and other species by where they come from and where they belong, or who they belong to, for the purposes of control. Before the late 18th century, when referring to plants and animals, the term 'native' was used to describe uncultivated or undomesticated species. Feral animals and naturalized plants were called native too because they did not belong to anyone and survived without human assistance. European botanists began to categorize species based on human agency in their dispersal, which became cemented in Western science to form the contemporary native-introduced dichotomy (Chew and Hamilton, 2011).

The idea that native species are generally more valued than non-native species is relatively new and limited to a small subset of cultural groups (Richardson, 2011). Indeed, people have been intentionally introducing species for millennia and did not necessarily assign greater value to native species. In the 1800s, Europeans intentionally sought to establish species (mostly animals) from Europe in colonized countries, and to move species across colonies and to their home countries, largely with anthropocentric (and Eurocentric) intentions (Minard, 2019; Rolls, 1969). They did not always achieve their goals of establishing populations of non-native species, but where 'successful' (e.g., in places like Australia and New Zealand), some species that were established soon became major economic pests and continue to be the focus of conservation and agricultural management (e.g., European rabbits, *Oryctolagus cuniculus*; refer to Minard, 2019). Formal acclimatization societies, which aimed to establish free-living populations of non-native species, largely disbanded or were converted into zoological and botanical societies, or - as in New Zealand - into the formal regulatory fish and game authorities that persist today (Dunlap, 1997). This coincided with, and was perhaps informed by, changing scientific understanding of ecology and human agency in shaping ecosystems (Minard, 2019). Nonetheless, some practices stemming from acclimatization societies persist today, for example, stocking waterways with introduced game fishes (Minard, 2019) and releasing non-native game birds and ungulates for recreational harvest (Blackburn and Gaston, 2021). Humans still intentionally move species for various purposes, including agriculture, the pet trade, landscaping, biological control, and assisted climate change adaptation.

3. Friction surrounding the native-introduced dichotomy

The emphasis placed on nativeness by some conservation paradigms has been the subject of extensive debate and critique within the field of invasion biology (e.g., Davis et al., 2011; Wallach et al., 2020). A cultural evolutionary lens can contextualize this debate by revealing how certain definitions of biotic nativeness may not incorporate social and ecological dimensions that are dynamic through time. To incorporate alternative value sets and ways of knowing in nature conservation, and to address some of the critiques of the native-introduced dichotomy, several other frameworks have been proposed. One of these is 'new' conservation, which focuses on the utility of species and ecosystems to humans regardless of their nativeness and resulted in the establishment of the ecosystem services concept (Kareiva and Marvier, 2012). Another is 'compassionate' conservation, which emphasizes the rights of individual animals and challenges the morality and institutionalization of killing one species to save another (Wallach et al., 2018). Recently, frameworks such as biocultural conservation (Gavin et al., 2015) and relational values (Chan et al., 2016) have emerged emphasizing the cultural value of species and ecosystems, which may not align with the traditional native-introduced dichotomy. We draw on some of these frameworks in describing challenges to the dichotomy below, outlining both social and ecological dimensions relevant to temporal change and friction embedded within the 'nativeness' concept - and, where relevant, describing how thinking and practice have evolved to respond to such friction.

3.1. Defining biotic nativeness

There is disagreement and ambiguity over defining biotic nativeness. For example, defining spatial boundaries around where a species belongs can be problematic because there are no set rules on scale or whether nativeness should be defined by geographic or political boundaries, by evolutionary history, or by functional alignment with the local ecology (Warren, 2007). However, all definitions generally center on human agency (Gilroy et al., 2017). The focus on human agency in transporting species as defining the species' value has been criticized as a form of human exceptionalism (Wallach et al., 2020), arising from the cultural concept that humans are above and separate from nature. Species have been moved intentionally and accidentally by humans for millennia, but, where relevant, conservationists align nativeness definitions with a temporal baseline that is often associated with a major cultural event, such as European colonization (Gilroy et al., 2017). We might therefore consider such definitions to be specifically a form of *Eurocentric* human exceptionalism, enforcing Western dominance in conservation narratives by defining legitimacy based on European records and perspectives (Reo and Ogden, 2018). For example, dingoes are believed to have been brought to Australia by people at least 3500 years ago, and yet they are legally and popularly regarded as native because they were present prior to European colonization (Smith and Appleby, 2015), combined with arguments that they have become naturalized and replaced other now-extinct top predators (Banks, 2021).

Temporal baselines are not universally accepted and may be arbitrary or difficult to define, especially when there has been no major cultural event such as European colonization. For example, in Europe, nativeness is inconsistently defined. It may sometimes include a temporal baseline of the neolithic period (Gilroy et al., 2017), with emphasis on species being classified as 'invasive' rather than non-native (Genovesi and Shine, 2004). Consistency across definitions is also complicated by

how species (and even our conceptualizations of nature, Ducarme et al., 2021) are described in different languages. For example, 'native' can refer to two different terms in German conservation law: i) *einheimisch*, which refers exclusively to species that have not been introduced by humans, and ii) *heimisch*, which also includes species introduced before 1492 (Klingenstein et al., 2005). Wehi et al. (2023) describe how words in some Indigenous languages classifying species as native or non-native may have positive or negative connotations in those cultures that do not align with Western categorization. Even in English, value-laden terminology describing invasiveness is inconsistently used across different contexts and species, not necessarily aligning with ecological theory (Mattingly et al., 2020).

3.2. Cultural diversity and the native-introduced dichotomy

Many Western natural resource management institutions implicitly adopt a definition of species belonging rooted in biotic nativeness, which may have varying relevance to communities living with the species in question (Kaplan et al., 2022). Conservation biology is grounded in Western scientific understanding, which is shaped by its origins in Judeo-Christian worldviews whereby humans are separate from nature (Hand and Van Liere, 1984; White, 1967). This is incommensurate with other, particularly Indigenous, worldviews that are centered around reciprocal relationships with nature (Berkes, 2018). Indigenous communities may not ascribe to the native vs. non-native dichotomy, instead valuing a species based on its perceived benefits or detriment to people and environments (Robinson et al., 2005). Such thinking may align with, but be inadequately captured by, a 'new' conservation framework (i.e., ecosystem services model, van Riper et al., 2017). Indigenous communities often lead or engage in introduced species control (e.g., Ens et al., 2010), but there are examples of value clashes (Nicholas et al., 2017; Ticktin et al., 2006; Wehi et al., 2023). Examples of Indigenous peoples ascribing cultural significance to introduced species include that Asian water buffalo (*Bubalus bubalis*) have been incorporated into Dreaming stories in Northern Australia (Albrecht et al., 2009), although these buffalo are considered to bring both positive and negative value and are actively managed by some communities (Ens et al., 2010). Domesticated horses were quickly adopted into the lives and cultures of many Indigenous peoples following European arrival in many places, particularly in the Americas where some nations attributed horses nationhood status (Taylor et al., 2023). In New Zealand, conflict between Western conservation and Maori people's priorities arise because Maori ascribe value to introduced kiore (Polynesian rat, *Rattus exulans*) (Wehi et al., 2023). In Hawai'i, pre-European species introductions (i.e., 'Polynesian introductions' or 'canoe plants') hold similar value for Native Hawaiians compared with species present locally (Winter et al., 2020).

Finally, perceptions of species belonging may differ among non-Indigenous populations, including in urbanized societies comprising diverse multicultural communities and novel species assemblages. Public categorization of species as native or non-native may not align with biotic nativeness classifications that are adopted in legislation and by management agencies (van Eeden et al., 2020). The populations of many Organization for Economic and Co-operation and Development (OECD) countries are multicultural; for example, in Israel, Luxembourg, Australia, Switzerland, New Zealand, and Canada, more than 40% of the population are foreign-born or have at least one foreign-born parent (OECD/EU, 2018). Different cultural backgrounds are associated with different environmental attitudes and values, manifesting in different preferences for nature and landscapes (refer to summary in Stodolska et al., 2017). Environmental values change slowly and can be retained over multiple generations following immigration (Manfredo et al., 2016). This means that urban places become a mixture of species and diverse social values pertaining to human-nature interactions, which creates friction with dominant conservation frameworks and government agency practices.

3.3. Human relationships with novel and changing ecosystems

Species ranges shift and ecosystem conditions change, whether naturally or with human assistance, creating friction with the native-introduced dichotomy and our conceptualizations of species belonging. Increasing urbanization (UN Department of Economic and Social Affairs, 2018) changes the nature of our relationships with nature through novel ecosystems (Dunn et al., 2006). Urban environments are ecologically novel in that they comprise diverse species assemblages that would not occur without human interference, but also because the soil and physical structures of cities have been so heavily altered. While many species have adapted to urban settings, such highly modified spaces can be hostile to species, such that non-native species may provide valuable ecosystem functions. In this sense, if we used a definition that considered nativeness to be defined as functional alignment with the local ecology, then perhaps urban-adapted species would be considered native to whichever urban environment they are living in, regardless of broader geographical context. Further, urban peoples' interactions with a melting pot of cosmopolitan species may lead them to value these mixed assemblages, while having little experience with or value attributed to less modified forms of nature (Leong, 2009; Dunn et al., 2006), or even fearing such forms (Soga and Evans, 2024).

Anthropogenic ecosystem changes and species movements cause species to change their behavior, which can shape our perceptions of their belonging. A species defined as a 'weed' is considered a species out of place and a 'pest' is a native or introduced species perceived to negatively affect things that are valued by humans, so perceived pest-like or weedy behavior may shape our perceptions of belonging (Leong, 2009). Animals in urban settings may become habituated to humans and dependent upon the byproducts of human habitation, including seeking human food and losing fear responses (Leong, 2009). Such behavioral changes can cause them to become 'unnatural' or 'out of place' (Jerolmack, 2008). Domestic animals may move into 'natural' spaces and in so doing become pests (Jerolmack, 2008). They may interbreed with their wild relatives, resulting in hybrid offspring who are framed as not belonging in either place based on their mixed ancestry, with problematic parallels to human cultural politics and discrimination (Probyn-Rapsey, 2015; Brewitt and Giles, 2023). Overall, anthropogenic ecosystem change will inevitably bring new or exacerbated challenges to understanding and managing the relationships of nonhuman species with people.

Climate change is also causing species to shift their range to locations with conditions suited to their survival, and, in some cases, conservationists are intentionally translocating species in response to or anticipation of these shifts (McLachlan et al., 2007). These changes, whether natural or human-assisted, confound definitions of nativeness. The conservation community is beginning to examine how such species would fit within legislative and social definitions of species belonging, even suggesting new labels (e.g., 'neonative', Essl et al., 2019). Legislation and policy have been modified to allow for new conservation needs outside of historical range, both for control of introduced species (e.g., European Parliament Regulation No 1143/2014) and conservation translocations (e.g., U.S. Title 50 Code of Federal Regulations Part 17).

Similarly, ecosystems are being modified in the name of 'rewilding' (Perino et al., 2019). Species are being reintroduced to regions from which they have long been extirpated, for example, European lynx (*Lynx lynx*) are proposed for reintroduction to Scotland despite having been locally extinct for 5000 years (Jørgensen, 2013). More radically, scientists are developing technologies with the aim of reversing extinctions, for example, by attempting to recreate dire wolves (*Aenocyon dirus*), thylacines (*Thylacinus cynocephalus*), passenger pigeons (*Ectopistes migratorius*), and woolly mammoths (*Mammuthus primigenius*) that have been extinct for decades or even millennia (Sherkow and Greely, 2013). Again, managers have yet to determine how such species belong within social and governance frameworks.

4. How conservation integrates diverse values

Here we consider how the native-introduced dichotomy manifests in practice, and how conservation approaches may integrate changing social and ecological dimensions. Conservation cultures and values shape decision making by conservationists and managers (Clifford et al., 2021; Luque-Lora et al., 2022) and may be reflected in the tools and techniques used to implement management of nature. We consider how such tools are underpinned by conservation norms and how managers can integrate and adapt to the presence of diverse worldviews and values. Applying a cultural evolutionary lens can in turn reveal opportunities for further transformation of governance.

4.1. Institutional context

Governing agencies and organizations decide which species belong using spatial zoning that is informed by culturally constructed imagined animal geographies (Philo and Wilbert, 2000). Spatial prioritization tools have been used for decades to decide which areas should be zoned for conservation and which should be production landscapes (Margules et al., 1988). Such land use zoning might require native species to be conserved and non-native species to be managed in protected areas, but if a native species crosses a fence line or invisible boundary, it becomes 'out of place' (Jerolmack, 2008). For example, gray wolves are protected under federal jurisdiction inside the boundaries of U.S. National Parks (e.g., Yellowstone National Park), but may be regarded as either game (with regulated harvest) or a pest (allowing unregulated lethal control) depending on which state boundary of the park they cross (Smith et al., 2016). Spatial zoning can create friction where there is disagreement, but it can also be a tool to accommodate differences in how communities value nature. Rather than governments imposing large-scale characterizations of belonging, finer-scale zoning can allow local communities to negotiate and decide what areas and species require management and what methods are acceptable.

Agencies have limited resources to promote conservation objectives. Beyond prioritization tools for spatial zoning, conservation decision support tools may be employed to inform management actions aimed at optimizing desired conservation outcomes. For example, a spatially-explicit cost-benefit analysis may predict management actions that will have greatest benefit to threatened species or other conservation priorities (Carwardine et al., 2012; Thomson et al., 2020). One limitation is that the data informing these tools may be outdated or represent a snapshot in time if there are limited resources available for ongoing monitoring, thus hindering opportunities for informed adaptive management. Further, they may be underpinned by a particular set of institutional norms and may make little to no attempt to incorporate diverse social values (Robinson et al., 2019). The legislation and policy governing environmental management moves slowly and can be difficult to change.

4.2. Social feasibility

Conservation decisions often entail intractable conflicts over values (Gavin et al., 2015). Decision-making tools make predictions about the impact of management actions on ecology, yet there may be limited evidence available to support predictions associated with human values and behavior (Robinson et al., 2019). Tools like Social Values Mapping (Alessa et al., 2008) have been developed for integrating social values into decision making, which can help identify locations of social or cultural value. However, a cultural evolutionary perspective tells us that social and ecological conditions are not static, meaning that these tools may face friction if they do not continuously monitor and update the data being used to allow for change over time.

There are other examples of tools employed to identify diverse public values that may not align with the native-introduced dichotomy. In some U.S. states, conservation management decisions may be informed by public ballot initiatives (e.g., Hoag et al., 2023). Community representatives may engage in decision making as members of wildlife or pest management boards or other community conservation groups. If diverse social values are incompatible, it may be impossible to achieve social license to undertake management (Clifford et al., 2021). Practitioners might therefore prioritize processes that allow for public discourse with the goal of legitimacy rather than consensus. Given that cultures are diverse and dynamic, this discourse will naturally change over time and vary across space to adapt to differing socio-ecological conditions (Gavin et al., 2015).

5. Looking forward

By recognizing that conservation governance comprises diverse cultures, and that cultures are dynamic, we encourage conservationists to recognize that conservation paradigms will continue to evolve and to understand the mechanisms by which they may do so. Here, we consider factors that may shape conservation governance futures and potentially influence evolving interpretations of species belonging.

Climate change is a leading contributor to contemporary systems change, changing how ecosystems function and how humans and other species interact with them. A changing climate provides further imperative to recognize that conservation cannot return modified ecosystems to some past baseline condition (Hobbs et al., 2013). Instead, restoration ecologists are encouraged to develop alternatives that support dynamic, productive, and resilient ecosystems, which may integrate diverse social values and potentially include species perceived as 'introduced' if they align best with the desired objectives. We may also expect increasing human-wildlife conflict under projected climate change scenarios, with species increasingly competing for scarce resources, adapting their behavior to suit changing systems, and moving into areas where they have not previously 'belonged' (Abrahms, 2021).

New technology may change how we interact with species and ecosystems. Technological changes are rapid and difficult to predict, but we need only to look to the past to see the rapid pace at which emerging technology has shaped conservation practices (e.g., remote introduced species control tools, including gene drive technology, remote sensing and artificial intelligence, participatory mapping). Current investment in de-extinction and bio-engineering technologies may change how we think about nativeness, raise ethical questions about conservation decisions, and present friction with existing policy and established tools.

Cultural values will also change in these evolving socio-ecological systems. For example, some studies have found that more mutualistic values arise as a result of increasing urbanization (Manfredo et al., 2021), which may influence policy by weakening social license for lethal control of charismatic species (Martínez-Jauregui et al., 2020). Increasing urbanization may also diminish people's overall connection with and ecological knowledge of less-modified natural systems, engendering fear of more 'wild' species (including native ones), while at the same time strengthening relational values towards others (including introduced ones; Jarić et al., 2022, Soga and Evans, 2024). For species they care about, the public may become increasingly engaged in guiding conservation decision-making through social media and increased information sharing, which may challenge traditional agency cultures, practices, and perceptions about species belonging. Humans now regard some formerly introduced species as native (e.g., dingoes in Australia) or fundamentally belonging (e.g., Hawaiian canoe plants), so we can expect to see perceptions about species belonging continue to change into the future.

Alongside changing social values, we may also see changing social power dynamics. Many government agencies in countries that were European colonies are increasingly recognizing the value of Indigenous knowledge system in achieving conservation goals, and many Indigenous peoples are actively exerting their rights to shape land governance (e.g., Reed et al., 2021). Centering Indigenous knowledge systems can also promote Indigenous self-determination through restoring power in

land management decision making and practice (Reed et al., 2021). Given differences in social values and priorities for human-nature interactions, this shift could result in friction with dominant cultures and perceptions of species. For example, Indigenous-led management may de-prioritize removal of introduced species and include control of species protected under current policies. Improving Indigenous representation within management agencies and consultation with Indigenous communities could reveal the value differences driving these frictions and identify paths towards productive co-management.

Conservation agencies in many countries are dominated by staff from a limited number of cultural backgrounds and most often trained in natural sciences with limited expertise in social science, hindering their ability to address the friction introduced by diverse cultural perspectives regarding management. Initial steps for transforming organizational culture to be more open to different perspectives could involve hiring staff from a range of backgrounds and training them to better understand and accommodate diverse views and perspectives, including relevant expertise from the humanities and social sciences (Luque-Lora et al., 2022; Berl et al., 2022). In our own experiences (including authors in government roles), increasing the integration of social scientists into conservation governance organizations has resulted in more effective use of social science in conservation planning and decision making throughout a project's lifecycle, and improved outcomes for people and ecosystems (Niemiec et al., 2021). Thus, organizations that embrace more diverse disciplinary expertise and methods have the capacity to facilitate more equitable, inclusive, and effective conservation practice (van Riper et al., 2017).

6. Conclusion

This paper focuses on conceptualizations of species belonging and the native-introduced dichotomy, which have been central to the dominant conservation framework for species management and prioritization. A cultural evolutionary perspective highlights the roots of friction among diverse social values and conceptualizations of belonging, and shows this dichotomy to be inherently political and contested (Robbins and Moore, 2013). Species nativeness is, on the surface, an easy way to draw political boundaries and write legislation, whereas pluralism in conservation objectives can be far more complex to operationalize. Recognition of the evolutionary nature of not just the cultures of constituents but also of the cultures of conservation itself encourages a shift towards diversification, flexibility, and innovation in seeking to manage nature adaptively and build resilient conservation institutions (Armitage et al., 2009; Fisk et al., 2024). We propose that conservation objectives can be made more generative, prioritizing value creation and outcomes, rather than seeking to adhere to particular pre-existing frameworks.

What exactly this looks like will depend on local socio-ecological contexts. It does not necessarily mean halting non-native species management, nor de-prioritizing extinction prevention. Rather, we encourage consideration of more diverse concepts of species belonging in situ, which could help to address conflict and achieve ecological and social objectives. Adaptive management frameworks and guidelines have been developed to inform decision making that accounts for changing ecological context (e.g., Hobbs et al., 2013; Schuurman et al., 2021). These approaches could additionally incorporate social dimensions, including diverse and dynamic sets of cultural values, to guide approaches to managing evolving socio-ecological systems. Success could also be aided by embracing adaptive forms of governance that change the power dynamics within decision making processes (Gavin et al., 2015). Governance changes needed to foster more pluralistic approaches may include major policy changes, restructuring, and transformative shifts in thinking and practices across geographic and temporal scales. This would likely entail moving away from single-solution approaches or 'policy panacea' to a suite of approaches adapted to particular socio-ecological contexts (Ostrom et al., 2007).

To make meaningful progress in responding to the biodiversity crisis, conservationists must be able to practice the dialogue- and partnership-based approaches that have been promoted in recent decades (Gavin et al., 2018, 2015). To embrace biocultural conservation, we need to first recognize conservation agencies and practices as cultural institutions (Fisk et al., 2025; 2024). By examining conservation's normative frameworks (such as the native-introduced dichotomy), their dynamic histories, and their potential shortfalls in adapting to systems change, we hope to encourage reflexivity among conservationists and highlight that there is no single appropriate approach. Reflexivity and willingness to understand cultural relationships, rather than diminishing differing priorities as inferior to or less scientific than dominant conservation objectives and approaches, has the capacity to improve managers' ability to sustainably co-manage places and species.

6.1. Addendum

Below we provide a statement of our own positionality relevant to conservation and the native-introduced dichotomy. Our author team comprises academics, government practitioners, and those with experience in both realms who are based in and largely educated in European or European-colonized geographies. Our education and professional experience mean we work in or with institutions that largely adhere to an orthodox model of conservation objectives, i.e., informed by but grappling with the challenges of the native-introduced dichotomy, along with other dominant cultural views. Our disciplinary expertise spans political ecology, environmental history, invasion biology, biological and cultural anthropology, and Indigenous scholarship and some degree of natural science training meaning we were predominantly schooled in Western conservation paradigms and bring those norms to our practice. Given this positionality and cultural foundation, several of us find that, throughout our careers, we increasingly call into question our own normative bias when we automatically adopt a heuristic of species belonging aligning with the native-introduced dichotomy. In doing so, we consider both whether this heuristic is helpful or harmful in achieving environmental objectives and how decisions informed by it might marginalize other cultural values.

CRediT authorship contribution statement

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Declaration of competing interest

The authors of this manuscript have no conflicts of interest to declare.

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Data availability

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

References

Abrahms, B., 2021. Human-wildlife conflict under climate change. Science 373, 484–485.
Albrecht, G., McMahon, C.R., Bowman, D.M.J.S., Bradshaw, C.J.A., 2009. Convergence of culture, ecology, and ethics: management of feral swamp buffalo in northern Australia. J. Agric. Environ. Ethics 22, 361–378.
Alessa, L., Kliskey, A., Brown, G., 2008. Social–ecological hotspots mapping: a spatial approach for identifying coupled social–ecological space. Landsc. Urban Plan. 85, 27–39.
Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.I., Charles, A.T., Davidson-Hunt, I.J., Diduck, A.P., Doubleday, N.C., Johnson, D.S., Marschke, M., McConney, P., Pinkerton, E.W., Wollenberg, E.K., 2009. Adaptive co-management for social–ecological complexity. Front. Ecol. Environ. 7, 95–102.
Banks, P.B., 2021. An eco-evolutionary rationale to distinguish alien and native status: why the dingo is a native species on mainland Australia. Australian Zoologist 41, 358–366.
Bellard, C., Cassey, P., Blackburn, T.M., 2016. Alien species as a driver of recent extinctions. Biol. Lett. 12, 20150623.
Berkes, F., 2018. Sacred Ecology, 4th edn. Routledge, Taylor & Francis, New York & Abingdon.
Berl, R.E.W., Manfredo, M.J., Gasta, M., Smith, D., Sullivan, L., Jacobson, C.A., Bishop, C., Camuso, J., Eason, T., Hayes, J.P., Jacobson, R., Melcher, C., Newmark, J., Novotny, P., Pauley, S.P., Smith, C., Sparks, C., Stoner, K., Strong, J.D., Ver Steeg, J., 2022. Building a systems framework to facilitate adaptive organizational change in state fish and wildlife agencies. Conservation Science and Practice 4, e591.
Bhattacharyya, J., Slocombe, D.S., Murphy, S.D., 2011. The "wild" and "feral" distraction: effects of cultural understandings on management controversy over free-ranging horses (*Equus ferus caballus*). Hum. Ecol. 39, 613–625.
Blackburn, T.M., Gaston, K.J., 2021. Contribution of non-native galliforms to annual variation in biomass of British birds. Biol. Invasions 23, 1549–1562.
Boyce, P., Bhattacharyya, J., Linklater, W., 2022. The need for formal reflexivity in conservation science. Conserv. Biol. 36, e13840.
Brewitt, P., Giles, L., 2023. Is that a wolf? Politics, science and red wolf identity. The Wolf: Culture, Nature, Heritage 25, 217.
Büscher, B., Fletcher, R., 2020. The Conservation Revolution: Radical Ideas for Saving Nature beyond the Anthropocene. Verso, Brooklyn, NY.
Carwardine, J., O'Connor, T., Legge, S., Mackey, B., Possingham, H.P., Martin, T.G., 2012. Prioritizing threat management for biodiversity conservation. Conserv. Lett. 5, 196–204.
Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., Turner, N., 2016. Opinion: why protect nature? Rethinking values and the environment. Proc. Natl. Acad. Sci. 113 (6), 1462–1465.
Chew, M.K., 2006. Ending with Elton: Preludes to Invasion Biology. Arizona State University, Tempe, p. 126.
Chew, M.K., Hamilton, A., 2011. The rise and fall of biotic nativeness: A historical perspective. In: Richardson, D.M. (Ed.), Fifty Years of Invasion Ecology: The Legacy of Charles Elton. Blackwell Publishing Ltd., New York, NJ, pp. 35–47.
Clifford, K.R., Cravens, A.E., Knapp, C.N., 2021. Responding to ecological transformation: mental models, external constraints, and manager decision-making. BioScience 72, 57–70.
Colchester, M., 2004. Conservation policy and indigenous peoples. Environ Sci Policy 7, 145–153.
Crawford, S.E.S., Ostrom, E., 1995. A grammar of institutions. Am. Polit. Sci. Rev. 89, 582–600.
Currie, T., Turchin, P., Bednar, J., Richerson, P.J., Schwesinger, G., Steinmo, S., Wacziarg, R., Wallis, J., 2016. Evolution of institutions and organizations. In: Wilson, D.S., Kiman, A. (Eds.), Complexity and Evolution: Toward a New Synthesis for Economics. MIT Press, pp. 199–234.
Davis, M.A., 2009. Invasion Biology. Oxford University Press, Oxford UK.
Davis, M.A., Chew, M.K., Hobbs, R.J., Lugo, A.E., Ewel, J.J., Vermeij, G.J., Brown, J.H., Rosenzweig, M.L., Gardener, M.R., Carroll, S.P., Thompson, K., Pickett, S.T.A., Stromberg, J.C., Tredici, P.D., Suding, K.N., Ehrenfeld, J.G., Philip Grime, J., Mascaro, J., Briggs, J.C., 2011. Don't judge species on their origins. Nature 474, 153.
Ducarme, F., Flipo, F., Couvet, D., 2021. How the diversity of human concepts of nature affects conservation of biodiversity. Conserv. Biol. 35, 1019–1028.
Dunlap, T.R., 1997. Remaking the land: the acclimatization movement and Anglo ideas of nature. Journal of World History 8, 303–319.
Dunn, R.R., Gavin, M.C., Monica, C.S., Jennifer, N.S., 2006. The pigeon paradox: dependence of global conservation on urban nature. Conserv. Biol. 20, 1814–1816.
Ellis, E.C., 2015. Ecology in an anthropogenic biosphere. Ecol. Monogr. 85, 287–331.
Ens, E.-J., Cooke, P., Nadjamerrek, R., Namundja, S., Garlngarr, V., Yibarbuk, D., 2010. Combining aboriginal and non-aboriginal knowledge to assess and manage feral water Buffalo impacts on perennial Freshwater Springs of the aboriginal-owned Arnhem plateau, Australia. Environ. Manag. 45, 751–758.
Essl, F., Dullinger, S., Genovesi, P., Hulme, P.E., Jeschke, J.M., Katsanevakis, S., Kühn, I., Lenzner, B., Pauchard, A., Pyšek, P., Rabitsch, W., Richardson, D.M., Seebens, H., van Kleunen, M., van der Putten, W.H., Vilà, M., Bacher, S., 2019. A conceptual framework for range-expanding species that track human-induced environmental change. BioScience 69, 908–919.
Fisk, J.J., Leong, K.M., Berl, R.E.W., Long, J.W., Landon, A.C., Adams, M.M., Hankins, D. L., Williams, C.K., Lake, F.K., Salerno, J., 2024. Evolving wildlife management cultures of governance through indigenous knowledges and perspectives. J. Wildl. Manag. 88, e22584.
Fisk, J.J., Berl, R.E.W., Long, J., Jacobs, L., van Eeden, L., Adams, M.M., Fernández-Llamazares, Á., Murphy, J., Gavin, M., Williams, C.K., Salerno, J., Verschuuren, B., Bennett, N., Idohou, R., Mawyer, A., 2025. Cultivating reciprocity and supporting indigenous lifeways through the cultural transformation of natural resource management in North America. People and Nature 7, 1171–1184.
Frost, K., Richerson, P., 2014. Is science postmodern? Cultural evolution as an example. In: Pléh, C., Csibra, G., Richerson, P. (Eds.), Naturalistic Approaches to Culture. Wolters Kluwer Group, Budapest, Akadémiai Kiadó, pp. 29–44.
Gavin, M.C., McCarter, J., Mead, A., Berkes, F., Stepp, J.R., Peterson, D., Tang, R., 2015. Defining biocultural approaches to conservation. Trends Ecol. Evol. 30, 140–145.
Gavin, M.C., McCarter, J., Berkes, F., Mead, A.T.P., Sterling, E.J., Tang, R., Turner, N.J., 2018. Effective biodiversity conservation requires dynamic, pluralistic, partnership-based approaches. Sustainability 10, 1846.
Genovesi, P., Shine, C., 2004. European strategy on invasive alien species. In: Nature and Environment. Convention on the Conservation of European Wildlife and Habitats (Bern Convention). Strasbourg.
Gilroy, J.J., Avery, J.D., Lockwood, J.L., 2017. Seeking international agreement on what it means to be "native". Conserv. Lett. 10, 238–247.
Goodenough, A.E., 2010. Are the ecological impacts of alien species misrepresented? A review of the "native good, alien bad" philosophy. Community Ecol. 11, 13–21.
Guiaşu, R.C., Tindale, C.W., 2018. Logical fallacies and invasion biology. Biol. Philos. 33, 34.
Hand, C.M., Van Liere, K.D., 1984. Religion, mastery-over-nature, and environmental concern. Soc. Forces 63, 555–570.
Hettinger, N., 2001. Exotic species, naturalisation, and biological nativism. Environmental Values 10, 193–224.
Hill, C.M., Webber, A.D., Priston, N.E.C., 2017. Understanding Conflicts about Wildlife: A Biosocial Approach. Berghahn Books, New York.
Hoag, D.L.K., Burkhardt, J., Ghasemi, B., Breck, S., Niemiec, R., Crooks, K., 2023. Willingness to pay for reintroducing wolves in a divided voting base. Global Ecology and Conservation 46, e02576.
Hobbs, R.J., Higgs, E.S., Hall, C.M., 2013. Novel Ecosystems: Intervening in the New Ecological World Order. Wiley-Blackwell, West Sussex, UK.
Jarić, I., Roll, U., Bonaiuto, M., Brook, B.W., Courchamp, F., Firth, J.A., Gaston, K.J., Heger, T., Jeschke, J.M., Ladle, R.J., Meinard, Y., Roberts, D.L., Sherren, K., Soga, M., Soriano-Redondo, A., Veríssimo, D., Correia, R.A., 2022. Societal extinction of species. Trends Ecol. Evol. 37, 411–419.
Jerolmack, C., 2008. How pigeons became rats: the cultural-spatial logic of problem animals. Soc. Probl. 55, 72–94.
Jørgensen, D., 2013. Reintroduction and de-extinction. BioScience 63, 719–720.
Kaaronen, R.O., Waring, T.M., Borgerhoff Mulder, M., 2023. Applying cultural evolution to address climate and environmental challenges. In: Tehrani, J.J., Kendal, J., Kendal, R. (Eds.), The Oxford handbook of cultural evolution. Oxford University Press.
Kaplan, H., Prahalad, V., Kendal, D., 2022. Native for whom: a mixed-methods literature review and synthesis to conceptualise biotic nativeness for social research in the urban context. People and Nature 4, 15–31.
Kareiva, P., Marvier, M., 2012. What is conservation science? BioScience 62, 962–969.
Klingenstein, F., Kornacker, P.M., Martens, H., Schippmann, U., 2005. Gebietsfremde Arten—Positionspapier des Bundesamtes für Naturschutz, p. 43. Bonn.
Knudson, C., Kay, K., Fisher, S., 2018. Appraising geodiversity and cultural diversity approaches to building resilience through conservation. Nat. Clim. Chang. 8 (8), 678–685.
Konrad, L., Levine, A., Leong, K.M., Koethe, F., 2024. Understanding perceptions that drive conflict over the endangered Hawaiian monk seal. Frontiers in conservation. Science 5.
Lane-Clark, S.N., Gagnon, V.S., Bal, T.L., 2024. Shifting the language of 'invasion' ecology: two-eyed seeing as a framework for discourse regarding introduced species. Socio Ecol Pract Res 6, 207–218.
Leong, K.M., 2009. The tragedy of becoming common: landscape change and perceptions of wildlife. Soc. Nat. Resour. 23, 111–127.
Luque-Lora, R., Keane, A., Fisher, J.A., Holmes, G., Sandbrook, C., 2022. A global analysis of factors predicting conservationists' values. People and Nature 4, 1339–1351.

Manfredo, M.J., Teel, T.L., Dietsch, A.M., 2016. Implications of human value shift and persistence for biodiversity conservation. Conserv. Biol. 30, 287–296.
Manfredo, M.J., Teel, T.L., Berl, R.E.W., Bruskotter, J.T., Kitayama, S., 2021. Social value shift in favour of biodiversity conservation in the United States. Nature Sustainability 4, 323–330.
Margules, C.R., Nicholls, A.O., Pressey, R.L., 1988. Selecting networks of reserves to maximise biological diversity. Biol. Conserv. 43, 63–76.
Martin, J.V., Epstein, K., Anderson, R.M., Charnley, S., 2021. Coexistence praxis: the role of resource managers in wolf-livestock interactions on federal lands. Frontiers in conservation. Science 2.
Martínez-Jauregui, M., Delibes-Mateos, M., Arroyo, B., Soliño, M., 2020. Addressing social attitudes toward lethal control of wildlife in national parks. Conserv. Biol. 34, 868–878.
Mattingly, K.Z., Pelletier, T.A., Lanterman, J., Frevola, D., Stucke, B., Kinney, K., Schwartz, R., Spacht, D., Dixon, G., Hovick, S.M., 2020. Disconnects between communicated impact and ecological impact of biological invasions. BioScience 70, 252–263.
McLachlan, J.S., Hellmann, J.J., Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conserv. Biol. 21, 297–302.
Mesoudi, A., 2016. Cultural evolution: a review of theory, findings and controversies. Evol. Biol. 43, 481–497.
Minard, P., 2019. All Things Harmless, Useful, and Ornamental: Environmental Transformation through Species Acclimatization, from Colonial Australia to the World. University of North Carolina Press, Chapel Hill, NC.
Nicholas, J.R., Kyle, W., Darren, R., Jodi, B., Emily, B., Braden, E., 2017. Invasive species, indigenous stewards, and vulnerability discourse. American Indian Quarterly 41, 201–223.
Niemiec, R.M., Gruby, R., Quartuch, M., Cavaliere, C.T., Teel, T.L., Crooks, K., Salerno, J., Solomon, J.N., Jones, K.W., Gavin, M., Lavoie, A., Stronza, A., Meth, L., Enrici, A., Lanter, K., Browne, C., Proctor, J., Manfredo, M., 2021. Integrating social science into conservation planning. Biol. Conserv. 262, 109298.
OECD/EU, 2018. Settling in 2018: Indicators of Immigrant Integration. OECD Publishing, Paris.
Ostrom, E., Janssen, M.A., Anderies, J.M., 2007. Going beyond panaceas. Proc. Natl. Acad. Sci. 104, 15176–15178.
Pereyra, P.J., 2016. Revisiting the use of the invasive species concept: an empirical approach. Austral Ecol. 41, 519–528.
Perino, A., Pereira, H.M., Navarro, L.M., Fernández, N., Bullock, J.M., Ceauşu, S., Cortés-Avizanda, A., van Klink, R., Kuemmerle, T., Lomba, A., Pe'er, G., Plieninger, T., Rey Benayas, J.M., Sandom, C.J., Svenning, J.-C., Wheeler, H.C., 2019. Rewilding complex ecosystems. Science 364 eaav5570.
Philo, C., Wilbert, C. (Eds.), 2000. Animal Spaces, Beastly Places: New Geographies of Human-Animal Relations. Routledge, New York.
Probyn-Rapsey, F., 2015. Dingoes and dog-whistling: a cultural politics of race and species in Australia. Animal Studies Journal 4, 55–77.
Reed, G., Brunet, N.D., Longboat, S., Natcher, D.C., 2021. Indigenous guardians as an emerging approach to indigenous environmental governance. Conserv. Biol. 35, 179–189.
Reo, N.J., Ogden, L.A., 2018. Anishnaabe Aki: an indigenous perspective on the global threat of invasive species. Sustain. Sci. 13, 1443–1452.
Richardson, D.M., 2011. Fifty Years of Invasion Ecology the Legacy of Charles Elton. Wiley-Blackwell, Hoboken, N.J.
Robbins, P., Moore, S.A., 2013. Ecological anxiety disorder: diagnosing the politics of the Anthropocene. Cult. Geogr. 20, 3–19.
Robinson, C.J., Smyth, D., Whitehead, P.J., 2005. Bush tucker, bush pets, and bush threats: cooperative management of feral animals in Australia's Kakadu National Park. Conserv. Biol. 19, 1385–1391.
Robinson, K.F., Fuller, A.K., Stedman, R.C., Siemer, W.F., Decker, D.J., 2019. Integration of social and ecological sciences for natural resource decision making: challenges and opportunities. Environ. Manag. 63, 565–573.
Rolls, E.C., 1969. They all Ran Wild: The Animals and Plants that Plague Australia. Angus & Robertson Publishers, Sydney.
Sagoff, M., 2018. What is invasion biology? Ecol. Econ. 154, 22–30.
Sandbrook, C., 2015. What is conservation? Oryx 49, 565–566.
Schimmelpfennig, R., Muthukrishna, M., 2023. Cultural evolutionary behavioural science in public policy. Behavioural Public Policy 1–31.
Schuurman, G.W., Cole, D.N., Cravens, A.E., Covington, S., Crausbay, S.D., Hoffman, C. H., Lawrence, D.J., Magness, D.R., Morton, J.M., Nelson, E.A., O'Malley, R., 2021. Navigating ecological transformation: resist–accept–direct as a path to a new resource management paradigm. BioScience 72, 16–29.
Sherkow, J.S., Greely, H.T., 2013. What if extinction is not forever? Science 340, 32–33.
Smith, B., Appleby, R., 2015. Forging a new future for the Australian dingo. In: Smith, B. (Ed.), The Dingo Debate: Origins, Behaviour and Conservation. CSIRO Publishing, Clayton South, Australia, pp. 301–316.
Smith, D.W., White, P.J., Stahler, D.R., Wydeven, A., Hallac, D.E., 2016. Managing wolves in the Yellowstone area: balancing goals across jurisdictional boundaries. Wildl. Soc. Bull. 40, 436–445.
Soga, M., Evans, M.J., 2024. Biophobia: what it is, how it works and why it matters. People and Nature 6, 922–931.
Soto, I., Balzani, P., Carneiro, L., Cuthbert, R.N., Macêdo, R., Serhan Tarkan, A., Ahmed, D.A., Bang, A., Bacela-Spychalska, K., Bailey, S.A., Baudry, T., Ballesteros-Mejia, L., Bortolus, A., Briski, E., Britton, J.R., Buřič, M., Camacho-Cervantes, M., Cano-Barbacil, C., Copilaş-Ciocianu, D., Coughlan, N.E., Courtois, P., Csabai, Z., Dalu, T., De Santis, V., Dickey, J.W.E., Dimarco, R.D., Falk-Andersson, J., Fernandez, R.D., Florencio, M., Franco, A.C.S., García-Berthou, E., Giannetto, D., Glavendekic, M.M., Grabowski, M., Heringer, G., Herrera, I., Huang, W., Kamelamela, K.L., Kirichenko, N.I., Kouba, A., Kourantidou, M., Kurtul, I., Laufer, G., Lipták, B., Liu, C., López-López, E., Lozano, V., Mammola, S., Marchini, A., Meshkova, V., Milardi, M., Musolin, D.L., Nuñez, M.A., Oficialdegui, F.J., Patoka, J., Pattison, Z., Pincheira-Donoso, D., Piria, M., Probert, A.F., Rasmussen, J.J., Renault, D., Ribeiro, F., Rilov, G., Robinson, T.B., Sanchez, A.E., Schwindt, E., South, J., Stoett, P., Verreycken, H., Vilizzi, L., Wang, Y.-J., Watari, Y., Wehi, P.M., Weiperth, A., Wiberg-Larsen, P., Yapıcı, S., Yoğurtçuoğlu, B., Zenni, R.D., Galil, B.S., Dick, J.T.A., Russell, J.C., Ricciardi, A., Simberloff, D., Bradshaw, C.J.A., Haubrock, P.J., 2024. Taming the terminological tempest in invasion science. Biol. Rev. 99, 1357–1390.
Soulé, M.E., 1985. What is conservation biology? BioScience 35, 727–734.
Stodolska, M., Peters, K., Horolets, A., 2017. Changes in recreation participation in natural environments after immigration among immigrants in the U.S., Netherlands. Germany and Poland. Leisure Studies 36, 811–824.
Sullivan, L.M., Manfredo, M.J., Teel, T.L., 2022. Technocracy in a time of changing values: wildlife conservation and the "relevancy" of governance reform. Conservation Science and Practice 4, e545.
Taylor, W.T.T., Librado, P., Hunska Tašunke Icu, M., Shield Chief Gover, C., Arterberry, J., Luta Wiŋ, A., Nujipi, A., Omniya, T., Gonzalez, M., Means, B., High Crane, S., Dull Knife, B., Wiŋ, W., Tecumseh Collin, C., Ward, C., Pasqual, T.A., Chauvey, L., Tonasso-Calviere, L., Schiavinato, S., Seguin-Orlando, A., Fages, A., Khan, N., Der Sarkissian, C., Liu, X., Wagner, S., Leonard, B.G., Manzano, B.L., O'Malley, N., Leonard, J.A., Bernáldez-Sánchez, E., Barrey, E., Charliquart, L., Robbe, E., Denoblet, T., Gregersen, K., Vershinina, A.O., Weinstock, J., Rajić Šikanjić, P., Mashkour, M., Shingiray, I., Aury, J.-M., Perdereau, A., Alquraishi, S., Alfarhan, A.H., Al-Rasheid, K.A.S., Trbojević Vukičević, T., Buric, M., Sauer, E., Lucas, M., Brenner-Coltrain, J., Bozell, J.R., Thornhill, C.A., Monagle, V., Perri, A., Newton, C., Hall, W.E., Conver, J.L., Le Roux, P., Buckser, S.G., Gabe, C., Belardi, J. B., Barrón-Ortiz, C.I., Hart, I.A., Ryder, C., Sponheimer, M., Shapiro, B., Southon, J., Hibbs, J., Faulkner, C., Outram, A., Patterson Rosa, L., Palermo, K., Solé, M., William, A., McCrory, W., Lindgren, G., Brooks, S., Eché, C., Donnadieu, C., Bouchez, O., Wincker, P., Hodgins, G., Trabert, S., Bethke, B., Roberts, P., Jones, E. L., Running Horse Collin, Y., Orlando, L., 2023. Early dispersal of domestic horses into the Great Plains and northern Rockies. Science 379, 1316–1323.
Thomson, J., Regan, T.J., Hollings, T., Amos, N., Geary, W.L., Parkes, D., Hauser, C.E., White, M., 2020. Spatial conservation action planning in heterogeneous landscapes. Biol. Conserv. 250, 108735.
Ticktin, T., Whitehead, A.N., Fraiola, H.A., 2006. Traditional gathering of native hula plants in alien-invaded Hawaiian forests: adaptive practices, impacts on alien invasive species and conservation implications. Environ. Conserv. 33, 185–194.
UN Department of Economic and Social Affairs, 2018. World Urbanization Prospects: The 2018 Revision. United Nations, New York.
van Eeden, L.M., Newsome, T.M., Crowther, M.S., Dickman, C.R., Bruskotter, J., 2020. Diverse public perceptions of species' status and management align with conflicting conservation frameworks. Biol. Conserv. 242, 108416.
van Eeden, L.M., Crowther, M.S., Dickman, C.R., Newsome, T.M., 2021. Wicked "wild dogs": Australian public awareness of and attitudes towards dingoes and dingo management. Australian Zoologist 41, 467–479.
van Riper, C.J., Landon, A.C., Kidd, S., Bitterman, P., Fitzgerald, L.A., Granek, E.F., Ibarra, S., Iwaniec, D., Raymond, C.M., Toledo, D., 2017. Incorporating sociocultural phenomena into ecosystem-service valuation: the importance of critical pluralism. BioScience 67, 233–244.
van Riper, C.J., Thiel, A., Penker, M., Braito, M., Landon, A.C., Thomsen, J.M., Tucker, C. M., 2018. Incorporating multilevel values into the social-ecological systems framework. Ecol. Soc. 23.
Wallach, A.D., Bekoff, M., Batavia, C., Nelson, M.P., Ramp, D., 2018. Summoning compassion to address the challenges of conservation. Conserv. Biol. 32, 1255–1265.
Wallach, A.D., Batavia, C., Bekoff, M., Alexander, S., Baker, L., Ben-Ami, D., Boronyak, L., Cardilin, A.P.A., Carmel, Y., Celermajer, D., Coghlan, S., Dahdal, Y., Gomez, J.J., Kaplan, G., Keynan, O., Khalilieh, A., Kopnina, H., Lynn, W.S., Narayanan, Y., Riley, S., Santiago-Ávila, F.J., Yanco, E., Zemanova, M.A., Ramp, D., 2020. Recognizing animal personhood in compassionate conservation. Conserv. Biol. 34, 1097–1106.
Waring, T.M., Kline Ann, M., Brooks, J.S., Goff, S.H., Gowdy, J., Janssen, M.A., Smaldino, P.E., Jacquet, J., 2015. A multilevel evolutionary framework for sustainability analysis. Ecol. Soc. 20.
Warren, C.R., 2007. Perspectives on the 'alien' versus 'native' species debate: a critique of concepts, language and practice. Prog. Hum. Geogr. 31, 427–446.
Wehi, P.M., Kamelamela, K.L., Whyte, K., Watene, K., Reo, N., 2023. Contribution of indigenous peoples' understandings and relational frameworks to invasive alien species management. People and Nature 5, 1403–1414.
White, L., 1967. The historical roots of our ecologic crisis. Science 155, 1203–1207.
Winter, K.B., Ticktin, T., Quazi, S.A., 2020. Biocultural restoration in Hawaii also achieves core conservation goals. Ecol. Soc. 25.