How Working Across Indigenous Knowledges and Academic Scientific Systems Strengthens Research Quality and Societal Relevance

Lessons from lived experiences in a community of practice

Authors:
Claudine Hauri, International Arctic Research Center, University of Alaska Fairbanks, chauri@alaska.edu
Julia R. Andreasen, International Arctic Research Center, University of Alaska Fairbanks, jrandreasen@alaska.edu
Simona Aracri, National Research Council of Italy, Institute of Marine Engineering (CNR-INM), simona.aracri@cnr.it
Jakob J. Assmann, University of Zurich, Switzerland, jakob.assmann@uzh.ch
Lauren Divine Berry, ldivineberry@gmail.com
Jessica Black, University of Alaska Fairbanks, College of Indigenous Studies, jcblack@alaska.edu
Cansu Culha, PermaC Land & Environment Inc. and University of British Columbia, Vancouver, BC, Canada, cansu.culha@gmail.com
Laura Ghigliotti, National Research Council of Italy, Institute for the study of anthropic impacts and sustainability of the marine environment (IAS), laura.ghigliotti@cnr.it
Myrah Graham, Amundsen Science, myrah.graham@as.ulaval.ca
Rowenna Gryba, Inuit Circumpolar Council, rgryba@inuitcircumpolar.com
Donna Hauser, International Arctic Research Center, University of Alaska Fairbanks, dhauser2@alaska.edu
Henry P. Huntington, Ocean Conservancy, hhuntington@oceanconservancy.org
Cana Uluak Itchuaqiyaq, (Iñupiaq) Noorvik Native Community and Center for Sustainable Engagement in the Arctic, Virginia Tech, cana@vt.edu
Noor Johnson, National Snow and Ice Data Center, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, noor.johnson@colorado.edu
Stanislav Saas Ksenofontov, ARCTICenter, University of Northern Iowa stanislav.ksenofontov@uni.edu
Anita Lafferty, (Dene) Liidlii Kue First Nation, University of Alberta, alaffert@ualberta.ca
Emily Lescak, International Arctic Research Center, University of Alaska Fairbanks, elescak@alaska.edu
Anne Morgenstern, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany, anne.morgenstern@awi.de
Monica Ogawa, National Institute of Polar Research, monica.ogw@gmail.com
Margaret Anamaq Rudolf (Inupiaq), International Arctic Research Center, University of Alaska Fairbanks, mhrudolf@alaska.edu
Shin Sugiyama, Arctic Research Center, HokkaidoUniversity, sugishin@lowtem.hokudai.ac.jp
Daniela Walch, Université du Québec à Rimouski, wald0001@uqar.ca

Author Positionality and Scope

Arctic research takes place on Indigenous Lands[1] and within living social-ecological systems shaped by colonial histories and persistent power imbalances in governance, education, and knowledge production. These imbalances continue to privilege externally driven research agendas and scientific institutions over Indigenous governance and knowledge systems, shaping who defines research priorities, how knowledge is generated and interpreted, and whose perspectives are amplified in local, regional, and global decision-making processes. We situate this work within this context and acknowledge our varied positions within these systems.

We are a cross-disciplinary group of Indigenous and non-Indigenous researchers, educators, and practitioners engaged in Arctic research, inclusive education, policy-relevant work, and efforts to elevate Indigenous Knowledges and the co-production of knowledge. We span multiple nationalities and are based in diverse institutional, cultural, geographic, and disciplinary contexts. Our perspectives are shaped by our roles (Rudolf et al. 2025a) as Indigenous Knowledge-holders, Elders, community members, educators, researchers, practitioners, and learners, and by differing relationships and accountabilities to place.

Collectively, we bring a wide range of experience working with Indigenous Peoples and Indigenous Knowledge Systems, spanning lived experiences, early engagement, long-standing partnerships, and leadership in co-produced research.

We are united in a shared journey of learning and reflection, and by a recognition that Arctic research must continue to evolve to more meaningfully respect and engage Indigenous Knowledge Systems, recognize Indigenous rights and sovereignty, and improve how research practices contribute to equitable, informed, relevant, and scientifically rigorous outcomes (Herrmann et al. 2023). This paper does not seek to present a singular prescriptive model, nor do we presume to speak on behalf of Indigenous Peoples or Knowledge-holders, though some of us are Indigenous. We rely on Indigenous Peoples guidance through protocols and recommendations (ICC 2021; Naalakkersuisut 2022; Kawerak 2024; ITK 2018). Rather, it reflects a collective effort to synthesize lessons, questions, and examples across disciplines and experience levels, and to make pathways toward more responsible and reciprocal Arctic research more visible and accessible.

Building from this shared recognition and diversity of experience, we focus this paper on what becomes possible when Indigenous Knowledges and academic scientific systems are brought together in practice.

Using one case study as an anchor (in a later section), we show how working across knowledge systems leads to stronger research outcomes and greater societal relevance. As a group, we have examined additional examples from across disciplines (summarized in Table 1), and

[1]Land, Air, Animals and Water are capitalized to honor it as a more than physical place or resource. Within Indigenous worldviews, Land, Water, Animals and Air are living relations, teachers, and holders of law and memory. Capitalizing Land, Air, Animals and Water signals respect and recognizes agency and the role they play in shaping identity and knowledge (Liboiron, 2021).

through these shared discussions, we have come to recognize the value of learning collectively by comparing approaches, reflecting on challenges, and exchanging ideas across diverse research contexts. These processes are not “one and done” but rather the living embodiment of deep and daily commitment towards transformative research.

Why Working Across Indigenous and Academic Scientific Knowledge Systems Matters

Across Arctic Indigenous cultures, there is a deep and enduring relationship to place, grounded in an understanding of people as living in relationship with the Air, Lands, Waters, and more-than-human relatives of home. These relationships are expressed through songs, stories, oral histories, and language, and reflect ways of knowing that are relational and holistic, rather than separating social, ecological, cultural, and ethical dimensions of the world. Disturbance to the Air, Land, and/or Water is therefore experienced as a disturbance to Peoples and culture in addition to place. Knowledge developed through respectful, reciprocal relationships with the environment supports abundance, balance, and the well-being of all relations. These relationships are reciprocal rather than linear. They ebb and flow with the seasons and in response to events and changes. To fully understand, one must deeply embed oneself in relationship with Indigenous Peoples, Lands, Waters, Air, and Animals.

Living, adapting, and thriving on Arctic Lands for millennia reflects deep knowledge, resilience, and stewardship. Indigenous Knowledges encompass understanding of the rhythms of the Land, Waters and Air, as well as the immense wisdom needed to sustain cooperative, reciprocal communities. Carefully cultivated, preserved, and built over generations, these Knowledges offer insight into patterns, cycles, and relationships that connect all parts of the environment, relationships that formal scientific approaches to research often overlook. Respect is also a word that is frequently mentioned when describing these deep relationships sustained through time. Respect for the Land, Animals, Air and Waters and their agency to help sustain life and provide to people or not.

Academic scientific research in the Arctic has a far shorter history to draw on, and when considered in isolation, relies on a limited temporal and experiential record. Conclusions based solely on this perspective therefore risk overlooking longer-term patterns and relationships that are well documented within Indigenous Knowledge Systems. Also, much Arctic academic research remains structured within disciplinary boundaries, which can limit its ability to fully account for the interconnected social, ecological and cultural dynamics. For example, when many Indigenous nations consider a species' abundance or decline, they think of the impacts on the entire ecosystem whereas in academic sciences, the species may be the only thing considered/student. While interdisciplinary approaches can address some of these gaps, working across Indigenous and academic scientific knowledge systems offers ways of understanding connection, change, and responsibility that go beyond disciplinary integration alone.

Working with Arctic Indigenous Peoples and their Knowledge Systems brings significant practical and intellectual benefits, while ethical, respectful, and reciprocal research also supports the well-being, priorities, and knowledge of Arctic Indigenous Peoples and their communities. Indigenous Peoples have long provided guidance for safe conduct in Arctic

environments, without which many research projects would have struggled to succeed or, in some cases, caused or come to harm. Disregarding these Knowledges can place both projects and personnel at risk, while careful engagement with community expertise makes research safer, more effective, more efficient, more holistic, and more successful (Erickson 2020). Beyond improving safety and feasibility, collaboration with Arctic Indigenous communities also enhances the scientific rigor and capacity of research. Community involvement increases observational coverage and improves responsiveness in rapidly changing Arctic environments (Eicken et al. 2021). Community-based monitoring can also produce scientifically rigorous datasets while enhancing the continuity and spatial resolution of environmental observations (Danielsen et al. 2022). Indigenous Knowledges and community participation further extend both the temporal and geographic reach of field monitoring, particularly in Arctic regions where year-round researcher presence is impractical (Johnson et al. 2022).

As a matter of relational responsibility and respect, researchers working in the Arctic should educate themselves about the history, cultures, values, and ways of being of the Indigenous Peoples in whose traditional territories they work (Kirkness & Barnhardt 1991). Researchers also have the responsibility to inform those whose areas they will be working in, and, where applicable, seek formal permission or approval. This responsibility is reflected in the principle of Free, Prior, and Informed Consent (FPIC), which is recognized in the UN Declaration on the Rights of Indigenous Peoples (United Nations 2007).

While formal requirements vary across the Arctic regions, the underlying ethical standards are consistent: to communicate effectively, ensure consent without pressure or imposed timelines, avoid harm, treat consent as a continuous process, and provide local benefits (FAO 2016). In many regions, these responsibilities are not only ethical but legal, reflecting Indigenous rights and sovereignty over their Lands, waters, species, and knowledge. Awareness of and compliance with relevant governance and legal frameworks are therefore fundamental responsibilities for researchers working in the Arctic.

These rights are set forth in international and national laws, agreements, documents, and commitments. For example, the United Nations Declaration on the Rights of Indigenous Peoples affirms the recognition and implementation of FPIC[2], while agreements such as the Central Arctic Ocean Fisheries Agreement recognize the importance of engaging Indigenous Peoples and their knowledge in research and management. Several other institutions and laws set forth similar policies such as First Nations principles of ownership, control, access, and possession; Inuit Nunaat Declaration; Nunavut Land Claims Agreement; Arctic Council Permanent Participants; and the Dene Declaration, to name a few.

Illustrating practice through a case study

Below we present the lessons learned from one case study, to illustrate how working across Indigenous and academic scientific knowledge systems can be carried out in practice. This example forms part of a broader effort to compile and synthesize case studies and methodologies from across academic disciplines, with the goal of highlighting how equitable co-produced research strengthens scientific quality and societal relevance (Table 1). Ongoing

[2]United Nations General Assembly. (2007).

discussions, including a session at the upcoming Arctic Observing Summit in Aarhus, Denmark, provide opportunities to refine examples, exchange lessons learned, and advance this work collaboratively. These discussions are intentionally open, inviting additional participants from across disciplines and career stages to join and contribute additional examples and perspectives to help shape the next phase of this collective effort.

This Arctic wildlife and conservation case study (Gryba et al., 2025a, b) illustrates how Indigenous Knowledges, specifically Iñupiat Knowledges, and academic scientific methods can be connected within the core analytical workflow to strengthen scientific quality, research outcomes, and societal relevance. The study focuses on the co-development of habitat selection models for ringed seals near Utqiaġvik, Alaska, in partnership with Iñupiat hunters.

The central challenge addressed by the study is that although Indigenous Knowledges are widely recognized as valuable, they are seldom directly incorporated into the quantitative models that guide species management and decision-making. Gryba et al. address this challenge by developing approaches that directly include Indigenous Knowledges of species-environment relationships into habitat selection models. Specifically, Indigenous Knowledges are used both as the sole data source within a habitat selection framework (Gryba et al., 2025a) and, in combination with animal movement data, as prior information and covariates within a Bayesian habitat selection model (Gryba et al., 2025b).

Through in-depth interviews with Iñupiat hunters, the research team documented Indigenous Knowledges about environmental variables influencing ringed seal habitat use, including distance from shore, ice concentration, ocean currents, and spatial regions. These relationships, identified by knowledge-holders, were translated into statistical distributions and incorporated into the modelling framework as probabilistic priors within a Bayesian habitat selection model. Academic scientific approaches provided the statistical structure needed to estimate habitat relationships and generate spatial predictions, while Indigenous Knowledges guided the selection and representation of species-environment relationships within the model.

Throughout the modeling process, model inputs and outputs were reviewed with Indigenous Knowledge-holders, and feedback was used to revise model assumptions and interpretation. In this way, Indigenous Knowledges and academic scientific approaches were connected iteratively within the core analytical workflow, rather than treated as separate or sequential inputs.

Working Across Knowledge Systems to Strengthen Research Quality and Societal Outcome

This case study illustrates how working across Indigenous Knowledge Systems and academic scientific systems can strengthen research quality and societal outcome in concrete ways. By bringing Indigenous (Iñupiat) Knowledges directly into the structure of a quantitative habitat selection model, Gryba et al., (2025b, a) demonstrate how Indigenous expertise can shape model specification, guide interpretation of results, and support evaluation of whether model outputs are ecologically meaningful. These contributions result in clearer assumptions, more transparent uncertainty, and habitat models that better reflect the conditions experienced by Arctic species and the people who observe and live in deep relationship with them.

At the same time, the study shows how societal relevance was enhanced. The modeling framework aligns with tools commonly used in conservation and management, while the research process explicitly respects and supports Indigenous governance, priorities, and knowledge stewardship. Free, prior, and informed consent was obtained, agreements regarding knowledge use and sharing were established and revisited, and Indigenous Knowledge holders were involved in developing the research questions and objectives, as well as reviewing and refining model outputs. As a result, the final products, including probability-of-presence maps and habitat relationships, are both technically robust and more legitimate and usable within Indigenous and management contexts.

How to move from equitable engagement to meaningful outcomes

Working across Indigenous Knowledge Systems and academic scientific systems in ways that strengthen research quality requires more than intent. It requires approaches that translate equitable engagement, grounded in respect, reciprocity, and recognition of Indigenous authority (Itchuaqiyaq et al. 2023, Carothers et al., 2021), into concrete research outcomes, insights, and decisions that are meaningful for Indigenous Peoples, researchers, and broader decision-making processes.

In practice, this work involves two inseparable elements: (1) building and sustaining relational and ethical foundations, and (2) developing or adapting methodological approaches that allow Indigenous Knowledges and academic scientific approaches to be brought into dialogue in ways that generate shared understanding and tangible results (for co-production of knowledge Rudolf et al. 2025b). Strong relationships alone do not automatically lead to shared goals, insights, or research outputs, while methodological integration without solid relational and ethical foundations risks extractive practices or outcomes that are misaligned with community priorities. For example, co-production of knowledge methodological approach, defined by shared decision-making at every step of the research, was developed between the science-policy interface that has more recently been applied to working with Arctic Indigenous Peoples with varying success due to lack of culturally responsive partnerships (Rudolf 2025). Translating equitable engagement into meaningful outcomes therefore depends on holding both elements together as research partnerships and projects evolve.

Despite growing recognition of the importance of equitable engagement, many researchers struggle to move from ethical commitment to concrete outcomes. While guidance on respectful engagement with Indigenous Peoples is increasingly available, examples of how Indigenous Knowledges and academic scientific methods can be connected within discipline-specific research practices remain uneven. In some fields, longer histories of engagement have led to more established approaches, while in others, pathways remain limited, unclear, or even contradictory.

These challenges can be especially pronounced for researchers working outside social-ecological or community-based disciplines, as well as for those who are geographically distant from the Arctic and have limited relationships to place or opportunities to learn from Indigenous Peoples, cultures, and the colonial histories shaping contemporary research. As a result, co-production may be perceived as abstract, highly contextual, or incompatible with existing

disciplinary expectations, rather than as a practical approach for repairing/remaking research relationships and strengthening research quality and relevance.

Addressing this gap requires moving beyond high-level principles toward shared and lived practice. Rather than prescribing what researchers should do, this work emphasizes concrete examples that demonstrate how Indigenous Knowledges and academic scientific approaches have already been brought into dialogue to strengthen research and societal outcomes across disciplines. By focusing on realistic entry points and learning from existing practice (Ferguson et al. 2022), we aim to make collaboration more accessible and support the broader Arctic research community in translating responsibility into meaningful practice.

We recognize practical constraints, including the limited capacity of many Arctic communities relative to the number of researchers seeking engagement. It is the right of Arctic Peoples and communities to determine when, where, how, and to what extent they engage with research at every step of the research process. Our intent is to encourage research practices that engage early and often and are beneficial to those who live in the Arctic and to society as a whole.

Supporting Arctic researchers through a community of practice

Discussions at the International Conference on Arctic Research Planning (ICARP IV), an international Arctic science planning process convened by the International Arctic Science Committee (IASC), emphasized the growing need to clearly articulate and demonstrate the quality, value and merit of co-produced knowledge within the Arctic research context. While significant progress has been made in advancing ethical and equitable engagement in Arctic academic research, perceived and actual persistent barriers remain in the practical implementation of co-production methodologies across a wide range of disciplines.

These barriers often stem not from lack of interest, but from uncertainty about relevance and application. For example, some scientists support co-production of knowledge in principle, but do not see how it applies to their work, particularly in fields like the open ocean or atmosphere where human presence may seem indirect. Such views overlook the deep and enduring connections Indigenous Peoples and communities have to the Water and Air, as well as the rich generational knowledge held within these systems. Assumptions about what Indigenous Peoples may hold knowledge about or their wish to engage in academic research can therefore create unnecessary limitations and missed opportunities.

A community of practice that shares concrete examples and offers practical entry points for researchers at different career stages and across disciplines can help make co-production more accessible, particularly for those who may not yet know where or how to begin. Such communities emphasize learning from existing practice rather than prescriptive guidance, enabling researchers to see how working across Indigenous and scientific knowledge systems strengthens scientific quality, research outcomes, and societal relevance.

One example that illustrates how such learning environments can be fostered is the Tamamta program at the University of Alaska Fairbanks. *Tamamta*, which means ‘All of Us’ in the Yupik and Sugpiaq languages, is a fellowship program designed to create a safe and supportive

space for Indigenous students within academia, with the goal of strengthening Indigenous representation and leadership in research, policy, and governance in fisheries and resource management. In this way, Tamamta provides a concrete example for how Indigenous Knowledges can be embedded within academic institutions alongside academic scientific research, rather than being treated as external or supplementary.

While Tamamta is centered on Indigenous students, a key feature that is particularly relevant for the community of practice approach envisioned here is its allyship network, which intentionally brings non-Indigenous science faculty into the program. Through participation alongside Indigenous students and scholars, faculty are exposed to Indigenous Knowledges, colonial histories, and co-production as part of an ongoing learning process rather than a one-time training. Becoming a good ally is understood as a process, emphasizing reflection, respect, and recognition of Indigenous Knowledges as legitimate, holistic and equally authoritative alongside academic and other scientific systems. Faculty participants enter at different stages of their engagement journey, creating a welcoming and non-judgmental space for dialogue, reflection, and peer exchange. Sustained participation also fosters accountability among faculty, Indigenous fellows, community partners, and one another, as learning is grounded in ongoing relationships rather than isolated interactions. This aspect of Tamamta, an environment that openly shares what has worked, what has not, and where challenges remain, offers a useful model for how communities of practice can reduce barriers to engagement and support researchers in learning to work equitably across Indigenous Knowledges and academic scientific systems in practice.

International structures such as IASC, alongside other circumpolar networks such as the University of the Arctic, provide natural platforms for scaling a community of practice approach across the Arctic research community. Among these, IASC is particularly well positioned to support such an approach because it functions as a long-standing, international convening body that is not tied to a single discipline, funding program, or region. Through its working groups, standing committees, and science planning activities, IASC routinely brings together Indigenous scholars and knowledge-holders with researchers and practitioners from across the atmosphere, marine, terrestrial, cryosphere, and social and human dimensions of Arctic research, creating sustained opportunities to share practical examples, learn collectively, and support the development of co-produced research across disciplines and career stages. This convening role allows learning to accumulate over time and across research contexts, rather than remaining confined to individual projects or short-term initiatives.

A community of practice approach is likely to be more effective than prescriptive guidance alone because it is grounded in shared learning and reflection. A community is also a set of relationships, creating many dynamic pathways for interaction and learning rather than relying solely on formal, static, written materials. By making diverse pathways visible, supporting learning across disciplines, and reducing barriers to entry, a community of practice allows researchers to engage from where they are, normalize diverse knowledge backgrounds, and build understanding over time. In doing so, it supports researchers in learning how to work across Indigenous Knowledges and academic scientific systems in ways that strengthen research quality and support priorities that span local to global scales.

Conclusions

Working within and across Indigenous Knowledges and academic scientific systems is both a responsibility and an opportunity for Arctic researchers. When done well, it strengthens research quality, interpretation, and societal relevance, supporting more robust, trusted, and actionable science. We invite researchers, no matter where they are in their experience of working with knowledge systems, to begin exploring existing case studies, finding a community of practice to expand their own learning journey, contributing new examples from their own discipline, and using the shared case-study template below as a starting point for collective learning. Through continued exchange, we aim to make pathways for working across Indigenous Knowledges and academic scientific systems more visible, accessible, and effective for Arctic research and beyond.

Table 1. Case studies examined as part of this work, spanning multiple disciplines and research contexts, and highlighting different ways Indigenous Knowledges and scientific approaches have been brought into dialogue to improve research outcomes and societal relevance.

Author(s) & Year	Title	Focus / Context
Idrobo & Berkes, 2012	*Pangnirtung Inuit and the Greenland Shark: Co-producing Knowledge of a Little Discussed Species*	Co-production of Inuit ecological knowledge about Greenland shark in southern Baffin Island.
Simonee et al., 2021	*Sila Qanuippa? (How's the Weather?): Integrating Inuit Qaujimajatuqangit and Environmental Forecasting Products to Support Travel Safety around Pond Inlet, Nunavut, in a Changing Climate*	Builds a community-driven travel-safety tool through integration of Inuit knowledge and digital forecasting tools for safe travel on sea ice and land.
Dubos et al., 2023	*Fuzzy logic modelling of anadromous Arctic char spawning habitat from Nunavik Inuit knowledge*	Habitat-modeling of Arctic char spawning using Inuit knowledge and modelling methods.

Dubos et al., 2023	*Nunavik anadromous Arctic char life histories, behaviour, and habitat use informed by both Inuit knowledge and western science: a year in Ungava Bay*	Synthesis of Inuit and western science on Arctic char life-history and habitat use in Ungava Bay.
Dawson et al., 2020	*Infusing Inuit and local knowledge into the Low Impact Shipping Corridors: An adaptation to increased shipping activity and climate change in Arctic Canada*	Draws on Inuit marine use, sea-ice travel routes, and culturally important areas to inform Arctic shipping-corridor planning, arguing that Inuit knowledge is essential for safe, socially acceptable routing
Bélisle et al., 2025	*Indigenous knowledge, forest landscape modeling, and the cumulative effects of environmental changes*	Integrates Indigenous knowledge of forest use, species, and disturbance with landscape-change models to understand cumulative effects of industrial development and climate change on forest ecosystems and land-based livelihoods.
Esquible et al., 2025	*Bridging Knowledge Systems and Perspectives to inform Salmon management and research: A Kuskokwim River Study*	An Indigenous-led, community-based project that brings together Alaska Native fishers, managers, and biologists to re-think salmon research and management, centring relational principles and identifying concrete barriers and opportunities for more equitable co-management.

Figus et al. 2022 & 2025	*The Kake Climate Partnership: Implementing a knowledge co-production framework to provide climate services in Southeast Alaska* *Sharing Our Story to Build Our Future: A Case Study of Evaluating a Partnership for Co-Produced Research in Southeast Alaska*	A co-production of knowledge partnership formation (2022) and evaluation (2025) between a Tribe in Southeast Alaska around food sovereignty and security.
Fink-Mercer et al., 2024	*Cree-driven community-partnered research on coastal ecosystem change in subarctic Canada: a multiple knowledge approach*	Cree-led steering-committee process to investigate eelgrass decline and goose ecology. Together with scientists disentangling climate and hydroelectric impacts.
Fox et al., 2020	*Connecting understandings of weather and climate: steps towards co-production of knowledge and environmental management in Inuit Nunangat*	Presents the Silalirijiit project in Kangiqtugaapik, where Inuit Elders, hunters, and scientists co-designed weather stations, documented Inuktitut weather concepts, and developed human-relevant environmental variables, grounded in long-term relationship-building and reciprocal visits.
Gryba et al., 2025a	*Indigenous knowledge as a sole data source in habitat selection functions*	Develops habitat-selection models for ringed seals using Iñupiat hunters' knowledge as the only data source to inform critical-habitat and co-management decisions.

Jones et al., 2023	*Integrating local environmental observations and remote sensing to better understand the life cycle of a thermokarst lake in Arctic Alaska*	Integration of local observations and satellite data to study thermokarst-lake dynamics.
Metcalf et al., 2025	*Co-producing knowledge about the Pacific walrus and climate change*	Co-produces a walrus population and bioenergetics model through a 3-day workshop between Yupik walrus hunters and US Fish and Wildlife Service biologists.
Mercer et al. 2025	*Empowering Indigenous-led contaminant monitoring through collaborative partnerships and two-way capacity sharing*	Reflections of Indigenous and non-Indigenous early career researchers developing an Indigenous-led monitoring program.
Wilson et al., 2021	*The Mittimatalik Siku Asijjipallianinga (Sea Ice Climate Atlas)*	Community-produced sea-ice atlas integrating Inuit knowledge and climate data for Mittimatalik (Pond Inlet).
Bronen et al., 2019	*Usteq: integrating Indigenous knowledge and social and physical sciences to co-produce knowledge and support community-based adaptation*	Works with two Alaska Native communities to co-design monitoring of erosion, storms, flooding, and permafrost thaw, in order to develop an Indigenous-led relocation governance framework.

Case Study Template

Case study title

Reference: (Authors, year)

Disciplinary and geographic context

- Discipline(s):
- Region and place(s):
- Indigenous Peoples / Knowledge holders involved:

Initial research question or challenge

- What scientific or management challenge motivated the work?
- What limitations or gaps were identified in existing approaches?

Entry point for Indigenous Knowledges

- At what stage did Indigenous Peoples and Indigenous Knowledges enter the research (e.g., framing, methods, interpretation)?
- How was Indigenous Knowledges documented or shared?

How Indigenous Knowledges and scientific approaches were connected

- How was Indigenous Knowledges and/or scientific knowledge interpreted, summarized, translated to connect approaches?
- What specific methods or tools were used to connect knowledge systems?
- How did Indigenous Knowledges influence scientific approach (e.g. variables, scales, assumptions)?
- Were there remaining areas identified where knowledge could not be connected?

Scientific outcomes

- How did working across knowledge systems change interpretation, synthesis, or evaluation?
  What aspects of scientific quality were strengthened (e.g., model structure, uncertainty, relevance)?

Societal outcomes

- How did the research improve relevance, trust, legitimacy, or usability?
- How were ethical considerations, consent, and governance addressed?

Transferable lessons

- What aspects of this case are relevant to other disciplines or regions?
- What entry points or principles could others adapt to their own work?
- What methods would need to be developed to make it transferable?

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