

# Learning Environments with Other Animals

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**Abstract:** The question of how humans have come to know their environments and how such knowledge is accrued and deployed has gained novel significance in an age of deepening ecological crisis. Engaging with this long-standing issue, this article draws attention to overlooked more-than-human contexts of environmental knowledge-making. We suggest that studying processes of human environmental learning from a multispecies perspective can transform our understanding of past human–environment relationships. We begin with an outline of the deeply entrenched anthropocentrism that has shaped concepts of knowledge and learning in the European(-derived) tradition. We then propose a framework to facilitate interdisciplinary investigations into the interspecies dimension of human environmental learning in the form of a tripartite heuristic of learning *through*, learning *from*, and learning *with* other animals. With particular emphasis on the third and most complex modality, we discuss how this scheme can provide new insights into how humans and other animals have inspired each other to act and dwell in past shared landscapes, with lasting consequences for broader historical trajectories including material culture, cognition, and discourse. Since such interspecies dynamics have rarely been addressed in historical scholarship, the article draws together a range of examples and contexts in which learning with other animals appears to have been a history-shaping dynamic, comprising such variegated societies as Pleistocene and early Holocene North European hunter-gatherers, Indigenous Arctic foragers, and North American Plains horse pastoralists. Based on these explorations of human environmental learning, we suggest that interspecies learning mechanisms can provide a multispecies analogue of lateral gene transfer for more-than-human history and multispecies archaeology, help us integrate human history into animal history and the broader history of the biosphere, and hold implications for future-making conversations on reimagining our coexistence with other earthlings.

**Keywords:** *More-than-human history; multispecies archaeology; human-animal relations; environment; knowledge; learning*

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**T**he question of how humans come to know and understand environments has been a long-standing research problem across the cultural and ecological sciences, gaining new significance in the context of deepening global environmental crises.<sup>1</sup> Environmental knowledge has been understood as a key source of human action and, potentially, a key reason for transformative change in how people interact with their nonhuman surroundings.<sup>2</sup> It is increasingly understood as pluralized and heterogeneous, given that different human cultures and lifeways can promote different modes of attending to and knowing environments. In this vein, Western scientific knowledge of “the environment” has been contrasted with a wide range of localized environmental knowledges, moving “Traditional Ecological Knowledge” (TEK) to the centre of broader debates about nature conservation and ecological stewardship.

In this article, we suggest that these conversations can greatly benefit from careful interdisciplinary examination of the ways in which people in the past and deep past have familiarized themselves with, and adapted to, novel environmental conditions. Such a perspective must consider the possibilities and intricacies of *learning* environments, the cultural biases involved in such learning processes, and how the latter relate to regimes of ecological knowledge and sense-making. In tackling this issue, we propose that environmental learning has often occurred as a distributed process in what anthropologist Tim Ingold has called “sentient ecologies”<sup>3</sup> and involved not just human beings but also broader multispecies assemblages. Here, we are especially interested in the role of nonhuman animals not just as environmental agents in a general sense but as teachers and guides—inspirations and models for the human groups with whom they cohabit. In this way, we seek to complement perspectives on environmental learning that have been framed in human-centred terms, as is the case with Marcy Rockman’s notion of “landscape learning” developed for archaeological investigations of

1 See, for example, Moran, *People and Nature*.

2 Coldicutt, “Environmental Knowing and Action”.

3 Ingold, *The Perception of the Environment*.

how Pleistocene foragers made themselves at home in unfamiliar environments.<sup>4</sup> The term “learning environments” evokes both process and place—environmental learning as a set of practices and the historically situated environments in which such learning occurs in particular ways—in an attempt to address the distinctive sets of opportunities and constraints different landscapes offer to, or impose upon, different types of organisms and lifeways.

Animal-oriented investigations are increasingly regarded as a mainstay of history and archaeology, dismantling deep-seated ideas about animal-human distinctions and critiquing reductive understandings of animal contributions to human life and society in which animals figure primarily as resources, symbols, or passive objects of human knowledge practices.<sup>5</sup> However, so far little attention has been paid to how these developments might be brought to bear on entrenched anthropocentric circumscriptions of both learning and knowledge. Human learning is generally understood to be unparalleled in scope, potency, and evolutionary implications, enabling the development of “cumulative culture” based on sophisticated learning ecologies.<sup>6</sup> In the humanities, discussions of the dimensions and dynamics of learning have thus largely been limited to a focus on human-to-human processes at work in more or less formalized systems of intrahuman socialization and education. But, as we wish to argue in this article, an all-too-exclusive focus on human beings as uniquely “knowing animals”<sup>7</sup> has not only led us to underestimate the learning capacities of other species but also obscured how human knowledge projects have themselves been shaped by historically situated more-than-human entanglements. Taking seriously the active role of animals in histories of human environmental

4 Rockman, “Knowledge and Learning in the Archaeology of Colonization”; Rockman, “Landscape Learning in Relation to Evolutionary Theory.”

5 A few examples are Nance, *The Historical Animal*; Baratay, “Building an Animal History”; Specht, “Animal History after Its Triumph”; Ohrem, “A Declaration of Interdependence”; Roscher et al., *Handbook of Historical Animal Studies*. For works in archaeology, see Hill, “Archaeology and Animal Persons”; Hamilakis and Overton, “Multi-Species Archaeology”; Sykes, *Beastly Questions*; Armstrong Oma, *Sheep People*.

6 Haidle et al., *The Nature of Culture*; Migliano and Vinicius, “The Origins of Human Cumulative Culture.”

7 Tallis, *The Knowing Animal*.

learning means acknowledging that animals are adept learners in their own right: that they embody potent ways of ecological knowing which have repeatedly made animal behaviours and lifeways a privileged domain of human learning. The idea that animals are learners implies that they are also *knowers*—holders of effective, reliable, and valuable knowledge, rather than creatures whose perceptions of, and engagements with, their worlds are delimited by biologically pre-set instincts that remain largely unaffected by experience.

Knowledge is a concept that is as contested as it is central to how we understand ourselves and our role as humans in Earth's history. In European philosophical traditions, it has commonly been reserved for the highest echelons of organic life, regarded as a marker of humans' special place in the world they inhabit. In this anthropocentric perspective, humans are able to move beyond their animality through their ability to reflexively relate to it, privileging intellectual operations that seemingly transcend the immediacy and concreteness of the lifeworld. Unlike, say, dogs or horses, whose relationship with their environment has been typically construed as "largely fixed," the worlds of humans require active construction, underlining both the unique agentiality and constitutional vulnerability of creatures whose "world-openness" enables and compels them to create uniquely *cultural* worlds.<sup>8</sup>

The classic—if now embattled—"justified true belief" (JTB) account of knowledge holds that, in order to count as a knower, a subject must not only believe a true proposition but also be (rationally) justified in doing so.<sup>9</sup> Influential figures like Wilfrid Sellars and, in a different way, Ernest Sosa have proposed further metacognitive criteria that effectively distinguish human knowledge-making from epistemic processes at work among nonhuman animals. According to Sosa, for example, it is the "special status" of higher order "reflective knowledge" that distinguishes human cognition from "knowledge

8 Berger and Luckmann, *The Social Construction of Reality*, 65. In this sense (according to Arnold Gehlen), the human being is a "special biological problem". See Gehlen, *Man: His Nature and Place in the World*. See also Ohrem, "An Address from Elsewhere".

9 Turri, "Is Knowledge Justified True Belief?"; Dutant, "The Legend of the Justified True Belief Analysis."

of the sort attainable by beasts”.<sup>10</sup> Varying in emphasis and orientation, such accounts have contributed to a cluster of “differentialist” perspectives united in their insistence on strong qualitative differences between human and animal ways of knowing—a picture we seek to complicate in this article.<sup>11</sup>

We especially wish to contribute to the ongoing cross-disciplinary reappraisal of human-animal relations by exploring, in a preliminary way, histories of animal-mediated forms of human environmental learning, which we consider to be an underappreciated perspective on the ways in which animal agentive ingenuity and worldmaking capacities have shaped human histories. Interspecies learning has only recently been identified as a source of human and nonhuman knowledge formation, even as traditional ethnographies are at times replete with evidence of animal observation and mimicry as key cultural inputs. Following a brief discussion of the concept of environmental learning, we present a tripartite heuristic of animal-mediated environmental learning. We first consider what we call learning *through* animals, a modality in which animals have often figured as disembodied, generalized, and largely interchangeable abstractions. We distinguish this modality from, respectively, learning *from* and learning *with* animals as two principal forms of learning shaped by historically situated, embodied, and embedded animal others. Here, we focus most of our attention on historical examples of learning *with* other animals, which we argue has often occurred in relatively durable and mutualistic (if rarely symmetrical) interspecies arrangements in particular shared environments.

10 Sosa, “Human Knowledge, Animal and Reflective,” 291; Sosa, “Knowledge and Intellectual Virtue,” 242.

11 For a discussion and critique of “differentialism”, see Glock, “Animals, Thoughts and Concepts”; Glock, “Non-Human Knowledge and Non-Human Agency.” Attempts at establishing clear distinctions between “lower” and “higher” forms of knowing and the relegation of the former to the animal side of the equation tie in with a longstanding philosophical project committed to identifying the parameters of human uniqueness and “determin[ing] human specificity over and against those beings who/that threaten to undermine that specificity.” Calarco, *Zoographies*, 52; Sorabji, *Animal Minds and Human Morals*.

## Toward a More-than-Human Account of Human Environmental Learning

As an important mechanism of knowledge generation and transmission, learning has figured prominently in debates about the cultural evolution of human societies.<sup>12</sup> For our purposes, learning can be understood as a dynamic process that bridges knowing and doing—encompassing skills, behaviours, attitudes, and values—and that depends on different “operators” such as observation, familiarization, imitation, systematization, analogization, and experimentation. It is thus shaped by diverse factors and can involve various systematic biases that influence how knowledge is acquired and applied. Emphasizing the embodied nature of knowledge production in specific socioenvironmental contexts, we understand knowledge as emerging from conditions of worldmaking that testify to what Michael Polanyi has called the “kinship of knowing and living”.<sup>13</sup> In its contents and consequences and in the methods of its formation, knowledge is always “enworlded” and enacted by variously configured collectives in a way that unsettles any strict separation between knowing and doing.<sup>14</sup>

In his classic *Personal Knowledge*, Polanyi directly addresses animal learning by arguing that instances in which “an animal shares in the intelligent effort which another animal is making in its presence” should be considered examples of a “true transmission of knowledge”—not “blind parrot-like imitation,” but “real communication of knowledge on the inarticulate level”.<sup>15</sup> For Polanyi, the acquisition of “tacit knowledge” is rooted in “pure conviviality,” that is, in the desire for, and praxis of, cultivating “good fellowship” that humans share with other social animals.<sup>16</sup> He suggests that animals, too, inhabit a “heuristic field,” which provides them with opportunities and with the task of making use of them, underlining that “*knowing belongs to the*

12 See, for example, Shennan, *Genes, Memes and Human History*; Mesoudi, *Cultural Evolution*; Ellis et al., “Evolving the Human Niche”.

13 Polanyi, *Personal Knowledge*, 404.

14 Descola, “Cognition, Perception and Worlding.”

15 Polanyi, *Personal Knowledge*, 206.

16 Polanyi, *Personal Knowledge*, 210.

*class of achievements that are comprised by all forms of living*".<sup>17</sup> More recent works in naturalistic epistemology, such as those of Hilary Kornblith, have rejected an overly restrictive emphasis on metacognitive reflective capacities, underlining instead that the cognitive processes involved in knowledge production have evolved to help all kinds of organisms interact effectively with their environments.<sup>18</sup>

As "interested" entities whose behaviours are guided by an elective openness to a world "strewn with opportunities and risks," animals provide crucial orientations and exemplars for other beings, humans included.<sup>19</sup> Roberto Marchesini argues that human life has been "surrounded by animal knowledges", and animals have long functioned as nonhuman "knowledge *partners*" as well as "sources of fervid creativity for our species," their influence reaching deeply into what is usually conceived as an exclusively human cultural sphere.<sup>20</sup> It is perhaps especially in the production and mobilization of *environmental* knowledge— understood here as a body of actionable knowledge (know-that and know-how) that both pertains to and emerges from specific human-environment configurations—that human learning tends to exceed any strictly "human" domain. At its core, environmental knowledge is a form of culturally mediated experiential-observational knowledge that develops and transforms as different groups of humans respond to, negotiate, and modify the patterns of possibility for action—"affordances" in the language of ecological psychology<sup>21</sup>—that structure their modes of existence in specific environments. While actionability is a key purpose of human learning more generally, it holds particular importance in the encounter with unfamiliar environments (for example, in contexts of

17 Polanyi, *Personal Knowledge*, 403; original emphasis.

18 Kornblith, *Knowledge and Its Place in Nature*; Kornblith, "Epistemology and Cognitive Ethology".

19 Marchesini, *The Creative Animal*, 84.

20 Marchesini, "The Theriosphere," 114, 115. Marchesini captures this dependence on non-human animality in the evolution of human thought and the constitution of "plurispecific communities"—reductively understood as "human" societies—with his concept of "zoomimesis". See also Bird-David, *Us, Relatives*, chap. 5.

21 See Gibson, *Ecological Approach to Visual Perception*; Chemero, "An Outline"; Jenkins, "Gibson's 'Affordances'".

migration or displacement) or the adaptation to environments that have become unfamiliar through significant environmental change. However, like other types of cultural learning, environmental learning has an inherently creative dimension and is not reducible to a set of responses to “deficiencies” or “challenges.” It is shaped by the dynamic interplay between existing cultural frameworks and environmental characteristics and thus defined by receptivity to forms of nonhuman agency.

Indigenous knowledges have provided important reference points and inspirations for rethinking environmental learning in more-than-human terms. Ethnobotanist Robin Wall Kimmerer draws attention to the “grammar of animacy” at the heart of Indigenous ecologies and suggests that (re)learning of this grammar—an act of listening to the myriad of nonhuman voices that surround us and re-attuning human attention to this plentiful natural world—is among the most pressing challenges.<sup>22</sup> The important lesson is that environmental knowledge is often rooted in learning with and from nonhumans, constituting *knowledge-making communities* of a distinctly more-than-human nature. Knowledge of this sort is formed within ecologies saturated with heterogeneous beings who, through their behaviour, volition, memory, and speech, invoke the possibility of sentience and invite engagement with their presence, agency, and successful operation in their environments. Such environmental learning does not have to be symmetrical, and indeed often won’t be. What is important is that it cannot be reduced to an exclusively human affair in terms of agentiality, directionality, and the “sources” and parties involved. It is also crucial to recognize that it varies in historical form and relevance, for example because sentience can be differentially ascribed or because different knowledge partners can be drawn upon to learn and navigate particular environments based on particular cultural frameworks. In short, we need to pay attention to how humans and nonhumans are caught up in specific historical contexts that shape what they have to say to each other under changing conditions.

22 Kimmerer, *Braiding Sweetgrass*.

A growing body of evidence from the sciences of animal behaviour supports this attention to environmental learning and to knowledge embodied in, and enacted by, animal others. These fields have begun to challenge the idea of animal behaviour as fixed by pre-given action patterns tied to particular ecological milieus, an image traditionally juxtaposed with what has been understood as the human prerogative of environmental and behavioural underdeterminedness—that is, the relative freedom from pre-specified stimulus-response patterns and a corresponding openness to multiple possible ways of acting in, and relating to, a given environment. Evidence for animal “world-openness” comes, for example, in the form of diverse animal cultures now documented across various genera,<sup>23</sup> and the long-underestimated role of social learning (with evidence for nonhuman cumulative culture) even in behavioural domains such as subsistence and mobility, which have often been treated as governed by hard-wired behavioural patterns.<sup>24</sup> Evolutionary biologists now increasingly speak of animal agency and niche construction, and report both phenotypic and behavioural plasticity in many nonhuman organisms.<sup>25</sup> Scholars have also begun to recognize that contemporary observations of animal behaviour may register historically specific learning environments (shaped by Anthropocene conditions) rather than unchanging and broadly generalizable species repertoires. For instance, human-accelerated warming of the Arctic and the associated reshuffling of marine ecosystems have prompted orcas to develop new forms of behaviour and create novel ecological niches. At least three orca “ecotypes” are now widely recognized, exemplifying different trajectories by which nonhuman animals can learn to adapt to unprecedented environmental situations in real time.<sup>26</sup>

23 Ramsey, “Culture in Humans and Other Animals”; Whiten, “Burgeoning Reach”; Whitehead and Rendell, *Cultural Lives of Whales and Dolphins*.

24 Jesmer et al., “Is Ungulate Migration Culturally Transmitted?”; Slagsvold and Wiebe, “Social Learning in Birds”; Sasaki and Biro, “Cumulative Culture”.

25 Odling-Smee et al., *Niche Construction*; West-Eberhard, *Developmental Plasticity and Evolution*; Walsh, *Organisms, Agency, and Evolution*; Natoli et al., “Coexistence between Humans and ‘Misunderstood’ Domestic Cats in the Anthropocene”; Read and Szokolszky, “What Animals Can Do.”

26 de Bruyn et al., “Killer Whale Ecotypes”.

As Jedediah Allen and Kristin Andrews have argued, our ability to appreciate how other animals navigate their worlds is still hampered by an overriding conceptual bias that undercuts our ability to recognize observational evidence for behavioural designations otherwise assumed to be exclusive to humans.<sup>27</sup> The idea that learning is a sociological rather than an ecological phenomenon further adds to this architecture of biases and blind spots, which is not only anthropocentric but also tends to package learning processes tightly within the boundaries of species. Cross- or interspecies learning is at present rarely considered in mainstream accounts of learning, despite recent emphasis on the ways in which different organisms jointly shape each other's semiotic environments. Meerkat warning calls, for example, help other animals navigate predatory landscapes. Similarly, vultures and other scavenging birds alert terrestrial scavengers — perhaps including Pleistocene hominins<sup>28</sup> — to carcasses through their flight patterns and calls, and there is strong evidence for multispecies scavenging sequences among birds anchored in cross-species semiosis and co-adaptation.<sup>29</sup>

Many human-animal interactions are likely to involve some form of interspecies learning. The challenge is to describe, qualify, and differentiate these forms, and to assess their short and long-term consequences for human and animal behaviour alike, including their potential integration into broader multispecies arrangements. Domestication, for example, offers a model case for how humans and animals attune their behaviours to each other and physiologically change in the process. This co-adaptive process does not happen in a learning void but is critically facilitated by mutual understanding and co-adjusted knowledge — or “zoocialization”.<sup>30</sup> Beyond domestication, a range of more specific cases illustrates how such learning can be organized in different ways for different ends.

27 Allen and Andrews, “Over-Imitation in Animals”.

28 Morelli et al., “The Vulture in the Sky”.

29 Grubb et al., “Winter Scavenging”. Environmental learning can also take the form of intraspecific learning between social groups possessing different levels of experience regarding certain human-animal interactions. See, for example, Whitehead et al., “Adaptation of Sperm Whales”.

30 Petitt and Brandt-Off, “Zoocialization.”

Human–honeyguide relations across sub-Saharan Africa involve both intra- and interspecific learning, as people adopt imitated bird calls to initiate the interaction and have learned to attend to and coordinate with the birds to acquire honey. Humans have learned to read the birds’ flight patterns, calls, and perching choices as indications of the direction and distance to bee nests. Once a nest is located and opened, humans harvest the honey and sometimes leave behind wax comb and larvae for the bird.<sup>31</sup> Importantly, honeyguides are nest parasites, suggesting that interactions with humans result from individual learning and experimentation, rather than transmission from parents to offspring.<sup>32</sup> Some whales and dolphins have also learned to cooperate with people, and this is often linked to foraging synchrony.<sup>33</sup> In addition, cormorant-assisted fishing has long been a central livelihood practice in China and Japan, involving cross-species habituation and learned behaviours in humans and their birds.<sup>34</sup>

These few examples already indicate that learning with animals is not merely a theoretical prospect but has long been important to human life, setting the scene for a dedicated analysis of how environmental knowledge is *co-constructed* by humans and other animals in lived interspecies praxis, involving different forms of expertise and traveling through heterogeneous networks of people, things, and animals. Calls for more inclusive research epistemologies demand that we take seriously what Jamie Lorimer and Timothy Hodgetts have called “more-than-human knowledge practices”.<sup>35</sup> They activate the anthropological concept of multinaturalism—a perspective that not only rejects human-nature dualism but also pluralizes what in European traditions has often been imagined as a singular domain of Nature, positing multiple natures corresponding to different kinds of beings—to draw attention to how knowledge is not a human prerogative but “possessed by nonhuman subjects, like animals, plants,

31 Wood et al., “Mutualism and Manipulation”; Spottiswoode et al., “Reciprocal Signaling”.

32 Fleischer, “Ladies and Gentes.”

33 Cantor et al., “Foraging Synchrony”.

34 Jackson, “Fishing with Cormorants”; Manzi and Coomes, “Cormorant Fishing”.

35 Lorimer and Hodgetts, *More-than-Human*.

and even geomorphic agents like rivers”.<sup>36</sup> Such work foregrounds nonhuman beings as knowers and thus encourages us to rethink anthropocentric epistemologies. Our aim here is to turn the problem inside out by asking whether such more-than-human knowledge practices have been operative in, or co-constitutive of, specific cultural and historical human contexts, some of which may hence be better conceptualized as multispecies lifeforms.

The perspective developed here also creates new impetus for experimental and cultural evolutionary investigations into the social transmission of knowledge: as soon as we challenge the assumption that the communities of practice that constitute corresponding communities of learning are human-exclusive, we can begin to unpick animal-mediated environmental learning with concepts developed in these fields. We may, for example, ask what role the learning biases such as the “content bias,” “model-based bias,” and “frequency-dependent bias”<sup>37</sup> have played in different historical contexts. The confrontation of specific human forms of life and the relevance of specific nonhuman agencies therein may already hint at the potential to generalize the “context bias” of learning and social transmission.<sup>38</sup> The model-based bias is particularly worth highlighting here, as it describes learning that preferentially occurs with a view to agents who can serve as *models* with certain characteristics and behaviours. Modalities of human environmental learning that are largely oriented toward certain keystone animals might conform to such a model-based bias, underscoring the point that learning theory would benefit from multispecies perspectives.

## **A Heuristic Typology of Animal-Mediated Environmental Learning**

What humans can learn from other animals and how they can learn it is neither entirely arbitrary nor fully determined by supposed sets of species-level behaviours of the animals in question. Environmental

36 Lorimer and Hodgetts, *More-than-Human*, 12. On (perspectival) multinaturalism, see Castro, “Cosmological Deixis”.

37 Mesoudi, *Cultural Evolution*; Heyes, *Cognitive Gadgets*.

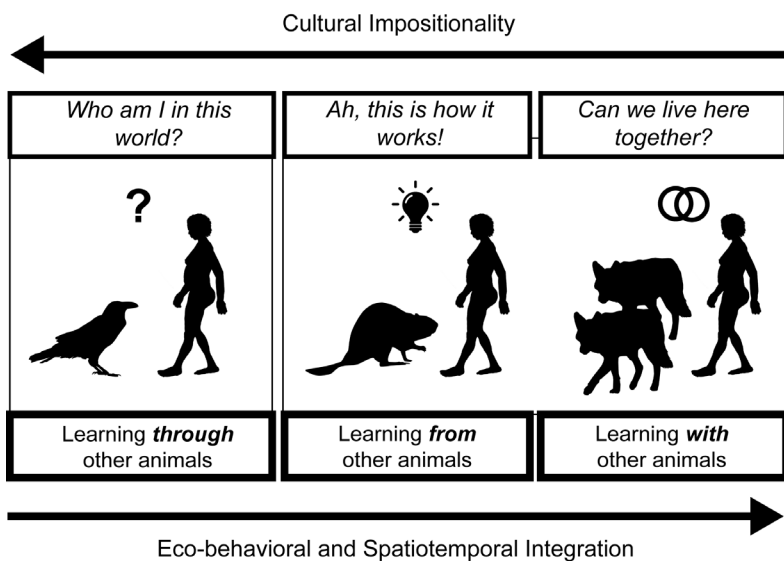
38 Wood et al., “Context-Dependent Model-Based Biases”.

knowledge is negotiated under varying conditions of more-than-human praxis. It is contingent upon how humans come to live together with other animals and where, when, and how they interact with them in relation to their own projects and ambitions. It speaks to a spectrum of degrees of proximity, reciprocity, and intensities of relations, ranging from the imitation or emulation of zooalterity through various cultural practices to what might be understood as more fully fledged multi- or interspecies cultures as potent learning contexts.<sup>39</sup> Making analytical space for how animals have influenced the learning ecologies of human collectives requires a sensibility for the historical contingency and heterogeneity of interspecies knowledge formation.

To take a step toward rethinking learning from a multispecies perspective, it may be useful to begin differentiating between various ways in which animals have figured in how humans have made sense of particular environments. For this purpose, we propose a tripartite heuristic of animal-mediated environmental learning that involves three basic modalities with different levels of spatiotemporal and eco-behavioural integration (that is, how closely human and animal lifeways are woven together in time, space, and patterns of activity): learning *through*, *from*, and *with* animals (Fig. 1). This threefold scheme represents a first attempt at systematizing how we might approach the multifarious involvements of other animals in human environmental knowledge formation. It is neither exhaustive nor are the proposed analytical categories mutually exclusive or sharply distinguished, and we will likely find that they often overlap and should thus be understood as layered rather than competing descriptions. Nonetheless, this typology allows us to analytically foreground different aspects of animal involvement in environmental learning—for instance, whether animals primarily function as observational models for humans or figure as active co-participants in joint projects. It may also serve as a flexible basis for investigating related issues, such as whether modalities of learning by coordination can be expanded to encompass more-than-human learning ecologies.<sup>40</sup>

39 Cabral and Lähdesmäki, “Multispecies Cultures and Environmental Change”; Parker et al., “Interspecies Cultures and Future Design”.

40 Charbonneau et al., “Flexible Cultural Learning”.



**Fig. 1**

Schematic representation of the three modalities of animal-mediated environmental learning.

The first modality, learning *through*, pertains to insights and inspirations gleaned from animals as cultural figures (and metaphors) rather than knowledge generated through the direct observation of, or interaction with, animals as ecological agents in specific environmental contexts. As indicated in Figure 1, learning through is thus logically set apart from the other two modalities, but it is included here both because of its broad historical and cultural relevance and as a contrastive foil for our account of learning from and with animals. Unlike the latter two, learning through de-emphasizes animals' status as affective-embodied beings with distinct worldmaking capacities in specific sets of ecological relations. It thus does not fully meet what we consider a key criterion of animal-mediated environmental learning proper: a receptive engagement with embodied and embedded forms of zooalterity. Learning through tends to be about symbolic rather than corporeal animals, who primarily function as purveyors of cultural norms or moral lessons. It has, for example, helped people make sense of their place in the cosmos, their roles, and responsibilities, but it tends to involve a high degree of cultural impositionality in relation to its animal referents, prompting a reaffirmation rather than transformation of extant cultural frameworks.

In mainstream Western thought, learning through animals has also tended to reduce the latter to interchangeable "ciphers," reproducing notions of human sovereignty over nature and animal life.<sup>41</sup> Thus, learning through does not refer to ways of attending to other animals based on the recognition of how people are *productively different* from animals, be it as a ground for cultivating and negotiating such differences or as an impetus to work toward other-than-human qualities; it instead operates through anthropocentric analogies or allegories in which animals appear as projections or mirrors of human ideals, virtues, or flaws. That is not to say, however, that all forms of learning through are necessarily detached from actual animal presences, histories, and lifeways. Coyote, an ambivalent trickster and creator figure in many North American Indigenous traditions, may be a case in point. Coyote's central cultural role may have some

41 Tyler, *Ciferae*.

historical grounding in the animal's ecological biography and status as a "consummate survivor in a shifting world," who may have drawn human attention for enduring the climatic changes and megafaunal extinctions of the late Pleistocene and — as a highly social predator — invited identification on the part of human hunters, suggesting a symbolic codification of an original responsiveness to animal alterity.<sup>42</sup>

Learning *from* other animals prioritizes engaging with animals as ecological agents and occurs when people look to animals as models for how to be active in the world, as sources of information, skills, or tools. Animals in this modality will often exemplify what kind of insights may be gained by embracing specific perspectives on a shared environment: they illustrate what can be done and known by mobilizing specific bodies and perceptive registers. Learning from animals will thus involve strategies of mimesis, simulation, impersonation, and re-enactment, and typically requires some form of transfer or translation. An interesting case of this is animal self-medication, a phenomenon observable in a diversity of species from honeybees to spider monkeys that has spawned its own area of multidisciplinary study, zoopharmacognosy or "animal knowledge of medicine".<sup>43</sup> Already in Aristotle we find reports of animals using plants to treat illness, repel parasites, neutralize poisons, or heal wounds, and both European folklore and TEK harbour a rich panoply of evidence that people have long turned to animals to gain medicinal knowledge.<sup>44</sup> Traditional tracking practices can also be seen as products of animal-mediated landscape learning, helping people navigate their environment, find specific locales and landforms (such as water holes and islands), access particular animal and vegetal resources, and generally shape landscape perception and conceptualization in significant ways.<sup>45</sup>

42 Hyde, *Trickster Makes This World*, 43; Flores, *Coyote America*, 28–29.

43 Rodriguez and Wrangham, "Zoopharmacognosy"; Huffman, "Animal Self-Medication and Ethno-Medicine."

44 Huffman, "Folklore, Animal Self-Medication, and Phytotherapy".

45 Pastoors and Lenssen-Erz, *Reading Prehistoric Human Tracks*; du Plessis, "Tracking Meat of the Sand".

However, it is the third modality—learning *with* animals—that we are particularly interested in here and wish to explore in more detail. This modality moves beyond isolated instances of observation or borrowing through transfer or translation onto sustained interactions, typically bound to modes of multispecies dwelling that foster landscape sharing and provide openings for animal neighborhoods. Learning with animals thus designates a broader set of conditions in which human action and thought in and about particular landscapes are formed within, and depend upon, human-animal co-ecologies.<sup>46</sup> Such knowledge formation is deeply embedded in patterns of co-existence and relies on a convergence of human and animal lifeways, so that the conduct of animal life can serve as a potent context to develop or inspire ways of acting and thinking in these landscapes. Learning with animals in this sense is most likely to attest to their congeniality, autonomy, and agency as they enter human practices as ecological guides and teachers. It is the most subtle and complex modality, as the sort of environmental insights proffered will emerge from how humans and other animals *come to co-inhabit* their landscapes. Such learning will rely on animal-informed rhythms, perspectives, proclivities, and sometimes materialities, but it will almost always promote some kind of eco-behavioral familiarization or attunement.

Learning with animals can be understood as a consequence of human “relevance realization” in specific human-animal systems, insofar as the agency of humans as biocultural organisms is both grounded in and responsive to those more-than-human aspects of the environment that are deemed relevant in a given context. Like other creatures, humans, too, must selectively transform “ill-defined problems into well-defined ones,” large worlds into smaller, meaningful ones that afford concrete action.<sup>47</sup> This relevance is not pre-given but relational, and so the intriguing question is which animal others inform human dwelling in which societal and environmental configurations, and in what ways. To the extent that *learning* with and *living* with other animals are deeply integrated processes,

46 See, for example, Fuentes, “Naturalcultural Encounters in Bali.”

47 Jaeger et al., “Naturalizing Relevance Realization”. 2.

individual aspects of the former may be challenging to disentangle analytically from the broader cluster of interspecies relations. We should note that we do not make a general distinction between learning with animals and their instrumental use here, although distinctions of this kind may crystallize empirically when looking at specific cases. Rather, our operative assumption is that what Donna Haraway has termed “relations of use” may often also be relations of learning, as long as people attend and adjust to animal capacities.<sup>48</sup> The key point about learning with animals is not symmetry but the co-enabling character of specific multispecies arrangements, and the kind of action spaces that specific beings and lifeways can open up for each other. This can be formulated as a question of affordances: what are the affording qualities of the ways animals use and inhabit landscapes for the people who share those landscapes with them?<sup>49</sup>

## Learning Environments with Other Animals

Early Holocene beavers in northern Europe provide a good example of such affording quality. Beavers have long been argued to have prepared and “nursed” these landscapes at the end of the Ice Age, facilitating the return of human foragers to higher European latitudes.<sup>50</sup> The available (zoo)archaeological evidence suggests that beaver niche construction and ecosystem engineering supplied foundational environmental affordances drawn upon by Mesolithic and Neolithic foraging societies (c. 10,000–4,000 years ago).<sup>51</sup> A macro-scale analysis of the pan-European north indicates that these human societies oriented their foraging behaviours toward the mammal and fish species promoted in beaver-sustained wetlands, gathered reptiles and water plants benefiting from beaver pond-building, and relied on the rich avian communities (especially waterbirds) sustained by biodiversity-fostering beaver landscapes. In northwestern and even more so in northeastern Europe, Mesolithic societies acquired

48 Haraway, *When Species Meet*, ch. 3.

49 Hussain, “Deep Animal Prehistory.”

50 Coles, *Beavers in Britain's Past*; Liarsou, “Interactions”; Hjørungdal, “Reaching Them a Human Paw”.

51 Hussain and Brusgaard, “Human–Beaver Cohabitation”.

beaver teeth and near-complete mandibles and employed them as tools.<sup>52</sup> Strikingly, these beaver-sourced tools were often minimally modified yet maintained and resharpened, undermining their interpretation as mere “ad hoc” instruments. Moreover, their modes of instrumentalization closely mirror the original role of the associated beaver body parts,<sup>53</sup> suggesting that specific “beaver functionalities” exemplifying the environmental agency of these animals were *borrowed*, albeit slightly adjusted and thereby “translated,” into the domain of human action.<sup>54</sup> All of this suggests that beavers galvanized an entire way of life for their human neighbours and helped motivate these humans to live in and interact with their environments in particular ways. While practices of selective borrowing and translation may also exemplify human learning *from* beavers, the more salient point for us is that attention to beaver others emerged from multi-millennial human-beaver wetland co-dwelling which, in turn, reconfigured human foraging strategies, mobility patterns, and material culture.

Human-bear relations promise to disclose complementary patterns of animal-mediated environmental learning. Owing to their pronounced ecological and dietary plasticity, bears have often been among the pioneer species to occupy novel environments and thus served as other-than-human model organisms, teaching humans how to inhabit, and survive in, these environments. An interesting candidate context for this is the Dorset period of the Canadian Arctic and Greenland (c. 2,500–800 years ago). Like their pre-Dorset precursors, Dorset foragers predominantly targeted subadult seals close to the edge of the sea ice, a strategy bearing striking echoes of polar bear seal-hunting behaviour.<sup>55</sup> In addition, polar bears form the most significant theme in carved zoomorphic art and visual culture, second only to human depictions. These bear renderings are overtly “representational” in that they reproduce the postures and movements most characteristic of seal-hunting

52 See Schmölcke et al., “Bears and Beavers”; Zhilin, “Beaver Mandible Tools”.

53 Zhilin, “Beaver Mandible Tools”.

54 Hussain and Brusgaard, “Human–Beaver Cohabitation”.

55 Murray, “Prehistoric Use of Ringed Seals”.

polar bears and emphasize the body features — notably heads and limbs — most important in these activities. Indeed, the proportionality of bear representations along these dimensions of “being-an-ursid-seal-hunter” correlates closely with the distributional frequencies of such behaviour among contemporary seal-hunting polar bears.<sup>56</sup> Matthew Betts and colleagues have argued that Dorset seal-hunting technology has been adapted to still-standing lurking/stalking, the same hunting habitus most frequently adopted by bears and most abundantly visualized in the art, suggesting a close alignment between Dorset hunting practice, bear hunting behaviour, and bear-centred visual culture as a medium of animal-mediated environmental learning.

The first people who came into the Canadian Arctic may have thus learned to live along the ice from polar bear others, the original inhabitants of these landscapes. To thrive there, people observed and emulated bears and translated what they learned into their lifestyle and material culture. The fact that Dorset bear representations become more frequent in the archaeological record over time supports this interpretation<sup>57</sup> as the respective bear-related knowledge was codified in material culture — a constant reminder that in order to be Dorset one needed to be, or needed to “aspire to be,” bear and act bear-like in the Arctic environment.<sup>58</sup> This idea of human-bear ecological kinship may have been further elaborated through practices of materially harnessing bear perspectives and capacities, visually evoking human-bear hybrids, and manufacturing artefacts with joint human and bear counterparts. Dorset longhouses — large communal structures — have been suggested to be architectural recreations of “bear-ness,” spatial representations of a bear’s spine and head and its axial skeleton,<sup>59</sup> an idea supported by depositions of polar bear bones from the same body parts in the axial extremities of some of these longhouses.<sup>60</sup> Dorset therefore registers a pervasive

56 Betts et al., “How Animals Create Human History”.

57 Hardenberg, *Trends and Ontology*.

58 Betts et al., “How Animals Create Human History”, 107.

59 Plumet, “Le Foyer dans l’Arctique.”

60 Damkjar, “Late Dorset Longhouses.”

“bear logic”: bear behaviours, capacities, and interpositions with humans appear to anchor much of its archaeological record, suggesting that inhabiting the landscape for Dorset people often meant matching perspectives with the bears and heeding bear-mediated knowledge.

After the glaciers had retreated at the end of the last Ice Age, beached large baleen whales such as bowheads and ice-trapped belugas were likely a key factor sustaining the earliest human excursions into the far north of southern Scandinavia, the virgin extension of the eastern North Atlantic ocean today known as the Skagerrak-Kattegat seaboard.<sup>61</sup> Among the few carnivores represented in the pioneer assemblages of northern Jutland, where the Skagerrak and Kattegat meet, are brown and polar bears, dated to a warm phase during the Late Glacial period — the Allerød interstadial (c. 13,300-12,800 years ago)<sup>62</sup> — the same timeframe the earliest forager material culture is presently attributed to.<sup>63</sup> Modern Arctic polar bears in coastal regions are known to rely periodically on stranded whales, especially during warmer stages when the sea ice shrinks and seal availability is reduced,<sup>64</sup> and it has also been suggested that bears might have been key to the early navigation of the unfamiliar landscapes of northern Jutland. Together with the seabirds rapidly aggregating at whale carcasses, bears acted as beacons, drawing human attention to stranding sites, occasionally excavating frozen whales, and locating and preying on smaller whales such as belugas trapped by the ice, thereby making otherwise hard-to-detect resources environmentally salient for human foragers.<sup>65</sup> Consequently, in the context of early human dispersal into such landscapes, bears might have helped orient human behaviours by pointing to relevant resources, locales, and ecosystem dynamics, with bear agency becoming an exemplar for human action and cognition. Emerging biomolecular

61 Hussain et al., “Late Glacial Human Occupation”.

62 Aaris-Sørensen, *Diversity and Dynamics*, 18.

63 Hussain et al., “Late Glacial Human Occupation”.

64 Laidre et al., “Large Whales as Food for Polar Bears”.

65 Hussain, “The Heath and the Sea”; Heide-Jørgensen et al., “Three Recent Ice Entrapments” for recent analogues of beluga sea-ice trappings.

evidence from recovered stone tools supports this general scenario, notably pointing to human-bear convergences vis-à-vis beluga whale exploitation.<sup>66</sup>

When co-inhabiting landscapes with people, bears have frequently been among the “cultural keystone species”<sup>67</sup> of Indigenous societies around the world, yet they often remain relatively invisible in their material and visual cultures. This may offer an important reminder for investigating the role of animals in human learning. When people learn the specificities of their environments with animals, the latter are the embodied referents of such learning, and the relationship is observational, lived, and direct—the target is the empirical other as a sentient being. Yet human-bear relations negotiated through material and visual practices may involve representations of bears as a *substitute* for such lived engagements, and, as such, may flag culturally derived interstices decoupled from lived experience or at least indicate *post hoc* integration of ecological knowledge into broader worldviews and normative registers, shifting animal-mediated learning from immediate co-presence to a more detached, symbolic and abstract register. This inherent tension, in turn, may indeed help explain why bears rarely show up as depicted animals in the archaeological record and why engagement with bear materiality and visibility often increases with more advanced regional settlement histories.<sup>68</sup>

Eurocentric perspectives on the deep-time processes of dog domestication similarly tend to overlook significant opportunities for mutual learning and co-adaptation that undergirded incipient human-wolf relationships.<sup>69</sup> The oral history and cultural memory of North American peoples from the Great Plains and Intermountain

66 Blood serum analysis of a sample of stone tools from the Hollendskær area of northern Jutland has yielded preliminary evidence of 1–2 residual blood signatures of beluga whales (unpublished data).

67 Clark et al., “Grizzly and Polar Bears”.

68 This is reflected not only in the Dorset case but also in the Mesolithic-Neolithic-Bronze Age sequence of hunter-gatherer-fisher societies of the East European plain forest zone. See Kashina and Khramtsova, “In the Company of Bears.”

69 Fogg et al., “Indigenous American Peoples and Wolves”.

West suggest that the human-initiation model of Pleistocene dog domestication (in both of its variants, the “scavenger hypothesis” and the “cross-species adoption hypothesis”<sup>70</sup>) requires critical re-evaluation, as wolves are conceptualized as potent guides and key nonhumans who taught humans how to navigate and sustain themselves in their environments. Lupines conspicuously feature as “tutors” and “instructors” from whom people learned how to hunt when they first arrived in North America.<sup>71</sup> Indigenous accounts not only suggest that people observed wolves and then adopted some of their hunting techniques, such as driving prey off cliffs, into ravines, or into deep snow,<sup>72</sup> they also point to important behavioural complementarities between the two species that would have encouraged interspecies synchronization and perhaps even cooperation: wolves have the ability to more easily stalk, pursue, corner, and exhaust large prey animals such as elk, bison, or mastodon yet often face difficulties killing them, while the human foragers tool-assisted lifestyle likely made them more suited to this task.<sup>73</sup> Even “optimal foraging” accounts must consider interspecies cooperation under such conditions: “humans would have avoided costly pursuits and wolves would have avoided injuries sustained while killing dangerous prey”.<sup>74</sup>

The large-scale funnelling landscapes with “bison drive architecture” Indigenous North Americans began to devise and maintain from at least 13,000 years ago onward<sup>75</sup> — and the distinct affordances for social organization that came with them — may have thus been inspired by wolf-derived knowledge. Practices of sharing meat with wolves that have persisted to this day also support an original context of collaborative hunting.<sup>76</sup> Carcass sharing and defence are indeed an important yet often neglected means of negotiating and

70 Serpell, “Commensalism or Cross-Species Adoption?”

71 Fogg et al., “Indigenous American Peoples and Wolves”; Pierotti and Fogg, *The First Domestication*.

72 Barsh and Marlor, “Driving Bison and Blackfoot Science.”

73 Cram et al., “Ecology and Evolution”; Shipman, *The Invaders*.

74 Cram et al., “Ecology and Evolution”, 845.

75 Speth, “13,000 Years of Communal Bison Hunting”.

76 Pierotti and Fogg, *The First Domestication*.

reinforcing interspecies bonds<sup>77</sup> — and, following Kimmerer, these practices were likely integral to a broader “economy of gifts and abundance” in which sharing, respect, gratitude, and reciprocity extended into the nonhuman realm.<sup>78</sup> Indigenous human-bison relationships may have also been a product of wolf attunement and wolf-oriented landscape learning, emerging from efforts to coordinate and broker human and wolf neighbourhoods. As Barsh and Marlor note, “[Blackfoot could have adopted] a deductive, ‘scientific’ approach. Or they could have observed wolves, recognized the usefulness of wolves’ knowledge, and then imitated wolves’ behavior to insert themselves into the existing bison–wolf relationship without significantly changing it. Blackfoot today report that they followed this ‘empathetic’ approach. Instead of collecting data on bison, Blackfoot performed wolves.”<sup>79</sup>

Irrespective of whether people and bison were initially drawn together by wolf agency (and answers may differ across contexts), sustained cohabitation with bison populations opened up another set of distinct learning opportunities. There is significant geographic and temporal overlap between the presence of bison, the extent of a prairie-woodland mosaic, and anthropogenic fire practices throughout the Holocene in northeastern North America. The area also broadly overlaps with the region in which early evidence for plant management and cultivation has been recorded, including the so-called Eastern Agricultural Complex of the mid-Holocene. By considering bison ecology and ecological engineering and conducting controlled field experiments in the Joseph H. Williams Tallgrass Prairie Preserve, which is grazed by around 2,500 bison, Natalie Mueller and colleagues have demonstrated that bison agency, promoted by regular low-level burning, creates distinctive pockets of early-succession vegetation (often in edge habitats, adjacent to bison trails, or in bison wallows) and that such pockets uniquely support progenitor crop species and other edible plants, including species such as little barley, mayflower, and sumpweed. Moreover, dense clusters

77 Nadasdy, “The Gift in the Animal.”

78 Kimmerer, *The Serviceberry*, 78, 105.

79 Barsh and Marlor, “Driving Bison and Blackfoot Science”, 585.

of crop progenitors in these experimental settings assumed “the appearance of fields”.<sup>80</sup> As people traversed bison landscapes following bison tracks, living with and being attentive to bison others would thus have provided a compelling context for learning to manipulate and manage plants for human sustenance and quite literally *modelled* field-tending dynamics. Bison affordances may hence point to a hitherto neglected context of discovery and impetus for innovation regarding the emergence of human agro-ecologies, offering an alternative perspective on the early development of “agricultural” practices and challenging classic “Neolithic revolution” narratives with their Euro- and anthropocentric legacies.<sup>81</sup>

This also discloses a broader perspective on some of the relevant learning contexts contributing to the portfolio of human interventions with the world of plants. The majority of the wild ancestors of the small-seeded species of herbaceous annuals cultivated in the mid-Holocene (such as millet, quinoa, and buckwheat) were facilitated by the activities of grazing megafauna, who dispersed and promoted them in the landscape in a way that humans could easily emulate, eventually assuming megafaunal functions like seed dispersal. In doing so, humans initiated a trajectory of human-plant co-evolution which in many cases would lead to plant cultivation.<sup>82</sup> Based on a review of ethnographic data on pastoralist socioecological systems in the Americas, Lezama-Núñez et al. trace how “Old World” herbivore introductions in the fifteenth to sixteenth centuries engendered entirely “novel uses of the local flora” and associated human lifeways, in some cases encouraging previously unrecorded plant management practices and human selection of plant phenotypes.<sup>83</sup> Navajo livestock corrals, for example — the core of Navajo livelihoods since the nineteenth century — have promoted unique pioneer vegetation through sheep, cattle, and horse grazing, strongly overlapping with a sizable range of traditional Navajo food plants such as beeweed, knotweed, and mustards. The integration

80 Mueller et al., “Bison, Anthropogenic Fire, and the Origins of Agriculture,” 154.

81 Swanson et al., *Domestication Gone Wild*.

82 Spengler and Mueller, “Grazing Animals Drove Domestication of Grain Crops.”

83 Lezama-Núñez et al., “Herding Ecologies”.

of these plants into human lifeways, in this case, is neither strictly human- nor animal-initiated but instead emerges from shared multispecies life. The same plant-animal-human relationships are codified in Navajo cosmovisions, in which sheep figure as “carriers” and “consignors” of valuable plants.<sup>84</sup>

In a related historical and geographical context, the reshaping of Indigenous life in the North American grasslands through human-horse entanglements in the eighteenth century can then be understood in part as the product of a novel equine-mediated affordance landscape, the transformation of the Great Plains into a dynamic space of unprecedented mobility accessed and maintained through the capabilities of equine bodies. Horse metabolisms made the generous amounts of photosynthetic energy stored in the grasslands available for human use, yet they also changed “the meanings of the land — what people saw when they looked at the country and imagined its future”.<sup>85</sup> The potential that came with rearranging human modalities of existence around equines was recognized both by long-standing inhabitants of the grasslands, such as the Blackfoot, and by latecomers like the Comanche and Cheyenne. Historians have pointed to the enormous sociocultural, ecological, and political consequences of the widespread transition to equestrian nomadism.<sup>86</sup> The central role of horses not only required (as noted by John C. Ewers) the “learning of new motor habits” and “specialized manual skills”<sup>87</sup> such as hobbling, picketing, or corralling, it also meant that the equines themselves functioned as conduits of new forms of environmental knowledge that provided the basis for the human-horse entanglements that came to dominate life on the Plains in the eighteenth and nineteenth centuries. The bison economy had drawn Native peoples onto the prairies, and an understanding of bison behaviour depended in part on an understanding of the grasslands’

84 Kuznar, “Ecological Mutualism in Navajo Corrals”; see also Weisinger, *Dreaming of Sheep*.

85 West, *The Contested Plains*, 54.

86 West, *The Contested Plains*; Ewers, *The Horse in Blackfoot Indian Culture*; Roe, *The Indian and the Horse*; Hämäläinen, “Plains Indian Horse Cultures”; Mitchell, *Horse Nations*, chaps. 4–6; Bethke, “Revisiting the Horse in Blackfoot Culture.”

87 Ewers, *The Horse in Blackfoot Indian Culture*, 301.

defining environmental feature: the grass itself. Yet it was arguably only when Plains equestrians developed from mounted bison hunters into bison-hunting horse pastoralists, who inhabited the grasslands year-round with often sizeable herds of equines, that they came to view and manage these prairie landscapes as a complex mosaic of grazing areas and water sources in a way that reflected a distinctly equine-mediated and equine-centred “relearning” of the grasslands *as* grasslands in a more comprehensive sense than (was necessary) before. In this process, the horse gradually emerged as a kind of nonhuman benchmark and model system for inhabiting and acting in the Plains environment.

Consequently, the idea of Plains Indian “horse cultures” needs to be conceptualized beyond the mere use of horses as tools of mobility and warfare or markers of social status and economic wealth. It also encompassed essential learning and decision-making processes that emerged from the observation of, and interaction with, horses as embodied ecological agents. To a significant extent, learning with horses consisted of the adaptation of traditional ethnobotanical knowledge as knowledge of grassland topography and ecology was modified to account for equine foraging patterns and grazing preferences and the distribution, accessibility, quality, and seasonal cycles of prairie grasses—from the bluestem grasses abundant in the tallgrass prairie and mixed-grass ecotone to the grama and buffalograss of the drier shortgrass prairie—some of which grew in distinct plant communities.<sup>88</sup> Attending to how horses maintained weight or declined on particular pastures, how quickly grazed areas recovered, and where animals chose (or refused) to graze might have offered indications of soil and forage quality not legible to human observers alone. This may be understood in terms of specific “somatic modes of attention,” in which human bodily awareness was trained on equine bodies and movements as vehicles of environmental information.<sup>89</sup>

88 Savage, *Prairie*; Sherow, *Grasslands of the United States*.

89 Csordas, “Somatic Modes of Attention.”

Paying attention to the meanings of equine movement across the landscape and developing an eye for subtle differences in vegetation that perhaps went unnoticed during what Ewers called the “Pedestrian Culture Period” were interconnected dimensions of environmental learning that became increasingly important with the rise of horse pastoralism. Horses did thus not simply extend human reach: their bodily responses to grassland environments became a medium through which people could refine and recalibrate their understandings of the grasslands as a differentiated ecological field, bringing into view a mode of learning fostered through human–equid coupling.

Plains Indians also learned to accommodate the specifics of equine grazing behaviour and “horse perspectives” into their patterns of nomadic mobility and land use. Being selective grazers, horses tended to move on to other grazing areas rather than resort to grasses of inferior quality (from their point of view) once the desirable grass in an area had been depleted, and Plains people quickly learned that grazing horses wandering out of sight of the camp were a clear indicator of the need to relocate. Securing nutritious winter pasturage was a significant issue that was addressed by splitting up into smaller bands and spending the cold season in riverine or riparian micro-environments where stretches of grass continued to be available and horses could be fed with cottonwood bark when grass became scarce.<sup>90</sup> Piegan Blackfoot elders interviewed by Ewers in the 1940s informed him that their preference for wintering along Montana’s Marias River came to be because they observed that it contained a variety of grasses liked by their horses.<sup>91</sup> In Rockman’s terms, both “locational” and “limitational” environmental knowledge among horse pastoralists spoke to, and helped sustain, the reality of deepening human-horse entanglements that defined Plains horse pastoralism and the concomitant interplay of human and horse (or human-horse) agency and vulnerability within a specific set of socioecological parameters.<sup>92</sup>

90 Ewers, *The Horse in Blackfoot Indian Culture*, 40–44; West, *The Way to the West*, chap. 1; Sherow, “Workings of the Geodialectic”; Moore, *The Cheyenne Nation*, chap. 5; Osborn, “Ecological Aspects of Equestrian Adaptations”.

91 LaPier, *Invisible Reality*, 58–59.

92 Rockman, “Knowledge and Learning”.

At this point, we should caution against reading an implicit normativity into both the general idea of learning with other animals and the examples given here, in the sense that this modality of environmental learning might seem to offer a prescriptive “model” for an ethics of multispecies conviviality, speaking to broader attempts at overcoming entrenched regimes of destructive anthropocentric exploitation. It is important, therefore, to be wary of an “Anthropocene presentism” that frames how we look at (all) animal-mediated environmental learning—as a blanket alternative to anthropocentric power dynamics, as an inherently emancipatory process, or as an unambiguous ecological or ethical good. In principle, environmental learning—or its downstream effects and implication in broader processes of social and ecological transformation—can support both convivial and coercive configurations of life as well as a vast space of ambiguity in between. Plains horse cultures might themselves serve as an example for this, since the new forms of mobility and subsistence (and resistance) enabled by equestrianism and rapidly growing horse herds not only contributed to the ecological decline of the grasslands but also led to increased warfare and social stratification through concentrations of equine wealth among a small circle of male elites.<sup>93</sup>

The histories of settler colonialism might similarly bring into view a darker side of the phenomenon: cases in which animal-mediated environmental learning was directly entangled with, or even actively employed for, projects of domination. If we understand settler colonialism as a multispecies phenomenon that saw European settlers mobilize (with varying degrees of purposeful directedness) the biological capacities, behavioural specificities, and ecological impacts of the organisms they brought with them, and surrounded themselves with, then settler environmental learning can be investigated as the historically situated ways in which settlers came to observe, interpret, and strategically recalibrate these dynamics in order to remake landscapes in their own image. In this context, European domesticates have been variously discussed as creatures or proxies

93 See Hämäläinen, “Plains Indian Horse Cultures”.

of empire or as “shock troops” of expanding settler collectives, with cattle and sheep having assumed important roles as colonial landscape and ecosystem engineers who helped create conditions of habitability that fit settler socioeconomic and cultural needs.<sup>94</sup> We might ask to what extent such roles emerged automatically from the mere presence of these animals, and to what extent they were instead shaped by self-consciously articulated settler understandings. As Norbert Finzsch has argued in the Australian context, instead of fostering ecological resilience, environmental learning may well be a driving force behind ecocidal processes, not least if contested modalities of land use and inhabitation are accompanied by highly asymmetrical power relations. Finzsch underscores that at least some Australian settlers were not only quite aware of the socioecological intricacies that shaped Australian landscapes, native fauna, and Aboriginal people—specifically the interdependencies between traditional fire management, open grasslands, kangaroo populations, and Aboriginal livelihoods—they also saw how their own land use practices—specifically the introduction of cattle and the concomitant expansion of grazing—advanced what the settler populace conveniently understood as an inevitable “extinction” of Indigenous life in the face of European “civilization”.<sup>95</sup> While a more detailed discussion of this issue is beyond the scope of this article, it is thus worth investigating how far such ecological outcomes can be traced to identifiable instances of environmental learning through which settlers selectively incorporated and repurposed knowledge about local ecologies in ways that furthered colonial projects.

## Conclusion

The problem of knowledge has been increasingly pluralized, as a multiplicity of “ways of knowing” are now being recognized as crucial to the operation of both society and science<sup>96</sup> and as alternative

94 Anderson, *Creatures of Empire*; Dale, “Empire’s Proxy”; Milton, “The Transvaal Beef Frontier,” 200; Ohrem, “Human-Animal Relations and the Ontopolitics of Civilization.”

95 Finzsch, “The Intrusion Therefore of Cattle”. On kangaroos in Aboriginal and settler contexts, see Gelder and Weaver, *Colonial Kangaroo Hunt*; Telfer and Garde, “Rock Kangaroo Ecology”.

96 Kellert et al., *Scientific Pluralism*; Cat, “Essay Review”.

cognitive and practical resources for tackling a planetary polycrisis intricately interwoven in its historical genesis with dominant (and destructive) epistemologies and forms of knowledge.<sup>97</sup> Knowledge production has been disaggregated and shown to be more messy, multifarious, and distributed than traditional accounts have been willing to admit, with significant implications not only for what knowledge *is* but also for where it resides and what agencies take part in its creation and propagation. The plurivocality of human knowing is increasingly viewed as a value in itself, and there is growing recognition that coming to know the world in human terms is also a matter of justice, insofar as different forms of human life articulate and depend on different forms of knowing. Knowledge shapes and is shaped by human actions, needs, and imaginative horizons, and is thus a fundamental legacy of the attempts of human societies to make themselves at home in environments shared with diverse non-humans. This diversity of human knowing is an integral part of our species-level heritage. But as we have argued in this article, making adequate sense of this heritage benefits from, and indeed often requires, a multispecies perspective.

Human knowledge gestures beyond the human and therefore requires attention to the ways in which it is *historically* configured in, and through, specific more-than-human entanglements. This includes a consideration of nonhuman model organisms who may provide short cuts to relevant elements of know-that and know-how especially in scenarios of elevated environmental novelty exposure (whether produced by environmental change or human agency). We hope that the examples we have sketched here underscore that specific nonhuman modalities of life within broader multispecies assemblages can disclose potent learning contexts for human communities that address specific human needs and tie in with specific human practices and lifeways, commonly organized (for lack of better concepts) around broad categories such as terrestrial foragers, marine collectors, pastoralists, horticulturalists, farmers, and so forth. From human–honeyguide collaboration in

97 Frank et al., *The Blind Spot*.

African savannas via Arctic seal hunters attuning their practices and built environments to polar bear ways of being to the equine-mediated “relearning” of the North American grasslands—the key point we have tried to convey here is that the historical and archaeological records hold alternative interpretations and neglected perspectives on how humans have come to know, differentiate, and rework environments through sustained engagements with other animals’ bodies, behaviors, and ecological relationships. Taken together, the examples of animal-mediated environmental learning discussed here thus point to a “didactic opening to animal alterity” as a consequential force in human history and a central characteristic of human worldmaking.<sup>98</sup>

Paying attention to how nonhuman beings have co-configured processes of human environmental learning helps dismantle “species island” models of behaviour and cognition and may provide additional grounding for perspectives on multispecies societies or (co-) cultures.<sup>99</sup> Horizontal interspecies learning dynamics may indeed offer a mechanism for more-than-human history broadly comparable to the principle of horizontal gene transfer in evolutionary biology, and we argue that its transformative potential may be no less significant.<sup>100</sup> In this regard, it can be useful to think of such interspecies learning as a form of situated modelling in which the physical, behavioural, and cognitive features of an organism’s *Umwelt* are sieved and represented in terms of their relevance and affording qualities for the organism in question, with key animal others emerging as model systems for habituation.<sup>101</sup> As “inferential blueprints,”<sup>102</sup> models of the situated environment allow organisms to learn this environment without cognitive overload, yet who or what counts as a (key) agent within these models remains an open question that demands historical specificity.

98 Marchesini, “Theriosphere”, 119.

99 Cabral and Lähdesmäki, “Multispecies Cultures and Environmental Change”; Andrews et al., “Multi-Species Societies”; Sueur and Huffman, “Co-Cultures”.

100 Soucy et al., “Horizontal Gene Transfer”.

101 Jaeger et al., “Naturalizing Relevance Realization”; Kockelman, “Biosemiosis, Technocognition, and Sociogenesis”.

102 Massmi, *Perspectival Realism*.

We suggest that a focus on animal-mediated environmental learning allows for a fruitful broadening of current learning theory by attending to “heterospecific” or “hybrid” communities of learners.<sup>103</sup> To make some initial sense of the diversity of animal-mediated learning dynamics, we have proposed a heuristic distinction between three kinds of environmental learning: learning *through*, learning *from*, and learning *with* animals. Most of our examples have dealt with the latter category, as this form of embedded learning by means of extended co-existence is arguably most easily overlooked when standard learning categories—including those from cultural evolutionary learning theory<sup>104</sup>—are employed to study interspecies dynamics. We have identified learning with animals as the most complex modality of animal-mediated learning: it is expected to be less concretized (for example, through isolated focal animal-mimicking practices or specific material artefacts) and will often revolve around animal-oriented action coordination and broader convergences of human and animal life. Importantly, the three modalities proposed here are not intended to be ontologically discrete or even mutually exclusive kinds of animal-mediated learning but rather analytical lenses that allow us to foreground different aspects of more-than-human learning ecologies. Concrete historical situations will often involve more than one modality, and different modalities will assume different degrees of salience or centrality. Which configurations matter in any given case will have to be established empirically on a case-by-case basis, and it will also depend on the kinds of questions asked and scales of analysis adopted.

Grappling with these issues of human environmental learning holds much contemporary relevance—after all, the Anthropocene predicament, according to many, involves our “alienation” from nature, and our inability to learn *with* nature instead of against it. “An important aspect of our current dilemma,” notes anthropologist Emilio Moran, “is the grasping under what conditions human populations learn and

103 Marchesini, “Theriosphere”, 117; Lestel, “Hybrid Communities”.

104 Shennan, *Genes, Memes and Human History*; Eerkens and Lipo, “Cultural Transmission Theory”.

adapt to their environment.”<sup>105</sup> One response to the diagnosis of the escalating polycrisis has been a clarion call for turning to the ecological sensibilities encoded in Indigenous knowledges in a way that has sometimes veered toward a (mis)appropriation or overburdening of such non-Western knowledge systems.<sup>106</sup> There has been a solutionist tendency to cut off TEK and other forms of environmental knowledge from their matrices of practice and lived ecologies, effectively reducing them to decontextualized means of “problem solving”. This not only reproduces the problematic assumption of modern technoscience that all proper knowledge is instrumental, it also clouds the view of how different environmental knowledges are *formed* and *enacted*, and what their historical efficacy is— what kinds of action and insight they enable, how they support certain ways of being in the world and not others. Part of the same problem is an undifferentiated celebration of Indigenous knowledge as the new model system for “ecological stewardship” and the tendency to attest all “pre-modern” societies rich and intimate ecological knowledge. In line with the well-worn trope of the “ecological Indian,”<sup>107</sup> Indigenous peoples, it is often presumed, simply know almost everything about their environment, even if they do not explicate this deep ecological knowledge or articulate it only in “cryptic” or other-than-scientific terms. Hasty ascriptions of comprehensive Indigenous knowledge tend to distract from the specific sources, logics, and methods that different people(s) have relied on to learn and make sense of their environments. What is needed instead are historically and ethnographically specific accounts of how such knowledges are learned, maintained, and transformed within their own sociopolitical and multispecies ecologies, and which nonhuman others are drawn into such ecologies for what reasons.

As a final point, we wish to note that even though this article has primarily sought to advance historical and archaeological perspectives, it is attentive to the multispecies negotiations that have become increasingly urgent in our present moment of accelerating extinctions

105 Moran, *People and Nature*, 122.

106 See Nadasdy, “Politics of TEK.”

107 Nadasdy, “Transcending the Debate”.

and ecological destruction, as communities of various backgrounds and positionalities find their lives and livelihoods intersect with those of nonhuman others. For example, “rewilding” — one of the many contemporary attempts to restore some of the basic functioning of degraded ecosystems — has been conceptualized through the lens of “human-wildlife conflict,” as so-called “dangerous” animals are reintroduced into landscapes that have been human-dominated for centuries or more.<sup>108</sup> Rather than reducing these animals to their potential for conflict and focusing on (preventing) negative interactions, however, we should realize that such endeavours also offer underestimated opportunities for interspecies learning and that whether we frame them in terms of conflict or conviviality is likely to influence the space of possibilities for living with each other we are able to imagine and the forms of multispecies solidarity we are willing to pursue.<sup>109</sup> *Learning to live with other animals*, then, poses a principal challenge wrought not only by a planet characterized by fundamental ecosystem novelty<sup>110</sup> but also by new imaginings of how we want to share the planet with other life, a concern reflected in recent debates around “convivial conservation” and the hope to create “long-lasting, engaging and open-ended relationships with nonhumans and ecologies”.<sup>111</sup> Yet learning to live with other animals requires a break with entrenched notions of human sovereignty in which even nonessential human interests often trump the most basic existential needs of other creatures. It requires us to move beyond anthropocentric notions of coexistence<sup>112</sup> and to grant nonhuman creatures behavioral plasticity – the capacity, that is, to learn to live with other animals.<sup>113</sup>

108 Glentworth et al., “Place for People in Rewilding.”

109 van Dooren, “Military Snails”.

110 Kerr et al., “Widespread Ecological Novelty”.

111 Büscher and Fletcher, “Towards Convivial Conservation”.

112 Pooley et al., “Human–Wildlife Coexistence”.

113 For contemporary examples using alternative templates of human-wildlife coexistence, see Panggur et al., “Living in Harmony with Dragons”; Nair et al., “Sharing Spaces”.

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