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REVIEW AND SYNTHESIS

Well grounded: Indigenous Peoples' knowledge, ethnobiology and sustainability

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Abstract

1. The biological knowledge and associated values and beliefs of Indigenous and other long-resident Peoples are often overlooked and underrepresented in governance, planning and decision-making at local, regional, national and international levels. Ethnobiology—the study of the dynamic relationships among peoples, biota and environments—is a field that places Indigenous Peoples' ecological knowledge and ways of knowing at the forefront of research interests, particularly in relation to the importance of biocultural diversity in sustaining the Earth's Ecosystems.
2. In this paper, we examine the nature and significance of Indigenous Peoples' knowledge systems concerning environmental sustainability, as documented in collaborative ethnobiological research. We emphasize the diverse aspects of Indigenous knowledge in conservation, and the role played by ethnobiologists in respectfully highlighting this knowledge, and link these to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Global Assessment's key levers and leverage points for enabling the transformative change required for achieving more sustainable lifeways. Drawing on diverse ways of knowing—respectfully, collaboratively, ethically and reciprocally—can help provide more detailed knowledge of local ecosystems, and guide all humans towards greater sustainability.
3. From environmental monitoring, to building relationships with plants and the land, to ecological restoration, there are many lessons and ways in which the intersections between Indigenous knowledge and ethnobiology can inform and contribute to the future of humanity and other life on earth.

KEYWORDS
climate change, ethnobiology, ethnobotany, Indigenous knowledge, Indigenous Peoples, reciprocity, relational values, sustainability

1 | INTRODUCTION

> Care and respect for nature are values deeply rooted in our culture. These values have always guided us in our stewardship practices. Many of our traditional stories speak about the importance of caring for nature. We are taught to take only what we need and to always acknowledge and show respect for everything we take, be it plant, animal or fish; our ancestors taught us that all things are alive (Brown & Brown, 2009, 5).

> Ethnobiology is the scientific study of dynamic relationships among peoples, biota and environments.... *The diversity of perspectives in ethnobiology is our greatest strength* [emphasis added]. It allows us to examine complex, dynamic interactions between human and natural systems, and enhances our intellectual merit and broader impacts (Society of Ethnobiology website: https://ethnobiology.org/about-ethnobiology/what-is-ethnobiology; accessed September 23, 2020).

> Salient innovative aspects of the [Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services] IPBES Conceptual Framework are its transparent and participatory construction process and *its explicit consideration of diverse scientific disciplines, stakeholders, and knowledge systems, including indigenous and local knowledge* [emphasis added] (Díaz et al., 2015, 1).

There is no question that Earth's ecosystems are deteriorating rapidly due to human impacts. 'Human activities have taken the planet to the edge of a massive wave of species extinctions, further threatening our own well-being' (Millennium Ecosystem Assessment, 2005, p. 3). So far, we have not made effective progress in meeting the requirements for sustainability as set out in various international documents (Chan et al., 2019, 2020; Government of Canada, 2020). As we humans throughout the world work our way through these uncertain times, trying to make the best choices for ourselves and our families, there are many lessons to be learned from others—past and present, nearby and far away—who have experience and wisdom to share. Indigenous and other long-resident peoples, in particular, hold significant, accumulated knowledge, that has enabled them to live in one place, using the resources of their homelands sustainably, for countless generations.

Over time, most if not all Indigenous Peoples have developed values of gratitude and appreciation for the plants and animals that have sustained them (Berkes, 2018; Brown & Brown, 2009; Geniusz, 2015; Kimmerer, 2013; Turner & Mathews, 2020), and have, in turn, developed practices of care, reciprocity and stewardship of their homelands—practices and values that have often been cast aside in the globalized world of commerce and enterprise (Klein, 2014). Over the past centuries, 'Western' worldviews have prevailed over much of the globe, with a predominant view that nature has been provided for the use of humankind (Cuerrier, 1996; Soulé, 1995). This perspective has largely directed actions and relationships with the environment and other species in North America and in many other parts of the world. Western scientific knowledge has been tainted by this view and, as such, we argue, has participated in the divide between human and nature despite the tremendous benefits western science has contributed to humanity.

The interdisciplinary field of ethnobiology embraces the study of interactions, past and present, among people and other biological organisms and their environments as reflected in diverse languages and cultures. Ethnobiology draws on many areas of inquiry, from biology and ecology, to Indigenous studies, anthropology, geography, pharmacology, nutrition, linguistics, history and philosophy. In turn, it incorporates many more focused but integrative areas of study, for example ethnobotany, ethnozoology, ethnoecology and ethnomycology (Anderson et al., 2011; Ellen, 2006). All humans, everywhere, past and present, have, or have had, interactions with other species and environments, and these relationships are reflected in many ways: through practical strategies for living, through stories, ceremonies, language and songs, and through people's governance, health practices, planning, decision-making and ways of educating their children and youth. The different perspectives and 'ways of knowing' about species and their environments among different groups of people are what makes ethnobiology so rich and so relevant in today's world. The insights gained through the study of ethnobiology, highlighting the diversity of perspectives, values and ways of knowing reflected in Indigenous societies, we argue here, are critically important to the transformational changes needed to alleviate and reverse our overall damaging human impacts on the Earth's ecosystems.

We are EuroCanadian (AC, NT) and Indigenous (LSJ) ethnobiologists[1] who have strong interests in and respect for the knowledge and wisdom of Indigenous Canadians. In this paper, we draw on our collective experiences as ethnobiologists working collaboratively with Indigenous Peoples in different parts of Canada to examine aspects of Indigenous knowledge, as highlighted in ethnobiological research, that can provide key lessons, supporting and strengthening the levers and leverage points for sustainability from the IPBES Global Assessment, raised by Chan et al. (2019, 2020). These insights can serve to reinforce pathways towards sustainability, contributing to the common knowledge base for biodiversity and ecosystem services as part of the IPBES mandate.

[1]NT: I am an ethnobotanist of European heritage from French/German/Dutch/English ancestry and I have dedicated my research career to building relationships with Indigenous communities in North America and carrying out community-based research in respectful and reciprocal ways.

AC: I am an ethnobotanist from French descent living in Montreal. I have been working in ethnobiology since 2001 when I was asked to be in charge of the First Nations Garden at the Montreal Botanical Garden. I have based my work on respect and openness to other cultures and have contributed to building awareness of the richness and wisdom that exists in Indigenous communities.

LSJ: I am an Indigenous woman from Sḵwx wú7mesh (Squamish) and Snuneymuxw (Nanaimo) and European ancestry. I have dedicated my work in the field of ethnobotany to contributing to Indigenous cultural political resurgence and knowledge renewal in connection to culturally important plants.

The following section (1) sets the stage by providing background information on the state of the world's ecosystems and global efforts in assessing and alleviating human-caused damage to biodiversity. Section 2 describes the interdisciplinary field of ethnobiology, its goals and ethical considerations in the context of documenting ILK systems. In Section 3 we provide an overview of some of the key concepts in ILK systems relating to global sustainability. Essentially this section provides a pathway towards drawing together and synthesizing the combined environmental wisdom of many human societies through ethnobiological insights. In Section 4, we align some of the approaches and outcomes of ethnobiological research relating to the various facets of ILK systems, and examine how the contributions of other ways of knowing can fall in with western scientific and policy approaches, such as the sustainability leverage points from the IPBES Global Assessment, to strengthen and reinforce them in efforts towards greater global sustainability. We conclude with a call to policy and decision-makers at all levels to recognize and incorporate diverse perspectives, ideas and approaches relating to the environment from across the spectrum of human cultures and experience, to help guide us into a more sustainable future. Environmental knowledge of place-based Indigenous Peoples and respectful collaboration with ethnobiologists in supporting and upholding this knowledge will contribute immensely in this endeavour.

2 | ASSESSING THE STATE OF THE WORLD'S ECOSYSTEMS AND THE IMPACTS OF HUMANITY

Scientific research over the past centuries has, indisputably, brought very real, positive improvements to the lives of many humans worldwide, with advances in medicine and associated cures for serious diseases, genetic engineering and manipulation with almost inconceivable precision, creation of novel materials, electronic innovations allowing far-reaching communication, and technologies that permit space exploration and viewing of distant galaxies. Yet, we humans still find ourselves in trouble. Our global climate is warming at an alarming rate, the earth's biodiversity is plummeting, and there is massive economic disparity among human individuals and peoples around the world (IPBES, 2019a, 2019b; Pereira & Bina, 2021; Whyte, 2019; Wilson, 2016). There is also seemingly continuous strife, triggered not only by economic inequalities, but also by systemic racism, conflicting ideologies, religions and values, including the ways in which we use and treat other species and their habitats.

At the turn of the 21st Century, in 2001, the Millennium Ecosystem Assessment was established with the objective of '[assessing] the consequences of ecosystem change for human well-being and the scientific basis for actions needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being' (cf. MEA, 2005, 1). The MEA conceptualized 'ecosystem services', including Supporting, Provisioning, Regulating and Cultural services (the last incorporating 'recreational, aesthetic, spiritual, etc.') benefits provided by the ecosystem. Later (p. 58) Cultural services were defined more fully as, 'the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences'. Cultural diversity, Spiritual and religious values, Knowledge systems, Educational values, Inspiration, Aesthetic values, Social regions, Sense of place, Cultural heritage values and Recreation and ecotourism were cited as general categories within Cultural services. Notably, these topics have been of interest and concern within the field of ethnobiology, in some cases for many decades, particularly as they relate to diverse, land-based cultures throughout the world (Anderson, 1996; Hunn, 2007).

In 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was established as an independent body by over 100 governments, with the goal of providing objective, scientific assessments of the state of Earth's ecosystems and associated biodiversity, and the essential services they provide to humans. The Platform was intended to provide the scientific knowledge and associated perspectives needed for effective decision-making for the participating nations:

> The Platform is expected to fill existing gaps in the science-policy interface relating to biodiversity and ecosystem services by synthesizing, reviewing, assessing and critically evaluating relevant information and knowledge generated worldwide by governments, academia, scientific organizations, non-governmental organizations and indigenous communities for the effective use of science in decision-making (Government of Canada, 2020).

By recognizing the potential contributions of 'indigenous communities' and others in helping to develop policy, legislation and actions, the IPBES effectively acknowledged the important role of different perspectives and ways of knowing, which must be taken into account alongside strictly scientific assessments in governmental decision-making. This, again, is an area of focus in ethnobiology, and can be informed through careful, collaborative, Indigenous-led research in this interdisciplinary field.

Ethnobiological concepts and approaches also align well with the concept of 'relational values…as preferences, principles and virtues about human-nature relationships' (Chan et al., 2018: A1). As Chan et al. note, relational values research embraces qualitative approaches from social sciences and humanities that are 'often neglected within environmental management and science'. We discuss the alignment of ethnobiological research with the relational values concept further in Section 3.

3 | ETHNOBIOLOGY: AN INTERDISCIPLINARY, COLLABORATIVE FIELD

As noted in the introductory quotation, Ethnobiology is the scientific study of dynamic relationships among peoples, biota and

environments. In partnership with Indigenous Peoples, Ethnobiology as a field of study can help to bring about the changes that humanity needs for our survival and for the support and wellbeing of the other life-forms on which we all depend (Geniusz, 2015; Hunn, 2007; Johnson et al., 2016; Kimmerer, 2013; Turner & Spalding, 2018; Whyte et al., 2016; Wolverton et al., 2014).[2] Table 1 presents a list of periodicals and books in the field of ethnobiology relevant to the topics developed in this paper. We have included some key Indigenous authors from complementary fields.

As codified in the Declaration of Belem (International Society of Ethnobiology, 1988 and the ISE Code of Ethics, 2006), ethnobiologists have, for decades, acknowledged the significance of Indigenous Peoples' environmental knowledge, and the role of Indigenous Peoples as stewards of the majority of the world's biodiversity (cf. also Gadgil et al., 1993; Garnett et al., 2018; Schuster et al., 2019). One of the fundamental premises of ethnobiological research is the recognition of Indigenous Peoples as owners of their knowledge, their fundamental rights to their intellectual property and their rightful control over what is shared, how it is shared and how benefits from the sharing might be realized in culturally appropriate ways (Bannister, 2020; Hunn, 2007; Posey, 1996; Posey & Dutfield, 1996).

Ethnobiology has both general and specific contributions to make in our efforts to alleviate the environmental problems we humans have created. As an interdisciplinary field, it embraces diversity and complexity, yet can also focus on very specific and intricate questions relating to human–environment interactions. Essentially it provides a pathway that connects the wisdom of humans with their knowledge of nature and the environment within which they are inextricably embedded (Atleo, 2011). Indeed, for Indigenous Peoples, plants, animals and nature are kin: humans and nature share ecological ties and are part of the same family, with common history and ancestry (see discussion of kincentricity below under Section 3.1).

In the past, sharing knowledge has led to some profound injustices for Indigenous Peoples. For example, Indigenous Peoples' medicines and foods have been commercialized and patented without permission, compensation or recognition of the sources (Tuhiwai Smith, 1999). At the same time Indigenous Peoples have been forcefully, often violently, dispossessed of their ancestral cultivation and harvesting grounds and the knowledge that is linked to such culturally important places. Ethnobiological research, thus, requires strong ethical standards of consultation, collaboration and informed consent of the knowledge holders and their communities for learning about, documenting and disseminating their knowledge (Bannister, 2020; Fowler & Herron, 2018; ISE Code of Ethics, 2006).

On a broader scale, Indigenous Peoples world-wide have suffered many other injustices and discriminatory actions from dominant societies and governments. These include the theft of Indigenous lands and resources, enforced attendance at residential schools, banning of key ceremonies such as the Potlatch (meaning 'to give'; ceremonies held for marriage, naming children, mourning the deceased, in which gifts are given to the guests to uphold reciprocal relationships, economies and laws) in Canada, and banning of traditional sustainable harvesting and management practices, such as prescribed burning and loss of access to much of people's ancestral land base (Boyd, 1999; Cranmer Webster, 1996; Pyne, 2007; Turner, 2014, 2020). These injustices require much work and commitment to recognizing the role of colonialism and the ongoing impacts of systemic racism at the heart of these injustices, and ensuring that they will never be repeated—all the more so as we suggest how valuable the contributions of Indigenous knowledge are in helping us to overcome the global threats we are now facing.

Ethnobiologists, including Indigenous ethnobiologists, have been at the forefront of efforts to challenge such injustices, especially those relating to land use and stewardship, and to partner with and support Indigenous Peoples working to protect their territories and foster better care of resources (Brown & Brown, 2009; Joseph, 2020; Turner, 2020). Politically and ethically, there is much to be done. By working in meaningful collaboration with Indigenous Peoples around the world, and by bringing forward and highlighting Indigenous knowledge, practices and beliefs relating to human relationships with other species and environments, ethnobiology has an immense role to play.

The interdisciplinary field of ethnobiology and the subfields encompassed within it, by linking human relationships with other species and by emphasizing knowledge of our environments and our place within them, are well positioned to help document and support diverse ways of knowing, and, therefore, to play a role in improving the health and wellbeing of people and ecosystems into the future. As of 25 September 2021, there were some 10,400,000 'hits' in an internet search for 'ethnobiology'. A review of the published contributions from ethnobiologists in journals (see Table 1)—and there are also related journals in anthropology, archaeology and conservation and environmental management—reveals a plethora of important, detailed and thoughtful studies that span the previously identified topics above. There are also many books pertaining to ethnobiology and its contributions (see Table 1). They stand out as particularly relevant, as do a number of special issues or sections in the *Journal of Ethnobiology*, for example, on: traditional resource and environmental management (Lepofsky, 2009); ethnobiology and food security (Nolan & Pieroni, 2014); climate change and ethnobiology (Wolverton et al., 2014); fire ecology and ethnobiology (Fowler & Welch, 2015); pastoralism and biodiversity conservation (French, 2017); ethnobiology and fisheries

[2]In this paper we take an emic (i.e. from a local people's perspective) approach to understanding the interrelationships between people, culture and the natural world. Co-author styawat/ Leigh Joseph, as an Indigenous ethnobotanist and community-based researcher, has found herself bridging the study of ethnobiology and her own experiences and understandings as a member of the **Skwxwú7mesh (Squamish) First Nation.** While studying botany and ecology she felt that there was no place for her personal experience as an Indigenous person within the subject matter. This meant there was a barrier for her in turning to her cultural relationships and values in connection to particular plants and ecosystems and that made her feel uncomfortable and unseen within the fields she chose to study. Ethnobiology has a history of taking emic approaches to involvement with community and on the land and recognizing the interrelationships between human and non-human life and landscape. Western science favours an etic approach which removes the layers of cultural context and interconnectedness but leaves Indigenous learners (such as styawat) disconnected from the intersection of the subject matter and the lived experience of being in relationship with the land and non-human kin.

TABLE 1 List of periodicals and books in the field of ethnobiology and from key Indigenous authors from complementary fields, relevant to the topics developed in this paper. Books can be found in the reference section

Periodicals	*Journal of Ethnobiology, Ethnobiology and Conservation, International Journal of Ethnobiology & Ethnomedicine, Asian Journal of Ethnobiology, Economic Botany, Human Ecology, Ecology and Society, Indian Journal of Traditional Knowledge, Conservation Biology, Restoration Ecology*
Books	*Nauriat Nigiñaqtuat. Plants That We Eat* (Jones, 1983) *Nch'i-Wana, "The Big River": Mid-Columbia Indians and Their Land* (Hunn & with James Selam and family., 1990) *L'ethnobotanique Montagnaise de Mingan* (Clément, 1990) *Before the Wilderness: Environmental Management by Native Californians* (Blackburn & Anderson, 1993); *Footprints of the Forest. Ka'apor Ethnobotany – the Historical Ecology of Plant Utilization by an Amazonian People* (Balée, 1994); *Look to the Mountain: An Ecology of Indigenous Education* (Cajete, 1994); *The Nature and Status of Ethnobotany* (Ford, 1994); *Ethnobotany: Evolution of a Discipline* (Schultes & Von Reis, 1995); *Ecologies of the Heart: Emotion, Belief and the Environment* (Anderson, 1996); *Ethnobotany: Principles and Applications* (Cotton, 1996); *People and Plants Handbook* (Martin et al., 1996); *Ethnoecology* (Nazarea, 1999); *Cultural and Spiritual Values of Biodiversity* (Posey, 1999); *Indigenous Environmental Knowledge and its Transformations* (Ellen et al., 2000); *Ethnobotany: A Reader* (Minnis, 2000); *Biodiversity and Native America* (Minnis & Elisens, 2000); *Gwich'in Ethnobotany: Plants Used by the Gwich'in for Food, Medicine, Shelter and Tools* (Andre & Fehr, 2000) *Working on Country* (Baker et al., 2001); *Ethnobiology at the Millennium, Past Promise and Future Prospects* (Ford, 2001); *Ethnobiology and Biocultural Diversity* (Stepp et al., 2002); *Ethnobotany of the Anishinaabek of Northern Great Lakes Indians*. (Herron, 2002); *Intellectual Imperatives in Ethnobiology* (Salick et al., 2003); *Gitga'at Plant Project: The Intergenerational Transmission of Traditional Ecological Knowledge Using School Science Curricula* (Edõsdi Thompson, 2004); *Ethnobotany: a Methods Manual* (Martin, 2004); *Tending the Wild* (Anderson, 2005); *"Keeping it Living": Traditions of Plant Use and Cultivation on the Northwest Coast of North America* (Deur & Turner, 2005); *Ethnobiology and the Science of Humankind* (Ellen, 2006); *Original Instructions: Indigenous Teachings for a Sustainable Future* (Nelson, 2006); *Being and Place Among the Tlingit* (Thornton, 2008); *The Ozette Prairies of Olympic National Park: Their Former Indigenous Uses and Management* (Anderson, 2009); *Staying the Course, Staying Alive: Coastal First Nations Fundamental Truths* (Brown & Brown, 2009); *Trail of Story, Traveller's Path: Reflections on Ethnoecology and Landscape* (Johnson, 2010); *Landscape Ethnoecology: Concepts of Biotic and Physical Space* (Johnson & Hunn, 2010); *Ethnobotany in the New Europe* (Pardo-de-Santayana et al., 2010); *Ethnobiology* (Anderson et al., 2011); *Principles of Tsawalk: An Indigenous Approach to Global Crisis* (Atleo, 2011); *Biocultural Diversity Conservation* (Maffi & Woodley, 2012); *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources* (Anderson, 2013); *Indigenous Peoples' Food Systems & Well-being* (Kuhnlein et al., 2013); *Braiding Sweetgrass* (Kimmerer, 2013); *Ancient Pathways, Ancestral Knowledge* (Turner, 2014); *Caring for Place* (Anderson, 2014); *Plants Have So Much to Give Us, All We Have to Do Is Ask* (Geniusz, 2015) *Ethnobiology for the Future* (Nabhan, 2016); *Secwépemc People, Land, and Laws / Yerí7 re Stsq̓ey̓s-kucw* (Ignace & Ignace, 2017) *As we've always done: Indigenous freedom through radical resistance* (Simpson, 2017) *Sacred Ecology* (Berkes, 2018); *Kaiāulu: Gathering Tides* (Vaughan, 2018); *DamXan gud.ad t'alang hllGang.gulXads Gina Tllgaay (Working together to make it a better world).* (Wilson, 2019). *Plants, People, and Places* (Turner, 2020); *Plants, People & Culture* (Balick & Cox, 2021) *Advanced Introduction to Community-based Conservation* (Berkes, 2021) Indigenous Intergenerational Resilience (Williams, 2022)

(Morales et al., 2017); children and ethnobiology (Gallois & Reyes-García, 2018); ethics and ethnobiology (Fowler & Herron, 2018); and 'action ethnobiology' (Armstrong & McAlvay, 2019). *Botany* (formerly *Canadian Journal of Botany*) has also published some papers and special issues [e.g. *Canadian Journal of Botany*, 1981 (11), 2008, (2), 2022 (2)].

Ethnobiologists have also worked closely with the concepts of managing the commons and common property resources (cf. Berkes, 2021; Ostrom, 1990), and of social–cultural convergence, as highlighted through the work of the Resilience Alliance (cf. Berkes et al., 2003; Folke, 2016; Gunderson & Holling, 2002). Through this work they have developed useful blended concepts to help explain some of the dynamics and perspectives of Indigenous Peoples and their systems of governance and relationships with other species. 'Biocultural diversity' (diversity of life in all its manifestations: biological, cultural and linguistic; Maffi, 2005; Maffi & Woodley, 2012) and 'ecocultural restoration' are examples, previously mentioned. As well, there are metaphorical parallels to be drawn between 'ecological edge' effects and 'cultural edges' (Turner et al., 2003), and between 'keystone species' and 'cultural keystone species', to highlight the close cultural ties between people and particular species which characterize their lifeways (cf. Garibaldi & Turner, 2004). Extending from this concept is 'cultural keystone places', helping to emphasize the central importance of particular places within Indigenous Peoples' homelands (Cuerrier et al., 2015; cf. also Raymond et al., 2013).

4 | INDIGENOUS KNOWLEDGE SYSTEMS

'Decolonization brings about the repatriation of Indigenous land and life; it is not a metaphor for other things we want to do to improve our societies and schools' (Tuck & Yang, 2012).

'A resurgence of Indigenous political cultures, governances and nation-building requires generations of Indigenous Peoples to grow up intimately and strongly connected to our homelands, immersed in our languages and spiritualities, and embodying our traditions of agency, leadership, decision-making and diplomacy' (Simpson, 2014).

People everywhere hold knowledge of interest to ethnobiologists, and perspectives about human relationships with other life-forms and environments that can be studied and provide critically important information (cf. Herron, 2002; Leopold, 1949; Molnar and Berkes, 2018; Berkes, 2021; Geniusz, 2015; Kimmerer, 2013; Luschiim & Turner, 2021; Simpson, 2014; Wilson, 2019). Those peoples who have lived in one place for multiple generations, sometimes for millennia, however, hold particular special knowledge about their homeplaces, the species that occur there, the changes that have taken place over the years, and the close, interdependent relationships among people and other life-forms. These people are, indeed, 'well grounded'. For this reason, the knowledge and perspectives of Indigenous Peoples and other long-resident peoples are highly relevant within the pursuits of ethnobiology.

Indigenous knowledge systems represent cumulative lived experience, and are not generally fragmented or reduced to their component parts as is often undertaken in academic and western scientific practice. Keeping in mind that everything is connected, or, in Nuu-chah-nulth language, *Hishuk ish ts'awalk* (Atleo, 2011; Clayoquot Scientific Panel, 1995), there are, nevertheless, different aspects, or 'faces' of Indigenous knowledge systems that can be considered in terms of contributions they are making, and can make, towards future sustainability and wellbeing of the earth (Houde, 2007; Turner et al., 2000).

The following section draws on the analysis of Indigenous Peoples' traditional ecological knowledge as a complex of knowledge, practice and belief, passed down through generations and adapting to changing conditions as required (Berkes, 2018), and provides a template for exploring how each of these aspects can inform and contribute to the future of humanity and other life on earth. The sub-sections focus on these different, although tightly interrelated, aspects of Indigenous knowledge systems and draw on Berkes' theories along with Indigenous theories and perspectives.

4.1 | Beliefs: Worldviews and values

How people see themselves and other entities in the world is perhaps the most fundamental determinant of how their knowledge is developed and applied. Generally speaking, many Indigenous Peoples approach consumption and harvesting in ways that are embedded in respect, recognition of relationships and a deep notion of others, in that resources must be there for generations to come and available for non-human life that relies on them. In Squamish culture, for example, there are teachings connected to harvesting that centre on respect, reciprocity and responsibility, meaning that if you are going to take a living being for your nourishment or health you must also be sure to do that in a respectful way, offer something back and not take too much. For Inuit, one must hunt animals with respect, killing only what they need and there is also a necessity of using all the animal (Cuerrier and Elders of Kangiqsualujjuaq, 2012).

Relationality sets the foundation for how we as humans are responsible and accountable to our natural surroundings and non-human kin (see Chan et al., 2018). In this paper, we refer to relational values through the lens of understanding that we are part of an extended network of life that relies on upholding responsible, reciprocal and respectful practices and in which we as humans are not elevated above, or separated from, other life in our surroundings. Such perspectives are sometimes referred to as kincentricity, a term suggested by Indigenous restoration practitioner and ethnobiologist Dennis Martinez (Martinez & Hall, 2008; see also Salmón, 2000, 2020; Turner, 2005, 2014). Not only are animals and plants regarded as members of the same big family, but these non-human relatives are the ones who aided and assisted humans to enter or emerge from the world, according to many cultural traditions (Kimmerer, 2013).

Kincentricity guides ethical ways of being and leads people to behave in certain ways towards other species and their environments: with care, humility, respect and gratitude (Brown & Brown, 2009; Geniusz, 2015), as reflected, for example, in the Haudenosaunee Thanksgiving Address (Six Nations Museum, 1993), or the 'First Foods' ceremonies of the Coast Salish and other Indigenous Peoples of British Columbia (Turner, 2005), or in the Nuu-Chah-Nulth principle of *isaak* ('sacred respect'; Atleo, 2011). The same obligations that almost all humans feel towards their own family members are, in the

case of the kincentric views of Indigenous Peoples, extended to all life. It is the duty and responsibility of humans to acknowledge, and to look after, *all* of their relatives, and to consider their wellbeing as inextricably bound to the health and wellbeing of humans. It is seen as a sacred trust, to care for the earth and all its inhabitants, as they all care for us (Kimmerer, 2013; Salmón, 2000, 2020). Many cultural teachings reflect these worldviews, such as taking only what one needs, and not wasting anything that is taken. A corollary to this would be share with others, and leave some for the future. Long-term 'seventh generation' thinking is also a common theme in these teachings. Taboos and sacred places are likewise related to people's worldviews. The field of ethnobiology has often leaned towards the study of and shared the learning about these worldviews and how they reflect and are reflected by people's actions (Anderson, 1996, 2014; Hunn, 2007; Nelson, 2006; Posey, 1999; Thornton et al., 2015).

4.2 | Practical observations, knowledge and experiences for sustainable living

Knowledge about resources on which people rely—for example, where and when to find, harvest, transport, prepare and store their food; how to harvest and use the materials they need to maintain themselves: fuel, tools, containers, clothing; and how to use medicines to maintain their health or treat injuries or illness—is gained over time by people living in a given locale and depending on their local sources of food, water, materials and other necessities (Turner et al., 2000). This kind of knowledge often revolves around seasons and particular places and habitats, and is closely tied in with people's values and worldviews, as well as with their languages, including place names and names for culturally important plants and animals, and processes that relate to them. For example, in Indigenous communities, strict teachings generally accompany the harvesting of plants, the taking of fish and hunting of animals. As emphasized in Section 3.1, these resources are widely recognized as living beings and are honoured through ceremony and narrative. Their lives and contributions to human wellbeing are acknowledged and respected. As explained by Nuu-chah-nulth Elder Roy Haiyupis:

> Nothing is isolated from other aspects of life surrounding it and within it. This concept is the basis for the respect for nature that our people live with, and also contributed to the value system that promoted the need to be thrifty, not to be wasteful, and to be totally conscious of your actual needs in the search for foods. The idea and practices of over-exploitation are deplorable to our people. The practice is outside our realm of values (Clayoquot Scientific Panel, 1995, 6).

These teachings, about honouring the resources that are harvested, never taking more than one needs, and ensuring that there will always be enough for future generations, are widely held (Brown & Brown, 2009; Turner & Berkes, 2006; see also Section 3.3). Ethnobiologists have been prolific in their collaborations with Indigenous Peoples, in observing and documenting of this kind of knowledge, often recording in great detail the species of plants and animals used as foods, materials and medicines, their harvesting, preparation and modes of consumption or application (cf. Hunn, 2007; Hunn et al., 1998; Hunn & with James Selam and family., 1990; Kuhnlein & Turner, 2020; Moerman, 2003). Increasingly Indigenous ethnobiologists are leading this work within their own and other Indigenous communities. This inclusion of Indigenous scholars and researchers is an important step in the evolution of the field. In some sense, this kind of practical knowledge is often readily aligned and integrated with western scientific knowledge, but is also vulnerable to being co-opted, taken out of context, and misused for the advantage of others, as, for example, local people's knowledge of particular food harvesting locales (Berkes et al., 2006).

4.3 | Ways of acquiring and passing on knowledge

Western scientific and other academic knowledge is often acquired and developed within a classroom, lecture hall or laboratory, although practical, 'hands-on' experiential learning is also required, especially in fields such as ecology. For Indigenous Peoples, knowledge is largely acquired and passed on through place-based, participatory learning and direct observation, as well as through ceremony, storytelling and, at times, formal instruction (Beckwith et al., 2017). Language is, of course, a critically important aspect of learning, and many ethnobiologists have a particular interest in the linguistic aspects of knowledge systems, including so-called 'folk classification systems' for plants, animals and natural phenomena (Berlin, 2016; Brown, 1984; Stepp, 2005), and how terms and names embody and reflect changes in knowledge (Turner & Brown, 2004; Turner, 2014). In many Indigenous societies, teaching, learning and training are often begun at a very early age, preparing children and even infants to understand the importance of their homelands, their place in the world, and their roles and responsibilities to their families, including their non-human relations (cf. George, 2003).

4.4 | Looking after the lands and waters: Traditional management systems

Indigenous systems of tending or managing species and habitats on which they rely vary broadly, but are generally congruent with natural processes of nutrient and water cycling, regeneration and reproduction, and ecological succession and are grounded in relationship. Whether Traditional Land and Resource Management pertains to domesticated crops and livestock, or to ways of enhancing the quality and productivity of native species in situ, within the landscapes and seascapes of people's territories, the practices are guided by people's values and beliefs, as well as by practical observations and experiences.

Again, these systems of care and management in different parts of the world have been of enduring interest to ethnobiologists (Altieri, 1987; Anderson, 2005, Anderson, 2013; Balée, 1994; Blackburn & Anderson, 1993; Bye Jr., 1981; Deur & Turner, 2005; Fowler & Lepofsky, 2011; Kraft et al., 2014; Larson et al., 2014; Lepofsky, 2009; Lertzman, 2009; Menzies, 2006; Minnis & Elisens, 2000; Molnár et al., 2020; Turner, 2005, 2014; Turner et al., 2011, 2021; Turner & Spalding, 2018). People's ways of using and managing their resources are also reflected and determined by systems of planning, decision-making and governance, as well as by interrelationships among different families, communities and larger groups. Indigenous law provides the underpinning for cultural governance processes and both of these areas of expertise influence broader relationships with the land and ways of informing and educating people about these (cf. Asch et al., 2018; Atleo, 2011; Borrows, 2006, 2019)—and these, too, are important in ethnobiology (Turner, 2020).

4.5 | Research ethics in working with Indigenous People

Ethnobiologists are responsible for ensuring that when they are working with Indigenous communities and Indigenous knowledge, including if this is with their own Indigenous community, that they are keeping the priorities of the community at the forefront in considering why they are doing the work. It is essential that the primary benefits of any ethnobiological work carried out in collaboration with Indigenous communities are going directly to those communities, first and foremost. This means that meaningful collaboration, relationship building and trust building are at the forefront of any projects, research or other scholarly collaborations. It is important to involve the community from the outset and while planning for and carrying out ethnobiological work in collaboration with Indigenous communities. One can draw on both ethnobiological literature, theories and methodologies while being sure to integrate any work carried out by Indigenous ethnobiologists and Indigenous scholars from complementary fields such as Indigenous Studies to increase the Indigenous perspectives integrated into the field. It is also important to ensure that Indigenous knowledge is treated as an equivalent system of knowledge and theory, as there has been a long history of non-Indigenous researchers interpreting and speaking for Indigenous Peoples. This is an outdated approach, which will continue to change as Indigenous representation within the field of ethnobiology continues to increase.

5 | GROUNDED KNOWLEDGE FOR GREATER SUSTAINABILITY

Many of the topics and concepts embodied in Indigenous knowledge systems, and reflected and documented in diverse ways in ethnobiological research, are highly relevant in guiding humanity into the future (Nelson, 2006). There are many different areas within our collective human ways of living where alternative perspectives and values, approaches, and knowledge can be effective in planning, decision-making, educating and practicing for long-term sustainability. The different aspects of Indigenous knowledge systems provide needed diversity, alternatives and opportunities for improvement in our dominant approaches. In collaboration with Indigenous Peoples' Communities, ethnobiologists are well positioned to help facilitate their recognition.

In this section, we outline the diverse ways in which Indigenous knowledge systems and associated ethnobiological research can contribute to broader initiatives in sustainability.

5.1 | Fostering values and relationships for sustainability

As humans, our ties and bonds with others determine our actions and behaviours towards them. Human societies everywhere value family and clan connections, within and across generations (Chan et al., 2020). For many Indigenous societies, however, as mentioned previously, family and ancestral connections extend much further—to other species, both plant and animal, as well as to the land itself. These ties are manifested in the concept of bestowing personhood and agency to trees and other plants, animals and even mountains and rivers (Artelle et al., 2018; Atleo, 2011; Ruru, 2020). By doing so, we expand our family ties, our caring and our responsibilities beyond the human realm. Caring for our non-human relatives, signified by the common phrase 'All my Relations' among North American Indigenous Peoples, means being mindful of their needs, their dwelling places and their lives, and being respectful towards them, not wantonly harming or destroying them and giving back through actions of reciprocity.

Indeed, these non-human relations are generous, and provide for humanity's needs, but as Indigenous Peoples would affirm, we have responsibilities to them in return. If these relational values were better understood and appreciated by all of us, we would be less destructive and more careful with other species and habitats, and by doing so would embrace more sustainable living practices (Brown & Brown, 2009; Chan et al., 2016, 2018, 2020; Whyte et al., 2016). These values underlie many other potential contributions of Indigenous knowledge systems. Reaching out to the scientific and non-scientific worlds, in collaboration with Indigenous knowledge holders/scholars/researchers/community leaders, ethnobiologists have been at the forefront of the scientific community in communicating about the important perspectives and relationships encompassed within many Indigenous cultures and reflected in their approaches to tending their lands and resources (cf. Anderson, 2014; Baker, 2020; Dolan, 2016; Kimmerer, 2013; Posey, 1999; Salmón, 2000, 2020; Turner, 2005, 2014).

5.2 | Traditional land and resource management

Chan et al. (2020), which is an extension of IPBES Global Assessment itself, and Berkes (2021), along with diverse international conventions,

such as the United Nations Convention on Biological Diversity (United Nations, 1992), stress the importance of including Indigenous Peoples and Local Communities (IPLCs) in conservation and resource management initiatives. These conventions do resonate with the IPBES Global Assessment (see Chan et al., 2019). As noted previously, Indigenous Peoples have developed, often over multiple generations, a plethora of approaches and strategies for managing, tending or caring for their resources and home places. Such traditional land and resource management systems, which link closely with values and worldviews, have been of immense interest to ethnobiologists (Anderson et al., 2011; Anderson, 2014; Anderson, 2005; Baker et al., 2001; Balée, 1994; Boyd, 1999; Deur & Turner, 2005; Fabio et al., 2002; Fowler & Welch, 2015; French, 2017; Hunn, 2007; Ignace et al., 2017; Joseph, 2012, 2021; Lepofsky, 2009; Minnis & Elisens, 2000; Morales et al., 2017; Peacock et al., 2016; Peters, 2018; Posey, 2002; Posey & Balée, 1989; Posey & Balick, 2006; Silvano & Begossi, 2002; Thornton et al., 2015; Turner, Berkes, et al., 2013, Turner et al., 2021). Increasingly, Indigenous Peoples' Communities are leading and guiding the conversations and are partnering with industries in such areas as fisheries, forestry, wildlife management and park management, often with assistance of ethnobiologists (Berkes, 2017, 2018; Clayoquot Scientific Panel, 1995; Middleton, 2011). This important Indigenous representation and inclusion has led to Indigenous-led management and Indigenous co-management of lands and resources (Armitage et al., 2007). The Haida Gwaii Watchman Program, in place on Haida Gwaii since 1981, was at the forefront of Indigenous land oversight (see: https://coastalfirstnations.ca/our-environment/programs/coastal-guardian-watchmen-support/). The Indigenous Leadership Initiative, an organization aimed at strengthening Indigenous leadership on the land and advancing Indigenous-led conservation initiatives across Canada, is another prime example. The current Director, Innu forestry expert Valérie Courtois (2021), specializes in Indigenous Issues, forest ecology and ecosystem-based management and planning. Values-led management—management 'founded on values that underpin stewardship-like relationships between people and place and that in turn guide related objectives, policies, and practices'—is another outcome of collaborative work with Indigenous Peoples (Artelle et al., 2018, 34).

5.3 | Ecological assessment and environmental monitoring

In terms of assessment and oversight of lands and waters, knowing their home territories and the habitats and species they support, often over a multi-generational time frame, many Indigenous Peoples are experts on the populations of plants and animals of their homelands, with deep familiarity of their reproductive patterns, their seasonal and cyclical fluctuations, vulnerabilities, impacts caused by human and other disturbances, and their overall health and wellbeing (e.g. Brown & Brown, 2009). For this reason, Indigenous Peoples' knowledge is increasingly recognized in environmental assessments and in monitoring environmental health, including detecting cumulative effects of multiple stressors (cf. Ban et al., 2019; Lantz & Turner, 2003; McElwee et al., 2020; Mulrennan & Bussières, 2020; Turner et al., 2008). The field of ethnobiology is at the forefront in documenting such knowledge and participating in ecological assessments guided by Indigenous Peoples, although too often, when large-scale industrial developments take place, such knowledge and perspectives are overlooked in favour of short-sighted economic gain. In such cases, as in the immense environmental destruction in the oil sands region of northern Alberta, ethnobiological approaches have been instrumental in documenting the impacts on Indigenous Peoples, and to bear witness to the loss of food species and other valued entities of their lives (cf. Baker, 2020; Black Elk & Baker, 2020; Garibaldi, 2009; Thomas et al., 2016).

5.4 | Land and marine guardianship and Indigenous protected areas

Monitoring and oversight of lands and waters requires particular institutions and actions that allow active and direct management to conserve biodiversity. In the past, not only was knowledge of Indigenous Peoples generally ignored in conservation, but Indigenous Peoples were removed, often forcibly, from their homelands when parks and protected areas were established (Spence, 1999). The recent developments of Indigenous guardian programs and Indigenous Protected Areas are key outcomes of this imperative. A variety of programs have been formally established in which Indigenous Peoples have taken on such formal roles, empowering themselves to fulfil their responsibilities to the land, and ensure compliance with regulations and requirements by all those who are living within or travelling through these areas. Examples include the Indigenous Leadership Initiative (2020), the Coastal Guardian Watchmen program (Coastal First Nations, 2017), and Indigenous Rangers programs (Thomson, 2020). Again, support of ethnobiologists and ethnobiological research and documentation of Indigenous knowledge and management systems have contributed to the success of these programs (cf. Anderson, 2009; Anderson & Barbour, 2003; Corrigan et al., 2018; Cuerrier et al., 2015; Deur & James, 2020; Enns et al., 2016; Hoole, 2014; Indigenous Circle of Experts, 2018; Langton et al., 2005; Lepofsky et al., 2017; Middleton, 2011; Mulrennan et al., 2019; Posey & Dutfield, 1997; Turner, 2020; Tuxill & Nabhan, 1998; West Coast Environmental Law Association, 2020).

5.5 | Biodiversity conservation and ecological restoration

The widespread deterioration of ecosystems, globally, from forests to coral reefs, grasslands and wetlands, is one of the key environmental concerns in the world today. Areas that are still intact need extra care in conservation, and those that have been damaged need focused restoration. Many of these areas, occupied by Indigenous Peoples for generations,

sometimes for millennia, have been, until recently, intact and productive, fostered by careful monitoring, tending and management, as discussed previously (Fa et al., 2019; French, 2017; Johnson, 2010; Thomas et al., 2016). In fact, close correlations have been drawn between areas of high biodiversity and areas occupied and stewarded by Indigenous and Local Peoples (Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), 2012; McElwee et al., 2020; Nabhan, 1997; Pretty et al., 2009). Cultural diversity—represented by language diversity, and distinctive cultural traits, histories, lifestyles and relationships to place of peoples world-wide—is being threatened and reduced at an even faster rate than biodiversity, as Indigenous lifeways are subsumed and marginalized by dominant 'western' languages and lifeways in the processes of colonization and globalization.

Over the past few decades, ethnobiologists and others have started to refer to these inextricably linked concepts of biodiversity and cultural diversity as 'biocultural diversity', or 'ecocultural diversity' (cf. Hunn, 2007; Maffi, 2005; Maffi & Woodley, 2012; Nabhan, 2016; Nazarea, 1999; Roué & Molnár, 2016; Stepp et al., 2002; Wilder et al., 2016a, 2016b). Given this history, and associated knowledge, Indigenous Peoples are often best situated to conserve the ecological integrity of their own homelands, to reverse the trends of destruction, and, where serious damage has already occurred, to participate in, or lead, their ecological restoration (Artelle et al., 2019; Carson et al., 2018; Clayoquot Scientific Panel, 1995; Reyes-García et al., 2019; Senos et al., 2006; Wehi & Lord, 2017).

The role of sacred groves and other Indigenous sacred sites, where associated restrictions of use and special status help to retain biodiversity, is particularly notable (Gadgil, 2018; Kandari et al., 2014; Raincoast Conservation Foundation, 2020; Rath & Ormsby, 2020; Roué & Molnár, 2016; Verschuuren et al., 2010). Forest conservation is also linked to cultural practices and Indigenous management systems where the lives of trees and other forest species are respected, and many forest products are sustainably harvested, with bark, pitch, limbs and even planks removed from standing, living trees which continue to grow, often for centuries, sometimes being harvested from multiple times (Turner et al., 2009). These practices not only conserve trees and understorey plants, forest birds and insects, but at the same time maintain the integrity of associated waterways, including fish habitat, and prevent soil erosion. Following these traditional management approaches and embracing their underlying values is an excellent pathway for sustainable use of non-timber forest products, from berries to pharmaceutical products (Turner, 2001).

Ecological restoration is another area where Indigenous Peoples' knowledge and practices are invaluable and can lead to meaningful and transformative work (Joseph, 2012; Senos et al., 2006). Applying traditional management practices and restoring areas with culturally important indigenous plants, for example, can be highly effective. Even urban areas, including lawns, golf courses and reclaimed building sites, may be restored ecologically with the application of ethnobiological knowledge and participation of local and Indigenous knowledge holders (Emery & Hurley, 2016).

At the same time, these conservation and restoration activities also present opportunities for people to revitalize their knowledge systems, languages and cultural practices, and to pass their environmental knowledge on to the younger members of their communities through restoration activities and relearning ancestral place-based knowledge. Such ecocultural or biocultural restoration has often been assisted through the research and support of ethnobiological research (cf. *Journal of Ethnobiology and Conservation*; Armstrong & McAlvay, 2019; Gomes, 2012; Stephenson et al., 2014).

5.6 | Indigenous Peoples' health and food security

Health and wellbeing embrace not only human physical, mental and psychological well-being, but also environmental health (Assembly of First Nations, n.d.). As many Indigenous knowledge holders have stated, 'If our environment is not healthy, how can we be healthy?' Ethnobiology, spanning the human–environment complex, including the past, present and future health of both humans and ecosystems, is of vital importance in documenting biocultural health (cf. Armstrong, 2020; Arnason et al., 1981; Balick & Cox, 2021; Ignace et al., 2016; Joseph, 2021; Leduc et al., 2006; McCune & Cuerrier, 2020; Turner, Berkes, et al., 2013; Wall & Teixidor-Toneu, 2020).

Many Indigenous Peoples world-wide have experienced significant dietary change as a result of colonial impacts over the past few generations, resulting in widespread instances in decreased overall health, with increasing incidence of type II diabetes, obesity, heart troubles and high blood pressure, and resultant lower life expectancy. In combination with the resurgence of cultural knowledge and the reclamation of land-based rights and practices happening within Indigenous communities, ethnobiological research in Indigenous food systems, traditional healing practices and overall wellbeing of Indigenous populations, based on cultural knowledge and related studies, has contributed extensively to our understanding of these issues and how they might be addressed. This includes studies of Indigenous and local food biodiversity, genetic selection and crop cultivars (e.g. Kraft et al., 2014; Kuhnlein & Turner, 2020; Nabhan, 2016; Ragone et al., 2004), ancient food production systems (Hoffmann et al., 2016); local food production and food security (Andre & Fehr, 2000; Kuhnlein, 2014; Nolan & Pieroni, 2014; Pardo-de-Santayana et al., 2010; Turner, Deur, & Lepofsky, 2013); and nutritional contributions of Indigenous food systems and impacts of dietary change (Joseph & Turner, 2021; Kuhnlein et al., 2006, 2009, 2013; Turner et al., 2011; Turner & Turner, 2008).

5.7 | Documenting and supporting learning, communication and transmission of Indigenous knowledge

Learning about cultures and environments within the context of Indigenous Knowledge systems is key to the perpetuation of this knowledge over the generations, and is considered paramount to the knowledge holders and experts of these communities. Ways of passing on knowledge are, in fact, a significant element of

the knowledge systems themselves (Kimmerer, 2013; Snively & Wanosts'a7 Williams, 2016). Language and classification systems for plants and animals (Berlin, 2016), as well as places, and landscape features, and associated stories (Cuerrier et al., 2021; Ignace et al., 2016, songs, ceremonies and lessons, are all integral to ways of knowing, and to gaining the wisdom and values that underlie practical knowledge and governance. Experiential knowledge is a key component as well. As one Indigenous elder explained, 'You have to *do* it!' (Beckwith et al., 2017). Therefore, participatory observation and engagement is one of the methods frequently used in ethnobiological research in collaboration with communities. Due to many diverse factors, from land alienation, to urbanization, from marginalization to language loss, and the impacts of residential schools, many Indigenous People are concerned that their knowledge is not being passed on to the younger generations in their communities. While first acknowledging that many Indigenous communities are already engaging in this critical work of cultural renewal, this is an area where researchers can assist and offer their skills and training to support Indigenous-led resurgence. Many people have shared their precious knowledge with ethnobiologists for the very reason that they want to ensure that the young people in their communities will be able to access it in the future and the more places this knowledge is carried the higher the chance that the practices connected to this knowledge will strengthen and grow (Edōsdi Thompson, 2016; Gallois & Reyes-García, 2018; Luschiim & Turner, 2021; Turner, 2021; Turner et al., 2008). One key role for projects in ethnobiology is to serve as catalysts of intergenerational transmission of knowledge through workshops and directing their resources towards creating opportunities for land-based learning led by the Indigenous communities they partner with (Cuerrier et al., 2012; Downing et al., 2013).

So much knowledge and depth of understanding is embedded in Indigenous languages yet many Indigenous languages are at risk of going extinct. With the loss of these languages comes loss of place-based and land-based knowledge that often holds the keys to sustainable interrelationships with the land. Language revitalization is a way of reclaiming identity, strength and knowledge and is ongoing for many Indigenous language groups across Canada and beyond. Environmental, botanical and zoological vocabulary is key to language use and acquisition. The work that ethnobiologists and ethnolinguists are undertaking, in collaboration with Indigenous speakers of the languages, in the areas of documenting terms, their origins, species of reference and other aspects of 'folk classification' systems, constitutes important contributions to language documentation and transmission and supports the overall work of language revitalization happening in Indigenous communities (Berlin, 2016; Hebda et al., 1996; Turner, 2021; Wilder et al., 2016a).

5.8 | Supporting environmental and social justice

'Relational accountability, an ethical guideline for conducting research with Indigenous nation partners, references the kincentric beliefs among many Indigenous Peoples. It implies that researchers are responsible for nurturing honorable relationships with community collaborators and are accountable to the entirety of the community in which they work, potentially including collaborators' more-than-human network of relations' (Reo, 2019, 65).

'We propose a re-configuration of ethnobiological research that may allow us to transform some of our research by moving from a state of self-reflection and culpability to a state of action. We argue that activism, allyship, and advocacy (collectively, action) are one avenue for addressing injustices within our own research and within the communities we are from and/or work in'. (Armstrong & McAlvay, 2019, 3).

As noted in section 3.5 on 'Research ethics in working with Indigenous People', ethnobiology has been a discipline linked closely with Indigenous communities and with guidance from Indigenous knowledge holders has contributed to recognizing the Intellectual Property of their Indigenous collaborators and ethical aspects of their research in general and integrated that into the ways they work with communities. 'Indicative of our fierce commitment to resist the final triumph of global capitalism' (Hunn, 2007, 9), many ethnobiologists have supported Indigenous Peoples' laws, treaties and land rights, and have worked as allies with Indigenous Peoples to support their efforts to maintain access to their resources and to continue their land-based traditions in the face of industrial development and government suppression (Armstrong & McAlvay, 2019; Davis, 2011; International Society of Ethnobiology, 2006; Posey, 1990; Posey & Dutfield, 1996; Turner, 2020; Turner, Berkes, et al., 2013; Wyndham et al., 2021). Upholding the terms of the UN Declaration on the Rights of Indigenous Peoples (United Nations, 2007), and the requirements of other international conventions and agreements, such as the UN Convention on Biological Diversity (United Nations, 1992), and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (2012), as well as national documents such as Canada's Truth and Reconciliation Commission's (2015) Calls to Action and Report of the Royal Commission on Aboriginal Peoples (Government of Canada, 1996), needs to be of paramount importance to all researchers.

5.9 | Planning, decision-making and governance

Indigenous societies and many local communities have their own laws and, based on them, effective systems of governance (cf. Borrows, 2006, 2019; Curran & Napoleon, 2020; Mills, 2020; Okanagan Nation Alliance, 2014; Williams, 2022). These systems have been in place, in some cases, for millennia, and incorporate not only ways of relating and living together as human communities, but also ways of being in the world with other species, bequeathing personhood and kinship status to plants and animals and even features of the landscape. Many of the fundamental laws relate to long-term relationships with other beings, and to protocols of sharing, responsibility, reciprocity and respect (Artelle et al., 2018, 2019; Berkes, 2018, 2021;

Joseph, 2021; Tengö et al., 2014; Wilson, 2019). These laws are gaining wider recognition and regard as systems of governance embodying environmental perspectives that have much to offer society at large. Again, documentation for these, including in the legal arena, is often undertaken by ethnobiologists (Carroll, 2015; Turner, 2020).

5.10 | Encouraging connections to nature in our urban planning and environments

Over half of the world's human population lives in cities, and this includes many Indigenous People and others who have recently originated from smaller, more rural communities. In most cases, the cities themselves are situated directly within Indigenous Peoples' homelands. In dense urban centres it is extremely difficult to maintain relationships with other species or to even recognize their importance. But for many, the ties, connections and values still exist. From developing community gardens and seed cooperatives, to creating habitats in yards and even on rooftops of buildings, accessing urban parks, walkways and other less developed spaces—around museums and university and college campuses, for example—to developing botanical and ethnobotanical and medicinal herb gardens, to participating in urban ecological restoration projects: all of these provide ways to keep these important relationships with plants and animals alive. And the ideas generated by these activities can be multiplied out to other communities, enriching the lives of many more individuals. Learning about ways in which people are able to continue these connections is an important aspect of ethnobiological research and practice (cf. Emery & Hurley, 2016; Ford, 1979; Turner & Wilson, 2006). Many of the world's botanical gardens, such as the famous Royal Botanic Gardens at Kew, London, the New York Botanical Garden, Missouri Botanical Garden and Montreal Botanical Garden, to name just a few, are well known for their support of Indigenous Peoples' knowledge, practices and resources, and of ethnobiologists, particularly ethnobotanists (cf. Balick & Cox, 2021; Barabé et al., 2012; Cuerrier et al., 2019; Prance, 2000; Salick et al., 2003).

5.11 | Knowledge for adaptation to climate change and other types of environmental change

As we face inexorable climate and environmental change globally, due in large part to mainstream society's seemingly unquenchable thirst for fossil fuels combined with our inability to govern ourselves with the longer term future in mind, Indigenous Knowledge systems can provide models for both adaptation to change and governance approaches that might reduce our environmental impacts and slow or reverse climate change. In the latter case, emphasizing the true values of diverse habitats and other, non-human species in terms of human wellbeing, as well as the importance of governance that considers the long term (i.e. '"seventh generation thinking'), are common threads in Indigenous Knowledge systems. Indigenous Peoples, no matter where they reside in the world, have, as communities and lineages, experienced and adapted to many changes, both short term and long term, and are therefore ideal leaders and partners in developing adaptive co-management approaches in resource use (Armitage et al., 2007; Artelle et al., 2018; Berkes, 2017, 2018; Berkes & Ross, 2013; Berkes et al., 2003; Charles et al., 2020; Folke et al., 2010; Turtle Lodge, 2020; Williams, 2022). Working closely with Indigenous Peoples world-wide, many research projects have been at the forefront of documenting their observations and knowledge of environmental change, including climate change, and the strategies Indigenous Peoples have developed to adapt to and mitigate these changes (Bond et al., 2019; Ford et al., 2016; Ford et al., 2020; Gómez-Baggethun et al., 2013; Rapinski et al., 2018; Reyes-Garcia et al., 2021; Salick & Ross, 2009; Savo et al., 2016; Wolverton et al., 2014). There are Indigenous climate change activists, Indigenous grassroots youth movements focused on addressing the climate crisis from culturally grounded places, Indigenous scholars, researchers, politicians and policy makers who can also contribute to this process in collaboration with their communities. Working together can create powerful and positive change as much of the knowledge needed to live in respectful, reciprocal and sustainable ways with our natural environments is embedded in Indigenous knowledge.

5.12 | Developing an inclusive green economy

Western economic systems have created an unbalanced world, both in terms of social and economic inequalities that most often impact Indigenous People and other people of colour disproportionately and of relationships with our plant and animal kin and our earth. The grave and ignorant misunderstanding of human beings as being more important and dominant over other life on earth, over ecosystems, and exempt from the consequences of seemingly limitless growth, wealth and consumption, has led to a climate state of emergency. Although there are multiple voices advocating for greener development of the world economy, Indigenous Peoples in particular have much to teach us here. There are many roles for Indigenous Peoples in developing a 'green economy'. Living sustainably within their homelands for generations, with deep knowledge of the local plants, animals and culturally important places and habitats, and with values that promote respectful use and reciprocity towards other living things, these peoples are well placed to serve as teachers, guides and hosts for others wishing to learn about and enjoy different locales and cultures. Small-scale ecotourism and cultural tourism, ecoforestry, sustainable harvesting and use of non-timber and value-added forest products, arts such as woodcarving, basketry, weaving and painting, cultural experiences with museums, music production, videography, photography and sustainable entrepreneurship; these are all areas where Indigenous Peoples can, and have, contributed substantially in ways that have helped to sustain their livelihoods. In all of these environmentally based activities taking place on their homelands, the people themselves need to be fully in control, but there are many opportunities for outside partnerships

in research, training, development and marketing. Ethnobiologists, through undertaking background research, helping document community perspectives, and helping develop guidebooks, cookbooks and other materials to support this work, can play, and have played, a significant role in many of these areas (Edōsdi Thompson, 2016; French, 2017; Joseph, 2021; Martin et al., 1996; Posey & Balick, 2006; Singh et al., 2010; Turner et al., 2012).

6 | CONNECTING WITH INTERNATIONAL INITIATIVES

It is now evident that achieving key societal goals associated with sustainability and the environment will require transformative change—'fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values' (IPBES, 2019a, 14; see also Chan et al., 2020, 694).

The areas relating to Indigenous Knowledge systems as outlined above in Section 4 are congruent with a number of recent international initiatives, going back to the Brundtland Report, *Our Common Future*, which states:

> These (Indigenous) communities (of the world) are the repositories of vast accumulations of traditional knowledge and experience that link humanity with its ancient origins. Their disappearance is a loss for the larger society which could learn a great deal from their traditional skills in sustainably managing very complex ecological systems (United Nations, 1987, 115).

Indigenous Peoples' land-based knowledge and associated rights are also highlighted in other international conventions and agreements, such as the UN Convention on Biological Diversity (United Nations, 1992). The United Nations' Food and Agricultural Organization (FAO) has explicitly recognized the close ties among Indigenous Peoples' traditional food systems, environmental health, and human health and food security, as discussed in Section 4.6, above. The Millennium Ecosystem Assessment (2005) has already been mentioned as contributing the concepts of Ecosystem Services, including Cultural Services that relate to Indigenous Peoples' knowledge and values (Chan et al., 2012; see also Chan et al., 2016 and Turner & Mathews, 2020). Other international organizations contributing to sustainability and to systems approaches, such as the Resilience Alliance (Berkes et al., 2003; Folke, 2016; Folke et al., 2010), noted previously, have also been closely tied to Indigenous Peoples and to research and concepts from the field of ethnobiology.

As cited in the Introduction and elsewhere, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an independent intergovernmental body, linked with the United Nations, was established in 2012, in recognition of the deeply unsustainable trajectory that humanity has launched itself on. As a component of the IPBES Global Assessment, and applying a social–ecological systems lens, Chan et al. (2020), identified eight 'leverage points'—points of priority for intervention, and five intertwined 'levers'—strategic interventions assessed to be key to necessary societal transformation, to be applied across the leverage points and more broadly. These levers and leverage points are all connected but not substitutable, each enabling others, with likely synergistic benefits. Together, they represent a clear statement, drawn from the combined contributions of dozens of nations, of the changes that need to be made on a global scale to attain sustainable pathways (Chan et al., 2020). Table 2 outlines these levers and leverage points, and shows how they connect with concepts embedded within Indigenous knowledge systems—and reflected in large part through research in ethnobiology—as presented in Section 4 (see also Figure 1). It is perhaps not surprising that there is significant overlap and congruity across these different considerations of multiple approaches and contributions of Indigenous knowledge systems that we identify here as being relevant to sustainable living.

The IPBES Global Assessment stresses how the dominant approach (in contrast with an Indigenous approach) has resulted in overarching societal problems that impact all of us as humans, as well as other non-human life, and warns of the dire consequences of *not* initiating change, innovation and diversity in our choices and approaches in relation to other species and the ecosystems we share. Somehow, the short-term economic gains of a relative few are the drivers of the majority of our collective human impacts on the earth. This is unsustainable. In this global system, the rights, wishes and perspectives of people of colour, including Indigenous Peoples, are subsumed by the seemingly insatiable demands of mainstream society for all manner of 'goods', which to some seem to have greater value than the very ecosystems and life-forms that we need to survive. Many of us in the so-called 'developed world' are living as if other people and other species do not matter, as if we are above them. Multinational corporate interests, large-scale production, and big government, fed by technologies based on western scientific and engineering research—developed sometimes with the best of intentions—have subsumed valued forests, wetlands, coastlines and other habitats, to the detriment of both placed-based peoples and our non-human relatives. We know intuitively and by any number of measures, with growing certainty, that the Earth's systems are in trouble, and that this situation needs to change dramatically if the ecological integrity of the earth is to be repaired and sustained (Díaz et al., 2019; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019c).

In terms of human knowledge systems and lifeways, we are in danger of losing everything if we invest only in the dominant approach driven by capitalism, materialism and an assumption of human exceptionalism. To undertake the necessary changes, we in mainstream 'western' society need to understand that there are valid alternative ways of knowing and being, practices and behaviours and ways of seeing, understanding, and valuing the land. There are choices to be made. Shifting and expanding our ways of being, currently overwhelmed by economic development, into a more diverse

TABLE 2 List of all the leverage points raised and described by Chan et al. (2020) for the pathways towards sustainability. Many points are aligned with Indigenous Peoples' and ethnobiologists' visions as seen in the last column and described in Section 4. Note that the definitions of the leverage points are from Chan et al. (2020)

	Levers	Description	Indigenous Peoples (IPs)/Ethnobiology
(A)	Incentives and capacity building	Positive and negative incentives via regulations and market-based instruments; building capacity to foster conservation and stewardship practices while cultivating appropriate norms and values	Aligns with **Developing an inclusive green economy (see Section 4.12)**; Indigenous and Local Peoples (ILPs) are well placed to both contribute to and benefit diverse sustainable economic activities, with incentives and capacity building; ethnobiological research can support capacity building
(B)	Coordination across sectors and jurisdictions	Integrating management across administrative silos and regions as an important mechanism to realize co-benefits and avoid trade-offs among competing sustainability goals and objectives	Aligns with **Planning, decision-making and governance (Section 4.9)**; Indigenous law and governance systems, embodying environmental perspectives, have been in place, often for millennia, in many parts of the world, and need to be recognized as a key sector in integrating management for sustainability
(C)	Pre-emptive action	Addressing emerging risks in a precautionary or pre-emptive way, even without absolute proof of impact; may entail imposing constraints to slow rates of change in natural systems or resources, or capping the scale of changes	See also **Planning, decision-making and governance (Section 4.9)**; Indigenous laws, protocols and actions relating to environmental relationships are based on close, careful observation and experience, and on fostering long-term relationships with other beings. They are therefore inherently precautionary, presenting models for decision-making that are broadly relevant
(D)	Adaptive decision-making	Designing policies, programs and initiatives to be robust to uncertainty, responding to ecological and socio-economic dynamics and cultivating system resilience to maintain critical functions despite disturbance and change	Aligns with several areas: **Planning, decision-making and governance (Section 4.9)**; **Encouraging connections to Nature in our urban planning and environments (4.10);** and **Knowledge for adaptation to climate change and other types of environmental change (4.11)**; resilience and adapting to change are primary features of ILK systems, and these can contribute immensely in informing adaptive policies, programs and initiatives more widely
(E)	Environmental law and implementation	Developing and consistently enforcing stronger international laws, constitutions and domestic environmental law and policy to protect human and ecosystem health; protecting the rights of the public and future generations from incursion by private interests	Aligns with **Supporting environmental and social justice (Section 4.8)**, **Planning, decision-making and governance (Section 4.9), Knowledge for adaptation to climate change and other types of environmental change (4.11)**, among others; Indigenous Laws guiding environmental relationships have been a strong and enduring aspect of ILP knowledge, and a key area of interest in ethnobiology
	Leverage points	**Description**	**Indigenous Peoples (IPs)/Ethnobiology**
(1)	Visions of a good life	'Visions of a good life that go beyond those entailing high levels of material consumption'	Aligns with **Fostering values and relationships for sustainability (Section 4.1), Indigenous Peoples' health and food security (4.6), Encouraging connections to Nature… (4.10), Knowledge for adaptation to climate change and other types of environmental change (4.11)**, and **Developing an inclusive green economy (4.12)**; Indigenous and Local Peoples' values and deep understanding of others and associated ethnobiological research are congruent with this point
(2)	Total material consumption and waste	'Entail reducing or reversing the growth of aggregate material production, as a function of population size and per capita consumption and waste'	Aligns with **Developing an inclusive green economy (**see **Section 4.12)**; ILPs' respect of resources, which must be there for generations to come, and their kincentric perspectives—taking only what is needed and leaving resources for non-human allies—induces careful, thoughtful consumption and precludes food waste
(3)	Latent values of responsibility	'Unleash latent capabilities and relational values (including virtues and principles regarding human relationships involving nature, such as responsibility, stewardship and care)'	Aligns with **Fostering values and relationships for sustainability (Section 4.1)**, and **Encouraging connections to Nature in our urban planning and environments (4.10)**, and **Biodiversity Conservation and Ecological Restoration (4.5),** among others; recognizing kincentricity and responsibility towards wellbeing of plants, animals and habitats, which in return, bring wellbeing to humans is foundational to ILP's knowledge, as is revealing and embracing worldviews and visions of sacred places

TABLE 2 (Continued)

	Leverage points	Description	Indigenous Peoples (IPs)/Ethnobiology
(4)	Inequalities	'Reducing inequalities is central to many sustainable pathways'	Aligns with **Indigenous Peoples' health and food security (Section 4.6)**, **Supporting environmental and social justice (4.8)**, among others; for ILPs, respect for all lives, helping others and sharing are central to ways of living, including sharing land with and helping non-humans as well
(5)	Justice and inclusion in conservation	'Just and inclusive approaches to conservation and restoration will be needed to attain sustainable pathways'	Aligns with **Traditional land and resource management (Section 4.2)**, **Land and marine guardianship and Indigenous protected areas (4.4)**, **Supporting environmental and social justice (4.8)**, **Planning, decision-making and governance (4.9)**, and **Knowledge for adaptation to climate change and other types of environmental change (4.11)**, among others; ILPs struggle in many places to protect their lands and resources. Partnering and supporting them in challenging injustices regarding stewardship and land use and access, recognizing land rights and treaties, as well as Intellectual Property Rights; adhering and promoting strongly to International Declarations and research ethics are all important goals and aims of ethnobiology
(6)	Externalities from trade and other telecouplings	'Global sustainability will require individuals, organizations and jurisdictions taking responsibility for distant, diffuse and delayed effects, including by assessing, avoiding and mitigating negative impacts'	See **Developing an inclusive green economy (Section 4.12)**; ILPs deep understanding of local plants, animals, and culturally important places are key aspects of ethnobiological research; promoting a 'green economy' based on ILPs' wisdom; learning from ILPs about sustainable harvesting, ecotourism; co-creating co-management boards with ILP regarding parks, and lands in general are seen as an important collaborative research areas in ethnobiology
(7)	Responsible technology, innovation and investment	'A regime change towards affordable technologies that reduce negative environmental impacts and towards those with net-positive impacts'	See, again, **Biodiversity Conservation and Ecological Restoration (Section 4.5)**, and **Developing an inclusive green economy (4.12)**; developing green technologies with the help of ILPs' knowledge and wisdom, including: cultural tourism; use of non-timber forest products; promoting arts and videography; acknowledging ILPs' ways of knowing and connections to the land; and diversifying technologies
(8)	Education and knowledge generation and sharing	'Promoting knowledge generation and sharing in general, and particularly via learning and knowledge systems for sustainability, is central to sustainable pathways'	Aligns with **Ecological Assessment and Environmental Monitoring (Section 4.3)**, **Documenting and supporting learning, communication, and transmission of Indigenous and local knowledge (Section 4.7)**, **Knowledge for adaptation to climate change and other types of environmental change (4.11)**, and **Encouraging connections to Nature in our urban planning and environments (4.10)**, among others: Knowledge of ILPs relating to environment and human–environment relationships is profound, and collaborations with ethnobiologists can contribute in honouring and disseminating this knowledge through producing educational materials (books, videos, posters) for local schools and post-secondary institutions; supporting transgenerational and transcultural workshops; giving a voice to ILPs in congresses, meetings and other venues; showcasing, with their approval, ILPs' knowledge; designing an ethical space for knowledge sharing; and promoting different ways of knowing and relationships with nature

Texts in bold refer to the 12 subsections in Section 4 of our paper.

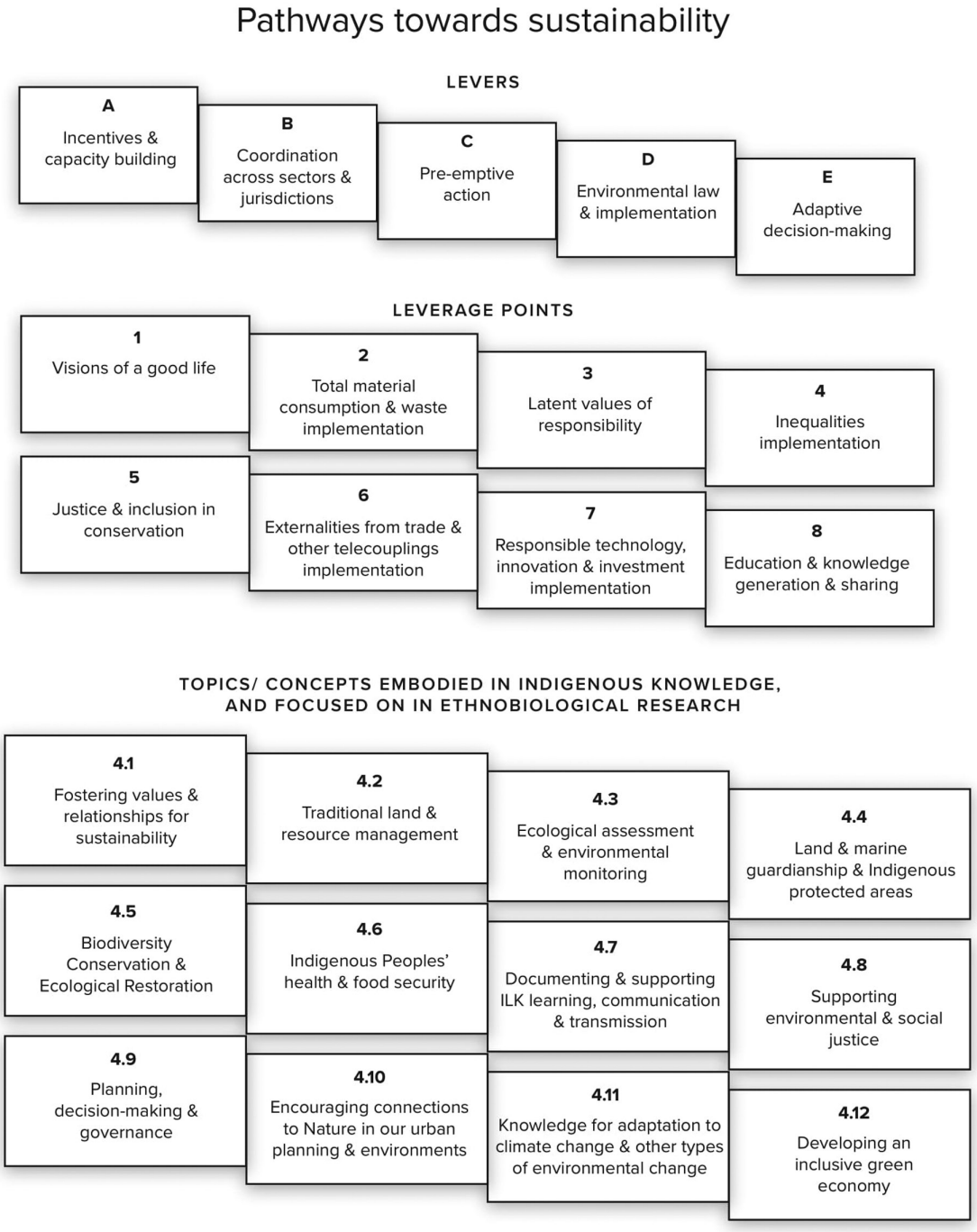

FIGURE 1 Schematic diagram of Chan et al. (2020) levers and leverage points for the pathways towards sustainability, showing alignment with key goals of Indigenous Peoples and topics of focus in ethnobiological research (see Table 2 for more details)

suite of relationships and values, embracing less destructive ways of living and rendering greater appreciation for what is truly important to our survival, is what is needed.

There are, indeed, other options for happiness and fulfilment: ways of being that may alleviate habitat deterioration and destruction, spreading the joy of living more broadly across humanity and the earth's biosphere, and extending this privilege to those still to come, through to seven generations and beyond. Knowledge and wisdom of Indigenous Peoples, accumulated over centuries and millennia of residing in one place, using mainly local resources and learning to live within the boundaries established by ecosystem productivity and its limits, can provide alternative models to emulate and inform our future decisions and direction (Artelle et al., 2018; Atleo, 2011; Berkes & Turner, 2006).

There is no way to recapture the past in this era of the Anthropocene. Nor is there a way to bring back the Indigenous languages that have become extinct, or much of the orally transmitted knowledge from previous generations that has been lost to the

direct and ongoing impacts of colonization. Yet, the existing knowledge, resilience and wisdom of Indigenous Peoples world-wide is profound, and Indigenous knowledge holders are often willing to share with others for the benefit of the earth. Anishenaabeg Elder Dr. Dave Courchene of Turtle Lodge, Manitoba, explained:

> Our ancestors left a footprint, a trail founded on Indigenous values of respect, which can lead us all to have a healthy relationship with each other and the planet. Our children are depending on us to follow in those footsteps, walking this trail of peace, friendship and reconciliation (Turtle Lodge, 2020).

As stressed in the UN Declaration on the Rights of Indigenous Peoples (United Nations, 2007), Indigenous Peoples deserve the respect and the right to have their knowledge and perspectives recognized, their ties to their homeplaces and rights as stewards and guardians of their lands to be honoured, and their wellbeing and lifeways to be of importance and relevance to all. Ethnobiological research brings forth other views, understandings and values from diverse Indigenous Peoples' Communities that can provide alternatives and lead the way to more fully embraced sustainable lifeways that take the future of the Earth to heart.

7 | CONCLUSION

Respecting and learning about diverse knowledges and practices reflected in human–environment interactions from Indigenous and other land-based peoples world-wide stands to support all of humanity in finding more sustainable paths to the future. These communities hold insights and instill values that support intact, fully functioning environments, and at the same time can lead to lives that are more enjoyable and more meaningful, than the way many of us are living today (Asch et al., 2018). Numerous initiatives, some led by Indigenous Peoples and others in partnership with ethnobiologists and other allies, are already underway; these can serve as examples for all of us to learn from.

Understanding and recognizing the importance of Indigenous knowledge both now and into the future is a fundamental goal of ethnobiologists. Indigenous knowledge systems, developed over countless generations based on intimate knowledge, observations and experience, have often been overlooked in considerations of sustainability by national governments, planners and decision-makers. Working collaboratively and ethically with Indigenous Peoples is of primary importance, and ethnobiologists aim at documenting and communicating their important perspectives using an ethical approach.

So far, in dominant society, our relationships have been increasingly skewed in favour of humans' immediate needs and wants, to the detriment of many other species. We need to change course, and we need as many perspectives, ideas, and approaches as human ingenuity can provide to help guide us into the future. The knowledge, practices, wisdom and values of Indigenous Peoples and other long-resident communities can help us to achieve planetary sustainability (Roué & Molnár, 2016), but only if we work together and draw strength and knowledge from each other in the spirit of respect and reciprocity. Indigenous scientist and ethnobotanist Robin Wall Kimmerer (2013) describes how we can braid different knowledges—from western scientists, from Indigenous Peoples and from the other species on which we depend—like the strands in a braid of sweetgrass—without subsuming one system for another.

These perspectives are, of course, not confined only to Indigenous Peoples. For example, Aldo Leopold (1949), in 'The Land Ethic' from *A Sand County Almanac*, reflects similar values, stating: *"We abuse land because we regard it as a commodity belonging to us. When we see land* [including *'soils, waters, plants, and animals'*] *as a community to which we belong, we may begin to use it with love and respect."* Eco-philosophers like Arne Naess, who founded the Deep Ecology Movement (Devall & Sessions, 1985), also subscribe to a more holistic vision of the world and reject the notion of human supremacy. Eco-centric values are also promoted elsewhere, even in mainstream media today—for example in reports about rescuing whales caught in fishing nets, or how special forested areas have been made into reserves that will never be clearcut. Nevertheless, the significance of kincentric perspectives predominant among 'well-grounded' Indigenous Peoples, coupled with a deep knowledge of home environments drawn from generations of observations and perceptions, is undeniable.

As stressed by Chan et al. (2020, 694), 'The societal imperative [for transformative change] could scarcely be greater'. The obvious synergies between Chan et al.'s identified levers and leverage points for sustainability (Table 2; Figure 1) and the lessons and contributions to be drawn from alternative ways of knowing and being—Indigenous knowledge systems—a focus of the field of ethnobiology, are perhaps not surprising. The levers and leverage points, in fact, integrate seamlessly with the areas of interest and contribution in ethnobiology. With the strength of knowledge and wisdom of Indigenous Peoples world-wide, in partnership with those who recognize and respect this knowledge, transformative change and future global sustainability may well be attainable (Berkes, 2021). Ethnobiology, ethnoecology and related fields of study can contribute to this imperative through researching, highlighting and helping to adapt and renew Indigenous Peoples' earth-centred ways of knowing: respectfully, collaboratively and ethically. Perhaps we can bring together ethnobiological understandings from diverse land-based peoples and western scientific knowledge and governance concepts. Perhaps, through the strength of partnerships, these combinations will generate new, more effective and more powerful systems of knowledge and wisdom from which to make the best possible choices for the future of Mother Earth.

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CONFLICT OF INTEREST

No conflict of interest.

AUTHORS' CONTRIBUTIONS

N.J.T. wrote the first draft of the paper; A.C. and L.J. revised and added ideas.

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No data included.

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