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"Two-Eyed Seeing": An Indigenous framework to transform fisheries research and management

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Abstract

Increasingly, fisheries researchers and managers seek or are compelled to "bridge" Indigenous knowledge systems with Western scientific approaches to understanding and governing fisheries. Here, we move beyond the all-too-common narrative about integrating or incorporating (too often used as euphemisms for assimilating) other knowledge systems into Western science, instead of building an ethic of knowledge coexistence and complementarity in knowledge generation using Two-Eyed Seeing as a guiding framework. Two-Eyed Seeing (*Etuaptmumk* in Mi'kmaw) embraces "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," as envisaged by Elder Dr. Albert Marshall. In this paper, we examine the notion of knowledge dichotomies and imperatives for knowledge coexistence and draw parallels between Two-Eyed Seeing and other analogous Indigenous frameworks from around the world. It is set apart from other Indigenous frameworks in its explicit action imperative—central to Two-Eyed Seeing is the notion that knowledge transforms the holder and that the holder bears a responsibility to act on that knowledge. We explore its operationalization through three Canadian aquatic and fisheries case-studies that co-develop questions, document and mobilize knowledge, and co-produce insights and decisions. We argue that Two-Eyed Seeing provides a pathway to a plural coexistence, where time-tested Indigenous knowledge systems can be paired with, not subsumed by, Western scientific insights for an equitable and sustainable future.

KEYWORDS

co-production, *Etuaptmumk*, indigenous knowledge, knowledge coexistence, pluralism, Western science

1 | INTRODUCTION

1.1 | Positionality statement

It is with *t'ooyaks* (Nisga'a for 'thanks') to senior author and Mi'kmaw Elder Dr. Albert Marshall that we (the author team) have come to learn and embrace the concept of *Etuaptmumk* (Mi'kmaw for 'Two-Eyed Seeing') and it is through his guidance that we have envisioned a new path for fisheries research and management. The knowledge Albert has imparted through his work over the decades, he is adamant, is not his own to claim, for he is but a conduit for the knowledge of generations. It is thus to those generations of Mi'kmaq

Knowledge Keepers, past, present, and future, Albert included, that we express *t'ooyaks*. Andrea Reid is a Nisga'a fisheries scientist who led this effort from Algonquin Anishinaabeg traditional territory. Andrea carries a responsibility to hold place for Indigenous voices in the academe, especially within the natural sciences, where often no space is held, and she is supported and upheld in this work by settler scholar colleagues, allies, and mentors Lauren Eckert, John-Francis Lane, Dr. Nathan Young, Dr. Scott Hinch, Dr. Chris Darimont, Dr. Steven Cooke, and Dr. Natalie Ban. Together, the author team welcomes the reader to this space created expressly for Indigenous and mainstream fisheries knowledges and ways of knowing to come together, to coexist for the benefit of all – fish, people, and place – today and in the future.

1.2 | Background and purpose

All research, scientific or otherwise, is shaped by philosophical foundations and assumptions. Research paradigms or worldviews are defined and distinguished according to their ontologies (the nature of reality), epistemologies (the theory of knowledge and its validity), axiologies (the nature of values) and methodologies (the purpose and process of research; Godfrey-Smith, 2009; Wilson, 2008). Collectively, these core philosophical underpinnings reflect researchers' perspectives or views of reality, determine what they count as knowledge and accept as ways of knowing, and guide their priorities, choices and actions in research (Held, 2019). It follows that multiple research paradigms exist as there is a plurality of ways in which the world around us is read or interpreted (Guba & Lincoln, 1994). However, it is their long-term coexistence that comes into question as colonial forces and linked power imbalances promote certain knowledge types and ways of generating knowledge (e.g. Western science) over others (e.g. Indigenous; Cajete, 2000).

The science and management of conventional fisheries is based on a Western or Eurocentric paradigm. It was originally developed in the service of single-stock, large-scale and commodity-oriented fisheries in North temperate parts of the world (this is evident in early texts such as Beverton & Holt, 1957; King, 1995; Lackey & Nielsen, 1980; Royce, 1975). In stark contrast to most small-scale, subsistence-oriented fisheries worldwide, the former relies on a positivistic epistemology (i.e. that there is one "knowable" truth; Berkes, 2003; Denny & Fanning, 2016) and adheres to an "illusion of certainty" in which nature is predictable and controllable (Charles, 2001). The dominant worldview has been both hierarchical and paternalistic (Davis & Jentoft, 2001), ascribing to "command and control" resource management (Holling & Meffe, 1996). The net result is a global system that is largely failing both ecologically and socially (Brashares et al., 2014; Loring, 2013; Pauly et al., 2002), although some managed stocks are rebuilding (Hilborn et al., 2020; Hilborn & Ovando, 2014; Krueger et al., 2019). There have been clarion calls for "reinventing fisheries management" (Pitcher et al., 1998; Stephenson & Lane, 1995) and a push for fisheries science to adopt an ecosystem-based approach (Holling, 2001; Jackson et al., 2001). However, these have yet to surmount the substantial inertia of current practices and prevailing paradigms (Caddy & Cochrane, 2001; Tudela & Short, 2005).

Fisheries are tightly coupled and highly complex social–ecological systems—complicating both their management and their study (van Poorten et al., 2011). In a fishery, "resource units" (e.g. fish), "users" (e.g. large- and small-scale fishers) and "governance structures" (e.g. rules, governing bodies) exist and are separable, but all interact to produce outcomes on a system level (Ostrom, 2009). They are considered "complex" in that they involve two-way feedbacks and are characterized by nonlinearity, uncertainty, multiple scales, self-organization and adaptation (Berkes, 2003). Given these features, there is no single comprehensive or "correct" perspective in a complex fisheries system, but it is instead perhaps best understood through a plurality of ways (Olsson et al., 2004). Particularly at this time of stagnating or declining fisheries catches (Watson et al., 2013), intensifying fishing effort and poor management (Pitcher & Cheung, 2013), and having a lack of complete data for many of the world's fisheries (Costello et al., 2012), there is an urgency to improving this understanding and our actions towards complex fisheries problems, as well as significant potential costs (i.e. ecological, economic, socio-political, e.g. Pomeroy et al., 2007) in not doing so.

Not only would it behove fisheries scientists to use all and the best tools and knowledge available at this time of crisis, irrespective of their origin and the perceived objectivity and superiority of Western scientific approaches (TallBear, 2014), but this would importantly serve decolonial and reconciliatory efforts that help rectify uneven power relations, knowledge inequalities, and other racially linked and unjust dynamics in fisheries (Held, 2019; Latulippe, 2015).

Addressing this complexity and confronting existing problems, *Etuaptmumk* (Mi'kmaw for "Two-Eyed Seeing") provides a conceptual framework for equitably embracing multiple perspectives within a system. Mi'kmaw Elder Albert Marshall defines Two-Eyed Seeing as "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). Two-Eyed Seeing has been used to promote the coexistence of disparate paradigms across a variety of fields—for instance, in education (Hatcher et al., 2009; McKeon, 2012), medicine (Hall et al., 2015; Martin, 2012) and wildlife health (Kutz & Tomaselli, 2019)—and while a growing number of studies point to its promise for fisheries research and management (e.g. Abu et al., 2019; Giles et al., 2016; Mantyka-Pringle et al., 2017), there has yet to be equivalent comprehensive consideration of Two-Eyed Seeing applications in this domain.

Here, we move beyond the all-too-common dialogue of integrating, combining or incorporating (commonly used as euphemisms for assimilating) other knowledges and ways of knowing *into* Western science, and instead build an ethic of knowledge coexistence and complementarity in knowledge generation using Two-Eyed Seeing as a guiding framework. We first examine the notion of knowledge dichotomies and imperatives for knowledge coexistence (Section 2) and then draw parallels between Two-Eyed Seeing and other analogous Indigenous frameworks (Section 3). Next, we examine aquatic and fisheries case-studies that embrace Two-Eyed Seeing as they co-develop questions, document and mobilize knowledge, and co-produce insights and decisions (Section 4). Lastly, guided by these works, we detail ontological, epistemological, axiological and methodological changes required to transform fisheries research and management for an equitable and sustainable future (Section 5).

2 | BEYOND DICHOTOMOUS DISCOURSE

Defining Indigenous knowledge is shifting away from a focus of "utility" (what it can do for Western science) and reductionism (how it provides "data" to Western scientific analyses). However, delineating what Indigenous knowledge is and how it operates has remained largely the purview of external organizations, governments, institutions and researchers rather than by Indigenous peoples them/ourselves (Battiste & Henderson, 2000; Eckert et al., 2020; McGregor, 2004a). The associated terminology has been evolving—away from "tradition" or "folk" terms (e.g. traditional ecological knowledge or TEK) that once dominated the conservation literature (Gómez-Baggethun et al., 2013)—towards language that connotes the contemporary and diverse realities of these knowledge systems (Battiste, 2005). Indigenous knowledge (our term of choice—but see Cruikshank (1998) for an alternate view) is now widely accepted as "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). A critical addition to this definition is that this "situated knowledge" is neither separable from the knowledge holders or keepers, nor is it divisible from the environment in which it is embedded (McGregor, 2004; see glossary: Table 1). We define this term here for the purpose of the present dialogue while also recognizing problematic aspects of doing so given that Indigenous knowledge is not uniform across all Indigenous peoples (hence, why this term is often referred to in the plural form: Indigenous knowledges), and for many, it is not a definable object, but instead a way of being and living in the world (Battiste & Henderson, 2000).

Society under colonial influence has long perceived Indigenous knowledge as "the other" and in binary opposition to Western scientific knowledge (Battiste, 2005). Where the latter is thought to be quantitative, factual, analytical, reductionist and literate, the former is assumed qualitative, anecdotal, intuitive, holistic and oral (Berkes, 2018; Mistry & Berardi, 2016; Nadasdy, 1999). According to Castleden et al. (2017), who argue that "we need to challenge the dichotomy discourse," this dualistic and simplified view leads directly to notions of knowledge inequality and an othering process that favours continued division over coexistence. There are certainly distinctions in attributes that lead to both having individual strengths in specific contexts, but there is no righteous hierarchy of knowledge systems where one is systematically better or consistently outperforms another (Berkes, 2018). Both centre on improving our understanding of the world around us (Cajete, 2000)—an end that surely becomes more achievable through a plural coexistence (Howitt & Suchet-Pearson, 2006; see glossary: Table 1) where time-tested Indigenous knowledge systems can be paired with revelatory Western scientific insights (Benessia et al., 2012; Mistry & Berardi, 2016; Pierotti & Wildcat, 2000).

The prevailing solution to confronting this plurality has been "knowledge integration" (Nadasdy, 1999), a process fraught with risks and limitations. The process aims to bridge multiple knowledges, bringing new information into an existing body of knowledge (generally that which wields greater power; Hart, 2010), and to identify key similarities and differences so the latter can be minimized and knowledge consolidation simplified (Bohensky & Maru, 2011). But, as noted above, Indigenous knowledges and ways of knowing are far more than simply "information" to be subsumed into the mainstream of Western science (Agrawal, 1995)—which in essence serves only to strengthen Western science for its own ends and "to concentrate power in administrative centers, rather than in [Indigenous] communities" (Nadasdy, 1999). For these reasons, some scholars have abandoned potentially problematic terms such as integration or bridging, while others advocate that we can update their meaning and usage as Berkes (2003) has done with respect to "resource" and "management." Both options are viable ones so long as there is concomitant recognition that language choices reflect biases, and can even perpetuate colonial inequalities, so users of these terms (or their alternatives) must be explicit and transparent about their intentions with their usage. Here, we use terms such as "pairing," or better yet "adopting a Two-Eyed Seeing approach," to speak to circumstances where Indigenous and Western scientific knowledge

TABLE 1 Glossary of key terminology

English term (abbreviation)	Indigenous term (language; area)	Definition (source)
Double-Canoe	*Waka-Taurua* (Māori; Aotearoa/ New Zealand)	A conceptual framework formalized in 2018 for unifying knowledges and ways of knowing, especially Western and Māori. It is described as "two canoes… lashed together… each canoe represents the worldview and values of the people who are coming together to achieve a common purpose… each group is inherently different, and the knowledge, values and actions of each, are not made to fit into the other" (from Maxwell et al., 2019).
Indigenous Knowledge (IK) *or* Traditional Ecological Knowledge (TEK)	[a]	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 (from Berkes, 2018). It is not separable from the knowledge holders/keepers or the environment in which it is embedded (McGregor, 2004a).
Māori Guardianship	*Kaitiakitanga* (Māori; Aotearoa / New Zealand)	"Reciprocal care between Indigenous-Māori people and their territorial environment"—"Kaitiaki" means guardian, and "tanga" is a common suffix akin to "ship" (as in "kinship" or "relationship"; from Maxwell et al., 2019; Roberts et al., 1995).
Mi'kmaq Sustainability	*Netukulimk* (Mi'kmaw; Eastern Canada)	"Achieving adequate standards of community nutrition and well-being today without jeopardizing the integrity, diversity, or productivity of the environment for the future"—for seven generations to come (from McMillan & Prosper, 2016; Prosper et al., 2011).
Plural Coexistence	[a]	"A model of cross-cultural relations that acknowledges and respects Indigenous ontologies, or ways of being, and at the same time is attentive to the historical and current dominance of Eurocentric thinking within natural resource management" (from Howitt & Suchet-Pearson, 2006; Zanotti & Palomino-Schalscha, 2016).
Two-Eyed Seeing	*Etuaptmumk* (Mi'kmaw; Eastern Canada)	The gift of multiple perspectives; a conceptual framework coined by Mi'kmaw Elder Albert Marshall in 2004 for unifying knowledge systems. It is described as "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 Western knowledges and ways of knowing, and to use both these eyes together, for the benefit of all" (from Bartlett et al., 2012).
Two Row Wampum	*Kaswentha* (Haudenosaunee; Central Canada)	A 17th-century treaty belt to record an agreement between the Haudenosaunee Confederacy and Dutch settlers. "It consists of two rows of purple beads separated by rows of white beads. The purple rows represent the different vessels of the Dutch (a ship) and the Haudenosaunee (a canoe) travelling side-by-side down the "river" of existence (the white beads). While the two vessels remain separate (i.e. the cultures remain distinct), the people from each vessel are meant to interact and assist each other as need be." (from McGregor, 2004b).
Two Ways	*Ganma* (Yolngu; Northern Territory, Australia)	A metaphorical concept of how to mix knowledges equitably and achieve meaningful two-way collaborations. "It relates to the separateness of fresh water and salt water knowledge even at the point where they meet and mix. It is like what some [non-Indigenous people] call a "dialectical" relationship, in which two opposed patterns of ideas complement, interact and relate to one another, but never lose their distinctiveness as separate and opposed parts of one whole." (from Muller, 2012)

[a]Terms for these concepts are found across many Indigenous languages worldwide and vary by language/language group.

systems contribute in parallel to produce an enriched picture and mutual understanding—while recognizing that ultimately it is the actions taken that matter most, rather that the words used to describe them.

Pressure is mounting across spheres (i.e. legal, practical; see Table 2) and scales (institutional to global) to pair Indigenous knowledge systems together with Western scientific practices (Ogar et al., 2020). Regardless of terminological preferences, what we sorely need are approaches that: remedy, rather than reinforce, existing power relations; respect differences, instead of suppress them; and uphold, as opposed to diminish, their unique strengths (Muller, 2012). These latter elements comprise yet another imperative, a moral one (Paton, 1971), to conduct research in a way that

TABLE 2 Legal and practical imperatives for involving Indigenous knowledge systems in mainstream research across various scales—on the levels of institutions, Indigenous nations, nation states and internationally

Imperative	Scale	Source	Policy / Call to Action[a]
Legal: specific instruments stipulating respect for and/or inclusion of Indigenous knowledge in research, teaching and more generally	Global (148 UN member states)	United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP; UN General Assembly, 2007)	• Respect that Indigenous knowledge contributes to sustainable and equitable development, and proper environmental management [Guiding Principle] • Indigenous peoples have the right to maintain, control, protect and develop their knowledge, sciences and intellectual property over such [Article 31]
	National (Canada)	Truth and Reconciliation Commission (TRC; Government of Canada, 2015)	• Provide necessary funding to post-secondary institutions and Aboriginal schools to bring Indigenous knowledge and teaching methods into classrooms [Actions 62.2 and 62.3]
	Indigenous Nation (Heiltsuk Nation)	Heiltsuk Integrated Resource Management Department (Heiltsuk Nation, 2015)	• All research questions and activities in Heiltsuk territory will be framed to involve Heiltsuk knowledge [Guiding Principle] • All research will acknowledge Heiltsuk as an integral part of ecosystems [Guiding Principle]
Practical: requirements for obtaining approvals and/or funding to develop Indigenous-related research projects	Global (192 UN member states)	Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore (WIPO, 2010)	• Recognize value of Indigenous knowledge (social, economic, intellectual, scientific, ecological, commercial, educational); of equal scientific value as other knowledge systems [Policy Objective 1] • Respect contribution of Indigenous knowledge to conservation, food security, sustainable agriculture, progress of science and technology [Policy Objective 2]
	National (Australia)	Guidelines for Ethical Research in Australian Indigenous Studies (AIATSIS, 2012)	• The rights (as laid out in UNDRIP *Article 31* above) of Indigenous peoples must be upheld and recognized [Principle 2] • Researchers must have a good understanding of the nature of Indigenous knowledge systems and intellectual property [Principle 4]
	Institutional (Canadian universities)	Ethical Conduct for Research Involving Humans (CIHR, NSERC, & SSHRC, 2018)	• Engagement with Indigenous communities is an integral part of ethical research involving Indigenous peoples [Premise] • Researchers should appropriately engage Indigenous communities to involve knowledge holders and systems in research [Article 9.15]

[a]Policy articles and calls to action were paraphrased for brevity; meanings or implications remain unchanged.

promotes social justice and self-determination (Artelle et al., 2019; Held, 2019; Ludwig, 2016). In sum, a plural coexistence holds multiple possibilities within it: (a) improving our understanding of complex systems, with insights and information from multiple knowledges contributing to an enriched picture; (b) conforming to legal norms and practical requirements, without which many research programmes simply would not be advanced by today's funding bodies and research ethics boards; and (c) answering to undeniable moral queries about what is "right" in terms of human rights and equality.

3 | MODELS OF KNOWLEDGE COEXISTENCE

While as diverse as the ecosystems to which they are inextricably linked, Indigenous worldviews globally share a number of philosophical and spiritual underpinnings (Simpson, 2000). The knowledge held may be highly distinct across groups, but the process through which knowledge is generated predominantly ascribes to a paradigm that is cyclic, interconnected and fundamentally relational (McGregor, 2004a)—where knowledge itself depends on relationships and

connections between living beings (including humans) and non-living entities (as above; Wilson, 2008). They tend to embrace both "communitism" (the search for and commitment to Indigenous community and values; Weaver, 1997) and respectful individualism and cultural sovereignty (where individual and cultural differences are upheld and maintained rather than homogenized; Gross, 2003). Indigenous worldviews thus have potentially profound implications for how knowledges can come to be complementary and coexist, rather than compete or be subject to assimilation.

In their formative writing on multiple evidence base (MEB) approaches, Tengö et al. (2014) identify a need for new tools and approaches for co-developing questions, documenting and mobilizing knowledge, and co-producing insights and decisions—all under the guiding principle of valuing diversity in knowledge systems. In their view, "a MEB approach emphasizes the complementarity of knowledge systems and the values of letting each knowledge system speak for itself, within its own context, without assigning one dominant knowledge system with the role of external validator" (Tengö et al., 2014). A key point emerges: each way of knowing should not be assessed by external referents, but rather by internal criteria (Klenk & Meehan, 2015). MEB approaches seek to connect distinct knowledge systems (Alexander et al., 2019), often through parallel lines of Indigenous and Western scientific inquiry (Tengö et al., 2014), but mechanisms and successful examples of this or equivalent approaches in practice, especially in an aquatic or fisheries context, have been few and far between (e.g. Cooke et al., 2020; Laidler, 2006; Mackinson, 2001).

A number of long-standing and/or contemporary Indigenous frameworks, although scarcely represented in the academic literature (and where they are, it is largely at the hand of Indigenous scholars and/or in Indigenous-focused journals), may answer directly to this need. They offer means to conceptualize and operationalize the cross-fertilization and coming together of distinct knowledge systems—epistemic pluralism (Carter, 2017) through an Indigenous lens. Conceptual frameworks are reflective of the knowledge one privileges (Kovach, 2010), and their visualization can guide important research choices (Latulippe, 2015). The subsequent four highly visual and conceptual frameworks (Figure 1; glossary: Table 1) exemplify that highly comparable approaches can arise across distinct and distant Indigenous cultures and suggest that these are likely but a small selection of a much larger number of Indigenous conceptualizations for promoting knowledge coexistence. The following descriptions provide references to key sources—many of which are written by members of the cultures from which they stem (and to which the author team does not belong, with the exception of Elder Dr. Albert Marshall of the Mi'kmaq Nation discussed in Subsection 4).

1. The *Kaswentha* (Haudenosaunee for "Two Row Wampum"; Figure 1a) is a 17th century treaty belt to record an agreement between the Haudenosaunee Confederacy and Dutch settlers in eastern New York (Ransom & Ettenger, 2001). It contains two rows of purple beads that each represents the different vessels of the Dutch (ships) and the Haudenosaunee (canoes). They are surrounded by white beads that symbolize the shared "river" of existence (McGregor, 2002). These distinct vessels remain separate, each containing their own laws, traditions and rights and neither disrupting the integrity or process of the other, though they travel together and work in partnership on common problems (Rathwell et al., 2015). Though a historical model of coexistence, it remains salient today where it is being applied to environmental protection and restoration programmes (Ransom & Ettenger, 2001), water quality monitoring projects (McGregor, 2002) and resource co-management initiatives (Stevenson, 2006).
2. On the north-eastern coast of Arnhemland, Australia, the Yolngu people have a long-standing framework that centres around

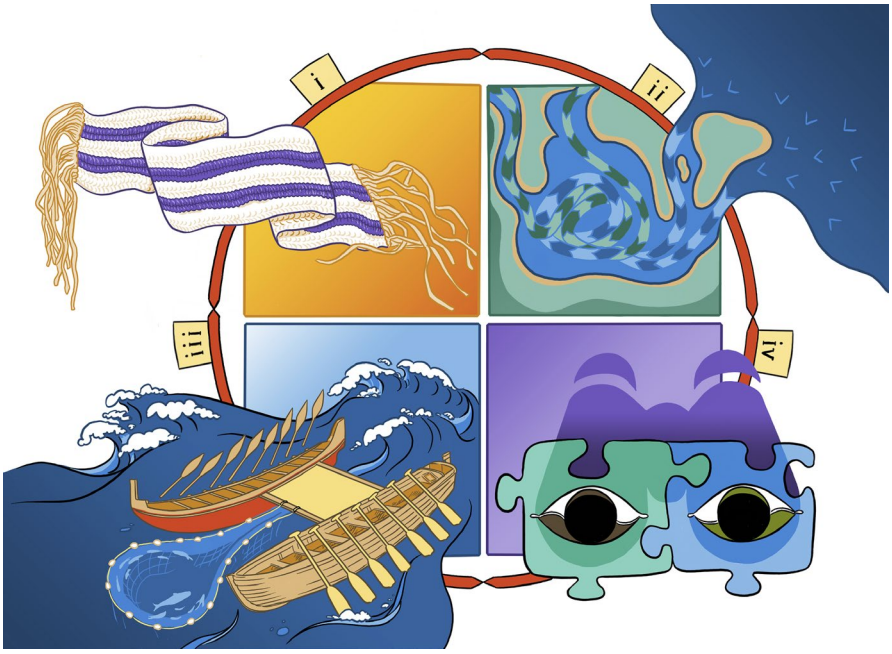

FIGURE 1 Indigenous conceptual frameworks for promoting knowledge coexistence: (i) the "Two Row Wampum" or Kaswentha in Haudenosaunee; (ii) the "Two Ways" or Ganma in Yolngu; (iii) the "Double-Canoe" or Waka-Taurua in Māori; and (iv) "Two-Eyed Seeing" or *Etuaptmumk* in Mi'kmaw. Refer to main text (section 3) for full descriptions of each framework (Subsections 1–4, respectively). Artwork by Nicole Burton

Ganma (a particular confluence of sea water and fresh water; Christie, 2007). The two waters represent distinct knowledge systems that come together, interact, but maintain their separateness akin to isohalines in a lagoon or estuary (Muller, 2012; Figure 1b). Rather than compromising one another and becoming a homogenous whole, this "Two Ways" or "Both Ways" metaphor centres around the creation of a new space where two understandings and knowledges can come together equitably and work in parallel—ultimately creating greater shared understanding (Bat et al., 2014). It is used as a mechanism to this day to ensure that Yolngu are represented equally in the thinking and planning of both land and sea management (Dhimurru Aboriginal Corporation, 2013; Marika, 1999).

3. In *Aotearoa*/New Zealand, the *Waka-Taurua* (Māori for "Double-Canoe") is a contemporary metaphorical framework where two canoes (each representing distinct knowledge systems) are lashed together temporarily for a common purpose (e.g. operating a large seine; Maxwell et al., 2019; Figure 1c). It recognizes inherent differences on both sides and is based on the assertion that respective knowledges, values and actions are not made to fit into each other. As above, there is "negotiated space" (in this case, between canoes) where knowledge systems can interface and innovate (Mila-Schaaf & Hudson, 2009; Smith, 2012). It is embedded within *Kaitiakitanga* (a Māori concept for reciprocal care between people and place; Roberts et al., 1995) and has been applied to uphold Māori and Western scientific knowledges within marine co-management and co-governance (Maxwell et al., 2019).
4. *Etuaptmumk* or Two-Eyed Seeing, as previously introduced, draws together the strengths of mainstream and Indigenous (specifically Mi'kmaw) knowledges (Bartlett et al., 2012; Figure 1d). This binocular framework leads to a "wider, deeper, and more generative field of view" than could be achieved by either perspective or knowledge system in isolation (Iwama et al., 2009). It shares with the above frameworks the notion of working collaboratively across knowledge systems on a common problem (Berkes, 2018), and as with the Double-Canoe, it centres on a cultural conservation concept that of *Netukulimk* where ecological integrity is maintained for the next seven generations (Prosper et al., 2011). It too creates space for common ground and respects differences by reducing us/them dichotomies and breaking down the compartmentalization of knowledge that leads to domination and exclusion (McMillan & Prosper, 2016).

While Two-Eyed Seeing bears substantial resemblance to the other presented frameworks, it is perhaps set apart in its explicit action imperative. Central to Two-Eyed Seeing is the notion that knowledge transforms the holder and that the holder bears a responsibility to *act* on that knowledge (Hatcher et al., 2009). *Netukulimk* implores one to uphold their responsibilities to future generations (Prosper et al., 2011); much like the early conceptual space of conservation biology (Soulé, 1985) but with emphasis here on responsibility to the place from which the knowledge emerges. To do so, *Netukulimk* uses the two perspectives made available through Two-Eyed Seeing processes to improve those very actions (McMillan & Prosper, 2016). This is not to say that the other frameworks do not share similar motivations or implications (recalling *Kaitiakitanga*), but rather that Two-Eyed Seeing uniquely moves beyond "unified-knowledges" as the end goal, to "unified-knowledges-and-here-is-what-we-are-compelled-to-do" as the ultimate realization of the framework. It is perhaps in part due to this assertion that Two-Eyed Seeing has extended past conceptual spaces, and there are a growing number of concrete examples of Two-Eyed Seeing in practice. The big question is not *whether* Two-Eyed Seeing (or like frameworks) will help us confront challenges in a post-colonial society or amidst environmental crises, but, in the words of Lawless et al. (2013), it is "rather, *how* they might be configured and applied." A significant challenge to date is the lack of pre-existing guidelines as the application of these frameworks depends highly on the specific context and the receptiveness of all actors involved (Denny & Fanning, 2016).

4 | TWO-EYED SEEING IN PRACTICE

To gain insight into how Two-Eyed Seeing approaches can and have been applied in aquatic and fisheries research and management contexts, we examine three recent case-studies that speak directly to the abovementioned need for tools and approaches for: (a) co-developing questions; (b) documenting and mobilizing knowledge; and (c) co-producing insights and decisions (Tengö et al., 2014). Given its place of origin (Eastern Canada; Bartlett et al., 2012), these examples of Two-Eyed Seeing in practice are all Canadian-based, but we draw parallels to other pertinent studies centred in other parts of the world, where possible. The subsequent case-studies each take a holistic approach, considering more than strictly fish- or fisheries-related parameters to include multiple indicators of aquatic ecosystem health (cases 4.1 and 4.2) and broader societal implications for fisheries co-management and co-governance (case 4.3).

4.1 | Co-developing questions in the Slave River Delta

This first case-study centres on the theme of developing power neutrality in the research process (Figure 2a). In response to a co-developed set of questions, the collaborative author team of Mantyka-Pringle et al. (2017; comprising Indigenous community members, academics, and other groups) employed a participatory modelling approach (Bayesian belief networks, BBNs) as the central methodology for operationalizing Two-Eyed Seeing.

In the Slave River Delta in the Northwest Territories of Canada, significant resource development activity upstream (e.g. oil sand operations in northern Alberta, the W.A.C. Bennett Dam in northern British Columbia) is having profound impacts on ecosystem health and societal well-being downstream (Dagg, 2016). This is a place where hunting and fishing comprise a vital part of Indigenous

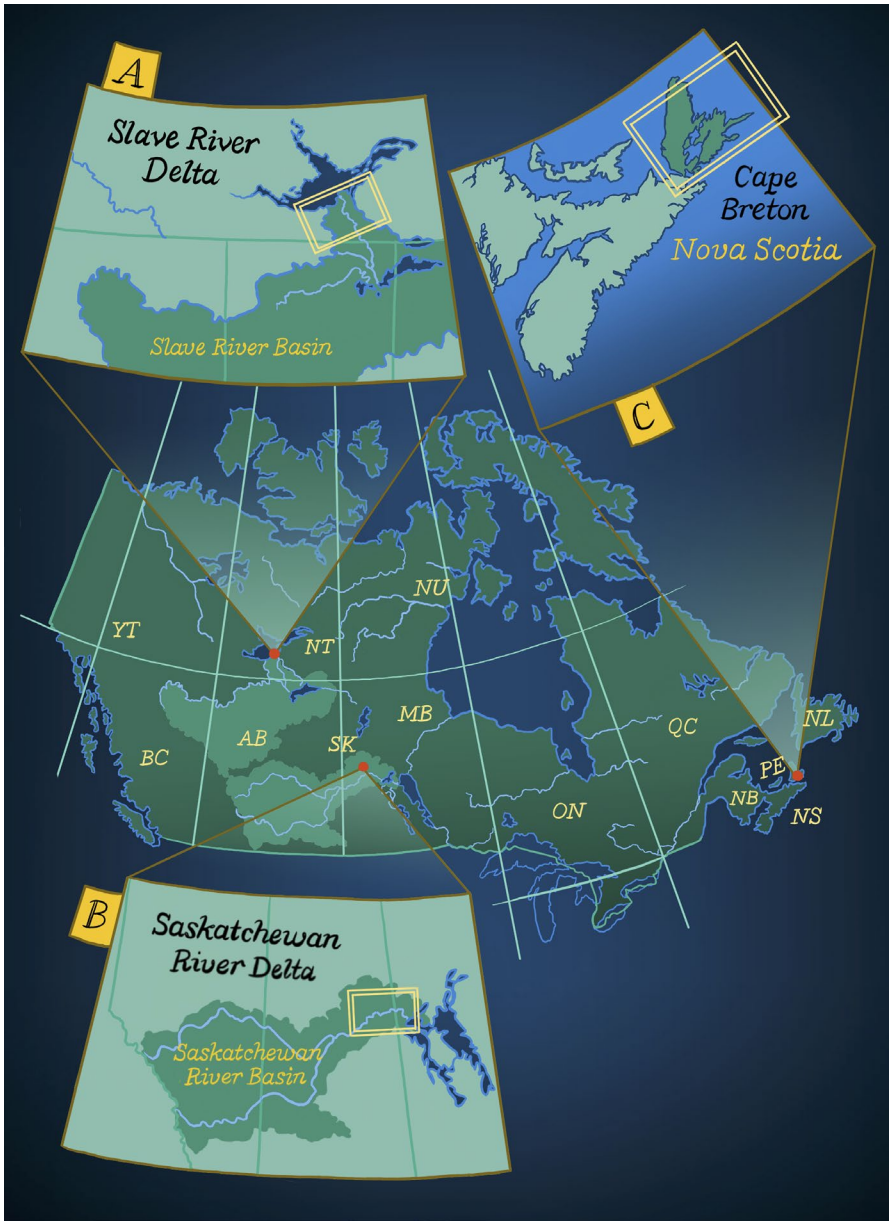

FIGURE 2 Map of Canada illustrating the location of the three case-studies operationalizing Two-Eyed Seeing: (a) Slave River Delta; (b) Saskatchewan River Delta; and (c) *Unama'ki*/Cape Breton. The landmass depicted here involves complex intersections of Indigenous territories and language groups with similarly diverse place names––we present names in English only because we cannot do this diversity justice in the scope of this diagram. Refer to main text (section 4) for full descriptions of each case-study (Sections 4.1–4.3, respectively). Artwork by Nicole Burton

life—for example, in one Slave River community (Fort Resolution), 66% of all Indigenous peoples participated in hunting and fishing in 2013, and 92% of all households ate meat or fish derived from those activities that year (NWTBS, 2014). In direct response to growing community concerns about the health of fish specifically, a diversity of "actors" in the region (three First Nations, three Métis organizations, two towns, a college and research institute, and various territorial and federal government agencies) united to create the Slave River and Delta Partnership (SRDP) in 2010. Their main goal was to develop community-based monitoring activities throughout the region, for which they solicited the help of multiple academic partners (six universities; Dagg, 2016). At an aquatic ecosystem health workshop in 2011, the SRDP and various academics co-developed three key central questions ((a) Is the water safe to drink?; (b) Are the fish and wildlife safe to eat?; and (c) Is the ecosystem healthy?") to which Mantyka-Pringle et al. (2017) offered responses.

At the 2011 workshop, >100 participants identified key indicators of aquatic ecosystem health along two distinct and complementary lines of inquiry: Western science and Indigenous knowledge. Where water quality and fish health could be described, respectively, in terms of "turbidity" (in Nephelometric Turbidity Units) or "fish external anomalies" (number of cysts, tumours, lesions and malformations) through a Western scientific lens, they could likewise be understood in terms of "the physical appearance of water" (changes in water visibility or movement over time) or "fish aesthetics" (changes in frequency of lesions or deformities over time) through an Indigenous lens. Data to inform Western science indicators ($n = 19$) were obtained through field observations and document reviews between 2011 and 2015, while key informant interviews with Elders in 2014 (Bradford & Bharadwaj, 2015) formed the basis for Indigenous knowledge indicators ($n = 22$). Two-Eyed Seeing was the core principle that informed how these two knowledge systems (and

41 indicators) would coexist, and BBNs served as the central methodology for operationalizing Two-Eyed Seeing. In 2015, the team led an expert elicitation process where they combined visual, narrative and textual tools to have key knowledge holders (an equal number of Elders, harvesters/fishers, government staff and scientists) to assess the causal links between the indicators and the three guiding questions above. Experts evaluated the following: the importance of indicators and their interactions; the state of indicators compared with the past (low, medium or high); their own level of expertise for each assessment (to populate the BBN with uncertainty estimates); and the resulting model output and behaviour (Mantyka-Pringle et al., 2017).

By bringing together interview transcripts, field data, existing models and expert judgement via participatory modelling, this team was able to provide a power-neutral approach to answering a co-developed set of questions and produce a co-authored report (i.e. Mantyka-Pringle et al., 2017 with the SRDP listed as senior author). Together, they determined a low probability that the social–ecological system is as healthy as it once was, and they found that where multiple Western science indicators were graded as "moderate" compared with the past, Indigenous knowledge indicators were graded as "low"—suggesting either that Western science is less able to detect incremental change given shorter timescales, or an unsubstantiated perception of change by Indigenous knowledge holders, or both (Moller et al., 2004). Notably, as BBNs can readily be updated as new knowledge becomes available, this study serves as but an initial model that can be refined over time. Mantyka-Pringle et al. (2017) add to the growing narrative that BBNs provide an effective means to widen the evidence base (e.g. Ban et al., 2014; Johnson et al., 2013), allowing for both quantitative and qualitative information to come together for a more holistic understanding of a complex system and enabling knowledge-inclusive partnerships to exist and be effective.

4.2 | Documenting and mobilizing knowledge in the Saskatchewan River Delta

This second case-study, Abu et al. (2019), centres on the theme of consilience—the congruence or agreement between the approaches to a topic or question by different knowledge or information systems (Figure 2b). Here, Indigenous knowledge, archival records and information collected using modern scientific instruments are brought together using the Two-Eyed Seeing framework, and their consilience is examined for a vast array of hydrology, fish and wildlife, and vegetation indicators of ecosystem change.

The Saskatchewan River Delta—North America's largest freshwater delta (10,000 km^2)—shares a similar context with the example above, where upstream anthropogenic activities (primarily the E.B. Campbell, Gardiner and Nipawin Dams) have profoundly reshaped system hydrology and fish and wildlife populations, provoking both community concern and the 2012 formation of a collaborative community–academic partnership in response (Patrick, 2014). One of the main goals of the partnership centres on finding ways for Indigenous communities and academic researchers to work together as equals, where both Indigenous knowledge and Western science are equally valued and unified to improve collective understanding of ecosystem change in the delta. Academic partners from the University of Saskatchewan identified three main questions that they explore in Abu et al. (2019): "(a) How can we learn about long-term social-ecological change from diverse knowledge holders? (b) How can we provide for the coexistence of plural forms of knowledge while engaging in respectful critique? and (c) How can we document the relative contribution each knowledge system provides and explain how each helps to fill in the gaps of the other?"

Through literature review, the authors outline various approaches for bridging knowledge systems (touching on a number of the concepts described here in Sections 2 and 3) and identify Two-Eyed Seeing as the guiding framework that will enable them to address their first two central questions. The article draws on three sources of evidence of ecosystem change in the delta. The first line of evidence was Indigenous knowledge drawn from key informant interviews with Elders and harvesters (inclusive of fishers, hunters and trappers) in 2014, which included accounts of key historical events and perceived changes in the system (Abu & Reed, 2018). Once transcribed and analysed, preliminary results were presented back to the community for review and approval. The second evidence base was archival records from the Provincial Archives of Saskatchewan on key historical events and past system changes, as well as information on resource-related policies (e.g. permits, quotas, regulations) and government correspondence (e.g. letters, petitions). The third form of evidence was instrumental observations (i.e. information collected using scientific instruments such as water gauges, or through field records such as fish-landing data). All three evidence bases included both quantitative and qualitative information that were brought together to address their third guiding questions using a simple but elegant means of examining knowledge congruence (c.f. Jackson et al., 2014) where knowledge systems were indexed as either consistent (in agreement), inconsistent (in disagreement) or an evidence type was lacking for comparison. This was performed for multiple indicators of change in hydrology ($n = 12$), fish and wildlife ($n = 16$), and vegetation ($n = 9$).

Taking this MEB approach guided by Two-Eyed Seeing, this team documented one evidence base (i.e. Indigenous knowledge; Abu & Reed, 2018) and mobilized two others (i.e. archival records and instrumental observations) for a novel and holistic approach to examining the state of a complex social–ecological system. They found a high degree of convergence across knowledge systems, where adverse changes in hydrology (83% congruent indicators), fish and wildlife (94%), and vegetation (100%) are reflected across all since the development of upstream dams. Incongruent indicators, as examples, included Indigenous knowledge signalling currently poor water quality (whereas instrumental observations declare it "safe") and a high abundance of northern pike (*Esox lucius*, Esocidae; *wícégāpís* in Cree; whereas instrumental observations find it near zero—but this may be explained by a decline in commercial interest, and thus fish-landing

data, for this species). For six out of nine vegetation indicators, pertaining largely to knowledge of berries and other flowering plants, Indigenous knowledge provided the sole source of information available. Given the overall high degree of agreement between knowledge systems (as similarly found in Jackson et al., 2014; Service et al., 2014), Abu et al. (2019) provide further reason to be confident about understanding ecological phenomena through more than a strictly traditional (i.e. Western science) lens.

4.3 | *Towards* co-producing insights and decisions on *Unama'ki*/Cape Breton Island

For this third case-study, Giles et al. (2016), we move beyond examples of uniting disparate knowledges to an instance of bringing together disparate experiences with respect to gaining insights about a fishery and making decisions based on those contrasting understandings (Figure 2c). We also move from Northern and Western parts of Canada to the East Coast where the Two-Eyed Seeing concept came into being in *Mi'kma'ki*—the traditional and contemporary territory of the Mi'kmaq people.

Unama'ki/Cape Breton Island is home to the largest Indigenous community in Atlantic Canada and the largest Mi'kmaw community on the continent: the Eskasoni First Nation (population ~4,000; MacPherson et al., 2016). Located along the Bras d'Or Lakes and surrounded by the Atlantic Ocean, the Eskasoni community is deeply engaged in fishing activities for food, social and ceremonial (FSC) purposes and commercially—with a community-owned and community-operated fishing company that employs >150 fishers and contributes to nearly 10% of Eskasoni's annual revenues (Eskasoni Band Council, 2014). Since 1999, Eskasoni has been home to the *Unama'ki* Institute of Natural Resources (UINR)—representing Eskasoni and the four other Mi'kmaq communities on the island (i.e. Membertou, Potlotek, Wagmatcook, and We'koqma'q)—and this is a group that, consistent with the previous two case-studies, was formed in response to rising community concerns regarding natural resources (especially fisheries) and their sustainability. One of UINR's central goals is to strengthen research and natural resource management while maintaining Mi'kmaq knowledges and worldviews. To this end, they frequently partner with external governments, organizations and universities on key environmental concerns (UINR, 2016). One such partnership, Giles et al. (2016), involved researchers from both Dalhousie University and UINR, as well as commercial fishers and representatives from the Eskasoni First Nation. Together, they examined Indigenous inclusion in policy-level fisheries decision-making in Canada, using Eskasoni's American eel (*Anguilla rostrata*, Anguillidae; *Kataq* in Mi'kmaw) fishery as a model system.

The American eel has been vital to the Mi'kmaq for thousands of years (primarily used now for FSC purposes and largely absent from Eskasoni's commercial fishery; Davis et al., 2004), but it has come under threat in recent decades due to the combined effects of habitat destruction and fragmentation from hydroelectric development, as well as targeted commercial fishery operations and other threats (Cairns et al., 2014). Dramatic declines (65% fewer maturing eels in the Great Lakes and upper St. Lawrence River area between 1996 and 2010) have led the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to list the American eel as threatened in 2012 and prompted its consideration for listing under Canada's 2003 *Species at Risk* Act (SARA).

While SARA states that "the traditional knowledge of the aboriginal peoples of Canada should be considered in the assessment of which species may be at risk and in developing and implementing recovery measures," there are inherent challenges that arise from the attempted "integration" of Indigenous knowledges and values into government level policy, which Giles et al. (2016) examined. Moreover, FSC fisheries are constitutionally protected in Canada and the listing of a culturally significant species such as eel could have profound impacts on community subsistence, well-being, and constitutional and treaty rights. It follows that Mi'kmaq inclusion in the COSEWIC and SARA processes for eel should be a given, but Giles et al. (2016) find minimal evidence that Mi'kmaq were included in the process.

In 2014, using Two-Eyed Seeing as a guiding framework (as UINR does through all its activities; UINR, 2016), Giles et al. (2016) interviewed both Eskasoni eel fishers (about the fishery and linked knowledges)and federal government representatives involved in COSEWIC and SARA assessments (about the process and its "use" of knowledge). They found that despite the existence of an Aboriginal Traditional Knowledge Sub-Committee (ATK SC) within COSEWIC, as well as various other measures within SARA (e.g. the National Aboriginal Council on Species at Risk (NACOSAR) and Aboriginal Funding for Species at Risk (AFSAR), which were not even raised by respondents during interviews), "the full understanding of a Mi'kmaq knowledge system is not reflected in [current] management decisions" (Giles et al., 2016). Additionally, Mi'kmaq eel fisheries were found to be underpinned by the values of kinship, relationality, generosity and *Netukulimk*, whereas the governmental approach to eel fisheries was found to be governed by a Western scientific worldview that instead prioritizes process, compartmentalization, economic benefits and conservation.

Reconciling the two vastly differing approaches to knowing and managing the eel fishery sustainably presents a considerable challenge. From the perspective of government respondents, the barriers are logistical (citing: no formal process for "integration"; concerns around data ownership), conceptual (no space in the process for cultural or spiritual components; the two systems operating on incompatible time scales—immediate vs. seven generations) and communication-based (using different languages and interpretations; unresolved historical traumas and issues of mistrust between the Mi'kmaq and the Canadian Government). Nevertheless, the authors report "considerable opportunity" for bringing Mi'kmaq knowledge systems to bear on the COSEWIC and SARA processes—highlighting specific mechanisms in their workflow (e.g. ATK SC, NACOSAR, AFSAR) and flagging areas that could be enhanced (e.g. through the inclusion of community advisory boards, scenario-building activities), as well as identifying multiple benefits of doing so *via* a

Two-Eyed Seeing approach (i.e. promoting cross-cultural and enriched understandings, fostering mutual respect, and upholding constitutional and treaty rights). Here, we find a critical examination of the involvement of Indigenous peoples and knowledges in policy decision-making and an envisioned path for meaningful and equitable co-governance based on a Two-Eyed Seeing approach—similar arguments and scenarios have been built around the Two Row Wampum model (see Stevenson, 2006), the Two Ways philosophy (see Muller, 2014), and the Double-Canoe framework (see Maxwell et al., 2019).

Two-Eyed Seeing has had visible traction in co-developing questions, documenting and mobilizing knowledge, and co-producing insights, and it holds promise for guiding policy decision-making in fisheries. But, without clear evidence here of the latter coming to full fruition (i.e. true decision co-production), this calls into question whether the mutual understanding generated through Two-Eyed Seeing is of much consequence if it is not then reflected in policy decision-making, which ultimately determines how a fishery is managed, studied, perceived and utilized. It also raises the issue of whether Indigenous knowledge systems are only being valued here because they are supported by and in strong congruence with Western science—but continued colonial sentiment throughout governing bodies prevents their full and equitable inclusion into policy decision-making.

There needs to be a fundamental rethinking in how we come to know and manage fisheries that allows space for multiple ways of knowing if we are to fulfil our obligations (legal, practical, moral, as discussed in Section 2) and achieve its co-benefits. As examples, the inclusion of Indigenous knowledge systems in fisheries research and management has been shown to: offer technological shifts that improve fisheries selectivity and sustainability (Menzies & Butler, 2007); enhance early warning systems for sea state forecasting (Sethi et al., 2011); reverse declines in the abundance and size of exploited species (Frid et al., 2016); yield otherwise inaccessible ecological insights such as missing baseline information (Eckert et al., 2018; Marin et al., 2017); and play a critical role in the improvement and the collective adherence to fisheries policy (Berkes, 2018; Johannes et al., 2000). However, rarely are the past and present impacts of colonialism on these knowledge systems and their power recognized, let alone rectified, which is both "practically and politically dangerous" (Butler, 2006) for all of the reasons presented herein.

5 | RE-ENVISIONING FISHERIES RESEARCH AND MANAGEMENT

The last decade has seen significant strides made in decolonizing research and methodologies (Held, 2019; Kealiikanakaoleohaililani & Giardina, 2016; Smith, 2012; Wilson, 2008) and in defining Indigenous worldviews *as* research method—as a defensible paradigm to guide scholarly inquiry (Kovach, 2010; Latulippe, 2015; McGregor et al., 2018). Held (2019) brings together many of these and additional works as she defines an Indigenous research paradigm in terms of its own philosophical assumptions (i.e. ontology, epistemology, axiology, methodology) and in relation to other major paradigms that inform primarily social inquiry (i.e. positivist, post-positivist, constructivist, transformative and pragmatic research paradigms). From this foundation and informed by philosophical examinations of conventional fisheries alternatives (Berkes, 2001, 2003) and the case-studies above, we can collate the purposes, main assumptions and worldviews that underpin Western and Indigenous approaches to fisheries research and management (see Table 3), and identify avenues for ontological, epistemological, axiological and methodological transformation in fisheries that allow for the full operationalization of Two-Eyed Seeing.

Instead of "fishing-as-business" (Berkes, 2003), Indigenous fisheries are often driven by ethics of sustainability (e.g. *Netukulimk*, *Kaitiakitanga*), protecting the present and future well-being of fish, people and place (Maxwell et al., 2019; McMillan & Prosper, 2016; Prosper et al., 2011; Roberts et al., 1995). While modern fisheries scientists acknowledge uncertainty in their models and projections (e.g. credibility envelopes) and contextualize their findings as being based on the best available evidence at the time, subject to change as new data arise, their discipline historically stems from a realist ontology (that there is but one knowable reality), an objectivist and empirical epistemology (where research findings are "true"), a values-free axiology (where influences and biases are denied) and an experimental and top-down methodology (through which hypotheses are verified and findings universal). In contrast to the more conventional fisheries notions, Indigenous fisheries ascribe to a relativist ontology (where multiple socially constructed realities exist), an intersubjective epistemology (that respects multiple ways of knowing and forms of knowledge), a values-centred axiology (where relational accountability is key), and a participatory and contextualized methodology (that is knowledge-inclusive and its findings specific to place; Held, 2019). The former is characterized by reductionism, positivism and "expert-knows-best" science, while the latter adopts complex systems thinking and is inclusive of local knowledge systems (Berkes, 2003). This culminates, on the one hand, in a Western scientific perspective that is founded upon a utilitarian worldview where humans are in control of nature (as described in Section 1), and an alternate perspective that humans are part of ecosystems, on the other—where, in the latter case of Indigenous fisheries, it is human actions rather than natural systems that are subject to governance and structure (Berkes, 2001, 2003). The aim here again is not to pit one approach against the other or to place them at irreconcilable odds, but rather to highlight their distinctiveness given that both have individual strengths in specific contexts.

Frameworks such as Two-Eyed Seeing that enable parallel lines of inquiry to come together require an openness to other ways of being and knowing on both sides that historically has not been reflected in the mainstream approach to fisheries research and management (Denny & Fanning, 2016; Figure 3). As made evident by the case-studies above, knowledge coexistence "for the benefit of all" (Marshall et al., 2015) depends on who is at the table and their receptiveness to alternate modes of knowing and generating knowledge. From these case-studies, there are clear actionable steps that emerge

TABLE 3 Philosophical assumptions historically underpinning conventional and Indigenous fisheries approaches and worldviews

Paradigm dimensions	Conventional fisheries	Indigenous fisheries
Purpose	Fishing-as-business	Sustainable livelihoods; collective well-being
Ontology	Realist; one knowable reality	Relativist; multiple socially constructed realities
Epistemology	Objectivist; empirical truth	Intersubjective; multiple forms of knowledge
Axiology	Values excluded; influence denied	Values included; centre relational accountability
Methodology	Experimental; top-down	Participatory and knowledge-inclusive; place-based
Worldview	Control nature; utilitarian	Humans indivisible from nature; relational

Adapted from Held (2019) and informed by Berkes (2001, 2003).

that can inform other research programs moving forward (Figure 4). For instance, in Mantyka-Pringle et al. (2017) and Abu et al. (2019), Indigenous knowledge and Western science were clearly placed on equal footing, with both serving as evidence bases to inform various indicators of aquatic ecosystem health. In the case-studies presented above, most approaches were highly participatory, being co-developed, co-run and/or co-evaluated by the collaborative teams conducting the research, with evaluations primarily measured against internal rather than external referents (e.g. experts evaluating their own expertise and model output in Mantyka-Pringle et al., 2017; researchers bringing their preliminary interview results back to the community for review and approval in Abu et al., 2019). All studies were set in motion by communitism—where Indigenous communities identified the original need(s) and invited external partners in accordingly, which was reflected in co-authorship (UINR partners in Giles et al., 2016; and the SRDP as a collective in Mantyka-Pringle

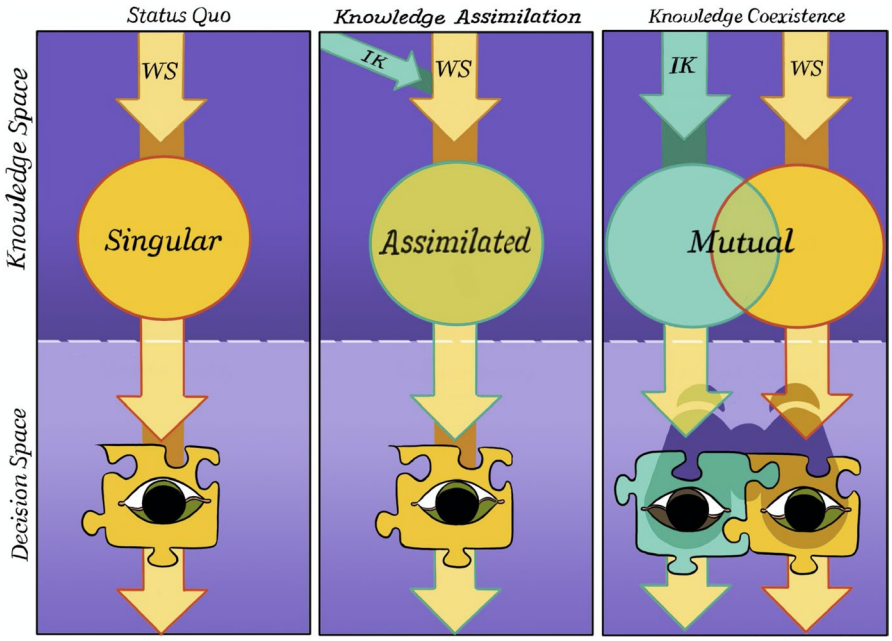

FIGURE 3 A conceptual framework detailing the flow of knowledge (IK, Indigenous knowledge; WS, Western science) that underpins researchers' understandings or views of reality, and ultimately guides their research and management decisions, as classified under three main archetypes. Status Quo (left) depicts a "one-eyed" approach that accepts solely Western science as a valid knowledge system, producing a singular understanding that informs decision-making. Knowledge assimilation (centre) is typical of many management approaches that incorporate Indigenous knowledge into Western science for an improved understanding to inform decision-making, ultimately producing another "one-eyed" approach (however, the reverse situation can also occur whereby Indigenous peoples utilize Western scientific approaches to inform their decision-making that is guided principally by Indigenous knowledge; also "one-eyed" but in the inverse orientation). Lastly, Knowledge coexistence (right) shows an approach where Western science and Indigenous knowledge contribute in parallel to produce a mutual understanding from which context-specific decisions are formed—this reflects an approach that is congruent with Two-Eyed Seeing (represented here by the same symbology shown in Figure 1). Artwork by Nicole Burton

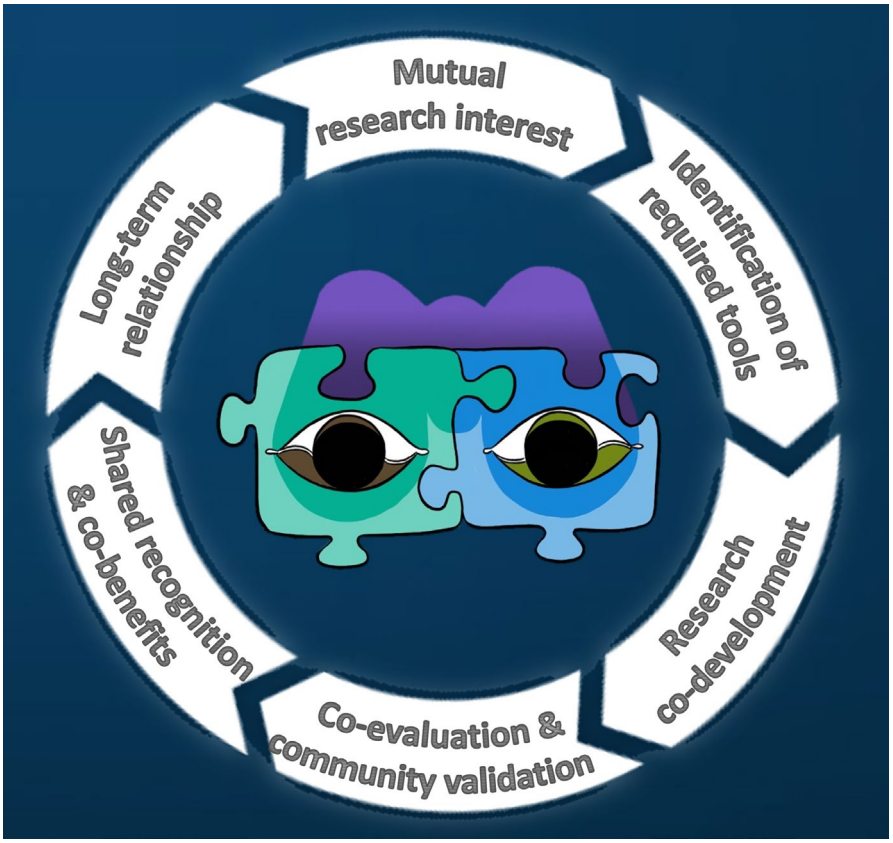

FIGURE 4 A stepwise framework for applying Two-Eyed Seeing to research, reflecting a summary of beneficial steps taken in three case-studies explored herein. The asterisks emphasize the need for a mutually recognized knowledge gap or research potential as the starting point for this cyclical process that can only be fully realized through the conceptualization of a given research programme as a relationship to be maintained and honoured over the long term

et al., 2017) or acknowledgements (Abu et al., 2019). Each study created a unique current or future pathway for Two-Eyed Seeing in their context, and all are poised for operation in the long term. They demonstrate the context-dependent nature of this framework, and that solutions are not one-size-fits-all scenarios—in fact, knowledge unification was achieved through a multiplicity of mechanisms that matched their individual circumstances.

The prevailing paradigm that was conducive to Two-Eyed Seeing in all three case-studies shares many parallels with Indigenous fisheries approaches and worldviews (Table 3). Each study respected multiple realities (reflective of a relativist ontology), considered multiple knowledges as valid and equal (an intersubjective and pluralistic epistemology where experiential and relational knowledge is equally valued), embraced relational accountability by promoting respectful representation and reciprocity (a value-centred axiology), and carried out highly inclusive and situated research processes (a participatory and place-based methodology). Holding space for multiple perspectives and seeing value in multiple teachings through respectful individualism is an adaptive feature of many Indigenous knowledge systems (Berkes, 2018), and it is a principle that is shared across many Indigenous groups, as was made evident by the plurality of models for knowledge coexistence (Section 3). This may be why Two-Eyed Seeing and other Indigenous knowledge coexistence frameworks seem to be so readily embraced by Indigenous knowledge holders and community members (Bartlett et al., 2012) where there is perhaps less of a paradigm shift required "to use both these eyes together" than for those that ascribe strictly to a Western scientific tradition.

The case-studies also highlight some challenges that need to be overcome if conventional fisheries management and research are to embrace Two-Eyed Seeing. The Slave and Saskatchewan River Delta case-studies, while both very successful, are relatively small in scale compared with the spatial extents of many fisheries. Perhaps part of their success is because they are localized, each clearly linked with specific Indigenous management areas, and about mostly FSC fisheries. The success of Two-Eyed Seeing in these case-studies illustrates that it can be done in small-scale fisheries that have to date largely been ignored by conventional fisheries management and science. The American eel case-study, with commercial interests, has been more challenging (Giles et al., 2016) and has focused on one small part of the eel's range. Fully embracing the concept of Two-Eyed Seeing at the same scale as the range of fish species, fisheries and/or management areas would require coordination of many Indigenous peoples and other interests spanning many governments and knowledge types. Such possible mismatches of scale for some species and fisheries may be an obstacle to the uptake of Two-Eyed Seeing for commercial fisheries that focus on wide-ranging species. However, examples do exist demonstrating how such frameworks can and have led to legislated spatial closures for larger scale commercial fisheries (Ban et al., 2018). But even if most initial examples of Two-Eyed Seeing in fisheries are relevant to small-scale fisheries, improvement in such fisheries is needed (Hilborn et al., 2020) and much

learning can come from such case-studies and lead to future attempts to apply Two-Eyed Seeing more broadly to commercial and industrial fisheries.

A useful thought exercise at this stage is to conceptualize how this vision could be applied to a specific fishery or other aquatic issue (e.g. development of species at risk recovery plan; siting of a protected area). How would a relativist ontology, pluralistic epistemology, value-centred axiology, and participatory and place-based methodology change the context's current and future state? How would linked practices and policies reflect the interdisciplinary, cross-cultural and pluralistic nature of Two-Eyed Seeing? This exercise could veritably provide a study unto itself, and so for the purposes of the present argument, we can instead take the existing groundwork that has been laid by Giles et al. (2016) who put forward a set of recommendations to improve Mi'kmaq input into the current Western-dominant approach to American eel fisheries and their management. Specifically, they lay out many eeling practices (e.g. sharing eels with Elders, family and community members; being highly selective during summer eeling) and corresponding management recommendations (e.g. minimum FSC level ensured; size limits for summer eeling, respectively) that they wish to be reflected in the forthcoming update to the American eel Integrated Fisheries Management Plan (IFMP) for the Maritimes region of Canada. The Department of Fisheries and Oceans Canada (DFO) is currently in negotiations with various Indigenous organizations and communities to update the IFMP appropriately, and the authors flag this as an "opportunity to explore the complementarity among the First Nations and Western scientific approaches to management while allowing for the value systems and beliefs among the different knowledge systems to be respected" (Giles et al., 2016). It is critical to note, however, that the differing worldviews underpinning Mi'kmaq and Western decision-making processes currently produces distrust and frustration on both sides, and while the authors still see "considerable opportunity" for Two-Eyed Seeing in this context, there may be many comparable cases where such an approach is wholly inappropriate to apply. For instance, as Indigenous Nations increasingly return to self-determination, there needs to be a commensurate rise in the state's confidence in the capacity of these peoples to "manage" fisheries without federal oversight (or that of another colonial force). This relinquishing of power to Indigenous process and management rights is also imperative as many post-colonial nation states grapple with reconciliation. Two-Eyed Seeing will never fit a context in which both sides are not willing partners, which may well be the case where Indigenous Nations exercise fishing rights legislated constitutionally, in treaties and/or through international legal norms (e.g. the United Nations Declaration on the Rights of Indigenous Peoples, UNDRIP Articles 25, 32.2 and 32.3).

Along a similar vein, cases may often arise where predictions and/or results are incongruent or unaligned. For instance, in both Mantyka-Pringle et al. (2017) and Abu et al. (2019), water quality was found to be in a "worse" state based on Indigenous knowledge indicators compared with Western scientific indicators, which graded water quality more moderately. A viable explanation for this trend is that through a Western scientific lens water with levels of chemical contamination below a certain threshold is considered safe to drink (a universal truth based on objectivism), whereas through an Indigenous knowledge lens, any departure from a past known state is being noted so the substantial changes in water quality being signposted by Elders are strongly suggesting otherwise (Mantyka-Pringle et al., 2017). Such discrepancies are in fact informative as they provide a fuller understanding of a complex system where Indigenous knowledge systems may exhibit higher sensitivity to environmental perturbation making them early detectors of ecological change (Berkes, 2018). Though not generally supported by the case-studies presented herein, there may of course be instances where predictions or results point in completely opposing directions—but, as with northern pike in Abu et al. (2019), these disconnects may again be illuminating and indicative of multiple realities existing within a system (e.g. where a high local abundance is being reported by local knowledge holders, and few fish landings are being reported coincident with declining commercial interest in this species). In many cases, access to multiple knowledge types may itself be a luxury, and drawing from multiple evidence bases may be the only means of filling critical knowledge gaps (e.g. as with vegetation indicators in Abu et al., 2019). Additionally, some nations may choose not to engage with colonial governments due to histories of violent colonization, and resulting relationship fractures and distrust.

Conflicting interpretations of recent events and information abound in complex fisheries systems (e.g. Newfoundland's northern cod (*Gadus morhua*, Gadidae) fishery; Finlayson, 1994), and if we continue to subscribe to the notion that knowledge is free from social process, or that scientific interpretations are not socially constructed to a large extent, then we are choosing to uphold the *status quo* or Western approach to fisheries research and management that has led us to this current state of many fisheries failing both ecologically and socially (Pauly et al., 2002). Rounding out our understanding and approach to fisheries to include other knowledges and ways of knowing is no longer an issue of awareness or method, as exemplified here, but rather the barriers are time (to build the requisite relationships), a general lack of incentives (little provocation away from inaction), and entrenched systems of political power or unsubstantiated perception of knowledge hierarchies. As common in co-management schemes (Chuenpagdee & Jentoft, 2007), the precursor to each case-study was environmental perturbation followed by a need for innovative approaches to understand and manage the aquatic environment—are we then to wait for the global disruption of all fisheries, large and small, before we choose to depart from the safety of the *status quo*? Our collaborative departure from this *status quo* can instead be a shared choice—an action imperative—generated through an equitable Two-Eyed Seeing approach which leverages many tools and perspectives towards imagining better futures for fisheries and humanity.

6 | CONCLUSIONS

Two-Eyed Seeing offers a legitimate, decolonial approach for working on "wicked" fisheries problems or other aquatic environmental challenges where singular solutions are near impossibilities, and emphasis must instead be placed on engaging in "interactive communication and learning among stakeholders, where norms and values are played out and where different ethics, ideologies, and epistemologies are active" (Jentoft & Chuenpagdee, 2009). Through its action imperative and cooperative foundation, Two-Eyed Seeing values collective over individual action and collaborative learning or "co-learning" (Bartlett et al., 2012) where once disparate and polarized groups or knowledge holders are united, bringing together their respective understandings, insights and skills to bear on a common or shared problem. They learn from one another and in doing so produce a collectively enriched picture of a complex system. Two-Eyed Seeing is a framework that very much centres on *process* rather than *outcome*, and it is actualized in its unending pursuit of responsibilities to those beings—all beings—now and seven generations ahead (McMillan & Prosper, 2016). Improving how fisheries and aquatic ecosystems are studied and managed would not be an end point *per se*, but rather a transformative and ongoing action that can be brought about through Two-Eyed Seeing that remedies power relations, respects differences and upholds unique strengths instream with its uniting of knowledges and ways of knowing. The approach outlined here also has tremendous merit and relevance to other complex environmental problems or issues beyond the aquatic realm, and we challenge our readers to personally take on the action imperative of applying the Two-Eyed Seeing framework to the context—fisheries, aquatic or otherwise—in which they study, work and live.

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DATA AVAILABILITY STATEMENT

This does not apply to the present article as no data sets were generated or analysed in the course of this work.

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