Weaving the Seen and Unseen: Stewarding the Arctic Means Sustaining Indigenous Monitoring

https://doi.org/10.25923/qrm7-bv68

H. -M. Ladd[1], V. M. Padula[1], A. Bishop[2], B. Robson[1], R. Fried[2], B. Barst[3], S. G. Crawford[4], A. R. Gastaldi[4], D. Melovidov[1], and O. M. Gologergen[2]

[1]Aleut Community of St. Paul Island Tribal Government, St. Paul Island, AK, USA
[2]University of Alaska Anchorage, Anchorage, AK, USA
[3]University of Calgary, Calgary, AB, Canada
[4]University of Alaska Fairbanks, Fairbanks, AK, USA

Headlines

- On St. Paul Island, Alaska, the BRAIDED Food Security Project (Building Research Aligned with Indigenous Determination, Equity, and Decision-making) and the newly established Bering Sea Research Center (BSRC) delivered food safety information directly to the community in 2025, weaving what is seen in harvests with what is unseen with analysis of contaminants in traditional foods.
- For over two decades, the Indigenous Sentinels Network (ISN) has collected observations on weather and wildlife by providing the cyberinfrastructure to Indigenous communities and partners to support data collection and governance.
- Weaving the seen and unseen shows why this work matters: Indigenous-led monitoring through BRAIDED, BSRC, and ISN supports Arctic stewardship and community resilience.

Introduction

Across the Arctic, survival has long depended on close observation of lands and waters. Families watch the sea and skies, reading shifts in currents, winds, and wildlife. Knowledge is inseparable from culture: observing is stewardship, livelihood, and science all at once (Carroll 2024). Community members see when sea ice forms late or breaks up too soon. Harvesters know when fish arrive later or when seals show signs of stress. Elders track shifting winds and the silence where birds once nested. Observations are not anecdotes; they are essential data points for decision-making and survival.

For too long, Arctic research has treated Indigenous peoples as “informants” or “stakeholders.” Yet, Indigenous Sentinels and Guardians— Indigenous experts who, like Australia’s Rangers or Canada’s Guardians, combine Traditional Knowledge and Western science to care for their lands and waters—have always been scientists (Government of Canada 2023; National Indigenous Australians Agency 2025; Fox and Jaypoody 2024). Today, their expertise is essential to resilience and research in the Arctic.

Here, we focus on St. Paul Island—the largest of the Pribilof Islands—home to the Unangax̂ (Aleut) peoples (Fig. 1). The island is shaped by winds up to 60 mph and is one of the world’s most ecologically productive marine ecosystems. Currently, this region is experiencing dramatic environmental impacts (Slats et al. 2019). This article tells the story of two interconnected initiatives led by the Aleut

Community of St. Paul Island (ACSPI) Tribal Government: the BRAIDED Food Security Project (Building Research Aligned with Indigenous Determination, Equity, and Decision-making) and the Indigenous Sentinels Network (ISN). These efforts are more than projects; they are pathways to resilience, rooted in Indigenous leadership and designed to meet the challenges of a changing world.

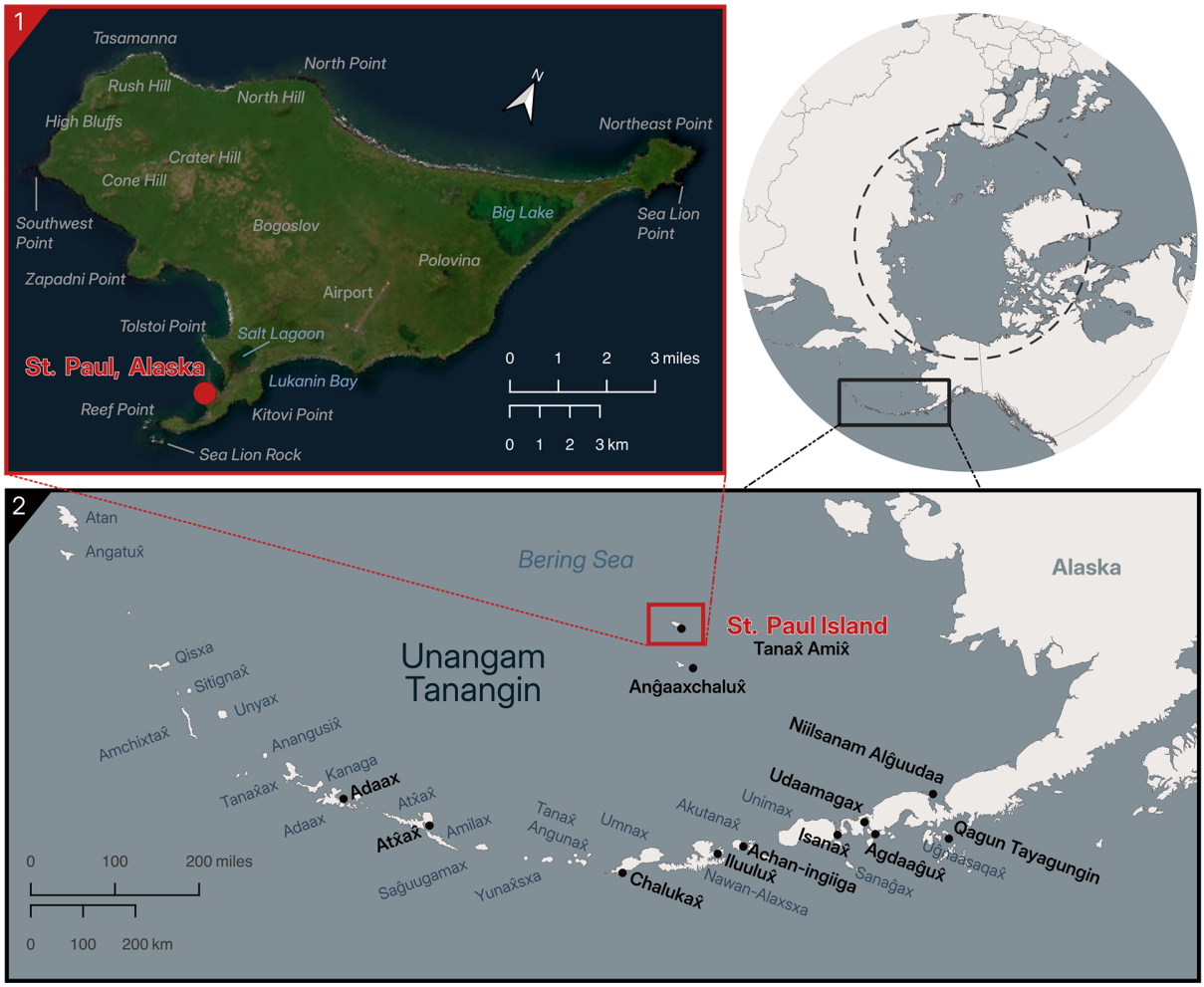

Fig. 1. Map of the Arctic showing (Insert 1): St. Paul Island, the pilot location, the largest of the Pribilof Islands, located at 57.2° N, 170.3° W. The city of St. Paul, Alaska (Tanaŝ Amiŝ) is located on the southern peninsula of the island. (Inset 2): The Aleutian Islands (Unangam Tanangin) with island (blue) and village (black) names in Unangam Tunuu, the Indigenous language of the Aleutian and Pribilof Islands region. Credit: Matthew Druckenmiller.

Background

In the 18th and 19th centuries, Russian and U.S. regimes forcibly relocated Unangaŝ communities to the Pribilof Islands for commercial fur seal harvests (Torrey 1983). After the United States purchased Alaska from Russia in 1867, federal policies in the 1870s continued to exert tight control over Unangaŝ communities on the Pribilofs, reflecting the long arc of colonial management that shaped local governance and resource use (Torrey 1983; Burch 1998). Despite this tragic history, the people of St. Paul Island have remained deeply connected to their environment. From an Indigenous perspective, our ecosystems are a living network of relatives, providers, kin, and teachers who are woven into identities and cultures (Carothers et al. 2021). Impacts to our environments are not only an ecological crisis but

also a cultural one, rooted in both the historic trauma of forced relocation and in the ongoing grief that comes with threats to the right to remain in one's homeland.

Recognizing this reality, the ACSPI has spent decades building local leadership in economic development and research so that St. Paul Island would not just be a site of study but a full partner, with Tribal leadership shaping and governing the work.

Two initiatives now carry this vision forward:

The **BRAIDED Food Security Project** began as a pilot in 2023 to test new ways of monitoring contaminants and strengthen community control over decisions related to food safety. Mercury is a World Health Organization top ten contaminant of concern. BRAIDED aimed to monitor mercury by establishing the Bering Sea Research Center (BSRC) on St. Paul Island. Instead of sending samples off-island—a process requiring expensive shipping from one of the most remote communities in the Bering Sea and long waits for results—Tribal staff can now receive donated tissues from harvesters, process them locally at BSRC, and analyze fish, seals, seabirds, and other harvested foods. The pilot phase, completed in 2025, laid the foundation for the program's continuation and expansion by building the capacity and confidence of Tribal staff to independently assess the health of harvested foods and maintain on-island laboratory operations.

The **ISN** builds on more than 20 years of local innovation. Created and designed by ACSPI, ISN is a suite of software tools supported by training programs that allow Tribes to design and manage their own monitoring programs across the state of Alaska. ISN's foundation is Indigenous Data Sovereignty (IDSov): all data are owned and controlled by the communities that collect them. ISN trains Sentinels and Guardians to collect observations within their communities. ISN data are stored in secure systems, but can also be connected to larger Arctic research networks.

Together, BRAIDED and ISN show what it means for Indigenous communities to lead Arctic research. Four themes woven throughout this work illustrate the impact of Tribally-led research: community-driven monitoring, food safety, IDSov, and training and capacity building.

Community-driven monitoring: Sentinels and Guardians as eyes and ears for lands and waters

Resilience depends on seeing change as it happens. While conventional Arctic science often relies on short-term field seasons, Indigenous peoples live in a deep relationship with place. Implementing monitoring programs that are driven by communities ensures that essential knowledge and observations are informing stewardship of lands and waters in real time (see Figs. 2 and 3).

Fig. 2. Coastal erosion monitoring in Golovin, Alaska, is conducted by local observers documenting shoreline change as part of regional monitoring efforts. Such observations provide critical information for understanding climate impacts in vulnerable communities. Credit: Hannah-Marie Ladd.

Fig. 3. A group of four Sentinels and two NOAA NMFS officials conduct surveys on Northern Fur Seal rookeries on St. Paul Island. Sentinels use long-standing knowledge of rookery behavior, seasonal timing, and seal movement patterns to guide when and where surveys occur, complementing co-management efforts with NOAA NMFS. Together, they monitor population numbers and search for entanglements as part of a co-management agreement to protect this vital marine species. Credit: Hannah-Marie Ladd.

The ISN provides cyberinfrastructure and a supportive network for community-driven monitoring. Outside scientists engage through partnerships that bring in technical expertise, while adhering to community protocols for access and use of data. ISN equips Sentinels and Guardians with tools, technology, and training, including a community-owned database, mobile data-collection apps, and reporting dashboards, that empower them to document their observations (see Figs. 4 and 5). For example, Sentinels often use traditional knowledge of the seasons to determine when to begin monitoring efforts, what species or conditions warrant attention, and how to interpret unusual

observations. The result is science and research that are both more accountable, place-based, and adaptive: local decisions are informed by Traditional Knowledge, lived experiences, and local expertise, data gaps are filled, research is collaborative, and global research benefits from knowledge shared from the frontlines of change.

Fig. 4. An observer logs data into the Anadromous Waters Catalogue (AWC) while surveying a stream in Southcentral Alaska. The AWC supports monitoring of fish habitats, and the Fish Map App, powered by ISN, enhances data collection and community participation in fisheries stewardship. Credit: Lee House.

Fig. 5. Observers in Southeast Alaska use GPS tools to log vital data for the AWC. Integrating mobile technology empowers communities to drive data collection and support sustainable fisheries management. Credit: Lee House.

Food safety: Food security is climate security

For Arctic communities, food safety and concerns about contaminants have caused stress and changes in diet. The BRAIDED Project has had a demonstrable positive impact by embedding environmental monitoring and research directly within the ACSPI. The BRAIDED project departs from conventional citizen science by placing community members at the helm of the research process, with scientists acting as collaborators rather than gatekeepers (UAA 2024), strengthening the relevance, quality, and quantity of data being collected. The BRAIDED project has relied on long-standing relationships and trust with university researchers, where earlier partnerships laid the foundation for BRAIDED to take root. By equipping local staff to test harvested foods in the BSRC, scientists have succeeded in increasing trust, timeliness, and community capacity, and are aware that they will eventually 'put themselves out of a job.'

Quantitative outcomes from the first year in 2024 included nearly 100 tested biological samples, ranging from marine mammals to seabirds, analyzed locally by community members (UAA 2024). The samples were tested for mercury contamination using a Nippon MA-Solo direct mercury analyzer, with results uploaded to ISN. While there are no current guidelines for mercury levels in marine mammals in Alaska, BRAIDED supports community interpretation by pairing each result with textual reports and visual summaries presented to the Tribal council, using familiar reference points, such as Alaska fish consumption advisories, to contextualize values. During community presentations, report-backs, and one-on-one conversations, Tribal staff help interpret mercury results for harvesters and families. A formal training course (described below) further introduced participants to how mercury moves through

marine ecosystems and how to interpret results within traditional harvesting practices. Together, these approaches ensure that results are communicated in accessible ways and interpreted locally under Tribal leadership as the program continues to develop.

Data sovereignty: Trust, governance, and resilience

IDSov ensures that information collected about Indigenous peoples, their lands, waters, and knowledge systems remains under their ownership and governance. The FAIR (Findable, Accessible, Interoperable, Reproducible) principles for data management are widely known and broadly endorsed. They emphasize machine readability, "distinct from peer initiatives that focus on the human scholar" (Wilkinson et al. 2016). In contrast, the CARE Principles (Collective Benefit, Authority to Control, Responsibility, Ethics) developed through the Global Indigenous Data Alliance reflect the human side of data and ask researchers to put human well-being at the forefront of open-science and data sharing practices (Carroll et al. 2020).

ISN is designed with IDSov and CARE principles at its core and supports communities and Tribes across Alaska in defining access, ownership, and governance of their data. IDSov is not only about protection; it is also about stewarding data to ensure resilient knowledge systems.

Training and capacity building

Resilience requires training and intergenerational learning; without it, monitoring risks being temporary. In 2024, BRAIDED partnered with Iḷisaġvik College to offer an in-person accredited "One Health" course on St. Paul Island, which emphasized the interconnected health of people, animals, and ecosystems, and brought together Elders, harvesters, youth, and community to explore these connections (UAA 2024).

Course instruction and training included:

- Place-based instruction at the BSRC, using samples from local harvests to teach laboratory procedures.
- Mentorship from trained local Sentinels, ensuring the transfer of skills within the community.
- Integration of Traditional knowledge alongside scientific techniques, grounding in local harvesting methods and emphasizing the nutritional benefits of traditional foods.

Participants demonstrated measurable gains in awareness and understanding of mercury contamination, food safety, and laboratory techniques (National Institute of Food and Agriculture 2024). These findings illustrate that community-driven monitoring is not only scientifically rigorous but a vehicle for (re)building capacity. Both physical infrastructure, like the BSRC, and cyberinfrastructure, like the ISN, anchor capacity and training for generational resilience.

Conclusion

The BRAIDED project and ISN show what is possible when Indigenous communities lead: timely, locally-controlled information, earlier warnings, protected data, and trained local experts. These projects center on Tribal sovereignty and community leadership, not as an added benefit, but as the foundation of Arctic resilience. Supporting them means supporting Arctic resilience. Importantly, support requires more than recognition; it requires investment in several measurable forms:

- Sustained funding for Indigenous-led monitoring programs that go beyond pilot projects, including long-term operational support, staffing, and training.
- Infrastructure support, from community laboratories like the BSRC to digital systems that uphold IDSov and CARE principles, like ISN or other existing databases.
- Workforce development, creating long-term, regenerative jobs for Sentinels and Guardians.
- Partnerships that position Tribes as leaders, not stakeholders, in Arctic research.

Supporting Indigenous-led monitoring is both an ethical imperative and a practical investment in innovation. Arctic resilience depends on shifting power and resources to communities that have cared for their lands and waters for millennia. BRAIDED and ISN show us how. Now it is time to scale up, strengthen, and sustain this work for St. Paul Island, for the Bering Sea, for the Arctic, and for all the ecosystems that support and sustain us.

This work was funded by USDA-NIFA (project accession #1031690).

References

Burch, E. S., 1998: The Eskimo and Aleut peoples: Their history and cultural traditions. Arctic Research Consortium of the United States (ARCUS), Fairbanks, AK.

Carothers, C., and Coauthors, 2021: Indigenous peoples and salmon stewardship: a critical relationship. *Ecol. Soc.*, **26**(1), 16, https://doi.org/10.5751/ES-11972-260116.

Carroll, S. R., 2024: Indigenous peoples breathing data back. TEDxUArizona. [Available online at https://www.youtube.com/watch?v=jPS_3mZXWXw]

Carroll, S. R., I. Garba, O. L. Figueroa-Rodríguez, J. Holbrook, R. Lovett, S. Materechera, M. Parsons, K. Raseroka, D. Rodriguez-Lonebear, R. Rowe, R. Sara, J. D. Walker, J. Anderson, and M. Hudson, 2020: The CARE principles for Indigenous data governance. *Data Sci. J.*, **19**, 43, https://doi.org/10.5334/dsj-2020-043.

Fox, S., and M. Jaypoody, 2024: The original researchers: Hunters are scientists deserving sustained support. *Arctic Report Card 2024*, T. A. Moon, M. L. Druckenmiller, and R. L. Thoman, Eds., https://doi.org/10.25923/af21-r537.

Government of Canada, 2023: Indigenous Guardians. Environment and Climate Change Canada. Accessed 22 September 2025, https://www.canada.ca/en/environment-climate-change/services/environmental-funding/indigenous-guardians.html.

National Indigenous Australians Agency, 2025: Indigenous Rangers Program (IRP). Australian Government. Accessed 22 September 2025, https://www.niaa.gov.au/our-work/environment-and-land/indigenous-rangers-program-irp.

National Institute of Food and Agriculture (NIFA), 2024: BRAIDED Food Security – Building research aligned with Indigenous determination, equity, and decision-making. USDA NIFA Project report.

Slats, R., C. Oliver, R. Bahnke, H. Bell, A. Miller, D. Pungowiyi, J. Merculief, N. Menadelook Sr., J. Ivanoff, and C. Oxereok, 2019: Voices from the front lines of a changing Bering Sea: An Indigenous Perspective

for the 2019 Arctic Report Card. M. L. Druckenmiller, R. Daniel, and M. Johnson, Eds. *Arctic Report Card 2019*, J. Richter-Menge, M. L. Druckenmiller, and M. Jeffries, Eds., https://arctic.noaa.gov/report-card/report-card-2019/voices-from-the-front-lines-of-a-changing-bering-sea/.

Torrey, B. B., 1983: Slaves of the harvest. St. Paul Island, AK: TDX Corp.

University of Alaska Anchorage (UAA), 2024: BRAIDED Food Security Project: Building research aligned with Indigenous determination, equity, and decision-making. University of Alaska Anchorage Project booklet.

Wilkinson, M. D., and Coauthors, 2016: The FAIR Guiding Principles for scientific data management and stewardship. *Sci. Data*, **3**, 160018, https://doi.org/10.1038/sdata.2016.18.

December 4, 2025