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# Social Capital, Indigenous Storytelling, and Fish Diversity: Learning Together Through Community-university Partnerships in Downeast Maine

Michelle de Leon
*University of Maine*, michelle.de@maine.edu

**SOCIAL CAPITAL, INDIGENOUS STORYTELLING, AND FISH DIVERSITY: LEARNING TOGETHER THROUGH COMMUNITY-UNIVERSITY PARTNERSHIPS IN DOWNEAST MAINE**

By

Michelle de Leon

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Advisory Committee:

Linda Silka, Professor Emerita, School of Economics, Co-Advisor

Gayle Zydlewski, Professor of Marine Sciences, Co-Advisor

Jessica Jansujwicz, Research Assistant Professor, Wildlife, Fisheries, and

Conservation Biology

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**THROUGH COMMUNITY-UNIVERSITY PARTNERSHIPS IN DOWNEAST MAINE**

By Michelle de Leon

Thesis Co-Advisors: Dr. Linda Silka and Dr. Gayle Zydlewski

An Abstract of the Thesis Presented in Partial
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Not only can community-university partnerships be vehicles for mobilizing community

resources and affecting change, they also have high potential to produce useful, nuanced

research and enable renewed visions of trust. I explore partnerships rooted in trust in the

context of a community-university partnership between the Passamaquoddy Tribe at Sipayik

and the University of Maine and its work through the Passamaquoddy-led StoryMaps Team. To

accomplish this, I take a transdisciplinary approach to incorporate diverse perspectives on

understanding critical and ethical approaches to engagement with Indigenous communities.

The central focus among all three chapters is the need for Indigenous communities and

institutions of higher education to learn together to meaningfully produce community

resilience scholarship.

In Chapter 1, I explore community-university partnerships as social capital and

emphasize the role of trust in community-university partnerships with Indigenous communities.

Through a literature review that places scholarship in a culturally relevant context for

Indigenous communities, I explored community-university partnerships and emphasized that with refreshed views of trust after learning and making mistakes together, community-university partnerships can build trust in collaborations across Western science (WS) and traditional ecological knowledge (TEK). University partners can meaningfully share power with Indigenous communities by using Indigenous research methods (IRMs) in research projects.

Chapter 2 focuses on a collaborative research project that is useful, culturally appropriate, and ethical for the Passamaquoddy Tribe. I collaborated with the Sipayik Environmental Department, Wabanaki Youth in Science, and Maine Sea Grant to support the Indigenous storytelling work seeking to raise awareness of municipal water issues at Sipayik. We utilized StoryMaps, a digital storytelling software, to critically bring together TEK and WS and move toward overcoming histories of mistrust. This chapter presents an ethnography of my participant-observation of the StoryMaps Team, and because I joined the team with an open mind and commitment to lifting Indigenous voices, I found emergent themes and identified two critical strategies – trust through partnership and flexibility in the research project – that community-university partnerships with Indigenous communities may learn from. This chapter contributes to ongoing discussions of community-university partnerships with Indigenous communities by highlighting storytelling as a critical approach.

In Chapter 3, I recognize the Indigenous and Western significance of the fish communities in Western Passage and contribute to the current knowledge base that could help fisheries management and decision-making at both the state and tribal levels. We used recreational (WS) fisheries survey methods to build on past work in Western Passage and Gulf

of Maine: jig and longline. I examined whether adding an additional gear type (longline) would provide a different perspective of the fish community than when using jig gear alone. Gear type differences did not influence conclusions about diversity across the survey sites sampled. This chapter concludes with considerations to further explore the utility of the added longline sampling. All data will be shared openly with tribal, state, and public partners.

**DEDICATION**

This thesis is dedicated to the memory of my dear friend Tobias Engel. He taught me to

appreciate the beauty in conservation, community, and storytelling. Thank you, Toby Dog.

# ACKNOWLEDGEMENTS

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CCF – Community Capitals Framework

CKK – Cultural Knowledge Keeper

GIS – Geographic Information Systems

H – Shannon-Weaver Diversity Index

HTC – HomeTown Competitiveness

IACUC – Institutional Animal Care and Use Committee

IRB – Institutional Review Board

IRM – Indigenous Research Method

J – Jig

L – longline

Maine SG – Maine Sea Grant

MSP – Marine Spatial Planning

PO – Participant Observation

SED – Sipayik Environmental Department

TEK – Traditional Ecological Knowledge

UMaine – University of Maine

WaYS – Wabanaki Youth in Science

WS – Western Science

**CHAPTER 1**

**SOCIAL CAPITAL AND TRUST IN COMMUNITY-UNIVERSITY PARTNERSHIPS WITH INDIGENOUS COMMUNITIES**

**1.1 Abstract**

Community-university partnerships are one approach through which communities can mobilize community resources to affect change. Social capital theory has been broadly applied to collaborative efforts in communities that seek to enhance community resilience. This chapter explores community-university partnerships as social capital and emphasizes the role of trust in community-university partnerships with Indigenous communities. Through a literature review that is culturally appropriate to Indigenous cultures, I emphasize that with refreshed views of trust after learning and making mistakes together, community-university partnerships can build trust in partnerships engaging Western Science (WS) and traditional ecological knowledge (TEK). Attending to trust enables community-university partnerships to produce useful research through Indigenous research methods (IRMs). Trust in research partners, institutions, and different knowledge systems support community-university partnerships in deliberating across differences for community resilience.

**1.2 Introduction**

Partnerships between institutions of higher education and community members go by many names (e.g., academic-community partnerships, university-community partnership), and I utilize community-university partnership because it places priority on community needs and is widely applicable across research contexts. Community-university partnerships dynamically engage researchers, policymakers, community members, and other stakeholders (Hegger et al.,

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2012). Participants vary by project circumstances, such as the needed knowledge to identify the issues, skills to lead a team, and the experience to implement innovative solutions. Because there is not a universal formula for creating a successful team, identifying who has pertinent knowledge is an ongoing challenge among community-university partnerships that seek to mobilize community resources and affect change.

Community-university partnerships are vehicles for mobilizing community resources and affecting change because of the obligation for universities to serve the public, as well as the motivation of researchers and stakeholders to produce applicable knowledge for present issues. For one, universities can and need to serve the general public (Groulx et al., 2020). The acknowledgement builds on the Kellogg Commission's (1999) call for universities to enrich current and future student experiences through practical opportunities, to prepare students through theory and practice, and to dedicate knowledge and expertise to serve communities. Organized around higher education reform, the Kellogg Commission (1999) prompted universities to go beyond a one-way transfer of knowledge from universities to communities – and move toward an engaged approach that makes knowledge useful for communities. This ongoing shift is pertinent for Indigenous communities who have come to know a long, ongoing history of research reducing Indigenous people to uncivilized stereotypes, thereby causing trauma to Indigenous communities (Smith, 1999; Beltrán & Begun, 2014).

Second, the results of research projects often end up on shelves instead of being used by community practitioners and members (Stoecker, 2009). In an analysis of 232 proposals submitted to the Sociological Initiatives Foundation research funding pool, proposals were qualitatively coded according to the stated goals, roles of various participants, and the

proposed outputs (Stoecker, 2009). Although Foundation guidelines instructed applicants to state intended outcomes, Stoecker (2009) found that nearly one-third of applicants proposed neither clear actions nor clear outcomes. His study exemplifies the all-too-common anecdote of research collecting dust.

Scholarship has illuminated a number of conceptual frameworks, particularly community resilience, to produce useful research to help communities respond to local challenges (Chapman et al., 2018). Community resilience scholarship has widely accepted Magis's (2010) definition of community resilience: "the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise" (p. 402). Working directly with stakeholders, university researchers can realize nuanced and applicable community resilience scholarship (Chapman et al., 2018). Community-university partnerships seek to make research more useful for communities (Hart & Silka, 2020; Gruber et al., 2017; Stoecker, 2009).

In what follows, the goal of the chapter is to provide a literature review that situates community-university partnerships as social capital—the connections between people and organizations that affect change (Emery & Flora, 2006)—and explores the role of trust in community-university partnerships between Indigenous communities and universities. Social capital is important for understanding community-university partnerships because it describes collaborative efforts that can promote community resilience (Pfefferbaum et al., 2017). As such, researchers and practitioners alike have recognized the need to attend to social capital in both social science research and public policies (Aldrich, 2011). Moreover, the broad application of social capital has realized a coupling of social capital with trust. For example, in a study drawing

on two decades of work on vernal pool management in Maine, Jansujwicz and Calhoun (2017) illustrate that developing and maintaining social capital is critical for conducting scientific research, engaging community members, and influencing vernal pool policy in Maine. Regular face-to-face and hands-on interaction between researchers, community members, and regulatory stakeholders generated the trust needed to realize results (Jansujwicz and Calhoun, 2017). Trust is a key ingredient for creating and sharing useful knowledge through community-university partnerships.

Literature reviews are culturally appropriate to Indigenous communities: in *Research Is Ceremony*, Wilson (2008) argues that literature reviews put research conducted by non-Indigenous researchers into an Indigenous context. By putting research into a culturally appropriate context that builds on the work of others, insight from literature reviews can inform working relationships with Indigenous communities (Wilson, 2008). This chapter demonstrates how trust can be built by research partners, institutions, and different knowledge systems seeking to collaboratively enhance community resilience scholarship and practice.

**1.3 Social Capital**

Social capital is elusive and multi-dimensional, generally incorporating several social phenomena such as interpersonal relationships, reciprocity and exchange, and trust (Sabatini, 2008; Barnes-Mauthe et al., 2015). In his seminal definition, Bourdieu (1986) presented social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" (p. 248). In another seminal definition over 10 years later, Lin (1999) broadly defined social capital as "investment in social relations with expected returns" (p. 30). Lin

(2008) further argued that social capital includes "resources embedded in one's social networks" (as quoted by Aldrich 2010, p. 595). This echoes a World Bank report in which Woolcock and Narayan (2000) defined social capital as the "norms and networks that enable people to act collectively" (p. 225). The position of social networks as a key element of social capital persists across disciplines. For one, in citizen science scholarship, Cooper (2016) defined social capital as "the social networks, cohesion, and individual investments in community that make democracy work better." (as quoted by Jansujwicz and Calhoun, 2017, p. 38). Rooted in psychology scholarship, Pfefferbaum et al. (2017) emphasized that while some definitions include people, institutions, and the networked links between them, others also refer to the resources derived from the linkages. Magis (2010), in her seminal work on community resilience, referred to social capital as "the ability and willingness of community members to participate in actions directed to community objectives, and to the processes of engagement" (p. 407).

Community resilience theory and practice can draw on community development approaches (Berkes & Ross, 2013; Zautra et al., 2014; Ross and Berkes, 2014; Cavaye & Ross, 2019) to understand social capital. One approach includes the Community Capitals Framework (CCF), a model rooted in community development theory that examines social practices in relation to other dimensions of a community (Emery & Flora, 2006; Thompson & Lopez Barrera, 2019). In development of CCF, Emery and Flora (2006) defined social capital as the "the connections among people and organizations or the social 'glue' to make things, positive or negative, happen" (p. 21). I adopt Emery and Flora's (2006) definition of social capital because

CCF systematically explores communities and has been applied to both community resilience and community-university partnership literatures.

Social capital was found to initiate the mobilization of other capitals in a process that allows capitals to build on one another (Emery & Flora, 2006). Focusing on HomeTown Competitiveness (HTC), a comprehensive community development effort in rural Nebraska, Emery and Flora (2006) analyzed interviews with community leaders and partners, project reports, and participant observations and found that community leaders recruited high school students for leadership development (social capital influencing human capital). Community leaders also formalized a foundation for community giving and sustainable economic development (social capital influencing financial and natural capitals). HTC facilitated the transfer of wealth to encourage people to be proud of and give back to their community (social capital influencing cultural capital). Business owners also increased their use of technology and participated more in government (social capital influencing built and political capitals). Per the CCF, building social capital enables the generation of additional social capital and other community capitals: for example, building social capital (HTC connects organizations within Nebraska) makes it easier for a community to build natural capital (community leaders enhance greenspace) (Emery & Flora, 2006).

A key gap in the literature is that social capital theory has not been applied to exploring collaborative work between researchers and Indigenous communities. Scientific research traditionally conducts research about, rather than with, Indigenous peoples (Smith, 1999). Applying social capital theory to Indigenous communities does not align with current efforts to

create partnerships with and for Indigenous communities (McGreavy et al., 2021). McGreavy et al. (2021) presented case studies on adaptive responses to emerald ash borer insects, protection of public health and reduction of shellfish bed closures, and dam removals and river restoration. They engaged in tensions rooted in the histories of mistrust and committed to centering Indigenous sovereignty, supporting Indigenous leadership in research, and redesigning research for inclusivity and dialogue (McGreavy et al., 2021). This approach is vital because partnerships are well-positioned to support community resilience research through culture and place specific research (Hutchins et al., 2013).

It should be noted that Loban et al. (2014) examined the role of Indigeneity in cross-disciplinary collaborations through a social capital framework. The authors had backgrounds in law, accounting, economics, and human resources, and through a reflection piece on their collaborative work, they articulated a deep respect for Indigenous perspectives in research (Loban et al., 2014). Their work centered around fisheries management in the Torres Strait and the tensions surrounding equitable shares of fishing effort between the rights of Indigenous and commercial fishers (Loban et al., 2014).

### 1.3.1 Social Capital and Community-University Partnerships

I present different forms of social capital to provide guiding images of how social capital functions in communities, yet I broadly interpret social capital to focus on community-university partnerships advancing community resilience. Bakker et al. (2019) provide that resilient communities strategically manage social capital to access resources beyond community boundaries. In a study observing a marine spatial planning (MSP) process in

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Scotland, fisheries communities leverage social capital to position fisheries as a governance priority in the community, exchange knowledge between agents of change, and facilitate community participation (Bakker et al., 2019).

Understanding different forms of social capital is useful for examining the role and impacts of social capital in communities (Green & Haines, 2015). The three widely accepted forms of social capital are bonding, bridging, and linking. Bonding capital describes connections between people who already know each other to strengthen the existing relationship (Green & Haines, 2015). In the earlier example in Scotland (Bakker et al., 2019), bonding capital describes the relationship between shell fishers who share distinct cultural values regarding hard work, passion for the industry, and an understanding of occupational hardships. Bonding is critical for social cohesion and support (Poortinga, 2012).

Whereas bonding capital describes existing relationships, bridging capital connects people who did not previously know each other in order to establish new social ties (Green & Haines, 2015). While there was limited interaction between shell fishers and other stakeholders in the MSP process, the fisheries community leveraged bridging capital to emphasize the importance of marine spaces and reframe the influential role of shell fisheries in marine development (Bakker et al., 2019). Bridging helps realize solidarity, respect, and mutual understanding (Poortinga, 2012).

Lastly, linking capital refers to the ties between community members and local institutions (Green & Haines, 2015). An example of this tie is stakeholder trust in institutions. The trust between shell fishers, marine governance authorities, and the fisheries market is a key linkage between actors in the MSP process. Trust enables different actors to communicate

their priorities and influence the MSP process (Bakker et al., 2019). It follows that linking

enables the mobilization of resources and power (Poortinga, 2012).

While bonding, bridging, and linking provide insight into the complexity of social capital,

there remains disagreement on whether some forms of social capital are more influential than

other forms. In their observational study of the MSP process, Bakker et al. (2020) proposed that

bonding and bridging are more influential than linking. In contrast, Poortinga (2012) analyzed

two years of biennial Citizenship Surveys to understand the interrelationships between

bonding, bridging, and linking social capital for community resilience. The survey is used in

England and Wales to inform government priorities around diverse topics, including community

cohesion, civic engagement, and political trust. Poortinga (2012) examined the 5-point scale

survey data of 17,572 respondents, and he concluded that because there was no significant

difference between the effects, a broad interpretation of social capital is a useful approach to

community resilience. A broad conceptual understanding of social capital also aligns with this

chapter's objective to explore community-university partnerships as social capital.

Moreover, while social capital has high potential to influence collective action in

communities, it has received criticism for perpetuating exclusion in decision-making processes

(Cretney, 2014; Cleaver, 2005). Social capital analyses have been seen by some as lacking a firm

theoretical framework and as too often highlighting only positive interactions within

communities. As such, social capital has been used to work around issues of exclusion without

proper consideration of social or institutional constraints (Cleaver, 2005). Issues related to the

exclusion of outsiders rarely appear in discussion around social capital. For one, in the MSP

process, social capital neglects to account for other players that may be pertinent to MSP: what

stakeholders have not been engaged and what is the relationship between those included and excluded through the MSP process? Similarly, research processes have historically excluded Indigenous communities (Smith, 1999). Responding to these concerns is critical for advancing study of community resilience with Indigenous communities because of the strong potential for social capital to mobilize resources and affect change (Pfefferbaum et al., 2017; Green & Haines, 2015).

### 1.3.2 Community-University Partnerships

Because social capital theory captures social relations across different collaborative contexts (Borron et al., 2019; Adger, 2003), social capital provides insight on organizations sharing capacities and resources for useful research outcomes. Most tasks in community-university partnerships are best accomplished in a manner that engages the strengths of partners (Gruber et al., 2015). Common tasks and outcomes include (Agans et al., 2020; Chapman et al., 2018; Strier, 2014; Silka et al., 2008; Hart & Silka, 2020; Hart & Wolff, 2006): co-defining problems together; sharing goals and agendas; sharing funding for projects, (community) staff, students, and faculty; measuring success in mutually beneficial ways; generating local interest in new and potential future projects; translating and disseminating information; and offering program evaluation. These collaborative tasks rely on ongoing relationships between participants in the partnerships (bonding capital), inclusion of new participants with relevant knowledge and skills (bridging capital), and trust that tasks will be prioritized and completed (linking capital).

Universities are well-prepared to fill gaps in community capacities (Gruber et al., 2015). In a study surveying policy makers, local non-governmental organizations, and local community

leaders in New Hampshire and Minnesota, Gruber et al., (2015) utilized a five-point Likert scale

to identify primary and shared roles for university and community partners collaborating to

increase community resilience and social capital for watershed and infrastructure protection.

They found that there are roles most suitable for the university and other roles more suitable

for community partners. Partners at the local level may lack financial resources and technical

capacities to plan for, undertake, analyze, and respond to complicated social-ecological issues

(Gruber et al., 2015). Partnerships not only share experiences and research skills, but also

engage community partners to help generate knowledge (Bakker et al., 2019). Rather than

universities solely designing and owning projects, community-university partnerships can allow

community members to contribute as architects of the study design instead of objects of study.

Gruber et al.'s (2015) study broadly illuminated power sharing tensions in research, and while

there is literature that explores historical tensions between Indigenous communities and

universities (McGreavy et al., 2021), the literature at present does not examine role and power

sharing between Indigenous communities and universities through social capital and

community resilience frameworks.

Moreover, although it is clear that community-university partnerships can lean on social

capital to exchange skills and resources, partnerships are characterized by the paradox of

collaboration and conflict (Strier, 2011). For one, community-university partnerships have been

critiqued for not truly engaging the public (Stoecker, 2009; Hart & Wolff, 2006) and for being

wrought with miscommunication and misunderstandings (Silka et al., 2008; Agans et al., 2020).

Kindred and Petrescu (2015) examined a community-university partnership in Michigan in

which a university served as an intermediary between federal agencies and nonprofit

organizations building community strengths amid economic recovery. Drawing on their experiences working with the nonprofit organizations, literature on communication and relationships between organizations, and data from interviews and focus groups of organizations and the university, they found that there were clear misunderstandings about the expectations of the partnership, especially when compared to reality (Kindred & Petrescu, 2015). Community organizations pointed to reporting requirements requiring more time and effort than they initially anticipated, as well as timelines being unrealistic and burdensome. Kindred and Petrescu (2015) also found asymmetry between the 11 partners in the economic recovery projects: despite formal contracts describing grant expectations, informal ties between partners enabled participants to create expectations of grant work.

The asymmetric relationships, miscommunication, and lack of understanding are all too common, creating tension between faculty across disciplines as well as with community members, but tension is not necessarily a barrier in collaboration. Conflict among researchers or between researchers and stakeholders can generate meaningful insight (Hart & Silka, 2020), including inviting research partners to deepen shared understanding of multi-dimensional issues, encourage learning between groups, and link knowledge with action (Hutchins et al., 2013).

Calling for researchers to rebuild the ivory tower, Hart and Silka (2020) demonstrated opportunities for researchers and communities to learn—and make mistakes—together. They recount a collaboration with Wabanaki (People of the Dawn) communities in Maine focused on potential barriers around basket-making, a traditional craft that strengthens the economic and cultural well-being of Wabanaki tribes (Hart & Silka, 2020). The researcher co-leading the

project was a tribal member who, because of his long-term relationships with basket-makers, believed the biggest barrier was access to quality brown ash trees (Hart & Silka, 2020). However, tribal basket-makers revealed that access to trees was not their biggest concern: instead, it was the threat of the invasive emerald ash borer that has already destroyed millions of ash trees across North America (Hart & Silka, 2020). Researchers, resource managers, and Indigenous participants shared lessons learned from controlling emerald ash borer populations, as well as the impacts of the insect on Indigenous cultural practices (McGreavy et al., 2021). The conflict therefore was able to guide useful conversations and outcomes for researchers, managers, and tribes.

The meaningful insight realized through conflict drives interest to make science more accessible to the general public (Silka, 2013; Strier & Shechter, 2015). Although social capital can bring together differences, partnerships also risk replicating the relations between universities and communities that make science seem inaccessible (Strier, 2011). Strier (2011) put forward that university faculty are often perceived as elite due to their access to resources, and that meaningful collaboration can move past this perception by making science more accessible. Enhancing the accessibility of science has become known as the democratization of science.

Democratizing science highlights the fragmentation of community-university partnership efforts (Silka, 2013). Rather than calling for a single approach to democratizing science, this push demands what Silka (2013, p. 12) refers to as the "unified front." This front represents, but is not limited to, citizen science researchers inviting citizens to play a central role in data collection, participatory research practitioners allowing non-scientists to drive the

research agenda, and community-based participatory researchers centering communities as architects of study. It also includes ethical engagement with Indigenous communities. The unified front critiques the underpinnings of traditional, siloed scientific approaches, such as the pursuit of tenure through publications (Hart & Silka, 2020), and the reality that communicating within and outside academia is difficult due to the risk of not being taken seriously (Hart & Wolff, 2006). By critiquing the traditional approaches to science, community-university partnerships can prioritize useful research for (Indigenous) communities. Prioritizing the democratization of science requires trust building and a deep commitment to sharing power (Jagosh et al., 2015). Partners in community-university partnerships are inherently different in terms of their resources and capacities (Strier, 2011), and such differences are exemplified in historical and cultural differences between Indigenous communities and institutions of higher education. Answering to frequent calls for participation and justice in resilience literature (e.g., Ranganathan and Bratman, 2019), community-university partnerships have high potential to foster this trust and commitment.

## 1.4 Trust Across Knowledge Systems

Focused on the potential of community-university partnerships to generate new, and leverage existing, social capital, collaborative research projects that engage community members can provide a refreshed view of "familiarity, intimacy, openness and trust between researchers and the community" (Strier & Schechter, 2016, p. 344). In their study of HTC in Nebraska, Emery and Flora (2006) illustrate that social capital enabled communities across Nebraska to overcome historical conflicts through volunteering together, connecting with other community development organizations throughout the state, and providing technical support

across non-profit, business, and government sectors. Collaborative research projects provide researchers and community members direct interaction with one other, and these interactions are opportunities to build trust (Strier & Schecter, 2016).

The earlier example of Wabanaki basket-makers in Maine emphasizes the need to shift focus on community voices in research, away from academic voices. Planning and implementing strategies for community resilience is based on people's perceptions of issues and needs (Berkes & Turner, 2006). Wabanaki basket-makers in Maine maintain a long history of learning from crises and mistakes to sustain their people, culture, and environments. Researchers with pertinent research and personal experiences can add to, but should not speak for, traditional (Indigenous) needs. Community resilience scholarship has adopted learning across disciplinary and institutional boundaries as a norm, yet resilience researchers must go beyond integrating culture to situating collaboration in culture (Arora-Jonsson, 2016). This involves subjecting scientific knowledge to scrutiny. Cote and Nightingale (2012, p. 480) echoed this and called for situated resilience scholarship: "analyses of the capacity to adapt to change must be framed within an understanding of cultural values, historical context and ethical standpoints of the kinds of actors involved." Building partnerships for resilience can be supported by a critical understanding of social-psychological variables and contextual variables that may impact partnerships (Bieluch et al., 2016). For the Wabanaki community, ash trees, forest ecosystems, basket-making, and Indigenous identities are only a few examples of these variables. Because variables are relational—for example, the impending threat of emerald ash borers on Wabanaki basket-making in Maine—attention to local relations is pertinent to meaningfully involve community member knowledge in research.

Different ways individuals and communities relate to the world prompt conversation around knowledge systems. Knowledge systems exist through "agents, practices and institutions that organize the production, transfer and use of knowledge" (Cornell et al. 2013, p. 61). Collaboration across knowledge systems calls for the scientific community to build awareness and acceptance of its responsibilities for community transformations and engagement (Cornell et al., 2013). Researchers typically practice *Western science* which for the purposes of this thesis, is centered around the scientific method as the process of making sense of the world. Here I use WS practices as including use of hypotheses, research methodologies, and approaches. Literature on collaboration across different knowledge systems presents a long-standing challenge of separating WS from different ways of knowing because like other knowledge systems, it is rooted in observation and experience (Davis and Ruddle, 2010; Agarwal, 1995; Johnson et al., 2016). WS is often defined comparatively with other knowledge systems and characterized by technical, institutional, and corporate approaches (Davis and Ruddle, 2010; Agarwal, 1995; Johnson et al., 2016). In their work bridging knowledge systems for marine mammal management, Weiss et al. (2013) pointed to social (power) structures embedded in decisions informed by WS. The established dominance of WS often has ambiguous cultural underpinnings yet reflects Western traditions of hierarchical knowledge, such as academic disciplines and departments (Weiss et al., 2013). Different knowledge systems offer different perspectives on community issues (Aikenhead and Ogawa, 2007).

During research collaborations with Indigenous communities, WS interacts with *traditional ecological knowledge* (TEK). TEK—also called *Indigenous knowledge* as a less value laden term (Berkes et al., 2000)—articulates cultural and historical significance of relational

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knowledge (Olsson & Folke, 2001). Investigating how TEK is represented in peer-reviewed empirical scientific papers, Lam et al. (2020) found that Berkes's (2018, p. 8) definition of TEK has been widely accepted: "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment." This knowledge is embedded in experience (Kassam, 2009) and has been gathered by observers whose lives relied on this knowledge and its application (Berkes et al., 2000). For example, Cree geese hunters in Canada learn how and where to successfully take geese for sustenance and cultural uses (Ruiz-Mallén & Corbera, 2013). Local people elaborate on TEK by testing it iteratively and learning from mistakes. That includes learning through where and when to find successful places to hunt geese. WS approaches, by contrast, rely on hypothesis testing, data analysis, and reporting to determine geese management strategies.

TEK is locally transmitted and guarded with the intention to adapt practices to social-ecological changes (Ruiz-Mallén & Corbera, 2013). Based on a shared memory and exchange of observations of geese population across generations, the Cree geese hunters adapt their geese management strategies and in times of changing environmental conditions, reduce hunting pressure (Ruiz-Mallén & Corbera, 2013). Not only does culture provide the foundation for decision making (e.g., when and where to hunt), but culture also serves as a mechanism for learning across generations. Knowledge is shared across generations, and Indigenous cultures maintain an inherent trust in ancestor's knowledge (Chapman & Schott, 2020). It is therefore through inter-generational knowledge that Indigenous peoples learn to make sense of the world.

### 1.4.1 Trust is Earned

In partnerships with Indigenous communities, researchers must be aware that trust is earned, not assumed (Harding et al., 2012). TEK that tribal members hold is privileged information, gained through generations of observation, iterative testing, and cultural values. This wisdom has guided Indigenous peoples to survive through successes and hardships across many generations, and as such, TEK is typically guarded as personal and sacred stories. In a storytelling project with the Inuit community in northern Canada, an Indigenous health professional working in the region told Willox et al. (2016) that they were "impressed" that researchers gained permission to listen to and share personal stories (p. 137). This was a signal of trust because community members often proceed with caution and skepticism in community-university partnerships (Silka et al., 2008).

A lack of focus on building trust endangers knowledge sharing in research projects with Indigenous communities. Researchers unfamiliar with histories of mistrust may (Harding et al., 2012):

- be surprised when Indigenous communities are reluctant to engage in proposed research projects,
- find it challenging to incorporate non-WS perspectives within a project, or
- learn that communities insist on shifting the study scope to more urgent priorities that were not initially identified in the funded project.

Trust between Indigenous communities and universities can help researchers learn through these challenges, as well as support tribal members through histories of mistrust. Trust

is critical for effective knowledge transfer (Chapman & Schott, 2020; Tengo et al., 2017). Tengo et al. (2017) presented a five-step framework for implementing useful research projects that influence policy: mobilize, translate, negotiate, synthesize, and apply multiple forms of knowledge. Each step is unique and dynamic, yet central to each stage is the need for trust: "attention needs to be directed towards engagement of knowledge holders and their institutions, and well-designed processes that build trust and communication across barriers of language, culture, worldviews and experience" (Tengo et al., 2017, p. 24).

Community-university partnerships can build trust by first giving attention to trust in different forms and the outcomes it realizes. Jansujwicz et al. (2021) provided that trust influences acceptance, and sharing, of information, as well as participation of community members. Conceptualizing the many dimensions of trust, they point to trust in: stakeholders, science, different knowledge systems, and the use of information (Jansujwicz et al., 2021). These forms of trust affect the information produced, generated, and incorporated (Jansujwicz et al., 2021). This understanding is pertinent to creating equitable community-university partnerships that develop practical research addressing community issues. Through interviews of authors of longitudinal studies of community-university partnerships, Jagosh et al. (2015) found that developing and strengthening partnerships through trust result in sustaining collaborative efforts, inspiring new projects, and realizing systemic transformations. Continued collaboration and the uptake of systemic change underscore the capacity of researchers and community members to work together and affect meaningful change.

Identifying common goals, discussing shared values, and creating trust enable meaningful community-university partnerships (Schusler et al., 2003). Awareness of TEK demands a critical eye on the cultural context of WS (Kimmerer, 2002). Science is traditionally led by Western perspectives and philosophies. For example, the scientific method is a Western norm reproduced throughout the global scientific community, positioning WS as a superior (expert) knowledge system when compared to TEK. However, as TEK challenges the superiority of WS, tensions between cultural contexts provide opportunities for cross-validation of scientific hypotheses amid plural perspectives and diverse insights (Kimmerer, 2002). Listening to TEK in scientific processes recognizes the value and useful contributions of TEK. This is a leap for Indigenous communities overcoming the hegemony of the expert (Kassam, 2009), as well as WS researchers.

Understanding community-university partnerships and the necessary trust as social capital enables partners to build expectations and reciprocity (Green & Haines, 2015). For one, articulated expectations can offer clarity and accountability for shifting away from histories of mistrust. Second, reciprocity (explored further below) signals exchange of perspectives and knowledge between Indigenous communities and researchers. Researchers face multiple layers of working through a plurality of perspectives, such as (1) integrating perspectives between scientific disciplines, (2) recognizing the interests and knowledge of diverse community members and stakeholders, and (3) respectfully teasing out how different knowledge systems from practice and science are functionally relevant for producing knowledge (Scholz & Steiner, 2015). Social capital theory addresses these challenges by providing a framework of connecting people with community resources to affect change (Adger, 2003).

**1.4.2 Reciprocity**

Arguing that reciprocity is an ethical basis for research relationships, Maiter et al. (2008) define reciprocity "as an ongoing process of exchange with the aim of establishing and maintaining equality between parties" (p. 305). Researchers collaborating with different knowledge systems must recognize that they are morally and ethically responsible to create mutually advantageous knowledge that (1) strengthens TEK and (2) reflects on the impacts of WS (Chapman & Schott, 2020). This includes respecting the values, morals, and beliefs embedded in TEK. While WS generally attempts to separate knowledge from social values, Chapman and Schott (2020) highlighted that the Western cultural values are often not explicitly stated and consequently impact science and management without intentional deliberation. Research partners can learn to recognize their own biases and grow curious of other legitimate knowledge systems (Pahl-Wostl et al., 2007).

This curiosity has led to adopting Indigenous research methods (IRMs), that is, equitable and respectful approaches that honor Indigenous sovereignty and culture (McGreavy et al., 2021; Willox et al., 2016). Scholarship on IRMs expresses a commitment to Indigenous people's agency and right to self-determination, emphasizing that collaborations between TEK and WS can be intentionally designed to support these commitments (McGreavy et al., 2021). This looks like uplifting Indigenous voices, prioritizing inclusion and representation of Indigenous peoples, and respecting sovereignty. IRMs increasingly center Indigenous diplomacy in response to criticisms of power in knowledge co-production processes (Smith 1999; McGreavy et al., 2021). In a shift away from prioritizing WS processes and challenging their notions of time, McGreavy

et al. (2021) acknowledged that there are Indigenous practices and governance which have evolved with the ecosystem and culture of the land studied. Rather than a WS focus on time as a scarce resource determined by funding and programmatic timelines, the team oriented to managing their work around the timing of fish moving upstream (McGreavy et al., 2021). This in turn became an important way of remembering the promise of restoration (McGreavy et al., 2021).

Moreover, culturally relevant research methods build trust and provide insight on documenting TEK (Willox et al., 2016; Daigle et al., 2019). For example, storytelling is emerging as a culturally relevant research method with and for Indigenous communities (Willox et al., 2016; Daigle et al., 2019). In Willox et al.'s (2016) study in northern Canada, the Inuit communities explored linkages between climate change, health, and well-being, and Indigenous participants expressed their knowledge, values, and traumas through storytelling. Storytelling allowed Willox et al. (2016) to first establish a reciprocal and respectful relationship with participants as individuals and members of communities. Centering their perspectives engaged community participation and consequently shared power with different perspectives on climate change, health, and well-being in northern Canada. When researchers foster diverse participation instead of narrowly choosing what is best for the research agenda, decision making processes widen (McGreavy et al., 2021).

Through trust in research partners, institutions, and different knowledge systems, community-university partnerships can prioritize social capital and deliberate across differences. Collaboration does not necessarily breed social capital, and when it is a goal to

build social capital, collaborative groups may need to be intentionally plan for the outcomes of their interactions (Wagner & Fernandez-Gimenez, 2009). Community-university partnerships generate social capital through knowledge sharing, and through relationships that recognize diverse perspectives, partnerships can provide a wider scope of options for inquiry, action, and collaboration, and in turn, ease the way to compromise. As community members and researchers share different practices, knowledge, and experiences (Maclean et al., 2014), the partnership can allow for different perspectives to raise and collectively consider issues and when moving toward meaningful decisions (Schusler et al., 2003). Building trust between institutions promotes the legitimacy of decisions and plans, as well as supporting community members in their perception that they have the capacities to mitigate change (Adger, 2003). In case studies of extreme weather in Southeast Asia and coastal management in the Caribbean, Adger (2003) demonstrated that social capital can describe interactions between individuals, community groups, and government institutions and their work together to manage the risk of climate change to collective resources. When diverse knowledge systems learn with and from one another, they can support managing for, and responding to, change (Armitage et al., 2009; Pahl-Wostl et al., 2007; Maclean et al., 2014; Maclean et al., 2017; Schusler et al., 2003).

It follows that community-university partnerships have high potential to offer necessary support, realize community capacity, and motivate a focus for renewed hope (Maclean et al., 2014). For example, Aldrich (2011) emphasized that social capital enables community resilience by (1) providing support networks for financial and logistical guidance, (2) preparing for the mobilization of resources, and (3) increasing the probability to articulate needs and use voices. This was evident in the cases of Inuit storytelling (Willox et al., 2016) and Wabanaki basket-

making (Hart & Silka, 2020). Prioritizing social capital enables researchers to better understand

what communities must do to mobilize community resources for community resilience

(Turcotte & Silka, 2007).

**1.5 Discussion and Conclusion**

In this literature review, I broadly apply social capital theory to community-university

partnerships that seek to advance community resilience. Social capital has been criticized for

perpetuating exclusion, and community-university partnerships have also been criticized for not

truly engaging conflict and having many misunderstandings and miscommunications.

Community-university partnerships with Indigenous communities endure histories of mistrust,

yet partnerships based in trust across knowledge systems can support useful research

outcomes and rebuild trust needed to support mutually advantageous outcomes.

Meaningful engagement with community partners provides a refreshed view of trust

through learning and making mistakes together. When a researcher learns that Wabanaki tribes

are more concerned about emerald ash borers rather than the availability of quality ash trees,

the community-university partnership learns from its mistake and identifies useful research

problems (Hart & Silka, 2020). Without this humility, a lack of trust endangers the ability of the

partnership to produce research that is useful and addresses community issues. Centering

Indigenous voices helps community-university partnerships respect different knowledge

systems while reflecting on their own biases. Willox et al. (2016) centered Inuit voices in the

storytelling project exploring linkages between climate change, health, and well-being and

found that this approach shared power around whose narrative is shared in northern Canada.

Moreover, attention to trust enables community-university partnerships to identify common goals, discuss shared values, and create trust, particularly because researchers must earn, not expect trust from Indigenous communities. It follows that understanding community-university partnerships as social capital facilitates partners creating expectations and reciprocity rooted in a university's recognition for its moral and ethical responsibilities to strengthen TEK and reflect on impacts of WS. This shift has generated and promoted IRMs to further respect Indigenous sovereignty. The trust in research partners, institutions, and multiple knowledge systems support community-university partnerships in prioritizing social capital and deliberating across differences for community resilience.

While this chapter addresses the gaps in the application of social capital theory to community-university partnerships with Indigenous communities, there are three key limitations. First, it discusses only two knowledge systems, whereas there is a multitude of ways through which communities relate to and understand the world (e.g., local ecological knowledge). Future work can consider applying social capital theory to community-university partnerships that engage local ecological knowledge, TEK, and WS. Second, this chapter focuses solely on social capital, the community capital well-recognized by researchers and practitioners to spiral up community capitals. Future work can begin to explore community-university partnerships with Indigenous communities by also exploring political, cultural, human, natural, financial, and built capitals per the CCF. Lastly, the application of CCF and social capital theory in this chapter has been conceptual. Empirical exploration of community-university partnerships with Indigenous communities has potential to advance community resilience scholarship

seeking to incorporate transdisciplinary approaches, as well as guide researchers committed to

overcome histories of mistrust.

**CHAPTER 2**

**STORIES ARE EARNED: TRUST AND FLEXIBILITY IN A STORYMAPS PROJECT BETWEEN THE PASSAMAQUODDY TRIBE AND UNIVERSITY OF MAINE**

## 2.1 Abstract

Community-university partnership scholarship often focuses on the university's side of the partnership with an anecdotal, rather than critical, perspective. Collaborative research projects with Indigenous communities can utilize (digital) storytelling to respect different knowledge systems and work toward overcoming histories of mistrust. This chapter presents an ethnography of my participant observation of the StoryMaps Team, a community-university partnership between the Passamaquoddy Tribe at Sipayik and UMaine. The Wabanaki Youth in Science student selected municipal water quality as the storytelling topic, and her interests and needs led the project during the study period (June-December, 2021). Exploring community-university partnerships as social capital and attending to the role of trust in the partnership, I coded fieldnotes taken during and between team meetings. Emergent themes include: trust, family, and support. The themes point to two strategies – trust through partnership and flexibility in research projects – that community-university partnerships with Indigenous communities may learn from. Indigenous storytelling research projects utilizing StoryMaps have high potential to be useful for ethical engagement in community-university partnerships with Indigenous communities. This chapter contributes to ongoing discussions of community-university partnerships with Indigenous communities by highlighting storytelling as a critical approach.

## 2.2 Introduction

With trust central to community-university partnerships (Chapter 1), Clifford and Petrescu (2012) astutely argued for partnerships to "rethink the purpose of institutions of higher learning, focus on the well-being of society, and address economic, social, and environmental problems at the community level" (p. 78). One way to serve communities and make research useful is through reciprocity (Chapter 1), and reciprocity has since been institutionalized by the Kellogg Commission (1999). This approach to partnerships is vital for innovating research-based solutions for the complex issues that communities face (Silka et al. 2013; Maiter et al., 2006).

Cretney (2014) challenged resilience researchers to consider who and what are included in resilience solutions. In Maine, researchers are progressively engaging in research projects that share power with Indigenous peoples (Hart & Silka, 2020; McGreavy et al., 2021; Daigle et al., 2019; carr et al., 2017). Sharing power is critical for community resilience because power underpins a community's ability to mobilize community resources (Cavaye and Ross, 2019). Researchers admit that the negative effects of social-ecological issues are concentrated in the most socially vulnerable populations (Aldrich, 2011), and Indigenous communities have been historically and continuously marginalized in research and policy processes.

Indigenous communities often shy away from research (projects) because of atraumatic history of research reducing Indigenous people to uncivilized stereotypes (Smith, 1999; Beltrán and Begun, 2014). IRMs move toward including Indigenous communities as architects of study, rather than objects of study which has flattened the knowledge and agency of Indigenous peoples to address issues in their communities (Chapter 1). Community-university partnerships

often form to address complex social problems like inequitable power relations, and

partnerships risk re-opening old wounds and reactivating histories of mistrust (Strier, 2014).

Critical approaches acknowledge and engage with power dynamics to create ethical solutions.

In a literature review exploring the past two decades of work between communities and

universities, Koekkoek et al. (2021) found there is a need for community voice and for a critical

perspective in community-university partnerships. Without excluding any disciplines, they

found that scholarship tends to emphasize the university perspective on issues, and this in turn

prioritizes (research) student and faculty objectives over community objectives. Moreover, the

scholarship is often anecdotal and normative (Koekkoek et al., 2021): for example, many faculty

researchers assume that community members are interested in and trust the work conducted

by institutions of higher education. This assumption is based in anecdotal evidence and persists

as a norm in community-university partnership scholarship. A critical approach guided by

empirical research can challenge research norms that perpetuate histories of mistrust.

Moreover, while community resilience research recognizes the need for diverse

perspectives, engagement with Indigenous knowledge has not been thorough. Lam et al. (2020)

investigated how traditional ecological knowledge (TEK) is represented in peer-reviewed

empirical papers that apply TEK in transformations, transitions, and change, key elements of

resilience. They found that 52% of papers trended toward assimilating Indigenous knowledge

with Western science, rather than acknowledging it as a separate and equally relevant

knowledge system. This trend mirrors the gap of research ethics with tribal communities:

sovereignty, ethics, and informed consent (Harding et al., 2012). Indigenous research methods

(IRMs) address research ethics (Smith, 1999; Harding et al., 2012), and collaboration and

dialogue between researchers and Indigenous peoples have successfully impacted policy

(McGreavy et al., 2021).

One IRM is storytelling: storytelling integrates indigenous research methods,

collaboration, and dialogue to promote research ethics. Corntassel (2009) defined stories as the

"lived values that form the basis for Indigenous governance and regeneration" (p. 138).

Storytelling is culturally relevant to Indigenous peoples (Willox et al., 2016; Daigle et al., 2019;

McGreavy et al., 2021) and is an emerging research approach in Maine (Daigle et al., 2019).

While Daigle et al. (2019) utilized Indigenous storytelling to collect data on basket-making

from/with the Wabanaki people, including the Passamaquoddy Tribe, there has not yet been

scholarship specifically observing community-university partnerships with the Passamaquoddy

Tribe on an Indigenous storytelling project (Marafino, 2020).

In this chapter, I share an ethnography to observe an Indigenous storytelling project

conducted through a community-university partnership between the Passamaquoddy Tribe and

University of Maine. The research ethically engages Indigenous communities through two

strategies I discuss later: trust in the partnership and flexibility in research projects. **The

objective is to contribute to ongoing discussions of community-university partnerships with

Indigenous communities by highlighting storytelling as a critical approach.**

Storytelling challenges underlying assumptions in community-university engagement

and explicitly centers community voice. Embedded in Indigenous storytelling is the vital nature

of relationships for Indigenous values (Beltrán and Begun, 2014). Similarly, Indigenous values

highlight ethical and methodological considerations that exist outside traditional approaches to

(Western) science (Caxaj, 2015). Also moving beyond traditional approaches, storytelling that

utilizes digital technology can meaningfully reframe experiences of historic and ongoing

traumas of Indigenous communities (Beltrán and Begun, 2014). Digital storytelling has the

potential to further address the hegemony of Western science in decision making (Kassam,

2009). By centering the lived values of the Passamaquoddy Tribe, this work attends to diverse

knowledge systems that redistribute power to TEK in community-university partnerships

(Ballard et al., 2008; Chapter 1).

**2.3 Background on Indigenous Storytelling**

While there is no single definition for storytelling, it is well-accepted that in Indigenous

cultures, storytelling embodies lived values (Corntassel, 2009). Iseke (2013) added that

storytelling is a practice that sustains Indigenous cultures by validating the experiences of

Indigenous peoples, providing opportunities to nurture relationships, and sharing TEK. Most

vital to storytelling is the transmission of traditional values, sense of community, and spirituality

(Caxaj, 2015). In turn, it conveys cultural meaning and social memory through intergenerational

involvement (Guyette, 1995; Daigle et al., 2019). By integrating values and knowledge, this

practice is a means for Indigenous individuals and communities to make sense of their

individual self and the world.

Daigle et al. (2019) illustrated through focus groups with Wabanaki citizens that

storytelling incorporates knowledge, information on environmental change, and its impact on

traditional lifestyles. The Wabanaki people are dependent on natural resources and systems for

wild foods and traditional activities such as basket-making. As these ecosystems are changing,

storytelling supports Wabanaki approaches to adapt to a changing climate by offering a process

for multiple generations to collaboratively identify and communicate information relevant to

local ecological changes. Storytelling allows Indigenous community members to witness each other's experiences and remember the past while transforming for the future (Iseke, 2013). Therefore, it is a process for reclaiming knowledge and highlighting the resiliency of Indigenous cultures despite a long legacy of colonization (Beltrán and Begun, 2014).

A modern means of storytelling, digital storytelling is celebrated for engaging storytellers and allowing them to customize their stories (Robin, 2009). Digital technologies, including video and audio productions, expand how storytellers can create and share stories for healing from the impacts of colonization (Beltrán and Begun, 2014). Beck and Neil (2020) echoed this in their findings from semi-structured interviews with a group of international nursing students about their digital storytelling experiences. They found that benefits of digital storytelling include: the depth of discussion; ability to make points; engage students; and promote self-reflexivity and empathy (Beck and Neil, 2020). Insights from the health domain are useful for Indigenous storytelling because Indigenous communities adopt a holistic approach to well-being (mind, body, spirit, environment) (Willox et al., 2016; Lam et al., 2020).

Because digital storytelling is customizable, engages both (Indigenous) storytellers and listeners, and is useful for communicating information, digital storytelling is a culturally appropriate way to engage TEK. Digital storytelling also emphasizes the quality of the process over the finished digital product because the emphasis is on the knowledge from relationship rather than the content itself (Jernigan and Roach, 2021; Beltrán and Begun, 2014). The attention to relationships aligns with the potential of social capital to influence change.

**Figure 1.** ESRI StoryMaps home page. Available at https://storymaps.arcgis.com.

### 2.3.1 StoryMaps, A Digital Storytelling Software

One software for digital storytelling is StoryMaps. Developed and maintained by ESRI, StoryMaps is a web-based geographic information systems (GIS) platform that combines maps, multimedia content (photos, videos, audio, etc.), and text to tell a compelling story in a creative way. Users can create their own StoryMap from a template and customize the template elements and colors to fit their needs. They may also choose to explore collections developed by ESRI, NOAA, NASA, and others, as well as collections on a diversity of topics, such as climate change, art, women's suffrage, and the steps of James Bond (Lusardi and Harldson, 2021). Jayawardene (2020) found that StoryMaps is a culturally appropriate and collaborative tool to visually represent stories, communities, and places.

Moreover, StoryMaps are a useful tool for critical engagement because not only are they effective for teaching and learning, StoryMaps are also easy for users to navigate. In an introductory soil science course of 58 students, Cope et al. (2018) developed a StoryMap on

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topography and quizzed students on their ability to gain knowledge using the StoryMap. Students received an average score of 8.2 out of 9 and commented that ESRI StoryMaps were a useful tool for learning (Cope et al., 2018). StoryMaps are useful not only in terms of gathering information, but also creating the story itself. Echoing the usefulness of StoryMaps, Howland et al. (2020) also emphasized that they are a straightforward tool that can be updated iteratively and used "as a platform [for students] to tell their own stories and explain their own relationship with their cultural heritage" (p. 357).

The content and design of a StoryMap can be improved with a team of multidisciplinary editors (Cortes Arevalo et al., 2020). For example, Cortes Arevalo et al. (2020) engaged with RiverCare, a river conservation program in the Netherlands, as well as its partner researchers, advisors, project managers, and interested professionals, to evaluate the perceived usefulness of and engagement with StoryMaps. They found that visual and interactive elements of a StoryMap are attractive, and future StoryMaps should have a multi-disciplinary team to: (1) balance the level of detail, (2) provide visuals that complement the text, and (3) negotiate the content of the final StoryMap (Cortes Arevalo et al., 2020). StoryMaps are well-positioned to enable collaboration between those with different needs and interests to create a communication product that is useful and understandable to a broad audience.

Community-university partnership with Indigenous communities can utilize StoryMaps to engage diverse knowledge systems in projects. Jernigan and Roach (2021) urged that to overcome histories of inequity, (digital) storytelling should include tribal citizens as research partners and knowledge holders, rather than participants. Indigenous stories should center

Indigenous, rather than Western, experiences of historical and ongoing relations in and around their homeland.

**2.3.2 Storytelling in Community-University Partnerships**

Chapter 1 explored trust and called on the need to attend to trust when building partnerships, and community-university partnerships can build trust through culturally relevant approaches, i.e., IRMs. At present, WS tends to integrate TEK by assimilating it into Western norms of analyzing and communicating knowledge, rather than respecting TEK as a separate and valid knowledge system (Chapman and Schott, 2020; Kassam, 2009). Moreover, building trust through critical strategies addresses the need for community engagement to move beyond anecdotal evidence (Koekkoek et al., 2021). By utilizing methods based in theory, community-university partnerships can meaningfully contribute to the growing interest in the relationship of Indigenous peoples with their environments, as well as their abilities to overcome crisis (Lam et al., 2020).

Researchers can further center respect by building awareness of the changing role of the WS researcher in projects with Indigenous communities. The changing role of the researcher is key to community-university partnership processes (Bulten et al., 2021). Researchers can move beyond academic culture to publish or perish by embracing an experimental attitude and learning by doing with communities (Hart & Silka, 2020). When UMaine researchers assumed that Wabanaki basket-makers were more concerned with access to quality ash trees than the threat of the emerald ash borer, the team humbly learned together and refocused the research to focus on managing for emerald ash borer (Hart & Silka,

2020). To move beyond traditional academic expectations, researchers need to renegotiate their roles in science when centering community knowledge, and to be open to analyzing the consequences of their science (Bulten et al., 2021).

Project-based research offers researchers the opportunity to reflect upon their roles while inviting community members to contribute their knowledge (Hidayat & Stoecker, 2021). When collaborating with Indigenous communities, Caxaj (2015) reminded researchers that projects cannot just "add a dash of Indigenous and stir" (p. 10). Instead, research projects can meaningfully respect TEK when researchers reflect on how diverse knowledge systems are embodied. McGreavy et al. (2014) found that when matched with critical reflection and strategic intervention to improve research, effort and attention to differences between partners have the potential to promote outcomes of collaborative research.

Lastly, a two-way flow of resources between communities and universities meaningfully aligns with calls to institutionalize reciprocity (Kellogg Commission, 1999; Weerts & Sandmann, 2008). As discussed in Chapter 1, ethical partnerships are built on reciprocity, and collaborative decision making throughout research processes prioritize mutual benefits between partners. This includes co-identifying problems, such as shifting the focus on emerald ash borers (Daigle et al., 2019). It also involves effort to move away from research being a dirty word in Indigenous communities, as well as effort to produce research outcomes that matter.

## 2.4 Study Context and Methods

The Passamaquoddy Tribe at Sipayik (Pleasant Point) is one of five nations in the Wabanaki Confederacy. The reservation is located in Downeast Maine. According to the U.S.

Census 2019 American Community Survey data, the reservation experiences low income, low

employment rates, high rates of poverty, and difficulty with access to transportation (U.S.

Census, 2019). These socioeconomic conditions compound with the difficulty to access clean

drinking water. Socioeconomic and ecosystem issues are important to the Passamaquoddy

Tribe due to their intimate and spiritual relationship with the local ecosystem (Sutton, 2020).
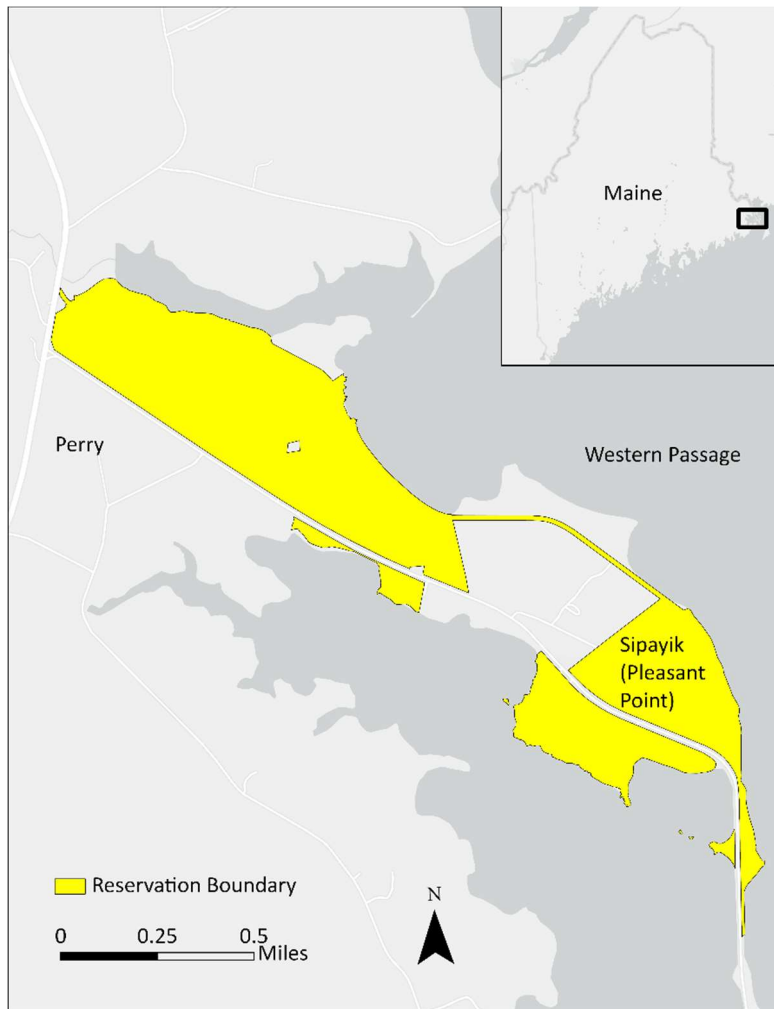


**Figure 2.** Map of Passamaquoddy Tribe at Sipayik (Pleasant Point)

In 2019, the Sipayik Environmental Department (SED) collaborated with a UMaine

research team working in Western Passage to organize community meetings at Sipayik

(Marafino, 2020). Centering Wabanaki voices, these meetings utilized a participatory mapping activity to discuss cultural and Western science perspectives on changes in the local ecosystem. A SED staff member identified that it would be useful for the Department to have a series of StoryMaps to communicate important research and stories that convey their conservation goals and interests. The four priority narratives collaboratively identified were: sea run fish conservation, municipal water quality, the causeway that runs through the reservation, and shellfish management and conservation (Marafino, 2020). StoryMaps were selected because it was an accessible software, easy to use, and offered data visualization for diverse audiences through an online link.

SED and UMaine established a StoryMaps team in December 2020 through a team charter. The charter called for bi-weekly meetings until project completion and identified team members interested in engaging Wabanaki youth to share knowledge within the Sipayik community. This in turn included the recruitment of Wabanaki youth and individuals to provide technical and administrative support for creating StoryMaps. Whereas the researchers on the StoryMaps team included a Maine Sea Grant (Maine SG) marine extension associate and a UMaine graduate student (myself), there were also three roles filled by Passamaquoddy tribal members. The team was led by a SED staff member and engaged with two tribal members through Wabanaki Youth in Science (WaYS): a student and a Cultural Knowledge Keeper (CKK). The student was the Indigenous storyteller in this project.

Administered in partnership between UMaine and tribal communities throughout Maine, the WaYS program provides paid internship opportunities for Wabanaki middle school,

high school, and college students to engage with WS and connect with their culture and traditions (carr et al., 2017). Students are placed with a Cultural Knowledge Keeper (CKK) that is another (elder) tribal member compensated to provide input and mentorship on the WaYS student's project. (While students typically have one mentor, the WaYS student went through a transition from one CKK to another CKK during the StoryMaps project) WaYS students also collaborate with natural resource professionals, such as at SED, Maine SG, and UMaine.

The StoryMaps team started with a focus on fish restoration, yet University researchers, WaYS leaders, and SED were flexible to meet the needs and interests of the student. Rather than prioritizing the completion of the four collaboratively identified narratives, the team agreed to allow the WaYS student to focus on one StoryMap and table the other narratives. She selected the municipal water quality topic to carry on her family's legacy of caring for water and family. The water focus positions the StoryMap to be a communication product that built on contemporary efforts to improve access to clean drinking water.

Aligned with the goals of the WaYS Program to connect Wabanaki youth with TEK and WS (carr et al., 2017; carr and Ranco, 2017), the WaYS student and two CKKs incorporated cultural data and WS data into the StoryMap to share with Passamaquoddy leadership and community, as well as the general public. The WaYS student and CKKs defined processes for gathering multimedia cultural information relevant to the water topic. For one, the CKK compiled several documents and photos related to water, such as photos of the water from the faucet, historical drawings in and around Sipayik, and minutes from water district meetings. The student later reviewed photos with the CKKs and selected photos that would complement

her written stories. Second, at the time of establishment, the StoryMaps team prepared

guidance worksheets on how to create a compelling StoryMap, and while the student initially

used the worksheets, she later opted to structure her story based on her family experiences

and the cultural data available, including the photos.

Her written story also integrates two interviews and a survey that the first CKK designed

and conducted prior to the study period. While the interview and survey designs did not follow

WS traditions (e.g., sampling techniques, question design), the CKKs interpreted the results to

be important data about lived experiences across generations as well as five neighborhoods on

the reservation. Each interview focused on the tribal elder's experience with municipal water

since their youth, indicating the multi-generational duration of the water issue. The first CKK

also led the survey on access to drinking water on the reservation.

Because WaYS Program seeks to meet the needs of students through collaborations

across knowledge systems, carr and Ranco (2017) explained that it is vital for WaYS and the

students to collaborate with WS researchers who are willing to work in multicultural and learn

with CKKs. Consistent with the need to respect Indigenous intellectual property (Harding et al.,

2012) and assumptions in TEK to trust ancestor knowledge (Chapter 1), data from the

interviews and survey were reviewed by CKKs, SED, and the student and not WS practitioners.

Instead, I trained SED in ESRI products (Western technology) to manage and visualize their

survey data for an interactive map, and this map has been included in the StoryMap. Other WS

data, namely community demographics and the water notice, were sourced from government

agencies. After the student weaved together TEK and WS, she presented her StoryMap to the team. It is available at [www.tinyurl.com/sipayik-water](www.tinyurl.com/sipayik-water).

**2.4.1 Participant Observation**

Researchers engaging with TEK should channel their efforts and attention into novel approaches to challenge WS scholarship (Fernandez-Llamazares and Cabeza, 2017). This study adopted an ethnographic research approach that included participant observation. In *Participant Observation as a Data Collection Method*, a seminal guide synthesizing participant observation (PO) as a research method, Kawulich (2005) defined PO as the "process enabling researchers to learn about the activities of the people under study in the natural setting through observing and participating in those activities" (para. 2). Guest et al. (2013) echoed this, arguing that natural settings immerse the researcher among the human behavior in the specific study context. As a qualitative method, PO is likely to capture holistic elements of Indigenous communities and TEK that are not commensurable with traditional, reductionist science (Lam et al., 2020). Observation and participation with Indigenous communities in a natural setting, rather than a structured interaction for empirical study, invites researchers to build rapport as well as be sensitive to context-specific ethics, such as Indigenous ethics.

Moreover, PO can be implemented on a spectrum (Gold, 1958): on one end, a researcher may engage more in observation, noting the activities of people, or a researcher may engage more in participation, performing activities as part of a team with the peoples studied. The latter allows for both Indigenous community members and researchers in community-university partnerships to learn by doing, together. Drawing on Chapter 1 and the

call for institutions of higher education to rethink how they serve (Indigenous) communities,

researchers can contribute at a similar capacity as other team members rather than guiding the

process and perpetuating the hegemony of WS.

PO is appropriate for this study because it challenges researchers to consider people's

lives and social relations (capital), forcing researchers to consider new directions and reflect on

theories and assumptions (Shah, 2017). Observation of the storytelling project in our

community-university partnership allowed StoryMap team participants, including researchers,

to explore storytelling as an emergent IRM that respects and honors the Wabanaki need to

document their histories in a culturally relevant way (Daigle et al., 2019).

The work in the storytelling process is participant-generated by the Passamaquoddy

participants, and I acted as a participant observer on the team during the study period May

through December 2021 (IRB # 2021-05-03). In my participant role, I provided technical support

on geographic information systems and writing, and administrative support on project

coordination. In my observer role, I observed the storytelling process to (1) maintain respect for

intellectual property of the StoryMap and (2) build on digital storytelling scholarship that

focuses on the processes and relationships of storytelling, rather than the physical output.

Team meetings were one hour long via Zoom, per COVID-19 social distancing protocols. They

were organized around WaYS student needs and occurred 1-3 times per month during the

study period, June-December 2021.

During and between meetings, I maintained ethnographic fieldnotes on the storytelling

process (Schindler and Schäfer, 2021; Wolfinger, 2002). Fieldnotes are especially pertinent to

participant observation because it encourages the researcher to reflect on their role and the

project (Schindler and Schäfer, 2021). Common observations to fieldnotes include what

happened (or did not happen) during interactions, who was (or was not) present, and decisions

on the StoryMap process and content. I followed Creswell's (2013) encouragement for

qualitative researchers to identify codes that they expected, or were surprised, to find. My

initial codes included: *collaboration across knowledge systems, social capital*, *trust*, *community*

*resilience*, and *community development*. Codes are biased by researcher's recording process,

i.e., decisions on what to include in fieldnotes (Bernard and Gravlee, 2014).

The coding process involved iteratively re-organizing notes under codes, reflecting on

notes to further identify patterns, then utilizing emergent, inductive analysis to further identify

codes (Creswell, 2013; Bernard and Gravlee, 2014). Codes generally described interactions

among Passamaquoddy and Western priorities; relationships; and decision-making logics. I

regularly questioned my observations and consulted with academic advisors to better maintain

distance in my observations. Seeking patterns, and deviations, in the codes, I classified them

into themes based on observed repetition (e.g., frequency of code among multiple participants)

and transitions (e.g., participant shifted focus of interaction) (Ryan and Bernard, 2003). Themes

are illustrated in the Findings section.

### 2.4.2 Marine Fish Study

In support of the Passamaquoddy's intimate and reciprocal relationship with the local

ecosystem, I conducted a marine fish study to contribute to the knowledge base of fish

communities in Western Passage, Maine. The data would provide current information that

contribute to the understanding of impacts that development projects might have for fish communities (Lotze et al., 2004; Macdonald et al., 1983). The study was conducted in collaboration with Maine SG, and methods are presented in Chapter 3. While the study was not designed in collaboration with SED, I collected results with the intention of sharing them with the Passamaquoddy Tribe for their use, e.g., in a StoryMap. The fish study and StoryMaps work built on work done by Marafino (2020).

## 2.5 Findings

The following emergent themes describe the storytelling project in the community-university partnership between the Passamaquoddy Tribe at Sipayik and UMaine: trust, family, and support.

## 2.5.1 Trust

In June 2021, SED kicked off the study with reiterating and confirming team consensus around data ownership and intellectual property. These conversations were motivated by SED's history of collaborating with several non-profit organizations, government agencies, and institutions of higher education. Maintaining ownership would allow the tribe to not only access their work in the future, but it would also recognize Indigenous contributions to community change as SED's external partners came and went. Given that the goal of the project was to communicate a Passamaquoddy story, the team easily came to consensus for data and intellectual property to belong to SED. Data in the project concerned the written story in the StoryMap, photos and videos shared among the team, survey results, interviews, maps, and the StoryMap itself.

The student, closely guided by the CKKs, determined what would be included in the StoryMap. From June to November, this process included the student iteratively reviewing multimedia data and reflecting on her family's experiences with water quality issues. The team suggested revisions for clarity and cohesion, and the student responded constructively to comments. She also maintained her close relationship with the CKKs and regularly incorporated their input. CKKs not only guided the student but also provided opportunities for all team members to learn about Passamaquoddy history and current priorities

Moreover, the study also re-initiated regular communication among team members, from infrequent and irregular communication starting in December 2020 to weekly communication since the study began in June 2021. I invited the student to meet with me one-on-one to introduce ourselves, and our conversations stopped short of creating to-do lists and assigning storytelling tasks. Rather, we chatted about our family, personal goals, and life as a young adult in Maine. We also touched on our motivations to be part of the project, as well as the shared belief that each person deserves clean water. Moreover, the team norm was to communicate via email, yet when I asked the student how she prefers to be contacted, she explained that she does not own a computer and is most responsive to text messages. After this meeting, the student and I communicated, mostly via text, weekly rather than over irregular patches of time.

Reflecting on this, I believe I succeeded in navigating cultural differences by leaning on my own identity as a first-generation American and woman of color. The student and I built consensus on discrimination we experience as women of color, including ignorant comments

that we endure. For one, the student and CKK often shared that they felt separated from non-tribal communities in their area because when there are water notices, tribal users of the water system are not notified by the company while non-tribal residents are notified. They insisted it was one of many examples where their struggles are invisible to non-tribal members, leaving them to feel excluded from local communities. I echoed their sentiments of exclusion, and with my brown skin, Asian face, and Spanish last name, I prioritized the StoryMaps project as a tool for inclusion. Wabanaki experiences and traditions share perspectives on community issues that may be unfamiliar or surprising to non-tribal Mainers.

While I had the opportunity to grow more familiar with Passamaquoddy perspectives on their community issues, I also navigated different levels of familiarity among team members and myself. For one, the SED staff member and Maine SG staff member had a strong working relationship built on their experiences advancing fisheries management in the area for several years prior to the StoryMaps project. The Maine SG staff member and I built trust with one another while we planned the marine fish study on nearly weekly calls in December 2021 - August 2021. This relationship provided me with insight on local ecological issues, such as concern for alewives, and also prepared me to connect with and understand the priorities of SED. Moreover, the SED staff member and I were able to connect biweekly during StoryMaps Teams meeting, as well as between meetings when needed. He shared context about his culture and community, including the growing interest to involve Indigenous youth in projects, awareness of influential families in the tribe, and the belief that the StoryMap is important.

Among the Passamaquoddy tribal members, they knew each other from outside the project. The SED staff member knew the initial CKK professionally through her role on tribal council, and he was familiar with the second CKK because he is friends with her partner. While he did not have a pre-existing relationship with the student, he was familiar with her because of her family's involvement in the community. The first CKK is the student's grandmother, while the second one is the student's sister.

**2.5.2 Family**

While the team collectively built momentum through participation, a familial environment provided an impressive amount of support through changes in team participation. When the student struggled to respond to messages, share content for the StoryMap, or get her thoughts in writing, a CKK stepped up and either completed tasks or helped coordinate communication and meetings. When the student was nearly done drafting her StoryMap in the fall, she had temporary custody of her young brother and felt overwhelmed working at home, like many people with childcare responsibilities during the COVID-19 pandemic. Her sister, as CKK, invited her to her home office to work and made herself available to respond to questions and reflect together. Also, the grandmother and student had lived together, allowing the grandmother to update the team of the student's availability. The two CKK helped the student build confidence and communicate with the team that she was overwhelmed with the idea of completing multiple StoryMaps. Although the student was initially concerned with disappointing the team, the team embraced her and agreed that it made sense to work on a

StoryMap one at a time and start with her passion—clean water. These scenarios are only some of the many times the student's family came together to support her through the process.

Moreover, when the latter CKK stepped onto the team in June, it was clear that the student's engagement changed. While the CKK would go on maternity leave two months after joining the team, she welcomed questions from the student outside of team meetings, and the student was able to ask the CKK questions about storytelling and their culture during family events then report back to the team. The Maine SG staff regularly mentioned that the new CKK was a great addition to the team: the student was enthusiastic, shared often, and engaged in next steps. The student spoke highly of her sister's work promoting community development and equity in their community, and she admired the way her sister has started a family with a salaried job.

Not only did the familial environment help the student feel welcomed and supported in her work, but she also evolved as the two of us built trust. Almost weekly, she reiterated that it was a struggle to manage her time between work, college, and family, yet her goal is to complete the StoryMap on water quality. The student often emphasized that she took on the internship because the story is both her story and her family's story, pointing to her grandfather's continued unwillingness to give tap water to their pets. Moreover, she progressively shared stories that she thought no one discussed enough: her face and voice lit up on Zoom as she touched on socioeconomic disparities in the tribe and explained that difficulty with access to clean water is not an issue for all tribal members. Her grandparents, for example, can afford bottled water, whereas others can neither afford additional bottled water

nor have access to a car to buy water. In her community, she explained, many people are

uncomfortable discussing money, especially if they cannot afford a basic need like water.

When the student spoke of the community, she spoke of the Wabanaki peoples who call

the Sipayik area home, whether now or in the past and future. As an outsider to the

Passamaquoddy community, I was curious about who, or what, is community? Who is family?

The StoryMap included the student's words, yet it is the voice of the community across

generations. The community and family are integrated and without clear boundaries. For one,

while the student refers to her CKK as her sister, they are not biological relatives. Instead, the

student's grandparents became caretakers for the CKK when she was young, and being two

years older than the student, the CKK became an older sister figure and was involved in the

student's upbringing. The close ties between the individual, family, and community in

Wabanaki culture challenge WS scales of analysis.

**Figure 3.** Sipayik Water Quality StoryMap cover page. Full StoryMap available at www.tinyurl.com/sipayik-water.

**2.5.3 Support**

The trust built between the student and me allowed us to engage in dialogue on how to best support each other throughout the project. At one point, she explained to me how she felt bad for not contacting me for a month while she was working in the blueberry barrens, starting

a job, and enrolling in the local community college for fall term. We chatted about how it was not a problem to have an inconsistent schedule, including last minute call-ins into work, because the story was hers to tell and that it would be what she made of it. When the student had honest and supportive conversations like this with the team or just me, the chat served as a reminder that she could work on the StoryMap at her own pace. I also shared personal experiences of when I felt overwhelmed with work-life responsibilities, such as when I was a college student on work-study. My ability to respect and understand her need for space from the project demonstrated that the team was there to support her. To further demonstrate my understanding that she sometimes has emergencies and other priorities that arise, I checked in with her via text within a few hours of each meeting to see if she was still available. This support has been vital to her ability to create a StoryMap and led her to include a reflection of our collaboration and my support in her StoryMap.

I prioritized sensitivity to their community's struggle for health and justice. The topic of water quality is intimate for the student to share because the struggle to access clean water is entangled with generations of trauma. While she and CKKs shared stories of water, stories of substance abuse, sexual abuse, and complicated family dynamics also arose. These traumas occurred against the backdrop of feeling unsafe to drink tap water, an experience they perceived as a trauma itself due to the Passamaquoddy belief that water is sacred.

Supporting the team through the traumatic stories were not part of my defined role, though interpersonal communication skills has helped me navigate this complicated space. My primary role on the team was to provide technical and administrative support. When traumatic

stories arose, I remained cognizant of the boundaries of my responsibilities while also drawing

on my skills in trauma-informed communication to maintain a safe environment for

engagement. Practices included patience, active listening, and sensitive language to support

emotional regulation. Matching my responsibilities with my interpersonal communication skills

helped me remain motivated to break down silos and in turn, increase understanding of the

community's struggle for clean water.

Support also involved responding to changing needs of the community-led team,

including my transition from technical and administrative support to a mentor role. I was often

tempted to act as a facilitator, yet instead challenged myself to collaboratively set tasks. Rather

than assigning tasks, I asked partners what they perceived to be the priorities and helped

identify timelines and best people to complete the tasks. Tasks were feasible based on

availability, and timelines were discussed yet rarely concrete in order to avoid overwhelming

the student. Each team member represented different organizations with different

responsibilities. Remaining flexible to the needs of individual team members helped balance

roles.

As a researcher, I learned to trust the integrity of the collaborative research process.

When I joined the team, it was not clear to me what the data needs were to create a StoryMap

on municipal water quality. Rather than challenging the existence of toxins, I provided feedback

when requested, and when asked how to create engaging stories, I encouraged the use of

evidence of water issues that could be understandable to people who do not experience the

water issues themselves. The student responded by including in her StoryMap a water quality notice about byproducts from the chlorination process.

An iterative feedback process helped me not only understand data needs, but also fostered my curiosity to understand Passamaquoddy values. Another data need was the birthdate of interviewed community members: the student explained that birthdates are important to the tribe because they indicate what a person lived through. I remained open to different ways of knowing and collaborating, asking questions about their experiences and knowledge.

The StoryMaps team also supported each other and the project by sharing technical skills and funding. In terms of skills, the student led the process. Defining the process was initially challenging for the team because the water issue entangled dimensions of sacredness, public health, and technical water management, as well as intergenerational experience. Where would the team, and especially the student, start? What would the story include? Also, how do we manage transitions between CKKs? I shared strategic outreach skills to support the student in identifying what is important (to her) to include when educating others of the water issues in her community, while also making the StoryMap visually appealing and easy to use. Moreover, I shared writing skills to help focus the story on her identified priorities. The student often mentioned that while she grew comfortable speaking about the local water issue, she was not yet confident in her writing skills. In one instance, she prepared a paragraph describing a photo of a tub filled with discolored water and concluded that no one should have that kind of water. I encouraged her to explain why readers should care, even if it is obvious to the team.

We also discussed the need for coherence between her bodies of text, images, video, map, and interviews to make the story cohesive, and the student determined that a thread focused on her family's story and the belief that water is sacred would create a cohesive story. The student also appreciated support when we collaboratively analyzed and wrote about data, such as community survey results and U.S. Census data. Furthermore, building off of Marafino (2020), I had the opportunity to teach introductory GIS by helping the team create the StoryMap and visualize their survey data in an interactive map.

In terms of funding, the Maine SG staff was invaluable in coordinating external funding. He served as the point of contact for continued funding for the student and CKKs. Compensation was a priority for two reasons. First, SED emphasized that the agency relies on grant money to prioritize and implement its work. Without the Maine SG staff maintaining relationships for external funding, it would not have been possible to provide a stipend for the student and CKKs. Second, stipends demonstrate support for the storytelling work. During the transition between CKKs, the Maine SG staff and I maintained that stipends were vital for the project in order to compensate, rather than exploit, the team members' labor.

Related to valuing the contributions of the Passamaquoddy team members, their TEK was essential for creating digital storytelling content, as well as advancing the community-university partnership. As an Indigenous story, the StoryMap necessarily required the Wabanaki voice. The StoryMap was more than I could have done as a Western student-researcher, and iterative review also allowed the StoryMap to include a Western perspective, such as when the student decided to include the water notice. Similarly, the team echoed that the language and

content were more robust and engaging than they may have been able to create alone. The collaborative process bred a collaborative tool, and the Passamaquoddy team members welcomed me into understanding their intergenerational struggles.

In addition to the team supporting the WaYS student in her project, the team also supported my research. The team was enthusiastic to support my master's thesis work because of my enthusiasm to support their advocacy and contribute to their team. For one, they were open to observation during team meetings because they viewed my research as an opportunity to increase awareness of the project and a demonstration of my commitment to their community's work. The team also discussed the potential that the StoryMap may serve as a collaborative model for other communities in Maine. The team's conversations about my research were markedly different than those that I had with peers and faculty: my training as a student-researcher motivated me to consider impact and contribution to scholarship, and the team neither discussed my academic and disciplinary background nor what I may expect to observe during the storytelling process. However, the team did ask questions about the fish study. The Maine SG staff member and I collaboratively designed and conducted the study, while the Passamaquoddy tribal members on the team appreciated that I was interested in their community and homeland. The Passamaquoddy team members were invited to assist with the study, and the SED staff member gladly joined us.

**Figure 4.** Photo of team deploying longline gear as part of the fish study in Western Passage, Maine.

I also began to share data from the marine fish study, and these data represent Western scientific knowledge. While the student elected to focus her StoryMap on water quality, sea run fish conservation was another priority story identified by the Sipayik community. I visited with the SED staff regarding my study data for a StoryMap, and he shared that the data would be most useful when visualized in a map, rather than the raw data.
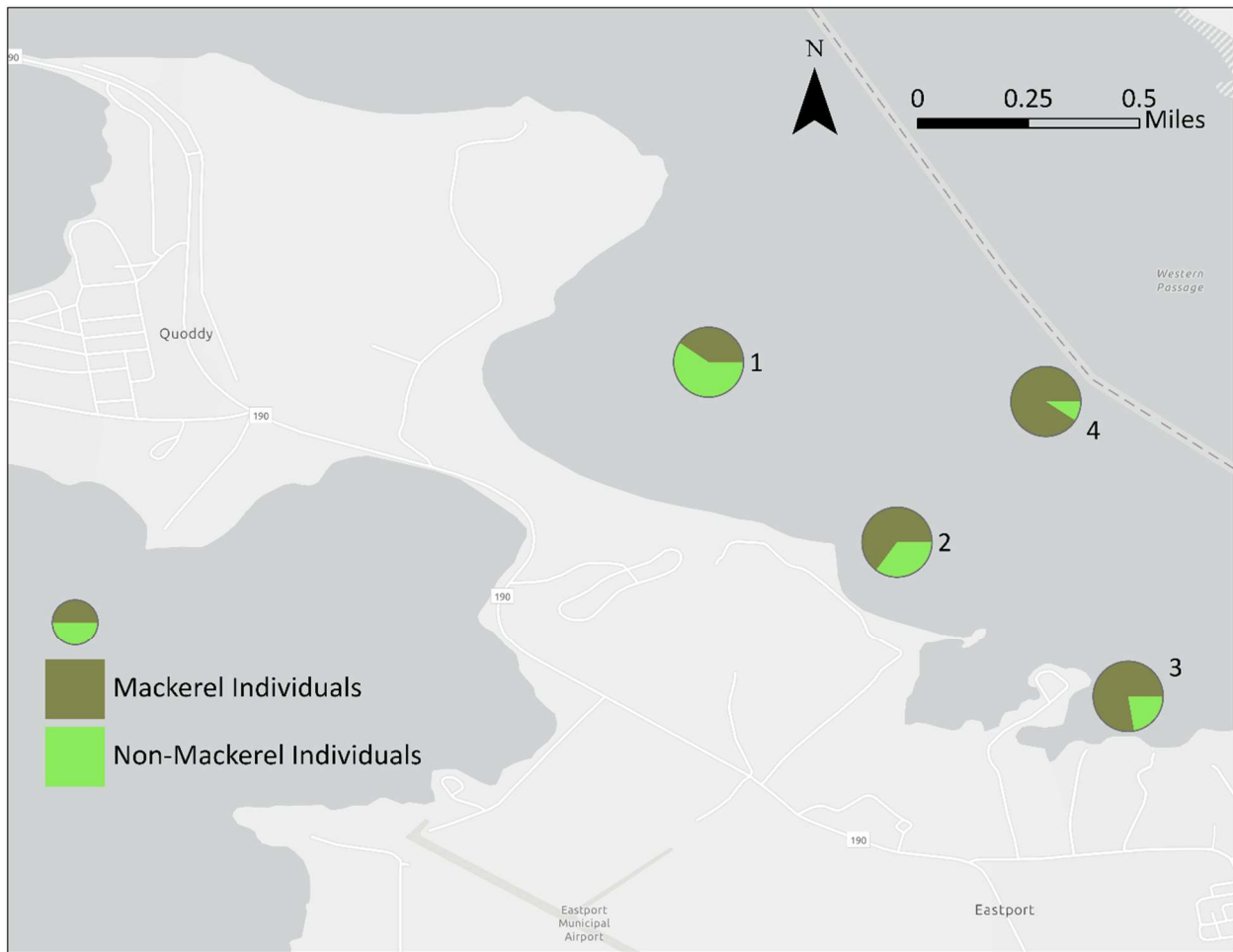
**Figure 5.** Map of ratios of Atlantic mackerel individuals to non-mackerel individuals in Western Passage, Maine. See Chapter 3 for more information on study sites and methods.

## 2.6 Implications

The themes contribute to ongoing discussions of community-university partnerships with Indigenous communities by highlighting storytelling as a critical approach (the chapter objective). The identified themes emerged from iterative analysis rather than defined prior to the study period, and these themes point to three strategies that community-university partnerships with Indigenous communities may learn from to advance meaningful research

projects across knowledge systems. The three strategies include: trust through partnership, the changing role of the researcher, and reciprocity.

**2.6.1 Trust Through Partnership**

Through establishing clarity around data ownership, connecting through existing and new relationships, and providing motivational support, StoryMaps team members learned to have confidence in one another and in ourselves. Meaningful collaboration takes time (Hart & Silka, 2020). Demonstrating their work rebuilding the ivory tower, Hart and Silka (2020) emphasized that open communication, mutual respect, and trust were the foundation of productive partnerships that produced salient and legitimate results in Maine. The StoryMap work also builds on continuing collaboration between the Passamaquoddy Tribe and UMaine (Marafino, 2020). Guyette (1995) reminded those engaging with Indigenous communities that "confidence is built upon a solid track record" (p. 248). Finding success and support between tasks encouraged the community-university partnership to mobilize resources (Chapter 1) and develop a StoryMap.

Over the duration of the study, the partnership progressively developed closeness, equity, and integrity, three attributes that describe community-university partnerships (Bringle et al., 2009). First, closeness refers to the frequency and diversity of interactions, as well as the strength of influence on one another (e.g., familiarity and regular interactions that build rapport) (Bringle et al., 2009). Team members had diverse interactions with one another. The student and CKKs were family, whereas the Maine SG staff was a familiar colleague to the SED staff and a new research partner to me. The Maine SG staff, SED staff, and I shared mutual

interest in fisheries management in Western Passage. With the potential for a fish conservation StoryMap, the three of us engaged in dialogue about the cultural and economic importance of fish in the region, and frequent conversations around fish led to the SED staff member joining me for the fish study in Western Passage.

Second, a pathway to satisfying relationships, equity refers to how people perceive inputs and outcomes as similar (e.g., perception that partners contribute similar amounts of resources and effort) (Bringle et al., 2009). Communication around data ownership demonstrated respect in the intellectual property of the tribe. Ranco (2006) recognized that responsible ethnographic research attends to biases in the process and control of access to data, and Harding et al. (2012) added that data ownership is a critical element in research ethics with Indigenous communities. Because protection of intellectual property is a principle of sovereignty (Harding et al., 2012), SED stores and manages the StoryMap and its relevant data. Moreover, this community-university partnership prioritized shared work by collaboratively creating tasks and respecting one another's professional and personal needs.

Lastly, integrity refers to shared values; interpretations and relations to the world; and vision in relationships (e.g., transparency in communications and decisions) (Bringle et al., 2009). The team shared a vision of raising awareness about tribal issues by lifting Wabanaki voices. We also enhanced integrity in the partnership by asking one another what support is useful to them and engaging in difficult conversations when needed, such as when the student revealed with the team that she was overwhelmed between the StoryMap and external responsibilities.

Modeling collaborations conducted between students, organizations in the community, faculty, administrators on the campus, and residents, Bringle et al. (2009) described the closeness, equity, and integrity on a continuum from exploitative → transactional → transformational and applied the attributes to interactions between individuals per the psychology assumption that interactions between individuals form the basis of relationships. The individuals on the StoryMaps team transitioned from transactional—exchanging demographic information—to a transformation through centering Passamaquoddy voices. By centering Wabanaki voice in storytelling—and firmly believing in the storyteller's ability to create a meaningful product, Indigenous community members had a direct opportunity to voice their values and concerns in/about their homeland.

Storytelling allows for sharing of diverse values and perceptions around environmental issues, and therefore creates opportunities for Indigenous stories to emphasize that connection with nature is a fact of life (Fernandez-Llamazares & Cabeza, 2017). Passamaquoddy tribal members maintain deeply rooted values in family and spirituality, including the belief that water, as well as the local ecosystem, is sacred. Caxaj (2015) explained that Indigenous storytelling is rooted in homelands and ancestry and forms the basis for Indigenous decision-making, such as the motivation to organize for clean drinking water at Sipayik. Like many Indigenous stories, stories depict values in sharing, interdependence, balance, and relationships with nature (Thomas et al., 2019). Their stories are guarded, and therefore must be earned with trust: ''Once a story is told, it is loose in the world. So you have to be careful with the stories you tell. And you have to watch out for the stories that you are told'' (Iseke 2013, p. 560). The partnership built trust through our shared commitment to the goal of the StoryMap: to raise

awareness of the water issue at Sipayik. Overtime, the student became less guarded and shared stories of struggles with water, health, finances, and trauma.

The student's participation helped facilitate social capital (connections) among Indigenous youth and StoryMaps team members. Emery and Flora (2006) emphasized that projects increase social capital by bringing people into leadership and fostering opportunities for youth and adults to work together. For one, youth participation through WaYS, supports an inclusive approach to science by bringing together TEK and WS (carr et al., 2017). In an article on the WaYS program as a tribal educational program integrating TEK and WS, carr et al. (2017) elucidated that learning is multi-directional: while the students learn from CKK and vice versa, research partners also learn from CKK. The CKKs introduced me to histories of struggle with water and trauma, as well as context on the data available to the student. The multi-directional learning created a foundation for the student to be empowered to own her story, recognize her individual role in a collective story, and appreciate the support in a team environment that promoted safety and interconnectedness.

The StoryMap also served as a communication tool to build social capital across organizations and sectors that are interested in water justice in Maine. The StoryMap was part of the tribe's ongoing legal efforts to secure safe access to drinking water. In December 2021, SED held an online event for the WaYS student to present her StoryMap, and in March 2022, the student and I presented on the community-university partnership and Indigenous storytelling at the Maine Water and Sustainability Conference. On April 21, 2022, Governor Janet Mills signed into law LD 906 – An emergency act to improve access to clean water at

Sipayik. The legislation transfers ownership of land to the Passamaquoddy Tribe for access to alternate supplies of groundwater. It also exempts the Passamaquoddy Water District from taxes since it was the only water district in Maine that was not exempt from taxes. The legislation also grants tribe power to regulate their own water to federal standards, a practice typical for tribes outside of Maine. Dialogue around the need for improved access to drinking water helps create focus in the community to influence change (Guyette, 1995). The StoryMap may have influenced advocacy for LD 906 through raising awareness around the water issue at Sipayik, motivating Mainers to attend a rally for LD 906 at Augusta, and presenting personal stories that integrate different ways of knowing. Through the research project, Passamaquoddy tribal members garnered support and leveraged community resources for advocacy projects and events. The Sipayik community continues to mobilize for change by exploring further opportunities to collaborate between SED, WaYS, and the CKK. The team has high potential to realize big results through designing the StoryMap in a way that has multiple results (Guyette, 1995), including awareness, future partnerships, policy change, and improved health conditions.

## 2.6.2 Flexibility in Research Projects

My role changed to help maintain engagement and support progress in the storytelling process. By changing from a support role to a mentor role, I was able to contribute to group cohesion, as well as cooperative goal setting, shared power, resources, and decision making, and partnership management (Mcnall et al., 2009). I practiced persistence through the partnership to encourage confidence and leadership. Persistence was a practice of active listening, allowing me to collaborate with the team rather than develop preconceived notions

about the storytelling process. The iterative process of learning by doing—and in this case, drafting and reflecting on the story—is a form of feedback learning (Berkes and Turner, 2006), and in community-university partnerships, interactions constitute iterative processes engaging diverse knowledge systems. This study echoes earlier examples of Maine researchers challenging their assumptions about the concerns of Wabanaki basket-makers (Daigle et al., 2019): by listening to Indigenous community members, the priority shifted from access to quality ash trees and to managing for emerald ash borers. The StoryMaps project evolved to center the needs of the community. As the partnership continues, continued collaboration with SED in identifying and planning projects would increase usefulness of research results. With attention to reciprocity and the changing role of the researcher, future work interested in producing high priority data for SED should consider including SED in study planning.

Loh et al. (2022) explored a decades old partnership between Tufts University and Dudley Street Neighborhood Initiative, a community organizing and planning group in Boston, and center relationships as everyday opportunities to disrupt inequitable power dynamics and move toward equitable power relations. They found that valuing WS over the knowledge of community residents and practitioners maintained and reinforced inequities in collaborations (2022). They then concluded that addressing these issues requires a reflexive practice: they call on university researchers to invest in "the time and resources to reflect on and learn from [community-university partnerships] practice is vital" (Loh et al., 2020, p. 14). Listening to TEK in scientific processes recognizes the value and useful contributions of knowledge systems other than WS (Peacock et al., 2021; Ruiz-Mallén and Corbera, 2013). For Wabanaki scholars, respect for TEK is vital because TEK values bodily, emotional, and spiritual knowledge of the self

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and other animate beings (carr et al., 2017). The WaYS program specifically seeks to create opportunities for students to learn both WS and TEK (carr et al., 2017).

Not only does the WaYS program disrupt inequitable power dynamics, but community-university partnerships have high potential to overcome what Godrie et al. (2020) named epistemic injustices. McGreavy et al. (2021) called for attention to difference, reflection on power in shared decision making, and a commitment to promote and improve collaborative learning. After reflecting on the importance of overcoming WS as the norm, I encouraged the student's stories rather than challenging them with scientific studies. When the team provided a water notice that chlorination byproducts were over 1.5x the federal allowable limit, it was clear that storytelling cross-validated the finding. The tensions between cultural contexts in WS and TEK provide opportunities for cross-validation of scientific hypotheses amid plural perspectives and diverse insights (Kimmerer, 2002).

In the community-university partnership focused on StoryMaps, improved learning involved awareness and respect for trauma. When Willox et al. (2016) implemented an Inuit (Indigenous) storytelling project on climate change and human health in Canada, they noted that as the workshops progressed, the process of personal storytelling became a healing process for personal traumas, including alcoholism and sexual assault. The researchers found this a challenge and also a learning opportunity to see that many participants needed to share particular traumatic stories before discussing other experience more pertinent to the project topic (Willox et al., 2016). Their experience mirrors my experience as a student-researcher on the StoryMaps team. Moreover, Willox et al. (2016) called for WS researchers and facilitators to

remain open and respectful to the need of participants to tell stories beyond the specific topic.

My ability to keep an open mind and maintain respect for traumatic stories enabled the team

to build trust and create a multi-media StoryMap. While water quality is traditionally a

community development issue for human health and safety, reframing issues with attention to

TEK and Passamaquoddy logics, including the need to discuss traumas, supports building an

ethical and effective partnership (Eversole, 2018).

Moreover, Spiegel et al. (2020) illustrated the need to understand intergenerational

trauma. Because Indigenous storytelling is grounded in homeland and ancestry, it integrates

multiple (generations of) voices, rather than the single voice of the storyteller (Gubrium, 2014;

Daigle et al., 2019). In their study exploring multi-media storytelling, intergenerational

environmental justice, and Indigenous sovereignty around a contested oil pipeline project, an

Indigenous participant revealed that water is a pathway to connect to ancestors, and like the

student on the StoryMaps team, the participant witnessed the changes in water color and felt

oil left on his body: "If you don't shower right away you get rashes... The water that heals and

teaches you is so polluted by colonization." (Spiegel et al., p. 7). This is pertinent to the

concerns in Sipayik that were emphasized throughout the storytelling process. These are not

experiences I endure as a researcher who does not live in the community, and COVID-related

challenges prevented opportunities to visit Sipayik. Nevertheless, the StoryMap included

photos as not only evidence but conversation openers (Spiegel et al., 2020).

While the team and I did not explicitly discuss WS and TEK, I critically reflected on

whose resilience I seek to promote in the partnership (Shrestha, 2019). Chapter 1 emphasized

histories of exclusion as WS approaches enforce WS norms. Overcoming silos of knowledge systems help communities enhance their community resilience (Vogel et al., 2007). Community resilience scholarship examines resilience at the community scale, yet Indigenous storytelling illuminate loose boundaries between individuals and communities. While the student shared her individual Indigenous voice, she also shared for her family and community in generations past, present and future. Storytelling, as a collective action, helps communities cope with generations of trauma (Mcnamara et al., 2013). Indigenous storytelling connects the storyteller to their audience and tradition through multiple layers of meaning and regular prompts for the audience to be reflexive (Thomas et al 2019). My participation on the team as a non-Indigenous audience member regularly invited me to reflect on my WS role and remain conscious to center community voices. The community voice embodied through storytelling is a traditional tool for the storyteller to reaffirm Indigenous family and community responsibilities in the pursuit for Indigenous justice (Corntassel et al., 2009).

**2.7 Conclusion**

The study contributes to ongoing discussions of community-university partnerships with Indigenous communities by highlighting storytelling as a critical approach that ethically engages TEK and WS. Indigenous stories are embedded in Indigenous values and reflect the knowledge rooted in homeland, ancestry, and history. Digital storytelling with the StoryMaps team produced useful research outcomes not only for the Indigenous youth storyteller's experience, but also for the health and safety of the Sipayik communities. The three emergent themes – trust, family, and support – contribute to ongoing efforts to include Indigenous communities as leaders in research projects in Maine.

Community-university partnerships that seek renewed vision of trust can learn from the emergent themes by focusing on two strategies: trust in partnership and flexibility in research projects. First, building trust across knowledge systems supports ethical collaborations between the Passamaquoddy Tribe and UMaine by centering community voice and exploring issues of power. Second, flexibility in the research project not only enabled researchers to promote Wabanaki diplomacy, but also contributed to creating a useful product and identifying data needs for SED. The community-university partnership centered Passamaquoddy voices and utilized storytelling to critically address histories of mistrust and trauma. StoryMaps have high potential to be useful for ethical engagement in community-university partnerships with Indigenous communities.

**2.7.1 Limitations**

Study limitations include a lack of mixed methods as well as timing. For one, while the qualitative nature of the study helps capture context specific nuances of the StoryMaps project, community meetings, interviews, and surveys may be useful to study how the StoryMap has influenced change in water quality at Sipayik, if at all. Change in community capitals may be one approach to evaluating the usefulness of the StoryMap. It would also be interesting to survey perceived trust and benefits of partnerships, though in community-university partnerships scholarship, it is rare to measure partnership outcomes (Mcnall et al., 2009)

In terms of timing, the StoryMaps team was an existing project prior to the study. While exploring the benefits of partnership potential prior to forming partnerships is important for trust in a partnership's perceived ability to influence change (Hutchins et al., 2013), it will often

be the case that researchers are not part of all the steps of designing, implementing, and evaluating research. Research teams should remain open minded to building partnerships where researchers and community members can join at different steps of the research process, rather than dismissing the potential of the partnership.

Despite these two limitations, Indigenous storytelling with the Passamaquoddy can serve as a model for future community-university partnerships seeking ethical approaches to collaborations across TEK and WS. It will serve community-university partnerships engaged in collaborative research projects with Indigenous communities well if researchers are open-minded to changing roles; remain flexible when the project focus shifts; and explore biases that WS may bring to research projects in community-university partnerships with Indigenous communities.

**CHAPTER 3**

**INTRODUCING A SAMPLING TECHNIQUE TO BETTER UNDERSTAND THE FISH COMMUNITY OF WESTERN PASSAGE**

## 3.1 Abstract

Western Passage is a waterway between the State of Maine and Canada that holds cultural, ecological, and economic significance. To best use and protect Western Passage, a current knowledge base of fish communities could help fisheries managers. However, Western Passage is a difficult area to conduct biophysical surveys because of its bathymetry and tidal features. Recreational fishing methods, such as hook-and-line, has been useful in contributing to an understanding of fish communities in Western Passage. This study simultaneously (1) implemented a jigging protocol and (2) piloted a longline protocol adapted from the Gulf of Maine Sentinel Survey protocol at four study sites from July 10-August 12, 2021, over eight sampling events (5 days in July and 3 days in August). There were nine species captured overall: three species were captured with jigging and not on longline, and four species were captured on longline that were not captured with jigging. The most abundant species, Atlantic mackerel, was captured only using jigging. The Shannon-Weaver Diversity Index, *H*, was calculated for all four survey sites and ranged from 0.305 and 1.54 and were not significantly different from one another. This suggested gear type differences did not influence conclusions about diversity across the survey sites sampled. This is likely due to gear selectivity and small sample size, and the study would need a very large sample size for statistical power. Future work should consider implementing both jigging and longline protocols with increased sampling to further explore the utility of the longline.

**3.2 Introduction**

Within the Quoddy region, situated between the State of Maine and southwestern New Brunswick, Canada, Western Passage is located in the inner Quoddy region which includes Passamaquoddy Bay (Lotzke & Milewski, 2002). The Passamaquoddy Tribe at Sipayik is located along Western Passage (Figure 6), and there is a Passamaquoddy word "*Menakatoluhkatomon*" that means "we move together," demonstrating the reciprocity and connectivity between tribal culture and the social and ecological environment (Daigle et al., 2019, p. 783). With the largest tidal whirlpool in the Western Hemisphere, habitat for endangered marine mammals, and traditional and commercial fisheries, these features come together to create a turbulent system that have (tribal) cultural and economic significance (Cammen et al., 2021). The area attracts a wide range of birds, fish, and mammals, and given its habitat diversity and rich food supply, Western Passage is a hotspot for diversity and productivity (Lotze et al., 2004). The ecosystem is sacred to the Passamaquoddy, and the spiritual relationship with it is emphasized in the tribe's way of understanding their natural resources (carr & Ranco, 2017; carr et al., 2017). The Passamaquoddy maintain spiritual relationships with the local ecosystem because it has provided for their existence (i.e., sustenance) and spirituality (Sutton, 2020). As such, humans and other life in the ecosystem, as well as the physical places themselves, are linked through a sense of reciprocity rooted in sustenance (Sutton, 2020). Contributions to the knowledge base of the fish community in Western Passage would provide information that could help fisheries management and an understanding of impacts that development projects might have on the fish communities (Lotze et al., 2004; Macdonald et al., 1983).

Indigenous and Western communities both value the cultural and economic significance of Western Passage. Culturally, Western Passage, and particularly the Eastport Breakwater, is a popular saltwater recreational site for local residents and non-residents (Bartlett & Athearn, 2008). Anglers visit Eastport to enjoy being on the water, eating fish they caught, as well as enjoying the sport of fishing (Bartlett & Athearn, 2008). Beyond cultural interests, the area's historical use was dominated by shipping and fishing activities, including fish canneries (Hall-Arbor et al., 2001). Charter fishing boats and whale-watching tours are based in Eastport and provide tourists and locals alike opportunities to engage with Western Passage's marine environment. Fisheries are a prevalent industry in this area, and a key issue for the region has been identified as a decline in fisheries, mostly due to over-fishing (Hall-Arber et al., 2001; Johnson et al., 2014; Sutton, 2020). Regulations that aim to address issues related to over-fishing, such as the 1976 Magnuson Fisheries and Conservation Act (re-authorized in 1996 as the Magnuson-Stevens Act) have in turn limited access to key fisheries (Hall-Arber et al., 2001). Interviews and focus groups of fishers near Western Passage (Hall-Arber et al., 2001; Johnson et al., 2014) indicate that there are reduced opportunities for fishers to switch their target species (e.g., from groundfish to lobsters). Moreover, according to Sutton (2020), the Wabanaki way of life and sustenance are impacted by Maine's fishing regulations because traditional Indigenous fishing implements (e.g., spears) are deemed unlawful.

This area also has been identified as a potential site for marine renewable energy development, and with the development of any power source comes a balance with the natural resources within the deployment area. One of the risks involved with tidal energy is the possibility that marine vertebrates physically encounter the turbines used to capture the

energy from the tides. Fish could interact with devices with uncertain outcomes (Viehman &

Zydlewski, 2015). Documented observations of animals in the potential project area are useful

for a better ecosystem-level understanding of other species that may prey on fish and

consequently interact with these devices. Biological, physical, and social sciences data have

been integrated and used to move toward relevant, useful, and accessible information for

decision making around coastal development (Cammen et al., 2021).

Western Passage is a difficult system to conduct biophysical surveys because of its

bathymetry and tidal features (Cammen et al., 2021; Marafino, 2020). Methods such as

hydroacoustics and DIDSON (Viehman & Zydlewski, 2015; Viehman et al., 2015), as well as

midwater trawling (Viehman et al., 2019), have been shown to not always work well in the this

highly turbulent environment. Moreover, trawl capture can be lethal or cause significant

injuries when successful in fish capture, and well-documented species in the area (e.g., Atlantic

herring and mackerel) frequently evade trawl capture (Vieser et al., 2018).

Recreational fishing methods, such as hook-and-line gear, could be used to fill a

methodological niche (Kuriyama et al. 2019; Marafino, 2020; Cammen et al., 2021). Hook-and-

line refers to a range of methods from rod and reel to longlines (Lennox et al., 2017). Marafino

(2020) piloted a hook-and-line method using a rod and reel in Western Passage and found that

jigging has the utility and effectiveness to contribute to the knowledge base of fish

communities in Western Passage.

Longline gear can be successful in targeting groundfish and has been used as part of the

Gulf of Maine Sentinel Survey (Henry et al., 2020). Longlines were a predominant commercial

fishing technology in the 1980s, and while it brought in several thousand pounds of fish then,

they are no longer used in regular practice in Western Passage (Hall-Arber et al., 2001). At this time, the Sentinel Survey does not include Western Passage, though its longline method has potential to contribute to the knowledge base of fish communities (Rodrigue, 2017).

I implemented Marafino's (2020) protocol and piloted the addition of longlines to compare the gear types using a diversity index as a metric for comparison. My hypotheses were, for each site:

- H0: The two gear types (i.e., jigging and longline) were independent.

- H1: The two gear types were not independent.

This chapter builds on the pilot hook-and-line (jigging) study conducted by Marafino (2020) and pilots a longline approach in Western Passage to further build the knowledge base of the fish community in Western Passage. It also builds on research conducted in nearby Cobscook Bay (Vieser et al., 2018).

## 3.3 Methods

### 3.3.1 Survey and Sites

Four sites were fished between July 12 and August 10, 2021. The sites and survey period were selected consistent with Marafino (2020). While Marafino (2020) fished the four sites in addition to one land-based site, the land-based site (i.e., Eastport Breakwater) was omitted because it may not be representative of the fish community in the broader Western Passage geography (Marafino, 2020). Logistical constraints (time, staff) also prevented this site from being surveyed in 2021. Sites were surveyed with 1-3 people in Marafino (2020) and the current survey was conducted with only two people, in coordination with Maine Sea Grant and used an 18-ft Lund with center console, powered by a 30hp Honda outboard.
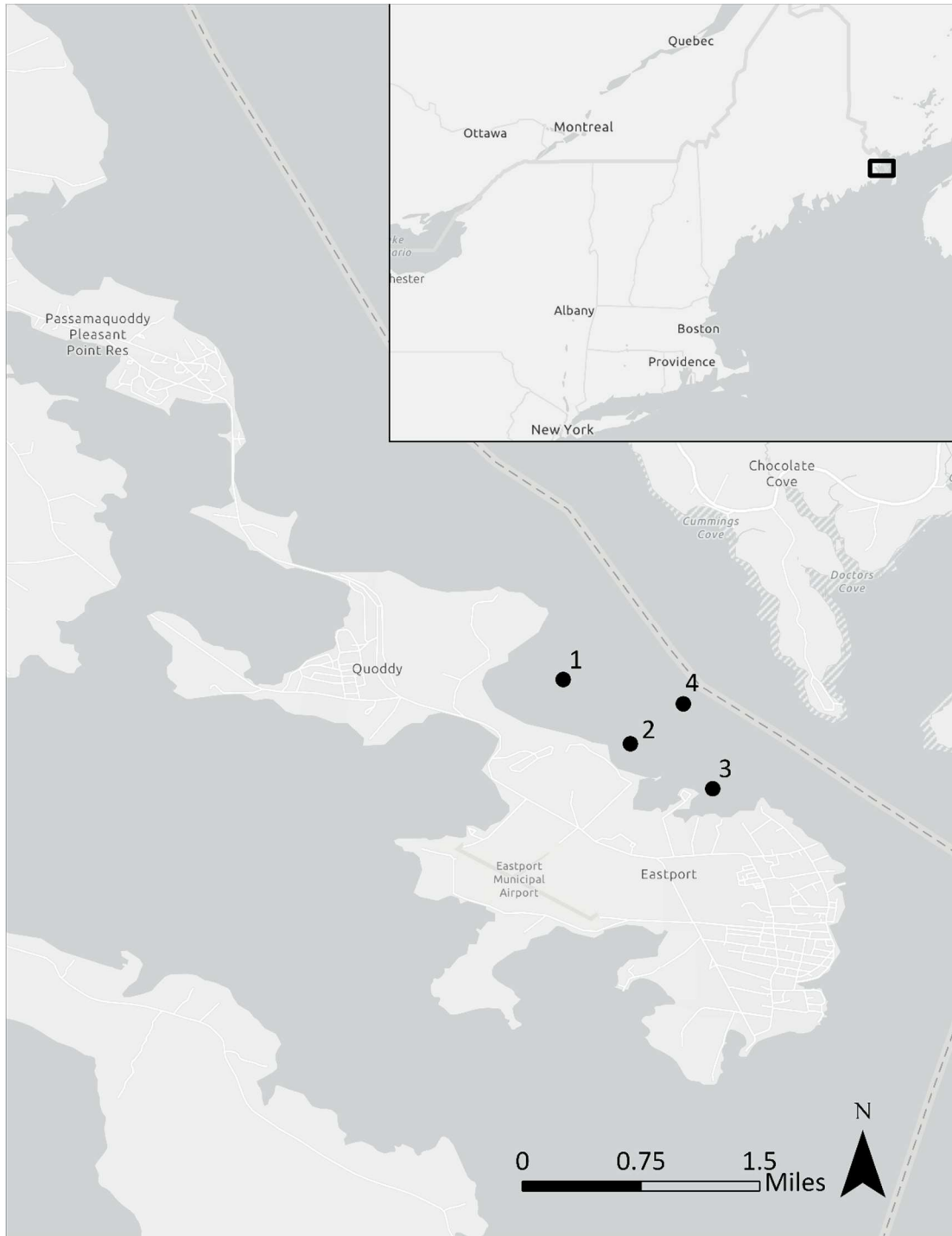
**Figure 6.** Map of the four study sites in Western Passage, Maine. Johnson's Cove (1), Murphy's Point (2), Harris Cove (3), and Mid-Passage (4).

Two protocols were simultaneously implemented: one for jigging (referred to as hook-

and-line in Marafino, 2020) and another for longline. Following the jigging protocol established

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by Marafino (2020), recreational rod and reel, using Sabiki rigs, were employed to collect fish over a 3 hour period. Hook size #6 was most frequently used. Each site was fished for 30 minutes. The survey period occurred close to slack tides, i.e., 1.5 hours before and after slack tide, to maximize time spent fishing during safe conditions.

The longline protocol was based on the Gulf of Maine Sentinel Survey protocol. The groundline employed was shorter than the length of the Sentinel Survey protocol to manage the pilot study within resources and time constraints. One 50-hook groundline was baited with mackerel and herring then deployed. Circle hooks size #6 were fixed to 15-inch gangions and spaced at 6-foot intervals along the main line. Gear was deployed for no longer than two hours. Gear was deployed at each site, except the Mid-Passage site due to risk of losing gear in tidal currents. A special license (ME 2021-52-04) was issued by Maine Department of Marine Resources in the event cod, ocean pout, Atlantic halibut, and winter halibut were encountered for which exemptions are necessary.

All captured fish were measured for weight and length then immediately released. Escapees, i.e., fish that were not landed but were given a positive identification, were not recorded as observations in this study. It should be noted that escapees were counted, and not measured, in Marafino (2020) when the species was positively identified. Moreover, because the 2021 study did not account for escapees, escapees from the 2019 dataset were removed and indices were recalculated.

**3.3.2 Data Analysis**

Summary statistics of fish length and weight were used to understand the jigging and longline approaches. The Shannon-Weaver Diversity Index was also calculated for each site to

understand diversity across sites, including sites surveyed in 2019 by Marafino (2020). The

index, $H$, is calculated as:

$$-\sum[(p_i) * log(p_i)]$$

where $p_i$ is the proportion of individuals of the $i$-th species in the community. A Chi-square test

was conducted to compare potential differences in diversity, $H$, as collected with the different

gear types at each site, as well as the overall capture of the two gear types. Lastly, a power

analysis was conducted to calculate the sample size requirements at each site and overall.

**3.4 Results**

Nine species and 236 individual fish were captured and measured during the five week

study period between July 12 and August 10, 2021 (Table 1). The nine species recorded

included (in order of abundance): Atlantic mackerel (n=146), Longhorn sculpin (n=34),

Shorthorn sculpin (n=22), Atlantic herring (n=21), Winter skate (n=6), Atlantic halibut (n=2),

Little skate (n=2), Sea raven (n=2), and alewife (n=1) (Table 1). The Atlantic Halibut was

recorded to be the largest sized species with a mean total length of 583 mm and mean total

weight of 2.29 kg. The Atlantic Herring was recorded to be the smallest sized species with a

mean total length of 178 mm and mean total weight of 0.08 kg. The mean sizes of the

remaining seven species are presented in order of mean total length: Winter Skate (536 mm,

1.6 kg), Little Skate (428 mm, 0.68 kg), Sea Raven (305 mm, 0.48 kg), Shorthorn Sculpin (295

mm, 0.49 kg), Longhorn Sculpin (282 mm, 0.28 kg), Atlantic Mackerel (266 mm, 0.16 kg), and

Alewife (264 mm, 0.14 kg).

| Fish Species | Count | Total Length min (mm) | Total Length mean (mm) | Total Length max (mm) | Weight min (kg) | Weight mean (kg) | Weight max (kg) |
|---|---|---|---|---|---|---|---|
| Alewife | 1 | 264 | 264 | 264 | 0.14 | 0.14 | 0.14 |
| Atlantic Halibut | 2 | 499 | 583 | 667 | 1.18 | 2.29 | 3.4 |
| Atlantic Herring | 21 | 155 | 178 | 195 | 0.02 | 0.04 | 0.08 |
| Atlantic Mackerel | 146 | 170 | 266 | 396 | 0.02 | 0.16 | 0.56 |
| Little Skate | 2 | 422 | 428 | 434 | 0.64 | 0.68 | 0.72 |
| Longhorn Sculpin | 34 | 218 | 282 | 348 | 0.12 | 0.28 | 0.52 |
| Sea Raven | 2 | 275 | 305 | 334 | 0.38 | 0.48 | 0.58 |
| Shorthorn Sculpin | 22 | 200 | 295 | 404 | 0.12 | 0.5 | 1.24 |
| Winter Skate | 6 | 452 | 536 | 686 | 0.72 | 1.55 | 2.8 |

**Table 1.** Table of summary statistics of fish size per species in 2021.

**Figure 7.** Photos of the captured species in the 2021 survey. Atlantic mackerel (panel a), Longhorn sculpin (panel b), Shorthorn sculpin (panel c), Sea raven (panel d), Alewife (panel e), Atlantic halibut (panel f), Winter skate (panels g and h), and Little skate (panels i and j). Atlantic herring not pictured. IACUC protocol number A2021-05-01.

At each of the four sites, there were 8 species recorded at Murphy's Point, seven

species recorded at Johnson's Cove, four species recorded at Harris Cove, and two species

recorded at Mid-Passage.Of the 236 individual fish captured with both gear types, there were

88 fish captured at Murphy's Point, 74 fish captured at Johnson's Cove, 63 fish captured at

Harris Cove, and 11 fish captured at Mid-Passage (Table 2).

Atlantic mackerel comprised 62%, or 146 of 236, of the total fish captured in 2021

(Figure 5). At Johnson's Cove, 41% of the catch were mackerel; the other species observed

were (alphabetically): Atlantic herring, Little skate, Longhorn sculpin, Sea raven, Shorthorn

sculpin, and Winter skate. At Murphy's Point, 65% of the catch were mackerel; the other

species observed were (alphabetically): Alewife, Atlantic halibut, Atlantic herring, Longhorn

sculpin, Sea raven, Shorthorn sculpin, and Winter skate. At Harris Cove, 78% of the catch were

mackerel; the other species observed were (alphabetically): Little skate, Longhorn sculpin, and

Shorthorn sculpin. Lastly, at Mid-Passage, 91% of the catch were mackerel; Shorthorn sculpin

was the other species observed.

**Figure 8.** Photo of mackerel captured on a Sabiki rig.

Jigging resulted in the collection of some species that were not collected using longline.

Jigging resulted in the capture of 74 fish at Murphy's Point, 58 at Harris Cove, 57at Johnson's

Cove, and 11 at Mid-Passage. Mid-Passage was difficult to fish due to the boat drifting at the

site. Of the nine species recorded overall, the Atlantic Mackerel (n=146), Atlantic herring

(n=21), and alewife (n=1) were the only three species captured with jigging and not on longlines, whereas Longhorn sculpin and Shorthorn sculpin were the two species observed using both jigging and longline. All Atlantic mackerel were caught using jigging; no mackerel were captured on the longline.

Longline sampling resulted in the capture of 17 fish at Johnson's Cove, 14 fish captured at Murphy's Point, and five fish at Harris Cove. Of the nine species recorded, four species were captured on longline that were not captured with jigging: Winter skate (n=6), Atlantic halibut (n=2), Little skate (n=2), and Sea raven (n=2).

| Fish Species | Johnson's Cove | | | Mid-Passage | | | Harris Cove | | | Murphy's Point | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Longline (2021) | Jig (2021) | Jig (2019) | Longline (2021) | Jig (2021) | Jig (2019) | Longline (2021) | Jig (2021) | Jig (2019) | Longline (2021) | Jig (2021) | Jig (2019) |
| Alewife | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Atlantic Cod | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 3 |
| Atlantic Halibut | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Atlantic Herring | 0 | 15 | 4 | 0 | 0 | 5 | 0 | 0 | 13 | 0 | 6 | 9 |
| Atlantic Mackerel | 0 | 30 | 64 | 0 | 10 | 12 | 0 | 49 | 157 | 0 | 57 | 120 |
| Little Skate | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Longhorn Sculpin | 6 | 6 | 16 | 0 | 0 | 1 | 4 | 2 | 11 | 9 | 7 | 11 |
| Pollock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Sea Raven | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Shorthorn Sculpin | 5 | 6 | 7 | 0 | 1 | 0 | 0 | 7 | 24 | 0 | 3 | 0 |
| Winter Skate | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| **Total Individuals** | **17** | **57** | **91** | **0** | **11** | **18** | **5** | **58** | **218** | **14** | **74** | **144** |

**Table 2.** Table of species and individuals captured per site and gear type in 2019 (Marafino, 2020) and 2021 (this study).

| Site | Gear (Year) | Number of Species | Total fish | Shannon-Weaver Index |
|---|---|---|---|---|
| | 2021 (L & J) | 7 | 74 | 1.54 |
| | 2021 (L only) | 5 | 17 | 1.41 |
| | 2021 (J only) | 4 | 57 | 1.16 |
| | 2019 (J only; Escapees removed) | 4 | 92 | 0.882 |
| Johnson's Cove | 2019 (J only) | 4 | 103 | 0.87 |
| | 2021 (L & J) | 8 | 88 | 1.163 |
| | 2021 (L only) | 4 | 14 | 1.03 |
| | 2021 (J only) | 5 | 74 | 0.612 |
| | 2019 (J only; Escapees removed) | 5 | 144 | 0.637 |
| Murphy's Point | 2019 (J only) | 5 | 150 | 0.62 |
| | 2021 (L & J) | 4 | 63 | 0.729 |
| | 2021 (L only) | 2 | 5 | 0.5 |
| | 2021 (J only) | 3 | 58 | 0.514 |
| | 2019 (J only; Escapees removed) | 5 | 218 | 0.966 |
| Harris Cove | 2019 (J only) | 5 | 234 | 0.96 |
| | 2021 (L & J) | 2 | 11 | 0.305 |
| | 2021 (L only) | n/a | n/a | n/a |
| | 2021 (J only) | 2 | 11 | 0.305 |
| | 2019 (J only; Escapees removed) | 3 | 18 | 0.787 |
| Mid-Passage | 2019 (J only) | 3 | 21 | 0.77 |

**Table 3**. Table of Shannon-Weaver Index per site in 2019 (Marafino, 2020) and 2021 (this study). L = Longline; J = Jigging

### 3.4.1 Diversity Across Gear Type

The diversity (Shannon-Weaver index) at each site was: at Johnson's Cove, H = 1.54; at

Murphy's Point, H = 1.16; at Harris Cove, H = 0.729. The diversity at Mid-Passage was H=0.305,

and because the longline was not deployed at Mid-Passage, this value represents diversity

measured using jigging only.

| Gear (Year) | Shannon-Weaver Index | | | |
|---|---|---|---|---|
| | Overall | Johnson's Cove | Murphy's Point | Harris Cove |
| Longline & Jig (2021) | 1.3 | 1.5 | 1.2 | 0.73 |
| Longline (2021) | 1.4 | 1.4 | 1 | 0.5 |
| Jig (2021) | 0.9 | 1.2 | 0.61 | 0.51 |
| Chi-square results | X-squared = 0.11 | X-squared = 0.054 | X-squared = 0.18 | X-squared = 0.057 |
| | df = 2 | df = 2 | df = 2 | df = 2 |
| | p-value = 0.95 | p-value = 0.97 | p-value = 0.92 | p-value = 0.97 |
| Sample size per power analysis | N = 42,119 | N = 26,187 | N = 9,590 | N = 29,897 |

**Table 4.** Table of Chi-square and power analysis results comparing Shannon-Weaver Diversity Index per gear type in 2021.

Because the index $H$ is proportional to the number of fish captured at a particular site,

diversity across sites was not compared statistically. There were no significant differences in

diversity based on gear types used at all sites, as well as at each site (Table 4). Across all sites,

there was no significant differences in diversity between capture with both gear types, capture

with only longline, and capture with only jigging (p-value = 0.95). Similarly, this was also found

to be the case at Johnson's Cove (p-value = 0.9731), at Murphy's Point (p-value = 0.9154), and

at Harris Cove (p-value = 0.972). Therefore, I fail to reject the null hypothesis that gear types

are independent. In other words, diversity metrics using either gear type result in similar

measures of diversity.

Lastly, I performed power analyses across gear types overall, as well as at Johnson's Cove, Murphy's Point, and Harris Cove (Table 4). Effect size was calculated with respect to the number of fish captured at the site(s), while the significance level is p=0.05 and degrees of freedom equals 2. When the power is 80%, the calculated sample sizes are 42,119 fish overall, 26,187 fish at Johnson's Cove, 9,590 fish at Murphy's Point, and 29,897 fish at Harris Point.

**3.5 Discussion**

The data collected in this study contribute to the knowledge base of the fish community in Western Passage over the July-August period. The fish captured using both longline and jigging supports Marafino's (2020) finding that hook-and-line gear can fill a methodological niche (Kuriyama et al., 2019) in Western Passage, while other approaches have not been effective in Western Passage (Cammen et al., 2021). However, comparing diversity across gear types may not be feasible due to the very large sample size needed to have statistical power.

Nevertheless, the use of both gear types are useful in terms of observing both pelagic and benthic species present in Western Passage. The longline and jigging gear target fish species at different levels of the water column, explaining differences in species observed by gear type. In this study, there were four species observed (i.e., Atlantic halibut, Winter skate, Small skate, and Sea raven) that were not observed using jigging in 2021 or 2019. Demersal longline gear is helpful for better understanding groundfish dynamics (Rodrigue, 2017). The longline provides insight on fish species present in the area that jigging may not. Species observed through jigging were primarily pelagic fish (e.g., mackerel). We captured only one alewife throughout the study period using jigging gear, and because alewives are a culturally significant fish to the Passamaquoddy Tribe (Sutton, 2020; Bassett, 2015), continued effort

targeting alewives both supports Passamaquoddy priorities and contributes to a more current understanding of the presence of alewives in Western Passage.

Gear selectivity likely influenced the species captured and the frequency at which they were captured (Lennox et al., 2017; Kuriyama et al., 2019; Marafino, 2020). In an interdisciplinary conceptual framework, Lennox et al. (2017) argued that fish catchability is biased by an individual fish's vulnerability, its encounter with the gear, and the characteristics of the gear. The high number of mackerel captured, relative to other species, using jigging suggests that there were more fish in the water than available hooks on the Sabiki rig (Kuriyama et al., 2019; Marafino, 2020). Bias from gear saturation (e.g., more fish than hooks) may be exacerbated when diverse species with behavioral differences are present (Kuriyama et al., 2019). It should be noted that mackerel can evade capture (McDonald et al., 1984), therefore further emphasizing the importance of the relatively high number of mackerel captured.

Consistent with Marafino (2020) and Bartlett and Arthearn (2008), there was a high abundance of mackerel, and since mackerel were observed only with jigging gear, the high abundance of mackerel may explain the differences in diversity across gear type. The Shannon-Weaver Diversity Index is a relative measure of abundance and richness, and a relatively high abundance of one species (e.g., mackerel) negatively influences species richness and therefore the index. However, richness is challenging to assess when the sample size is small (Gotelli & Colwell, 2011), and future studies can modify the protocol to include different hooks and bait to target species not yet captured (Marafino, 2020; Rodrigue, 2017).

The 2021 and 2019 data illustrate different numbers of individuals at each site. The difference in number of individuals may be due to fishing effort and more specifically, the number of individuals per survey trip. In 2021, there were 1-2 people fishing at a time: as one was continuously fishing, the other would break to measure and immediately release fish. In 2019, there were 2-3 people fishing at a time, allowing the study to have at least 2 lines in the water. Having more lines in the water likely impacts the number of fish captured during the 3 hour study period. The 2021 protocol strictly maintained 30 minutes fishing (jigging) periods at each site, whereas the 2019 study approximated 30 minutes and oftentimes allowed fishing periods to be longer than 30 minutes at each site. In addition to modifying the protocol to include different hook sizes and bait types, future studies should consider sampling teams of at least 3 people to maintain hook saturation in the water.

In terms of diversity, although there was no statistical difference in Shannon-Weaver indices between fish captured using the longline and jigging, anecdotal evidence suggests that two modifications in the longline protocols can be useful in further establishing the knowledge base of fish population in Western Passage. For one, it seemed that fish were more interested in the longline when baited with fresh mackerel, when compared to herring and mackerel that were a day or two old or were frozen. Other studies (e.g., Løkkeborg et al., 2014; Rodrigue, 2017) have shown different properties and treatment of bait may bias longline fishing catch. This may have influenced the number of fish, as well as fish species, captured, as there were two days with no catch on the longline that may have been impacted by relatively fewer fresh mackerel. Future studies may modify the protocol by capturing mackerel immediately before the study, or experimenting with different bait types and hook sizes.

Second, the small sample size observed through longline may be influenced by new moons that occurred at the beginning and at the end of the 2021 sample period. Of the eight sampling trips, we had two deployments with no capture, and it was challenging to deploy the longline gear due to boat drift. In the Bay of Bengal (India), Libini and Khan (2012) found that (gillnet) catches of mackerels showed an upward trend from new moon to full moon, then a downward trend toward new moon. Future work may consider a longitudinal study in which fish catches and lunar phases are compared across time to observe influence of a new moon on catch in Western Passage

The data gathered supports the cultural and ecological significance of Western Passage. The data will be shared with the Passamaquoddy Tribe for their uses adjacent to their conservation efforts that align with the cultural and economic significance of Western Passage. The data are also available to regulatory bodies interested in the potential impacts of marine renewable energy on the fish populations (Marafino, 2020). Lastly, the data provides insight on fish present that may be useful for persons or organizations supporting local recreation, tourism, and boat charters.

**3.6 Conclusion**

This study builds on Marafino (2020) and suggests that hook-and-line gear (both longline and jig) can contribute to the knowledge base of fish communities in Western Passage. Incorporating alternative fishing strategies can support the knowledge gap. However, longline is not useful at Mid-Passage due to risk of losing gear to tides. Additional limitations of the study include a small field survey crew, as well as a short sampling period. A crew of more individuals, for example interns from the University of Maine or Wabanaki in Youth Science,

and more trips during the two-month period, may facilitate additional effort that realizes a higher number of individual fish captured.

The study findings are significant because they contribute to both tribal and Western knowledge base of fish species in Western Passage. In terms of supporting the Passamaquoddy Tribe, the data will be made available for the Sipayik Environmental Department's future use, such as including the data in their databases or visualizing the data in future StoryMaps they may develop. Moreover, the longline has potential to further contribute to the knowledge base by surveying at Johnson's Cove, Murphy's Point, and Harris Cove, and not so much at Mid-Passage.

Recommendations for future work include adopting both methods, as well as modified protocols as discussed above (e.g., vary bait type, hook size, and number of fishers). Modifying protocols to target a larger sample size would help in determining the utility of the longline. In addition to modifying protocols, exploring other methods to feasibly survey Mid-Passage would contribute to the knowledge base as deploying the longline in Mid-Passage was not feasible. Future work will therefore require modifying and expanding the protocols to produce data that continue to advance understanding of fish communities in Western Passage.

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**BIOGRAPHY OF THE AUTHOR**

Michelle de Leon was born in New Haven, Connecticut on November 27, 1996. She was raised in Hamden, Connecticut and graduated Hamden High School in 2014. She attended Cornell University and graduated in 2017 with a Bachelor of Science degree in Environmental and Sustainability Sciences and a minor in English. She later moved to Maine amid the COVID-19 pandemic in fall 2022 and started the Ecology and Environmental Sciences graduate program at the University of Maine. After receiving her degree, Michelle will return to the U.S. Bureau of Reclamation, Water Resources and Planning Office, to continue her federal career in water conservation. Michelle is a candidate for the Master of Science degree in Ecology and Environmental Sciences from the University of Maine in August 2022.