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ORIGINAL ARTICLE

Anishnaabe Aki: an indigenous perspective on the global threat of invasive species

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Abstract

Conservation discourses tend to portray invasive species as biological entities temporally connected to colonial timelines, using terms such as "alien", "colonizing", "colonial", and "native". This focus on a colonial timeline emerges from scientific publications within conservation biology and invasion ecology and is enacted through invasive species management by state and NGO actors. Colonialism is influential for indigenous nations in myriad ways, but in what ways do indigenous understandings of invasive species engage with colonialism? We conducted ethnographic research with indigenous Anishnaabe communities to learn about the ways Anishnaabe people conceptualize invasive species as a phenomenon in the world and were gifted with three primary insights. First, Anishnaabe regard plants, like all beings, as persons that assemble into nations more so than "species". The arrival of new plant nations is viewed by some Anishnaabe as a natural form of migration. The second insight highlights the importance of actively discovering the purpose of new species, sometimes with the assistance of animal teachers. Lastly, while Anishnaabe describe invasive species as phenomenologically entangled with colonialism, the multiple ways Anishnaabe people think about invasive species provide alternatives to native–non-native binaries that dominate much of the scientific discourse.

Keywords Indigenous knowledge · Traditional ecological knowledge · Invasive species · Global change · Sustainability

Introduction

For decades, the role of invasive species has been central to discussions of anthropogenic environmental impacts (Vitousek et al. 1996). Research in the biological sciences shows a strong correlation between animal extinctions and invasive species (Clavero and García-Berthou 2005), with climate change projected to accelerate these rates (Thomas et al. 2004). Biotic exchange, i.e., "deliberate or accidental introduction of plants and animals to an ecosystem", is now considered a leading cause of global biodiversity loss (Sala et al. 2000). Mitigating the impacts of invasive species is a key sustainability challenge around the world (Paini et al. 2016; Simberloff et al. 2010; Butchart et al. 2010).

Invasive species research and management strategies are centrally concerned with environmental change related to the introduction of plant and animal life, including the displacement and loss of species considered native to a habitat or region. Attention to invasive species issues given by researchers, conservation organizations and land managers is wide, including work focused on protecting biodiversity (Gurevitch and Padilla 2004), protecting broader ecological functioning at broad spatial scales (Mack and D'Antonio 1998; Kenis et al 2009), and minimizing impacts to society including economic and other indicators of well being (Holmes et al. 2009; Pejchar and Mooney 2009). For mainstream conservation scientists and managers engaged in this work, new species are classified as alien or exotic based upon an association with humans, and this association often enables invasive patterns of mobility (e.g., aquatic plants and animals hitchhiking in ballast of cargo ships) and settlement (e.g., aquatic or wetland plant establishment being bolstered by land use-driven nutrient enrichment). Not all introduced species become invaders, only those plants or animals that

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spread rapidly on their own, and in some cases native species can become invaders too, e.g., the expansion of Victorian box (*Pittosporum undulatum*) in eastern Australia (Leishman and Thomson 2005). Moreover, and particularly significant in the context of US Native American communities, the term "native" species is temporally associated with colonial timelines (Davis 2009). Conceptual debates over whether native and invasive species are an appropriate lens for understanding dynamic ecosystems have significantly challenged traditional approaches to conservation (Davis et al. 2011). These debates, as well as the increasing significance of indigenous knowledge about sustainability science, has led us, like others (e.g., Robinson et al. 2005; Trigger 2008) to explore alternative frameworks to the predominant view linking invasive species to colonial timelines. In this paper, we ask if indigenous knowledge, such as knowledge held and enacted by Anishnaabe communities, offers an alternative framework for stewarding the Earth in a time of rapid anthropogenic change.

Methods

We conducted fieldwork with Anishnaabe tradition bearers in Michigan, USA to identify Anishnaabe understandings and generate new insights concerning this overarching research question. Our results suggest an alternative conceptual framework for understanding the processes of environmental change related to plant species introductions. Lead author Nicholas Reo is a member of one of these communities and has established research partnerships with Anishnaabe natural and cultural resource agencies, who are supporting this project. Building on a decade of Reo's research in the region, research for this project entailed two components. First, we conducted open-ended ethnographic interviews with 22 tradition bearers in the communities, in addition to 2 years of informal conversations and ethnographic research (Fig. 1a). Reo and three local Anishnaabe research assistants conducted the interviews, while Ogden helped to develop the research approach and analyze the data. We began our interviews broadly, asking questions about environmental change in the region, followed by questions specifically about changes related to non-native plant species. Interviews lasted from 1 to 3 h, were guided by a standard open-ended survey instrument, and were recorded. Tradition bearers were identified as community members respected for their knowledge of Anishnaabe custom and protocol, knowledge of plants and animals, and history of the area. Most tradition bearers were elders in the community, though we also interviewed younger community members involved in natural resource management and subsistence activities. We have followed community practice and used the term "traditional doctors" to describe traditional medicine practitioners and "plant helpers" to describe specialists who assist traditional doctors. Both groups are particularly knowledgeable about the medicinal and nutritional gifts of plants.

Second, we held a 3-day gathering where Anishnaabe tradition bearers shared their knowledge about the native broadleaf cattail (*Typha latifolia*) with local youth and natural resource managers (Fig. 1b). Community elders showed us how to gather and prepare cattails as food and for household uses such as mats and toys. Importantly, the gathering followed Anishnaabe cultural norms and protocols, including beginning and ending the experience with specific ceremonies.

Results

The homelands of the Sault Ste Marie Tribe of Chippewa Indians and Bay Mills Indian Community (Fig. 2) are at the cusp of significant environmental change following the introduction of two aquatic plant species, common reed (*Phragmites australis*) and hybrid cattail (*Typha x glauca*). These two plants can cause multifaceted, threshold-breaching ecosystem changes that push Great Lakes coastal wetlands into undesirable, alternative stable states (Tuchman et al. 2009; Lishawa et al. 2014). These dramatic ecosystem changes are part of a pattern found with other introduced species in the region (Walsh et al. 2016) and globally (Franklin et al. 2016). The arrival of these plants motivated our research project, in part, but our research with tradition bearers extended beyond specific species to discuss environmental change more broadly.

Like all communities, citizens of the Sault Ste Marie and Bay Mills tribes hold diverse values, opinions, and perspectives about the world, including environmental change. Within these two communities alone, there exist wide ranging perspectives and actions concerning environmental change and introduced species. Some Anishnaabe individuals and tribal governmental programs see introduced species as a significant threat and are combating them using multiple approaches and technologies, including occasional use of herbicides and pesticides. Staff from the natural resource departments within these two tribes view Western science and indigenous knowledge as complimentary sources for addressing environmental change issues. The Sault Ste Marie and Bay Mills tribes are actively experimenting with different responses to the introduced species that rely on both indigenous and Western scientific knowledge systems.

Yet, there are important and distinct ways of understanding what it means to be Anishnaabe that shape communal values and factor into their perspectives and responses to environmental change, even as community members negotiate diverse ways of living and being in the world. The concept of aki is foundational to Anishnaabe land ethics

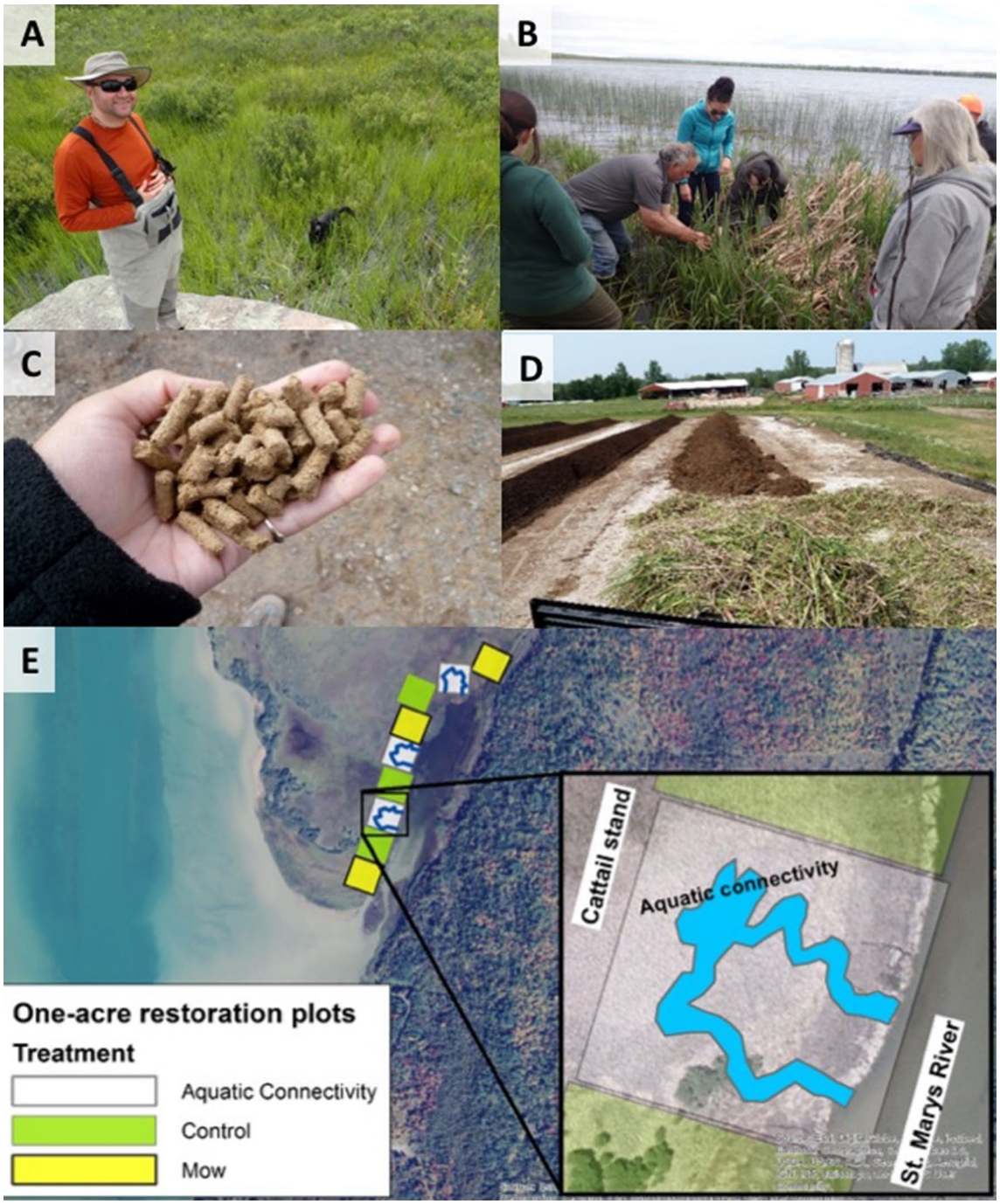

Fig. 1 **a** Photograph from a cattail gathering where knowledge holders from the Bay Mills Indian Community taught Anishnaabe and non-Anishnaabe community members about the many uses of cattails. The workshop was also intended to help sort out possible uses of "invasive" species of cattail that are new to the upper Great Lakes region; **b** Ethnographic work included many conversations indoors as well as out in Great Lakes coastal marshes; **c** collaborators from Loyola University of Chicago and the Bay Mills Community College experiment with pelletization of hybrid cattail (*Typha x glauca*) as a possible energy resource; **d** collaborators from Loyola University of Chicago work with local farmers to test the nutrient values of composted hybrid cattail; **e** schematic of an experimental design simulating open water habitat and connectivity corridors in hybrid cattail-invaded marshes, similar to those created by muskrat (*Ondatra zibethicus*). For Anishnaabe, the agency of plants and animals, as persons, relatives, nations and teachers, are all central to how they make sense of introduced species, and these conceptualizations are influencing the direction of our collaborative research

Fig. 2 Map showing location of two indigenous nations who participated in this study. Dot symbols indicate the location of tribal government offices, however, each of the tribes holds customary rights over a much larger area, over 13 million acres

and land tenure systems. Typically translated as "Earth" in English, the meaning of aki encompasses a broader cosmological sense of the sacredness of place (Cornell 1990). Our use of aki in this paper's title acknowledges the Anishnaabe teachings, which hold land as sacred and as the embodiment of Creation, as are all the living beings such as plants and animals, as well as water, stones, and supernaturals that many non-Anishnaabe do not recognize as lifeforms. Many of these basic Anishnaabe teachings concerning aki align with beliefs and teachings of many other indigenous cultures around the globe including the Rarámuri peoples of Mexico (Salmon 2000) and Yupik of western Alaska (Fienup-Riordan 1995). From this foundational and relational concept, Anishnaabe teachings instruct that all living beings have gifts that they share with the rest of Creation, and accepting these gifts (e.g., gaining nourishment from the gifts of the cattails) sets in motion responsibilities to the land and systems of reciprocity (Kimmerer 2013). While Anishnaabe people we spoke with expressed diverse ideas and perspectives about environmental change and introduced species, the ethical implications of aki shaped all our conversations.

Our research revealed three important findings, as we describe below, that provide alternative perspectives about invasive species. First, Anishnaabe teachings begin by recognizing all plants and animals as persons who assemble in "nations" as compared to the Western scientific notion of species. Instead of problematizing "invasive species", Anishnaabe teachings portray the arrival of new plants or animals as natural processes resulting from migrations by other-than-human nations. Second, according to Anishnaabe teachings, it is the responsibility of humans to determine the reason

why new plants or animals have arrived in their territories, and actively determine the nature of novel human–animal or human–plant relationships. Third, our Anishnaabe collaborators reframed problems of environmental change as related to the introduction of a Euro-American land ethic. Our interviews revealed specific linkages to European settlement, but not to simple timelines associated with post-contact biotic loss and change. Instead, according to Anishnaabe teachings, culpability lies in "invasive" ideologies rather than the fault of specific animals or plants.

Migrating nations

Within Anishnaabe teachings, plants and animals are more than species; they are regarded as persons. As examples, trees are "the standing people" and one Anishnaabe word for maple trees is anenemik or "the man tree" (Kimmerer 2013). Not only are plants and animals people, but they are kin, or part of Anishnaabe extended family (see Kimmerer 2013; Johnston 1976). As an example, Migiizi (eagle) is Anishnaabe's grandparent who is always keeping an eye on their human relatives from the sky. We initiated our ethnographic project to understand how a group of people with such a "kincentric" worldview (Salmon 2000) make sense of introduced and "invasive" species. Though there are no beliefs held in common among all indigenous people, it is a commonly held belief among many indigenous groups around the world that plants, animals and other beings are members of the extended family. For example, Māori peoples in Aotearoa New Zealand, like the Anishnaabe, recognize rivers as their living ancestors (Muru-Lanning 2016; Fox et al. 2017) and indigenous people of New South Wales hold kinship relations with the more-than-human beings in their homelands (Rose et al. 2003).

The tradition bearers we spoke with emphasized that their ethical obligations to plants and animals begins with the first principle of asking permission from these relatives before harvesting them. Anishnaabe teachings instruct people to speak to plants before harvesting them (see also Kimmerer 2013), which is a way of acknowledging relationships with non-human kin. As we observed, Anishnaabe harvesters will introduce themselves, explain why they want to harvest the plant, how they will show the plant respect, and express thanks and sorrow for potentially taking their lives. This Anishnaabe principle precedes and supersedes the legal requirement of harvest licenses or landowner permissions. Kathy Leblanc, a cultural leader and elder from Bay Mills explained "…to me it's our land I do not care if the state, private, or federal, it's Anishnaabe aki and I just need permission from the plants to pick; I do not need permission from the government or the conservation committees".

According to Anishnaabe teachings, all plant and animal nations have their own Creation stories, wisdom, and unique gifts given by Creator, but people are understandably ignorant about these details for newly introduced species. Several community members we spoke with expressed interest in learning about newly introduced plants and animals from the indigenous people who have the longstanding connections to those species as well as from the new species themselves. Bud Biron, cultural educator from the Sault Ste Marie tribe, for example asked, "I wonder if anyone has bothered to ask the Asian carp [*Hypophthalmichthys nobilis, H. molitrix, Mylopharyngodon piceus*, and *Ctenopharyngodon idella*] or the hybrid cattail [*Typha x glauca*] why they are here? We should use our ceremonies to ask these new plants and animals why they are here". Basketmaker and cultural educator Josh Hominga similarly recounted, "an elder spoke about using some of our traditions, you know, like has anyone ever gone and laid their tobacco down and asked this bug [emerald ash borer-*Agrilus planipennis*] to leave?"

Like human persons, plants and animals are enmeshed in multiple social relations, including collectives that Anishnaabe call "nations", and sub-groups within nations referred to as clans. As members of nations, plants, like animals and people, migrate. When asked, several of our Anishnaabe collaborators provided this explanation for plant population changes. While some traditional doctors and their helpers expressed concern with region-wide declines in specific plant populations, for the most part, they approach these changes with a wait-and-see pragmatism. Kathy Leblanc suggested that invasive species may just be enacting their own migration stories. For LeBlanc, it is unclear whether new plants are passing through or here to stay, but she sees nothing "unnatural" about their presence.

As an example, Keith Smith, an Anishnaabe traditional doctor from Red Lake Minnesota, described how the community viewed introduced earthworms. Earthworms, such as the common nightcrawler (*Lumbricus terrestris*), have become common in parts of Michigan, Wisconsin and Minnesota. This group of introduced species are known for rapidly altering nutrient cycling processes and reducing the diversity and abundances of understory plants within forests in the upper Great Lakes region. Herbaceous plants, such as wild ginger (*Asarum canadensis*), that the Anishnaabe use for food and medicine appear to be significantly impacted by invasive nightcrawlers (Bohlen et al. 2004). Even so, Smith contrasted non-Anishnaabe land managers' anxieties about these earthworms with his mother's welcoming attitude. As he described, his mother said to the worms "Come and eat!"

In contrast to the predominant perspectives in invasive species management and research, being new to an area, human-introduced, or even leading to environmental change does not make an animal or plant unwelcome or inherently bad. Plants and animals move and migrate, and these migrations are not inherently good or bad. Our interviews revealed a repeated caution to not judge plants

and animals for attributes beyond their control. As Rita Bulley described, "I feel bad for those things that are getting introduced, because… they don't know they're invasive. They're just growing, doing the only thing they know how to do". This hesitancy to judge has management implications as well. Anishnaabe elders, as Smith explained, often feel strongly that nature finds its own balance, and people should not intervene using chemicals or other drastic management techniques.

Relationships and responsibilities

Two related teachings about aki shared with us by Anishnaabe tradition bearers are that all plants and animals have a purpose and when people ignore their responsibilities towards plant and animal relations, these relatives go away.

Very old Anishnaabe teachings hold that if you do not use the plants and animals who offer themselves to the people, they will go away. Therefore, using plants according to their intended purpose is an obligation, and lack of use has led to decline in important medicinal and subsistence plants. Peggy Hemmingway, an Anishnaabe woman from the Sault Tribe's traditional medicine program describes how years ago elders warned that "what we do not use will be taken from us". She goes on to give examples, such as the loss of black ash to the emerald ash borer (*Agrilus planipennis*) as well as decline in sweetgrass (*Hierochloe odorata*). Hemmingway concludes by saying "I'm so happy more people are doing sugarbush because, even if it's on a little scale, that was given to us and that helps those trees, that's its purpose". To non-Anishnaabe people, this idea may sound selfish or anthropocentric. But, as Anishnaabe biologist Robin Kimmerer explains, using plants respectfully is a way of showing love for them, and a way of reciprocating the gifts plants provide (Kimmerer 2013). Thus, some Anishnaabe understand the ecological impacts of introduced species through an old teaching concerning active and proper use.

The flipside of this teaching involves determining the nature of new relationships with introduced plants and animals. Anishnaabe relationships with plants and animals often focus on the ways Anishnaabe use the gifts of these relatives, so determining the nature of new relationships naturally begins with looking for possible uses for these other-than-human nations.

A variety of introduced plant species have proven useful to Anishnaabe communities, even if it is unclear whether they are just passing through or here to stay. Hemmingway shared, "everything is good for something. Creator do not make nothing bad". Hemmingway and other Anishnaabe teachers shared that it is incumbent upon people to determine the purpose of newly arrived plants and animals and to sort out what if any responsibilities we have toward the new arrivals. When the purpose of new plants is not obvious, Anishnaabe plant specialists will turn to animals to help them understand how to interact with new species. Ethical obligations to discover a new arrival's proper use requires specific attention to the possibility of mutual benefit. As LeBlanc described, "I'm not so sure about 'invasive species'. I mean a lot of the plants that we use right now are not indigenous to America. They came with the settlers, way before I was born; but they happened to be beneficial health wise to you. The people, over time, learned how to use them". In another interview, Hemmingway gives the example of the dandelion (*Taraxacum officinale*), an introduced species in the area, that has multiple values and is used regularly by Anishnaabe traditional doctors. Hemmingway and Biron each mentioned that common plantain (*Plantago major*), a plant of Eurasian and possibly N. American origins, is commonly used by Anishnaabe to treat various ailments.

Dandelion and plantain are relatively simple examples because, while considered "weedy", they pose no real threat to biodiversity or cause other negative ecological impacts. Coming to terms with other introduced species is not so simple. For example, naaknaashgook (*Typha latifolia*) is a broadleaf cattail that has existed in the Great Lakes region for thousands of years. It is also recognized as one of Anishnaabe's most generous plant relatives. The list of cattail recipes and uses is impressively long, but includes preparations for new shoots, young flower heads, pollen, and rootstock. Two more recent cattails have the potential to transform the region's wetlands. *Typha angustifolia*, a narrow-leaved cattail, was likely introduced from Europe to the Americas over 200 years ago; the other is a hybrid of the two (known as T. *x-glauca*). Both outcompete native vegetation, dominating wetland communities within 10–15 years of being introduced to a new location (Lishawa et al. 2013). The arrival of these new cattails in the Eastern Upper Peninsula of Michigan has caused alarm within the conservation community due to impacts experienced in other parts of the region (Tuchman et al. 2009).

Given the usefulness and generosity of the naaknaashgook, Anishnaabe wonder how the new cattails can be used. Some of our university partners have been working with Anishnaabe and Euro-American community members to investigate the range of purposes for the new cattails (Fig. 1c, d). In our discussions, we heard repeatedly the importance of turning to animals for better understanding. For Anishnaabe, animals are teachers. Hemingway used the example of how swarms of biting insects will alert a plant harvester that they have picked enough medicine. Tradition bearers from the Bay Mills, Sault Ste Marie, and the Walpole Island First Nation all noted that zhashkoonh, the muskrat (*Ondatra zibethicus*), could provide guidance about the purpose of the hybrid cattail. Zhashkoonh is a cultural hero within Anishnaabe cosmology. As one of the most active members of the coastal wetland communities, who builds his

lodge within the cattails, zhashkoonh is closely aligned with aki. Anishnaabe and their university partners are observing his interactions with the new hybrid cattail in hopes of discovering wetland stewardship options (Fig. 1e). Regarding zhashkoonh as a potential teacher in invaded wetlands, M'no Giizhigad of the Walpole Island First Nation noted, "There is always a lot to learn from our relatives and from Creation, when we are prepared to listen".

An "invasive" land ethic

Colonialism's ongoing legacy and consequences are significant to Anishnaabe understandings of environmental change, though in ways that are more nuanced than a native and non-native binary. In the broadest sense, settler colonialism in North America radically disrupted Anishnaabe connections to place, livelihoods, and social relations with non-humans (White 1991; Norrgard 2014). Our interview data provide insights into connections between settler colonialism and invasive species. We found that Anishnaabe tradition bearers are more concerned about an "invasive land ethic" than the threats of invasive species. Elements of this invasive land ethic include the imposition of Euro-American property ownership regimes, "command and control" forms of environmental management, and a worldview predicated on the separation of people from nature. Our interlocutors described the ways this invasive land ethic manifests in non-indigenous governmental and NGO approaches to invasive species management.

Throughout our interviews, we heard that introduced norms concerning access and ownership of property represent an early and persistent, even "invasive", land ethic. Bucko Teeple, a Bay Mills cultural leader and elder, used the term "alien thought", to describe the ways Jesuit priests during the colonial era claimed and named everything in the Great Lakes to honor their "religion", "countrymen", and "kings and queens". Prior to the imposition of Euro-American ownership regimes, Anishnaabe had their own systems for controlling access to land and resources that revolved around active and proper use. As described in our interviews, if a family was actively and properly (according to cultural norms) using land for maple sugaring, hunting, berry picking or other subsistence purposes, other families knew to keep out or to ask permission to access these lands. Families with these traditional rights could use these lands seasonally, for example, during summer harvest activities, and safely leave their lodges and tools behind for the rest of the year. Kathy LeBlanc explains, "People knew what stand of woods belonged to who and people respected that; that that was their space…That was [our] cultural protocol". These cultural protocols still exist among Anishnaabe today, to some extent, but they are difficult to maintain given how much land is now privately owned or managed by settler American governments. LeBlanc describes these challenges saying, "I remember going with my grandma in the summer and people would pick blueberries all up to Raco and Whitefish Point. Now it's all privately owned. From here to Whitefish Point is pretty much, "Keep Out, Keep Out, No Trespassing".

Anishnaabe people we interviewed also expressed concerns over top-down, problem-focused land and resource management interventions that parallel "command and control" approaches described by Holling and Meffe (1996). Examples that emerged in our interviews range from landscape-scale transformations to specific management interventions. For example, the channelization, creation of locks, and damming of the St. Mary's River for commercial shipping and hydroelectric development transformed a watershed centrally important to Anishnaabe subsistence economies. In an interview, Josh Hominga of Sault Ste Marie Tribe specifically linked loss of fish stocks in the river to the imposition of a non-Anishnaabe land ethic "since the time settlers got here". More specific concerns included the use of chlorophenoxy herbicides (dioxin laden chemicals like those used in "Agent Orange") to clear powerlines of vegetation in Bay Mills, the introduction of pelagic salmon species into the Great Lakes to support recreational fisheries, and the use of "biological controls" to help combat invasive species. LeBlanc discusses this last example, stating, "we're supposed to respect all of nature. To me having respect for nature is respecting the fact that it knows how to balance itself and stop trying to introduce different things to fix this and fix that like [the Michigan Dept of Natural Resources] did with those gypsy moths. Respect nature and it will balance. I mean everything has its cycles, leave it alone for gosh sakes. Let it do its thing and quit playing God".

In the broadest sense, these concerns about an alien land ethic reflect broader philosophical differences about human and non-human relationships. Tribal Chairman Aaron Payment summarized these differences saying, "In our traditional beliefs, we are an extension of our natural environment; we're not separate from it. A Western thought has us believe that we have dominion over our environment, but in our traditional way we lived in ecological balance…". Anishnaabe philosophy about land, or aki, begins with notions of connectedness and responsibility. Stones and water are persons, as are plants and animals, each with their own unique gifts. Accepting the generosity of their gifts obligates one to reciprocate through active, proper use and stewardship. These concepts are basic building blocks of a land ethic in Anishnaabe societies, even as Anishnaabe individuals may hold diverse and multiple views about environmental change. As Warren points out (2007), the "alien" and "native" categories stand in stark contrast to this land ethic and interferes with Anishnaabe connections to place and their social relations with non-humans.

Conclusions

Our findings illuminate three key aspects of Anishnaabe perspectives about introduced species that contrasts with the mainstream conservation perspectives. First, for Anishnaabe, plants and animals are family members and respected as elder siblings to humans. Plants and animals move across the landscape, and mobility is not inherently good or bad, regardless of precipitating cause. Second, humans have an obligation to figure out the nature of our relationship with new arrivals, which includes careful consideration of their potential gifts and our reciprocal responsibilities. Neglecting our responsibilities for long-standing plant and animal relations is one way Anishnaabe people explain the ecological impacts of introduced species. Third, Euro-American approaches to land management, such as invasive species eradication programs, can create barriers to Anishnaabe fulfilling their responsibilities to plant and animal kin.

Anishnaabe cultural values that underlie each of these findings have parallels and applicability far beyond our study area. We recognize that no two indigenous people have the same worldview. However, kinship with more-than-human beings is foundational to many indigenous societies, shaping their stewardship ethics and practices. Examples range from Rarámuri kincentric ecology (Salmon 2000), the personhood of water in Māori societies (Kawharu 2000; Muru-Lanning 2016), animal relatives controlling hunting outcomes among Cree (Berkes 2012), Kluane First Nation practices of reciprocity in hunting (Nadasdy 2007), and many others. We also see important synergies outside of indigenous contexts, for instance in the more-than-human scholarship in geography (Haraway 2008; Whatmore 2002) and multi-species ethnography in anthropology (Haraway 2008; Ogden 2011; Ogden et al. 2013; Tsing 2015). We also recognize that the conservation biology community utilizes a diverse range of approaches and holds diverse perspectives about introduced species, including work that considers bi-directional impacts (Jeschke et al. 2014) and beneficial ecological outcomes of some introductions (Schlaepfer et al. 2011; Tassin and Kull 2015). The Anishnaabe understandings and perspectives presented here will be of interest to each of these intellectual communities.

Addressing global environmental change requires comprehensive and proactive approaches to Earth stewardship that value and incorporate diverse knowledge systems (Clark et al. 2016; Chapin et al. 2011). Incorporating indigenous cultural values and perspectives in these efforts is valuable for multiple reasons, though we highlight two.

First, indigenous peoples manage a significant percentage of the Earth's critically important habitats, though they make up only 5% of the world's population (Carino 2009, p 21). Based on the most conservative estimates, indigenous nations own or have customary rights to at least 20% of the Earth's territory (Stevens 2014; Collins 2009, p 84, see Fig. 3), a percentage that exceeds the total of the world's terrestrial protected areas (Juffe-Bignoli et al. 2014). In the United States, for example, American Indian Tribes control three times more land in the 48 contiguous states than the National Wildlife Refuge System (Schmidt and Peterson 2009). Throughout the world, indigenous lands offer high rates of biological diversity and ecologically intact habitats, for complex reasons including the legacies of displacements to lands far removed from settler interest and development (Toledo 2001; Sobrevila 2008). Recent scholarship suggests that biodiversity conservation efforts depend upon indigenous lands to ensure representation of functionally and biologically distinct forest classes (Asner et al. 2017) and protection of threatened species (Renwick et al. 2017).

Second, there is an emerging consensus that indigenous knowledge is fundamental to conserving biodiversity and ecosystem services. For example, both the Intergovernmental Platform on Biodiversity and Ecosystem Services' conceptual framework and Article 8 of the Convention on Biological Diversity urges the preservation and sharing of diverse scientific disciplines, stakeholders, and knowledge systems, including indigenous and local knowledge for the

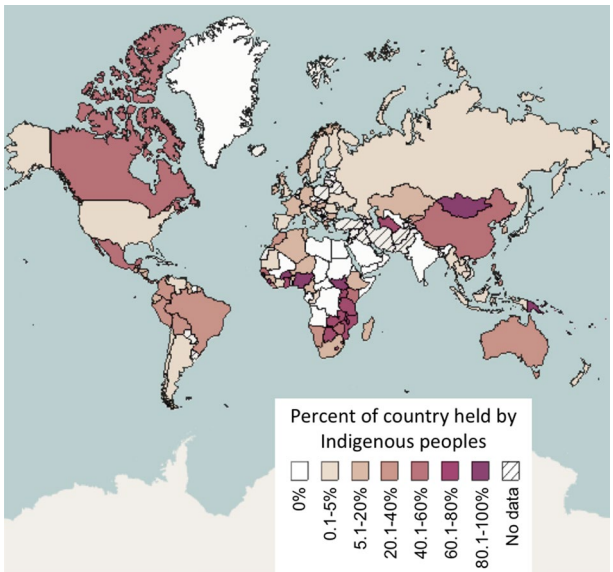

Fig. 3 Global map showing percent of each country's lands controlled by indigenous people, or where indigenous people have customary rights, triggering formal co-management or collaborative land tenure regimes with state actors. Source: Dubertret F and Wily LA. 2015. Percent of Indigenous and Community Lands. Data file from *LandMark: The Global Platform of Indigenous and Community Lands*. Available at: http://www.landmarkmap.org

conservation and sustainable use of biological diversity (Díaz et al. 2015; CBD 2017). These recommendations stem from research findings that demonstrate a correlation between cultural and biological diversity (Pretty et al. 2009), as well as the importance of indigenous knowledge and practices in maintaining biodiversity (Gorenflo et al. 2012; Walsh et al. 2013; Ens et al. 2015). Indigenous cultural values about introduced species do not always align with dominant conservation paradigms, and these cultural values should be understood as an aspect of broader knowledge systems and ethical commitments that have proven beneficial to conserving environments and species. Johnson et al. (2016, p 3) make a compelling argument for reframing sustainability science to involve more thoroughly "Indigenous science", recognizing that this process requires us "to think in ways that take seriously and actually respond to information, understanding and knowledges as if difference confronts us with the possibility of thinking differently". An important step in this direction could be to take seriously and respond to indigenous knowledge and perspectives on introduced species.

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