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People and Nature

PERSPECTIVE

The socio-ecological niche

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Abstract

1. Ecologists recognise that we live on an increasingly human-dominated planet, yet most of the field's foundational concepts remain essentially biophysical, with little reference to human society.
2. There are few better examples of this divide between ecological and social theory than the niche concept. During its century-long history, the niche concept has been defined in many ways, including to describe the ecological roles of humans. To date, however, it has not incorporated human influences into its various descriptions of other species' ecological roles.
3. In this essay, we present the socio-ecological niche (SEN) concept, which builds on the literature in niche theory by contributing insights from the social sciences and humanities to better understand the roles of non-human species in modern socio-ecological systems.
4. We argue that the SEN enriches the niche concept and offers a point of connection between ecology and justice.

KEYWORDS
canids, interdisciplinarity, justice, niche ecology, social-ecological systems, sociological imagination

1 | THE SOCIO-ECOLOGICAL NICHE

The "niche" is one of ecology's oldest and most familiar terms (Grinnell, 1904), but it is not a simple or static idea, having undergone numerous debates, revisions and elaborations (Blonder et al., 2014; Kearney, 2006; Moll et al., 2021; Sales et al., 2021; Whittaker et al., 1973). Today, the niche is usually defined as a set of ecological conditions within which a species can persist, access resources, shape its environment and interact with other species (Polechová et al., 2019). Ecological theory distinguishes between a species' 'fundamental niche', which includes its possible distribution and its 'realized niche', which includes factors that influence its actual distribution (Colwell & Rangel, 2009; Guisan et al., 2014; Hutchinson, 1957; Roughgarden, 1974). Humans may alter a species' realized niche, for example, by directly modifying its habitat or through altering the global climate. Yet ecologists have not produced theories that explain the many other complex, direct and indirect ways that human societies and social relations may shape a species' ecological role.

Several other fields have begun to emphasize the social construction of natural phenomena. For example, studies of disasters like hurricanes and droughts have shown that impacts are driven by human social systems, human relations and human preferences (Bullard & Wright, 2009; Van Loon et al., 2016). Both the causes and consequences of disasters are impossible to discuss in strictly biophysical terms but must instead be considered from a social-ecological lens (Collard et al., 2018; Neumayer & Plümper, 2007; Swyngedouw, 1999). Research in environmental justice has also

tracked the intimate connections between environmental and social domains. The distribution and impact of toxic pollutants, for example, result from a complex arrangement of biophysical factors and social relationships among people (Bullard et al., 2008; Cannon, 2024; Cushing et al., 2015). Indigenous scholarship in particular has attended to the relationship between historical and ongoing settler colonial processes and their consequences for environmental resilience and sustainability, with some arguing for a centering of relations across species and non-Western approaches to ecology (Martinez et al., 2023; Whyte, 2018). The growing fields of social-ecological systems and coupled human and natural systems have likewise shown that the ability to conserve and sustain ecosystems and systems of production relies on careful analysis that combines social and ecological dimensions (Costanza, 2014; Dunham et al., 2018; Liu et al., 2007; Ostrom, 2009). Even as other fields have gravitated toward increasingly integrated theorization of human and natural dimensions, many theories in ecology maintain a sharp distinction between these domains, treating humans as an exogenous, or outside, force on fundamentally natural processes (Braun & Castree, 1998; Plumwood, 2006; Swyngedouw, 1999). The niche concept offers an illuminating example that sheds light on broader opportunities for integrating social and ecological theories.

We argue that a species' niche is not solely a matter of biological traits such as its anatomy, behaviour, and genetics. Instead, we claim that in modern, human-influenced ecosystems, a species' niche is shaped by a variety of social factors, including its historical, legal, economic, political and cultural status, as well as the diverse claims of knowledge and justice that these social factors inform (Figure 1). Furthermore, many species have co-adapted to humans to such an extent that social and ecological drivers of niches are entirely inextricable, demanding an interdisciplinary concept and approach (Carter & Linnell, 2016).

We introduce a new concept, the *socio-ecological niche* (SEN), which incorporates these social factors, not as outside influences on ecologically driven dynamics, but as integral components of a holistic social-ecological process. The SEN builds on niche theory by adding insights from the social sciences and humanities to better understand the roles of non-human species in contemporary ecosystems. We do not draw from a single epistemological or ontological tradition in this essay, but rather we contend that a range of disciplines is required to offer a complete understanding of the complex production of the SEN. In our analysis, we engage most deeply with academic traditions in environmental history, sociology and justice, but fields like political ecology, environmental humanities, psychology, economics and others can also make essential contributions to the SEN concept. Given the diversity and complexity of fields necessary to detail the SEN concept, we offer this essay as an introduction rather than a comprehensive accounting of this concept. While we provide a list of dimensions, as is commonplace in niche theory, to introduce the SEN, we invite and encourage researchers to engage within and beyond this list, and to further integrate the elements that are presented here as distinct.

2 | DIMENSIONS OF THE SOCIO-ECOLOGICAL NICHE

In this section, we introduce the SEN concept by describing key social dimensions that can shape niche space. While these dimensions are not exhaustive, they offer a range of considerations that researchers can use to better understand the niches of the species they study. These dimensions interact with one another and with long-established biophysical elements of the niche, vary spatially, and often involve multiple rates of change

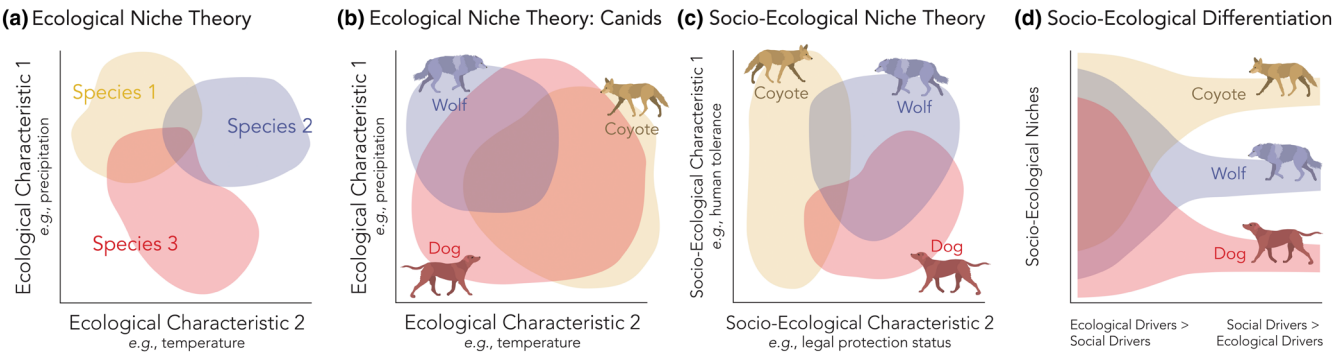

FIGURE 1 Often visualized as an 'n-dimensional hypervolume', the classical niche concept describes the range of conditions in which a species can persist and fulfil its roles. Socio-ecological niche (SEN) theory adds crucial new dimensions to ecological niche ecology. Ecological niche theory examines primarily the biophysical determinants of niche space, which in many cases contribute strongly to niche partitioning (a). However, for genetically and ecologically similar species like coyotes, wolves and dogs, ecological niches are often highly overlapping (b). In cases like this, social-ecological niche theory unearths critical drivers that distinguish niches on a human-dominated planet and allow for links between ecology, social science and environmental justice (c). When ecological drivers are stronger than social drivers, niche differentiation between dogs, coyotes and wolves is low, and hybridization may be common; when social drivers are much stronger than ecological drivers, canids occupy much more distinct niches (d). Future research can work to operationalize difficult-to-quantify SEN dimensions so that they can work effectively alongside established biophysical dimensions of niche ecology.

(Figures 1 and 2). For these reasons, the SEN, like the broader niche concept, is an emergent social-ecological property involving a complex range of forces, including power differentials in human society. In other words, the SEN is a hybrid concept (Stépanoff & Vigne, 2019; Swyngedouw, 1999), and understanding the SEN for any species will require an interdisciplinary approach. A rigorous understanding of the SEN is not without methodological challenges, but we argue that the SEN concept can improve the theoretical rigour of ecological science while better connecting it to observable conditions in Anthropocene ecosystems.

2.1 | History

Historians study trends, events, people and places and their roles in shaping the past, present and future. Change over time is shaped by both deterministic processes and contingent events. Ecologists and biogeographers have long recognised that contemporary niche spaces are shaped by history at multiple time scales, including both recent events and the long sweep of geological and evolutionary change. However, the entanglements between species and human society's cultural, political and economic systems have not been considered through the lens of niche ecology, which often conceptualizes niche spaces as 'snapshots' in time (Brown & Carnaval, 2019). Species' realised niches in a human-dominated world have been contoured not just by human alterations to habitat but also by histories of social relations that shape how people understand, value and interact with various species (Alagona, 2022). History intersects with all the other dimensions we discuss below, but the SEN can rely on history—especially over the last 250 years (Figure 2)—to help understand how social relations of the past have shaped present and future niche spaces.

American bison (*Bison bison*) offer a telling example of the complex role of history in shaping niche space. Once widespread across North America, bison populations dramatically declined in the 19th century. Market-oriented overexploitation and habitat destruction were important drivers of decline, but the relationship between the rapidly expanding American state and Indigenous people also played an important role (Isenberg, 2020). Many bison herds were deliberately exterminated with the intention of suppressing Indigenous populations who relied on them (Mamers, 2019). In the intervening century, a variety of historical changes in demographics, value orientations and land management practices have led to both the conservation and agricultural husbandry of bison, whose current niche space is largely shaped by these practices (Sanderson et al., 2008). The future of the bison niche space may be influenced by human relations that continue to evolve. As one example, the 2014 *Buffalo Treaty* between multiple Indigenous Nations and the US government has framed bison conservation as part of a growing movement for Indigenous resurgence, sovereignty and leadership that may continue to alter bison distribution and population sizes (Mamers, 2019).

2.2 | Laws and institutions

In most parts of the world, governance systems made up of laws and institutions define species' status as a pest, marketable resource, game species, protected species or culturally significant species for local, traditional or Indigenous groups (Doremus, 2010). In some cases, legal frameworks have promoted the extirpation of species, while in others they have enshrined them as protected (Musiani & Paquet, 2004). Land use laws, such as those establishing wildlife refuges or that guide urban development, influence where a species can live, how it can move through space, and what kinds of hazards it faces (Cannon et al., 2023). The strength or weakness of institutions, including the government agencies that interpret and enforce these laws, and non-governmental organizations that inform human-wildlife relations in myriad other ways, may profoundly shape a species' SEN.

In sub-Saharan Africa, the variation in legal protections and institutional capacity has played a role in shaping the niche space of African Elephants (*Loxodonta africana*). After facing high levels of overexploitation that led to range reductions and population declines, some African nations, like Botswana and South Africa, have instituted strong legal protections for elephants, strictly enforced protected areas and penalties for poaching. Elephant populations have declined, and ranges have contracted in countries where political instability has weakened institutional capacity or even incentivized poaching. In one striking example, elephants in Mozambique have rapidly adapted more aggressive behaviours and smaller tusks in response to heavy poaching pressures (Campbell-Staton et al., 2021; Poole et al., 2023). This has led to rapidly shifting human-elephant dynamics and novel ecological roles of elephants in both protected areas and human-altered landscapes.

2.3 | Economics

Local and global economies both play a major role in determining species' niche spaces. Global economic trade networks have led to resource extraction, the spread of introduced species, climate change and other effects that have reconfigured habitats and species assemblages around the world (Christoff & Eckersley, 2013). The effects of economics on niche space are more complex than these direct impacts on species and habitat. For example, in North America, conservation institutions formed in part as an antidote to laissez-faire economics: an attempt to bring a sustainable, utilitarian order to natural resource markets through scientific expertise, government regulation, law enforcement and bureaucratic management (Taylor, 2016). Early conservationists argued that the profit motive associated with market hunting often led to wildlife declines and that only regulations, properly enforced, could conserve wildlife (Geist, 1988; Geist & Mahoney, 2001). Today, economic factors continue to shape SENs in diverse ways (Ojiem et al., 2006), including through recreation, development-related habitat loss (Cannon et al., 2023), the legal collection, transport and sale of wildlife (Geist, 1988), and the illicit wildlife trade (Julián et al., 2023).

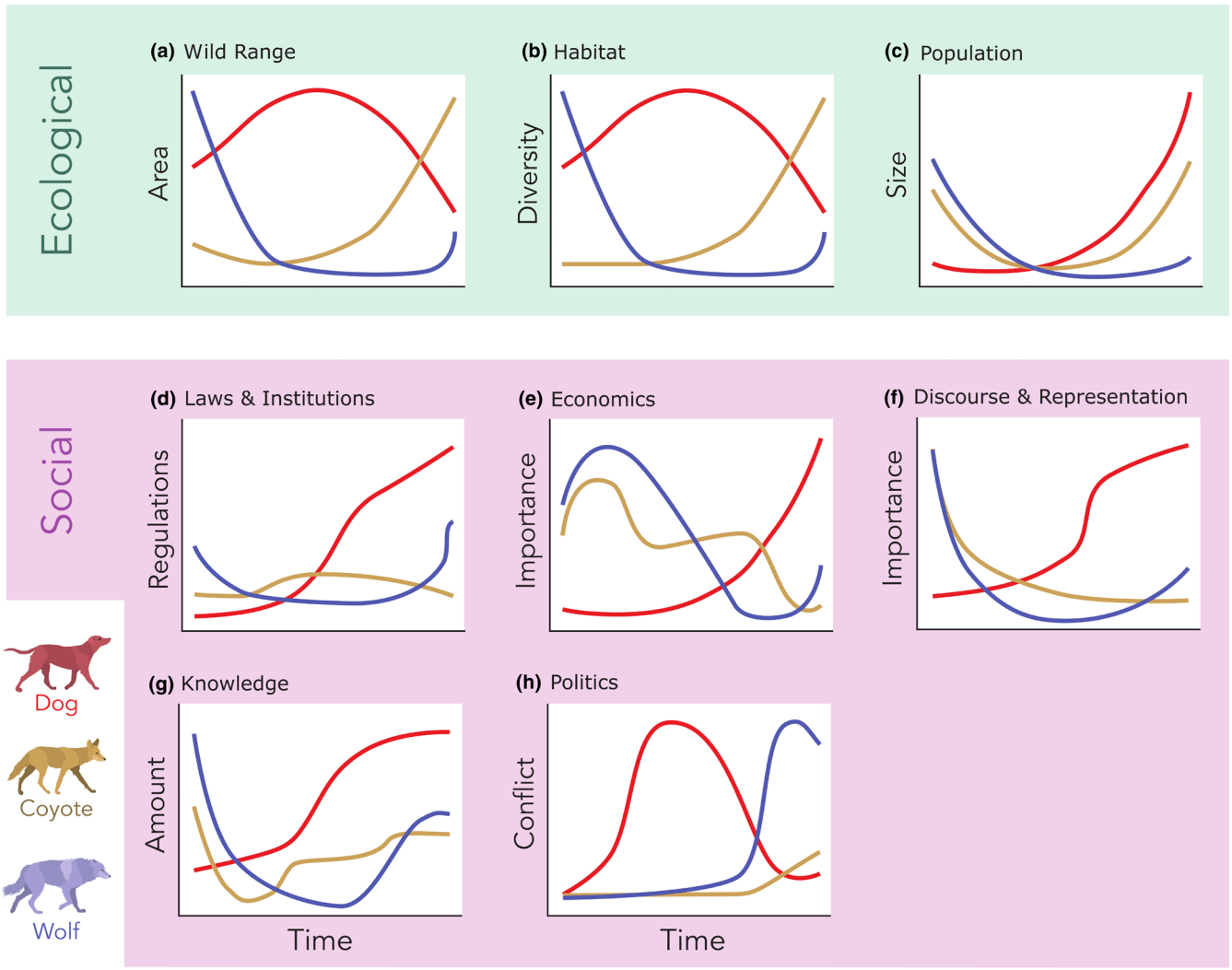

FIGURE 2 The ecological niche is often measured in terms of biophysical outcomes like range size, habitat availability, or population size (a–c). However, the underlying drivers that explain these measurable outcomes are often social (d–h). Both biophysical and social niche characteristics change over time, reflecting the importance of history. Here, we focus on change over time in the last 250 years. (a) The wild range of dogs has declined over the last 250 years as strays have been reduced in number, while the coyote's range has expanded dramatically, and wolf populations are just beginning to rebound after centuries of persecution. (b) Similar to (a), coyotes have dramatically expanded the diversity of habitats in which they live during this time period. (c) The populations of dogs and coyotes have increased dramatically over the last 250 years, while wolves are only beginning to recover from past extirpations. (d) Dogs have become the subjects of considerable animal welfare laws and institutions, and wolves are protected or highly regulated in many US states, while coyotes remain mostly unregulated except as the subjects of active control programmes in many regions. (e) Coyotes and wolves were long the targets of fur trappers, and coyotes were later viewed as significant threats to livestock operations. Today, Americans spend an estimated $48 billion on domestic dogs, including food and veterinary care (American Pet Products Association 2023–2024). (f) Wolves and coyotes long played important roles in Indigenous cultures. Over the last 250 years, dogs have assumed an increasingly prominent place in American, Canadian, and Mexican cultures, while wolves have become endangered icons and potent symbols of wild nature. (g) Indigenous peoples throughout North America long held extensive knowledge of native wildlife, including coyotes and wolves. Scientific knowledge about dogs has increased dramatically over the last 250 years through evolutionary and veterinary research. Knowledge about wolves is mostly ecological, and knowledge about coyotes has increased in waves of interest associated with twentieth-century pest control and more recent urban ecology. (h) Dogs were the subjects of intense political debates during the Victorian era. Wolves and coyotes, which were long universally despised, became more controversial during the second half of the twentieth century when conservationists began to argue for their protection—or at least for an end to predator control programs—and wolves and coyotes became symbolic for groups with opposing political views.

Local economies can also have pronounced effects on niche spaces, as evidenced by swiftlets (*Aerodramus* spp.) in Malaysia. The high value of the edible nests of these birds (as much as $10,000/kg) has led local people to construct swiftlet 'hotels' in buildings, simultaneously shaping local economic opportunity, the urban landscape and swiftlet niche space (Hao & Rahman, 2016). In George Town, Malaysia, the industry threatened the city's UNESCO World Heritage status and associated tourism revenues (Connolly, 2016). Many swiftlets have begun shifting their habitat from natural caves to urban environments, but this shift can be an 'ecological trap' when

nests are overharvested. At the same time, this change has disproportionately impacted Indigenous groups who had been the primary harvesters of nests outside of cities. When international demand for nests dips, it can send shockwaves through local economies, leading to the loss of anthropogenic swiftlet habitat (Thorburn, 2015). Conflicts about local harvest levels and growing international demand for both exploitation and conservation have deepened the entanglement between economics, laws and institutions, and the swiftlet SEN, which continues to rapidly evolve (Suzuki et al., 2020).

2.4 | Politics

It is difficult to imagine a species whose ecological relations are not somehow shaped by political debates. Political debates that encompass much broader issues—like economic transitions, individual freedoms, or taxation—can absorb other topics, including discourses about wildlife (Almarcha et al., 2022). Large carnivores in particular are often connected to broader political anxieties, leading to strong support and opposition that are disconnected from their material effects on people and working landscapes (Skogen et al., 2019; van Eeden et al., 2017, 2019). Species with significant obvious benefits or impacts are more likely to be at the center of political discussions, while other species may be affected indirectly by politics. For example, climate change has become an increasingly politically polarized issue in many parts of the world, and the outcomes of climate policy debates affect a wide range of species.

Many terrestrial large carnivores, such as mountain lions, have complex political histories that continue to shape their niches (Elbroch & Harveson, 2022; Lassiter et al., 1997). Wolves offer another example. Following their reintroduction to Yellowstone National Park in 1995, wolves have become political symbols of government overreach for some, while for others, wolves resonate with more liberal political ideals of environmentalism (Almarcha et al., 2022; Wilson, 1997). Such political symbolism results in feedback loops that reinforce attitudes, management regimes and human behaviours with direct consequences for wolf population viability. In a recent study in Washington state, researchers found that political affiliation was strongly correlated with attitudes toward wolves (van Eeden et al., 2019). In many parts of the United States, intolerance for wolves associated with their political symbolism can lead to illegal killings that threaten the persistence of wolf populations, directly altering their realised niche space (Treves, Artelle, et al., 2017; Treves, Langenberg, et al., 2017).

2.5 | Discourse and representation

Culture encompasses a broad range of social practices that can shape species' niches through complex causal pathways. Many theorists turn to discourses and representations—both forms of broad cultural narratives—to understand culture and its effects on wildlife (Cook & Sealey, 2017; Hajer & Versteeg, 2005; Hovardas & Stamou, 2006). Discourses and representations of animals in (social) media, nature documentaries and in diffuse public conversations can shape perceptions of animals as either villains or heroes, and this framing can profoundly influence how people interact with and manage them (White, 1999). Species commonly portrayed as villains may experience an erosion of public and institutional support, legal protection, and conservation action. Concepts like 'flagship', 'umbrella' and 'cultural keystone' species have narrated into being novel social-ecological niches by linking ecology with public appeal and conservation fundraising, which can have cascading effects on other species (Barua, 2011; Douglas & Veríssimo, 2013). Novel SENs are thus produced both by the cultural discourses that elevate human awareness and empathy as well as by those that heighten vulnerability (Table 1).

Few examples of the importance of discourses on the niche space are as famous as that of shark species. Blockbuster films like Spielberg (1975) created a powerful cultural narrative of sharks as dangerous and aggressive toward humans. This film was not alone, as sharks were widely represented as dangerous or even villainous by decades of sensationalised media coverage, films, and public discourse stoking fear, even as they pose relatively little risk to people (Crossley et al., 2014; Muter et al., 2013; Nosal et al., 2016). Sharks were excluded from many marine protection zones in the 1970s and 1980s, but shifting cultural discourses have led to increasing respect, empathy, and conservation action for sharks (Whitenack et al., 2022). The ability of sharks to survive and thrive in a range of habitats thus has as much to do with how humans engage with them on screen as in the water.

2.6 | Knowledge

Many forms of knowledge—including scientific findings, traditional knowledge, and public awareness—all influence species niches in different ways. 'Best available' scientific research is often a legally mandated aspect of wildlife management, although the means by which research findings are incorporated into decision-making processes can be complex, contested and vary across place and time (Doremus, 2004; Treves, 2022). There are examples of science shaping species' niches when it informs conservation planning, as it did for the conservation of the monarch butterfly (*Danaus plexippus*) migratory routes across borders (Diffendorfer et al., 2020; Oberhauser et al., 2015). Scientific research also informs media coverage—which is where most people get much of their information about wildlife—but is only a small part of the complex and rapidly changing media environment that produces everything from high-quality longform journalism to viral social media threads. Effective public communication—like recent efforts in cities like Seattle, WA and San Francisco, CA to educate urban residents about coyotes—can expand the niche space of such species by limiting conflict (Bonnell & Breck, 2017; Draheim et al., 2019). Traditional knowledge informs a range of Indigenous and community-based land use and wildlife-related practices, including notions of cross-species kinship and responsibility (Martinez et al., 2023; Ramos, 2016).

TABLE 1 Concepts and definitions.

Concept	Definition
Niche	A set of conditions in which a species can persist, use resources and impact its environment (Polechová et al., 2019)
Fundamental niche	The basic resource requirements that bound the potential occurrence and roles of a species (Hutchinson, 1957)
Realized niche	Interactions with other species and historical contingencies that limit the actual observed occurrence and roles of a species (Hutchinson, 1957)
Socio-ecological niche	Intimate feedbacks between social and ecological systems shape niche spaces in important but undertheorized ways
Socio-ecological systems	Complex adaptive systems with reciprocal interactions between social and ecological domains (Berkes & Folke, 1998; Schoon & van der Leeuw, 2015)
Environmental justice	Activism and scholarship that documents and redresses environmental burdens and benefits that disproportionately affect marginalized and vulnerable groups (Bullard, 2000)
Sociological imagination	Sociologist C. Wright Mills' (1959) concept that one can only fully understand a person's biography by placing it in its historical and social context
Socio-ecological imagination	Recognizes the myriad ways that non-humans are an integral component of human social systems and that how humans engage with nonhumans indelibly shapes both human society and nonhuman communities (Wilkie, 2015)

The recent history of sea otters (*Enhydra lutris*) on the coast of Canada exemplifies a range of ways in which knowledge can shape niche space. After populations of otters were decimated by overexploitation, scientific research on sea otters uncovered their roles as a keystone species that maintains kelp forests by eating urchins, an iconic example of a trophic cascade, which led to greater public recognition of their importance, pushes for their conservation, and even reintroduction efforts to restore otters to former coastal habitats (Gregr et al., 2020; Watson & Estes, 2011). Further research helped improve otter habitats by linking the flow of toxic materials from terrestrial freshwater to sea otter health (Jessup et al., 2007). Canadian First Nations had mixed responses to sea otter recovery, as some First Nations had developed economies around shellfish harvests that otters competed with, while others celebrated the return of a culturally important species (Levine et al., 2017; Salomon et al., 2015). Ongoing studies that have incorporated traditional and Western ecological knowledge and embraced collaborative governance have helped fine-tune sea otter niche space in coastal Canada to better accommodate human livelihoods, cultures and sea otter conservation (Pinkerton et al., 2019; Popken et al., 2023).

3 | POWER, JUSTICE, AND THE SOCIO-ECOLOGICAL NICHE

Integrating the social dimensions listed above can help improve the empirical predictive power of the niche concept. All the dimensions listed above reflect and are infused with issues of power and justice, issues that ecological science rarely attends to. However, we argue that relations of power and justice are both causes and consequences of the SEN. Relations of power and justice can create social-ecological patterns, and those patterns can also influence power relations and injustices within human society, and even across species (Pellow, 2017).

Sociologists have argued for over a century that 'power' is a cornerstone of human social and ecological relations (Buscher & Fletcher, 2020; Foucault, 1995; Weber, 2019). Power defines the ability of one individual or group to influence or control others, and it plays an essential role in shaping human social relations, from individual to institutional dynamics. Power is embedded in all the social dimensions we describe above, and thus understanding power relations in societies is essential to interpreting and integrating all of these dimensions.

One critical lens for linking questions of power to the social dimensions of the SEN is justice. Justice is a pluralistic concept and may refer to the fair distribution of goods and harms, the meaningful involvement of a range of actors, especially those who are marginalized and vulnerable, and the recognition of diverse worldviews and epistemologies (Schlosberg, 2007, 2009). Like the concept of power, justice is integral to the dimensions described above and plays a critical role in shaping the SEN.

Recent research has shed light on how histories of injustice have shaped the niche spaces of wildlife, especially in urban ecosystems. Schell et al. (2020), for example, showed that historical patterns of redlining, a practice by which neighbourhoods were

evaluated as real estate based on racial composition, and urban racism continue to shape ecological and evolutionary patterns of wildlife in cities. Cannon et al. (2023) showed that linked logics of oppression influence the complex interaction between human societies and urban wildlife, creating and constraining opportunities for species like coyotes to inhabit cities. In case studies throughout the world, Alagona (2022) explored complex and reciprocal histories of urban inequity and wildlife occupancy, supporting recent scholarship that cities are multispecies assemblages of people and wildlife (Fieuw et al., 2022; Houston et al., 2018; Hubbard & Brooks, 2021; Shingne & Reese, 2022). In many cities, green spaces are a luxury of affluent neighbourhoods, leading to a 'luxury effect' in which urban tree and wildlife species are more frequently found in these areas, often conveying mental health benefits to wealthy residents (Chamberlain et al., 2019; Clarke et al., 2013; Leong et al., 2018). Cities offer clear examples of how injustice can dramatically alter niche space, but a growing body of research in rural areas has also begun to show that injustice can influence conservation and coexistence efforts that have critical consequences for the ecology of species, especially of large carnivores (Bredin et al., 2018; Jacobsen & Linnell, 2016; McInturff et al., 2021). Other environmental injustices—such as the heavy concentration of toxic industrial facilities and other locally unwanted land uses in communities of colour—also routinely produce elevated health risks and habitat destruction for nonhuman species (Miyake, 2021; Pellow, 2017; Taylor, 2023).

More conceptually, research has also begun uncovering links between the treatment of non-human (or 'more-than-human') species and relations of power and justice in human society. There is often a blurred boundary between racism and speciesism, and scholars of justice have rightly critiqued instances where parallel discourses about people and wildlife have led to their simultaneous oppression (Boisseron, 2018; Celermajer et al., 2021; McInturff et al., 2021; Pellow, 2017; Wall, 2016; Weheliye, 2014). For example, as the extermination policy directed at Plains Indians via the eradication of bison indicates (see above Section 2.1), injustice not only impacts marginalized humans but also shapes niche space in complex and multifaceted ways. Niche spaces, in turn, impact humans, creating injustices for humans and, sometimes, for wildlife.

In addition to being a driver of social-ecological niche spaces, issues of justice can also be a consequence of socially defined niches. Human relations with animals have long encoded, provided metaphors for and undergirded human politics and social life. Previous research has established that our treatment of animals can be a mirror and a driver of human social relations (Haraway, 2008; Nibert, 2013). We argue that this same principle is true at a larger scale for niche spaces. The rise of the British empire, which involved the conquest of Ireland, Scotland, Australia and Aotearoa/New Zealand, was made possible in large part through the introduction of cattle ranching in each of those places, which altered and created niche spaces and was intimately entangled with racist ideologies that were deployed to justify the subjugation of local Indigenous populations (Nibert, 2013). Indigenous communities have long articulated methods of challenging these logics and practices, particularly around concepts like *kincentricity* (Martinez et al., 2023), *radical relationality* (Escobar, 2020) and *Indigenous cosmovisions* (Monani & Adamson, 2016). Potawatomi botanist Robin Wall Kimmerer (2013) argues that ecological sustainability cannot be achieved strictly through regulation but must also involve listening to, learning from and developing reciprocal relationships and obligations with more-than-human relatives. These scholars draw from Indigenous traditional ecological knowledge, a system of scientific engagement that rejects the modernist separation between humans and nonhumans (Blaser & de la Cadena, 2018; TallBear, 2019; Yazzie & Baldy, 2018).

A pluralistic understanding of power and justice thus is critical to a theory of the social-ecological niche, both in terms of its causes and its consequences. Justice is an integral component of all the social dimensions of the SEN we have described, and we urge scholars to elevate its relevance in future research on this topic (Table 2; Box 1).

TABLE 2 Future research questions.

Future research questions	Potential implications
How do considerations of justice and equity open up possibilities for more rigorous scholarship on niches across species and geographies?	Increasing the rigour of ecological research to more accurately capture human and social dynamics that influence ecological ones
Which research methods might be most effective for exploring and applying the SEN concept?	Advancing scientific methodologies that include both social and ecological science analytic approaches
How can social factors, like history and culture, be brought more directly into dialogue with the biophysical niche concept?	Increasing relevance of ecological theory, specifically biophysical niche concept, to important stakeholders including scientists, policymakers and the public
How can scholars and managers productively link SEN to wildlife conservation policy and practice?	Develop the reach of ecological theory to wildlife conservation policy, practice and environmental justice

BOX 1 An example of North American Canids

To further elaborate an example of the SEN in action, we turn to a discussion of North American Canids to highlight how social systems impact ecological niches. Wolves (*Canis lupus*), coyotes (*Canis latrans*) and dogs (*Canis familiaris*) exemplify how similar species can occupy distinct niches shaped by social, rather than purely ecological or biological, factors (Figures 1 and 2). Despite their genetic overlap and the ability to interbreed, these canids are treated and perceived differently by humans, offering insights into how power and social arrangements shape ecological niches.

The striking genetic overlap among these canids is a key point in this example. North American wolves exhibit varying proportions of wolf and coyote DNA depending on the region, while domestic dogs retain up to 98% Eurasian wolf DNA (Monzón et al., 2014; vonHoldt et al., 2016). Red wolves in the American Southeast were included on the inaugural US endangered species list in 1967, but most appear to contain only around 20 percent wolf DNA (Chambers et al., 2012; vonHoldt et al., 2016), fueling a multi-decade debate about their taxonomic classification and legal status. These genetic complexities challenge strict species boundaries.

In spite of their genetic overlap, the ecological roles and behaviours of these species are distinct. These distinctions cannot be explained without the social dimensions of the niche space. Domesticated dogs, products of human co-evolution, exhibit immense behavioural and ecological flexibility (Reid, 2009). Of the estimated 700 million dogs worldwide (Smith et al., 2019), around half are pets and more than three-quarters, as many as 525 million, are either completely feral or frequently roam free, and 71 million of these live in North America (Hughes & Macdonald, 2013). From feral scavengers to beloved pets, dogs' roles depend on cultural and legal frameworks. Modern laws protect dogs from harm, reflecting their status as companions, while feral and free-ranging dogs have significant ecological impacts, particularly in areas with less restrictive human-animal relationships (Young et al., 2011).

Wolves, the largest canids, are keystone species and cultural icons tied to wilderness (Arnds, 2020; Hale & Koprowski, 2018; Jones, 2010). While some societies revere wolves, others treat them as threats to livestock and livelihoods, leading to their classification as pests, game or protected species depending on context (Sandström et al., 2018). Their conservation status in regions like the Rocky Mountains sparks intense political debates that have materially shaped where wolves can and cannot live (Mech, 2017).

Coyotes, historically adapted to arid environments, have expanded across North America despite severe pest control campaigns that have killed millions (Coleman, 2006). In the absence of wolves, they may adjust by forming packs, becoming more wolf-like (Berger & Gese, 2007). Coyotes are increasingly recognized as urban ecosystem components, though their presence often generates polarizing views as either pests or adaptable survivors (Draheim et al., 2019; Weckel & Wincorn, 2016), leading to a continually evolving niche.

In addition to diverse social relations and perspectives that shape these species' ecologies, behaviours, and distributions, power and justice have also played a role in dictating their niche space. For example, harming dogs is often a crime in the United States, while killing coyotes or wolves often is not. Differential treatment is amplified in racialised contexts, such as law enforcement actions targeting African Americans with dogs (Bloch et al., 2020; Hattery & Smith, 2021). Similarly, coyotes and wolves face contrasting perceptions as pests or symbols of natural beauty. When coyotes appear in recreational spaces such as national parks, visitors often view them with awe and respect, yet some urban communities have organised efforts to 'evict' them from cities, drawing troubling parallels between human and animal belonging and injustice (Estien et al., 2023; Green, 2019; Niesner, 2023).

The SEN framework reveals that the niche spaces of these canids are shaped more by human social arrangements than by biology alone. Addressing these disparities requires acknowledging and rectifying the social injustices that drive them.

4 | IMPLICATIONS FOR THEORY AND PRACTICE

The SEN has important implications for advancing niche theory and improving our understanding of ecology and social-ecological interactions. By incorporating human influence into ecological frameworks, the SEN reimagines the relationships between species, their roles in ecosystems, and the social systems they inhabit. Here we underscore several essential implications and the broader potential of the concept to refine theory and practice.

First, the SEN provides fertile ground for developing novel hypotheses about niche spaces by integrating ecological and social dimensions. Traditional niche theory often explains species distribution based on resource availability, but the SEN reveals that factors like human discourse and cultural perceptions are equally critical. For instance, where wolves occur is shaped not only by prey abundance but also by narratives surrounding 'wolfness' and the socio-political context of their presence (Behr et al., 2017; Sandström et al., 2018).

Interdisciplinary approaches enabled by the SEN could generate testable hypotheses that bridge ecological and social science. Researchers might, for example, investigate how public attitudes toward wildlife influence behavioural adaptations in species, such as changes in hunting patterns or habitat use. Similarly, studying how cultural narratives drive policies like coyote extermination campaigns could uncover new dimensions of niche constraints that go beyond

ecological competition. The SEN concept also offers the tools of history and sociology to help attend to critiques of temporal 'niche conservatism' that have emerged in ecology (Pearman et al., 2008).

Second, a cornerstone prediction of niche theory is that species will minimise niche overlap to reduce competition, driving speciation and other major patterns in ecology (Cardillo & Warren, 2016; May, 1974; Sévêque et al., 2020). The SEN complicates this prediction by highlighting that socio-ecological overlap may persist or even increase due to human influence. For example, wolves, coyotes and dogs hybridise in regions where social and ecological pressures force them into overlapping spaces (Ellington & Murray, 2015; Pilot et al., 2021; Stépanoff & Vigne, 2019; Stronen & Paquet, 2013). Such hybridisations can defy classical ecological predictions, and they suggest that human interventions—like land-use changes or predator management—reshape evolutionary trajectories in unexpected ways.

Research on socio-ecological overlap could inform evolutionary ecology by identifying the conditions under which hybridization occurs or is prevented. For example, in areas where wolves and coyotes coexist, hybridization may serve as an adaptive strategy to navigate fragmented habitats and human-dominated landscapes. This approach could lead to novel discoveries about the interplay between social forces and evolutionary processes, enriching our understanding of biodiversity.

Third, the SEN decouples the niche concept from the species concept, emphasizing the importance of the 'functional niche' (Alagona, 2016; Kearney et al., 2010). While traditional ecological theory often links niches to species-specific traits and roles, the SEN framework highlights that distinct species can play overlapping socio-ecological *roles*. A similar shift in focus has been underway in literature on climate-driven ecological transformations (Fedele et al., 2019; Görg et al., 2017; Massarella et al., 2021). This shift has substantial implications for conservation and management. While landmark legislation like the Endangered Species Act (1973) focuses rigidly on the species level, a new practical focus on conserving SENs themselves could help expand conservation practices to new territory. This approach enriches ongoing work in ecosystem services, which links conservation with benefits provided to humanity (Chan et al., 2016; Daily & Matson, 2008; Loos et al., 2023). The SEN concept can help sharpen ecosystem service approaches by improving our understanding of the reciprocal connections between ecology, conservation and human society. Conservation strategies could prioritize preserving SENs as integrated systems that include species, people, and the relationships between them.

Finally, the SEN underscores the critical role of the humanities and social science in ecological management and conservation. Social science methods and insights, often underutilized, are vital for understanding the human dimensions of species interactions and landscapes. For example, studies on public attitudes toward wolves have shown that policies aligning with social values are more likely to succeed (Bruskotter et al., 2010). Integrating such approaches into conservation practice constitutes an essential, though often unacknowledged, part of 'best available' science. By encouraging interdisciplinary collaboration, the SEN framework equips researchers and managers to address complex socio-ecological challenges. It not only enriches niche theory but also offers practical pathways for fostering coexistence, conserving biodiversity and addressing justice for both people and wildlife.

5 | CONCLUSIONS

In 1959, the sociologist C. Wright Mills wrote that we can only fully understand a person's biography by placing it in its broader historical and social context. Wright called this idea the 'sociological imagination'. Something similar can be said of species' niches—they cannot be fully understood outside of their historical and social contexts. Thus, the SEN helps establish a new 'socio-ecological imagination'. The socio-ecological imagination builds on both Mills's (2023) concept and Norgaard's (2018) idea of the 'ecological imagination' (the relationship between human actions and the earth's biophysical system) by emphasizing the ways in which humans, nonhumans and ecosystems interact and influence one another as social and biological entities. Such an approach will help us to recognize the myriad ways that non-human species are an integral component of human social systems and that how humans engage with nonhumans indelibly shapes both human societies and nonhuman species (Wilkie, 2015). An interdisciplinary approach to niche science will not be without challenges, yet it also offers opportunities for creative, interdisciplinary methods to advance SEN with important implications for ecology, conservation and environmental justice. To fully appreciate what makes a wolf a wolf, a coyote a coyote and a dog a dog—and what defines any species' place in the Anthropocene—one must understand their SENs.

AUTHOR CONTRIBUTIONS

Alex McInturff and Peter S. Alagona developed the initial concept. Alex McInturff led the writing. All authors contributed to the concept formation, writing and revision.

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The authors have no conflicts to declare.

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