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### Sharing across the space: Introduction to a special issue on bridging Indigenous and non-Indigenous knowledge systems

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## Commentary

## Sharing across the space: Introduction to a special issue on bridging Indigenous and non-Indigenous knowledge systems ☆



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## ABSTRACT

This special issue contains 16 articles inspired from a session at the 2021 64th International Association for Great Lakes Research Annual Meeting entitled: “*Bridging Knowledge Systems between Indigenous and non-Indigenous communities*.” Four common themes associated with bridging knowledge systems emerged from the collection of articles herein. First, wise practices should form the foundation of ethical, responsive, and productive collaborations. Second, inclusive, and accessible practices can improve our ability to bridge knowledge systems. Third, celebrating and embracing diverse languages and cultures enriches our connection to and understanding of the world around us; languages and cultures are a critical aspect of ontology and expression of knowledge that cut across all articles contained in this issue. Fourth, constructs, such as *Etuaptmumk* or Two-Eyed Seeing, can help build mutual and equitable relationships drawing on strengths of both Indigenous and non-Indigenous knowledge bases. Lessons in applying knowledge-bridging constructs are contained throughout the collection of articles. Indigenous knowledges are a rich source of experiential learning that can no longer be ignored. Creating ethical spaces for co-production of knowledge, co-learning, and joint stewardship is critical to our future and our ability to uphold Indigenous rights today. Throughout this issue, many elements of guidance are offered as ways to begin building the relationships required to bridge knowledge systems in a good way. We intend this collection to further relationship-building and ultimately trust-building among Indigenous and non-Indigenous Peoples and communities.

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## Ohenton Karithwatehkwen

The words that come before all else.

This article is published as part of a supplement sponsored by the Great Lakes Fishery Commission.

☆ Given their roles as Guest Editor or Technical Editor, A. M. Muir, E.S. Dunlop, C. Febria, J. T. Ives, W.P. Mattes and D. McGregor had no involvement in the peer-review of this article and have no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to Robert Hecky.

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Whenever we are gathered, one of us is chosen to give a greeting and thanksgiving.

Today we, as People, have gathered and as we look around us, we can see that the cycles of life continue. We have all been given the duty to live in balance and harmony with each other and all living things. Let us now bring our minds together as one and can we agree that the People of the World are important to us.

We now turn our mind to our Mother Earth, for she gives all we need for life. She supports our feet as we walk about upon her. It gives us joy that she continues to carry out her original instructions as given to her from our Creator. Let us bring our minds together and send

greetings and thanks to our Mother Earth and can we agree that she is important to us.

We now turn our mind to all the waters of the world for quenching our thirst and providing us with strength. We know water in many forms such as rivers, streams, rain, mist, and Oceans. Let us now with one mind send our greetings and thanks to all the waters of the world and can we agree that the water is important to us.

We now turn our mind to the fish and all creatures that live in the waters of the world. They too still follow their original instructions as given to them from our Creator. They help to cleanse and purify the water. They give their lives in order that we may gain their strength. Let us now with one mind send greetings and thanks to all the fish life in the world and can we agree that they are important to us.

We now turn our mind to the plants of this world. There are fields of plants as far as the eye can see and they too still carry out their original instructions from our Creator. There are many kinds of plants. Plants that add beauty to our lives, plants that we eat, plants that are used to cure and heal our weaknesses. Let us now with one mind send out our greetings and thanks to the plants of the world and can we agree that they are important to us.

We now turn our minds to all the animals of the world that they still carry out their original instructions as given to them by our Creator. Animals have many things to teach us if we just take the time to watch, learn and listen. Let us bring our minds together and send our greetings and thanks to the animals of the world and can we agree that they are important to us.

We now turn our minds to the trees of the world. There are many families of trees. Some provide us with fruit, some with beauty, some with fuel, shelter, and shade. These trees still carry out their original instructions as given by the Creator. Let us now with one mind give greetings and thanks to the trees of the world and can we agree that they are important to us.

Let us now be of one mind and give greetings and thanks to the birds of the world. The birds' voices are music to our hearts, they provide us with grace and beauty and the mystery of far-off places that they must travel to complete their cycle of life. Let us now with one mind give greetings and thanks to the birds of the world and can we agree that they are important to us.

Let us now turn our minds to the four winds that cool our hottest days. They bring the rains, they help purify the air we breathe, they help bring on the changes in the seasons. Let us now with one mind give greetings and thanks to the four winds and can we agree that they are important to us.

We now turn our minds to the Thunders or the Grandfathers. They bring with them the waters that renew life and remind us to be ever vigilant for the world is changing and we must be ready. Let us now with one mind give greetings and thanks to the Thunders and can we agree that they are important to us.

We now turn our minds to our eldest brother, the Sun. We are grateful that the sun still carries out its original instructions given to it by our Creator. It is the source of all energy and light. Let us now with one mind give greetings and thanks to our elder brother the Sun and can we agree that he is important to us.

We now turn our minds to our Grandmother Moon who lights the night time sky. She is the leader of all women. She controls the movements of the oceans of the world. By her changing faces, we measure time, judge plantings and harvesting. She controls the cycles of life and birth. Let us now with one mind give greetings and thanks to the Grandmother Moon and through her all, female life, and can we agree that she is important to us.

We now turn our minds to the stars of the world. They provide us with much beauty and mystery of the night sky. They demonstrate the vastness of our Creator's ability. They provide us with information to help with our long voyages. Let us now with one mind give greetings and thanks to the stars and can we agree that they are important to us.

Let us now turn our minds to our enlightened teachers. They share the wisdom of our ancestors and keep alive all those things that are necessary for harmony in life. For it is their teachings that allow us to stand here and give greetings and thanks as our ancestors have done so. Let us now with one mind give greetings and thanks to the Teachers of the world and can we agree that they are important to us.

We can now declare this gathering officially opened as we keep these thoughts in focus as the day goes on. May all our decisions keep the next seven generations in mind. If there are any special thoughts or if I left anything out, let your thoughts now take care of that.

One last time, I call on you my friends, let us remember the Creator and send our best greetings and warmest thanks for all the gifts of creation. We are provided with all the good things to live a good life, to know love is still around us and there is beauty in everything.

It is with one mind that we send greetings and thanks to the Creator of all things.

Now our minds are one.

Niawa Gowa (Big thank-you)

### Contextualizing the opening and closing words

Dr. Henry Lickers, a Haudenosaunee citizen of the Seneca Nation, Turtle Clan provided the opening (above) and closing (provided at the end of the article) addresses at the 2021 64th Annual Meeting of the International Association for Great Lakes Research (IAGLR). The words he spoke in these two addresses are reproduced in written form herein to bookend the introduction to this special issue on bridging knowledge systems (with express permission from this co-author). The addresses are intended to be spoken. The words themselves are just words but take on meaning when intentionally and thoughtfully delivered by the speaker in a particular place and time and for a particular reason that provides context and meaning. The emotions conveyed by the speaker are an integral component of meaning, so for those who experienced the 2021 IAGLR Annual Meeting, the words shared may evoke emotions and sentiments, hopefully taking them back to that place and time. Dr. Licker's intent was to elicit strong emotions of feeling, caring, and responsibility in the audience - that's why the tone, cadence, and inflexions differ throughout the spoken address. For readers who were unable to participate in the 2021 IAGLR Annual Meeting, as words on these pages, the addresses should remind us of what is important in this world—what we should be mindful of and work together to protect for future generations. Seeing as others see, both human and non-human beings, fosters respect for one another's ways of being and knowing and opens up the possibility of bridging knowledge systems (Fig. 1).

### Positionality

Given the historical erasure and disrespect to non-dominant forms of knowledge, histories, and rights of Indigenous Peoples, communities, and knowledge systems, it is important for authors pursuing and publishing work to make visible their connections, relations and permissions to share privileged information, relationships, and knowledges. To not acknowledge the proper authorities, permissions, and source of knowledges would otherwise be disrespectful. While each research and collaborative effort may be unique, an emergent wise practice may be for authorship teams to consider as broad of a relational network possible, including whose land and what treaty applies to where the work was conducted. Statements of affiliation and relationship to the work and community, which may or may not include settler, Indigenous, diasporic/immigrant status, community permissions, and ethics approvals received are often appreciated.





**Fig. 1.** *Learning to See as Another Sees* was created by artist-scientist, Nicole Jung, as a physical materialization of iterative reflections on Dr. Henry Lickers' opening words, *Ohenton Karithwatehkwen*. The process of creating this art, in itself, included an engaged interaction between speaker (Lickers) and listener (Jung). Therefore, the art produced neither solely depicts what was spoken or heard in isolation. Rather, this piece draws attention to the space in which speaker and listener meet one another, emphasizing the moment when the listener's and speaker's lived experiences touch to *co-create shared meaning*. In these kinds of moments, the act of bridging knowledge systems becomes possible: It is when we agree to meet one another – to listen, to acknowledge our relatedness, and to respect one another's ways of being and knowing – that we open up the potential to celebrate the strengths of multiple ways of knowing. Nicole Jung is a settler-descendent of Chinese immigrants who lives in *WSÁNEĆ* territory on Vancouver Island, BC, Canada. Nicole's academic background is in Marine Biology and Indigenous Studies, and she currently works at the intersections of these disciplines through the Centre for Indigenous Fisheries at the University of British Columbia.

To these ends, this group of co-authors represent researchers and practitioners across Turtle Island (North America) who have a variety of distinct connections to the Laurentian Great Lakes basin. We come together with a shared interest in a more equitable and ethical approach to honoring Indigenous knowledge systems, Peoples, and lands in our individual and collective work. Our expertise and lived experiences span science, legal systems, Indigenous languages, traditions, and oral histories, as well as span gender identities and Indigenous and settler histories all while operating in different systems where science-based approaches to stewardship are being applied. We carry privileges and responsibilities that shape the work we conduct and the messages we share here.

## 2021 IAGLR session on bridging knowledge systems

The theme of the 64th International Association for Great Lakes Research (IAGLR) Annual Meeting was Bridging: Knowledges • Seven Generations • Land to Lake. The collection of 16 articles comprising this issue was inspired from a session at the 64th IAGLR Annual Meeting entitled: “*Bridging Knowledge Systems between*

*Indigenous and non-Indigenous communities*.” Throughout this special issue, the term *Indigenous knowledge systems* refers to “a cumulative body of knowledge, practice and belief evolving by adaptive processes, and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment” (Berkes, 2018). Herein, Indigenous knowledge(s) is/are synonymous with traditional knowledge(s), traditional ecological knowledge(s), or Indigenous ecological knowledge(s). In plural, these terms recognize the multitude of ways of knowing that exist across Indigenous cultures and contexts. As this knowledge emanates from the land and specific place-based relationships to land, there is no one monolithic Indigenous way of knowing, perspective, or worldview. The term *non-Indigenous knowledge systems* as used herein refers primarily to dominant/Western science, but concepts could be adapted for other non-Indigenous knowledge systems.

Language choices reflect biases. To be explicit and transparent, we define a bridge (Rathwell et al., 2015, Alexander et al., 2019) between knowledge systems as a co-produced construct (i.e., physical, spiritual, conceptual, practical) or connection that preserves co-existence of multiple ways of knowing while facilitating movement of individuals, communities, or institutions between

systems. A bridge facilitates practicing, generating, sharing, and communicating knowledge across those systems. In other words, we envision a bridge(s) as a safe, shared, ethical space to connect knowledge systems and Peoples based on a synergistic and reciprocal relationship for the mutual benefit of all (see [Almack et al., this issue](#), for an example of an ethical knowledge co-production framework). Here, we place emphasis on knowledge systems maintaining individual integrity, working in contrast to concepts in the literature about “integrating” or “merging” fundamentally different kinds of knowledge together to create something new. We recognize that knowledges may change, adapt, or evolve as a result of bringing different worldviews together, but change itself is not the ultimate goal. Consistent with the metaphor, once we cross a bridge, we may stay or we may return from whence we came, but either way, our world perception will be broadened by greater insight, and we will possess richer information upon which to base future decisions.

Globally, small-scale, subsistence fisheries predominate in freshwater and marine ecosystems ([Costello et al., 2012](#); [Dowling et al., 2016](#)), and these fisheries are largely governed by Indigenous knowledge systems. However, “Western” science and management concepts continue to be the norm in conventional resource management, including commercial and recreational fisheries. Fisheries are complex, they represent interactions between humans, fishes and their forage, etc., and are best understood by a plurality of ways; therefore, we believe that bridging Indigenous and non-Indigenous knowledge systems can enhance sustainability of global aquatic ecosystems. While many of the articles in this collection are situated in the Laurentian Great Lakes of North America, [Obiero et al. \(this issue\)](#) provided an insightful account of African Indigenous knowledge with examples from the African Great Lakes that parallel advantages gained by bridging knowledges in the North American Great Lakes.

The Bridging Knowledge Systems session was unique among IAGLR annual meetings in several ways. First, due to the global COVID-19 pandemic, the session was convened virtually, which was less than ideal considering that the topic required considerable emotional and spiritual engagement by participants. Second, the session was co-envisioned and co-coordinated from inception by an Indigenous community, Chippewas of Nawash Unceded First Nation, a provincial government, Ontario Ministry of Natural Resources and Forestry (OMNRF), and an international treaty organization, Great Lakes Fishery Commission (GLFC). The multi-national collaboration led to a unique IAGLR session and the co-production of this issue which represented important steps toward strengthening relationships, building trust, and beginning to build a new path forward. Third, Indigenous community member participation was sponsored by the GLFC, and a concerted effort was made to reach out to all Indigenous communities surrounding the Great Lakes, resulting in a tremendous response with 97 Indigenous community participants in the meeting. This level of Indigenous participation in IAGLR was unprecedented. Fourth, a call for presentations was distributed as broadly as possible to enhance inclusivity and to learn from diverse experiences bridging knowledge systems. The session abstract was broadly distributed, and we specifically reached out to over 170 Indigenous Nations, Indigenous scholars, and personal contacts within the Great Lakes basin and globally. Distribution efforts resulted in 24 oral presentations from across the globe scheduled over three IAGLR conference days ([Electronic Supplementary Material \(ESM\) Table S1](#)). As many as 105 participants were logged into the virtual session and no fewer than 50 logged in during any of the three days. Fifth, the session featured live-virtual ceremonies from Anishinaabek Elders including a pipe ceremony led by Vernon Roote of the Chippewas of Saugeen

First Nation and a water ceremony and closing prayer by Thecla Neyanegijig Mishibiaijima (Wiikwemkoong Unceded Territory). A four-person panel with a collective ~ 100 yrs experience on wise practices in co-developing knowledge with Indigenous communities was also a prominent feature of the session. The panel featured Rod Whitlow (Kanien'kehá:ka; People of the Flint), Deb McGregor (Whitefish River First Nation), Sue Chiblow (Garden River First Nation), and Ryan Lauzon (Chippewas of Nawash Unceded First Nation; see [Mussett et al., this issue](#)). Finally, six virtual talking circles were convened in breakout groups to capture challenges, opportunities, and recommendations for better bridging knowledge systems in the Great Lakes (synthesized in [Stirling et al., this issue](#)). In total, the IAGLR session resulted in a highly engaging and educational session experience, which came at a pivotal time in the relationship building and healing between Indigenous and non-Indigenous communities of the Great Lakes region.

### Creating ethical and equitable space

The journey that the *Journal of Great Lakes Research* and broader IAGLR community has embarked on in recent years has generated discussions and working groups dedicated to meaningfully introduce respectful practices throughout the varied modes of gathering, communicating, and strengthening capacity. Ethical and equitable space is the term we apply to capture the coming together of the dominant worldview and approach (i.e., Western science) with Indigenous worldviews to engage one another with the aim of fostering more meaningful dialogues and research relationships ([Almack et al., this issue](#); [Ermine, 2007](#)). Calls for researchers trained in the dominant Western science realms to pursue more ethical approaches to research, scholarship, and collaboration are increasing in Great Lakes communities and beyond ([Powell, 2018](#); [Wong et al., 2020](#)). Extending beyond notions of equity, inclusion, diversity, and kindness, the creation and upholding of ethical and equitable space bravely acknowledges oppressive power structures and relations, exclusionary values and positions, and requires accountability in relational work, ethical behaviors, and a culture of care.

In practice, this special issue and recent IAGLR session have featured promising steps toward fostering ethical spaces, including the normalization of cultural practices, such as ceremony, which aims to set forth dialogue and relationship-building with an open mind and heart. Referring to wise practices and relational labor as proceeding in a “good way” offers respect for Indigenous cultures and worldviews that reminds us to listen generously and seek to build trust. A range of offerings here and elsewhere provide rich insight into how research communities have respected relationships with Indigenous communities and practitioners to uphold self-determination, governance, data, and culture (OCAP® [[FNIGC, 2021](#)]; [Febria et al., 2022](#); [Gobin et al., this issue](#); [Ho-Tassone et al., this issue a](#)). For example, [Almack et al. \(this issue\)](#) presented an insightful ethical knowledge co-production framework that was co-developed to guide their project team and learning community in all aspects of a collaborative research project. Their framework included guiding principles for working together in a good way (using the Anishinaabe principle of *Mino-bimaadiziwin*), including mutual respect and understanding, equity in decision making, and developing shared goals to address specific challenges rooted in place and time. Consistent with creating ethical and equitable space, throughout this issue, the editorial team has taken care to emphasize the validity of positionality statements, capitalization of “I” in Indigenous, and clear definition of terms such as Indigenous knowledge, traditional ecological knowledge, and other similar terms.



## Overview of this special issue

In all, this special issue contains 16 articles ranging in scope, geography, and topic. When considered together, four key themes emerged from the collection and are discussed below. First, wise practices should form the foundation of ethical, responsive, and productive collaborations (Mussett et al., [this issue](#)). Second, inclusive and accessible practices can improve our ability to bridge knowledge systems (Stirling et al., [this issue](#); McGregor et al., [this issue](#); McGregor, [this issue](#); Chiblow, [this issue](#); Holtgren and Auer, [this issue](#); Bardwell and Woller-Skar, [this issue](#)). Third, languages and cultures are a critical aspect of ontology and expression of knowledge that cut across all articles contained in this issue (see especially Obiero et al., [this issue](#)). Fourth, constructs, such as *Etuaptmunk* or Two-Eyed Seeing, facilitate bridging between Indigenous and non-Indigenous knowledge systems in an ethical way (Ho-Tassone et al., [this issue a](#); Shaw et al., [this issue](#); Duncan et al., [this issue](#); Almack et al., [this issue](#); Gobin et al., [this issue](#); Ho-Tassone et al., [this issue b](#); Fessell et al., [this issue](#); Nonkes et al., [this issue](#)). Lessons in applying knowledge bridging constructs are contained throughout the collection of articles.

Rather than a listwise summary of individual contributions to this issue, we treat the articles as a unique body of knowledge emerging from a shared experience that collectively may serve as a resource for effective bridging of Indigenous and non-Indigenous knowledge systems. Herein, by identifying and discussing a few key themes that span the collection, we intend this introductory article to be a guide to encourage further exploration of the various topics, experiences, and views contained in the individual articles. We caution that individual Indigenous Nations and projects involving Indigenous Nations are autonomous, so the lessons, recommendations, and keys to success cannot be viewed as a process or protocol for success across all contexts. To illustrate the latter point, Gobin et al. ([this issue](#)) and Almack et al. ([this issue](#)) differentiate Saugeen Ojibway Nation (SON) knowledge from other knowledges as SON-based ecological knowledge or SONEK. We hope readers can gain an appreciation for the challenges, rewards, and wise practices associated with collaborative work and understand that by carrying out this work in a good way, we can empower future generations.

The team that coordinated and implemented the IAGLR session and the teams who generated, reviewed, edited, and published the collection of papers in this special issue faced a number of hurdles. The publication process was a first-of-its-kind for the *Journal of Great Lakes Research* in terms of special issues, article content, and review and editorial processes. Two Indigenous and three non-Indigenous people served as editors; the issue represents the largest collection of Indigenous-led or participatory articles published by the journal; and the review and editorial process was flexible enough to begin to accommodate Indigenous processes. For example, one reviewer, who was a biologist for an U.S. Tribe, engaged a group of community members to review one of the articles (Mussett et al., [this issue](#)) where their collective feedback was synthesized and submitted by the reviewer. Typical journal confidentiality policies do not accommodate community review of article content; but we suggest this is something that should change. Another example is the pressure of completing the peer review and revision process under tight timelines, which can be at odds with an Indigenous-led process that cannot be rushed and involves seeking consensus and input from community members and council. Editors were challenged by balancing differences in language, communication styles (oral vs. written), timelines, and journal and scientific standards all without altering the key messages and lessons. Authors, reviewers, and editors adapted to provide the flexibility to accommodate new processes. In summary, we

hope that the collective efforts to bring this special issue to life initiates conversations within a typically Western publishing community to develop with Indigenous partners standards and practices that make their outlets more inclusive and accessible.

## Wise practices

Why advocate for wise practices? In this special issue, wise practices that support ethical, responsive, and productive collaborations are illuminated through a vast array of contexts, geographies, and Peoples. Mussett et al. ([this issue](#)) described the convening of six scholars (including two community scholars) at the 2021 IAGLR Annual meeting who shared their insights on wise practices for Indigenous/non-Indigenous scientist engagement and the bridging of multiple knowledge systems. It is far more the convention to encounter “best practices” conveyed through various guidelines, procedures, and steps to produce desired outcomes. In contrast, wise practices require people involved in a collaboration, partnership or engagement to be fully engaged in a holistic way, drawing on experience, knowledge, and deep understanding of a given situation to make decisions based on wisdom. Wise practices, in other words, are about the people, their insights, intuition, lived experience, nuance, time, ethics, knowledge of their values and priorities. Best practices do not connote the same degree of self-reflection and knowledge, humility, and introspection that wise practices offer. Wise practices are about how people relate to each other, whereas best practices are often a set of procedures. Wise practices are particularly helpful in situations that are complex, uncertain, changing, and difficult as currently found in Indigenous-non-Indigenous relations within a broader societal context of ongoing colonialism and oppression. Wise practices as described in this special issue speak to Indigenous Peoples and scientists’ interactions as involving respect for different knowledge systems, lived experiences, and capacities to adapt and respond. At their core, wise practices speak to sound professional judgment that can change over time, context, and respond to the nature of current engagement. Wise practices often speak to the core values of People who seek to share knowledge. A profound example of wise practices-teachings is offered by the Seven Grandfather/Grandmother teachings for the Anishinaabek (Chiefs in Ontario, 2010):

- o Love (Zaagidwin): To care for and help one another
- o Respect (Mnaadendmowin): To take care of all things the Creator has given on Mother Earth (Kiing)
- o Wisdom (Nbwaakaawin): To seek and share knowledge
- o Bravery (Aakdehewin): To be ready to face all the things that are hard to do
- o Honesty (Gwekwaadziwin): To speak right of things; not to lie, cheat, or deceive.
- o Humility (Dbaadendizwin): To know that each of us is a part of creation and that all People are equal.
- o Truth (Debwewin): To recognize the work of the Creator in all things.

The Seven Grandfather/Grandmother teachings convey that experience over time, understanding, insights and life stages all matter in embodying and expressing wise practices. Wise practices can be scaled to the level of relationships between Nations or communities. No two Nations are the same. Furthermore, communities within a Nation also vary considerably, thus it is critical to work directly with individual communities when contemplating research collaborations at the appropriate scale that makes sense for the Indigenous Nations and researchers. Wise practices require commitment on behalf of scientists, researchers, and Indigenous

Peoples and communities to understand, respect, and honor diverse and multiple knowledge systems for the protection of all life.

### Inclusion and accessibility

Now is the time for change. As a new-normal emerges beyond the COVID-19 pandemic (Muir et al., 2023), society must change, and with change will come opportunities to shape the future of aquatic sciences. Aquatic scientists should seize the opportunity to create a fairer, more inclusive field that celebrates diverse cultures and knowledge systems (Cooke et al., 2021; Muir et al., 2023) while also improving the scope, rigor, and quality of science informing decision making. Socio-economic barriers must be broken down (Fulweiler et al., 2021; Kantamneni, 2020) and science and stewardship redefined to be more diverse, equitable, and inclusive, with a focus on future generations (Febria et al., 2022).

Important insights that emerged from the IAGLR session talking circles were summarized by Stirling et al. (this issue). Participants felt that scientific and academic communities could be more inclusive by: (1) evaluating hiring and rewards systems; (2) adapting editorial and review processes; (3) generating more accessible funding mechanisms that include relevant proposal evaluation criteria; (4) determining how to assess and include methods associated with diverse knowledge systems; (5) including Indigenous communities in research, assessment, planning, and management; and 6) supporting Indigenous-led research. King et al., (2020) called attention to the need for a fairer academic world where recruitment, retention, and promotion processes more aggressively enhance diversity, and minimize inequities. Several Canadian academic institutions have recently hired Indigenous faculty without the requirement of a Ph.D. Indigenous knowledge systems are traditionally oral, thus, as Indigenous leadership reaffirm roles in research and stewardship, publishers should consider ways to accommodate oral aspects of knowledge systems. Research that includes Indigenous communities or occurs within Indigenous territories, should include Indigenous knowledge holders, scientists, and scholars in the review process because they possess the relevant experience to assess the contribution (Mussett et al., this issue; Stirling et al., this issue). However, the “peer-review” process does not currently accommodate such inclusivity without overtaxing Indigenous communities; thus, meaningful, and feasible ways to adapt the peer-review process should be sought. Much like the journal peer-review process, funders should reflect on proposal evaluation criteria and metrics and, where possible, broaden them to include methods that accommodate diverse knowledge systems. Research funding institutions also need to support Indigenous-led research and the distinct questions that emerge from self-determined research (McGregor et al., this issue). The tendency is for funders to default to Western scientific methods (Almack et al., this issue) because reviewers are rarely equipped with training or experience to appropriately assess proposals containing methods associated with other knowledge systems. Finally, the IAGLR talking circles highlighted opportunities for conference and meeting models to be re-envisioned (Niner et al., 2020) to address inequities in access. The virtual aspect of the 2021 IAGLR Annual Meeting and the intentional actions taken during planning for the session leading to this issue facilitated inclusion of Indigenous Peoples, their cultures, and their traditions (Stirling et al., this issue).

Enhancing diversity, equity, and inclusion in our work will provide more holistic science to benefit people and place for generations to come. Despite the clear need for more inclusive research, without the necessary resources for implementing such practices, Indigenous communities could be rapidly overburdened by

requests to participate. However, Indigenous communities must be included in research, assessment, planning, and decision-making within their territories. McGregor (this issue) drew attention to the exclusion of the Whitefish River First Nation from an Ontario provincial source water protection planning process. This exclusion led the First Nation to establish its own source water protection plan based on their knowledge (Collins et al., 2017). Similarly, Chiblow (this issue) provided insights into reconciliation for water governance in the Great Lakes from Anishinaabek kweok (women), mishoomsinaanik (grandfathers), nokomisnaanik (grandmothers), and knowledge holders. Twenty-eight informants participated in recorded conversations that were transcribed verbatim and used in a thematic analysis to portray Indigenous knowledge on reconciliation with water, women, law, interconnectedness, and reciprocity. The example above demonstrates that where resources and capacity exist, and when Indigenous communities are invited to participate, they have considerable knowledge, experience, and perspectives to share. Developing more inclusive processes without overburdening Indigenous communities remains an impediment to more holistic science, and something we can work together to overcome.

One means of building capacity among Indigenous and non-Indigenous communities for bridging knowledge systems is through education that is inclusive of multiple ways of knowing and being. New programs with new philosophies and new curricula with modern content can train our youth with at least an appreciation for diverse knowledge systems and at best the ability to bridge across knowledge systems. The pitfalls of not overhauling education systems are highlighted by Holtgren and Auer (this issue). These authors undertook semi-structured interviews within both Indigenous and non-Indigenous communities to better understand how training and experience affected interviewees understanding of management priorities and science associated with a 2007 Consent Decree between what is now the State of Michigan and five Tribes signatory to the 1836 Treaty of Washington. A key finding in their surveys was a gap in training of State employees about colonial histories, philosophical commitments, beliefs, and biases that affected ethical engagement with Indigenous communities (Holtgren and Auer, this issue). This training gap could be considered an impediment to knowledge co-production and co-management, but Holtgren and Auer (this issue) noted that non-tribal member employees of Indigenous Nations with training or experience in both Indigenous and non-Indigenous knowledge systems could help bridge that gap. As an example of positive change to curricula, Bardwell and Woller-Skar (this issue) shared their experience in using Two-Eyed Seeing to design and teach a science course at a predominantly non-Indigenous institution in Michigan, USA. Virtual participants learned from six Indigenous experts on topics ranging from the Odawa Nation's connections to water and to Indigenous education, and chemistry. Strong institutional support, faculty collaborations, and relationship building were deemed important to successfully bringing Indigenous expertise to a predominantly non-Indigenous academic audience.

### Ancestral languages

“Language is land and land is language. Indigenous languages transmit unique ways of understanding and relating to the world. Safeguarding Indigenous languages and knowledges is vital for addressing the current climate and humanitarian crises” (Chiblow and Meighan, 2022). The use of Indigenous and place-based languages was an important consideration for many of the contributors to this issue and the 2021 IAGLR session. Indigenous Peoples continue to emphasize the importance of restoring, revitalizing, and retaining ancestral languages as paramount in environ-



mental and water governance (Chiblow, 2020; Holtgren and Auer, [this issue](#); Reo et al., 2019). Ancestral languages were included in the opening and closing ceremonies of the 2021 IAGLR Annual Meeting, as well as within the special session as part of introductions and recognitions of place and living beings. Ancestral languages reflect the deep relationship that Indigenous Peoples hold with the places they have taken care of for thousands of years and continue to do so (McGregor et al., [this issue](#)). Unfortunately, Indigenous languages have been under attack often as part of broader genocidal and assimilative policies (TRC, 2015) or reluctance for inclusion and funding, yet these same languages are associated with some of the most biodiverse land and waterscapes in the world (Nakashima et al., 2012).

This special issue illustrates how the consideration of language forms a critical aspect of Indigenous ontology and expression of knowledge. The implications of including ancestral languages in the domain of Western science can be seen as a way to respectfully acknowledge the connection and relationships Indigenous Nations have with their homelands and waters, which could have positive implications for collaborative partnerships and community-led research. Recognition of the importance of ancestral languages in bridging and scientific research represents a wise practice (Mussett et al., [this issue](#)). Such a practice is an expression of decolonization and stands in opposition to past attempts of assimilation and cultural erosion of Indigenous Peoples. An important aspect of ancestral languages is observed in how Indigenous Peoples express their genealogies and ties to families, clan, and place when introducing themselves. For example, the Anishinaabek practice is to introduce oneself through name, clan, place/home and Nation in Anishinaabemowin. Such a practice not only conveys knowledge of the lands and waters one comes from, but the *responsibilities* one also has to care for such landscapes. Languages are reflections of places and Peoples.

Language is important, but one must tread carefully. It is not simply an issue of translation; it must be recognized that one is moving between different worldviews and ontologies when using multiple languages. What is clear in Anishinaabemowin for example, would not be similarly understood if translated directly to English. Much of the context, internal references, and relationships are lost through translation. For this reason, it is important for research that attempts to bridge knowledges to include fluent language speakers when possible. Respect for and utilization of ancestral languages also supports Indigenous communities in their own efforts to revitalize and retain their own languages, re-establishing connections and responsibilities to the lands and waters ensures a direct benefit in the research relationship to Indigenous communities/Peoples. This involves more than utilizing ancestral language terms for plants and wildlife and identifying places (although important). McGregor et al. ([this issue](#)), based on gathering with Elders, practitioners, and youth, found that language emerged as an important theme when seeking to engage with Indigenous knowledge systems. It becomes important for external researchers or scientists to fully appreciate the goals and priorities of a community, including language revitalization, bringing youth on the land, and caring for the land/waters as a “good way” to support Indigenous research goals.

To better understand language is to better understand places and Peoples. To engage in this understanding however, practitioners and researchers need to be willing, ready, and open for it. For instance, two prominent concepts in non-Indigenous science “natural resources” and “management” do not have parallel concepts in Anishinaabemowin (Almack et al., [this issue](#); Holtgren and Auer, [this issue](#)). In conducting interviews to gain both Indigenous and non-Indigenous perspectives about fishery management, Holtgren and Auer ([this issue](#)) noted that one Tribal leader stated “I have a hard time saying natural resources because that is a very

Western notion. It is abstract but [rather] living the way we are supposed to live with the things the Creator put here for us. Can you rephrase the question?” Luckily, as indicated in this special issue, there is growing interest in applying wise practices, establishing ethical space, and engaging in research in a good way (Almack et al., [this issue](#); Mussett et al., [this issue](#)). We support this shift and make explicit the need for respectful and careful language work in this space.

### Bridging knowledge systems

Efforts to bridge knowledge systems are critically needed, but the motivation to do so must be focused on transformative change rather box-checking (i.e., consultation) or a veiled form of extraction (see Shaw et al. and references therein, [this issue](#)). Indigenous knowledges have well served respective communities for millennia and will continue to survive and serve future generations. Likewise, non-Indigenous knowledge systems, particularly Western science, have and continue to provide objective advice to decision makers. So, why bring multiple knowledge systems together? In the words of Mi'kmaw Elder Albert Marshall, bridging knowledge systems (specifically *Etuaptmumk* or Two-Eyed Seeing) entails “learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of mainstream knowledges and ways of knowing, and to use both these eyes together, for the benefit of all” (Bartlett et al., 2012, p. 335). The practice of bridging Indigenous and non-Indigenous knowledges is also embodied in the concepts of *Waka-Taurua* (Double-Canoe; Māori; Aotearoa / New Zealand; Maxwell et al., 2019) and *Kaswentha* (Two Row Wampum Haudenosaunee; Central Canada; McGregor, 2004), among others (Reid et al., 2020). A recent construct, collaborative watershed analysis, was explored by Ho-Tassone et al. ([this issue b](#)) as a potential way to address inequities raised by McGregor ([this issue](#)) about the exclusion of Indigenous participation in water protection planning. A key theme among these knowledge-bridging constructs is that by employing the strengths of multiple ways of knowing, we can better understand natural systems, how they function, how they are changing, and thereby make better, more informed decisions for the benefit of all. Critically, bridging constructs permit the creation of an ethical space (Ermine, 2007) and partnerships that honor the rights of *and* responsibilities to all living things (Duncan, 2020; Shaw et al., [this issue](#)). Investing in building trust and relationships is necessary to bridge knowledge systems for the future health and wellbeing of the world's Great Lakes. Shaw et al. ([this issue](#)) in “Seasons of research with/by/as the Keweenaw Bay Indian Community,” provide an excellent summary of what good partnerships look like: “Partnerships are known as reciprocal teaching and learning through shared experiences with one another, an accountability that fosters progress towards shared goals.”

Fear of divergent hypotheses, conflicting information, and contradictory positions may be the root of a common criticism preventing bridging knowledge systems and knowledges. We argue that proper training and education that spans multiple ways of knowing should embrace uncertainty, stochasticity, and variation inherent in biological systems and the notion of multiple competing hypotheses (Chamberlain, 1980) to explain such processes. Some scientific approaches, such as decision analysis and adaptive management (Holling, 1978; Keeney, 2004; Walters, 1986), and human dimensions methods, such as expert elicitation (e.g., Delphi method; Hemming et al., 2017) and map biographies (Duncan et al., [this issue](#); Tobias, 2009) as well as Indigenous constructs, such as Two-Eyed Seeing have demonstrated successes in helping bridge knowledge systems. Success of these approaches can partly

be attributed to their inclusive approaches that explicitly accommodate multiple knowledge systems. For example, [Almack et al. \(this issue\)](#) described how Two-Eyed Seeing helped the Chippewas of Saugeen First Nation and Chippewas of Nawash Unceded First Nation (Saugeen Ojibway Nation Territories; SON) and the OMNRF, two groups with divergent perspectives and a history of animosity, commit to exploring causes for declining lake whitefish (*dikameg*; *Coregonus clupeaformis*) abundance in the SON traditional territory of Lake Huron. A community led process described by [Gobin et al. \(this issue\)](#) identified multiple hypotheses for observed declines in abundance of this important subsistence and commercial species and led to co-development of research projects to explore their hypotheses. Co-developing a research project provided an opportunity for mutual understanding and enhanced confidence in the study's results from both Indigenous and non-Indigenous perspectives. Commitment to co-development of a project was of particular importance to both the SON and OMNRF because the groups were dealing with management issues informed by divergent views of what biologists published in the literature and the knowledge and observations reported by SON community members ([Almack et al., this issue](#)). The SON-OMNRF example of developing a Two-Eyed Seeing project demonstrates that we cannot let differences cloud our ability to work together for responsible stewardship, and putting all hypotheses on the table builds trust and support for such collaborative projects.

Less familiar knowledge bridging constructs can be found in the arts and humanities as illustrated by a project described herein by [Ho-Tassone et al. \(this issue b\)](#). The project team collaborated with a youth after-school music and arts program in the Six Nations of the Grand River community to develop, through a co-creative art-based research method, an understanding of youth relationships with water. Youth messages were later synthesized with contributions from non-Indigenous participants to guide future monitoring in the watershed. The example described by [Ho-Tassone et al. \(this issue b\)](#) highlights that many means of bridging knowledges can work, provided wise practices are followed.

A second common concern about bridging knowledge systems is that Indigenous and non-Indigenous knowledge systems can differ considerably in scope, scale, breadth, motivation, emphasis, method, types of evidence, and modes and systems of transmission ([Table 1](#)). Like others before us, we believe that each differing knowledge system can build from the strengths of the other. Differences should be embraced as complementary strengths as opposed to limitations. Respecting differences and identifying common grounds will provide a path toward bridging knowledge systems. Importantly, we note that Indigenous and non-Indigenous knowledge systems are not monoliths, but herein, the terms are used as umbrellas for utility in the current scope of work; this framing is not to erase important differences that exist within each larger knowledge system. In practice, specificity of which knowledges are interfacing (e.g., Inuit Qaujimajatuqangit) is wise. The constructs that represent bridges between knowledge systems should have the following characteristics: (1) be co-produced; (2) preserve knowledge co-existence; (3) be based in mutual understandings and respect; (4) address and work to rectify power imbalances; (5) be reciprocal and non-extractionist; (6) identify all alternative hypotheses; and (7) be adaptive and open to learning and changing environments.

Given the challenges described above, how do we bridge knowledge systems? In our collective experiences, prescribing a process will not work because processes must be specific to the issue, place, knowledges, and partners. For example, [Shaw et al. \(this issue\)](#) provided a thorough review of over 30 existing resources for building, strengthening, and sustaining equitable research partnerships with/by/as Indigenous communities (see their [Table 1](#) for resources). The Keweenaw Bay Indian Community Lake Superior Band of Chippewa Indians built on the synthesized body of knowledge to generate their own framework of expectations for external partnerships. Consistent with the notion of issue/place/community specific engagement, this special issue provides experience-based insights on potential approaches to bridging knowledge systems and highlights some lessons and guidance that could be helpful

**Table 1**

Generalized characteristics of Indigenous (i.e., Ecological Knowledge) and non-Indigenous (i.e., Western Science) knowledge systems (adapted from [Barnhardt and Kawgley \(2005\)](#) and [Chiefs in Ontario \(2010\)](#) with modifications by the author team) and potential common ground where opportunities for bridging between knowledge systems could emerge.

Organizing principles	Indigenous Ecological Knowledge	Common Ground	Western Science
<b>Scope</b>	Physical and metaphysical world in balance and linked to moral code, “a way of living”; beliefs and values inseparable from People who practice or the lands they are part of	<b>Universe is unified</b>	Physical world divided by discipline; objective
<b>Scale</b>	Long and cyclical; local and place/community-based; issue focused	<b>Knowledge is living and evolving; adaptive; ecosystem perspective</b>	Research often short and linear (cause and effect) but fields of study can be long and cyclical (e.g., physics, geology, paleontology, etc.); global extrapolation
<b>Breadth</b>	Diverse; holistic; respect for all things; being thankful for knowledge and gifts	<b>Ecosystem-based approaches</b>	Uniform; reductionist; extractionist
<b>Motivation</b>	Practical; survival; a way of life steeped in language, tradition, ceremony, stewardship, caretaking	<b>Honesty; respect, inquisitiveness, transparency, perseverance, open-mindedness</b>	Discovery; education; management; status or position; progress
<b>Emphasis</b>	Kinship; trust for inherited wisdom; belief systems; community based; consensus	<b>Ecosystem-based approaches</b>	Dominion; skepticism of results; principal investigator-based; peer-review publication
<b>Method</b>	Observational; practical experimentation based on survival and learning over generations	<b>Empirical observation in natural settings</b>	Hierarchical; hypothesis falsification; repeatable; experimentation; analytical
<b>Information</b>	Qualitative; experience/place-based knowledge	<b>Pattern recognition; verification through repetition; reducing uncertainty; learning</b>	Quantitative; tools expand the scale for direct observation and measurement (e.g., models and simulations)
<b>Transmission</b>	Oral; community-based; generational; emphasis on metaphor, vision, story, song, prayer, and dance connected to life, values, and behavior	<b>Empowering future generations</b>	Written; emphasis on theory, analytical methods, and evidence; academy
<b>Application</b>	Personal; integrated and applied to daily living; how People relate to one another	<b>Wise decision making; inference and prediction</b>	Impersonal; fragmented and applied through policy



**Fig. 2.** *Sunset on the Bay* was created by Keyanna Kimewon to reflect our shared path and future of working collaboratively. Depicted here are two individuals overlooking Georgian Bay, Lake Huron from the Niagara Escarpment. Keyanna Kimewon is an Anishinaabe of the Three Fires Confederacy from Saugeen First Nation #29 and Wikwemikong Unceded Territory. She is currently working at the Saugeen Ojibway Nation Environment office as an environmental technician and illustrator with the Coastal Waters Monitoring Program.

in such efforts but again should not be interpreted as step-by-step methods for bridging knowledge systems. In contrast to a prescriptive approach, the panel discussion highlighted “readiness,” “equity and collaboration,” and “relationships” as central themes in wise practices for developing respectful Indigenous-non-Indigenous relations. [Fessell et al. \(this issue\)](#) told the story of how differences among the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) and multiple municipal, state, and federal entities were acknowledged and set aside to come together in developing a novel project partnership agreement with the U.S. Army Corps of Engineers as a critical element of one of the largest whole river restoration projects in North America. These authors concluded that “The example set by GTB in this situation serves as an example of how important it is for tribal nations to speak and act in support of positive change that helps the challenges of past traumas move into opportunities to heal and grow in the best interest of the whole.” In another example, [Nonkes et al. \(this issue\)](#) shared perspectives on how Two-Eyed Seeing could serve as a framework for a more inclusive and holistic approach to Great Lakes invasive species, such as sea lamprey *Petromyzon marinus*. While there is no one way or method for bridging knowledge sys-

tems, the articles herein provide some shining examples of viable approaches.

Most of the articles in this special issue are co-authored by Indigenous and non-Indigenous partners; therefore, we hope that varied perspectives are captured on how to begin the work of bridging knowledge systems. Two-Eyed Seeing was prominently featured herein as a construct for bridging knowledge systems ([Almack et al., this issue](#); [Gobin et al., this issue](#); [Nonkes et al., this issue](#)) and has gained tremendous traction in the literature for a variety of fields (e.g., education, health). We intend this collection of papers to inspire others to engage Two-Eyed Seeing and related approaches to bridging knowledge systems, specifically in the realms of aquatic and fishery sciences.

### A renewed philosophy

“Science” is a Latin derivative for the word knowledge. World “knowledge systems” all generate “knowledge” to aid in decision making and ultimately survival. While the knowledge itself has important contextual differences that must be honored and

respected, differences largely result from alternative ways of knowing, or the methods by which knowledge is acquired, verified, stored, shared, and updated (See Table 1). Considerable differences in scope and scale occur, with Indigenous systems being hundreds of generations old, whereas non-Indigenous systems, or at least, what has been termed “Western science”, are largely generational (though notable fields that span millennia include physics, geology, and paleontology). Indigenous knowledge systems are specific to individual communities and how they interact with their environment (i.e., place-based and experiential), whereas “Western” scientists tend to seek universal truths. Fundamental differences in knowledge systems and resulting knowledges historically provided rationale for working separately and prioritizing one system over another. As we enter an era of reconciliation among Indigenous and non-Indigenous Peoples, we seek to find common ground upon which diverse knowledge systems can be bridged, prioritizing our collective understanding and treatment of the natural world. That is, if we can gather on common ground recognizing what is important to us and the generations to come, as reflected in Dr. Lickers opening and closing addresses, we can be better citizens of this world and better caretakers by leveraging our collective knowledge while celebrating our differences as we look to the future (Fig. 2).

### Closing remarks

Our last word and thoughts are to give thanks to:

*The People  
The Earth  
The Waters  
The Fish  
The Plants  
The 3 Sisters  
The Medicinal Plants  
The Animals  
The Trees  
The Birds  
The Four Winds  
The Thunders  
The Sun  
The Grandmother Moon  
The Stars  
The Four Sacred Beings  
The Enlightened Teachers  
Now let our minds be one*

*Now we come to the end, the Haudenosaunee say we must never ask anything of the Creator for everything has been provided to use; but on your behalf, I'll ask only two things of the Creator as we leave this place that no impediment is place in your way as you proceed your homes, your lodgings and communities and that you see the happy smiling faces of your families and community knowing that no misfortune has befallen them while you've been here.*

*I now call on you, my friends, one last time to send your finest thanksgivings and your best thoughts to The Creator of All Things for the beauty that surrounds us.*

*Now our minds are one.  
Niawa Gowa (big thank-you)*

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jglr.2023.04.001>.

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