



Insight

Boundary spanners: a critical role for enduring collaborations between Indigenous communities and mainstream scientists

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ABSTRACT. The need to diversify science includes increasing both the diversity of science practitioners and the voices included in decision-making processes. Indigenous communities have been sought out to provide Indigenous knowledge to mainstream science research programs. As working across the mainstream science and community boundary is increasingly codified into the future of natural sciences, models for equitable collaboration and roles within project structures are needed. The goal of this project is to present a framework for collaboration between mainstream science and Indigenous communities. Specifically, we are addressing an under-recognized role central to partnership, a boundary spanner, who acts as the fulcrum facilitating collaboration. To better understand the role of boundary spanners in collaborative projects, we engaged six boundary spanners who participated in semi-structured interviews and workshops. Emergent common experiences and perspectives of how boundary spanners can be supported and their role in collaborative projects were defined and articulated. The boundary spanners identified 10 characteristics that contribute to equitable partnership between mainstream science and Indigenous communities. From the perspective of the boundary spanners, they detailed how collaborative projects can be structured to increase long-term partnerships and community support of research projects. Equitable collaboration between Indigenous communities and mainstream science is frequently only achieved when individuals at the interface of the mainstream science and Indigenous community have a high level of cultural competency. Equally important is the support provided to the boundary spanners and early engagement of partner Indigenous communities. Through the use of story and metaphor, we highlight the voices of boundary spanners and how their contributions can best be used.

Key Words: *Co-production; decision making; eco-colonization; equitable research; ways of knowing*

Dedication

We dedicate this paper to our beloved friend and longtime colleague, Swinomish Elder Larry Campbell (wanaseah). Larry is one of the original boundary spanners. His innovative thinking and ground-breaking work for the last 35 years on behalf of his tribe and all Indigenous communities have forged the path on which we continue to this day. He gently guided with humor and perseverance; our work is in honor of the gifts of knowledge he bestowed upon us. tig"icid.

INTRODUCTION

In the words of Indigenous author Thomas King, “The truth about stories is, that’s all we are” (King 2005). In that spirit, we would like to share a story to help set the intention of this paper, drawing on the story’s metaphor to put concepts of collaboration, partnership, and equity into perspective. This story is shared with permission from author Skye Augustine from the Stz’uminus First Nation.

The cookie story

Two different groups of people, who have historically struggled to work together, decide to prepare some food that will nourish both their bodies and minds. They come together in the kitchen, the place that is often the center of a home and a place where many great stories begin. Before they start, they talk about what they will cook. “What kinds of foods do we like? What kind of

spices do we want? Do we want to put this in the oven or do we want to cook on the stove? Do we want this to be a meat dish? What do we want to do?”

After a robust brainstorming session, the group agrees to bake something. They are not yet sure what it will be, but they agreed on baking. They decide that each group will go back to their community, gather some of their favorite ingredients and return the next day to bake them into one dish. Everyone imagines it will be delicious.

The next day everyone comes back together. The first group arrives with pre-made cookies. Beautiful cookies that are symmetrical and uniformly shaped. They’re amazing! They also bring a variety of decorations, which they offer to the other group, “Look! We listened to what everyone said and we heard what was most important, and thought we could speed things along by getting the baking out of the way.” They handed out the cookies and invited those from the other group to pick out their favorite decorations to adorn them with. The other group, who arrived with a careful selection of ingredients from their community, looked confused and said, “We were hoping to bake bread.”

In this story, both groups had an opportunity to co-create a baked dish. They mutually agreed on baking as a shared method and held a promise to work collaboratively to co-create something that neither group could create on their own. But one group returned with pre-baked cookies: a metaphor that also represents

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a pre-determined research project created by the mainstream scientific community. The cookie decorations represent the limited and bounded input about the pre-determined project offered to the other group. In this metaphor, the group who was asked to simply decorate the pre-baked cookies represents Indigenous communities (but we note this is a common experience in many small and marginalized communities). The Indigenous group had different ideas about what to bake, based on the promise of collaboration, and had returned with ingredients rather than a pre-baked product. They were hoping for bread, but held off from baking in favor of contributing to an end product that would equitably share the knowledge and experiences and desires uniquely held by each group in order to co-create something together, and to build trust and partnerships in the process.

The cookie story illustrates a frequent form of “partnership” where the Indigenous community is consulted only after the geographic scale, human-ecosystem and/or knowledge space of the project has been pre-designed and determined by a research group external to the Indigenous community. The Indigenous community is asked only to provide after-the-fact “decorations,” such as “anecdotal observations” or logistical support. If the first group in the story had not arrived with pre-baked cookies produced to their specification and instead had approached the baking process as a collaborative effort, could the two groups have co-created something new, different, or better? When outsiders approach an Indigenous community with a pre-determined and “already baked” project, the opportunity to co-create is removed.

We posit that had there been a person or persons present at the beginning of the baking discussion who spoke the language of both groups and could help create a bridge between the groups to ensure agreed-upon objectives and actions, then perhaps the cookie ending could have been avoided and the opportunity to realize a co-produced product could have been realized. In this paper, we describe the attributes of the people who hold this bridging position, termed “boundary spanners.” We explore the concept of the boundary spanner as a person or team that can effectively facilitate collaboration between mainstream and Indigenous science without preemptive prioritization or assimilation by mainstream scientists. Then, drawing from our own experiences as shared and compiled as part of the National Science Foundation-funded Coastal Almanac program, we define the attributes of a boundary spanner, provide examples of successes and failures, and recommend amendments to current practices that would better support boundary spanners.

This paper is not advocating for readers to become boundary spanners, nor is it a how-to manual for becoming one. We will say that the choice to start down the path of becoming a boundary spanner is a personal one, regularly made in an early career stage, and often through the mentorship of one or more elders from both Indigenous and scientific communities. In this sense, boundary spanning becomes a life’s work, because it is only achievable through patience, and by listening, listening, and listening some more until one learns what the elders are teaching. There is no end point; the learning process is continuous.

THE NEED FOR BOUNDARY SPANNERS

In recognition of a need to diversify science and incorporate multiple ways of knowing into solution development for our

planet’s most pressing socio-environmental concerns, mainstream scientists (here used to refer to academic, government, and non-governmental researchers primarily from the geosciences and ecological, social, and archeological disciplines defined by Western European-style academia) have increasingly sought knowledge and partnerships from Indigenous communities (Ogar et al. 2020, Varghese and Crawford 2021). Within mainstream science, there is growing focus on the inclusion of Indigenous knowledge, Indigenous knowledge systems, and partnerships with Indigenous communities by governments (Truth and Reconciliation Commission of Canada 2015, Government of British Columbia 2019, Hill et al. 2020), funding agencies (TriCouncil of Canada 2019), and scholars (Salomon et al. 2018, Atlas et al. 2021). Compared to Western European scientific traditions, Indigenous knowledge is inherently place based (Wilder et al. 2016) and multi-generational (Barnhardt and Kawagley 2005). Indigenous knowledge systems expand into deep time horizons, extend social-ecological baselines, offer alternative epistemologies to understand ecological change, and present ecological management methods honed over thousands of years (Ellis 2005, Cruikshank 2012, Hoffman 2016, Lubchenco 2017, Arnott et al. 2020).

Despite these recent trends, mainstream science has often fallen short of true inclusion of Indigenous knowledge systems, relying instead on hierarchical assumptions about the relative value of different ways of knowing, which inherently places Western or mainstream science above all others (Liboiron 2021): that is, prioritization, selective extraction, and assimilation of information rather than including Indigenous project leadership (David-Chavez and Gavin 2018). Among Indigenous scholars and allies, there is discussion as to whether integration in such inequitable paradigms is possible (Agrawal 1995). Confounding integration is the blindness of many mainstream scientists to centuries of atrocities and ongoing extractive exploitation that have and continue to oppress Indigenous Peoples in the name of science (Deloria 1997, Nadasdy 1999, Deloria et al. 2001). This has led to an inherent (and justifiable) distrust of many mainstream scientists who seek research opportunities and collaborative activities with Indigenous communities (Bozhkov et al. 2020).

Within Indigenous communities, distrust of mainstream science is rooted in current and past inequities, systematic bias, and eco-colonization (the process of colonization through environmental policies based on data collected and analyzed by a dominant society and without partnership of the Indigenous population those policies affect; Norman 2012, Trisos et al. 2021). Given multi-generational experience with eco-colonization, many Indigenous people view mainstream science as a tool used to oppress rather than inform (Deloria 1997), much less invite Indigenous inclusion as fully capable knowledge holders and research partners.

Improvement in the relationships and collaborations of mainstream scientists and Indigenous community members has great potential for improving our collective understanding of global environmental change. David-Chavez and Gavin (2018) present a framework to quantify Indigenous community engagement in climate science projects, evaluating Indigenous partnerships along a spectrum, from extractive to Indigenous-led, and assessing participation and collaboration at the design,

implementation, and analysis stages. In their meta-analysis of 140 published climate articles that incorporate Indigenous knowledge, 87% were classified as extractive and none of the articles met the criteria of Indigenous-led. The criteria for Indigenous-led projects include fully collaborative and transparent exchanges of information between mainstream scientists and Indigenous communities, which can result in increased knowledge of local conditions and understanding of how those changes are taking place within larger ecological patterns and conceptual models, and how those changes may affect resources and people now and into the future (Ellis 2005, Robinson and Wallington 2021). These interactions are certainly the exception rather than current practice in the mainstream research community.

Thus, although calls for inclusion of Indigenous Peoples in environmental research are laudable and frequently include suggested best practices (Adams et al. 2014, Ford et al. 2015, Hill et al. 2020), the definition of what equitable research projects look like in mainstream science and in Indigenous communities is often different. Many mainstream research projects cite their projects as collaborative, yet that collaboration is often “contractual,” where Indigenous people serve as study participants, not partners (David-Chavez and Gavin 2018, Reid et al. 2021). A truly equitable exchange between mainstream science and place-based communities requires mutual understanding of goals, needs, priorities, and concerns, with intentional communication and facilitation of knowledge exchange (Adams et al. 2014, Harris et al. 2021). The question of how to move mainstream science toward equitable partnerships with Indigenous communities remains open.

BOUNDARY SPANNER CONCEPT

Boundary work is defined as “those acts and structures that create, maintain, and break down boundaries” (MacMynowski 2007). Boundary work is often focused on an activity such as jointly creating a meeting agenda or co-creating art (Zurba et al. 2019). Boundary-spanning organizations are typically mission driven to bridge the gap between mainstream science and their service population (Safford et al. 2017). For example, the Cooperative Extension program at Washington State University (a land grant university) serves as a boundary-spanning organization with the mission to “...engage people, organizations and communities to advance knowledge, economic well-being, and quality of life” (<https://extension.wsu.edu/about-extension/>). Boundary-spanning activities describe relationship building, outreach, communication, facilitation, evaluation, and conflict mediation that bridge language and cultural barriers. In environmental management, these activities can promote more equitable outcomes to natural resource management policies. Examples include kelp harvesting under different climate change scenarios (Kobluk et al. 2021), savanna land use planning (Reid et al. 2016), and ocean use policy (Posner et al. 2020). Although boundary spanning has been used to describe integration of mainstream science and Indigenous ways of knowing for development of environmental co-management (e.g., Robinson and Wallington 2021), or “two-eyed seeing” of knowledge coexistence and complementarity (Reid et al. 2021), our focus is on the importance of the agent, the boundary spanner, as a necessary role for successful science partnerships.

A boundary spanner is an individual who can connect people across social, societal, or cultural silos (Aldrich and Herker 1977, Tushman 1977). Emerging from the business literature to describe the importance of employees who connect distinct internal departments, the term has also been used to describe externally facing employees supporting networking between organizations (At-Twaijri and Montanari 1987, Ferguson et al. 2005); those assisting union contract negotiations (Friedman and Podolny 1992); public service employees who work across cultural communities (Buick et al. 2019); and fishers who work with fisheries researchers (Johnson 2011). Reid et al. (2016) refer to the intentional positioning of trusted persons (individuals or teams) along the boundaries between communities, researchers, and government agencies who can bring distinct stakeholder groups to the table, facilitate collaborative discussions, provide context and meaning to those unfamiliar with different ways of knowing and communicating, and link knowledge to action.

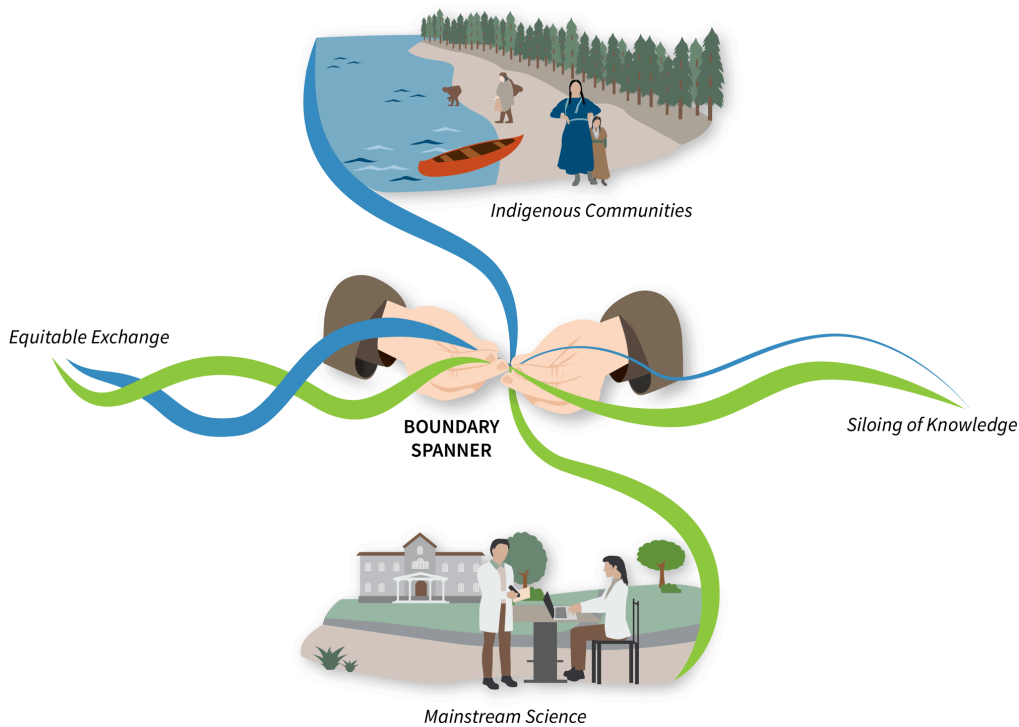
Within natural resource management and conservation, we believe there is an increasing need for individuals and teams with a set of skills, values, and priorities that support the development of equitable, enduring partnerships based on trust that span disciplinary and cultural boundaries. To assist in that goal, we offer a set of reflections from people actively working as boundary spanners as a starting place for mainstream scientists looking to strengthen their collaborations with Indigenous communities through authentic and effective partnership.

METHODOLOGY

Here we, as boundary spanners, tell our stories and provide insights into the mechanisms behind fruitful collaborations. This work and our conceptualization of boundary spanning have evolved out of a larger effort called the Coastal Almanac, which explored how non-mainstream, non-credentialed persons in coastal systems of the Pacific Northwest can contribute to long-term monitoring and inquiry-based science on issues of importance to the lives, livelihoods, and cultures of their communities. The Coastal Almanac was envisioned to collectively and collaboratively document and understand coastal change among members and participants of Indigenous, fishing, and coastal communities. In this paper, we concentrate only on the conversation threads with and among Indigenous communities. We meld those lived experiences together with a larger parallel effort to imagine a new paradigm of mainstream science with community interaction, termed the “Equitable Exchange” (Harris et al. 2021).

In an equitable exchange, place-based communities and mainstream scientists cooperatively determine what “currencies” or outputs and outcomes are important during project planning (Harris et al. 2021). In the context of mainstream science, currencies typically include publications, graduate student projects, grants, access to research sites, and data. In Indigenous communities, currencies are widely varied but could include support for K-12 education programs, community events with support for local cooks and artists, direct funding for community members, and integration rather than assimilation of traditional knowledge systems. Requisite to successful implementation of the equitable exchange model is a boundary spanner, a person or team who connects frontline communities and mainstream science (Harris et al. 2021), working to help each group to understand and incorporate the currency requirements of the other.

Fig. 1. In this figure boundary spanners are situated between mainstream science and Indigenous communities. The ribbons from mainstream science and Indigenous communities represent their respective contributions and involvement in projects. On the right moving toward siloing knowledge are projects that do not support boundary spanners and engage Indigenous communities as decorative additions to mainstream research projects. Moving left toward equitable exchange the boundary spanner is fully supported and engaged at the genesis of the project. In equitable exchange projects the boundary spanner can weave together mainstream science and Indigenous community epistemologies.



Although the boundary spanner framework can be applied to a wide variety of positions, in the context of this paper, the boundary spanner is a trusted individual, or close team of individuals, who simultaneously engages with and/or is a member of the mainstream scientific community, while serving their (partner) Indigenous community as their highest priority. Creating this intentional imbalance is an overt acknowledgment of the power and equity imbalance that has constituted the vast majority of Western-Indigenous interaction, including science (David-Chavez and Gavin 2018).

The boundary spanner works as an advocate in spaces that might not privilege the perspectives and priorities of Indigenous communities. Although engagement with the mainstream science is their goal, they will not compromise community integrity in the name of research. This requires the boundary spanner to have a foot in both worlds (Reid et al. 2021), to figuratively and often literally speak multiple languages. The archetypal boundary spanner is an Indigenous community member steeped in their culture who also holds an advanced degree in a mainstream scientific discipline, and who possesses an affinity to employ transdisciplinary approaches in their work. In practice, boundary spanners may be members of the Indigenous community or trusted allies and supporters of the vision and mission of the

Indigenous organizations they work for and with. As such, they hold applicable knowledge of both the concerns of the Indigenous community and outside resources that can help address these concerns (Fig. 1). Boundary spanners can also see the fundamental value Indigenous knowledge can bring to mainstream science, and the value that mainstream science can offer the Indigenous community. They see this as well as the paramount importance of not allowing Indigenous knowledge to be subsumed by mainstream science or bureaucratic red tape. They actively seek to restructure leadership and decision-making bodies and reframe research questions, study design, and project implementation in the pursuit of justice and equity.

We took the boundary spanner concept outlined in Harris et al. (2021) and explored this role in detail with a series of individuals working for/with Indigenous communities within the geographic scope of the Coastal Almanac project, and known to the project leads as colleagues. Each of these people, or team of people, has adopted and adapted this role within their Pacific Northwest Tribe, Canadian First Nation, or Alaskan Tribe through heritage and/or through employment with the Tribe. Boundary spanners were selected using a non-random snowball approach to cover a broad geographic range, from Washington State through Southern and Central British Columbia and Alaska, originating

with experts known to the project leadership, then asking them who else would be good to approach.

Author roles and positionality

Our interpretations of boundary spanning within north Pacific coastal Indigenous communities are informed by our heritage, lived experience, and professional roles. Among the authors, three are Indigenous, three are tenured members of the mainstream science community, eight hold or are currently enrolled in graduate degree programs, and six identify as boundary spanning between Indigenous communities and mainstream science.

Marco Hatch is an enrolled member of the Samish Indian Nation, an Indigenous Coast Salish Nation, and also an Associate Professor of Environmental Science at Western Washington University. Hatch works with tribal and non-tribal students and Indigenous nations throughout the Salish Sea on the ancient Coast Salish practice of clam gardening.

Skye Augustine is from the Stz'uminus First Nation, and also a Ph.D. student at Simon Fraser University. From 2015–2020 Augustine was the Clam Garden Project Coordinator at the Gulf Islands National Park Reserve, Parks Canada, where she interfaces between Indigenous ecosystem management, the federal government, and non-Indigenous academic researchers.

Larry Campbell (*wanaseah*) is a Swinomish tribal Elder and traditional speaker who has worked for his community for over 35 years on planning and decision making based on Indigenous community health priorities. Campbell received his Bachelor's degree in his early 40s after spending many years fishing and learning his culture; he is knowledgeable in multiple ways of knowing.

Lauren Divine has worked for the Aleut Community of St. Paul Island Tribal Government for more than 10 years and currently directs its Ecosystem Conservation Office. She is a non-Indigenous ally and holds a Ph.D. from the University of Alaska. Divine brings together local and traditional knowledges; tribal, federal, and state management; Western sciences; and stakeholder engagement through community-based and citizen science program management.

Jamie Donatuto holds a Ph.D. in Community Environmental Health from University of British Columbia, and has worked for the Swinomish Indian Tribal Community for more than 20 years. Working closely with Larry Campbell, they focus on harvesting and preserving traditional foods and medicines, researching Indigenous community health climate change adaptive strategies, and developing methods for equitably incorporating Indigenous health priorities into mainstream decision making.

Nicole Smith is an archaeologist with an M.A. from the University of Victoria and 20+ years of experience working with Indigenous communities, students, academics, and government agencies on cultural heritage projects throughout coastal British Columbia. She enjoys roles with organizations including the Clam Garden Network, Hakai Institute, and United Nations Ocean Decade.

Amy Groesbeck holds a Masters degree in Marine Ecology from Simon Fraser, where she worked on clam gardens. Groesbeck served as the Project Coordinator for the Coastal Almanac. In that capacity she was seminal in recruiting, and she interviewed Augustine, Campbell, Divine, Donatuto, and Smith.

Selina Heppell is a professor at Oregon State University where she currently chairs the Department of Fisheries, Wildlife, and Conservation Sciences. A marine ecologist and fisheries biologist, Heppell works with fishing communities, fishery cooperatives, non-governmental organizations, and state and federal management agencies to co-develop sustainable fisheries.

Julia Parrish is a professor at the University of Washington where she is currently also the Associate Dean for Academic Affairs in the College of the Environment. She has 25 years of experience running hands-on citizen science projects along the northeast Pacific coastline, involving thousands of coastal community members from all demographics.

Semi-structured interviews

Excepting the senior author, all boundary spanners participated in a semi-structured interview process conducted by Groesbeck, using a 14-question interview guide (see Appendix 1). The institutional review board–approved (University of Washington #52396) question set consisted of predominantly open-ended questions to ensure sufficient flexibility for participants to articulate their experiences (Miles and Huberman 1994, Gould et al. 2015). Each interview lasted between 1.5 and 2.5 hours. The interview guide questions were based on key components theorized to contribute to boundary spanner work. These include characteristics of boundary spanners, attributes contributing to or detracting from successful boundary spanning methods, and project objectives and goals.

Interview analysis

Following transcription (Temi transcription service), raw transcripts were returned to the interviewees for review. Approved transcripts were analyzed by using grounded theory and inductive coding to realize repeated themes (Corbin and Strauss 2015) within responses to each framing question. These were compiled into a synthetic document, masking interviewee identity, which became the basis of a two-day workshop designed to further synthesize the information in service of producing a manuscript. Workshop sessions included: roles and characteristics of boundary spanners and boundary spanning projects, key factors in project success (and failure), and how to codify and support boundary spanners in collaborative projects. During each session, a consensus approach was used as follows.

During the workshop each theme was discussed among the group of boundary spanners, who worked together to generate lists of attributes pertinent to each theme. All workshop attendees, including principal investigators (PIs), discussed each list, consolidating attributes where synonymies occurred, separating elements where discussion resulted in divergent understanding, and highlighting any terms for which there was not consensus for inclusion. The latter were re-discussed and included or excluded on the basis of boundary spanner consensus. Notably, consensus-building focused both on lived experience (“Yes, I do that”) and lived wisdom (“Yes, I have seen/heard of that done”). Using the consensus lists, PIs engaged in a writing workshop to create an initial results section, which was reviewed and edited by all authors, who collectively and substantively deepened all sub-sections, before reviewing them again for consensus. The final project thus represents a consensus opinion of the entire author set, although it does not necessarily represent the lived experience of all boundary spanners or PIs.

Table 1. Characteristics and abilities of a boundary spanner.

Characteristic	Explanation
Braided identity	Situated in the Indigenous community and in the mainstream science community.
Approachable	Respects and invites conversation and interaction from all parties.
Available	On call both formally (nine-to-five) and informally (24-7). Emotionally intelligent. Empathetic, sympathetic, self-aware, and community-aware.
Knowledgeable	A dual knowledge holder: deep knowledge of the customs, practices, systems of power, and communication pathways of their Indigenous community; a trusted source of disciplinary knowledge to their community.
Resourceful networker	A connector and networker; knows where to go to find answers on both sides of the boundary.
Hears what others can not	Hears the unspoken message; understands beyond the words to the intent; knows how words will be interpreted.
Committed	Long-term dedication to their Indigenous community; building trust on both sides of the boundary.
Balance power	Seeks to alter power dynamics across the boundary to ensure equity and respect for the Indigenous community.
Create space for community knowledge	Helps frame communication and interactions across the boundary to respect, balance, and hold space for all knowledge systems to be recognized and valued, particularly Indigenous community knowledge.

In this paper, we reproduce quotes from the original interviews that embody specific concepts and/or are examples of boundary spanning. In some cases, the original text has been shortened for clarity and/or brevity, as denoted by ellipses. In all cases, specific mention of individuals or organizations were deleted, occasionally resulting in insertion of subjects, pronouns, and/or tense changes. All word additions are signified by brackets. All final quotes, alongside the original full text wording, were reviewed and approved by the interviewee.

We highlight here that the boundary spanners and Coastal Almanac personnel were intentionally and fully integrated as workshop participants, and subsequently as co-authors. That is, although the interviews reflect the lived experiences of the boundary spanners, the synthesis reflected experiences shared by all of the co-authors: boundary spanners and mainstream scientists working together. This approach, although non-traditional, epitomizes the equitable exchange by acknowledging and championing boundary spanners as full members of the research team (Harris et al. 2021).

RESULTS

Based on the experiences of the six boundary spanners who were interviewed and/or participated in the two-day workshop to define the roles, skills, and characteristics of a boundary spanner, we present a synthesis of the definitions and roles of boundary spanning work within the context of Indigenous communities and mainstream science; describe key characteristics and abilities of boundary spanners that allow them to be successful in their roles in-community and in mainstream science; and describe how boundary spanners help create transformative projects (Table 1). Italicized words below highlight thematic categories from interviews and workshops and repeated (i.e., multi-interview) concepts.

Defining the role of a boundary spanner

Boundary spanners live in two worlds: they are from, or work within, an Indigenous community; they may or may not also be credentialed members of the mainstream science community. Not necessarily the leader, a boundary spanner is cognizant of being *one part* of the whole, and although a *complement* to the others, the boundary spanner holds a unique role.

In the specific context of Indigenous communities and mainstream science, a boundary spanner is an *ambassador* who

can *connect* one world to the other, and be a *conduit* of knowledge and knowledge systems in both directions. They function as *teachers* and *educators*, working with outside researchers to increase their cultural competency and awareness. In this sense, a boundary spanner is a *cultural translator*, *combatting stereotypes* and acting to *promote authentic communication* and to *facilitate mutual learning and understanding*. Because the chance for misunderstanding is high when different cultural traditions and knowledge systems are brought together, boundary spanners are thrust into active listening: listening to what is said and what is meant, and *reflecting* out loud their understanding until both sides are satisfied that they have been heard, and the boundary spanner believes that they understand each other.

Although a boundary spanner intentionally *bridges*, they are not *gatekeepers* actively preventing others from coming in or going out. Their role is not policing. However, they do *advise* the community, and may well recommend against involvement in a mainstream science project that fails to adequately address the needs and norms of fully equitable participation. Thus, a boundary spanner is often seen as an *entry point* by mainstream scientists seeking to engage an Indigenous community. They are viewed as a powerful person who *filters* which mainstream science requests, and what information, are passed on to the community or accepted. By contrast, we believe that boundary spanners should be seen as science partners who also serve as *liaisons*, able to *navigate* the structures, policies, values, beliefs, and approaches of each world in service of the other. They carefully consider what information should be shared and when, maintaining a keen sense of the appropriate timing for both parties. In this sense, a boundary spanner may become a *champion* for persons or projects they consider to be equitable, inclusive, and worthy. However, and crucially, boundary spanners work first in service of the non-dominant culture, the Indigenous community, by using their knowledge of and position within the majority culture to work against oppression, assimilation, or inequity. Thus, boundary spanners often *advocate* on behalf of community interests, equitable participation, authority, sovereignty, and funding.

Characteristics and abilities of a boundary spanner

Braided identity

A boundary spanner comes to understand, value, and live in multiple ways of knowing, and can “self-position” within both

an Indigenous community and mainstream science. In this sense, a boundary spanner is a code switcher. Because of this, a boundary spanner can “hear” the needs, priorities, and interests of the community even as others, including those seeking to work in and with the community, cannot. This makes a boundary spanner insightful.

My first education was the long house. I only went after western education once I felt that my tribal education, my spiritual education, was on a solid foundation. Now I don't look at them [traditional knowledge and western science] as competitors, I ask how can we combine them or get them to work cooperatively with each other, instead of the way it's been perceived forever as competitive or adversarial.

To do this work, you literally have to live in multiple worlds. You have to be comfortable in cultural protocol and language by and from community. You must maintain relationships in community and maintain goals that come from community, while simultaneously being a scientist. Which means using the scientific method and communicating to other scientists using technical and specific language. I engage in the scientific process of peer review. I also work for the federal government. Being familiar and proficient in government bureaucracy and protocols is another world that I inhabit.

Approachable

A boundary spanner is open and welcoming, inviting interaction from all parties, engaging with a wide range of disciplinary specialists, and working to bring diverse groups together. Especially when “facing inward” toward the community they work with, a boundary spanner hears everyone out with patience and respect, assuming that what is being said is important to the speaker, because otherwise they would not say it.

When “facing out” toward mainstream science, boundary spanners are approachable in part because of their scientific credentials. They understand and respond to the norms of academic and scientific communication pathways: they are prompt, respond to emails, return phone calls. They are the people who are “easier to find.” In interactions with mainstream scientists, boundary spanners attempt to increase understanding of community norms, moving away from mainstream science as the center, or only, form of knowledge by asking questions in ways that facilitate awareness. Even when turning projects or scientists' inquiries aside, they attempt to engage gently, in ways that invite future, and more appropriate, interaction.

Available

A boundary spanner's door is always open. They are always on and always involved. As a result, their work in-community follows both formal workaday pathways as well as informal engagement outside of a Monday-to-Friday, nine-to-five schedule. Involvement in the life and livelihood of the community could include conversations at community events or out in the field, questions from tribal youth, plugging in to community social media, receiving late night texts or phone calls, or drop-by visits at work or at home.

[Community members] call my cell phone or they come knock on my door; they show up. I like the fact that people feel like they can contact me anytime because it makes me feel like they see me as someone that can help, or has answers for them when they need them. And so I make myself available all the time.

Emotionally intelligent

Boundary spanners are empathetic, sympathetic, self-aware, and community-aware. They display the ability to understand the frustrations and passions of others, even when those emotions may be negative. They are calm, not quick to anger; thick-skinned and not defensive; but also strong, quiet but not submissive. They do not rise to the bait of a challenge, understanding that there are many truths, and the point is not to convince the speaker they are wrong. They are open to others' points of view. They assume positive intent. They take feedback in a positive way. Boundary spanners can accept blame, even if the fault is not theirs.

Boundary spanners believe, as a given, that they do not know everything. They are not afraid to admit they do not know the answer to a question or request. They are always ready to learn. They are polite and respectful, thanking the community for allowing them to be present, to be on community land, and to present information. A boundary spanner is not the most visible member of the group, and will not necessarily be found at the front of the room, or the person speaking the most or the loudest. This humility gives the boundary spanner the ability to “check their ego” when engaging. Boundary spanners “play the long game,” withstanding initial tests without running away. They remain standing, they keep showing up, they listen.

Knowledgeable

As suggested by the term, boundary spanners are well informed about, and well situated within, both their Indigenous community and their scientific discipline. Through heritage and lived experience, or on-the-job learning, they have acquired a deep knowledge of the customs, practices, formal and informal systems of power, and communication pathways of the Indigenous community they work for and within.

Because the boundary spanner also has the respect of their scientific discipline community, understanding “how things work” within their Indigenous community allows the boundary spanner to act as a source of information and translator for mainstream scientists seeking to engage with the community. Beyond the liaison function, the community often regards a boundary spanner as a credible and trusted source of information in their own right. Being a knowledge holder means that the boundary spanner is a contributing partner, actively involved in both the intellectual merit and the broader impacts of a project.

Resourceful networker

Although boundary spanners may be approached to engage as liaisons or gatekeepers broadly across mainstream science, their scientific expertise is grounded in their discipline, necessitating the ability to quickly figure out where to go for answers when the community turns to them with questions and concerns. Knowing whom to ask evolves from accruing connections to many different people and in multiple directions within and between their communities. Boundary spanners are networkers, becoming a nexus point connecting community to mainstream science.

I try with everything I do to connect the community with mainstream science. I am trying to carry the tribal voice in the mainstream science realm. I hope that what I am saying is making sure that mainstream scientists and researchers and managers and agency-related people have an accurate understanding of what the community's concerns are, what their viewpoints and worldviews are, and how different the community is from the mainstream science way of thinking. We also report back, and we get tons of questions from people, and we can answer some of those or follow up. So, we connect the community and mainstream science in many ways formally as well as informally.

Hears what others cannot

Boundary spanners engage daily in cross-cultural communication. In part because of their status as a dual knowledge holder, boundary spanners can “hear” verbal and nonverbal signals. Within their Indigenous community, boundary spanners come to know when elders are communicating their message through story, or when community members are using silence to speak. Within their scientific community, they know the jargon and the inherent form and format of the science that goes unspoken, yet can be central to understanding the speaker and the work.

Understanding beyond the “face value” of the words to the intent of the speaker allows boundary spanners to discern, and voice, a concern or request that is central but perhaps not stated in words. With respect to mainstream science seeking to reach out to Indigenous communities, boundary spanners can become both translators and teachers because they “hear” how the scientist is heard, understand what they are trying to say, and know what they need to communicate to be heard receptively.

[Much of it is about] spending time together on the land and also sharing food together. I'm trying to make both culture and science more accessible with some level of translation. With scientists I prep them with types of cultural protocol that they might interact with, and with community members I prep them with who the scientists are and why they care about the work that they're doing, what their goals are.... As often as possible I make sure that science gets communicated and co-created with communities right from the beginning. And for projects that are underway, Indigenous communities are regularly updated, results get communicated back, and no publications happen without community approval.

Boundary spanners help mainstream scientists slow down, take the time to introduce themselves, to share who they are and why they love science, and to share their motivations for the work. Without a boundary spanner, mainstream scientists tend to jump directly to the “business part” of the meeting, asking hyper-specific questions without the needed personal and professional context, without first following community-based communication protocols, and without demonstrating the intent to develop a longer-term relationship.

We really think about ways to ensure that the community knows what we're doing in terms of the science and the research that we're doing. I think in that way we're really

making an effort to ensure that their feedback is not just valued, but central to what we're doing. That creates a pathway so that folks feel more engaged, but is also changing the basic definition of what science is.

Committed

Boundary spanners display long-term dedication to their Indigenous community. Particularly for boundary spanners not from the community, earning community acceptance requires a repeated show of commitment. In this sense, boundary spanning is not a fleeting thing, but instead built up over multiple projects and years, through the personal relationships that are developed and deepened until the boundary spanner has earned the trust of the individuals on both sides of the boundary.

...It's taken us years to gain the trust of our own community because they've been so violated over the years.

As a non-Indigenous person, I think it is so important to go to the communities. Not have them come to you, but you make the effort to go and connect with people. It just really matters to meet in-person and to make the effort to go there. That's always key. A phone call isn't going to work, it's those face-to-face meetings and relationship building. And it takes a lot of time. I don't think people appreciate how much time it takes.

Balances power

Boundary spanners seek to alter the power dynamics between Indigenous communities and mainstream science. Their goal is to ensure that Indigenous knowledge systems are elevated and well respected. That means the people who are the holders and protectors of Indigenous knowledge are treated well, fully informed, provided veto, consulted on use and application, included in interpretation, and provided opportunities to learn about the mainstream science that has been conducted with their knowledge or in their territory. Boundary spanners desire to create projects with Indigenous leadership and involvement from the beginning.

Boundary spanners help meld community and mainstream science goals. For mainstream scientists, it may initially be difficult to release control of the research plan; however, by working with a boundary spanner the strengths of mainstream science can be used in concert with communities to open a new discovery space. Boundary spanners value specific knowledge of mainstream scientists but also want those scientists to be flexible and willing to stretch out of their comfort zones.

I have witnessed a scientific presentation where the marine biologists had specific questions that they asked of a First Nations' community. From the outset, it was clear that the scientists had a preconceived understanding of how the project would unfold, and asked community members to classify things according to the scientists' definitions and research structure. It was clear that the project lacked an individual who had enough cultural awareness or experience within that community to develop a research design with the Nation that was culturally appropriate and meaningful. As it was, the

Table 2. Attributes of unsuccessful (problematic) versus successful (goal-achieving) partnerships, specific to the mainstream science goals, and the structure and logistics of the project. Abstracted from interviews of boundary spanners working in Indigenous communities of the Pacific Northwest and Alaska, and subsequently synthesized during a workshop attended by the co-authors.

Attributes of:	Unsuccessful Partnerships	Successful Partnerships
Mainstream science researcher	A dominant, and dominating, voice; insensitive and uncommunicative, a poor listener Ignorant about data ownership, data use rights, and/or cultural significance Unwilling to go through formal process of securing permissions, signed partnership agreements Does not respect signed agreements or formal protocols Does not respect reporting requirements; centered in the academy Maintains sole PI or restricts PI status to mainstream researchers Invites Indigenous community only as token representative to the project Has a mismatch in skill set relative to community needs	Elevates and celebrates other voices, particularly non-dominant group members; keen to listen and learn Flexible, open-minded, willing to modify research plan to meet objectives of the community; willingness to change direction mid-project with community input Knowledgeable about tribal sovereignty and data and knowledge ownership Goes through formal process of securing permissions, signed partnership agreements, formal agreements, and related norms and adhering to cultural protocols Recognizes when data or knowledge is/is not appropriate to make public Collaborative in all aspects of the project Writes grants collaboratively with Indigenous community members and/or content experts; willing to cede expertise Willing to navigate the university, government agency and/or grantor systems with community interests centered Gives power and/or authority to tribal members Recognizes the experience and teachings of local knowledge holders as akin to university training Brings desired skills and knowledge to the community Questions are driven by a community group, centered on community interest or need Community members, and boundary spanner, are compensated for time, expertise, and project implementation Part of a long-term relationship maintained over a series of projects and fueled by personal relationships and mutual respect Supported by constant shifts in power and authority between team members and across the boundary Place-based and geographically centered within traditional community boundaries
Research project	Is only of academic interest Lacks a champion within the Indigenous community Lacks support from the Tribe Provides no direct funding for tribal involvement Is a one-off project proposed by individuals with no community ties Concentrates power and decision-making to a single PI, or mainstream science team, with no ties to the community Project is regional-to-global, a mismatch in spatial scale relevant to the community	Brings together tribal members, whether they are local or not Pre-project time devoted to develop/deepen relationships, co-create the project, and apply for needed permits and formal agreements Time for community interaction and listening sessions Project flexibility built in to allow for unexpected opportunities and connections Includes elements centered on tribal youth and community capacity building Brings elders, students, teachers, and mainstream scientists/academic together (e.g., science and culture camp) Fosters long term relationships between teachers and scientists
Project logistics	Completed “at a distance” such that communication and community involvement are limited Mismatches in time available to be directly involved relative to community expectations Does not allow sufficient time to navigate formal processes Does not allow time in-community, including “non-science” time to build relationships All facets of project implementation and authentic involvement are conducted by credentialled persons (including university students)	Brings together tribal members, whether they are local or not Pre-project time devoted to develop/deepen relationships, co-create the project, and apply for needed permits and formal agreements Time for community interaction and listening sessions Project flexibility built in to allow for unexpected opportunities and connections Includes elements centered on tribal youth and community capacity building Brings elders, students, teachers, and mainstream scientists/academic together (e.g., science and culture camp) Fosters long term relationships between teachers and scientists

scientists’ methods seemed irrelevant to the Nation which left me questioning their results.

Boundary spanners seek to break the paradigm of mainstream scientists defining community engagement by asking narrow, predetermined questions without taking the time to understand what the community is concerned about, what information is relevant, or what information the community needs.

Creates space for community knowledge to be valued within a project

Boundary spanners educate scientists on the importance of community knowledge both prior to and during scientific studies. A boundary spanner may help the scientific team understand who will be participating from the Indigenous community and highlight the knowledge and experience they bring. During the work, the boundary spanner creates safe and appropriate spaces for knowledge holders to be recognized and valued, and to share their observations and assessments. Often community knowledge

holders can be quiet and unassuming when compared to the scientific team who may be more boisterous and forthcoming with their methods. A boundary spanner works to respect, balance, and hold space for all knowledge systems to be recognized and valued.

What was really important for me to convey to [the scientific team] was that our two First Nations partners and representatives had roles as important as any of ours, and that's because they come with their cultural and spiritual training for working on ancestral sites. In Coast Salish territory, in the Southern Gulf Islands, there are many cultural and spiritual protocols around working on archaeological sites that you don't have elsewhere on the coast and it's really important to make sure that the scientists and researchers get that right. I really wanted the [scientific] team to know how important our First Nations partners' roles were and for them to feel like everybody understood that. There was a lot of really good sharing between everybody because we were all learning from everyone.

The need for boundary spanner acknowledgment and support

Although the boundary spanner role is often critical to the success of a collaborative, community-based project, the role is not often formally recognized. Individuals may carry this role in addition to their formal employment duties or volunteer their efforts in support of the program or community. They themselves may not formally recognize themselves as a boundary spanner, growing into the role over many years while building trust and credibility with experience.

By highlighting the importance of a boundary spanner individual or team, we are advocating for a formal recognition of the extra time, resources, and effort a boundary spanner contributes to the success of a project. Working with a boundary spanner requires a comprehensive investment. For boundary spanners to be effective, they need to be engaged early in the process and considered a critical and senior research partner with input into the scale and scope of the project at the design stage. Frequently, this includes developing relationships well before jointly pursuing funds. The challenge for those developing projects is to highlight the importance of the boundary spanning role, and to identify the individuals or team members who could fill this niche effectively.

The community and boundary spanner should be considered central parts of the investigative team, and funding should allow for the substantial time needed for the boundary spanner and community to engage in the project and offer their expertise. The time required for relationship building is crucial, but rarely included in funding applications. Foundational to a successful partnership is respecting that community partners are steeped in Indigenous Knowledge Systems that have accumulated over lifetimes of experience and that this knowledge and training is at least commensurate with a doctoral degree. The early and consistent participation of boundary spanners in a project can magnify a project's success and impact manifold.

If they hinge entirely on me that is a good recipe for nonstarters. One of the first things that I try and do with projects is to make sure that there are other places for those worlds to connect besides through me.

Attributes of successful partnerships

We considered the characteristics of “successful” collaborative research projects (those that resulted in satisfaction by all partners, promoted feelings of relevance and pride in the work that was done, and generated interest in continuation or expansion of continued partnerships between the mainstream scientists and the Indigenous community) and compared them to attributes that we have seen in many unsuccessful projects (Table 2).

Success would be scientific community members and Indigenous community members working together closely and often - with regular and frequent communication, clarification, and feedback occurring in both directions. A successful project would have distinct but complementary goals and objectives and would be composed of people who are determined and dedicated to finding scenarios where everyone wins. You can tell it is successful when people are willing to experiment and try things differently, and when everyone is prepared to question the status quo.

Even today, mainstream scientists frequently seek to extract place-based information and/or multigenerational knowledge from Indigenous communities, with little regard for community interests. Extractive projects not only lead to results that the community may disagree with but they reaffirm the time-honored distrust Indigenous communities have with mainstream science and scientists. The most egregious studies can often have unintended and longstanding political consequences for the Indigenous community within whose territory the work was conducted (e.g., Pacheco et al. 2013, Murdock 2018). In contrast, positive partnerships tend to build and spawn more projects.

A boundary spanner can identify and mitigate some of the negative attributes shown in Table 2. Grounded in community concern and seeking equitable partnership, a well-supported boundary spanner seeks to create successful collaborations across the Indigenous–mainstream science divide. However, they cannot accomplish this goal alone. The mainstream science researcher plays an important role in shaping these projects, setting the tone for the project, and ensuring flexibility and support for community-defined directions. Successful partnership comes from long-term partnership with decentralized leadership and the centering of community needs.

DISCUSSION AND CONCLUSIONS

In this paper, we have presented a composite picture of a boundary spanner, individual or team, working within a north Pacific coastal Indigenous community. Although none of us necessarily possess all of the characteristics we outline here in equal measure, or have experienced all of the positive (or negative) attributes of projects spanning the mainstream science–Indigenous community boundary, all of us agree that these characteristics and attributes are fundamental to successful work. Further, we posit that our collective list may be a useful starting point for others working along this braided path, and we invite extensions and embroiders to our model.

Rooted in Indigenous community practice and teaching style, we re-envision the Cookie Story with a well-supported boundary spanner in place to see how the outcome of the two groups could be different.

The baking story

Two very different groups of people, who have historically had their differences, decide to come together in the kitchen, a place where a lot of great stories start. They identify a person who has worked in the kitchens of both groups and who understands and can articulate the expertise and nuanced practices of each group, the ingredients that they use, and what they have cooked in the past.

Before they began, the boundary spanner had issued invitations to all participants, communicating the intention of this effort and encouraging everyone to arrive prepared to show up as themselves: willing to share their histories, their stories, and their hopes for the future. They also ask everyone to bring a favorite dish and be prepared to talk about it.

Everyone shows up and the kitchen is a flurry of activity. The smell of cinnamon mixing with cardamon, while ginger wafts from across the space. The boundary spanner thanks everyone for being there and then the stories begin. Stories of worn recipes that have traveled great distances and between many hands. Stories of great flavors pulled together during times of struggle. Stories of new foods that have been embraced.

Watering mouths turn into the scrape of forks against plates and smacking lips, satisfied and delighted.

Now that they know each other a little better, the boundary spanner asks everyone to consider what they would like to cook together. Everyone is brainstorming and at the end of the conversation all of the people agree to bake something. The boundary spanner asks, "What can we bake together that will be delicious and draws on our respective knowledges and talents best?" Each group has an opinion about this, and they talk about their favorite dishes and ingredients and what their grandmothers used to make. The first group explains that they want to make cookies with beautiful decorations, but the second group wants to make bread that will be more nutritious for everyone in their community. The boundary spanner tells each group why cookies and bread are both good and says, "Let's come back tomorrow with ingredients to taste so we can make something that everyone will love."

The next day everyone comes back together. The first group arrives with white flour and sugar and raisins, with a recipe for cookies. The second group arrives with grain flour and corn and salt, with a recipe for bread. They lay the ingredients out on the table and the boundary spanner says, "These are wonderful ingredients, let's see if we can put them together." The two groups agree to this and combine the ingredients, trying them in different ways. Soon, they create a delicious sweet bread that is both nutritious and delightful to taste. The boundary spanner helps them write down the new recipe to share with their communities.

Our experiences and those of many others provide evidence that teams with boundary spanners are more successful in terms of reaching goals that respect the needs and interests of mainstream science and Indigenous communities. The impact of these partnerships is more lasting and far-reaching, in both short and long-time frames:

The best work occurs when you have a [boundary spanner] team like ours that looks at it two ways, long term and short term. The short term ensures that the

resources keep coming to support the work. Short term is to get to believability within your leadership and your community, the long term is to make these paradigm shifts so a larger group of people [mainstream scientists] will approach their work differently.

Many "best practices" papers for scientific studies with Indigenous communities (e.g., Adams et al. 2014, Hill et al. 2020) provide examples of how the work should be done, but rarely focus on who should do the work, their attributes, and what support they need. We have identified the actor(s), the individual or group of individuals that facilitates the interactions and formation of shared knowledge. Although boundary spanners have been long identified in human relations (Thompson 1967), the best practices employed or project structure created by the boundary spanner has received more attention in the literature than the boundary spanning agent themselves (Williams 2002). We stress that the role of a boundary spanner in mainstream science with Indigenous communities is broader than the translator, mediator, or gatekeeper "jobs" described in other fields, such as business. A boundary spanner should possess a set of values that elevates the marginalized group to an equal partner in the research, with acknowledgment and respect for desired approaches, data ownership, and dissemination of results. With a foot in both worlds, the boundary spanner helps to create a braided path that integrates each distinctive knowledge system without assimilation of one by the other, making the results more accessible and meaningful to everyone.

This paper illustrates the "Baking Story," above. In a traditional mainstream science approach, a "Cookie Story," the grant holders (Hatch, Parrish and Heppell) would have created a research plan, developed a set of interview questions, identified subjects for the interviews (Augustine, Campbell, Divine, Donatuto, Smith), hired a technician to conduct, record, and transcribe the interviews (Groesbeck), analyzed the data, written a paper, and sent a completed copy to the boundary spanners for comment before publication. Instead, we worked together, combining observation, experience, and knowledge to define "boundary spanners" and their value in collaborative scientific research with Indigenous communities. We discussed themes and wrote the paper together, respecting the viewpoints and contributions of all authors and creating a product that will benefit all project partners and their communities. Our approach illustrates a co-production of knowledge that incorporates many of the steps required for equitable partnerships in scientific research. Our hope is that it is a useful and lasting story.

We imagine a future in which boundary spanners are recognized, compensated, and sought out for the role they play in collaborative projects. A future where this role is centered from the inception of new projects, ideally staffed by Indigenous people with backgrounds in both Indigenous and mainstream science. Some of us imagine a future where tribal communities are fully self-sufficient in their own sciences, both traditional and mainstream. Others imagine a world where mainstream science and Indigenous knowledge sit side-by-side as co-equally valued approaches, as multiple ways of knowing. And all of us imagine a world in which the hegemony of mainstream science has eased, that Western science and the academic tradition become inclusive without assimilation, becoming both more, and different, than what they are now.

Acknowledgments:

We would like to thank the Samish Indian Nation and Quinault Indian Nation for hosting MBAH and JKP for the initial conversions that led us down the boundary spanner path. We would like to thank the many communities and knowledge holders who have patiently taught us, shaped us, and empowered us. We would also like to thank Denise Augustine for the inspiration for the Cookie Story. (PIs: Hatch, Heppell, Parrish; key personnel: Groesbeck; National Science Foundation award #1649210). Ethics statement Participation in this project was approved by the University of Washington Human Subjects Division (application 52396). Additionally, Skye Augustine's participation was secured through Parks Canada Agency Research and Collection Permit number GINP-2018-28657. Participation from Swinomish Indian Tribal Community members and staff approved through a Data and Material Sharing and Ownership Agreement with Western Washington University and Senate Resolution No. 2017-10-239.

Data Availability:

The data/code that support the findings of this study are available on request from the corresponding author, M.B.A.H. None of the data/code are publicly available because they contain information that could compromise the privacy of research participants. Ethical approval for this research study was granted by the University of Washington Human Subjects Division, application 52396.

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Appendix 1

1. Describe how you connect the community you represent and mainstream science?
2. Do you feel like this is a unique position? What makes the role unique?
3. Are there terms you can think of that may adequately reflect what that role is? What do you call this role, or yourself in this role? Why is this distinction important?
4. How do you define, understand, and represent the needs/priorities/interests of the community in external partnerships? What does that look like?
5. How do you represent mainstream aspects of science to your community? What does that look like? Which aspects do you focus on most? Why?
6. What roles do you take on when facilitating partnerships between community and external mainstream science organizations - from initial interactions to establishing partnerships?
7. Describe some successful community-mainstream science projects you have been a part of? And unsuccessful projects?
8. Of the collaborative project partnerships that you've been a part of, what is the relative proportion of community-generated vs externally generated collaborative projects? In your opinion, were they equitable collaborations, or did one partner lead? Does this play into the success of the collaboration?
9. Are there things that would stop a project from going forward? Non-starters, full stops, or mid project stops - anywhere in the process from first interaction to after creating a partnership? If so, what are they? How does the involvement of someone in your role impact what happens when they encounter these stops?
10. Describe your vision of an ideal partnership success story? How and why is it successful? How do you know it is successful? What is the role of the someone in your current position within this story?
11. Do you feel that your role uniquely influences the level of collaboration that is able to be achieved in these projects?
12. Do you feel like your role is integral in creating more successful collaborations? (what is it that you, in your role, uniquely offer)? Is different than the status quo? If so, why?
13. How is your role recognized and valued by your institution?
14. Does your role influence community science participation? If so, how?