Flipping the Model: A Tribally Led Model for Resilient, Sovereignty-Based Food Safety Monitoring

Authors

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Plain Language Summary

Across the Bering Sea, Indigenous communities have long observed and cared for their environment. The BRAIDED Food Security Project brought together cultural and scientific knowledge to monitor traditionally harvested foods that are essential to the Unangax̂ people of St. Paul Island, Alaska. Led by the Aleut Community of St. Paul Island Tribal Government, the project “flips” the usual research model.

Through the Bering Sea Research Center and the Indigenous Sentinels Network, community members collected samples, and Tribal Government staff, in partnership with University researchers, measured contaminants and food safety, and shared findings directly with the community, leaders, and partners. This approach helped ensure that research reflects community priorities, Tribal governance structures, and that results are returned quickly to the community, supporting local decision-making and cultural continuity.

The BRAIDED model showed how Tribal-led science and Indigenous data sovereignty can build trust, strengthen food security, and make monitoring programs more effective for both communities and ecosystems.

Abstract

Many food safety monitoring programs in geographically isolated communities rely on contributory citizen science, where community-collected samples are sent off-site to academic or agency labs for analysis. While this can enhance engagement, it often delays results and reinforces inequities and mistrust. This study examined whether a tribally led research program, centered within the community, could address inequities in food safety, improve quality of life, and enhance resilience for Alaskan coastal communities. To test this, we piloted the BRAIDED Food Security Project, a tribally led alternative co-designed by the Aleut Community of St. Paul Island Tribal Government and partners, that relocated all stages of research - from problem definition to sample analysis - within the community. The project established on-island laboratory capacity through the Bering Sea Research Center and integrated data management via the Indigenous Sentinels

Network. From 2024-25, we collected and analyzed voluntarily donated traditional foods for total mercury on St. Paul Island. In total, 141 voluntarily donated traditional food samples were collected for analysis of total mercury, including laqudax (northern fur seal), halibut, cod, crab, reindeer, and seabird eggs. Training and outreach treated technical learning as an expression of sovereignty and relational accountability. Evaluation revealed faster result return, increased technical confidence, culturally grounded communication, and stronger partnerships. This model demonstrates how Indigenous-led monitoring builds resilience through local infrastructure and community data governance.

Key words

"Indigenous data sovereignty"; "community-led monitoring"; "Tribally-led research"; "citizen science methods"; "food safety and security"; "Bering Sea region"; "One Health approach"

Positionality Statement

The authors of this article write together as Unangax̂ people of St. Paul Island, employees of the Aleut Community of St. Paul Island Tribal Government (ACSPI), Indigenous peoples from diverse regions, Indigenous researchers, and non-Indigenous collaborators and researchers who work together through the BRAIDED Food Security Project. Our relationships, to each other, with the ocean, with the animals, and to our communities, shape the ways we understand food security and well-being.

This research took place on the traditional lands of the Unangax̂ (Aleut) people. The ACSPI Tribal Government and Council were partners in this project. This research was made possible

through the long-term investment, external funding, and guidance of the ASCPI, whose vision for tribally-led research and the establishment of a Bering Sea Research Center laid the foundation for this work. We acknowledge the Tribal Government's sovereign role in setting priorities and supporting research that reflects the community's values, responsibilities, and needs.

Our team is guided by Indigenous values of respect, reciprocity, and responsibility, and grounded in decolonizing and Indigenizing methodologies. We are committed to centering Indigenous leadership, upholding Indigenous Data Sovereignty, and braiding Indigenous Knowledge with Western science to sustain the health of our peoples and the ecosystems that nourish us.

Introduction

For generations, Indigenous peoples across the Arctic have relied on deep relationships with the land and sea to sustain food systems, cultures, and health. These connections are rooted in observation, reciprocity, and interdependence – a science in and of itself that has long guided the stewardship of ancestral homelands. Today, rapid environmental changes are disrupting these relationships and increasing food security challenges as they alter ecosystems, contaminate traditional food sources, and disrupt local harvests (Unc et al., 2025). Shifting ecosystems, contaminants, and barriers to access threaten both the safety of traditional foods and the knowledge systems that sustain them. In Alaska's coastal and island communities, where traditional foods remain central to nutrition, culture, and identity, understanding food safety is inseparable from maintaining sovereignty and self-determination. Yet monitoring programs and food safety studies have historically been designed, led, and analyzed by external research

93 institutions, often far removed from the communities most affected (Smith, 2012; Simpson,
94 2017). This model perpetuates delays between data collection and information return, limits
95 community control over data, and reinforces inequities in how research priorities are defined and
96 applied (Smith, 2012; Simpson, 2017; Donkersloot et al., 2025)
97
98 While community-based monitoring, citizen science, and participatory research have been used
99 to expand environmental observation, many models still reproduce colonial frameworks that
100 position Indigenous communities solely as data collectors rather than decision-makers (David-
101 Chavez and Gavin, 2018; Koster, Baccar and Lemelin, 2012; Latulippe and Klenk, 2020).
102 Conceptually, these approaches to research sit on a spectrum of public engagement: in
103 community-based monitoring (CBM), communities typically initiate and lead monitoring of
104 issues they prioritize, often using protocols provided by external researchers (Danielsen et al.,
105 2009); citizen science usually mobilizes volunteers to collect or process data under research
106 questions defined by scientists (Cooper et al., 2007); and participatory research implies deeper
107 collaboration in which co-design is prioritized for both questions and methods (Cornwall and
108 Jewkes, 1995). While all these models involve community members in knowledge production,
109 they differ in the degree of control, particularly regarding who sets priorities and makes
110 decisions (David-Chavez and Gavin, 2018). In this paper, we focus on improving citizen science
111 models specifically: our approach is tribally-led, with the Tribe defining research priorities and
112 directing outreach to both Tribal members and the broader St. Paul Island community. With
113 conventional citizen science, knowledge and samples are often removed from the community for
114 analysis, reinforcing dependence on external systems and limiting the ability to respond to local
115 concerns rapidly. This approach can improve data coverage and community participation, but it

frequently maintains hierarchical structures that position communities as contributors or "stakeholders" rather than sovereign leaders (Carroll, Rodriguez-Lonebear and Martinez, 2019; Smith, 2012; Walter and Andersen, 2013). As sovereign nations, Indigenous Peoples have the inherent right to govern their own knowledge and data and should be centrally involved in decision-making for environmental monitoring on their lands (Carroll et al., 2020; Kukutai and Taylor, 2016; United Nations, 2007). This shift requires recognizing Indigenous communities as rights-holders with authority over research processes, rather than as peripheral participants, so that community-based initiatives truly support self-determination and equitable co-governance (Cohen et al., 2021; David-Chavez et al., 2024; Carroll, Rodriguez-Lonebear and Martinez, 2019; Reed, Brunet and Natcher, 2020). Additionally, when results for citizen science efforts are returned, if at all, they are communicated through institutional channels with limited cultural or local context. These dynamics restrict opportunities for sovereignty, capacity building, and the direct application of knowledge to local governance frameworks and decision-making (Harris, 2016; Sahota, 2010).

For more than half a century, St. Paul Island, Alaska (Fig. 1), has been a place where science and stewardship meet. The Indigenous people of the Aleutian and Pribilof region traditionally refer to themselves as Unangax̂ (also Unangan/Unangas in plural form) in their own language, *Unangam Tunuu*. By contrast, "Aleut" is an exonym introduced by Russian colonial explorers in the 18th century and later institutionalized in U.S. federal classifications (Veltre, n.d.; Chew, n.d.; Laughlin, 1980; Bergsland, 1994). In modern scholarship and community discourse, the autonym Unangax̂ is preferred as the culturally appropriate term, underscoring the people's self-determination, self-designation, and distancing from the externally imposed label (Bergsland,

1994; Veltre, n.d.; Chew, n.d.; Smith, 2012; Simpson, 2017). Researchers have long been drawn to the unique wildlife and ecosystems of the Aleutian and Pribilof Islands region, yet much of that work occurred at a distance from the people whose knowledge and care sustains these places. Studies on laqudax (northern fur seal), marine birds, and traditional foods brought valuable information (Beckmen et al., 2002; Renner et al., 2012), but too often those findings were held by outside institutions, leaving community members without ready access to results that affected their own health and resources. This history has made research both highly valued and deeply scrutinized on St. Paul Island, underscoring the need for approaches grounded in trust, transparency, and shared authority. Despite this history, the Aleut Community of St. Paul Island Tribal Government (ACSPI) has remained open to research, recognizing its value when conducted in a good relationship and in accordance with the four R's in research: relationship, responsibility, reciprocity, and redistribution (Harris and Wasilewski 2004). Elders and local leaders on St. Paul Island have continued to call for science that respects Unangax̂ knowledge, returns results to the community, and strengthens sovereignty (Tribal Government of St. Paul Island, 2017; Tribal Government of St. Paul Island, 2023).

The Bering Sea Research Center (BSRC), established by ACSPI, is a direct response to those calls as a Tribally-owned research and education hub that advances local capacity for environmental monitoring, food security, and marine ecosystem science in the Pribilof Islands and broader Bering Sea region. Operating on St. Paul Island, the BSRC integrates community priorities with collaborative research partnerships, supporting locally-driven inquiry, sample analysis, and data interpretation that strengthen Indigenous stewardship and decision-making. Additionally, the Indigenous Sentinels Network (ISN), a database and monitoring software

owned by ACSPI aims to connect Tribes, communities, and partners across Alaska and beyond. Rooted in Indigenous Data Sovereignty (IDSov) principles, ISN provides cyberinfrastructure, data governance systems, and training to support community-led monitoring of wildlife, ecosystems, subsistence harvest, and environmental change. Together, the BSRC and ISN represent a tribally-led approach to research and sovereignty - linking Traditional Knowledge, community observations, and scientific research to promote responsive, equitable, and self-determined environmental management.

In this paper, we reflect on the BRAIDED Food Security Project (Building Research Aligned with Indigenous Determination, Equity, and Decision-making) that formed in 2022 and grew from ACSPI's vision for the BSRC and ISN, and their commitment to flipping the model on conventional research conducted on the island: a shift from research done *about* the community to research done *with and for* the community. This project was developed to address limitations by inverting the current citizen science research model (Fig. 2). At its core was an equitable community-university partnership focused on collaborative problem-defining and problem-solving among researchers at the University of Alaska Anchorage (UAA), University of Alaska Fairbanks (UAF), and the community of St. Paul Island. From past research and work conducted in partnership before the BRAIDED project, university researchers met with Unangax̂ Elders and other community members to discuss and identify concerns regarding the safety of traditional foods. From these discussions, the community determined that mercury monitoring in harvested traditional foods was an area of concern that they were interested in leading additional research on, alongside collaborating scientists.

Previously, wildlife monitoring for mercury found in harvested foods was conducted off-site at UAF, but as part of the National Science Foundation CIVIC Innovation Challenge, BRAIDED was developed across two stages to bring this work directly to St. Paul Island. First, a Planning Grant (6 mo) refined project goals, team roles, and a framework for equitable collaboration, and included participation in a national community of practice with other CIVIC participants. This was followed by a Pilot Project (1 yr) to implement the vision of a model for mercury monitoring that centered sovereignty and integrated Indigenous governance, scientific inquiry, and community priorities to close the gap between monitoring, analysis, and local action. Instead of sending samples and data away for analysis, BRAIDED established a place-based, tribally-led research program and laboratory within ACSPI. The rationale for this approach was that centering scientific infrastructure and decision-making authority within local Tribal governance systems can produce more timely, trusted, and contextually relevant outcomes than externally led citizen science models while supporting sovereignty in practice (David-Chavez et al., 2024; Carroll et al., 2020; Latulippe and Klenk, 2020; Reed, Brunet and Natcher, 2020). By aligning research design with Indigenous priorities and IDSov principles, the BRAIDED model aimed to create a pathway toward equitable and effective food safety monitoring that supports both scientific rigor and community self-determination. Our vision for a community-centered framework for research that flips the citizen science model included several expected short-term outcomes:

1. Reduction in delays between data collection and dissemination;
2. Enhanced local capacity for laboratory analyses of traditional foods;
3. Increased resident access to and engagement with contaminant data; and
4. Improved confidence in both food safety and research partnerships.

In this paper, we examined whether BRAIDED, a tribally-led, community-driven monitoring program, improved food safety outcomes, achieved a community-centered framework for research, and strengthened resilience for St. Paul Island.

Methods and Project Design

Co-design and Co-production with ACSPI

Co-design and co-production are central to Indigenous research methodologies that honor sovereignty, self-determination, and relational accountability. In Indigenous contexts, *co-design* refers to working together from the outset to define research questions, processes, and goals, while *co-production* emphasizes shared implementation, analysis, and interpretation of results (Arsenault et al., 2019; Kovach, 2009; Smith, 2021; Wilson, 2008). Together, these approaches form a continuum of collaboration grounded in respect, reciprocity, and responsibility, ensuring that Indigenous nations guide both the direction and the outcomes of research. As Wilson (2008) explains, relational accountability requires that knowledge creation occur within the context of meaningful, ongoing relationships. In this way, co-design is not only a methodological choice but an expression of sovereignty - ensuring that Indigenous nations define the questions, processes, and outcomes of research (Kovach, 2009; Smith, 2021). From this perspective, co-production extends beyond collaboration to become a process of shared leadership and mutual learning, where knowledge systems are braided together through trust, consent, and ongoing dialogue (Arsenault et al., 2019).

This approach guided BRAIDED's design and implementation, ensuring that every stage reflected Indigenous governance, values, and community well-being. Co-design and co-production are not one-time achievements but sustained practices - that require continual relationship-building, reflexivity, and accountability. Upholding these commitments in real-world research contexts is complex and often challenging, demanding time, trust, and a willingness to navigate complexities in order to maintain true reciprocity.

The BRAIDED project emerged from many years of dialogue and trust-building between ACSPI and university partners who collaboratively designed the project around locally defined priorities. Guided by the Inuit Circumpolar Council's *Guidelines for the Equitable and Ethical Engagement of Alaska Native Communities and Indigenous Knowledge Holders* and by Unangax̂ values of respect, reciprocity, and responsibility, this project was grounded in Indigenous principles of relational accountability (Inuit Circumpolar Council, 2022). Together, community and university partners identified research questions, collectively conducted community outreach, designed sampling and analysis protocols, and decided how results would be interpreted and shared. Decisions about what data mattered, how they would be handled, and when they would return to the community were made through ACSPI's governance processes. This ensured that research served local food safety decision-making and advanced community well-being.

While many frameworks use "co-" terminology interchangeably, BRAIDED intentionally situated its work along a continuum, from co-design to co-production to co-management, reflecting increasing levels of Indigenous leadership and authority over research processes and

outcomes. This approach aligns with Indigenous governance principles and the broader movement toward ethical, nation-to-nation research partnerships. From this foundation, four core components guided the project's vision:

1. the co-design of a community-centered research framework for mercury monitoring at the BSRC, owned and operated by ACSPI;
2. the co-production of local capacity and workforce pathways that braid Indigenous and Western sciences;
3. the co-management of marine mammals supporting the sampling and analysis of traditionally harvested foods; and
4. the co-development of a governance and communication process around results and the digital data dashboard centered on equity, access, and privacy.

To reflect our commitment to equitable partnership, the Tribal and university project leads shared decision-making authority and budget responsibilities, modeling collaborative governance and accountability throughout the project. Upholding these commitments required time, trust, and reflexivity, answering, as Wilson (2008) writes, "to all our relations" through continual dialogue and accountability.

Establishment of mercury monitoring in the Bering Sea Research Center.

The creation of the BSRC marked a major step toward strengthening local research capacity and sovereignty in food safety monitoring. From 2017-2022, with local partners and federal support, ACSPI completed major infrastructure projects including establishment of a building that could house the BSRC. In November 2022, the ACSPI Tribal Council committed additional funds to

purchase and install preliminary components of the research center including basic furnishings (e.g., lab benches, fume hoods). The creation of the BSRC was both a technical and cultural milestone. Built through years of local investment and Tribal Council commitment, it was the first tribally-led laboratory of its kind in the Bering Sea region.

In April 2024, the BRAIDED project established a station for quantifying mercury within the BSRC. This included purchasing and installing instrumentation for total mercury analyses in traditional food samples. The laboratory was equipped with a portable, compact direct mercury analyzer (Nippon MA-Solo, Nippon Instruments Co., Tokyo, Japan) that uses ambient air rather than compressed gases, making it safer and more feasible for use in remote field settings. This model was intentionally selected to support long-term sustainability of mercury analysis on the island, reducing dependence on off-island laboratories and minimizing risks associated with shipping or handling hazardous gas cylinders. Establishing this system required careful coordination with equipment suppliers who worked closely with ACSPI staff to accommodate the challenges of shipping sensitive instruments and laboratory materials to the Bering Sea community (Fig. 3).

The arrival of the equipment was paired with a series of community-focused events designed to introduce residents to the new laboratory and its purpose. A public meeting invited community members to walk through the full process of sample collection, analysis, and data reporting. Project staff also held a dedicated session with the island's Elders, providing space to ask questions, share reflections, and witness the instrumentation in action. Finally, an open house event at the BSRC welcomed residents to see and learn about the new facility and hear about

plans for its community-centered research framework. These gatherings were opportunities to have volunteer sign-ups for sampling support and demonstrations of how results would be shared through reports generated from the Tribe-controlled ISN database underscoring that information would first return to the community before being shared externally.

An employee of ACSPI, St. Paul resident, Tribal member, and co-author of this paper was supported as the community monitoring coordinator. This position was fully integrated into the establishment of the BSRC from setting up equipment, to serving as a liaison for harvesters within the community, to collaborating on development of protocols and Standard Operating Procedures for (a) data collection, (b) data management, (c) laboratory analyses, (d) quality assurance and control, and (e) results storage.

One Health training program.

Building local capacity was central to BRAIDED's purpose and approach. In alignment with Indigenous research methodologies, the project treated training not merely as skill development but as an expression of sovereignty and relational accountability (Wilson, 2008; Smith, 2021). Co-learning was emphasized as a form of mutual recognition - acknowledging that both Indigenous and Western sciences hold essential insights into the interconnected health of people, animals, and ecosystems (Reid et al., 2021). Guided by this principle, the BRAIDED team co-developed a One Health training program grounded in Unangax̂ values of respect, reciprocity, and responsibility, while integrating technical and analytical skill-building to support long-term community leadership in food safety monitoring. This approach reflected the concept of Two-

Eyed Seeing (Etuaptmumk), which emphasizes bringing together multiple ways of knowing for collective benefit (Bartlett et al., 2012).

Training for the community monitoring coordinator and other ACSPI staff began with hands-on experience in laboratory procedures and data management. The coordinator received instruction in total mercury analysis of harvested animals through a combination of off-site training at the University of Alaska Fairbanks' Marine Ecotoxicology and Trophic Assessment Laboratory (METAL; March 2023 and June 2024) and on-site mentorship within the newly established BSRC laboratory (April 2024). These opportunities were designed not only to transfer technical knowledge but to strengthen relationships between the university and the Tribal research team - ensuring that expertise and resources remain accessible for future generations of St. Paul residents.

Additionally, in summer 2024, BRAIDED and Iḷisaġvik College, Alaska's Tribal land-grant community college located in Utqiagvik (formerly Barrow), co-developed and delivered a short course on St. Paul Island titled *Topics in Modern Science: Braided Insights on One Health*. The curriculum combined classroom and experiential learning across two full-day, in-person workshops and asynchronous online activities. The course invited any interested community members, including Elders and youth, to explore the connections between environmental, animal, and human health through both Indigenous and scientific lenses. Over ten community participants joined one or both sessions, including the community program coordinator, Tribal staff, and local harvesters (Figure 4).

Course development was informed by a survey of 30 St. Paul residents to understand their perspectives on food safety and security, research participation, and the BRAIDED project. Lessons were grounded in both Unangax̂ cultural teachings such as *"Live with and respect the land, sea, and all nature"* and ecotoxicological concepts (e.g., biomagnification, potential adverse effects of mercury to animals and humans, how contaminants move through food webs, traditional practices of harvesting, and balancing the risks and benefits of consuming traditional foods). Learning objectives aligned with Alaska standards for culturally responsive schools, emphasizing critical thinking, stewardship, and community well-being (Alaska Native Knowledge Network, 1998; Barnhardt and Kawagley, 2005; Kaden et al., 2020; Chythlook and Fienup-Riordan, 2018).

To respond to the requests of ACSPI and previously identified community needs, participants gained experience in sample collection and biosampling procedures for traditional foods, following established BRAIDED protocols for preparation and processing (Fig. 5). Elders and local harvesters contributed knowledge about traditional harvesting and preparation techniques, linking ancestral ways of knowing about food safety and health to modern analytical tools. The course concluded with group reflection on how integrating Indigenous and scientific perspectives could guide future food safety monitoring and governance for the community.

To extend educational opportunities to younger generations, BRAIDED partners also developed K–12 materials which were used by approximately 20 children during Bering Sea Days, a community event focused on food safety, ecosystem health, and the interconnectedness of people, animals, and the environment. These outreach activities reinforced the message that food

safety is more than a scientific concern - it is an act of cultural continuity, care, and collective learning. These lesson plans have been utilized at the school multiple times since making them available to teachers.

Sample collection and analysis

Community-led sample collection began in summer 2024, grounded in the principle that harvesting and research should honor relationships between people, animals, and place. Participation was voluntary and coordinated through ACSPI, with announcements shared via radio, social media, newsletters, and word of mouth. The process invited residents to contribute samples of traditional wild foods as an act of stewardship, collective learning, and community care. Samples were gathered during regular subsistence harvests often through existing Tribal co-management or resource stewardship agreements, in which Tribes collaboratively manage local harvests and stewardship activities with federal or state partners. Such programs reflect long-standing efforts to formalize shared governance and uphold Indigenous authority in resource management (Berkes, 2009; Armitage et al., 2011; Natcher et al., 2005). For example, *laqudax* (northern fur seal) tissues were collected during community harvests with the guidance and permission of local harvesters. Each contribution was accompanied by information such as the date, harvester name, species, size, age class and harvest context, recorded through digital and paper forms co-designed by the community monitoring coordinator, ISN, and the BRAIDED team. Samples consisted of a small (5g) sample of muscle or organ tissue. Species sampled included *laqudax*, fish, birds, and reindeer - resources that have long sustained St. Paul's nutritional and cultural well-being, though some dietary preferences among younger generations

have shifted toward fish, reindeer, and sea lion. All samples were stored in a -20°C freezer at the BSRC until analysis.

In keeping with the community's commitment to conduct research locally, all mercury analyses were performed at the BSRC using the Nippon MA-Solo direct mercury analyzer, following U.S. EPA Method 7473 (Campisano et al., 2017). A small (approximately 200mg) portion of each thawed tissue sample was analyzed to quantify total mercury concentration and results were expressed in micrograms per gram (μg/g) or parts per million on a wet-weight basis. Calibration standards and fish protein certified reference material were used for quality control.

Data Stewardship, Sovereignty, and Communication

The BRAIDED team aimed to provide updates to the community as promptly as possible through Tribal council meetings and reports generated from the ISN platform that contained the local data dashboard, reflecting a commitment to keep information circulating between the lab and harvesters. Because this project represented the first pilot year of an on-island analytical workflow, the team had only one summer season to test and refine procedures for sample processing, data entry, and data management. As a result, the cadence of updates was shaped not only by analytical workloads but also by the need to establish and troubleshoot new workflow steps. All data were initially recorded on either paper field forms or in the mobile app during harvest, analyzed using a process that would be transcribed into Excel spreadsheets for quality checks and verification, and then uploaded into the ISN database.

Tribal sovereignty and independence in research and data collection were raised as key priorities during early community meetings. To ensure these values were upheld, workflows were tested to ensure data generated through BRAIDED were stored and managed within a dedicated app- and web-based database created through the ISN technology program (Fig. 6). This approach aligns with Indigenous Data Sovereignty principles: the ISN framework is guided by OCAP (Ownership, Control, Access, and Possession) and CARE (Collective Benefit, Authority to Control, Responsibility, and Ethics) principles. Together, these principles ensure the Tribe retains full authority over its data, while data practices remain responsible, ethical, and focused on community benefit.

The BRAIDED project-specific database was designed to enable approved and registered users - such as the project team and community administrators - to access mercury results for transparent and community-led decision-making. Rather than focusing on software architecture or technical specifics, the priority was to ensure functionality that reflected local governance: data security, consent-based data access, and clear data flow between laboratory work and community interpretation. Separate data entry forms were created for sample collection, mercury analysis, and quality control through an iterative, collaborative process. These design choices laid the foundation for ongoing work with ISN to refine and sustain data workflows for future projects, as described further in the results and discussion sections.

Throughout the project, ACSPI and university partners held community meetings, open houses, and information sessions to share updates and preliminary results. Outreach included in-person events such as the initial project kick-off, Elder luncheons, Tribal annual meetings, creation and

sharing of a project video, and activities for K-12 students, complemented by radio interviews, newsletter articles, and posts on the project's Facebook page. Information materials about fish consumption and mercury exposure were also provided to support informed choices among residents. These materials included a flexible points-based advisory system recommended by the Alaska Department of Environmental Conservation (DEC) to provide context without imposing rigid thresholds (Alaska DEC, 2020).

The project deliberately avoided framing risk communication around strict limits to mercury ingestion. Instead, discussions emphasized balanced eating, intergenerational learning, and the cultural continuity of being at harvest with family. This approach reflected both public health considerations and community values - recognizing that food security is grounded not only in nutrition, but also in identity, belonging, and the relationships that sustain life on the island.

Evaluation Methodology

Evaluation Design

Project evaluation was performed by an independent evaluator (Shaffer Evaluation Group, or SEG) contracted by ACSPI. This study employed a mixed-methods, community-engaged evaluation design to assess the implementation and early outcomes of BRAIDED. The evaluation examined how a Tribally led, community-centered food safety monitoring initiative positively influenced local capacity related to contaminant monitoring of traditional foods, timely access to and engagement with contaminant data, confidence in safety of consuming traditional foods, and trust in research outcomes and scientific partnerships. This evaluation also described factors that positively or negatively affected implementation, as well as

implementation successes and challenges and barriers to sustainability. Grounded in the principles of Indigenous data sovereignty (Carroll et al., 2020; First Nations Information Governance Centre [FNIGC], 2014; Smith, 2012), the methodology emphasized co-design, reciprocity, and culturally responsive inquiry. Evaluation activities were collaboratively developed by ACSPI, SEG, and the BRAIDED research team.

Data Collection

A convergent mixed-methods approach was used to integrate quantitative and qualitative data sources (Creswell & Plano Clark, 2018). Quantitative data included an intercept survey collecting Tribal members' perceptions of BRAIDED administered during the same timeframe as the community-focused events designed to introduce residents to the new laboratory (April 2024); and pre- and post-training surveys administered to participants in the *One Health* training program (June–July 2024). While the evaluation plan called for the administration of an intercept survey on community perceptions in summer 2025, the survey did not yield sufficient responses for analysis, largely due to a lapse in an airline contract for transportation services to St. Paul that prohibited the evaluator from administering the survey on-site.

The training surveys asked participants to rate their level of knowledge on a variety of topics, including knowledge of food safety, mercury contamination and ecosystem circulation, integrating Indigenous and western science. We also examined participants' confidence in assessing animal health, collecting and testing samples for contaminants, interpreting results, and using the ISN for food-related decision-making. The same questionnaire was implemented prior

to, and following course completion. Not all participants completed the pre- and post-surveys, so summative survey data are compared between the two time points.

Descriptive indicators such as the number and type of food samples analyzed through the newly established BSRC and the ISN database for the BRAIDED program were tracked. Qualitative data were collected through evaluator observations and semi-structured interviews with ACSPI staff, project team members, and community participants (April 2024; June–August 2025). The evaluator observed the project team's community engagement activities in April 2024, including the Elders session, public meeting, and open house event (Fig. 7). For the interviews, participants were purposely selected to represent project leadership, laboratory staff, graduate students, and community members engaged in sample collection or outreach. Discussion topics explored experiences with the BSRC, perceptions of trust and communication, barriers to sustainability, and applicability of the model to other Indigenous communities. Interviews were conducted via Microsoft Teams, recorded with consent, and transcribed verbatim. All transcripts were de-identified prior to analysis.

Data Analysis

Data were analyzed using a descriptive–interpretive framework emphasizing triangulation across data sources (Denzin, 2017). Qualitative transcripts were coded inductively to identify themes aligned with evaluation questions on implementation, outcomes, and sustainability. Quantitative survey data were summarized using descriptive statistics (e.g. means, proportions) to illustrate direction and magnitude of change rather than inferential significance testing, consistent with the

small-population, community-level design (Patton, 2015). Reflective field notes documented analytic decisions and ensured transparency.

The evaluator also conducted a sustainability assessment of the BRAIDED Food Security project, which was based on the Program Sustainability Assessment Tool (Luke, et al., 2014). This tool is designed to assess a program's current capacity for sustainability across a range of specific organizational and contextual factors including Environmental Support, Funding Stability, Strategic Planning, Partnerships, Communications, Program Adaptation, Program Evaluation, and Organizational Capacity.

Ethical Considerations

All procedures followed ethical guidance for Indigenous research emphasizing respect, reciprocity, and relational accountability (Smith, 2012). Data collection efforts were preceded by informed consent, providing information about the evaluation study, assuring confidentiality of information shared, and confirming the voluntary nature of the study. All survey and interview data were de-identified before analysis, and all Tribal members who participated in the evaluation study were compensated with a gift card. This study was reviewed and approved by the University of Alaska Anchorage Institutional Review Board (IRB) [Project # 2134198-3] and determined to be exempt from full review under 45 CFR 46.104(d), Category 2 on March 19, 2024.

In alignment with the CARE Principles for Indigenous Data Governance (Carroll et al., 2020) and the OCAP, all food-sample data remained within the ISN database platform under Tribal control; the evaluator accessed only de-identified summary data.

Results and Findings

Implementation Success

All four core design elements were successfully initiated. The establishment of a functional laboratory represents a direct realization of the proposal's vision of closing the loop between harvest, analysis, and decision-making on the island. Initial public meetings reinforced the Tribe's ownership of both the facility and the results, and these events marked the first time many residents could witness food safety science taking place on the island itself, strengthening transparency and trust. The combination of technical installation and community engagement underscored the project's commitment to embedding research infrastructure within cultural and social life, rather than treating it as a stand-alone scientific exercise. By the conclusion of the pilot year, 141 samples had been collected for analysis representing a wide variety of wild foods, including northern fur seal, halibut, cod, crab, octopus, reindeer, and seabird eggs.

Outcomes

The BRAIDED Food Security Project was successful in achieving or partially achieving its intended outcomes. It built trust, improved confidence and skills in scientific methods, and strengthened Tribal-university partnerships, among other outcomes. Although turnaround time improved significantly compared to off-island analysis, the sequencing of paper forms, spreadsheet verification, and upload of finalized data to ISN introduced a short lag between

analysis and public reporting during this first pilot year. This multi-step process - necessary to ensure data accuracy and to build a replicable workflow for future seasons - introduced some variability in the timing of final results to be uploaded into ISN. Staff availability, summer field schedules, and the sequential nature of paper-to-digital transitions occasionally caused delays between sample collection and final data analysis upload. These timing considerations are a feature of the pilot-year methodology and as a result, the cadence of updates was shaped not only by analytical workloads but also by the need to establish and troubleshoot new workflow steps. Despite this, multiple community members described the project as a "*huge success,*" both visually and symbolically. One ACSPI staff member noted that "*establishing and outfitting that building with a functioning lab bench and equipment*" represented a significant milestone.

BRAIDED increased capacity building related to laboratory analyses of traditional foods within the community. ACSPI staff demonstrated efficacy in processing and analyzing traditional-food samples and managing the lab station independently by the end of the pilot year. Some delays in data transfer did stem from the pilot-year reliance on a single technician to manage multiple steps of the workflow, from sample processing to quality assurance to ISN database upload. Despite these early-stage bottlenecks, the first summer provided essential learning that strengthened the future data pipeline and clarified where additional staff capacity or process refinement would be needed. Furthermore, results of pre-/post-surveys revealed that One Health short-course participants reported improved understanding of mercury pathways, local food-safety issues, and the interconnections between human, animal, and ecosystem health (Fig. 8). These relationships - long recognized within Indigenous worldviews - align with what Western science refers to as One Health (Bartlett et al., 2012; Wilson, 2008). Participants also

demonstrated increased confidence in using scientific methods to assess the health of harvested fish or wild animals and in uploading and accessing data on the ISN (Fig. 9).

This is supported by strong evidence that resident access to, and engagement with, mercury data increased during the pilot year. Residents were not passive recipients of data but active contributors and interpreters, volunteering in monitoring efforts. One Tribal member, who is also a hunter, shared during an interview that he submitted tissue samples, while younger residents he knew engaged in training and outreach activities. One community member reflected that his confidence in conducting biosampling and interpreting results grew, sharing that seeing contaminants that are "*invisible to the eye*" made science feel directly relevant to his subsistence lifestyle.

The Tribe's community program coordinator and lead community technician expressed strong confidence in his ability to test and analyze food samples. A project team member described him as an "*anchor*" for the project, someone who could run tests independently and communicate results with confidence. During interviews with ACSPI staff and project team members, however, there were repeated concerns with an overreliance on a single staff person, unrealistic expectations for his workload, and the need for staff redundancy. There was also recognition that the BSRC will need staff with more advanced science qualifications in the longer term.

There was moderate evidence that the project increased awareness of mercury without undermining confidence in traditional foods. One interviewed Tribal member noted that he hadn't changed his diet but was now "*more aware of how mercury gets into animals and even*

plants." Residents appreciated that information was framed in ways that respected subsistence practices. An ACSPI staff member reported that Elders asked probing questions about interactions between contaminants and nutrients, such as whether selenium could offset mercury risk. This curiosity indicated both trust in science and a desire to integrate findings into cultural frameworks of food knowledge. While there were no reports of residents changing their consumption patterns, some reported adjusting harvesting practices or preparation methods based on early results. An original goal of creating a public-facing dashboard was not achieved; instead, the project team, in collaboration with the ACSPI staff, remained committed to sharing information about findings through other venues, including open houses and live demonstrations. This transparency, according to an ACSPI staff member, allowed the project to "*move from just reporting numbers to having thoughtful conversations about what they mean*." One Tribal member expressed excitement during an interview at the possibility of *"going down to the lab at the next open house"* to see testing firsthand.

Though a longer-term outcome, there was demonstrable progress towards improved trust in civic and university research partnerships. In interviews with the evaluator, Tribal members and ACSPI staff repeatedly emphasized that this project was different because it was Tribally led and locally controlled. As shared by one staff member, "*This is the first time the data belongs to us*." Trust was strengthened in part because results were shared locally first: "*Local communication first, not publications first for academics.*" This reversal of typical research priorities ensured accountability to the community and boosted trust. Trust also grew in relationships with external partners. One project team member stressed that having co-leads from both the university and the Tribe *"equally at the table"* demonstrated genuine partnership.

614

615 *Sustainability*

616 In the sustainability assessment conducted by the evaluator using available documentation, there
617 was weak to moderate evidence that the activities initiated with CIVIC funding will be sustained
618 in the longer term (Fig. 10). The assessment revealed notable variation across the eight domains.
619 Strengths were identified in Partnerships and Program Adaptation (average scores of 80.95%
620 each), reflecting the project's strong community-university collaboration, active engagement
621 with Tribal Council and Elders, and capacity to adjust workflows in response to logistical and
622 seasonal constraints. Communications and Program Evaluation scored moderately high (71.43%
623 and 66.67% respectively), indicating effective two-way communication with residents through
624 in-person forums and feedback loops that informed ongoing improvements. However, Funding
625 Stability and Organizational Capacity (52.38% and 57.14% respectively) emerged as the weakest
626 domains. The project remained heavily reliant on short-term federal grants, with no multi-year
627 commitments, and staffing had depended largely on a single technician whose competing
628 responsibilities limited operational resilience. Strategic Planning scored moderately well, as
629 formal sustainability planning had begun, and technician redundancy was being addressed.

630

631 **Discussion**

632 *Reframing Citizen Science through Indigenous Sovereignty*

633 BRAIDED fundamentally redefined citizen science through an Indigenous lens. Rather than
634 relying on outside researchers to extract data from the community, this project demonstrated that
635 science conducted by and for Indigenous peoples can produce trusted, relevant, and actionable
636 outcomes. As one Tribal member shared, "*Before, we'd send a seal sample and wouldn't hear*

637 *back for a month.*" Now, with the BSRC operating on-island, the process transformed what had
638 been a "*black box*" of external science into a transparent, community-controlled process.
639
640 This transformation represents a deeper act of sovereignty. BRAIDED replaced the extractive
641 tendencies of conventional citizen science with a model rooted in relational accountability
642 (Wilson, 2008) and community governance (Smith, 2021; Carroll et al., 2020). By centering
643 local leadership, the project affirmed that data are not simply a product of research but an
644 extension of self-determination. Community stakeholders emphasized that ensuring *"the Tribe*
645 *owned the database*" meant results reached the Tribal Council and residents before outside
646 researchers, reversing long-standing hierarchies of knowledge sharing.
647
648 *Relational Infrastructure and Trust Building*
649 The project's early success stemmed from pairing technical innovation with relational
650 infrastructure. Investing in physical and community research infrastructure is not only a practical
651 capacity-building measure but also a symbolic assertion of sovereignty in the realm of
652 knowledge (Coulthard, 2014; Simpson, 2017). Such efforts align with broader movements of
653 Indigenous resurgence and Nation Rebuilding that emphasize restoring Indigenous governance
654 structures and revitalizing ways of knowing on Indigenous terms (Simpson, 2017; Jorgensen,
655 2007). The April 2024 laboratory installation was intentionally accompanied by public
656 gatherings - Elders' lunches, open houses, and harvest events - where residents could witness the
657 mercury analyzer in action and discuss traditional food practices. As the evaluator noted, these
658 events made science visible, tangible, and rooted in relationship (Shaffer, Hollar & Boyd, 2025).
659 The lab became more than a technical facility; it became a living symbol of self-determination,

representing the community's ability to generate knowledge on its own terms, and the realization of a decades-long vision to create a tribally-led research center (CEDS, 2017). This model aligns with broader Indigenous research frameworks emphasizing reciprocity and trust as the foundation of knowledge production (Kovach, 2009; Johnson et al., 2015). Similarly, the mercury analyses represented more than laboratory work - they were a demonstration of local capacity and the realization of a long-standing goal to return scientific processing and interpretation to the community. Each completed sample symbolized a cycle of sovereignty: data collected by residents, analyzed on island, and communicated first to those who rely on the information to make decisions about their families' food and health. Finally, by framing capacity building as co-learning, the project advanced both technical expertise and intergenerational knowledge transfer rooted in community-defined priorities and self-determination (Kovach, 2009; Arsenault et al., 2019).

Community-driven communication also proved to be one of BRAIDED's effective outcomes. As one stakeholder reflected, "*Fancy charts and graphs… are not the approach to take. In-person dialogue is best*." Elders' lunches and community events became trusted venues for interpreting data in ways that resonated with lived experience and traditional knowledge (Simpson, L.B., 2017). Conversations with community members during northern fur seal harvests were also effective because those who contributed subsistence tissue to the project watched the sampling occur in real time, connecting the ideas to the actions. Tools like visual reports and flyers can supplement, but cannot replace, face-to-face conversation. This finding echoes Indigenous epistemologies that value storytelling, dialogue, and collective reflection as core modes of data interpretation (Wilson, 2008; Smith, 2021).

Lessons in Capacity, Equity, and Sustainability

The evaluation revealed that while BRAIDED exceeded expectations in community engagement, sustainability and data workflow challenges remain. The project's reliance on a single highly trained technician created both efficiency and vulnerability. As the evaluator observed, this "*single point of reliance*" underscored the importance of shared capacity and redundancy to prevent burnout and ensure continuity (Shaffer, Hollar & Boyd, 2025). Clear roles and responsibilities across existing governance structures was also identified as a place for growth, and that future projects should couple infrastructure with explicit governance structures to avoid ambiguity that strains professional relationships. Solutions to both of these challenges are being addressed through developing plans for cross-training additional staff and integrating BSRC activities into broader Tribal workforce initiatives. This adaptation aligns with Indigenous governance values of collective responsibility, emphasizing that sustainability depends as much on people and relationships as on infrastructure (Luke et al., 2014).

Although the project fell short of its original goal of collecting 200 samples during the pilot, this reflected a conscious, culturally responsive decision rather than a shortcoming. The team adjusted sampling expectations to avoid overharvesting or stigmatizing traditional foods, demonstrating fidelity to community values. BRAIDED's emphasis on interconnected health systems reflected principles long embedded in Indigenous knowledge - what Western frameworks later came to describe as One Health. Within Unangax̂ and other Indigenous worldviews, the well-being of people, animals, and the environment has always been understood as interdependent (Wilson, 2008; Bartlett et al., 2012). Recognizing this continuity repositions

"One Health" not as a Western innovation but as a rearticulation of enduring Indigenous understandings of relational responsibility and balance. This adaptation reflects a critical lesson: progress is measured not by extractive output but by an ethical and adaptive process.

Similarly, an adaptive approach was needed to overcome technical and logistical obstacles. During the implementation phase of BRAIDED the new ISN platform was in the beta-testing phase and the team was fine-tuning the functionality for offline data collection in remote areas with poor connectivity. In combination with the difficulty of using mobile devices during harvest activities, this necessitated the use of paper forms which introduced another data entry layer prior to uploading sample collection data. Additionally, the BRAIDED project team had to adapt the process for importing raw data files generated by the Nippon Hg analyzer using the ISN Imports module and account for the fact that samples were run in duplicate, and mean Hg concentration values are what is ultimately reported to the community. Despite these issues, the project managed to have data shared in a timely manner allowing the team to assess the data and share it with the Tribal Council and the community. The valuable lessons learned in the BRAIDED project will allow ISN and our collaborators to continue to improve and streamline data collection and storage protocols in future projects. Such rapid pivots during a one-year pilot further highlight that adaptability was a hallmark of the project, strengthening workflows for sample collection and training, and allowing the team to be responsive to both community concerns and evolving scientific knowledge.

Data Sovereignty and Communication as Cultural Practice

BRAIDED demonstrated that data sovereignty is both a governance framework and a cultural practice. All mercury data results were reviewed locally first before any external sharing. This approach, described by staff as *"the data belongs to us,"* reasserted Indigenous authority over information flow (Shaffer, Hollar & Boyd, 2025). Communication strategies emphasized conversation and relational exchange - methods consistent with CARE principles of Responsibility and Ethics (Carroll et al., 2020) and with Indigenous oral traditions. This practice transformed data stewardship into a collective act of learning and accountability.

Scaling and Adaptation for Other Indigenous Communities

This evaluation study provides important insights into the implementation and outcomes of the BRAIDED Food Security project, yet several limitations should be considered when interpreting findings. The study was conducted in a single rural, predominantly Alaska Native community with a small population. Random assignment was not feasible, and participation in surveys, training, and interviews was voluntary. The project was also implemented on an accelerated one-year timeline, later extended, which limited opportunities for longitudinal data collection; observed changes in confidence or trust therefore may not directly translate into long-term behavioral change. While findings may not be statistically generalizable to other Arctic communities, they do provide valuable lessons for contexts with similar demographic and geographic characteristics. The recommendations below integrate lessons from this project with established best practices in community-based monitoring, Indigenous research, and knowledge co-production.

While the BSRC facilities are unique to the Bering Sea region, the evaluator found that the mercury analyzer was fully operational even before the BSRC building was complete, functioning "*with only a table and power outlet*" (Shaffer, Hollar and Boyd, 2025, p. 19). This demonstrates that infrastructure can be modular and accessible. Scaling also requires more than replicating laboratory infrastructure: it demands careful alignment of governance, training, funding, and cultural protocols. The primary constraints to replication - funding stability and organizational capacity - mirror challenges faced by many rural Tribal programs. Rather than replicate BRAIDED identically, other communities might adapt its core principles: hire local coordinators, implement culturally responsive training, and connect across regions through a Tribe-to-Tribe network. Such a network could expand IDSov across Alaska, enabling communities to share data ethically and strengthen interworking councils. A phased approach is also recommended: (1) readiness assessment and co-design; (2) infrastructure development and training; (3) pilot testing with iterative feedback; (4) operational refinement and expansion; and (5) networking with other tribally-led programs to share practices and resources. Similar adaptive approaches are well established in environmental monitoring literature (Danielsen et al., 2014). Moreover, the BRAIDED framework - anchored in place-based personnel, adaptable data systems, and cultural responsiveness - can be applied beyond mercury to address new environmental concerns such as harmful algal blooms, microplastics, or emerging climate-linked food safety issues. While contaminant monitoring is valuable, projects should situate it within the broader landscape of food security. Linking lab results to discussions of access, affordability, and sovereignty can increase relevance and community buy-in. This adaptability is a marker of resilience, reinforcing that Indigenous science thrives when grounded in both tradition and innovation (Simpson, 2017; Walter and Suina, 2019).

Conclusion

BRAIDED achieved its vision of creating a community-centered framework for research that strengthened food safety, accelerated data sharing, and reinforced Tribal sovereignty. Four key short-term outcomes were realized: (1) reduced delays between data collection and dissemination; (2) enhanced local capacity for laboratory analyses of traditional foods; (3) increased community access to and engagement with contaminant data; and (4) strengthened confidence in food safety and research partnerships.

By situating scientific infrastructure under Tribal leadership and coupling it with culturally grounded training, BRAIDED bridged the gap between Western and Indigenous sciences. The project confirmed that when Indigenous communities lead research, data are not just information - they become a living expression of governance, care, and continuity. As the evaluation found, BRAIDED "flipped the model" of research by embedding decision-making, analysis, and interpretation within the community itself (Shaffer, Hollar and Boyd, 2025).

Moving forward, sustaining and expanding this work will require investment in personnel redundancy, continued intertribal partnerships, and long-term funding. Funding stability was the sustainability domain with the lowest score during project evaluation, recognizing that short-term project grants risk collapse, whereas blended funding strategies, such as braiding together Tribal funds, public health agency grants, and philanthropic support, align with best practices for maintaining long-term community-based research. A similar recommendation was made in the most recent Arctic Monitoring and Assessment Report on Mercury in the Arctic, which

highlighted sustained funding for monitoring and research programs led by communities that would produce holistic knowledge (Arctic Monitoring and Assessment Programme, 2021). BRAIDED's success provides a roadmap for building sovereign research capacity across Indigenous communities: start with trust, invest in people, and treat infrastructure as a tool of self-determination. Through this approach, science becomes not an external system to navigate but a practice of belonging - to community, to place, and to future generations.

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Finally, we honor our non-human relatives, the animals, lands, and waters of the Bering Sea, that sustain the Unangax̂ people and this work. Their continued abundance is the foundation of the knowledge, resilience, and sovereignty that BRAIDED seeks to uphold.

Data availability statement

In alignment with Indigenous Data Sovereignty and ACSPI governance, sensitive or community-controlled data requires approval by the Aleut Community of St. Paul Island; requests may be directed to isn@aleut.com.

Ethics and Permits statement

This study was reviewed and approved by the University of Alaska Anchorage Institutional Review Board (IRB) [Project # 2134198-3] and determined to be exempt from full review under 45 CFR 46.104(d), Category 2 on March 19, 2024.

Conflict of Interest:

The authors declare no conflicts of interest. This work was conducted in partnership with, and under the governance of, the Aleut Community of St. Paul Island Tribal Government. No commercial relationships influenced the research design, data interpretation, or reporting of results.

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Tables & Figures

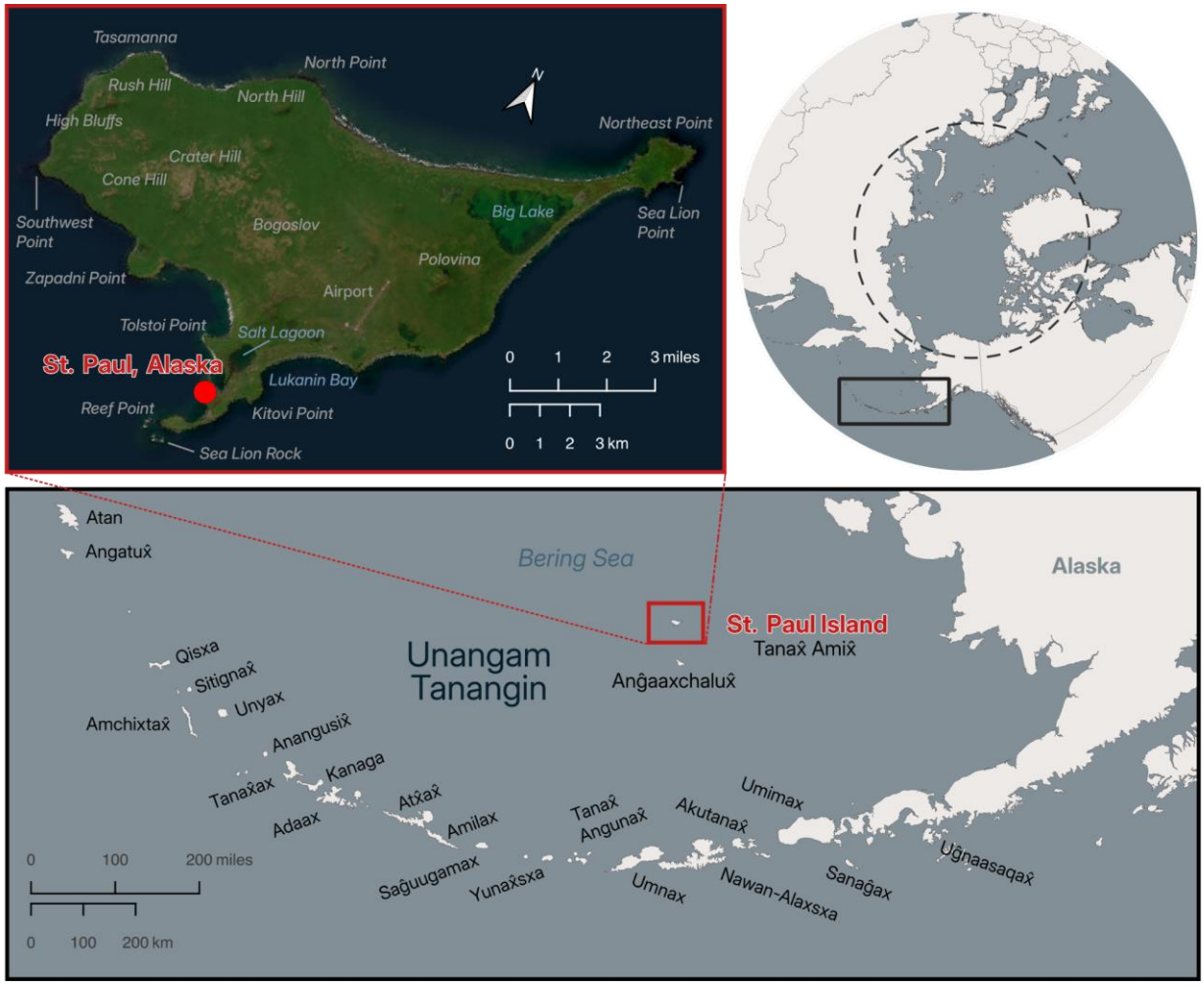


Figure 1. Location of the study area on St. Paul Island, Alaska, in the Bering Sea. The upper panel shows a satellite image of St. Paul Island (Unangam Tanangin), part of the Pribilof Islands, with the community of St. Paul indicated in red. The inset map (upper right) situates the island within the broader Arctic region, and the lower panel shows its position relative to mainland Alaska and the Aleutian–Pribilof region of the Bering Sea. Base map data: Esri, Maxar, Earthstar Geographics, and Natural Earth; Map co-created by M. Druckenmiller, National Snow and Ice Data Center and authors.

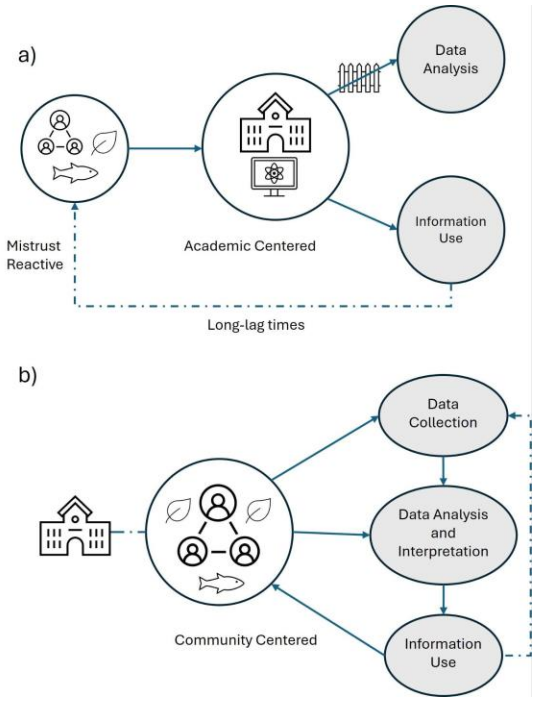


Figure 2: The current academic-centered model of a citizen science partnership (a) relies on communities as data collectors or problem identifiers, but data analysis and information processing takes place offsite which may create barriers, mistrust, and reactive use of information. Our vision (b) centers Indigenous communities as leaders in food-safety monitoring, supported by equitable partners with academics. This model includes co-designing research questions, infrastructure, place-based training, and data analysis occurring on-site within the community, which we predict will enhance Indigenous data sovereignty and interpretation, and reduce delays to facilitate informed decision-making and adaptive capacity.

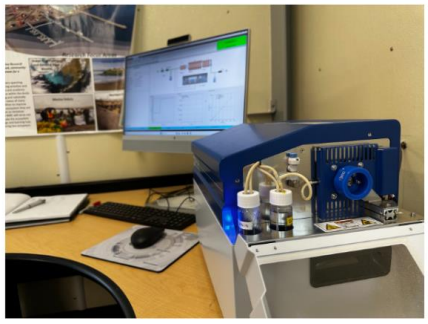
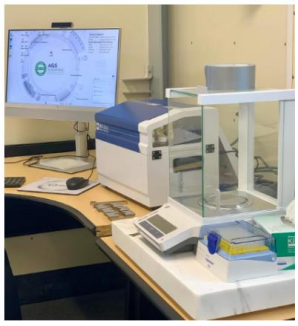
a)  b)  c) 

Figure 3. Gas-free analytical instrumentation installed at the Bering Sea Research Center, St. Paul Island, Alaska. Compact, safe-to-operate systems enable local sample analysis without reliance on compressed gases or full laboratory infrastructure. (a) Benchtop direct mercury analyzer configured for water and tissue analysis; (b) ACSPI staff performing calibration procedures; (c) Integrated analyzer and precision balance in the modular laboratory setup.

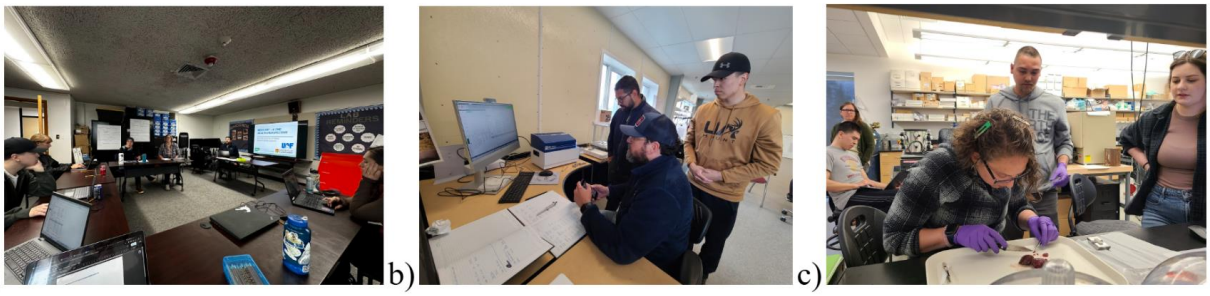


Figure 4. Classroom and laboratory activities during the *Topics in Modern Science: Braided Insights on One Health* short course, co-developed by BRAIDED and Iḷisaġvik College and held on St. Paul Island, Alaska, in summer 2024. (a) Students participate in classroom discussions on One Health frameworks; (b) participants practice data analysis and instrument operation in the Bering Sea Research Center laboratory; (c) hands-on laboratory session demonstrating tissue dissection and sample preparation techniques.

Figure 5. Community participants conducting biosampling and tissue preparation of traditional foods during the *Topics in Modern Science: Braided Insights on One Health* short course on St. Paul Island, Alaska. (a) Demonstration of fish tissue dissection; (b) group training in

standardized biosampling and labeling procedures; (c) sample preparation for laboratory analysis following BRAIDED protocols.

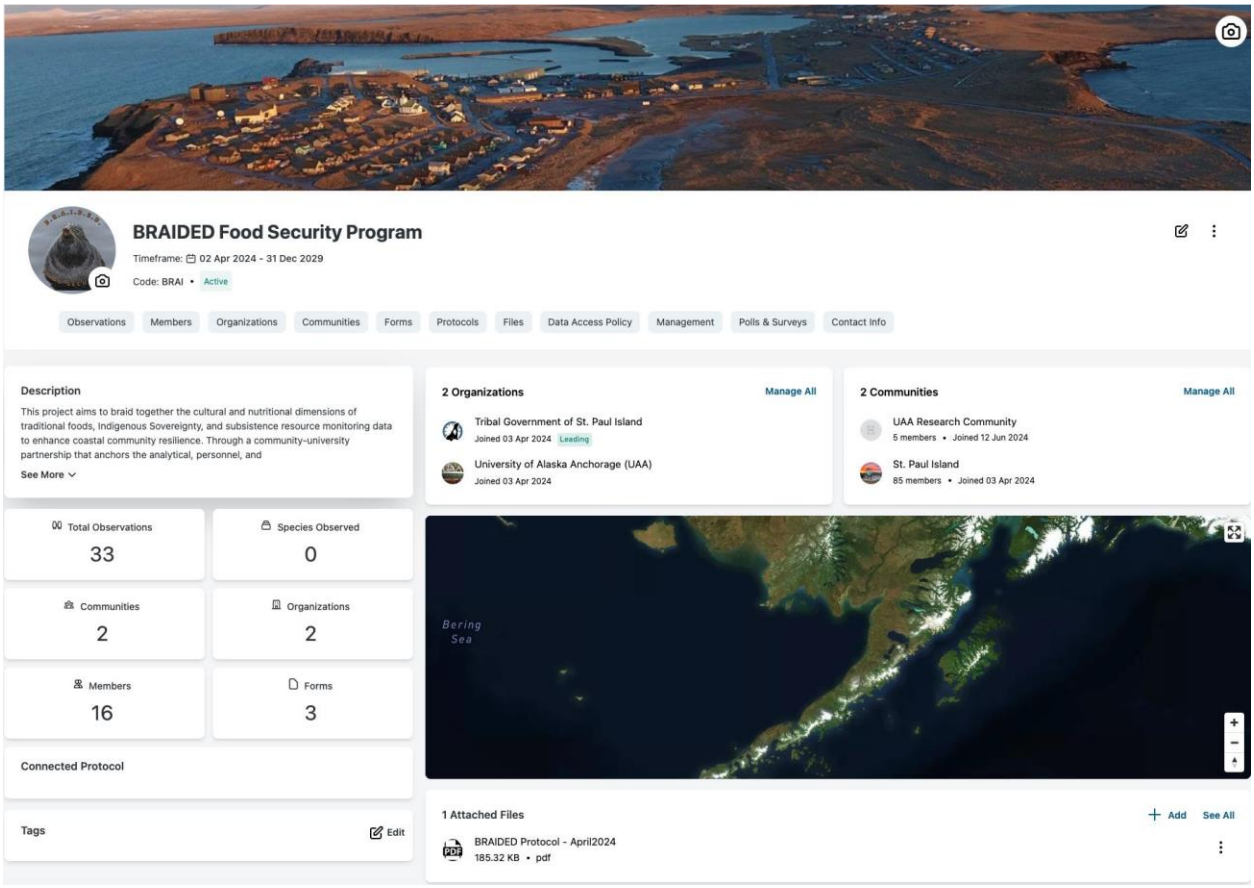


Figure 6. BRAIDED Food Security Program dashboard within the ISN platform during the first few months of the pilot, illustrating community-led data management and collaboration between the ACSPI and the University of Alaska Anchorage. The dashboard provides program administrators (i.e., BRAIDED staff team) access to observations, protocols, and participating organizations, supporting data governance and real-time monitoring of local food safety and environmental conditions.

a)  b) 

Figure 7. Community engagement events on St. Paul Island, Alaska, held in April 2024 as part of the BRAIDED Food Security project evaluation. (a) Elders discussion session highlighting reflections on food security and community priorities; (b) public meeting and open house where project updates were shared and community feedback was gathered, fostering dialogue and trust-building around the establishment of the Bering Sea Research Center.

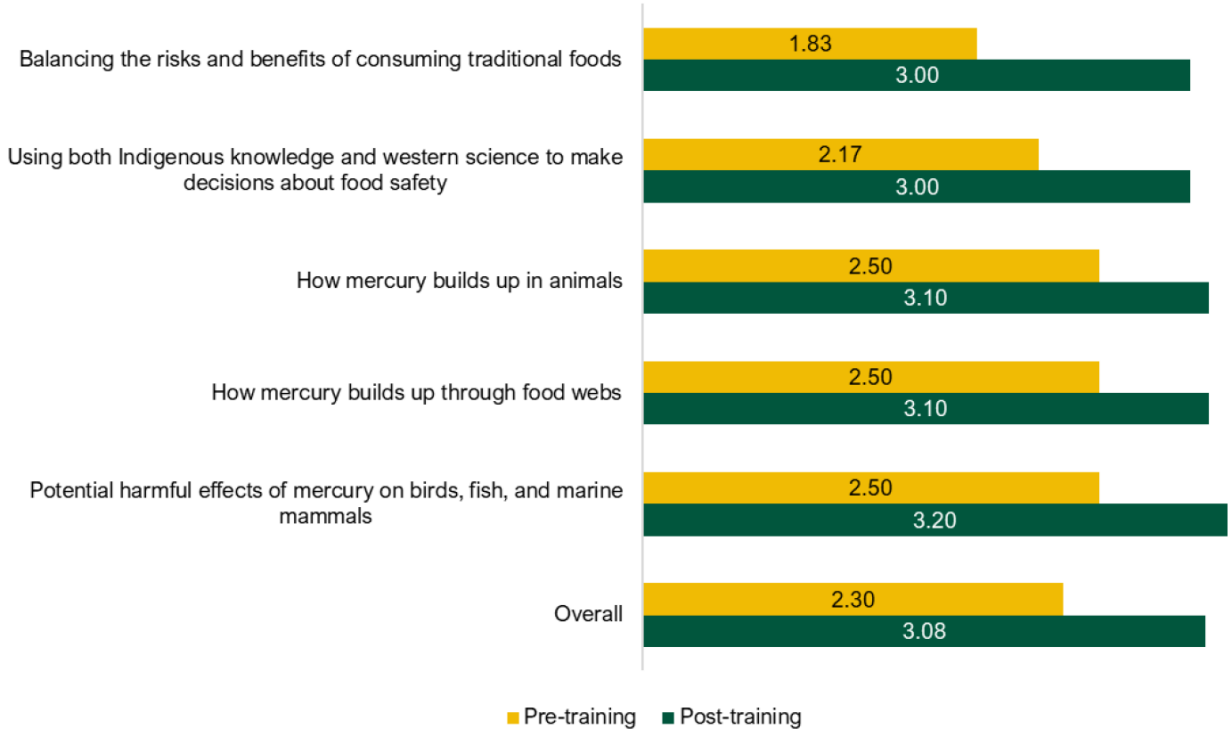


Figure 8: Course participants' knowledge/understanding of key course concepts, pre-post (n=6 (Pre), n=10 (Post); Scale 1-4, with 1=I don't know anything about this topic to 4=I could teach others about this topic)

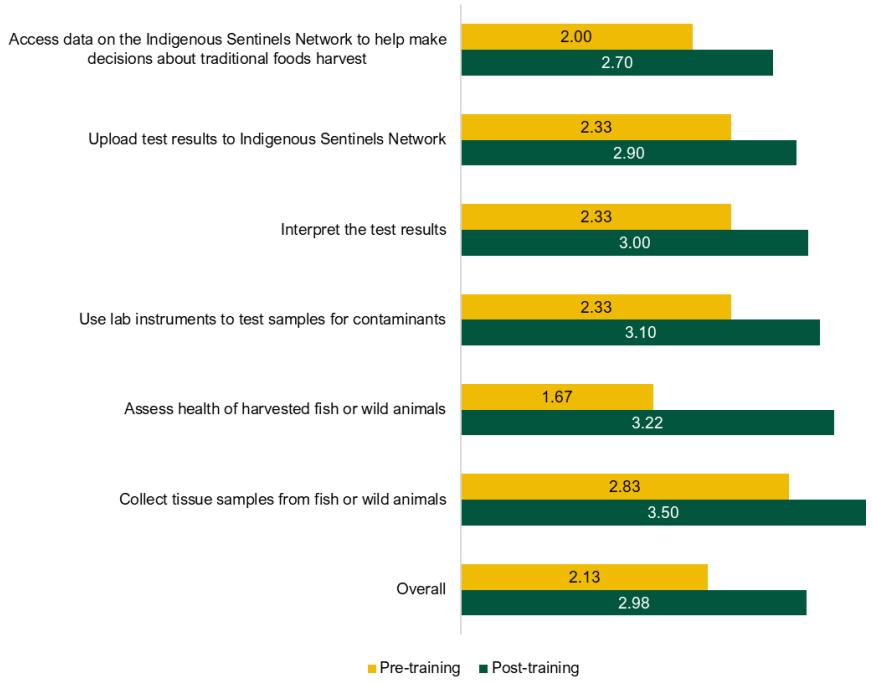


Figure 9: Course participants' confidence in their ability to perform activities related to key course concepts, pre-post (n=6 (Pre), n=10 (Post); Scale 1-4, with 1=Not at all confident to 4=Very confident)

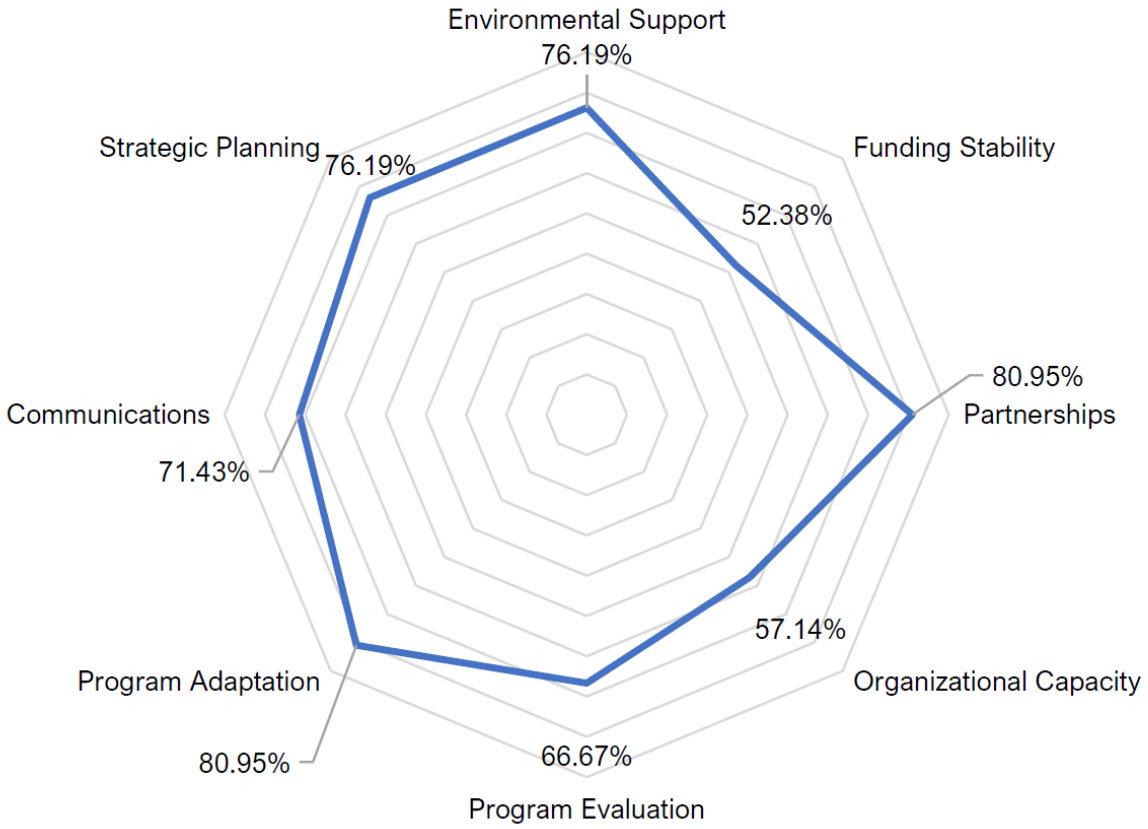


Figure 10: Sustainability assessment by domain for the BRAIDED Food Security program. Scores across seven domains (environmental support, funding stability, partnerships, organizational capacity, program evaluation, program adaptation, and communications) demonstrate overall program resilience and identify focus areas for long-term capacity development.