Fall 12-15-2023

Mobilizing Indigenous Research Methodologies and Wabanaki Knowledge in Biophysical Research to Restore Wabanaki Sweetgrass Harvesting in Acadia National Park and Identify Basket Quality Black Ash Habitat for Emerald Ash Borer (Agrilus planipennis) Preparedness

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MOBILIZING INDIGENOUS RESEARCH METHODOLOGIES AND WABANAKI KNOWLEDGE IN BIOPHYSICAL RESEARCH TO RESTORE WABANAKI SWEETGRASS HARVESTING IN ACADIA NATIONAL PARK AND IDENTIFY BASKET QUALITY BLACK ASH HABITAT FOR EMERALD ASH BORER (*AGRILUS PLANIPENNIS*) PREPAREDNESS

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A Dissertation

Submitted in Partial Fulfillment of the

Requirement for the Degree of

Doctor of Philosophy

(in Forest Resources)

The Graduate School

The University of Maine

December 2023

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An Abstract of the Dissertation Presented in
Partial Fulfillment of the Requirement for
the Degree of Doctor of Philosophy
in Forest Resources
December 2023

Black ash (*wikpiyik*/*Fraxinus nigra)* and sweetgrass (*suwitokolasol*/*Anthoxanthum nitens)* are two culturally important species to Wabanaki (Passamaquoddy, Penobscot, Maliseet, Mi'kmaq, and Abenaki) people, and to many other Native American tribes across the species' ranges. Wabanaki relationships with black ash and sweetgrass include creation stories, generational stewardship practices, important economic markets, and cultural identity. Land use patterns, changes in access, invasive species, and climate change are negatively affecting both the health of black ash and sweetgrass and Wabanaki people's relationship to these species. This dissertation consists of five chapters that mobilize Wabanaki knowledge and address Wabanaki access to sweetgrass and an invasive species response planning for black ash trees. In chapter 1, I utilize a case study approach to show the formative reciprocity between Wabanaki people, sweetgrass, and black ash. Through Emery's (1998) Non-Timber Forest Product (NTFP) sustainably framework, I demonstrate black ash and sweetgrass significance to Wabanaki people and illustrate how these materials are rooted within cultural survival. In chapter 2, I describe the relational and processual nature of Indigenous knowledge and how, through Indigenous Research Methodologies, research with Indigenous people can be co-produced and culturally relevant. This chapter acts as a foundation for research approaches described within the subsequent two chapters. In Chapter 3, I will report on a study to restore Wabanaki access to sweetgrass in Acadia National Park. A recent federal rule change has

created a regulatory pathway for Federally recognized tribes to gather plants within National Park boundaries. For the National Park Service (NPS), an Environmental Assessment (EA) and a finding of no significant impact (FONSI) is required for any species gathered within NPS park boundaries. This study demonstrates by showing that Wabanaki sweetgrass harvesting does not negatively harm sweetgrass population. This study has moved beyond just providing information for an EA but to one that supports and facilitates relationships for co-management of sweetgrass within Acadia National Park. In Chapter 4, I outline a basket quality black ash habitat suitability model in GIS to identify basket quality black ash stands. This GIS model is successful at finding black ash basket quality ash and coupled with other research findings, is able to identify the distribution of basket quality black ash across a landscape. Chapter 5 is a personal story that serves as a reflection on how the two studies reported in chapters 3 and 4 reflect my own identity as a Maliseet scientist.

DEDICATION

This dissertation is dedicated to all the people who have supported me throughout my journey to reach where I am today; to the people whose work created the path I follow, to the people beside me who share in uplifting the work, and to the people who come behind me. I hope you can soar forward for our people.

ACKNOWLEDGEMENTS

I want to acknowledge and recognize my husband and two children. Your love and support are my foundation, my cocoon, lift me up, and help me to be the person I want to be. Thank you, “Harvester #1”, for creating this life that I could only dream of.

Thank you to my advisors Dr. John Daigle and Dr. Darren Ranco. Both of you have been instrumental to my success and I will always appreciate all that you have done for me. Thank you to two of my committee member, Dr. Sandra De Urioste-Stone and Dr. Daniel Hayes, for helping me throughout my doctoral program. Thank you to Dr. Michelle Baumflek, my research partner and close friend. I’m grateful that we experience this work together.

Thank you to the larger Wabanaki harvest family. I am extremely honored to walk beside all of you.

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CHAPTER 1

Wabanaki People, Black Ash, and Sweetgrass

Introduction

Black ash (*wikpiyik*/*Fraxinus nigra)* and sweetgrass are two culturally important species to Wabanaki people and many other Native American's who live within the species' ecological range. Wabanaki people's relationship with these two species include creation stories, reciprocal care taking roles, and economic markets. Both sweetgrass and black ash are critical components in black ash basket making. The act of harvesting, processing, and weaving sweetgrass and black ash into a basket are pathways for ancestral connection, identity, and is a form of cultural resilience. I will utilize and expand Emery's (1998) Non-Timber Forest Product (NTFP) sustainably framework to synthesize black ash and sweetgrass significance for Wabanaki people and illustrate how these materials are rooted within cultural survival. This chapter serves as a foundation to understand the importance of preserving black ash and sweetgrass and Wabanaki people's relationships with them.

Wabanaki Confederacy

The Wabanaki Confederacy, meaning People of the Dawn, comprise five federally recognized Native American tribes, Maliseet, Micmac or Mi'kmaq, Passamaquoddy, Penobscot, and Abenaki, with tribal territories located in Maine, Quebec, and the Atlantic provinces. The Wabanaki Confederacy serves as political, cultural, and familial connections binding all five tribes in a larger framework. While each tribe in the Wabanaki Confederacy is a distinct political and social entity, all five tribes share a common cultural context that allows citizens to be described as one group for the purpose of this dissertation.

Traditionally the major watersheds separated the territories of tribes of the Wabanaki Confederacy (Figure 1.1). Penobscot Nation lands are within the Penobscot River watershed, Maliseet people lived within the Wolostoq River watershed, Passamaquoddy people inhabited the St. Croix River valley, the Mi'kmaq live to the east of the Maliseet, inhabiting the rest of New Brunswick and the Maritime Provinces, and the Abenaki's traditional territory extended west of Penobscot territory. Today Wabanaki people, living within the State of Maine boundaries, hold a much smaller portion of land than that was originally inhabited and each tribe has a reservation or tribal housing and government headquarters within their current land holdings (Figure 1.2).   In Canada, Abenaki, Maliseet, and Micmac Nations hold federally recognized reservations in the Quebec and the Atlantic Provinces.

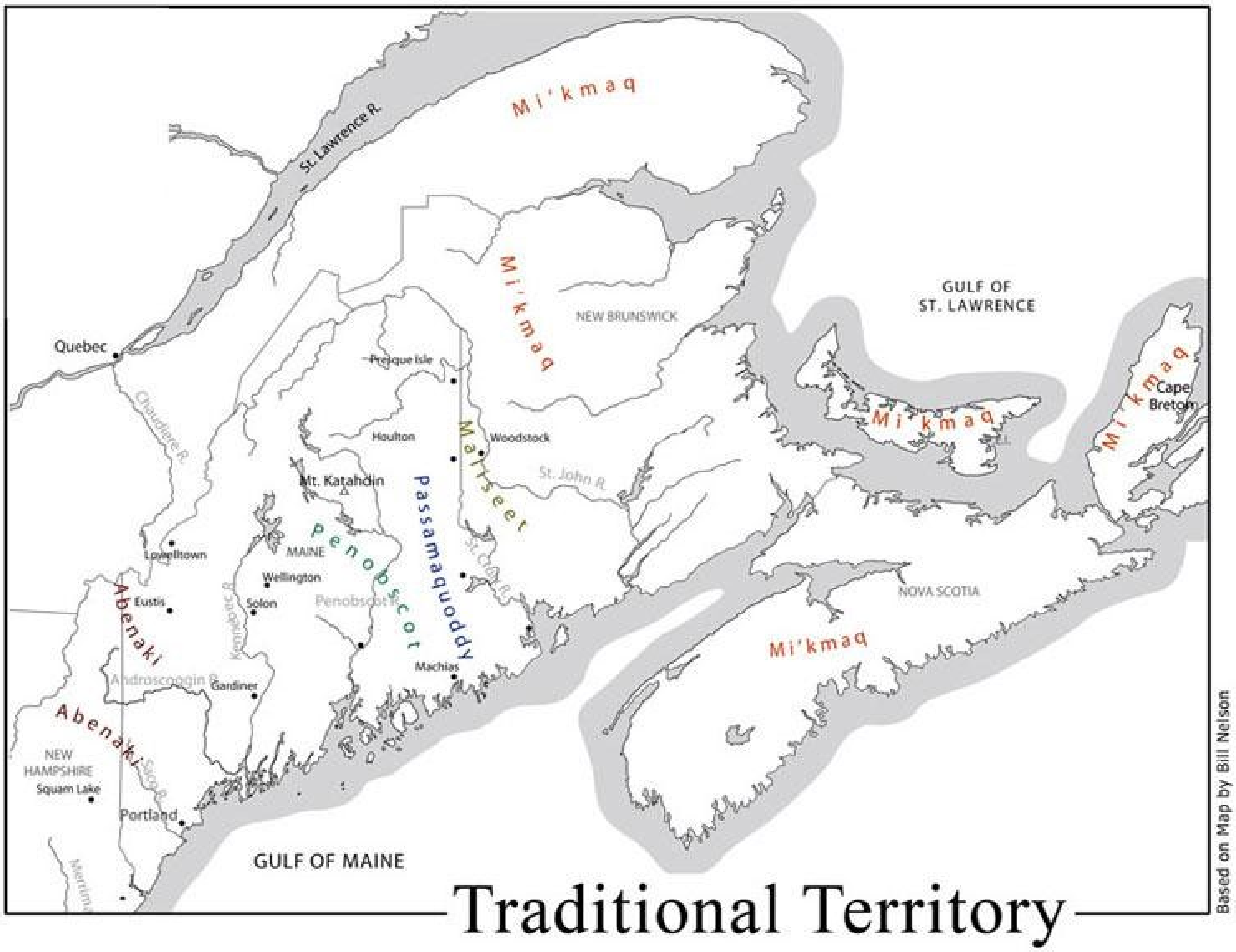

Figure 1.1 Wabanaki traditional territory. Accessed from http://www.abbemuseum.org/headline-news/Wabanaki%20Territory/HeadlineNewsWabanakiTerritory.html

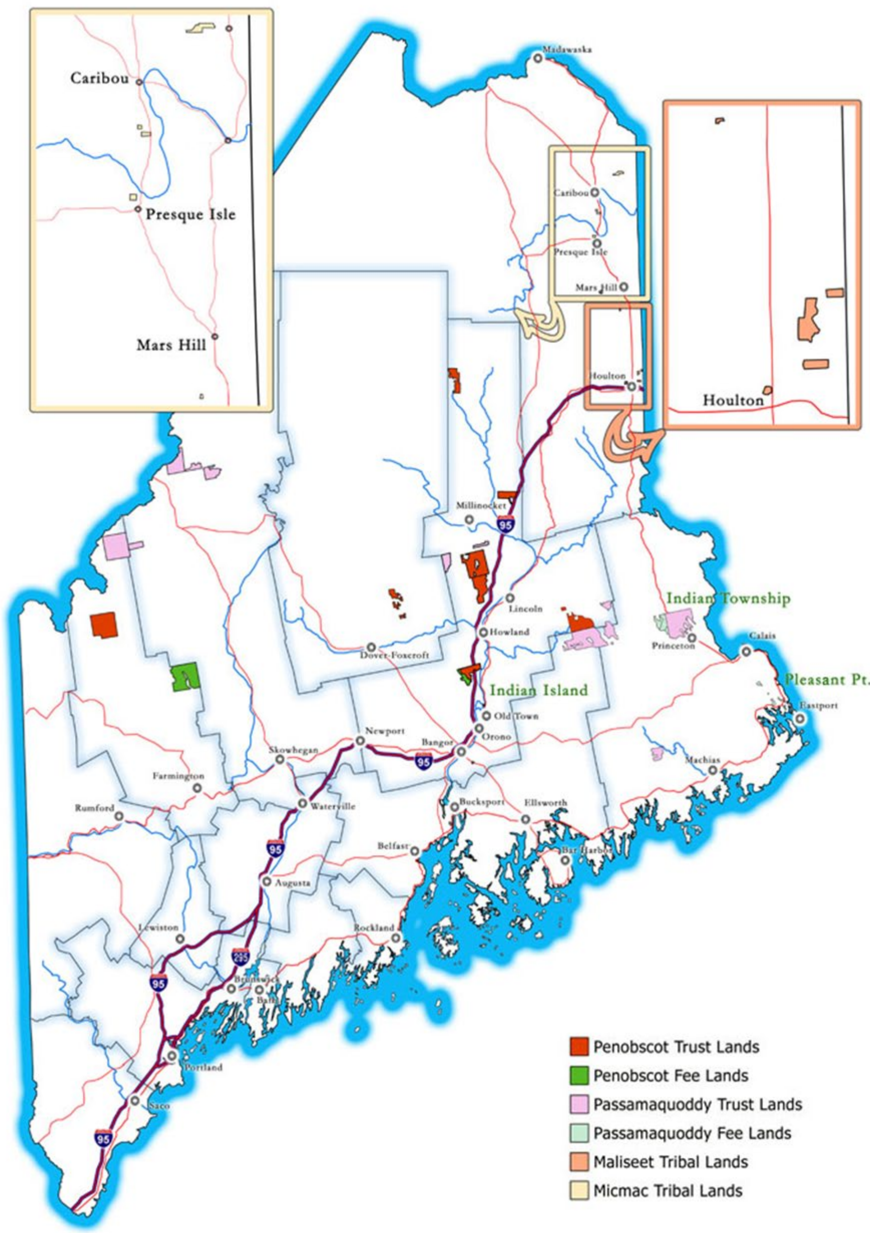

Figure 1.2. Current land base for Wabanaki tribes of Maine. Assessed from https://www.abbemuseum.org/headline-news/Wabanaki%20Territory/HeadlineNewsWabanakiTerritory.html

Significance of Black Ash and Sweetgrass to Wabanaki people

Black ash and sweetgrass hold spiritual, cultural, and economic significance to Native American people throughout the species' ecological range. These two species are considered to be a cultural keystone species which is defined as culturally salient species that shapes the cultural identity of a people (Garibaldi & Turner, 2004). Cultural keystone species frequently play a role in the origin stories of a people.

For Wabanaki people of Maine and the Maritime Provinces of Canada, our creation myth tells us that we have come from the black ash tree.

> *"Glooskap came first of all into this country…into the land of the Wabanaki, next to sunrise. There were no Indians here then… and in this way, he made man:*
>
> *He took his bow and arrows and shot at trees, the basket-trees, the Ash. Then Indians came out of the bark of the Ash-trees."– Molly Sepsis, Passamaquoddy in Charles G. Leland, Algonquin Legends (1884)*

Indigenous people hold a special cultural bond with black ash, sweetgrass, and basket making. "It's a part of our identity", as said by a Mi'kmaq basket maker Richard Silliboy, "separating myself from basket making would be the same as saying I'm not Indian." The act of basket making connects Wabanaki people to their ancestors. Many basket makers can trace their artistic lineage back multiple generations within their family. Gabriel Frey, a 13th generation Passamaquoddy basket maker, describes the process of basket making as collective memory, where his first lesson in basket making was "like remembering something instead of learning for the first time" (Donnely, 2016). The smell of sweetgrass often evokes memories of family and connections. Wabanaki people have harvested sweetgrass for generations often harvesting in the same location.

The economic significance of basket making ensured the continuation of the craft as well as provided income for many Wabanaki people who were not part of the conventional wage economy. By the 1900's, every Passamaquoddy and Penobscot's household had at least one member whose primary occupation was basket maker (Neuman, 2010). The economic significance of Wabanaki basket -making is described by Molly Neptune Parker, a Passamaquoddy basket maker, “If you know how to make baskets, you’ll never go hungry.” Wabanaki basket making continues to thrive with sale of baskets exceeding $150,000 annually in Maine alone (Daigle & Putnam 2009). Some basket makers rely solely on basket sales as their main source of income (Neptune et al., 2014).

Non-Timber Forest Products Sustainability

Non timber forest products (NTFP) are any plants, trees, or fungus that are harvested within forests for purposes other than timber (Chamberlain et al., 2018). Black ash and sweetgrass can be considered non-timber forest products (NTFPs) and these two species are valued by Native people throughout the species’ range as part of a land-based livelihood. NTFPs has been shown to be an integral part of the rural economy and sustain Wabanaki families and communities in times of economic scarcity, both for subsistence and market values (Neuman, 2010). However, sustainability of the basket making tradition is threatened by land use and access changes, an invasive Emerald Ash Borer beetle, and climate change (Ginger et al., 2012; Ranco et al., 2012; Voggesser et al., 2013). Sustainability of a livelihood based on NTFPs relies on four key elements: knowledge, availability, access, and need/demand (Emery, 1998) and each of these elements are critical to the sustainability of Wabanaki basket making.

Knowledge

Indigenous knowledge has been passed down through generations and is embedded within the culture. Wabanaki Knowledge of black ash and sweetgrass entails knowledge of locating and harvesting, processing materials, manipulating the materials, and the art of weaving. Knowledge production and transmission occurs through practice and oral traditions. Young boys accompany fathers and uncles on trips into the woods and learn to harvest black ash trees. Elder basket makers often tell stories of their earlier excursion into the woods with their family members. Women would host sweetgrass braiding parties with children observing and eventually participating (Neptune, 2008). Indigenous knowledge is an oral tradition and transmission relies on the harvesting of cultural materials and the act of basketmaking. While oral knowledge offers valuable lessons that written knowledge cannot transmit, oral transmission does heavily rely on active participation and can be more sensitive to becoming forgotten or lost. Indigenous knowledge systems are dynamic and adaptive. However, the loss of a single relationship has a ripple effect across the whole knowledge system and means that specific knowledge may not be available for future generations.

For Wabanaki people, knowledge is intertwined with cultural values and ethics. Wabanaki people's harvesting practice is more than just an ecological relationship. The act of harvesting black ash and sweetgrass form social relationships between Wabanaki people, black ash or sweetgrass and the landscape (Muir et al., 2010). Harvesting is a practice of Wabanaki philosophy in caring for non-human relatives. This philosophy assumes that both black ash or sweetgrass and humans have a responsibility towards each other where the tree or grass will provide for humans and in return Wabanaki people assume beneficial stewardship responsibilities. Knowledge and the action of knowledge are critical pathways for cultural identity and land relationships.

In 1993, responding to the decline in the number of basket makers and the seeing the potential of losing the knowledge of basket making tradition, a group of Wabanaki basket makers created the nonprofit organization Maine Indian Basket Alliance (MIBA) (Neptune, 2008). When MIBA first formed, Wabanaki basket makers totaled 53 people, with the youngest active basket maker in her 50's (Neptune, 2008). MIBA has successfully increased the number of Wabanaki basket makers. Today the organization's membership includes 200 basket makers, and the average age has dropped from 63 to 40.

External Demand/Internal Need

The external demand and internal need for Wabanaki black ash baskets have been a large driving force in sustaining the livelihood of black ash basket making over the century. Before European contact, black ash baskets were made to gather and prepare food and trap fish (Neptune, 2008). By the mid- eighteenth century, Wabanaki people began to trade ash baskets with Europeans for desired manufactured goods (McBride & Prins, 1990). The role of basket making took on greater economic importance for Wabanaki communities as traders, tourists, and industry formed a consumer market for Wabanaki baskets (Bourque & Labar, 2009). Reduced to a small land base and with few economic opportunities, Wabanaki basket makers adapted ash baskets to sell across a wide range of markets. From the 1850's to 1950's, Wabanaki baskets were sold for Northern Maine farming and hunting, Down East Maine fishing, and Coastal Maine tourist industries (MacDougall, 2004). By the 1900's, basket making was in every Passamaquoddy and Penobscot household (Neuman, 2010). Richard Silliboy, a Mik'maq basket maker elder, remembers weaving up to 125 baskets a week with his family to supply the Northern Maine potato farming industry. Each potato basket was sold for 50 cents apiece (Baumflek et al., 2010). From the 1950s to the 1980s, the Wabanaki black ash basket market began to collapse (Neptune, 2008). Imports of foreign baskets, mechanized equipment within farming and fishing industry, and diminishing tourist trade led to less demand for Wabanaki baskets. The diminishing market contributed to the decline in the number of Wabanaki basket makers. During this time many Wabanaki people migrated to southern New England and Massachusetts to find new job opportunities (Mt Pleasant, 2014). With the creation of MIBA in 1993, Wabanaki basket makers worked towards reinvigorating the basket market in Maine. Over the last 24 years MIBA has successfully established a thriving Wabanaki basket market and has helped to promote Wabanaki baskets as an art form across the country, which has increased consumer demand and prices for baskets. Today, Wabanaki basket makers can price their work for significantly more than 50 cents a basket. The current market can sustain prices that more accurately reflect a Wabanaki basket maker's time, energy, and artistry of each basket. Within the last 10 years, Wabanaki artists have expanded their audience to national platform where the artists sell their work in larger markets such as Native American Indian Market in Santé Fe, New Mexico and Heard Indian Market in Phoenix, Arizona. In both of these large Western markets where thousands of Native American artists enter their artwork in competition, a handful of Wabanaki basket makers have won competitive prestigious art awards. Currently, modern Wabanaki baskets can be found in museums and within art collections. MIBA's has been instrumental in revitalizing and enlarging the Wabanaki basket market.

While economic incentive is the basis for the internal need of Wabanaki basket making sustainability, the internal need of black ash basket is more complex than just basket sales.

Black ash basketry is a tool for Wabanaki people to adapt to a changing socio-economic environment while maintaining cultural traditions. Basket making provided a source of income, maintained cultural traditions, language, and family connections while creating a small form of resistance for Wabanaki people to federal assimilation polices. Throughout the later 1800's and 1900's, federal and state assimilation policies and the church created pressure for Indigenous people to reject their own cultures. Forced removal of Indian children to residential schools started in the late 1880's with the last residential school closing in Canada in 1990's. By Mid-1800's, Wabanaki people in the midst of a shifting socio-economic environment between their long-established seasonal rhythms that reflected game and fish migrations and the world of permanent settlements where the source of income was wage labor (Parenteau & Kenny, 2002). The expanding European population impacted fish and game resources. Forest clearings were turned into farm fields. The creation of mills and dams restricted fish passages. Hunting and fishing eventually became subject to state restriction or regulation. Wabanaki people could no longer rely on their traditional economy and settled near established towns to procure work.

Throughout this time, Wabanaki tribes signed a series of treaties with colonial and state governments (Hinton & Giles, 2022, Loring et al., 2023). Through treaties and the State of Maine illegal selling of Passamaquoddy and Penobscot lands, Wabanaki people were robbed of millions of acres of land (MacDougall, 1995, Hinton & Giles, 2022, Loring et al., 2023). While Wabanaki people were forced to live on a small land base, either federal reservations or unoccupied lands in and around towns, Penobscot Nation and Passamaquoddy Tribe owned larger tracts of lands retained within their treaties. Yet, the lands were held in "trust" by the State of Maine government and the State controlled the proceeds from logging within tribal forestlands and from illegal land sales to non-native people (MacDougall,1995, Loring et al., 2023). Indian agents, assigned by the State, lived on reservations and were charged to oversee the Native communities. Even though the Indian agent was paid through the tribe's money, the Indian agent controlled how each family received money and would often withhold weekly stipends of food and money as a form of punishment. With no control over their natural resources and their money, Wabanaki people were often forced into choosing European wage economy and farming (Mt Pleasant, 2014). These federal agents "who were charged with disrupting traditional economies based on hunting, fishing, and gathering (and corresponding seasonal relocations), tended to denigrate Indians' insistence on maintaining their basket-making traditions" (Mt Pleasant, 2014). Practicing cultural traditions such as basket making was in opposition to federal policies intended to transform Indians into farmers or wage laborers (MacDougall, 2004). In addition, basket making helped to maintain family structure and language usage (Neuman, 2015). Basket making was a family endeavor, with each member responsible for a portion of the basket making process. Entire families would work together all winter in preparation for the summer sales (MacDougall, 2004). Selling black ash baskets helped Wabanaki families to travel seasonal traditional land routes. By the 1870s resort hotels sprang up along the New England coastline and inland lakes. Wabanaki set up encampments besides the resorts to sell baskets (Mt. Pleasant, 2014). These locations tended to be near previous seasonal encampments where Wabanaki people would travel to fish or harvest. Beginning in the mid-nineteenth century, Wabanaki families routinely visited resort towns such as Kennebunkport and Bar Harbor on Mt. Desert Island, Maine (McBride & Prins, 2009). Income from the tourist resorts proved more lucrative than farming. Agriculture never became a major aspect of Wabanaki life that the state departments had intended (MacDougall, 2004). Given the continued economic and cultural significance, Wabanaki basketry remains a tool for cultural resilience, education, and decolonization (Neuman, 2010).

Availability

Black ash and sweetgrass availability are influenced by current land use, land management practices, and invasive species (Diamond & Emery, 2011; Head & Atchison, 2015; Benedict & Frelick, 2008; Costanza et al., 2017). Native American basket makers have reported a decline in available basket-quality black ash trees (Benedict & Frelich, 2008). Due to the decline of basket-quality black ash, some native harvesters are traveling greater distances- up to 200 miles to locate black ash. Land management practices such as timber harvesting can affect adjacent black ash stands due to changes in hydrology or light conditions. Herbicide or pesticide application on adjacent farm land concerns many basket makers in how the chemicals may affect the wood quality and their personal health (personal communication with Molly

Neptune, 2010). Invasive species such as Emerald Ash Borer beetle (EAB; *Agrilus planipennis*), which is decimating all ash trees, exponentially increases Wabanaki people's concern for the future of black ash trees. EAB, native to China, was first detected in Michigan in 2002. The invasive beetle has since spread east to New England and two Canadian provinces, with the detection in New Hampshire in 2013 and Maine in 2018 (Siegert et al., 2014). Climate change is predicted to shifts tree habitats and increase sea level rise within salt marshes (Iverson et al., 2016; Nielsen & Dudley, 2012). With the possibility of sea level rise within salt marshes, Wabanaki people have expressed concern for the future of sweetgrass habitat (Ellis, 2016)

Access

Wabanaki people have a small land base and need to rely on access to private property to harvest their cultural materials. Wabanaki people and Maine private landowners have different histories and knowledge associated with Wabanaki land access rights. Clashes between euro-settler meaning of private property and Wabanaki perception of homeland has been documented since the nineteenth century (Pawling, 2016). Pawling (2016) explains that within treaty rights, Wabanaki held subsistence fishing rights, which included access to fishing locations. Fishing was partially dependent on harvesting birch bark for torches, yet the state's legal system saw the two activities as unrelated. When a landowner confronted Passamaquoddy people about unlawfully harvesting birch bark on his property, the Passamaquoddy person's response was that he had a right to cut down birch trees and he will continue to do so (Pawling, 2016). Many Wabanaki basket makers share the same sentiment today, that it should be our right to cut down black ash trees (personal communication with Richard Silliboy, 2009). Wabanaki access rights to resources are strongly influenced in the legal and regulatory relationship with the state and federal government (Whyte, 2013a). Dispossession of Wabanaki lands and private property laws were settler colonial tools to benefit the statehood of Maine and its citizens (Loring et al., 2023). Wabanaki people were denied citizenship and the right to vote until the late 1930's and 1950's respectively. Wabanaki lack of access to natural resources is a reflection of structural inequalities (Ellis, 2016).

Wabanaki people are subject to state laws when harvesting sweetgrass and black ash. Maine has an open land tradition and the level to which the public can access private land is unlike other states in the United States (Acheson, 2006). Maine has a traditional open access policy to private forestlands that dates to colonial times. Considering that 90% of the state's land is held in private ownership, public access to private lands have been a vital asset for recreation, hunting, and fishing. (Acheson, 2006). In the State of Maine, people hunt on land owned by others, drive snowmobiles and ATVs, and hike and cross-country ski across privately owned land. These types of activities have helped to formulate Maine's identity. Many Mainers view accessing private property for recreational purposes is a traditional right and feel little obligation to ask for permission when entering large landowners' private property (Acheson, 2006). Recreational and hunting are large driver of economic vitality within Maine communities (Levert et al., 2007). The State of Maine encourages landowners to continue to allow the public to have access to their land (Acheson, 2006). The tradition of using other people's property for recreation has enormous economic implications for the state. One of the largest industries in Maine is tourism (Lilieholm, 2007). Reducing access to private lands almost certainly would result in far fewer people coming to Maine for outdoor recreation, which would result in a substantial loss to the businesses in inland areas serving these tourists.

Maine's history of an open land access is in part due to laws that reduce landowner liability (Acheson, 2006). Maine has a strong law to protect landowners, known as the "landowner liability" law, Title 14, M.R.S.A. Section 1 59-A. If someone accesses private land for outdoor recreation or non-commercial harvesting of trees and forest products, the landowner assumes no responsibility and incur no liability for injuries to that person or that person's property. The landowner is protected whether or not they give permission for a person to be their land. Even if a person sustains injuries, the landowner is still protected from liability when allowing volunteers to maintain or improve land for recreation or harvesting. Despite the incentive to have open access, landowners do have a right to control access. In Maine, private property rights ensure landowners have the right to keep uninvited people off their property by posting no trespassing on their property (Kenlan, 2016).

Wabanaki harvesters experience reduced access for both sweetgrass and black ash (Ellis, 2006; Baumflek et al., 2010). Wabanaki harvesters and private land owner interactions may differ across regions within the State of Maine. While public access restriction to private lands can occur in both developed and remote areas, access restriction is especially noticeable within developed areas of the State such as southern Maine and coastal properties (Daigle et al., 2012). The land parcels within developed areas tend to be small in size to a few acres (Acheson, 2006). Desirable sweetgrass grows within coastal properties and Wabanaki harvesters typically walk across private property to access traditional sweetgrass beds. Wabanaki sweetgrass gatherers report acrimonious interactions with private land owners when a private land owner denies them access to sweetgrass habitat (personal communication with Gal Frey, 2016). Ellis (2016) found coastal communities identified shoreline access as important for recreation and fishing but changes in land ownership, taxes, and development made maintaining access difficult.

In remote regions such as Northern Maine, Wabanaki people report increased difficulty of gaining access to black ash due to posting (Baumflek et al., 2010; Ginger et al., 2012). The northern two-thirds of Maine is heavily forested, sparsely populated, and a high proportion of the land is in unorganized territories. The land here is held by a few timber companies and investment corporations, some of which own hundreds of thousands of acres of land (Acheson, 2006). Large landowners such as timber/forest product companies and Real Estate Investment Trusts, regardless of the length of land tenure, continue to allow public access for hunting, fishing, snowmobiling, and ATVs (Daigle et al., 2012). Daigle et al. (2012) found that landowners who listed timber as their top priority may allow broader public access in comparison to landowners who's listed recreation management or nature preservation as their top priority. While private landowners did recognize the tradition of public access, they were aware that recreation did pose some cost to them on their land. Maine has a strong landowner liability law, but people are still concerned with being sued (Kuentzel et al., 2018).

Access to the black ash stands and sweetgrass habitat is vital for sustaining basket-making tradition and Wabanaki basket makers increasingly find their access restricted. With the conversion of agricultural land into residential land in Northern Maine, Native American harvesters are also reporting an increased difficulty of gaining access to black ash stands (Baumflek et al., 2010; Benedict & Frelich, 2008; Ginger et al., 2012). Private landowners are shifting away from the past open land tradition and an increase in posting against trespassing has caused a decline in black ash and sweetgrass access for Wabanaki harvesters (Ginger et al, 2012; Ellis, 2016). If a harvester is prohibited from accessing available black ash and sweetgrass, even with all of the knowledge they possess, basket makers cannot practice basket making. As access is reduced and there is a restriction to certain resources, it poses a challenge to the very basis of how Native identity is formed and maintained.

Conclusion

Wabanaki basket maker's ability to adapt to new markets, strong cultural connections, and depth of knowledge have been instrumental to continuation of basket making. New threats such as invasive EAB, reduced access, and climate change pose an increased risk to cultural resources availability. In recent years, Wabanaki harvesters have reported increasing difficulty in accessing basket quality black ash trees and traditional sweetgrass beds. Native American basket makers have also reported a significant reduction in the quality of black ash suitable for basket making. With the arrival of EAB in Maine and long-term climate change impacts, Wabanaki people are concern for the future of Wabanaki relationship with these cultural materials.

CHAPTER 2

Loskonowakon Neke, Toke, naka Nihkaniw: Weaving our Past, Present, and Future with Indigenous Research Methodology

Recognition of Indigenous Knowledge within conservation science is growing as scientists, institutions, and policy makers are promoting the inclusion of Indigenous knowledge (IK) in environmental research, conservation, and natural resource management (IPCC 2014). Scientists increasingly include IK within research to provide novel responses to climate change, deforestation, species extinction, and ecosystem degradation, etc. The lands Indigenous people steward encompass 22% of earth's biodiversity (Sobrevila, 2008). Over the last 500 years, coinciding with Western settlement on the Northern American continent, North America has experienced environmental degradation on a large-scale unseen within the geological record previous to Western settlers (Ellis et al., 2021). Native scholars express that Indigenous people and their knowledge are perhaps now more important for the planet's suitability and the future(Tsosie & Claw, 2019). While scientists are including IK within research, there is a call for scientists to recognize how their research can negatively impact Indigenous people (David-Chavez & Gavin, 2018a; Singleton et al., 2021). Overly homogenizing indigenous people and their knowledge as well as ignoring the unbalanced power relations are two critiques found in TEK inclusion research (Singleton et al., 2021). A single definition for IK, TEK, or ITEK is often required for conservation policy. Providing one definition is challenging due to the plurality of Indigenous knowledge systems which are diverse, dynamic and are an expression of different values embedded within Indigenous knowledge. Scientists tend to define TEK based on their assumptions and research goals (Whyte, 2013b). In this chapter, instead of offering a definition of IK, I will describe two components of indigenous knowledge (relational and processual) and describe how these two aspects are often removed when IK is employed within Western scientific integration research. I will describe Indigenous Research Methodology (IRM) and Two Eyed Seeing as an alternative approach to conducting research with Indigenous people and engage Wabanaki black ash basket making tradition as a metaphor in describing how to mobilize Wabanaki knowledge within biophysical research.

Indigenous Knowledge and Relational Networks

While all Indigenous peoples do not share identical ontologies, most have a land-based, holistic and relational worldview. Indigenous communities are guided by the natural world through relationships and responsibilities. They are intricately connected to the forest, rivers, lakes, bedrock, and all that inhabits their traditional territory. For Native people, landscape contributes to the formation of identity. Indigenous creation stories situate them coming from the land and their spoken history describes the origin of places and natural features. The result is a way of being that is founded on the recognition of a relational ontology or the interdependency of people and the natural and spiritual realms (Battiste, 2009)

Indigenous language, Indigenous knowledge and storytelling tell the perspective of indigenous world views and relationally networks. These expressions both stem from and inform how individuals live with one another, how they treat each other, and how the world around them fits together. Throughout all these expressions, cultural values are intertwined and create a foundation for how native people engage with the natural world. Reciprocal relationships with the human and non-human, the collective and the individual, including the self, form a set of responsibilities that is evident within Indigenous environmental knowledge and decision making (Whyte et al., 2018). Wabanaki languages are a verb-based language in which knowledge of processes, cycles, and interrelationships are embedded (Battiste, 2010). When indigenous people harvest cultural materials, individual responsibility and collective accountability are evident within the action, process, and formation of knowledge. Indigenous storytelling transfer and teaches knowledge, ethics, responsibilities, self-regulation and collective governance. These expressions extend from the same ontological foundation and form the web of being for native people.

Indigenous languages are a collective repository of held knowledge. Wabanaki place names can store information of the larger landscape community knowledge, local specific knowledge, and the human-environmental relationship. Understanding the information within a place name can show how knowledge is both generated from and informs a community. For example, Skutik is the Passamaquoddy word for St. Croix River and means the burning place (Neptune, 2015). Place names unlocks the knowledge of action and provides a lens in how native people viewed the landscape (Francis, 2008). Skutik, the burning place, refers to past Passamaquoddy landscape management through fire along a specific river. Intentional burning creates ecosystems and food sources that are important for nourishment and livelihood (Long et al., 2017). Through a name of a location, Passamaquoddy people knew the seasonal abundance of both fiber and food as well as how their influences of this area maintained these ecosystems. Skutik, as a place name, creates a communal mental map informing the cyclical and seasonal knowledge of food, fiber, sustenance, and mobility (Ingram, 2021; Sutton, 2020).

Within community knowledge, specific information is created and maintained through groups of individuals. For example, within intentional burning systems, informal or formal grouping of people held different responsibilities in a collective landscape management, ie medicinal harvesters, berry harvesters, paper birch harvesters, fisher people (Lynn et al., 2013). Clans are another example of specificity within community knowledge. Indigenous collective governance includes clans which are usually maintained through matriarchal lineage. Clans, such as the bear clan or the frog clan, are a reciprocal relationship with a non-human teacher (Whyte et al., 2018). Each clan hold specific teachings from the clan animal and in return, humans hold responsibilities to their non-human teacher. Within a collective knowledge, knowledge lineage creates diversity of knowledge and practices that ensures the community thrive (Whyte et al., 2018). Knowledge variation as an essential component of collective knowledge.

The collective nature of Wabanaki knowledge can be seen within the basket making community and the harvesting of both black ash and sweetgrass. Like in a place name, the basket making community creates and hold knowledge and there is a collective understanding of black ash and sweetgrass. All ash basket makers have a relationship with the ash tree, understand ash properties, and employ the same actions to process an ash tree into weaving material. This knowledge has been accumulated through generations of basket makers, harvesting ash in the same locations, and refining the knowledge within the same communities. As in the understanding of the place name Skutik, the community has a collective understanding of the ash tree and basket making.

Within the basket making community, knowledge lineages exist within the different styles of baskets. Fancy baskets makers and utility baskets makers uses the same material and processes but refines their actions to create material specific to their needs and style of baskets. These knowledge lineages are generated through the relationship between the teacher to the student. Specific weaves or designs are often passed down and maintained through each student. These lineages are maintained in harvesting cultural materials as well. Variations of length, width, and size of material is needed for the different types of baskets and dictate where to harvest. Sweetgrass and black ash harvesters will reference their teachers in their expression of knowledge. They will govern their actions based on the teachings they received and reference back to their teacher when they decide how, when, and who to teach. As a collective, everyone is acting within the same relational ontology that creates responsibilities and obligations, but variations exist in both the expression and practice of knowledge.

Indigenous knowledge is also an expression of a relationship between individuals: the person and the non-human relative. Wabanaki languages can express a specific relationship between humans and plants. Within the verb base language, one word can express action and response that are instructions embedded within the plant name. The rose plant is an example of how language expresses these cultural worldviews and relational values. In English, the word rose can conjure up images of a rose flower, valued for beauty, aroma, essence and often can represent emotions such as love and care. For people who know botanical knowledge, rose may refer to the knowledge of the rose plant family which are plants that hold similar parts such as the flower generally have 5 petals, 5 sepals, etc. The Rosaceae family include apples, raspberries, strawberries, plums, hawthorne, etc. The rose family has more than 2000 plants within this family. In Passamaquoddy, Kikcokalokiqeminsimus is the word for rose. This translates into a berry that can cause itchy bowels. The name does not refer to the flower but to the rose hips which is where the nutritional value is held and the most common harvested component of the plant. As a part of the action-oriented nature, Wabanaki words are constructed in parts that build the word and allows language holders to understand the knowledge within the word without knowing plant knowledge. When Roger Paul, a

Passamaquoddy language elder, interpreted the Passamaquoddy word, he didn't know the plant as a rose but could inform us, his students, the instructions held within the name. A medicinal knowledge holder told us that the name refers to instructions around processing the rose hip. If the hairs on the rose hip are not removed, when ingested the hairs will irritate a person's GI tract.

Indigenous knowledge is expression of relational teachings that are respective to the person who carries them. The expression of IK includes a person's physical, metaphysical, and spiritual experiences which informs individual action. When an individual articulates environmental knowledge, they will often express knowledge that includes their personal experiences, dreams, relationships, spirituality, feelings, and intuition (Kovach, 2010). When harvesting, sweetgrass and black ash harvesters will speak about the knowledge they received in their dreams. This knowledge can come in the form of instructions, solutions, and the land speaking to them. Dream knowledge is interlinked with environmental knowledge in ways that they come from the same place and are not separated into different compartments of knowledge with varying levels of validity. There is an individual relationship between the harvester and the cultural materials where the harvest is a student of the non-human relative. Sweetgrass harvesters will say the grass itself will tell a person if it wants to be picked and that sweetgrass requires the harvester to be in right relationship with the land. If one is in the right relationship, the grass gives itself to one's hand. If the grass doesn't let go of the soil easily, the grass is telling the harvester it does not want to be picked. Black ash harvesters express the black ash tree as a teacher. The black ash tree will tell a person how best to process the material and the tree will dictate what style of basket can be created from its materials.

Reciprocity and Protocols

Indigenous storytelling is a form of knowledge exchange, teachings of ethical behaviors, and future scenario planning. In the study by Daigle and others (2019) Passamaquoddy language and storytelling was used to explain relational aspect of social ecological relationships and the collective nature of decision making. In their study, Wabanaki storytelling was employed as a method to understand climate adaptation. Within a Wabanaki creation story, Gluscap shoots an arrow into the ash tree, from the tree comes Wabanaki people, animals, other beings. This creation story speaks to human relationships to all other beings which native people call relatives. Within human kinship to the trees, the animals, and other beings, native people have a collective responsibility to act with respect towards their relatives and recognizes other beings as holding agency. IK emerges from these relational networks of beings and the responsibility that is inherent with respect and forms obligations to all of our relatives. It's within these relationships and values emerges knowledge of the environment and sustainable practices.

The responsibilities and obligations between humans and non-humans form a set of protocols that govern practice and expression of knowledge. Indigenous knowledge contains obligations such as the ethic of reciprocity. Within this value is a sense of commitment and accountability which informs the human and environmental relationships in ways of behaving or cultural protocols. The 7th generation principle is an approach where when one harvests, they ensure that the cultural material will continue to thrive for seven generations. This approach values long term collective and individual benefits for all, both human and non-human. Within the relationship between the harvester and sweetgrass, harvesters express the grass needs us and we need them back. Through these obligations, Wabanaki harvesters ensure that they can harvest in the same locations, in the same stands, in the same sweetgrass locations for generations.

Harvesting protocols are not a prescribed set of rules or limits, such harvesting limits or explicit told behaviors. Cultural protocols are often expressed not as hard rules but as a form of knowing, intuition, nonverbal cues, family teachings, traditional stories, and community accountability. Cultural teachings start at an early age. Children often are with their family members while harvesting and are present when sweetgrass is being braided or baskets are being made. Ceremony that honors relational values occurs throughout all components of life. Indigenous storytelling is continual throughout all ages. Responsibilities and obligations become embedded to create the lens with how Indigenous people view the natural world where at times there are no English words to articulate decision making. Many of these values become a felt sense and informs ways of behaving that includes local awareness, self-management, and collective governance.

Processual Knowledge- A Knowledge in Practice

Indigenous knowledge is a practice that is held within Indigenous ways of being where non-human, community, and self all play a part in the formation of knowledge and setting obligations that govern the expression of this knowledge. Just like Wabanaki language is a verb-based language, IK is action-oriented or a processual knowledge (Whyte et al., 2018). It's within the process of knowledge, that cultural values and relational networks are expressed and held as a cultural context. When IK is extracted and treated as a form of data, relationality and cultural protocols are not attached (Harding et al., 2012). It's through Wabanaki harvesting practice, the knowledge is activated and maintains its full expression of indigenous values and relationality.

Many Indigenous communities have a profound connection to their traditional territory and to the interdependent ecosystem of plants and animals within which they live. Indigenous communities emerge from their long history of engagement with the land. The result is a worldview that is context specific to their environment. Their knowledge is held within the active relationship to their local environment and each community has its own ways of learning, experimenting, teaching, consensus seeking to generate knowledge. IK is a cumulative process, contains multiple knowledge sources, and requires experience and participation of indigenous people.

IK is typically embedded in the cumulative experiences and teachings of indigenous peoples. Learning takes place as part of daily life. It takes place within families, within communities as part of the daily activities. Lessons are not always documented and written down but are remembered and told through the mechanism of storytelling. IK is generated from the full range of human experience and learning processes, which is critical to the survival, and sustainability of any indigenous people (Battiste, 2010). Given the range of people generating knowledge, variation of knowledge is commonly accepted and understood within Indigenous community. Because of its practical and collective nature, the diverse elements of

IK are transmitted through all aspects of living. IK is systemic and holistic, encompassing spiritual life, observable patterns, and a multiple of senses; it is tangible and intangible (Battiste 2010). IK is generated through indigenous stewardship practices but environmental stewardships practices are not the only place environmental knowledge is generated and understood. Ceremonies and spiritual acts provide direct and powerful ways of understanding IK (Battiste 2009). They are the critical links between sacred knowledge, ethics, and values required for indigenous ways of being. Lifelong learning has been an essential component of IK within indigenous communities. IK emphasis in learning is on wholeness and relationships throughout a person's life. Lifelong learning teaches native people responsibilities to the ecosystem and obligations to families, clans, communities, nations, and confederacies. Through this continuous practice, indigenous people can observe how their presences affects the world around them. Native people are continually learning, practicing their knowledge, and adjusting to new environmental cues. This allows for a knowledge base to be adaptive to environmental changes. Wabanaki harvesters of both sweetgrass and ash have been harvesting for all their lives, going to the same locations every year or every couple of years. Wabanaki people can observe and interpret phenomena on the temporal scale of their lifetime and generations before. Through the cutting and processing an ash tree, Wabanaki harvesters can observe seasonal weather and climatic changes. Sweetgrass harvesters understand how small shifts in seasonal weather patterns affects the sweetgrass growth. Wabanaki harvesters know the human-environmental relationship on both a small and large scale built through a continuous lifelong practice to create sustainable livelihood that benefits both human and non-humans.

Historical knowledge with active stewardship practices shapes the expression of indigenous knowledge. Cultivating knowledge generation is just as important as the outcome of knowledge. A long historical continuity of stewardship allows for the evolution of knowledge in supporting Indigenous life ways. As with any culture, knowledge evolves, is adaptive, and influenced by historical, political, and environmental contexts (Hart-Fredeluces et al., 2022). For many Indigenous people, colonial forces created a severing of large landscape stewardship practices. Some Nations were forcibly removed from their traditional territory and/or their land base drastically reduced. Where Indigenous knowledge extends from Indigenous philosophies, many of these nations have built new relationships and/or are waiting for the time to reenergize a cultural practice into a living tradition. Resistance, adaptation, resiliency, and transformation are reflected in the histories of Indigenous people (Hart-Fredeluces et al., 2022; Clark et al., 2022).

Western Science and Indigenous Knowledge

With a changing environment and potential climate change crisis, alternative knowledge could help in the creation of sustainable options. Interest in IK has been growing among scientists, public municipalities, and government agencies as new source of information that can complement western environmental knowledge systems (Kimmerer, 2002) The knowledge indigenous people hold can offer insight and tools that can be applied to environmental conservation and restoration. Native people's historical continuity in resource usage has allowed them to devise ecosystem management tools that promote sustainability (Sobrevila, 2008). IK has been recognized for its value in promoting biodiversity (Kimmerer & Lake, 2001),food security (Jackley et al., 2016), and restoration of ecosystems management and conservation of species (Diemont et al., 2005; Reeder-Myers et al., 2022). Academic researchers and federal agencies have begun to recognize that such region-specific historical knowledge can contribute to climate change knowledge adaptation planning (Chisholm Hatfield et al., 2018). IK can offer integrated, multi-causal records of co-evolving human-environmental systems (Reeder-Myers et al., 2022). Indigenous knowledge systems are essential to understand our future environmental risks and responses. Yet, there is an inherent dilemma in scientists investigating Indigenous knowledge to formulate new solutions. Scientists often integrate Indigenous knowledge within a western scientific framework, the very knowledge tradition they are trying to diversify (Agrawal, 1995; Cisternas et al., 2019; Nadasdy, 1999).

Integration Studies

Academic investigators familiar with the benefits of IK have attempted to integrate indigenous knowledge systems with Western scientific studies and models (Betula et al., 2014; Bussey et al., 2016; Fernandez-Gimenez et al., 2006). IK is often seen as a complement to

Western science and Indigenous knowledge practitioners are perceived as important sources of data, where they can provide a more nuanced understanding of species distribution, population dynamics, behavioral changes and interactions of populations, and provide baseline data for measuring ecological changes. Integrating IK within a western science approach has ranged from IK being supplemental data which tends to be extractive to full collaborative research process where Native people are co-PI's (Cisternas et al., 2019; Mazzocchi, 2018). While more studies are practicing collaborative approaches, David-Chavez & Gavin, (2018) found that on a global scale 87% of climate studies practice extractive model of knowledge integration with Indigenous people. In these studies, Indigenous people have minimal participation or decision-making authority. Regardless of literature that calls for studies to center indigenous people to be knowledge producers instead of research subjects, biophysical scientists are still challenged in shifting this research paradigm.

A handful of biophysical studies approaches have integrated IK with western science to create scientific tools for Native Americans natural resource issues (Betula et al., 2014; Bussey et al., 2016). Hummel & Lake (2015) is one of these studies where the approach was to blend western science and TEK to help with management of cultural significant beargrass (*Xerophyllum lenax*). The scientists conducted a mix method (qualitative and qualitative) approach to identify ideal bear grass site conditions optimal for bear grass harvest. Hummel and Lake devised a hypothesis from published literature and written information on beargrass, site selection and site assessment were informed by IK, and a standardized system to measure the ecological variables associated with site quality was conducted. In this study, the IK integration included Indigenous people serving as a knowledge source to help scientist determine bear grass sites and potential important ecological variables to measure as well as Indigenous people evaluated site quality based on a classification system of poor, mediocre, and good. Hummel & Lake presented, with the native research participants, their preliminary results in a Northwest Native American Basketweavers Association meeting. Reporting preliminary results served to checked with the indigenous participants to ensure important ecological variables were not missed. While the study did not find any statistically significant predictive results, descriptive results between poor and good beargrass harvest sites were inferred.

While Hummel & Lake's findings are significant and contribute to the overall scientific knowledge of culturally important bear grass habitat, the indigenous participants had little to no decision-making authority within the research. In this approach, native people were asked for opinions and consulted with, but their knowledge was treated as a form of data to extract and integrate within western science. Indigenous knowledge strengths lie in understanding the whole system and contain knowledge about the iterative relationship between human-environmental systems (Berkes, 2017). The depth and breadth of indigenous knowledge is lost when Indigenous participants contribute their knowledge to a research approach conceived of by a western scientist. Hummel and Lake (2015) did acknowledge that they may have missed important ecological variables to measure but it was highly unlikely considering they "member checked" the variables with indigenous participants.

Integration of IK within western science has potentially many negative outcomes, including co-opting of traditional knowledge by non-Natives people, misuses or misrepresentation of such knowledge, or diminution of IK data to fit the parameters and interests of academic investigators and funding agencies, and limiting native people's ability to express their full knowledge (Agrawal, 1995; Cisternas et al., 2019; Nadasdy, 1999). Integration studies may reinforce Western cultural biases that in the end work against full community involvement in managing local land and wildlife (Nadasdy, 1999). Studies like Hummel and Lake (2015) are an example where in the intention to address a Native American resource issue, western science methodologies take precedent in defining the research problem, determining the methods to measure the problem, and then analyzing outcomes to fit within a numerical understanding of resource management and policy requirements.

Creating applied natural resource outcome for Indigenous needs can be challenging for many scientists trained in the positivist, deductive scientific approach. Integration studies often position the Western sciences as the dominant framework for investigating IK. This framing places a biophysical or qualitative scientist as the lead, the principal investor (PI). The PI sets the methodology or approach for knowledge generation and uses their trained knowledge to carry forward research. Most biophysical scientists are trained in a positivist research tradition, which aims to develop universal truths that can be used to predict phenomena and generalize outcomes across the species range. Developing universal truths does not allow for the relational aspect of Indigenous knowledge to be expressed or the variation with IK to be supported.

Researchers educated with both social sciences and basic sciences, may choose a methodology that employ both qualitative and quantitative methods to support the qualitative component of IK. This research approach was employed by Hummel and Lake (2015). They developed the research questions from previous published research and from the IK interviews. Yet qualitative research is still a western tradition and cannot support Indigenous perspectives throughout the integration research (Simonds & Christopher, 2013). Within Hummel and Lake (2015) study, IK was used as a form of data to feed into western approach of methods, statistical analysis, and reporting. Qualitative research is still a part of the western research tradition where knowledge gained from interviews is homogenized into one expression. This can be disrespectful because it severs the relationality between student and storyteller (teacher) (Simonds & Christopher, 2013). Any abstraction into a western frame removes the relationship embedded with the IK. Many indigenous scientists are critical that any western science tradition can fully apply appropriate methodologies towards indigenous philosophies and practices (Kovah, 2010; Smith, 2021)

Western integration research places power with the scientist. Scientists have the authority to define IK, determine which factors of IK are most important and validate IK relevancy in the scientific world (Nadasdy, 1999). Biophysical science typically follows the scientific method, where an observation is made, a literature review is conducted to gather more information, methods and analyses are designed, and findings are disseminated through a publication or report. Even if the research question is determined by Indigenous people, the scientist sets up the research design, objectives, and methods. Western scientists are typically trained in a relatively narrow niche of scientific inquiry and use a very narrow lens to relate to IK. They tend to only value the ecological attributes associated with IK. In Hummel and Lake (2015), the variables measured to predict bear grass habitat were beargrass leaf color, dead wood by size class, trees per acre, basal area of trees within plot, percent canopy cover, etc. These attributes were selected to accommodate time and budget limitations and to standardize methods across the range of conditions. Indigenous harvesters were asked to evaluate sites as good, mediocre, and poor, based on initial visit and a further evaluation of grass. Often when the IK is viewed through a western lens, the research question, and methods to understand the phenomenon are reductive and simplistic. In my past experiences, when I ask harvesters to evaluate a harvest site as good or poor, the harvester will respond with “that depends”. Due to the relationality networks and nature of IK, Wabanaki harvesters find these types of binary questions impossible to answer. For Wabanaki harvesters, to harvest a tree is not just based on a resource availability and perceived quality. Harvester’s decision-making includes the individual and collective relationships, and cultural protocols, but in a quantitative reductive question there are no opportunity to describes the relational variables or variations that are inherent with IK.

Western methods of knowledge collection are characterized by the individualized ownership of knowledge and efforts to quantify it for purposes of generalization (Simonds & Christopher, 2013). In this approach IK becomes transformed into empirical data, which can be easily translated within a western natural resource management and policy. The data becomes homogenized and turned into one expression. The collective relational aspect and variation of IK is ignored, and the results are usually unrecognizable and unusable by Indigenous people. The absence of cultural contexts may result in a scientist developing a superficial understanding of IK, especially if the outsider research is not equipped with the right cultural background. Documenting this knowledge, storing it, and relying on it as a data source for resource management or conservation may be problematic because it can become stagnant and irrelevant over time. When knowledge is removed from the cultural context, the adaptive and processual nature of knowledge is gone.

Beyond the empirical data of IK that is compatible with Western science, the broader aspects of IK represent deeper understanding biocultural relationships on multiple levels of the physical, social, and spiritual environment. Within integration studies, concepts of indigenous knowledge, Indigenous ethics and values, culture, and identity as they relate to land and stewardship are ignored and removed. Often there is little interest in the spiritual or sacred dimension of IK, which is seen as unscientific or even superstition. Western scientific methods often ignored Indigenous participants spiritual relationships and traditional experiences as source of research knowledge (Kovach, 2009). IK and spirituality are interwoven and if the spiritual and sacred elements are surrendered, then there is little left of Indigenous philosophies that will make any sense (Harding et al., 2012). The knowledge component that fits into the dominant perspective is strained and stretched so much that it becomes unrecognizable as IK.

Academic research can hold power over indigenous people's practice, including explaining, predicting, and arguing IK's value and validity. Many quantitative positivist studies employ statistics to produce objective knowledge. Positivism tradition assumes that authentic knowledge allows verification (Chilisa, 2019). Even though the two knowledge systems have different epistemological foundations, there is a general expectation that if IK is being translated into western science, then statistical analysis is essential to ensure accurate and sound results (Betula et al., 2014). Within integration studies, the reported results tend to be only what was found statistically significant regardless of Indigenous input. Hummel and Lake (2013) reported extensively on the statistical analysis in the results and some information on the Indigenous knowledge used to determine site conditions was reported in the methods section of the publication. When integrations studies only report statistical results, value is given to only the components of Indigenous knowledge that can be validated through western science traditions. Within these studies the objective statistical results are implied to be more valid and Indigenous knowledge are regarded as anecdotical.

The reductionist approach of Western science can disrespect the holistic nature of indigenous knowledge. Understanding IK through a statistical lens often continues to perpetuate the narrative of singularity instead of one of pluralism. Once indigenous knowledge is moved through statistical analysis, the nuances of IK become invisible (Lynch, 2017). In this approach IK is represented as empirical data, which can be easily translated within a western natural resource management and policy. Relying on quantitative measurement and statistical analysis is a continuation of western power dynamics. These outputs maintain natural resource management within a western scientific framework. While the need for indigenous natural resource department to manage cultural resources is important, numerical outputs of indigenous knowledge maintain the power dynamic of western science management over indigenous stewardship.

Academic publication and reporting require the scientific voice even in integration studies. Indigenous voices often get lost within this form of Western academic writing (Gratani et al., 2011). The system of authorship gives scientists authority to codify IK. Disparities exist in how different knowledges are seen, approached, researched, and reported on. Within scientific publications, Indigenous communities are often framed as deficient in their capacity to hold their knowledge without recognizing the socio-political framework that maintains this position (Walter & Andersen, 2013). Indigenous knowledge is usually position as in danger of being lost. This justifies western extraction and cataloging of IK. Through this positioning, the historical and current unequal power relations are ignored and the colonial structures that sever indigenous people relationship to the land are obfuscated. This form of reporting reinforces extractive approaches and contributes to western ownership of Indigenous cultural and intellectual property.

Control and ownership over indigenous knowledge and data has a long history within the western forms of research. The researcher has the authority to report all forms of IK observed and measured, even knowledge that is sacred, private, and not for public sharing. Historically an anthropologist, trained in the Western tradition, would enter into Native communities and observe cultural practices, indigenous knowledge and sacred ceremonies. He would interpret his observations for meaning and values and publish the work under his name which would usually serve to further an anthropologist's career (Ranco, 2006). This practice can be seen today when we identify indigenous anthropological collections in museums (Anderson, 2018). These collections are identified with the anthropologist's last name such as the Speck collection, which is a well-known Wabanaki cultural material collection, instead of the indigenous people who made the material. These collections are often owned by the anthropologist's descendants who sell/donate them to museum or sell them on the market never to be seen again. While anthropology may not fall under natural resource category, for

Indigenous people their cultural material is a source of ecological knowledge. Scientific studies have significant impacts and have been used for political tools to disenfranchise indigenous people (Schrack, 2018). Ranco (2006) describes how non-native Anthropologists often serve as Indigenous experts over any indigenous community member.

Integration studies reports rarely include how research outcomes will benefit Indigenous harvesters, the people where the knowledge is held and generated (David-Chavez & Gavin, 2018). Science is often framed as a solution for all and will contribute to the good of everyone. Yet, Smith (2013) states that indigenous people are the most researched people in the world yet their lives have not improved. Biophysical research is often positioned as an attempt to help better manage a resource for native people, people who have been successfully stewarding landscapes for generations. This narrative never gives full respect to native people's ability to manage their own resources. A better approach is how can science and scientists support native people and their practice. Research should report on Indigenous strengths, resiliencies, and experiences, and address issues that hinder Indigenous stewardship practices.

Western based research often removes indigenous agency within their knowledge and the cultural variance embedded with adaptive decision-making frameworks are obscured. Agrawal (1995) underscores the need to remain intent on who the knowledge is useful for. Instead of conducting integration research where western science sets the standards of how Indigenous knowledge will be understood, scientist should shift research focus towards understanding and supporting indigenous decision-making frameworks and enhancing indigenous sovereignty that are bound to stewardship practices. At this point, we need examples of collaborative models that will help us understand the conditions under which Indigenous people are able to succeed within their stewardship practices. Scientist, activist, and agencies should work cooperatively with indigenous people, recognizing and respecting the agency of the indigenous actors involved in producing the knowledge.

Indigenous Research Methodology

Indigenous scholars are critical of western science ability to understand indigenous knowledge yet understand the importance of working from within the academy to empower indigenous people. The lack of biophysical studies that mobilizes IK is troubling, considering research typically forms the basis of resource management and policy. Indigenous scientists want to shift the academy to better reflect indigenous perspective. While conducting research within Indigenous communities, Brayboy (2000) recommends that researchers should be aware of how their western research methods of collecting, analyzing, and reporting "facts" affect the indigenous participants and not employ methods that are culturally insensitive and negatively affect the lives of the people they study. Western methods analyzing indigenous knowledge may not be enough. Without a methodology that works to reflect indigenous peoples understanding, research may still act as a colonial project (Hart, 2010). Indigenous researchers express the need for a modern Indigenous peoples' research project that resists the oppression and an approach to research that stem from Indigenous peoples' roots and principles (Smith, 2021).

Many Indigenous researchers call for a research methodology that reflects their community's ways of knowing (Ranco, 2006). Wanting to move away from merely including Indigenous perspective in research, Indigenous scholars are using Indigenous paradigms as a foundation for research. Kovach (2010) refers to indigenous methodology as a paradigmatic approach. This is a set of beliefs about the world that guide people's actions in how they will conduct their research. IRM is for indigenous people, conducted within an indigenous community. IRM requires research to be located with an indigenous paradigm. Fundamental to Indigenous research methodologies is the recognition that Indigenous knowledge systems and worldviews are legitimate ways of knowing and, along with Indigenous perspectives and Indigenous research paradigms, must inform the research process (Chilisa, 2011).

Employing IRM means Indigenous knowledge and Indigenous people will guide how research is done, how knowledge is gained, what methods that are chosen and, explain why those certain methods or tools were employed. Indigenous knowledge systems are dynamic, context specific, experiential, encompassing collectivity, reciprocity and respect (Battiste, 2010). Just as these are components of Indigenous knowledge systems, they need to become components within Indigenous research methodologies. Indigenous knowledge is specific to place and distinct from other indigenous epistemologies in terms of location and relationship to specific place. While variations exist within knowledge systems, similarities exist across indigenous knowledges. Kovach (2015) focused on four themes to hold a central focus: Indigenous knowledge foundation, relationality, collective, and the methods.

IRM aims at strengthening the dynamics of indigenous knowledge foundations. Indigenous perspective is the starting point and guides the methodology. Such initiatives start with understanding and appreciating the culturally embedded worldviews, ways of learning and theoretical frameworks of peoples. Indigenous culture is always a part of research and thus research cannot be culturally neutral.

Relationality means to acknowledge and support the relational network IK is built on. The relationships between me, as a Maliseet scientist, the research experts (harvesters) many of which are my friends and family members, and the relationship we have with the landscape are all sources of knowledge and information within the research. Indigenous people should be a part of the research process from the beginning. In IRM, indigenous people are active agents within the research process and collectively make decisions on approach, process, methods, analysis, and outcomes. Indigenous perspective, values, knowledge, and cosmology would have been heard and valued throughout the study. Preliminary findings have included scientific findings and Indigenous knowledge and languages.

Collaboration is a relational aspect of indigenous knowledge. Learning through the transmission of indigenous knowledge between or among generations over a lifetime is a shared collaborative learning process. Collaborative working groups and partnerships within research creates opportunities where everyone can be informed on the process, discuss issues and problem solve, and determine new paths to take. Developing ethical and meaningful research partnerships with Wabanaki communities requires researchers to understand and commit to an ongoing process of authentic and deliberate relationship-building, cross-cultural learning, open communication, trust, and reciprocity. Collaboration helped to create outcomes that are community drive, instead of externally driven agendas.

The collective entails the ethic of reciprocity and responsibility. Within this value is a sense of commitment and accountability. IK is framework that seeks to engage Indigenous communities with the land in a purposeful approach. It is important that researchers are accountable to Indigenous participants and the wider community in all aspects of the researcher from developing the research question, to the outcomes and results of the research (Chilisa, 2011). Reciprocity doesn't end when the research is done but should extend into future research impacts and outcomes to indigenous communities (Peltier, 2018). Fast & Kovach (2019) finds the ethic of reciprocity informs researchers that they should share themselves as well within the research process. Instead of seeing themselves as neutral observers, researchers are active participants where their perceptions, assumptions, and values should be shared with the group. The act of sharing themselves follows indigenous protocols and respect. The collective also is a sense of commitment and responsibility to the indigenous partners within the study. In turn, knowledge gained through research should be done with an applied purpose where scientists are accountable to the research group.

IRM ethics inform which methods to use. The range of methods are extensive, and some include storytelling (Daigle et al., 2019), dream journaling (Kovach, 2015), ceremony (Hart, 2010), or conversational (Kovach 2010). Community based action research and Participatory Action Research (PAR) coupled with IRM are common approaches (Botha, 2011; Peltier, 2018). Methods used within IRM are co-developed by the researcher and Indigenous partners with the intent to finding a set of complementary methods to express themselves, their worldviews, and accomplish their research goals (Ryder et al., 2019).

Two-Eyed Seeing

Two-Eyed seeing offers a template that provides both guidance on how to bridge Indigenous forms of science and knowing with western science and knowing. It ensures legitimacy to all forms of knowing asserting that divergent epistemologies are equally valuable and capable of generating further knowledge and insights (Bartlett et al., 2012). In the two-eyed seeing process, the researcher is to weave back and forth between indigenous and western scientific worldviews, as it may be that the approach that one worldview provides is more suitable to a specific intended outcome. This is a good template in thinking of how to weave both biophysical research approach with IK. Centering IK within research does not mean that only traditional knowledge is valued but means that Indigenous people are able to choose the methods that best fit their needs. Methods used within IRM are co-developed by the researcher and Indigenous partners with the intent to finding a set of complementary methods to express Indigenous people, their worldviews, and accomplish their research goals (Ryder et al., 2019).

Ryder et al. (2019) uses a coiled basket methodology to weave both Indigenous knowledge and western knowledge to engage in indigenous health research. Ryder (2019) describes how in weaving the two knowledge systems like a coiled basket, they never sit on top of one another trying to out compete with each other. Biophysical research often requires quantitative results because of the applied aspect is going to contribute to natural resource management. In understanding how to employ quantitative measurements and statistical analysis, the goal is to support indigenous knowledge and people. The IRM model intent is to make the two knowledges weave together that ensures knowledge integrity for both knowledge systems. Sockbeson (2011) a Penobscot scholar, employs a Wabanaki intellectual tradition of black ash basket weaving and creation story of Gluskabe to serve as the methodology and foundation to understanding Waponahki policymaking and research. Sockbeson connects policy development and basket making as both rely on experience, connection to people, and knowledge of who Waponahki people are. Both Sockbeson and Ryder and others found culturally relevant frameworks to set the foundation of their research and these approaches will serve as a reference and inspiration in the creation of a Wabanaki paradigm approach to address Wabanaki natural resource issues.

Lessons within Black Ash Basket Making

Biophysical scientists are often inexperienced in employing IRM while working with indigenous communities (Lynch, 2017). Shifting the power dynamics in research can be daunting for many scientists. There is not one approach to decolonizing the research relationship with Indigenous communities (Windchief & San Pedro, 2019). Each Indigenous community has unique ways of understanding the world and require culturally specific approaches to create cultural appropriate research. For Wabanaki people, the process of ash basket making is an apt framework in understanding how to mobilize Wabanaki knowledge within research. Lessons held within the knowledge of basket making can contribute to understanding how to shift research process and relationship. As a template to engage with

Wabanaki people, this metaphor positions biophysical scientist as constructive participants, working alongside Wabanaki people to create outcomes that reflect Wabanaki knowledge.

Creating a basket from a black ash tree is an extensive process with many steps to achieve a functional basket. The whole process can be separated into three phases: 1. Preparation – knowing how to identify the tree, 2. Process - pounding the black ash log and processing the material, and 3. Weaving - weaving the basket, finishing the basket with a binding, hoop, and handle. While people see the finished product of a basket and observe the work involved in the weaving process, most people don't realize how much efforts goes into the first two steps and how critical the knowledge within these phases are to the full expression. The three stages of basket making will frame and inform three stages of research to produce respectful, valid, and beneficial outcomes. Wabanaki black ash basket making will serve as a metaphor to guide a process where all research partners will collaboratively decide how IK and western forms of science are woven to create structurally sound and strong results.

Preparation

"*Not all ash trees are basket trees*" (Frey Tomah)

Growing in small, scattered stands though out Maine, black ash comprises 1%-2% of the total Maine forest. Wabanaki black ash harvesters report that within the small population of black ash found in Maine, only about 5%-20% of the black ash has characteristics suitable for basket making. Wabanaki black ash harvesters will say that not every ash tree is a basket tree. Both the environment around the tree and the tree itself will determine if the tree is a basket tree. This is the same for scientists working with indigenous people. Not all scientists are qualified to work with Indigenous people. Understanding Indigenous Knowledges epistemologies and critical reflexivity are essential for a scientist to effectively work with Native people.

The process starts with the individual. Just like a basket tree is influenced by its environment, a scientist is informed by their education, environment, and experiences. A Western scientist trained in the basic scientific western tradition tends to perpetuate the western lens and their education training will inform research choices. Creating research that centers IK and outcomes for Indigenous needs can be challenging for many biophysical scientists with no IK training or education. To understand how to dismantle the power dynamics within science, the researcher should be able to evaluate and understand their own positioning. Research is never morally or ethically neutral, and researchers need to account for the impact their own understandings, values and beliefs have on how they organize, set up, and carry out research (Chilisa, 2011; Kovach, 2010).

Researchers that are shaped by a Western paradigm need to be aware of their own values, assumptions, and beliefs. Sciences, including biophysical and conservation sciences, have a history of causing harm to native people. Previous scientific extractive research has led to continued indigenous marginalization and exploitation, which has increased depletion of their social and natural resources (Smith, 2008). Centering IK in collaboration and co-production requires scientist to be honest and critical of themselves about how power dynamics are situated. This may require a scientist to evaluate their past work and reflect upon previous extractive approach that they unintentionally perpetuated. The reflective nature of IRM disrupts the traditional conceptions of the researcher as an individual who is neutral, isolated, and decontextualized from their research (Kovach, 2010).

The researcher should know how to be accountable to the indigenous people they work with. This often requires the researcher to take on a position of a student. Shedding the authoritative position and occupying a beginner's mind allows a relationship to build based on openness and respect. Wabanaki people are familiar with both IK and western science and they continually navigate and blend both ways of knowing. For many non-indigenous scientists, they may be the only person to completely learn a new culture and worldview. Scientists should embrace the learner position which will help in seeing a new perspective.

While self-reflection is a critical component, the researcher simultaneously needs to be open, adaptable, respectful, and understand how to shift research practices to decolonize the research relationship. The understanding of how to do research differently is important to know before collaborative meetings with Indigenous partners occur. This is a two-pronged approach. The researcher should be familiar with both Indigenous and western forms of science as well as be knowledgeable about how western research approaches can create harm to native people. Scientist trained in only the western paradigm with no IK education can only use their lens when collaborating with Indigenous people. Just knowing how to employ qualitative methods is not enough. Knowledge of decolonizing research allows academic partners to explicitly acknowledge traditional authoritative roles, the historical harm within the western tradition, and state their commitment with action to do research differently at the beginning of a project. This reflects the need to review other Indigenous-based research projects, particularly projects that center or are led by Indigenous peoples. The burden should not be on native people to educate the researcher on how to conduct a respectful research project. How a researcher initially engages with Indigenous people sets the tone for trust and relationship building. The researcher should be aware of how to do engage with people differently, have knowledge of decolonizing practices and application of a variety of methods and analysis is important.

Process

"*Sometimes you really have to fight with the brown ash to make it work. I can't use it for certain things because it won't bend no matter how much I dampen it. It won't bend and it doesn't look right*." (Penobscot fancy basket maker).

After a black ash tree is selected, cut, and brought home, a basket maker will process the tree to understand the characteristics. The time spent processing the material is building a relationship with the tree. In that relationship, the tree will inform the basket maker what they can do with the it's material.

A central tenet of IRM is to remain accountable to communities by involving them in all aspects of research. Collaboration is essential to ensure Indigenous people have authority within the research process. Working together sets the stage to develop meaningful relationships and contribute to mutually beneficial research partnerships (Cisternas et al., 2019). Research relationships depend upon trust and flow of knowledge. Through working together on equal footing, research relationships can flourish.

Wabanaki knowledge is specific to place. The Indigenous paradigm needs to be appropriate for Wabanaki people and specific cultural protocol should be understood. This requires a much deeper commitment to specific Wabanaki ways of knowing throughout the research project. Despite a researcher's best intentions and training, non-indigenous researchers may be limited in their access and understanding of indigenous knowledge and protocol. Relationships built on trust provides the researcher an understanding how to divest research authority and power to native people. Power sharing may include redesigning all stages of research to support dialogue and inclusivity, attending to multiple temporalities, and supporting Wabanaki and Indigenous students as researchers and leaders (McGreavy et al., 2021).

Collaboration requires a lot of time to build relationships based on trust. Through respectful relationships, the researcher will come to understand the biocultural context is not the only specific understanding that is necessary to engage with an Indigenous community. There are historical, political, and environmental contexts that have disrupted their relationships to land and are critical barriers within Wabanaki natural resource issues. Researchers need to move beyond initial conversations and dialogue about worldviews, assumptions, and values, towards deeper understanding of the research issue. From this understanding, collaborative conversation about the research process and goals can occur. In this process, Indigenous people express their own objectives of collaboration. Indigenous people are valued as experts and decide why, what and when knowledge is being sought and the methods being used to seek it. Instead of the researcher maintaining objectivity, Datta (2018) describes how he, the researcher, and participants evolve into we. This melding of research group serves to ensure indigenous protocol is adhered (Fast & Kovach 2019)

The Black Ash Task force is an example of partnerships between non-native scientists, Wabanaki scientists, Wabanaki basket makers, foresters, federal and state agencies, and a non-government tribal organization that work to address Wabanaki driven priorities (Ranco et al., 2012). Responding to the impending arrival of Emerald Ash Borer, an invasive beetle that kills ash trees, this collaborative working group helped to drive proactive invasive species responses such as early education and outreach efforts, State and Federal regulatory responses, and aiding in tribal invasive species response planning (D'Amato et al., 2023b). Team members from the Black Ash Task force hosted a black ash symposium (Costanza et al., 2017). The symposium was created to discuss Wabanaki knowledge and research advancements related to black ash. Instead of following typical academic symposium setting, participants were invited to attend a field trip to look at black ash together where ideas and knowledge were shared in the field. The publication findings incorporate both Indigenous knowledge and biophysical science pertaining to black ash that was shared at the symposium (Costanza et al., 2017).

Consultation with Indigenous tribal government is required when seeking to conduct research on tribal lands. Tribal governments are the only ones with authority to "speak for" the tribe as an entity. It is important for researchers to recognize that each tribe and tribal community is unique. Tribal sovereignty provides tribal nations with separate legal and political authority, including the authority to regulate research on their lands. Penobscot Nation created a range of strategies to address the colonial theft and extraction of the western science tradition. A few strategies are the creation of a tribal Institutional Review Board that reviews scientific research involving Penobscot people and research conducted on tribal lands. Penobscot Nation negotiated two Memorandums of Understanding (MOUs) regarding Penobscot involvement in co-curation and access decisions for Penobscot materials that are currently held at the University of Maine and the American Philosophical Society (Anderson, 2018).

Organizational constraints create challenges when centering Indigenous people and their agenda. Collaboration with Indigenous people requires more time and money than typical research grants provide. Indigenous people usually share food and offer gifts when exchanging knowledge. Tribal needs may not accommodate research timelines (Harding et al., 2012). Multiple perspectives, collaborative meetings, and the iterative nature of IRM research can require a lot of planning, time, and money. This will likely be a slower process and more expensive than other scientific studies. While the study is the scientist's main job, indigenous collaborators probably work during the week and may only be able to participate on the weekends (Cisternas et al., 2019). Compensating participants as experts is important when conducting IRM. The scope of the project may be challenging for one researcher. Tribal communities may insist on changing or broadening the study scope. This may not align with the original grant purpose (Harding et al., 2012).

Within the collective aspect of IRM, accountability and reciprocity are key factors (Kovach, 2010). Through IRM, research can serve to be accountable to tribes and support tribal sovereignty. Working within ethical space of IRM, researchers co create research process that facilitates amicable partnerships and research dissemination strategies where indigenous principles are upheld (Singh & Major, 2017). Reflexive and collaborative approaches along with the time to do so are essential for co-production of knowledge.

Weaving

"The weaving should be the easiest part" (Passamaquoddy basket maker)

After the pounding of the ash log and processing the ash strips, the materials is ready to weave into a basket. The first step, which was developed through the processing time, is to know which material will be the standards and which will be the weavers. The standards of the basket are upright strips of ash that create the base and the structure of the basket. These tend to be a little thicker and sturdier than the weavers. Weavers are the ash strips that are woven in and around the standards of the basket and help to create the shape of the basket. With all of the preparation, the weaving of the basket should be the easier part of the basket making process.

In this metaphor the standards represent Indigenous people and their knowledge. Just like a basket begins with the standards and standards provides the structure, IRM research starts with Wabanaki people and their knowledge creates the foundation of the research. Wabanaki knowledge is a complete knowledge system and includes cultural protocols, values, and relationality. Ensuring that research aligns with Wabanaki epistemological practices means that the voices, experiences and lives of Indigenous people are privileged. With the goal of maintaining the integrity of Wabanaki knowledge, researchers shouldn't bend IK to fit within the parameters of western research. Wabanaki knowledge serves as the foundation, the structure to weave around. Through IRM, Wabanaki individuals and the communities of harvesters are supported to express their worldview in creating a strength-based, comprehensive, and culturally appropriate research.

The weavers will be slightly thinner than the standards so the weavers can be flexible enough to move around the standards and molds to the standard's shape. Weavers should never force the standard to change shape. Weavers are woven around the standers up the side of the basket to create a container.

The weavers represent the researchers. IRM requires research to be located within an indigenous paradigm. Indigenous epistemology is a fluid way of knowing. A researcher needs to be a flexible thinker to employ methods and analysis that address the research issues while maintaining the integrity of both Wabanaki and scientific ways of knowing. Many Wabanaki natural resource issues require western application of natural resource management tools. Often with biophysical research, there is a requirement for quantitative results or GIS mapping because of the applied nature. Researchers should know of a variety of approaches, methods, and analyses to weave around IK and still produce the required outcomes.

In weaving a basket, the standards are chosen in a way that will create the structure of the basket. They become what the weavers will move around. To start the basket making process is to create a base. The standards are selected and stacked on top of each other with a couple of weavers to form a base. Creating a base and testing how the material works together can be iterative. Basket makers may start a base a couple of times until they get exactly what they want. Getting the base right is important for structural integrity.

Creating the basket base represents the research team collectively deciding the research approach, methods, analysis, and outcomes. A research relationship built on trust, respect, and shared authority is crucial for co-creating research. The team will work through the research issue, potential outcomes, and appropriate methods and analysis that serve to uplift and support Wabanaki people. IRM includes community involvement in design, shared power over the implementation and use of the research, and the research benefits the community the knowledge is derived from (Peltier, 2018). A variety of methods can be employed within IRM. Relationships between indigenous experts, researchers, cultural perspectives, dreams, ceremony, storytelling, and intuitions are valued data to understand and explore (Hart, 2010; Kovach, 2010). The inclusion of spirituality within data generation is a key aspect of IRM. Acknowledging spirituality as a source of knowledge allows indigenous people to incorporate their non-human relatives as a part of their community (Whyte et al., 2015). IRM affords indigenous scholars to serve as data. Hart (2010) incorporated subjective insights through self-reflection, analysis, and synthesis of her internal experiences and insights and connections through ceremony. Collectively, the research team determines the right methods to express themselves and their community's worldview (Prete, 2019). This process is iterative. With a lack peer-reviewed literature that employs IRM within biophysical sciences, finding the right approach for everyone will probably be challenging. Sometimes the right relationship between western scientific methods and Indigenous knowledge emerges through the action of research.

The weaving process is the action of forming the basket shape. All the previous work has led to the action of weaving the standards and weavers together to create a functional basket, a new structure that will be functional for a new use. Wabanaki people, through IK, maintain the structural integrity of ash while processing and making a basket. The strength of a basket is a reflection on how the standards and weavers work together.

The researcher and partners act as the basket weaver, choosing individual pieces of material for specific characteristic that will contribute to the basket's strength. The two knowledges weave together in a fashion that ensure knowledge integrity. In this methodolgoy, the researchers and research partners decide how knowledge is woven in to create structually strong results. Within this approach, the two knowledge systems, maintain each way of being without forcing the other one to change. The whole research design complements both ways of knowing.

The final part of making a basket is carving a hoop, maybe a handle, and binding the basket so the weave is set in place and won't move. Without binding a basket, the basket is unable to maintain the structural integrity and will become unusable over time.

Just like binding the basket ensures a basket is functional, researchers have a responsibility that the knowledge that is co-produced has use and the research outcomes have an applied aspect. This means that the interests and needs of Indigenous people must be central in planning research to ensure relevance not only to the researcher, but also to Indigenous partners. IRM incorporates Indigenous values, beliefs, rights, and practices within the research agenda, remaining especially conscious of who benefits more, the academy or the community.

Reciprocity as a research value focuses on how researchers will ensure Indigenous community members can access benefits from research outputs and outcomes. Through IRM, Indigenous partners would have access to any reports generated, be granted access to published journal articles, conference papers (Cragoe, 2019). This ensures accountability of the researcher to the subjects and their communities. In turn, outcomes should also include projects that Indigenous people value and these products should be locally disseminated. These may be co-written published articles, videos, locally produced such as booklets, videos, maps, curriculum, or poster. Co-writing creates a collaborative story that avoids positioning researchers as storytellers and ensure appropriate credit is given to indigenous participants (Cisternas et al., 2019). In co-writing power is given to indigenous participants to determine what knowledge is appropriate to share. If co-writing is not possible, indigenous participants should see drafts with sufficient time to edit and be given credit for their knowledge and contribution. Cisternas et al. (2019) found that writing together achieves an authentic indigenous voice and there is agreement about the ideas expressed and promoted.

The Basket: An Expression of Relationships

"*While Wabanaki baskets are functional containers, they are also an expression of the relationship between the black ash tree, the basket maker, his/her ancestors, and the land that connects us all*" (Greenlaw, 2023)

IRM research is an authentic collaboration with researchers, academic institutions, indigenous people, state and federal agents, etc. A research project contains more than just the research outcome. It holds the relationships between all partners involved, intentions, hopes, cultural materials, and the land. Indigenous worldview values knowledge as a gift that comes with responsibilities. What are the responsibilities of the researcher who works with native people?   IRM research can have far reaching impacts, more than just the research objectives. IRM research is an act of strengthening Indigenous knowledge and practices. Elevating authentic indigenous perspectives in research can show how different worldviews hold relationships with non-human relatives, how indigenous people hold collective and individual knowledge, and that ethics embedded with in sciences are not a detriment to knowledge. As IRM is employed more within biophysical research, native people will have a voice in how future research supports their knowledge evolution.

CHAPTER 3

Wabanaki Plant Gathering in Acadia National Park: Mobilizing Indigenous Knowledge to Restore Traditional Sweetgrass Harvesting

Abstract

Indigenous communities in North America are actively engaged in reestablishing plant gathering rights on federal landscapes, including those of the National Park Service (NPS). However, such efforts may be challenging due to the federal policy requirements. For NPS, an Environmental Assessment (EA) and a finding of no significant impact (FONSI) is required for any species gathered within NPS park boundaries. Currently there is little written biological data of culturally significant plants and harvesting impacts to support a FONSI. More importantly, there is a lack of co-developed research with Indigenous people to support restoring indigenous plant harvesting within National Parks and other conservation lands. This study focuses on collaborative work with Wabanaki communities in what is now known as Maine with the goal of restoring Wabanaki sweetgrass (*Anthoxanthum nitens)* harvesting in Acadia National Park. Through an Indigenous research methodology and participatory action research, we collectively worked to address NPS plant gathering requirements and create an emergent shared governance approach within monitoring and management of a culturally important species. This interdisciplinary work includes a gatherer-led harvest study and stewardship approach, cultural protocol agreement, and Indigenous developed interpretation. This study highlights a broader need for respectful co-developed research where Indigenous people have active roles in all aspects of the research process. We report on a process that has grown beyond information needs to focus on how Indigenous governance can be incorporated into a transformative process that can guide Tribal-federal relations into the future.

Introduction

Indigenous communities in North America are enacting multiple strategies to maintain and reclaim relationships with their homelands. These efforts, born and led from within communities take many interwoven forms and include the rematriation of land, seeds and cultural practices (Wires and LaRose 2019), engaging in land back movements (Robbins, 2021), bolstering Indigenous food sovereignty (Mihesuah & Hoover 2019), language revitalization (Koller et al., 2023), decolonizing ecological restoration efforts (Artelle et al., 2021; Fox et al., 2017), co-managing and reintroducing caretaking processes, including fire, back onto the land (Lake et al., 2017).

Many Indigenous homelands in the United States are currently under federal management, reflecting histories of dispossession and displacement (Spence, 1999; Catton, 2016). Indigenous peoples have therefore invoked multiple ways of interacting that range from non-engagement to partnerships that facilitate shared governance. One such manifestation is establishing plant gathering agreements on National Park Service (NPS) lands. In 2016, the National Park Service modified the regulation governing the gathering of plants (Code of Federal Regulations, title 32, sec. 2.6., 2016). The revised regulations allow citizens of federally recognized Native American Tribes to gather and remove plants or plant parts for traditional purposes. However, gathering agreements are challenging to develop and implement due to federal policy requirements, and federal-tribal dynamics (Deur & James 2020). Importantly, there is a lack of co-developed research with Indigenous peoples to support restoring Indigenous plant harvesting within National Parks and other conservation lands.

Recent policy guidance from the White House emphasizes the importance of including Indigenous Knowledge in federal decision making (White House, 2022). Yet, implementation of such directives is complicated, contextual, and must operate within existing regulatory structures that constrain the expression of Indigenous knowledges. For example, to enter a formal plant gathering agreement, certain types of information must be provided by the requesting Tribe related to species of interest and harvest activities (see Federal Register 2016). Additionally, an Environmental Assessment (EA) and a finding of no significant impact (FONSI) is required for any species gathered within park boundaries. While the intent of an EA is to ensure that plant populations and associated ecological communities can support traditional gathering, it also creates challenges in formalizing plant gathering agreements. While much Indigenous knowledge around culturally significant plants is held within communities, there are few biological studies of culturally significant plants and harvesting impacts to support a FONSI. Western science-based Indigenous sustainable harvest studies or ethnographies typically support an EA's findings and currently these types of studies are lacking (Chamberlain et al., 2019). Furthermore, White House guidance asserts that "…Agencies do not need to judge, validate, or evaluate Indigenous Knowledge using other forms of knowledge in order to include Indigenous Knowledge in Federal policy, research, or decision making" (White House, 2022 pg. 16).

This study focuses on the process of co-developing knowledge to support plant gathering agreements between Wabanaki Tribes of Maine and Acadia National Park. Focused on the culturally significant plant, sweetgrass, our research seeks to provide information for an EA and supports the co-management of sweetgrass within Acadia National Park.

Project Background

The land now under management jurisdiction of Acadia National Park is within Wabanaki lands used jointly by the Passamaquoddy, Penobscot, Maliseet, and Mi'kmaq Nations. These relationships are described in Park documentation, including Asticou's Island Domain: Wabanaki Peoples at Mount Desert Island 1500-2000 (Prins & McBride 2007).

Ahead of the rule change to 36 CFR 2.1, which accommodates plant gathering by Native American Tribes in National Parks, Acadia National Park (ACAD) required information about plant resources that are of cultural importance to Wabanaki Nations. ACAD hosted a tribal consultation meeting in 2010 where gathering was identified as a critical resource issue for the four federally recognized tribes in Maine. The tribes have a strong interest in the rule change and had requested information about plants of cultural significance. However, at the onset of this project, ACAD had limited information (no information for some species) on the presence, distribution, abundance, demography, phenology, and general ecology of the more than 125 different plants that were historically harvested in the Acadia region (Prins & McBride 2007).

Tribal Consultation

In advance of the approaching rule change, initial tribal consultations with Wabanaki Nations in Maine started in summer 2015. Consultation combined with research (Baumflek, 2015) highlighted over 58 types of plants of potential interest to Wabanaki gatherers. Wabanaki people expressed interest in understanding more about the types of plants growing within Acadia, so that information could be shared with community members. Consultations with all Tribal Historic Preservation Officers (THPOs) for the Mi'kmaq Nation, Passamaquoddy Tribe, Penobscot Nation, and an acting representative for the Houlton Band of Maliseets all identified sweetgrass as a plant of particular interest to tribal members and the decision was made to focus initial efforts on sweetgrass.

Sweetgrass

Sweetgrass is known as welimahaskil or suwitokolasol (Maliseet/Pasamaquoddy), weljemajgewe'l (Mi'kmaq), and wəlí-mskihkwəal (Penobscot). The common name sweetgrass refers to several closely related perennial grasses within the genus *Anthoxanthum*, including some with circumboreal distribution. Our work focuses on *Anthoxanthum nitens*, which is native to the northeastern United States and widely distributed across Canada. It is a facultative wetland species, typically occurring in salt marshes, fresh or brackish shorelines, wet meadows, and marshes (Haines, 2011).

Sweetgrass is a slender, fragrant, rhizomatous perennial grass, capable of forming dense mats. Though capable of forming monotypic stands, sweetgrass is more typically found growing within a complement of other plants. Within ACAD, co-occuring species include *Carex paleacea*, *Sporobolus michauxianus, Calystegia sepium, Festuca rubra, Agrostis stolonifera,* and *Symphyotrichum novi-belgii.* Similar plant communities have been documented in Nova Scotia salt marshes (Goldsmith & Murphy, 1980).

Leaf blade length is variable across the plant's geographic range. In New England, sterile stems of 90cm or greater have been documented (Haines, 2011). Some Wabanaki gatherers prefer to gather sweetgrass in coastal marshes because it is longer than in inland habitats (Baumflek, 2010). Flowers are contained within spikelets borne on a loose panicle. Sweetgrass is wind pollinated (Friedman & Barrett, 2009), however sexual reproduction is infrequent, and production of fertile seeds is rare (White, 2002). Vegetative propagation, through tillers, is the main mechanism of reproduction.

Sweetgrass Harvesting

Previous studies examining the effects of sweetgrass harvesting have not occurred in Wabanaki sociocultural or ecological contexts. Past research has primarily occurred with Haudenosaunee communities in what is now New York State (Shebitz & Kimmerer 2004; Shebitz 2005; Reid 2005). Those studies note the absence of traditional tending techniques including burning, and presence of introduced species in traditional sweetgrass harvesting locations.

Through an experimental harvest, Reid (2005) found that harvesting sweetgrass at a 50% harvest level over a two-year period using traditional methods did not result in population decline. That study employed two different harvesting practices used by gatherers: cutting single blades of sweetgrass, and a 'bunch' method in which many tillers were pulled up at the same time. While informed by traditional practices and harvest levels, the study was performed in a restored garden site, in a stand of pure sweetgrass. Haudenosaunee gatherers did not conduct the harvest, and therefore certain types of knowledge may not have been included when making choices about what and how much to gather. Shebitz (2005) also found that Haudenosaunee gatherers implemented a variety of different harvesting practices, including pinching from the base of the stem, cutting, and pulling up individual stems with small pieces of rhizome attached.

Sweetgrass in Acadia

While sweetgrass was known to grow in Acadia National Park, comprehensive distributions and abundance were unknown prior to this study. Mount Desert Island is Wabanaki traditional territory and Wabanaki people have a long-standing relationship to the land, but have not been able to harvest within the Acadia Natation Prak for generations due to previous regulations prohibiting gathering. Sweetgrass holds cultural and spiritual importance for Wabanaki people. Wabanaki sweetgrass harvesters hold relationships with sweetgrass and Wabanaki people know harvesting sweetgrass will increase the population of sweetgrass. Further research was needed to understand the sweetgrass response to Wabanaki harvesting which will support the required environmental assessment needed for a plant gathering agreement. While western scientific knowledge of sweetgrass is limited, there is a great deal of Indigenous knowledge among Wabanaki harvesters as to preferred sweetgrass habitat, sweetgrass growth in response to environmental factors, and sweetgrass harvesting strategies.

This research focuses on three questions;

1). What is the general distribution and abundance of sweetgrass in Acadia National Park?

2) How do sweetgrass populations respond to Wabanaki harvesting?

3) How can Wabanaki sweetgrass harvesters' knowledge, preferences and protocols inform right relationships with Acadia National Park?

Indigenous Knowledge

Indigenous knowledge (IK) is generated by Indigenous people, extends from their worldviews, and has supported Indigenous livelihoods for generations. It is a complete knowledge system with its own concepts of epistemology, philosophy, and scientific validity (Battiste, 2010). Indigenous knowledge is systemic and holistic; encompasses the tangible and intangible; it is both a process and a product of knowledge. IK is knowledge of the environment (Turner & Reid, 2022), individual species (Turner & Clifton, 2006), socio-ecological interaction (Chisholm Hatfield et al., 2018), and historical environmental occurrences (Reeder-Myers et al., 2022). IK is also a knowledge of and embedded with care taking lessons, sustainable harvest practices, ethics, communal governance, spirituality, cosmology, education, and ancestral connections (Kimmerer, 2018; Berkes, 2018; Whyte et al., 2018). The formation, maintenance, and evolution of indigenous knowledge is held within indigenous people's practice. While a single definition is too constraining for the multiple ways indigenous people hold and generate knowledge, most indigenous knowledges are an expression of relational ontology where knowledge is gained and understood through different forms of relationships (Whyte et al., 2018). This relational ontology creates roles of reciprocity and responsibilities with human and non-human relatives (Whyte, 2013b).

Decolonizing Research

Indigenous communities repeatedly call for recognition and support in asserting inherent rights over their knowledge systems (Carroll et al., 2019; Wong et al., 2020). Native and nonnative scholars have expressed a need for research that supports multiple perspectives (Tengö et al., 2014, Watson & Huntington, 2014) and builds indigenous capacity instead of research that promotes western discovery, extraction, and ownership of IK (Smith, 2021). Decolonizing research is not a prescriptive methodological approach but a research practice of critical reflectivity, reciprocity and respect for self-determination, valuing multiple knowledge systems as valid forms of knowledge, and engaging in a transformative practice (Thambinathan & Kinsella 2021). Decolonizing research includes both addressing colonial impacts on native people and shifting research to support indigenous sovereignty and self- determination.

Valuing Indigenous ways of knowing is highly nuanced and distinctly contextual. Indigenous communities have distinct cultures and ways of being. Decolonizing research requires place-based and context-based relationship building and collaboration from the beginning. Authority is often held by the researcher in determining when, how, and why indigenous knowledge is included (David-Chavez & Gavin, 2018). A decolonizing approach changes practices to co-creation where approach, methods, and outcomes are determined collaboratively with shared authority between researchers and indigenous partners.

"Two-eyed seeing", *Etuaptmumk* in Mi'kmaw, is a concept, formed by Mi'kmaq Elder Albert Marshall, to bridge Indigenous forms of sciences with western science. Two-eyed seeing can be understood as seeing from one eye with Indigenous knowledge and ways of knowing, and from the other eye with Western knowledge. With two eyed seeing, all forms of knowledge are legitimate and divergent epistemologies are equally valuable and capable of generating further knowledge and insights (Bartlett et al., 2012). In practice, two-eyed seeing is a careful and selective process engaging with both Indigenous knowledge systems and Western scientific knowledge systems (Gobin et al., 2022; Nonkes et al., 2023; Smith et al., 2023). This approach is particularly useful when research outcomes will be applied within western frames of management or conservation.

Two-eyed seeing engages multiple knowledge systems without assuming knowledge integration. Knowledge integration often positions western science as the dominant framework and Indigenous knowledge becomes integrated and becomes homogenized into western forms of knowing (Nadasdy, 1999). Two eyed seeing builds on traditions of Indigenous research as well as other transformative or action-oriented paradigms such as Participatory Action Research, that emphasize the agency of community members in driving change and often draw mixed-methods approaches to strengthen analyses and support culturally appropriate methods (Datta et al., 2015; Peltier, 2018). Through two eyed seeing, Indigenous knowledge can be centered within the research and western methods are adapted if deemed appropriate and beneficial by the native people. Through this approach, Indigenous people can choose for themselves to leverage Western science in service of Indigenous values for restoration, revitalization, and rematration.

It is critical to co-produce research and novel processes that respond to tribal needs/priorities and create appropriate opportunities to mobilize Indigenous knowledge. Focusing on Wabanaki relations with sweetgrass, we respond to a series of information needs regarding the development of plant gathering agreements between Acadia National Park and Wabanaki Tribes of Maine. Our approach co-produces knowledge about sweetgrass that can be used to support environmental assessments, and simultaneously integrates plant gatherers into processes with the intent of centering Wabanaki knowledge, governance, and priorities into park management.

Methodology

As a team of Indigenous and non-Indigenous researchers, a "two-eyed seeing" philosophy guided our approach in employing Indigenous Research Methodologies (IRM) and Participatory Action Research (PAR). PAR seeks to change practices, empower participants who are often marginalized, and address real-life problems (Kindon et al., 2008). PAR is often chosen when circumstances require flexibility, the involvement of the people in the research, or change that must take place holistically. PAR was developed to utilize qualitative approaches, methods, and action for emancipating and transforming communities through group action (Chilisa, 2010). While IRM and PAR have different foundations, both methodologies share value of ongoing reflexivity, rationality, decolonizing/social justice approach, and ontological assumptions such as multiple realities (Chilisa, 2010). Indigenous Research Methodology is for Indigenous people and conducted within an Indigenous community. Throughout IRM, Indigenous perspective informs the research process. Cultural protocol, values, and behaviors such as relational accountability to one's own community, including non-human communities, are integral parts of IRM (Kovach, 2010). Indigenous research methods are informed by indigenous ethical protocol (Fast & Kovach, 2019). The researchers with the participants determine the right methods to express themselves and their community's worldview (Prete, 2019). IRM affords Indigenous scholars to serve as data and data that is gathered is treated respectfully.

Research Design

The study is designed to center Wabanaki sweetgrass knowledge and scientific ecological knowledge to form a comprehensive understanding of sweetgrass abundance, distribution, growth response to Wabanaki harvesting, and management. This approach will allow for more robust management of sweetgrass that privileges indigenous perspectives and creates power sharing within sweetgrass management.

A mixed-method approach was designed to both center Wabanaki sweetgrass knowledge, provide information for the EA, and to guide future management. A quantitative field study was designed to determine distribution, abundance, and sweetgrass response to Wabanaki harvesting. Qualitative methods were employed to elevate Wabanaki sweetgrass knowledge, Wabanaki sweetgrass gathers concerns, and facilitate Wabanaki self-determination within sweetgrass management. These findings will also aid in the understanding of monitoring and management of sweetgrass.

Wabanaki Knowledge Co-producer's Selection

Wabanaki community members were asked to participate in this project based on their experiences and deep knowledge as sweetgrass gatherers. Each Wabanaki Nation Tribal Historic Preservation Officer (THPO) was contacted and included in the development of research methods and protocol as suggested to conduct appropriate ethical research within Indigenous communities (Schnarch, 2004). THPOs were asked to recommend gatherers from their communities to participate; in several cases we were in contact with certain gatherers first, and specifically asked THPOs to approve their participation. Building on these recommendations, we also used a purposeful sampling strategy (Patton, 2002) to include representation of varied ages, Tribal affiliations and genders. These 17 experts are profiled in Appendix A.

Quantitative Methods

Botanical Inventory

In the summer of 2016, Mittlehauser (2017) conducted a botanical assessment of the salt marshes within ACAD (Appendix B). Using a program that created a grided overlay of all marsh habitats, Mittlehauser and his field assistants evaluated the marsh in 25 meter by 25 meter segments, assessing for the presence, absence and qualitative abundance of sweetgrass. Those data informed the creation of a GIS layer that denoted locations in the marsh with high abundance of sweetgrass.

Sweetgrass Harvest Response

For 2016 to 2017, Mittlehauser (2017) conducted a sweetgrass harvest response study found in Appendix (B). In response to Wabanaki sweetgrass harvesters' comments, a parallel sweetgrass harvest study was conducted and is the focus of this dissertation chapter.

Site Requirements and Plot Location

Wabanaki harvesters chose their preferred sites to harvest and these areas became the research harvest plots. A 1x1m grid plot was placed in the harvester determined site location. All plots were GPS-ed in UTMs using NAD83. Two orange fiberglass poles were sunk in at two opposite corners of each plot. These became the permanent markers for each plot and a research tag with the grid cell number was attached to one of the plot poles. A small 1-foot-long piece of rebar was also placed adjacent to the fiber- glass pole, fully sunk into the ground, so that the transect ends can be found with a metal detector in the future even if the fiberglass poles are lost. 1x1m grid control plots were established in close proximity to harvest plots.

Quantitative Sweetgrass Response Methods

All plot assessments were conducted between June to August of 2017 to 2019. After a permanent 1x1 meter plot was established, a Wabanaki person harvested to their desired harvest amount. For each plot, the harvested stems were counted and sweetgrass stems left within the plot were counted. After harvest, sweetgrass stem heights were measured in 4 locations in each subplot. Percent cover for sweetgrass and the present cover of all other species were visually estimated. For harvest plot when the sweetgrass gatherer agreed, the harvested sweetgrass amount was weighed in grams. For control plots where there was no sweetgrass harvesting, sweetgrass stem counts were conducted and percent cover for sweetgrass and the precent cover of all other species were visually estimated. Sweetgrass stem heights were measured in 4 locations in each control subplot.

Statistical Analysis of Sweetgrass Response to Harvest

One-way repeated Anova were used to test sweetgrass response to Wabanaki harvesting. Additional 5 control plots from Mittlehauser (2017) sweetgrass harvest response study was identified in 2018. These five plots were included into the study to increase control plot sample size. These plots were chosen due to their close proximity to Wabanaki chosen harvest plots and were measured for stem density only between 2017 to 2019.

Qualitative Methods

Interview Materials

Prior to conducting interviews with Wabanaki sweetgrass harvesters, a draft interview question guideline and an information flier was created. An information flier was shared with each participant before they were interviewed in an attempt to fully inform the participants of the research goals and give the participants a way to contact the researchers. The interview question guidelines were developed to draw on Wabanaki harvester's knowledge of sweetgrass.

Digital Recording

All interviews were recorded using an Olympus DS60 audio recorder or iphone. Interviews ranged in length from 20 minutes to two hours. Each participant gave permission to record their interviews and has the opportunity to have the digital recording destroyed. Each digital voice file was then downloaded and converted to an audio file for transcription.

Data Management

Each interview was transcribed to a text file, with the occasional omissions of conversation that was not pertinent to the research. This included jokes that had no relevance to sweetgrass. The interviews were transcribed verbatim where the written words are an exact replication of the audio-recorded words (Poland, 1995). The text was then imported into the NVivo 10 software (QRS 2017) to aid in data analysis. NVivo allows for data analysis transparency (Beekhuyzen et al., 2010). Once uploaded into NVivo, each interview was assigned attributes such as tribal affiliation, age range, and preferred gender.

Data Analysis

The initial step in data analysis and coding was rereading the interview transcriptions. We employed thematic analysis (Boyatizis, 1998) where the themes were generated inductively from the interview materials. We read each transcription and discussed the dominant themes and patterns that emerged from the data. These dominant themes became initial coding categories (Miles et al., 2014). To test for reliability of the coding scheme, Baumflek and Greenlaw independently applied the coding scheme to a selection of interviews and compared results. The coding scheme was then applied to all interview transcripts. These themes were used as a framework to analyze the data. Data display provides organized, compressed assembly information that permits drawing conclusions. Matrix queries were conducted and data display matrices and exploratory data matrices were formed within NVivo (Miles et al., 2014).

Conclusion drawing involves stepping back to consider what the analyzed data mean. We discussed the emergent conclusions of the harvesting process. Once we developed the conclusions that were of interest to the research, we revisited the data to cross check and verify the conclusions (Miles et al., 2014). The conclusions have been confirmed with the participants as plausible and accurate.

Results

Quantitative Field Results

We documented the sweetgrass population in Bass Harbor Marsh in a total of 39 plots during 2017 and 42 plots during 2018 and 2019. Of the 39 plots we assessed in 2017, 30 were designated as harvest plots where Wabanaki sweetgrass gathers harvest sweetgrass and 9 were designated as control plots that had no sweetgrass harvested. In 2018 and 2019, 32 plots were harvest plots and 10 were control plots.

Harvest Plots Descriptive Results

In 2017, in the 30 harvest sweetgrass plots, we documented an average of 313 sweetgrass stems m^2 before harvest was applied. After harvest in 2017, the sweetgrass stem density was 161 stems m^2. In harvest plots the average stem height was 21 cm. For year 1 ,the stem height was measured after harvest. In 2018, harvest plot stem density average was 404 stems m^2 with an average stem height of 53 cm. In 2019 the stem density was 407 stems m^2 with average stem height of 59 cm.

Mean sweetgrass coverage within harvest plots was 16% m^2. We documented a total of 23 taxa in our monitoring plots (Appendix D). Most frequent co-occurring species were *Spartina pectinata, Juncus arcticus subsp. littoralis, Aster sp., Calystegia sp., Carex paleacea, and Festuca rubra.*

Control Plots Descriptive Results

In the 9 control plots we assessed in 2017, the average sweetgrass stem count was 286 stems m^2 and an average stem height of 24 cm. In the 10 control plots we assessed during 2018, we documented an average of 349 sweetgrass sems m^2, and an average stem height of 57 cm. In 2019, the average stem density was 370 sweetgrass stems m^2 and an average stem height of 62 cm.

Mean sweetgrass coverage within control plots was 21% m^2. Most frequent co-occurring species were *Spartina pectinata, Juncus arcticus subsp. littoralis, Aster sp., Calystegia sp., Carex paleacea, and Festuca rubra.*

Statistical Analysis

One Way repeated Anova in R program (R Core Team, 2021) was conducted on 30 sweetgrass harvest plots that were consistently measured each year from 2017 to 2019. The 2 harvests plots that were measured in 2018 and 2019 were not included due to the lack of consistency over the three years. The harvest plots are labeled as the treatment plots within the graph (Figure 3.1). The control plot sample size was 14. The 1 control plot that was measured in only 2018 and 2019 was removed from analysis due to lack of consistency over the three years. The 5 control plots identified from Mittlehauser (2017) were included within the control sample population. The total control population was 9 control plots from this study and 5 control plots identified from Mittlehauser (2017) for a sample size total of 14 control plots. In Table 3.1 are the mean stem density per year with standard deviation for both control and harvest plots that were measured within the one-way repeated Anova analysis.

Table 3.1. Mean Stem Density with standard deviation for treatment and control plots measured within the One-Way repeated Anova.

	Treatment plots stem density (N = 30)	**Control plots stem density (**N=14)
2017 pre harvest	313 (SD=197)	286 (SD=151)
2017 post harvest	161[a] (SD=92)	286 (SD=151)
2018	420[a] (SD=227)	343 (SD=213)
2019	416 (SD=282)	368 (SD=209)

Superscript indicates between-group differences significant at the $p < .05$.

A one-way repeated Anova was performed to compare the effects of sweetgrass harvesting on the sweetgrass population over three years, 2017 to 2019. The experimental design can be described as a two factor: one between plots factor (Treatment vs. Control) and one within plots factor (year). The alpha value used to determine statistical significance was .05. The one- way Anova revealed that there was a statistically significant positive difference in sweetgrass population mean stem densities between the 2017 post-harvest stem density mean of 161 as compared to the 2018 stem density mean of 420, df=3 F-value =4.806, p=0.0033. There was also a positive but not significant increase in sweetgrass population stem density means for the control plots over the three years. Finally, there was no statistically significant difference between treatment plot and control plot sweetgrass density stem means over the three years, p= 0.915.

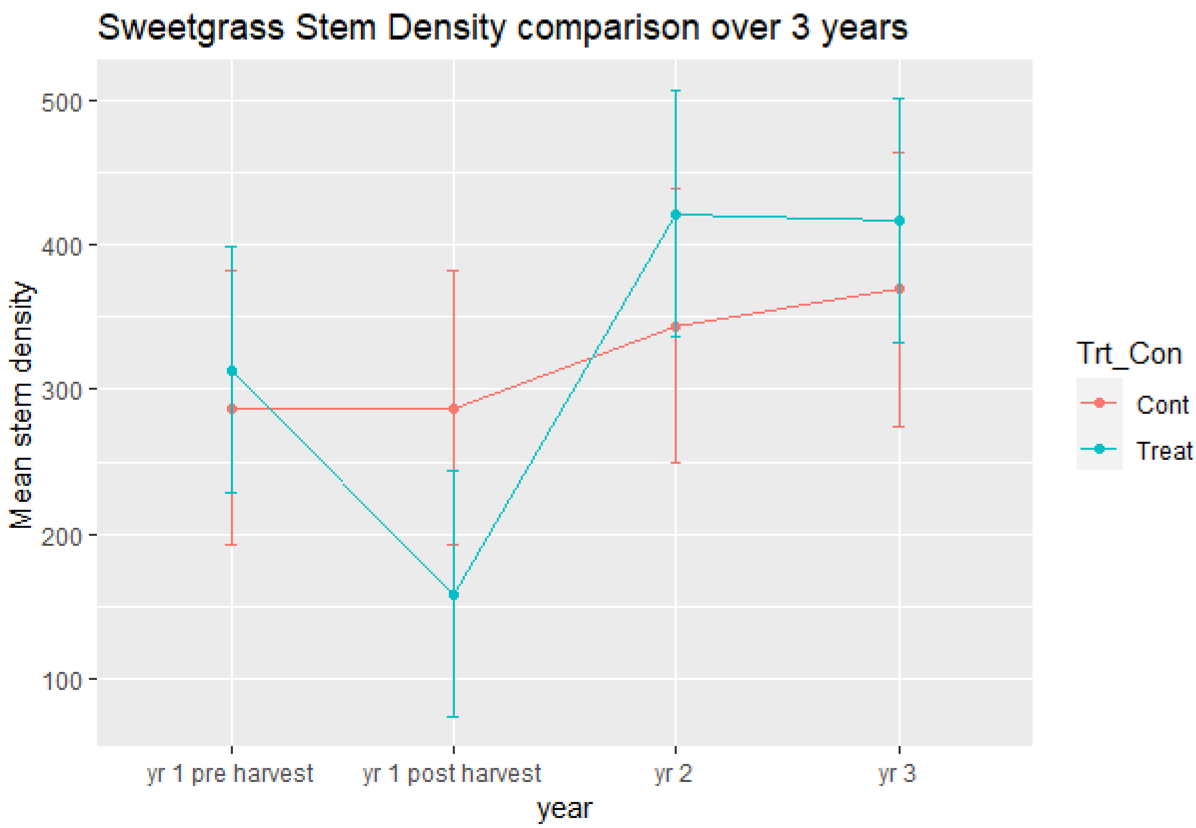

Figure 3.1 Sweetgrass Stem Density comparison of control and harvest plots over 3 years. Treatment plots N=30 and Control plots N=14.

Harvest (treatment) plots and control plots both increased in sweetgrass stem density over the three years between 2017 to 2019. The most significant interaction occurred between year 1 to year 2. In year 1, before treatment, both control and harvest plots had similar sweetgrass stem density of 286 and 313 stems respectively. In year one, after treatment, the harvest plots had a negative difference in stem density to 161 m^2 stems. The following year, 2018, both control and harvest plot stem densities had a positive difference. From year 1 to year 2, the harvest plots stem density went from a negative difference to a positive difference of 404 m^2 sweetgrass stem density in year 2. This is a 162% increase from year 1 post harvester to year 2. The control plot increased in density to 349 m^2 sweetgrass stems in year 2. This is a stem density increase of 20% from year 1 to year 2. The subsequent year (year 3), both treatment and control plots change little (Table 3.2).

Table 3.2. Sweetgrass Stem Density % change over 3 consecutive years (2017-2019)

Stem Density % change

	Harvest plot	Control plot
2017 post-harvest	-48.63%	0.00%
2018	162.01%	19.84%
2019	-1.14%	7.39%

Gather profile of harvest choices

Sweetgrass gatherers had an average harvest weight of 257.8 grams per m^2 (N=25). The average stems harvested were 152 sweetgrass stems per m^2. Sweetgrass gatherers' harvest amount ranged from 24 stems (90 grams) per m^2 to 590 stems (680 grams) per m^2 (Table 3.3.).

Qualitative Results

With the goal of mobilizing Indigenous knowledge, a holistic understanding of Wabanaki sweetgrass knowledge is described here. The biocultural context is not the only specific understanding that is necessary to engage with an Indigenous community. This holistic perspective on IK gives a fuller understanding of IK practices and the cultural worldview that governs Wabanaki sweetgrass caretaking. We describe Wabanaki sweetgrass caretaking and stewardship through a framing of Wabanaki sweetgrass individual and community relationships. As an extension of this intent, we choose to share results in a manner that highlights both individual and communal voices. Therefore, our results are structured to include ample direct quotations to highlight the diversity that exists within Wabanaki sweetgrass knowledge systems. Ensuring that data are treated with respect and in ways that align with Indigenous epistemological practices means that the voices, experiences, and lives of Indigenous people are privileged (Simonds & Christopher, 2013).

Wabanaki Sweetgrass Knowledge Framework

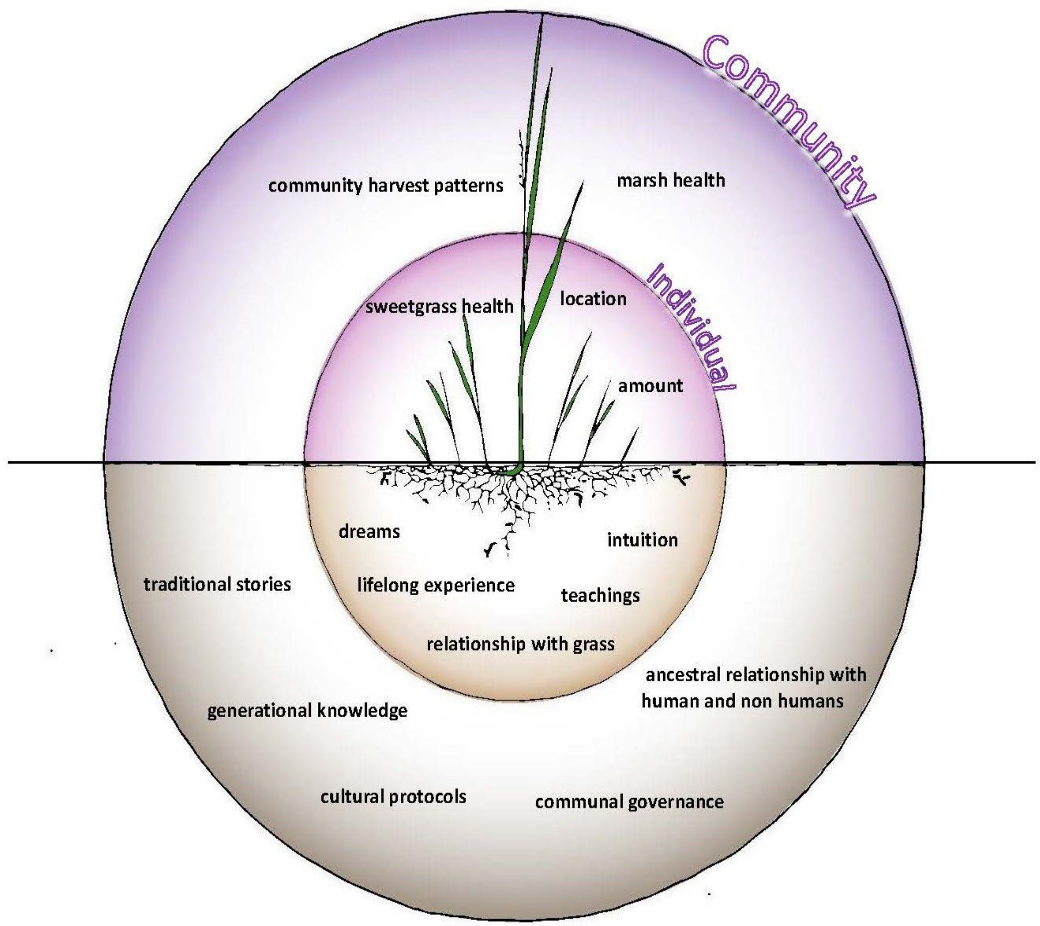

Figure 3.2. Wabanaki Sweetgrass Knowledge Framework. This framework encompasses tangible and intangible components that govern sweetgrass gathering decision making.

Tangible

The tangible aspects of Wabanaki sweetgrass gathering are components that are observable and/or measurable. These include sweetgrass health, harvest location, harvest amount, salt marsh health, and community harvest patterns.

Sweetgrass health

Gatherers reflected on the variability of sweetgrass health over the course of a season as well as from year to year. The main environmental factors that gatherers attributed to sweetgrass health were precipitation throughout the season and water level of the marsh. Some noted that if the rainfall was low that year, the grass would become brittle, or "rusty". They also noted that too much standing water was not good for the grass either.

> *"There is too much water here. I think that's why they're not growing as much as they should. Cause in Lubec, do you remember George, it was almost dry."- Molly Jennette Neptune Parker*

All harvesters' expressed harvesting is good for sweetgrass. Some harvesters expressed the absence of harvesting was why the sweet grass population was low in some locations.

> *"Yup, well what has discouraged the sweetgrass too is that it hasn't been picked. I think that has hurt it a lot because in order for each one to grow, it has to be removed."- Molly Jennette Neptune Parker*

Harvest location

Gatherers shared diverse preferences for harvest locations, based on the qualities of sweetgrass they were interested in. They identified certain location characteristics such as shaded areas, open areas, areas with taller grass and sedge communities, areas where sweetgrass abundance was preferred over sweetgrass length, and areas where sweetgrass length was preferred over sweetgrass abundance. Location preference was often in relation to their intended use of the sweetgrass, such as for baskets, earrings, brooms, or braids. While sweetgrass was found throughout the marsh, gatherers chose to harvest in a small subset of available sweetgrass areas.

Harvest Practices

Gatherers expressed their relationships with sweetgrass through adaptive picking styles that guide their choices in harvest techniques, site rotation, harvest amounts, and harvest timing.

Techniques

All of the gatherers who participated in this project reported harvesting sweetgrass by pulling individual culms one at a time, an action that sometimes removes a small amount of rhizomes as well. None harvested by cutting with scissors. Gatherers discussed harvesting that focused on mature culms, noting that this strategy gives more time, space, and light for smaller culms to grow, and promote the availability of grass in coming years. Several gatherers also noted that a pulling technique aerated the soil, and provided a seedbed for new grass to sprout.

> "*Oftentimes, the way you harvest has to do with future harvest. You want to take stuff that's already well established to give the smaller stuff time to reestablish. So thinking about maintaining a plot is a lot about how you harvest in the first place*."*- Gabe Frey*

Rotation

Similar to techniques discussed above, some gatherers choose to rotate sites to allow enough time for sweetgrass to develop into a harvestable size. This decision was often dependent on the individual's picking style, and if they harvested a specific location intensely.

> "*Because I already picked here last year. Let it rest for a year. I don't know the science of it. I just know it's better to move around*."- Jen Neptune

“*When I clear that patch out here with the big stuff, and the smaller stuff is going to grow up in its place right? But, when that grows up, you're going to have to stay away from there for about a year or two, to really give it time to mature*.”*- Rocky Bear*

Harvest Amount

Related to harvest practices, harvest amounts varied for each gatherer, and correspond to the harvesting techniques employed in relation to environmental conditions and their own need or intention. Rather than obscure this diversity, we present the range of harvest amounts in Table 3.3, to demonstrate that gatherers employ different harvest practices depending on the amount of sweetgrass present, environmental conditions of the marsh, and in relation to other gatherer’s activities.

Table 3.3 Sweetgrass gatherers harvest strategy profile and stem density response

Gatherer	Stem Density 2017, pre-harvest	Stems Harvested 2017	Percent harvested (%), 2017	2018 Stem Density (% change from 2017 pre- harvest to 2018)	2019 Stem Density (% change from 2017 pre- harvest to 2019)
Harvester 1	**97**	40 (290g)	41.24%	**184** 89.69% increase	**251** 158.76% increase
Harvester 2	**446**	198 (250g)	44.39%	**669** 50.00% increase	**1058** 137.22% increase
Harvester 3	**671**	479 (800g)	71.39%	**695** 3.58% increase	**731** 8.94% increase
	878	590 (690g)	67.20%	**904** 2.96% increase	**923** 5.13% increase
	709	556 (600g)	78.42%	**306** -56.84% decrease	**502** -29.20% increase
Harvester 4	**109**	36	33.03%	**275** 152.29% increase	**188** 72.48% increase
	398	161 (115g)	40.45%	**457** 14.82% increase	**180** -54.77% decrease
Harvester 5	**366**	167 (190g)	45.63%	**590** 61.20% increase	**295** -19.40% decrease
	330	124 (150g)	37.58%	**414** 25.45% increase	**263** -20.30% decrease
Harvester 6	**71**	24 (90g)	33.80%	**212** 198.59% increase	**254** 257.75% increase
	166	43 (90g)	25.90%	**274** 65.06% increase	**219** 31.93% increase
Harvester 7	**76**	50	65.79%	**72** -5.26% decrease	**189** 148.68% increase
	166	54	32.53%	**332** 100.00% increase	**251** 51.20% increase
	235	102	43.40%	**409** 74.04% increase	**250** 6.38% increase

Table 3.3 continued. Sweetgrass gatherers harvest strategy profile and stem density response

Gatherer	Stem Density 2017, pre-harvest	Stems Harvested 2017	Percent harvested (%)	2018 Stem Density (% change from pre- harvest to 2018)	2019 Stem Density (% change from pre- harvest to 2019)
	165	108 (100g)	65.45%	**180** 9.09% increase	**169** 2.42% increase
	192	99 (60g)	51.56%	**263** 36.98% increase	**156** -18.75% decrease
	251	140 (160g)	55.78%	**568** 126.29% increase	**783** 211.95% increase
	172	102 (95g)	59.30%	**255** 48.26% increase	**339** 97.09% increase
	330	109 (110g)	33.03%	**713** 116.06% increase	**1065** 222.73% increase
Harvester 8	**434**	300 (380g)	69.12%	**726** 67.28% increase	**582** 34.10% increase
	59	29 (120g)	49.15%	**51** -13.56% decrease	**27** -54.24% decrease
Harvester 9	**89**	37 (150g)	41.57%	**47** -47.19% decrease	**108** 21.35% increase
	306	117 (150g)	38.24%	**570** 86.27% increase	**324** 5.88% increase
Harvester 10	**408**	136 (200g)	33.33%	**740** 81.37% increase	**490** 20.10% increase
	346	58	16.76%	**473** 36.71% increase	**557** 60.98% increase
	374	42 (70g)	11.23%	**571** 52.67% increase	**670** 79.14% increase
Harvester 11	**390**	115 (95g)	29.49%	**544** 39.49% increase	**601** 54.10% increase
	378	77 (400g)	20.37%	**350** -7.41% decrease	**311** -17.72% decrease
	301	100 (490g)	33.22%	**281** -6.64% decrease	**177** -41.20% decrease
Harvester 12	**469**	369 (600g)	78.68%	**543** 15.78% increase	**572** 21.96% increase

Table 3.3, Continued. Sweetgrass gatherers harvest strategy profile and stem density response

Gatherer	Stem Density 2017, pre-harvest	Stems Harvested 2017	Percent harvested (%)	2018 Stem Density (% change from pre- harvest to 2018)	2019 Stem Density (% change from pre- harvest to 2019)
				303	**332**
Harvester 13				**272**	**214**
average	**312.733**	152.067 (257.8g)	44.90%	**422.266** 47.23% increase	**416.166** 48.49% increase

Harvest Timing

Gatherers expressed the range of harvesting extended from June to September, depending on precipitation and weather. Gatherers observed that precipitation followed by sunny days affected the quality of the grass. Intense sun rays after rain would create burn spots or "rust" on the grass. The rust areas affected the quality of sweetgrass for use such as in braiding or weaving.

Community harvest patterns

Gathers expressed they could see where other people had harvested within that season and would choose to go to areas that hadn't been harvested. If harvested in the same vicinity as another harvester, they would choose to harvest nearby but not directly next to each other.

If a harvester observed an area that was over-picked, they would choose to let that area recover before they picked there again.

It takes… one spot I went and someone had gone there and picked it, it took years for it to come back to a length where it was even pickable. It was just really, really little and I left it alone for years.- Paula Love Thorne

Salt Marsh Health

Gatherers expressed a part of sweetgrass harvesting is taking care of the marsh by not leaving trash or negatively impacting the marsh.

"Our creation stories, they involve ash, they involve all of the things that we still gather. And it's really important. I've taught my nieces and nephews all how to pick grass and how to respect that land while you're there cause if you don't it won't be there for us to be able to pick. You don't leave anything on the land, you take what you brought and if you find something else you take that too just to try to keep it as pristine as you can."- Paula Love Thorne

Some gatherers discussed the importance of other grasses in the marsh that were found with sweetgrass. They preferred to harvest sweetgrass that was mixed in with the other long grasses and sedges. They noted that sweetgrass growing among other marsh grasses such as *Spartina pectinata (syn Sporobolus michauxianus)* grew longer because of competition or the grasses were "helping each other ".

Intangible

The intangible aspects of Wabanaki sweetgrass knowledge are not typically observable. On an individual level, this includes dreams, Lifelong experiences, a relationship with sweetgrass, teachings, and intuition. On a collective experience, the intangible includes traditional stories, ancestral relationship, generational knowledge, cultural protocol, and governance,

Dreams

Several gatherers recounted powerful dreams related to sweetgrass. While it is inappropriate to share the contents of those dreams, gatherers indicated that it was alright to explain that dreams often made connections between themselves, their ancestors and sweetgrass. Some described it as a cultural or cellular memory.

Lifelong experiences

Variation in sweetgrass knowledge and experiences manifests itself in a variety of practical ways. For example, while July and August are typical times for sweetgrass gathering, some gatherers shared that they prefer to harvest as early as June, and will sometimes pick as late as October, depending on environmental and weather conditions.

All gatherers had no previous experience or knowledge picking within the study site, yet they were able to look at the marsh from the road and identify potential sweetgrass harvest locations due to their knowledge built upon years of harvesting within salt marshes.

Some gatherers noted and understood how their specific harvest style would impact sweetgrass regrowth within the following years. Gal Frey spoke about how she understood how her harvest style would impact the sweetgrass growth the next summer. She expressed she was going to pick as much sweetgrass as she could within the short time frame she had in the marsh. With that harvest approach, she would not come back to the same spot the following year.   "If I came back here (next year), it (sweetgrass) would be here but it'd be less and it would be shorter."

Relationship to sweetgrass

Gatherers spoke about sweetgrass having agency and that picking sweetgrass is a form of a relationship. Sweetgrass informed the gatherer if it wanted to be picked. If sweetgrass didn't easily let go, the harvester would choose another stem of grass.

> *" I do [pick the roots. I've got a little bit of the root on these. I just pull and if it comes out easily I pick it. If it resists then I pick a different one. I don't get a whole bunch of roots"* - Jen Neptune

Gatherers expressed that harvesting sweetgrass is a reciprocal relationship where the "grass provides for us and we provide for the grass" -Jennifer Neptune.

> "*It's pretty awesome to think about that connection and I feel like once you start going to a place and you keep going back, it's like the grass has a memory. It remembers you . You get a relationship with it and I actually had a really powerful dream once about my sweetgrass spot"*- Jennifer Neptune

Relatedly, several gatherers who had been picking for over 20 years noted that the health of the sweetgrass within Acadia National Park would be improved through harvesting:

> "*It wants us here. "People haven't been here to pick*" *- Molly Neptune Parker*

On assessing a potential harvesting site, another gatherer attributed finding the sweetgrass to be shorter than anticipated to lack of harvesting:

> *" It [the sweetgrass] is pretty short. So even in this thicker patch, that's just because it hasn't been harvested in a very long time. If it's not harvested, there is not a whole lot of room, so it tends to choke out pretty quick and sometimes it can even choke itself out.*" *- Gabe Frey.*

Based on their experiences at other salt marshes, another gatherer reinforced the importance of interacting with sweetgrass to maintain populations:

> "*If no one else went there [to the marsh] they [sweetgrass] would just die out. I went to a spot with an elder in Pembroke one time…. they used to have all kinds of people come there but nobody had been there in years. So he took me and it was gone. There was no grass to be found anywhere. And I don't know why else that would be other than it just choked itself out*." *-Gal Frey*

Teachings

Gatherers expressed a number of different ways they had acquired teachings about how to interact with sweetgrass. One recurring theme was that learning happens through the active process of being in a salt marsh with others who know how to pick.

> *"Yeah. That [differentiating sweetgrass from other types of grass] was, you know it's not something that is actively taught. it's just something you do and when you have an activity that you do with your children, they learn. It's not like "do it this way and do this". It's just you watch, you participate or you don't. When you do, you learn."*- Gabe Frey

We spoke with a Wabanaki sweetgrass gatherer who didn't participate in this study and he expressed that he was taught to harvest with scissors. This was a different harvest style than the gatherers who participated within this study. This harvest noted he typically harvested fresh water sweetgrass.

Intuition

Gatherers expressed intuition as a form of knowledge.

> *"It usually attracts you to it, not it to you. It's something inside. It's just like picking medicines. A lot of people are already saying you go a certain time of year, or you know when you have to go. But I've never used a calendar. I always go when I feel it's time to go. And it's in your heart, in your spirit that you know when. You don't need a calendar. And you don't need the moon to tell you when to go out. It will call you. That's the way it's been with me for a long time."- Rocky Bear*

Traditional Stories

While in the marsh, gatherers reflected on traditional creation stories that tell the origins of sweetgrass and its significance for Wabanaki people. While gatherers asked that traditional stories not be shared here, Geo Neptune's words below

"When you smell sweetgrass, you are smelling the scent of Gluscap's breath. You are smelling the breath of life and it was the breath of life that Gluscap used to create us out of the ash tree to create our bodies from, wikip, from those ash strips. So when we smell it, we are smelling something that is a part of our very essences."- Geo Neptune

Generational Knowledge

While participating in this study, gatherers would often bring youth and/or elders when picking sweetgrass. This included a parent-child, grandparent-grandchild or three generations harvesting sweetgrass together. While picking and walking through the marsh, adults or elders would tell stories about how they learned to pick sweetgrass from their grandparents or parents.

"Oh my goodness. I haven't done it for a long time but I used to go with my parents as a child. I used to go pick sweetgrass and then for the past few years I've been picking with Donald, Donald Soctomah or if I get a chance to buy it I'd rather buy it."- Molly Neptune Parker

Cultural Protocols

Gatherers expressed and demonstrated certain ways of behaving around sweetgrass and sweetgrass knowledge. Giving thanks through a gift of tobacco was commonly demonstrated within the marsh and at group meetings. Gift giving was an important cultural protocol within the study. During our large group meetings, gifts were given to everyone attending.

Cultural protocols were expressed in stated rules of behavior. Experienced pickers explained that they are able to see if someone has been in a certain area before them, which is an indicator to harvest in a different location. Another behavior was to pick for people who couldn't pick for themselves. Some gatherers stated they were picking sweetgrass for youth or elders

" Yeah we have elders that have a hard time. We usually try to get some for them."- Kyle Lolar

Cultural protocols can be unstated rules of behavior, especially around care and transfer of knowledge. Teaching and sharing sweetgrass knowledge in a good way is a responsibility embedded within sweetgrass knowledge. While gathers did not directly state this as an action, everyone talked about learning sweetgrass picking from another tribal person and spoke about the importance of teaching youth. One gatherer identified the people she brought with her as her students. Another reflected on the importance of multiple community members in imparting teachings about sweetgrass to him:

> *"My grandfather was the first one to teach me. But I came back to the island back there for a little bit, just to get reconnected and meeting back up with my family because my mom married someone in the military so we moved around a lot. John Neptune and Carol Dana and people like that started to help me out, taking me to some of the old spots cause I could describe them but I didn't know how to get to them."- Kyle Lolar*

In creating this report, gatherers and the research team discussed what sweetgrass knowledge is appropriate to share and what is not appropriate to share. Gatherers identified certain information such as marsh location, specific harvest areas within the marsh, dreams, and traditional stories as knowledge not appropriate to share. Some gatherers expressed concern sharing photographic images of sweetgrass and creating a "how to pick" guide for public dissemination.

> *"Sharing that it's a grass that's important to the culture and important to basket makers and a really long tradition but maybe not like having a poster that shows what the roots look like and here's how to identify it within the other grass you know that's sometimes too much. I don't know. I mean that's just my opinion." -Jennifer Neptune*

All the information within this report was approved by the gatherers.

Communal Governance

Gathers expressed pathways within the community to prevent and respond to over picking of sweetgrass. Education was the most common approach. Teaching how to appropriately harvest sweetgrass, offering more knowledge if someone was overharvesting, and informing other sweetgrass harvesters if a specific location was over-picked were the multiple approaches gatherers articulated.

Experienced sweetgrass gatherers expressed that teaching tribal people how to identify, select, and pick sweetgrass in a good way is important to sustain the sweetgrass population.

> *"Because you don't want people out there overpicking or messing up someone's spot or ruining it for us. Because I know we need this grass to be basket makers, we need it for our ceremony, we need it for so many different reasons and it's so important that the people that we teach and stuff we teach them how to be respectful in doing it and how to you know kind of quietly go about doing it so we don't lose the places that we pick. And somebody that doesn't have that deep responsibility to it or to a culture or a tribe or something might not go in with the same amount of respect that we would or that one of our students would." -Jen Neptune*

Overwhelmingly, gatherers expressed concern around a harvest permit system in that a tribal citizen could receive a permit to pick sweetgrass without receiving cultural teachings. Gatherer expressed the need to offer teachings in the form of a written document to ensure some knowledge was shared but to keep this document internally within tribes.

When asked how they would like to see potential issues of overharvesting resolved, gatherers including Molly Neptune Parker and Geo Neptune stressed that they would first want to approach resolution within the Wabanaki community. Additionally, Geo noted that they were less concerned about overharvesting sweetgrass, but of secondary effects related to harvesting:

“I think overharvesting is not something we necessarily worry about because it grows back so well. It’s more someone coming and ruining it… It would be that they were leaving trash or trespassing or all the other problems we had in other spots.” -Geo Neptune

Gatherers expressed a reluctance to call in park law enforcement to deal with any potential issues of overharvesting, and instead indicated that they would handle it internally by contacting the people who were over harvesting.

Sharing information about a location that was potentially over-picked and/or picked out is another form of communal governance. They share this information to let other gatherers know to avoid this location and potentially choose other sweetgrass harvest locations. For example, a gatherer shared information of a sweetgrass location being overharvested that year. This area is a well-known sweetgrass location and is frequented by numerous sweetgrass gatherers. This gatherer expressed frustration and told other sweetgrass gatherers her concern about this location being over picked. She articulated she was not going to pick sweetgrass there this year so the sweetgrass could grow back.

Ancestral Relationships

When asked what sweetgrass gathering meant to them, gatherers often reflected on the practice’s ability to connect them with their relatives, ancestors, and communal gathering places:

“It’s definitely a way of connecting to traditions and ancestors, and I always think of my grandfather and my dad when I’m out here because they were always picking. I think about how long places have been picked and you know if you think how awesome it is that for like probably hundreds if not thousands of years you know people have been in this very same spot picking sweetgrass you know for. -Jen Neptune

"Kind of getting to walk where my ancestors lived and my immediate departed family members have been. I mean it's kind of getting a chance to walk with them again."- Kyle Lolar

"It's like I get to be in this place that is outside of the time space that we're in, and it's a place that my ancestors also visited. And because it's outside of time and space they are there at the same time that I am there even though we are both not there physically." - Geo Neptune

Reconnecting with Landscape

Ancestral connections and connections to sweetgrass also figured prominently in the desire to gather sweetgrass on Wabanaki homelands where they were removed from within recent generations. While in the marsh, gatherers reflected on the significance of reestablishing care for sweetgrass, noting that sweetgrass

"If you think about it, this hasn't been picked in 100 years."- Gabe Frey

"Picking sweetgrass, it's a lot, it's very similar to the way I feel about basket making where it's something that my ancestors did and they often did it the same way and in the same places. So to be able to go to this place and come here to probably the very likely that my ancestors did too."- Geo Neptune

Acadia as a Safe Space for Wabanaki-Centered Teachings

During conversations and workshops, gatherers indicated interest in Acadia serving as a location to support intertribal educational efforts. For example, John Neptune and Rhonda London envisioned bringing youth to the marsh to teach about sweetgrass harvesting, and combining the trip with other activities such as going to the beach or crab hunting. During workshops, other gatherers indicated that Acadia's marshes could serve as a location where interested Tribal members could come to learn about respectful ways of picking sweetgrass from other community members.

"Yeah, I'm so thankful [to be in the marsh at ANP]. I haven't had this privilege for a very long time. I was talking about healing yesterday and I was told a long time ago by Bernard and Mona that I was going to learn about the medicines and be like that and I was just like "oh geez, I can't see that" and now I'm like you know I want to learn everything there is to know."- Tania Morey

Gatherers also voiced interest in harvesting at Acadia because it would be a safe space. Many gatherers reflected on shifting access to salt marshes on the Maine coast. Specifically, several people shared stories about being threatened with violence for trying to access saltmarshes adjacent to private property. This all-too-common experience has limited the number of gathering locations that certain people feel safe visiting.

Relationships to the Park/Law Enforcement

A desire for safety also extended to feeling safe during interactions with park law enforcement officers. During conversations and workshops, gatherers suggested a number of ways to promote positive interactions while harvesting sweetgrass. Foremost expressed was the need for park law enforcement officials to be educated about the significance of sweetgrass harvesting to Wabanaki people. Gatherers also emphasized the need for respect and privacy when picking sweetgrass, and a preference for minimal interaction.

"Like kind of like um "can you make sure you call and tell the authorities when you go to church today." "Just so that we know". Does that make sense? And I think a lot of people would have that feeling more than the which is a very real realistic point of view of the park to be like yeah this is federal lands and you know we want to know who's doing what where but then there is also the concept of to the Indigenous people this is the land of our ancestors and if we are going to spend time with them are we to check in first." - Gabe Frey

Workshops

As part of our collaborative research process, we have hosted yearly gatherer workshops in 2018, 2019, and 2020 (virtual). The workshops have been a space to share and receive feedback on research findings, and discuss next steps as a group. These meetings provided gatherers a way to engage in a process with Acadia National Park employees in ways they typically may not have exposure to. For example, gatherers were informed and able to understand the NPS plant gathering rule in detail. Gatherers were able to ask questions pertaining to how Acadia National Park employees may potentially carry out the plant gathering rule. Acadia National Park staff were able to hear directly from gatherers on gatherer concerns, issues, and frustrations with the federal rule.

Workshop Outcomes

As a group, we identified the need for an inter-tribal advisory council and continued conversation in regards to the plant gathering permitting and monitoring process. The group identified concerns about Intellectual property and a desire to create shared writing products. Gatherers also suggested that we create a gathering request letter template, which could be shared with THPOs for each Tribe. This provided an opportunity for direct relationships building between NPS staff and Wabanaki gatherers which led to the creation of a cultural protocol document (Appendix E)

Discussion

A common theme across all gatherers who participated in this study is that harvesting is good for sweetgrass. Caring for plants is a responsibility, and the importance of reestablishing reciprocal relationships for the health of Indigenous peoples, plants and ecosystems has been demonstrated repeatedly in other contexts as well (Baumflek et al, 2021).

Within the sweetgrass response harvest study, sweetgrass responded positively within Wabanaki harvesting plots. Harvest plots stem densities rebound to 160% in the first year after harvest. Plots with no harvesting increased in population by 21% from year 1 to year 2. In this study, Wabanaki harvesting did not show to have a negative effect on sweetgrass stem density. Sweetgrass most commonly reproduces vegetatively. Population increase in control plots could be attributed to the disturbance required to count sweetgrass stems such as shifting and moving the dead vegetation.

When looking at individual harvest plot response, stem density decreased in certain plots over the three years. For this study, stem density and associated plant species were the only factors measured. Precipitation, ground disturbance due to salt marsh shifts, and standing water in specific locations were all observed but not measured. These changes, especially ground disturbance, had obvious impacts on stem density within research plots. Sweetgrass grows throughout the entire study site marsh. While our project surveys found that sweetgrass exists in varying abundance throughout the marsh, only a small subset is long enough to be of interest for harvesting.

It's important to note that while Wabanaki harvesters appreciated the study results, this study showed what collectively gatherers have been stating for generations, "harvesting sweetgrass in a good way is good for sweetgrass".

Indigenous knowledge is a reflection of the community that holds the knowledge. The holistic understanding of Wabanaki sweetgrass gathering demonstrates how a Wabanaki worldview governs sweetgrass harvest decision making. Wabanaki harvesting is not just choices based on observational quantitative sweetgrass response. Harvesting choices are based on an interrelated web of both observation patterns and cultural worldviews and values as seen in Figure 3.2. Dreams, traditional stories, and non-human relationships are all valid forms of knowledge that are included when an individual makes harvest choices.

Wabanaki knowledge expands across generations and is grounded in cultural practices and traditions. Lifelong learning and practice teach Wabanaki people responsibilities to the salt marsh and obligations to sweetgrass. Through this continuous practice, indigenous people can continually observe how stewardship practices affect a landscape. Gatherers understand how their harvest will impact the sweetgrass population and employ site rotation time frames in response. One collective approach to picking sweetgrass in the same marsh is to pick in separate locations within the marsh.

Wabanaki gatherers expressed different variations of harvest techniques such as rotation, harvest amounts, locations choices, and harvest time which had varying effects on sweetgrass stem density. Variations within practice and knowledge is an important aspect of IK where gatherers can harvest in the same location without competing for the exact same quality of sweetgrass. Knowledge and practice that is adaptive and holds variation as a strength can respond to environmental change and leads to resilience.

As a community with diverse needs, gatherers may over pick sweetgrass. While not common, most gatherers had a personal experience or heard a story of a sweetgrass area being over-picked. Gatherers demonstrated rotation, resting of the entire area, and community social networks and communication as tools to reduce long term impacts to sweetgrass. Education and communication through social relationships are two pathways to help prevent and change behaviors negatively affecting sweetgrass populations. Internal governance approaches are preferred over employing punitive approaches such as shutting down harvesting completely or working through law enforcement that may enforce a monetary fine.

Sweetgrass knowledge transfer is an aspect of sweetgrass harvesting. Teaching is often verbal and within the practice of harvesting sweetgrass. Gathering is often done in groups with family members in attendance. This is an important aspect of traditional knowledge generation and transfer.

Research as Healing

Indigenous research as envisioned here is concerned with the ethically and culturally appropriate study of Wabanaki sweetgrass that supports self-determination and sovereignty. Within this study, the holistic aspect of knowledge is described to ensure sweetgrass knowledge sits within a Wabanaki worldview which shows how this worldview is what supports decision making. As researchers, we took a lot of care to ensure Wabanaki people and their knowledge were expressed as a whole instead of a collection of reductive actions.

Wabanaki sweetgrass harvesters and their knowledge employ ethics, accountability, and reciprocity. They hold obligations and responsibilities to their tribal communities, the sweetgrass community, to the salt marsh, and to sweetgrass. They are the best "land managers" for sweetgrass management. Wabanaki frameworks for sweetgrass care taking have ensured sweetgrass has thrived for generations.

Through two eyed seeing approach and centering IK, cultural values and protocols are explicitly built into the research design including relationality and reciprocity with research participants and communities. Wabanaki sweetgrass gatherers were valued as experts and treated as such. While participating in this study, a gatherer expressed surprise at the depth of knowledge she possessed. Another gatherer, Tania Morey, said "*I think there's a lot of healing that's happening and just having the opportunity to do these things proves it".* This study is an example of a research process that can be both healing and mobilizing as opposed to one focused on results and discovery.

The research approach with Wabanaki sweetgrass gatherers provides a strong basis on which to build meaningful co-governance. Group meetings and gatherings with National Park officials and Wabanaki sweetgrass gatherers provided critical time together. The original purpose of group workshops were for the researchers to share research results and hear from the sweetgrass gatherers. Throughout the years of this study, the intent of the annual meetings evolved and expanded. While conversations around research were always present, conversations expanded into Wabanaki harvesters concerns about picking sweetgrass within Acadia National Park. Gatherers also expressed frustration to NPS officials about harvesting sweetgrass under the a NPS plant gathering rule and federal regulations. These meetings allowed for a direct relationship between sweetgrass gatherers and Acadia NP officials where information was exchanged. This removed the researcher as the "gate keeper" of information and further supported Wabanaki sweetgrass gatherers as decision makers within the study. The written cultural protocol is a direct result of these meetings.

Future Considerations

Increased precipitation and sea level rise are two climate change predictions that will affect salt marshes in Maine and Wabanaki sweetgrass gathering. For Maine summers, the predicted increased precipitation will be in the form of extreme weather patterns such as increased storm events with heavy rainfall and increased drought periods (Jacobson, Fernandez, Mayweski, & Schmitt, 2009). Precipitation is one of the main factors affecting sweetgrass health and the predicted extreme weather patterns will negatively affect the quality of sweetgrass for harvesting

While the extent of sea level rise in Maine is unknown, the saltmarshes within Acadia National Park are projected to rise (Nielsen & Dudley, 2012). A healthy marsh can respond to sea level rise through shifts and horizontal migration. Soil accretion and space for horizontal migration are two factors in determining salt marsh response to sea level rise (Nielsen & Dudley, 2012). Salt marshes alterations, such impoundments, dykes, and historical farming practices negatively affect soil accretion (Vincent et. al, 2013). The study area marsh has dykes, impoundments, and private land parcels bordering the marsh. All of these factors may negatively affect the study area marsh response to sea level rise (Nielsen & Dudley, 2012). If the marsh is not able to migrate, inundation will occur and the salt marsh may dramatically change in species composition negatively affecting Wabanaki sweetgrass harvesting.

Conclusion

Wabanaki sweetgrass knowledge is a practice and is held within Wabanaki ways of being where non-human, community, and self all play a part in the formation of knowledge and setting obligations that govern the expression of this knowledge. While we are reporting on the findings in this 5-year study, we want to reiterate that this study is not to objectively set boundaries on sweetgrass harvest practices. Wabanaki Sweetgrass gatherers are extremely experienced in knowing when and how to harvest sustainably. They adapt their harvest style based on their knowledge and practice. Indigenous harvesters are the holders are the best available science for their own practice.

There are few examples of tribal plant gathering and management in national parks that can serve as models. At the onset of this project, congressionally authorized plant gathering by Tribes was permitted in only eight of 401 park system units. Six of these were located in the Southwest. As the entire park system faced proposed regulatory changes, examples of sustainable plant harvesting protocols created in collaboration with Tribes are needed in more densely populated northern and eastern regions.

CHAPTER 4

Mapping with Wabanaki Black Ash Harvesters: Identifying Critical *Fraxinus Nigra* Habitat in Houlton, Maine

Black ash basketry is a vital form of cultural preservation and economic security for Wabanaki people. The impending scarcity of ash trees threatens Wabanaki livelihoods and cultural continuity. The loss of black ash *(Fraxinus nigra)* will have devastating effects on Wabanaki culture and incomes. Wabanaki sale of baskets in Maine exceeds $150,000 annually (Daigle & Putnam, 2009). With recent Emerald Ash Borer (*Agrilus planipennis*; EAB) detection in Maine, this is a critical time in preparing for the inevitable EAB invasion of this culturally sensitive ash resource. Basket makers, scientists, and natural resource professionals have expressed a need for basket-quality black ash management tools in the wake of EAB detection. Prioritizing basket quality black ash and collecting baseline data of basket quality black ash stands is an initial step to effectively develop a culturally informed invasive species response plan. Through Indigenous research methodology and a mixed methods approach I developed a habitat suitability model to represent the landscape distribution of basket quality black ash and ground truth modeling with Wabanaki harvesters. Collaboration and co-production with Wabanaki harvesters are a central component of the study design. Results will contribute to black ash response planning and potential restoration efforts.

Introduction

For Maliseet, Mi'kmaq, Passamaquoddy, and Penobscot people (Wabanaki), the invasive beetle Emerald Ash borer threatens the sustainability of black ash basketry. Black ash is the main and essential component of Native American ash basketry. Wabanaki people living within Maine and the Atlantic Provinces hold spiritual, economical, and cultural connections with black ash. Known to the Wabanaki as the basket tree, black ash can be pounded and split along its growth rings to produce exceptionally strong and pliable strips to weave. Basket quality black ash stands are difficult and time consuming to locate. Black ash is found in a small proportion of the total forest of Maine and Wabanaki harvesters report about 5%-20% of black ash trees are suitable for basket making (Constanza et al., 2017). Specific width, flexibility, and durability are essential characteristics of basket quality black ash. Through Indigenous knowledge, Wabanaki basket makers understand environmental characteristics associated with basket quality black ash. Black ash harvesters report increasing difficulty obtaining basket-quality trees and have expressed concerns for the future of black ash trees due to the inevitable infestation of EAB.

The Emerald Ash Borer, native to China, was first detected in Michigan in 2002 (Cappaert et al., 2005). The invasive beetle has since spread east to New England and two Canadian provinces, with EAB detection in Maine in 2018 (Siegert et al., 2014). EAB spread is due to both natural and human-influence dispersal. EAB natural dispersal creates a gradual range growth with the median distance of adult flight less than 3 kilometer (Taylor et al., 2010). Females will lay most eggs within 100 meters from their emergence point when ash trees are in the immediate vicinity (Mercander et al. 2009). Human-influence dispersal has greatly increased the distribution of EAB. At low densities, EAB can be difficult to visual detect unless the tree is debarked. Daigle et al. (2019) identified campers who thought their firewood was safe and reported transporting firewood even though they had heard of EAB and the dangers of transporting EAB in firewood. Unknowing tourist and second homeowners unintentionally transport EAB infested ash material, such as nursery trees, logs, or firewood, to non-infested EAB locations. Both of these human influenced infestations create the long-distance dispersal of EAB. Low-density infested ash materials create new satellite populations far from the original infestation sites. Satellite populations will grow and eventually merge to create a new primary invasion front. Inadvertent human transport of EAB infested material has accelerated EAB's spread east across ash habitat (Cappaert et al., 2005; Mercader et al., 2009).

EAB is a bark-boring beetle that feeds on any *Fraxinus* species leaves and lay eggs within the bark of ash trees. Adult beetles lay eggs individually within bark cracks and crevices, and larvae hatch within two weeks (Wang et al., 2010). Neonate larvae bore through the outer bark and begin feeding in galleries in the phloem and cambium, disrupting the translocation of water and nutrients (Cappaert, Mccullough, Poland, & Siegert, 2005). The initial EAB infestation is difficult to observe, but as larval density builds within a tree, canopy thinning and branch dieback become evident (Herms & McCullough, 2014). Once EAB infestation begins, ash trees result in almost 100% mortality within three to six years (Poland et al., 2011; Klooster et al., 2014). Most larvae complete their feeding and overwinter in small chambers in the outer bark or within the outer 1–2 centimeters of sapwood (Cappaert et al.,2005). Larvae pupation occur in mid to late spring and adults emerge soon thereafter to find another ash host (Cappaert et al., 2005). Since the arrival of EAB, tens of millions of ash trees have been killed in the north central United States (Poland & McCullough, 2006). Black ash is EAB's preferred host and has the least resistant to EAB invasion (Siegert et al., 2021).

Invasive forest pests are major drivers of forest disturbance in the northern regions (Dukes et al., 2009). Invasive species coupled with climate change pose a threat to forest resilience and sustainability (Reo & Parker, 2013). Invasive species shift forest structure and composition, affect ecosystems functions, impact economic systems, and can have detrimental impacts to the people who rely on plants (D'Amato et al., 2023b; Gandhi & Herms, 2010). Native Americans depend upon forest systems for cultural, spiritual, and economic activities (Frey et al., 2019). Many forest locations are ancestral sites with generations of Native American care and stewardship. Considered cultural keystones, forest species have shaped the identity of Indigenous people and in return native people care for the health of these species (Garibaldi & Turner, 2004).

Invasive species response planning is a high priority for Native American natural resource managers (Dockry et al., 2023). Indigenous people's approaches to protect their cultural resources from invasive species is underrepresented within the literature (Pfeiffer & Voeks, 2008; Wehi et al., 2023). What is published highlights Native Americans engaging in a combination of Indigenous knowledges and western science to proactively responds to invasive species on Tribal lands (Reo et al., 2017; Wehi et al., 2023). Reo et. al (2017) found Native American harvesters are far less concerned with invasives as a "threat" and more concerned with the colonial "invasive land ethic" that imposes a command-and-control approach within invasive species management. Indigenous relational ontology does not separate humans from environments. For many native people, plants are relatives and in return, native people have care taking responsibilities towards plants (Baumflek et al, 2022; Lynn et al., 2013; Whyte et al., 2018; Muir et al., 2010). Native people can view invasive species as new relatives to understand and require the time to become familiar with these new relatives (Mattes & Kitson, 2021; Reo & Ogden, 2018; Schelhas & Alexander, 2021). Bang et al. (2014) found the term invasive species reinforces a western ideology and suggests the alternative term "plants that people lost their relationship with". While EAB negatively impacts a highly valued cultural species like black ash, an indigenous response to invasive species may look different than western invasive species management approaches (Doiron, 2023; Reo & Ogden, 2018). In Reo & Odgen, 2018, an Anishinaabe elder asked," has anyone ever gone and laid their tobacco down and asked this bug [Emerald Ash Borer] to leave?".

Invasive species response planning typically engages western science approaches to help identify, predict, and respond to the invasive threats (Wehi et al., 2023). Native people are highly impacted by invasive species, yet Native American lifestyle or perspective is rarely a factor in invasive species response planning (Harris & Harper, 2000). Typical invasive species management techniques, such as eradication approaches, rapid response, and herbicide spraying, can be in conflict with Native people's practices and disproportionally affect Native harvesters. Herbicide spraying may create health risks for native people that harvest and consume host species of the targeted pests (Head & Atchison, 2015). With reliance on multiple species in one forest habitat, Native people can be extremely hesitant to employ western suggested pest management approaches such as tree removal for single species retainment (Alexander et al., 2017). In California, Alexander et al. (2017) found Native Americans adamantly opposed the western science based recommendation of pepperwood (*Umbellularia californica*) tree removal in favor of protecting oak (*Quercus spp.)* trees. Both pepperwood trees and oak trees are culturally important species and the pepperwood tree can serve as an inoculum reservoir for fungus-like plant pathogen that causes sudden oak death. Rapid

Response approaches to reduce the spread of invasives rarely allow for the time required to build trust between State, Federal and tribal governments. Cross cultural diplomacy between state, federal, and tribal entities is important to ensure an effective collaboration and an invasive species rapid response can exacerbate institutional distrust (Alexander et al., 2017; Mackenzie & Larson, 2010).

Historically natural resource policy and management decisions have relied solely on western science and Native people have largely been left out of decision-making processes that impacts their livelihood (Huntington, 2000). With the impending arrival of EAB, Wabanaki harvesters, University of Maine researchers, and federal and state agencies created the Black Ash Task Force in 2011 (Ranco et al.,2012) This collaborative working group helps to support proactive invasive species responses and create culturally driven tools for Wabanaki black ash issues. The task force priorities have focused on early education, outreach efforts, relationship building, and supporting Wabanaki Black ash harvesters and tribal Forestry departments. Outcomes include pushing for State and Federal regulatory responses of a firewood ban to slow the spread of EAB within the State of Maine, creating black ash inventory protocols, testing black ash log preservation techniques, supporting seed saving, tribal forestry trainings, and cross-cultural knowledge sharing (Siegert et al., 2014, Siegert et al., 2023; Everett, 2019; Costanza et al., 2017; D'Amato et al., 2023b). Shifting invasive species management approaches to include Indigenous ontologies and cultural values can create diverse outcomes that address tribal needs (D'Amato et al., 2023b; D'Amato et al., 2023a; Wehi et al., 2023). For Indigenous people, natural resource decision-making such as invasive species planning, is an expression of Tribal sovereignty (Kahn, 2013).

Wabanaki basket makers, scientists, and natural resource professionals have expressed a need for black ash management tools in the wake of EAB detection. EAB is expected to affect 95% of black ash range by 2025 (Siegert et al., 2023). Tribal forestry departments in Maine are in a pivotal position to proactively plan for the impending EAB infestation. This is the time to develop an EAB plan of action and response such as insecticide in choice seed trees, collect ash seeds from high quality trees, and identify sites for future regeneration activities (Everett, 2019). Evertt (2019) developed protocols for black ash inventory across Wabanaki territories However, black ash must first be located to inventory and effectively develop response plans. Initial steps towards in developing an EAB response plan is to know distribution and abundance of black ash stands.

The research consists of three objectives:

- Objective 1. Construct a GIS map predicting basket quality black ash in the Houlton, Maine region
    - Hypothesis: location of basket quality black ash in Maine can be predicted with independent variables that can be mapped such as topography, soil drainage, forest type and distance to water.
- Objective 2. Evaluate and assess accuracy of basket quality black ash habitat prediction model.
- Objective 3. Assess accuracy of basket quality black ash habitat prediction model on commercial forest land.

Methodology

Indigenous research methodology (IRM) was employed within this study. Indigenous research methodology is about centering Indigenous principles into a methodology so that research practices can assert Indigenous people's rights and sovereignty over their own knowledge (Datta, 2018). A central tenet of IRM is to remain accountable to communities by involving them in all aspects of research. Other practices include community involvement in design, shared power over the implementation and use of the research, and the research benefits the community the knowledge is derived from (Peltier, 2018).

Research Approach

This is a participatory GIS study that employs a mix method approach within. GIS mapping and remote sensing can provide tools in creating a proactive invasive species response and management over a large landscape. While GIS mapping is cause of concern for Indigenous people due to lack of knowledge protection, participatory GIS is a growing field where maps are context or issues driven and community involvement is emphasized in the production and use of geographical information (Dunn, 2007). Participatory GIS allows local priorities to feed into regional policy and planning (Davies & Acieem, 2015). Habitat suitability modeling is one tool that could enhance access to non-timber forest products or cultural resources (Baumflek et al., 2015). Habitat suitability models combine relevant environmental variables with occurrence data to estimate the actual or potential distribution of a species as well as socio-ecological factors that affect harvesting (Elith & Leathwick, 2009). Hyperspectral imagery can help to understand current distribution, quality, spatial, and temporal information of current ash stands.

Quantitative methods are used in creating a GIS map of ecological characteristics associated with basket quality black ash to predict basket quality brown ash location in Maine. Qualitative methods were employed in understanding the accuracy and usefulness of the GIS maps. This approach not only builds upon and refines a map of high-quality black ash sites in Maine, but also, more importantly focuses on the application of the map with Wabanaki black ash harvesters and contributes to Tribal natural resource departments EAB response planning. All harvester information is owned by the Tribal harvester. No specific ash location information will be shared within this study.

Wabanaki Black Ash Knowledge

Black ash, over other tree species used in basketry, has specific characteristics that allow the wood to split along its growth ring with repeated pounding. The wood quality, such as flexibility and durability, combined with the width of the growth ring are the main factors in choosing the appropriate tree. The ideal ring width ranges from 2 mm to 5 mm (personal communication Richard Silliboy, 2009).   Basket quality black ash stands are difficult and time consuming to locate. Black ash is found in a small proportion of the total forest of Maine such as 1-2% and Wabanaki harvesters report about 5%-20% of black ash trees are suitable for basket making (personal communication Richard Silliboy, 2009). Through traditional knowledge and generations of experiences, Wabanaki basket makers understand the environmental characteristics associated with basket quality black ash. Basket quality black ash habitat characteristics are specific soil drainage, landform, hydrology source, and forest type (Costanza et al., 2017).

Study Area

My model focus is in Houlton, Maine, which is located in south-eastern Aroostook County, in Northern Maine (Figure 4.1). Aroostook County is located in an ecological transition zone where temperate northern hardwood forest meets boreal spruce-fir forest. Mean annual temperature for the region are 37-43 degrees Fahrenheit. As a result, growing seasons are relatively short, lasting around 100-120 days.

The Houlton Band of Maliseet Indians (HBMI) Tribal locations and majority of lands holdings is based along the Meduxnekeag River in southeastern Aroostook County. HBMI is one band of seven bands that comprises the larger Maliseet Nation along the St. John River and its tributaries.

Black ash has been well studied within the western and central regions of the species range, namely in Minnesota and New York (Benedict & Frelich, 2008; Fraver et al., 2022; Looney et al., 2015, 2017; Palik et al., 2011; Touchet, 2000). Black ash within Maine, the eastern border of the range, has not been extensively studied. With Maine's strong black ash population, range location, strong IK base with active basket makers and area of management concern due in EAB, Houlton, Maine was chosen as a study area. For the model, the Meduxnekeag River, extending from Houlton to Littleton, Maine, was chosen due to availability of information for known basket quality black ash locations. I am a citizen of HBMI, a basket maker, and have personal relationships with basket makers from the region.

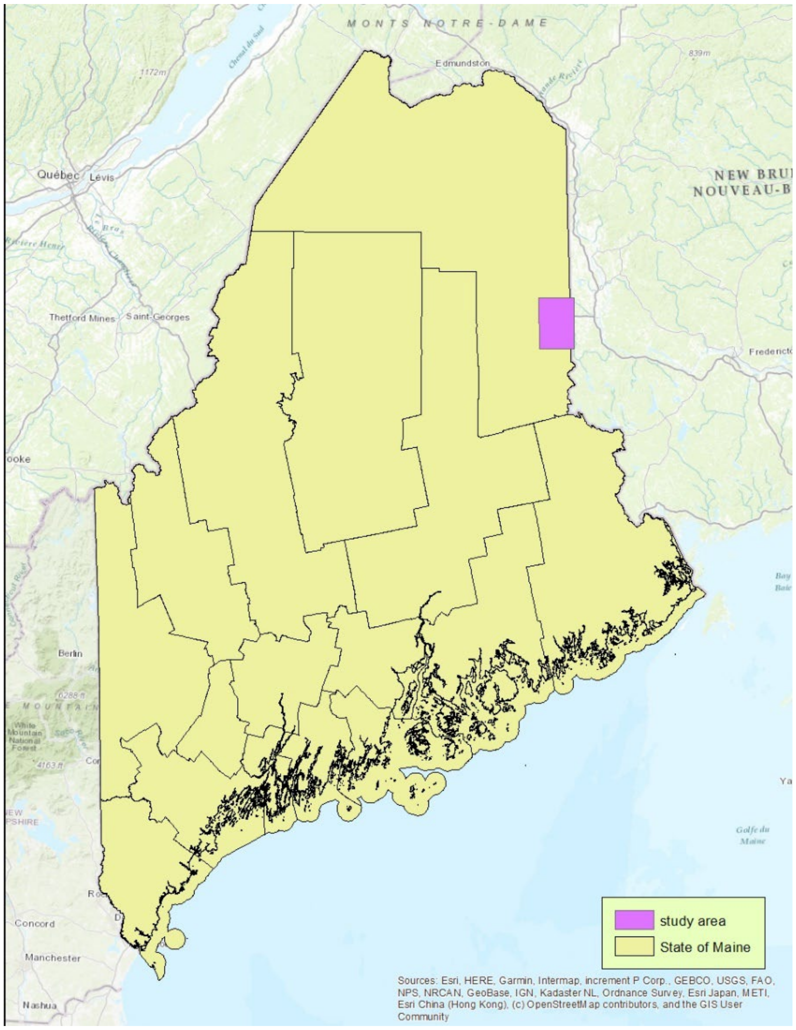

Figure 4.1 Study area

Methods

Data Generation

Empirical research remains limited on basket quality black ash. Flow type and basal area of softwoods/hardwoods are two predictors of black quality black ash (Costanza, 2015). Specific characteristics associated with basket quality black ash, such as soil drainage, landform, hydrology source, and forest type, were used in predicating basket quality brown ash habitat found in Table 4.1. (Costanza et al., 2017). Data sources and the resulting model parameters are shown in Table 4.1.

Reference Sites

Twelve black ash stands within the region of Houlton, Maine was identified and Wabanaki ash harvesters evaluated each stand as either basket quality or poor quality. A Wabanaki harvester identified six sites as poor quality, six sites were identified as basket quality. These sites serve as reference sites to construct and test the black ash habitat suitability model.

Remote Sensing Data

From the USGS Earth Explorer I downloaded Landstat 5 Path 11 Row 28 for September 11, 2011. All data layers were projected in the Universal Transverse Mercator, Zone 19N, North American Datum of 1983 coordinate system.

Geospatial Data

I obtained data layers to construct the model through Maine GIS Data Catalog, the Natural Resource Conservation Service Geospatial Data Gateway, and the USGS Earth Explorer website. I acquired the political layers, state, county, roads, hydrology, and Digital Elevation Model in 10 meters, from Maine GIS catalog. Soil data from the Soil Survey Geographic Database (SSURGO) for Aroostook County, Maine were downloaded from the Geospatial Data Gateway. All data layers were projected in the Universal Transverse Mercator, Zone 19N, North American Datum of 1983 coordinate system.

Model Development

The habitat suitability model was created using ARC GIS software, version 10.2 (ESRI. 2014). Flow accumulation represents the accumulated flow of water downslope as water moves via gravity. Flow accumulation basically counts the number of cells sending water downslope to the cell being evaluated. Ridge tops would have a flow accumulation of only 1while the value bottoms would have maximum accumulation. With the DEM in 10 meters, flow accumulation, slope and hill shade were created. Flow accumulation was reclassified for all values 0 to 10 to zero and 10 to 5,600,000 to 1.

A Landstat 5 TM Path 11 Row 28 image of September 11, 2011 was used for analysis. The aerial imagery was clipped to study area. An unsupervised classification was conducted due the lack of training data and ability for fast analyses. Initial classification had 30 classes. I assessed the land class with aerial imagery and converted the 30 classes to 10 classes; wetland, water, softwoods, hardwoods, mixed forest, impervious surface, grassland, farmland, disturbed (forest regrowth). I reclassified wetland, softwood, impervious surface, grassland, farmland, and water to the value zero. Hardwood and mixed forest were reclassified to 1. A time series analysis through 3 date NDVI with Landstat 5 TM Path 11 Row 28 images was conducted. The dates of the Landstat images are June 21, 1987, September 3, 1999, and September 11, 2011. An unsupervised classification was conducted with 30 classes. These 30 classes were converted to 5 classes; no change, water, regrowth, disturbance, and non-forest. All 12 ash stands were found within no change. I reclassified no change to a value of 1 and the other classes to a value of zero.

A buffer of 75 meters around the river vector layer was conducted. The distance was determined by the data shown in Table 1. The six known "good" sites were within 75-meter distance to the river. Basket quality brown ash was found in drained soils. Soil drainage map using Soil Data Viewer was downloaded. Polygons with drainage classes for "moderately well drained" to "excessively well drained" were selected.

Using Plus Tool in Raster Calculator function of the Spatial Analysist toolbox, I calculated suitability by adding the three maps together: land classification, forest change and flow accumulation, and created values of 0 to 3. Cells with a zero value predicts no basket quality ash habitat. Cells with the values 1 to 3 indicate a range of probability of basket quality brown ash with 3 being the highest probability of basket quality. I extracted the habitat suitably map by the buffer of 75 meter. I then extracted that map by the drained soil layers.

Predictor Variable Development

The reference sites were used to identify each data layer's threshold to predict basket quality ash sites and determined reclassification values. The training areas were based on these reference sites. This approach was appropriate given this model was developed to represent Wabanaki black ash knowledge. Given the exploratory nature of the model and the inclusion of Wabanaki black ash knowledge, a wide net was cast in how GIS data layers could represent different components of Indigenous knowledge. With a small data set of ash sites, descriptive statistics were calculated primarily to visually identify trends and thresholds (Table 4.1).

Table 4.1. Data Generation Table. The process to represent Wabanaki Knowledge of black ash habitat with corresponding GIS data layers. The map parameters are the corresponding ecological variables found within data layers for ArcGIS. The parameters serve to represents the ecological characteristic associated with basket quality black ash sites

Wabanaki Knowledge	**Map Parameters**	**Data Source**	**Threshold Value**
Ash grows near flowing water	Flow Accumulation	Digital Elevation layer	Cell values < 10
Ash grows in floodplains along rivers	Distance to river	River layer from MEGIS	Area> 75 meters from river
Ash grows with hardwoods	Hardwood companion species	Landsat	Hardwood and mixed forest types
Ash is at least 5" DBH	Stand age	Landsat – time series	Forest with no disturbances within 30 years
Soils are wet but not too wet	Soil drainage	USDA soil layers	Well – moderately drained soils

Model Evaluation

Six basket quality black ash stands within the reference sites were used to evaluate the model. With a Wabanaki harvester, the perimeter of these six sites were established. Cell values were tallied to understand the percentage of high probability pixels within the basket quality reference sites. A Wabanaki harvester and I reviewed the black ash habitat suitability map to identify locations with a similar probability matrix as the reference sites. We identified 25 probable basket quality black ash locations. These 25 locations were visited with a Wabanaki harvester and the harvester qualified these areas as low-quality habitat, moderate quality habitat, or high-quality habitat. Wabanaki harvesters' comments were noted. These observations are not an exhaustive assessment of the sites, just observations made as we walked through the locations.

Commercial Forest Company

The habitat suitability model was applied to a small area on a commercial forest land. I sent the model to the commercial forest company GIS specialist. He applied the model and produced a basket quality black ash habitat map to ground truth.

Results

Reference Site Evaluation

The six black quality ash reference sites have an average size of 2.159 hectare. The 6 sites have an average of 187 pixels with the highest quality probability, 495 pixels with the moderately suitability score, 127 with low probability scores, and 14 with zero value (Table 4.2). Moderate and high habitat suitability accounted for 23% and 60% of all cells respectively, whereas cells with null or low habitat suitability accounted for 2% and 15% respectively as shown in Table 4.2. An example of one reference site with the habitat suitability probability matrix is shown in Figure 4.2.

Table 4.2. Reference sites (N=6) habitat suitability matrix cell count averages

Habitat Suitability Score	**Average Cell count**	**% representation**
High probability	187	23%
Medium probability	495	60%
Low probability	127	15%
Null	14	2%

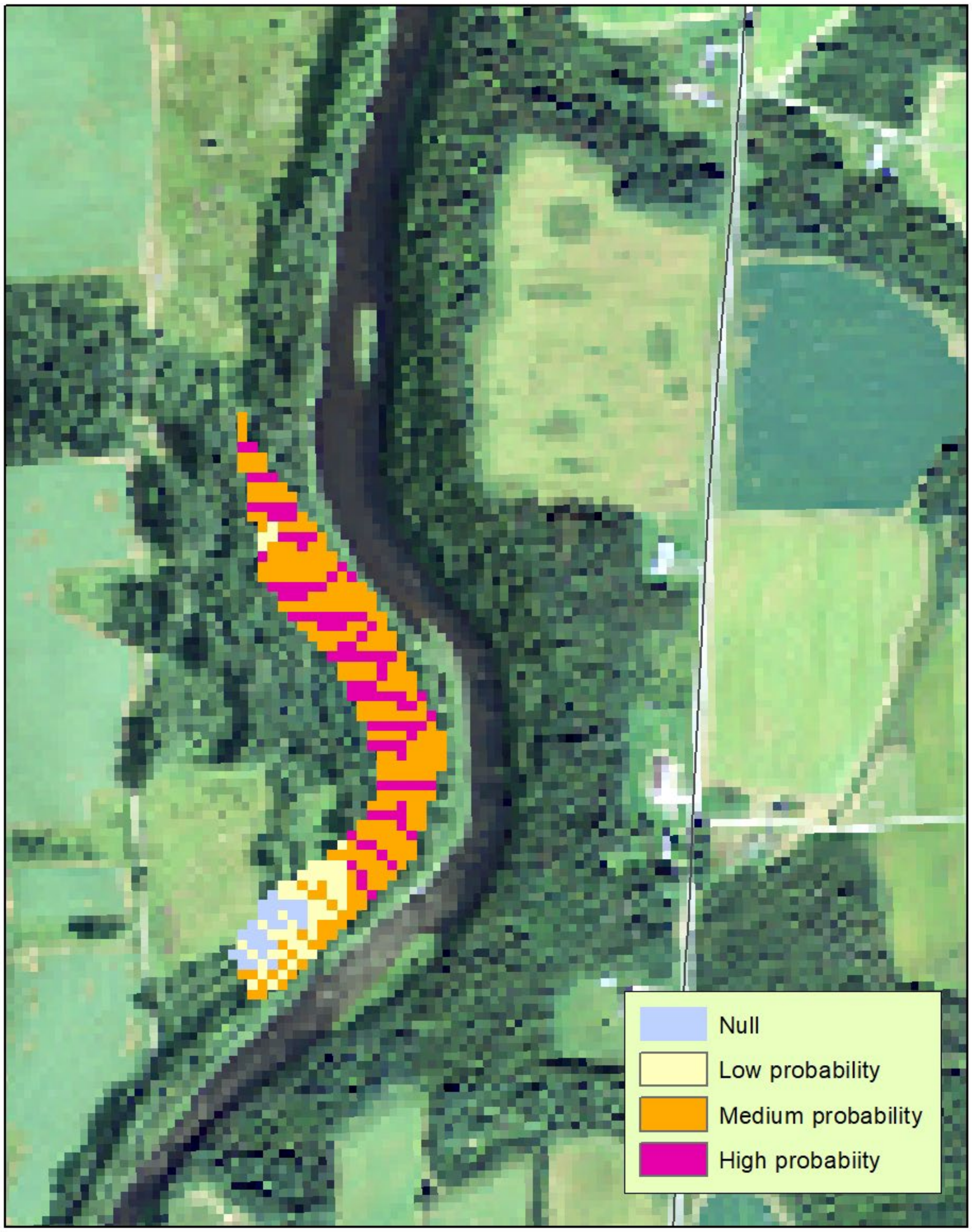

Figure 4.2 Reference site (Basket quality black ash site) depicting probability matrix.

Harvester's Observations of reference sites: These stands are high quality ash stands. The trees are predominantly black ash with a few hop hornbeam (*Ostrya virginiana)* and elm (*Ulmus americana*) growing with the black ash. Cedar (*Thuja occidentalis L*.), white ash (*Fraxinus americana*), balsam poplar (*Populus balsamifera*), box elder (*Acer negundo)* are growing near the stand, mostly around the perimeter or the stand edges. All sites had black ash regeneration present as small seedlings or young saplings. The harvester observed previous notching of black ash trees which indicates people had been harvesting black ash in these locations for a while. These areas are good fiddlehead (*Matteuccia struthiopteris*) locations. Red elderberry (*Sambucus racemose*), choke cherry, (*Prunus virginiana*) were observed. Herbaceous plants such as blood root (*sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), dolls eyes (*Actaea pachypoda*), zig zag goldenrod (*Solidago flexicaulis*), wood nettles (*Laportea canadensis*), meadow rue (*Thalictrum sp.),* cow parsnip *(Heracleum maximum),* and poison ivy (*Toxicodendron radicans*) were present. Invasive species such as moneywort (*Lysimachia nummularia*), garlic mustard (*Alliaria petiolate*), and honeysuckle (*Lonicera japonica Dipsacales*) were present.

Habitat Suitability Prediction Sites

From the 25 locations, the harvester identified 10 sites that were high quality habitat, 9 sites a moderate quality habitat, and 6 sites as low-quality habitat. From the 25 sites, 3 sites were found with basket quality black ash, 16 sites had little to no ash but was considered good or ideal locations for basket quality ash to grow, and 6 sites were considered not suitable for basket quality ash. With 19 from 25 locations identified as moderate to high quality habitat, the model is 76% accurate for predicting black ash habitat. With 3 sites from 25 locations identified as currently having harvestable black ash, the model is 12% accurate at predicting basket quality black ash presence.

Harvester's Assessment:

Basket Quality Black Ash Sites

The three sites with harvestable trees were high quality black ash in this stand. These locations were similar in site characteristics to the reference sites.

Moderate to High Quality Black Ash Habitat Sites

The harvester expressed many of these sites would be an either an ideal or possible locations for basket quality black ash to grow but black ash was not dominant enough to produce basket quality black ash. Some of these sites had young ash saplings mixed with other hardwoods. Other sites had one to two large black ash trees were not basket quality due to the low limbs, curvature in the trunk and damage on the outside of the tree. Common tree species observed were balsam popular (*P. balsamifera)*, box elder (*Acer negundo*), white birch (*Betula papyrifera*), and white ash (*F. americana).*

As the predicted sites were located closer to and within populated areas, the sites tended to have more recent human disturbances, such as trails, utility areas, and/or clearing of trees. The harvester noted that the site conditions were good, but the amount of tree removal made it challenging to identify these sites as high-quality habitat.

Low Quality Ash Sites

In the low-quality sites, the harvester could quickly assess these sites as poor quality. The harvester expressed the ash trees growing in these areas did not have visible indicators of a good ash tree. The bark was extremely thin, flat, with large flakes instead of a healthy corky bark with deep ridges. This is an indicator of extremely thin growth ring within the black ash tree. The tree roots were showing like knees around the tree. This is an indicator of too much standing water or the water not draining fast enough.

Private Forest Land

The model I received was as a shapefile (Figure 4.3). Habitat pixel matrix could not be evaluated.

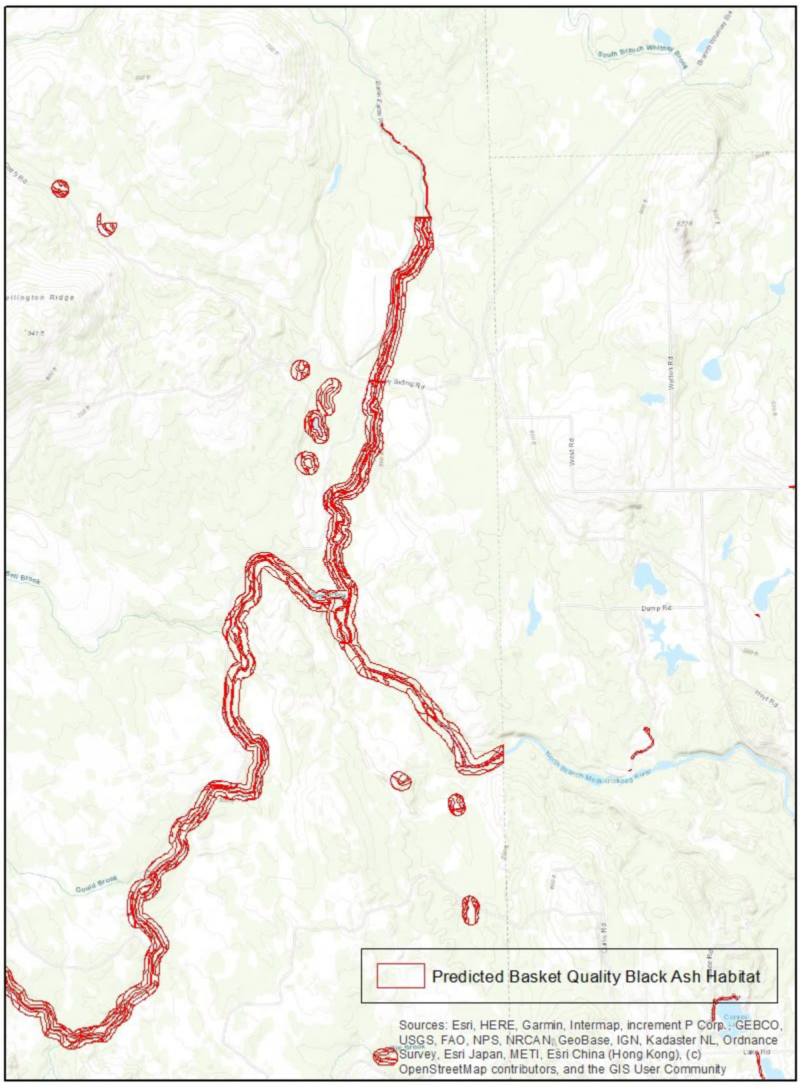

Figure 4.3. Black Ash Habitat suitability prediction on commercial forest land.

Harvester's Assessment:

The Wabanaki harvester qualified the majority of the landscape as moderate to high quality with some low-quality areas.   The high-quality location was at the confluence of the two rivers. Within this location, one large black ash tree was found. Red maple (*Acer rubrum*) was the dominant tree species within the ideal basket quality black ash habitat. No other tree species was observed. There were no visual signs of black ash regeneration. The harvester noted how this site was different than the reference sites. This site was a lot darker in the understory and the understory vegetation were less robust and less diverse.   Sensitive fern (*Onoclea sensibilis*) was dominant in the understory.

Discussion

Model Accuracy

Wabanaki basket makers know that the environment plays a large role in affecting a black ash tree to be basket quality. Harvesters will look for specific site conditions such as hydrology, land form, companion tree species, and soils when searching for basket quality black ash tree. The model creation in this study attempted to represent some of these characteristics within GIS and apply these characteristics over a large land base to predict basket quality habitat. The model developed in this study effectively identified basket quality black ash habitat with an accuracy rate of 78%. Through this study we identified 19 basket quality habitat locations. For identifying the current distribution of black ash, this model is only 12% accurate. On its own, this model is not effective in predicting black ash distribution.

Land Use History

Land use history was a factor in all of the black ash sites within this study. The reference locations which served as the foundation for constructing the black ash habitat model are sites that Wabanaki harvesters identified. These sites were not randomly found but are active black ash harvest stands.   Native people have been caretaking these black ash stands for generations, harvesting basket quality ash from the reference sites every couple of years (personal communication with Fred Tomah, 2010). While the level of influence has not been measured, generations of Wabanaki caretaking within these stands cannot discounted. Native people can harvest from these locations and know they can return to harvest again within a couple of years. Wabanaki black ash harvesting has a regenerative component embedded within their practice which is evident within their continuous relationship with these locations.

The basket quality habitat locations with little to no ash present had land use history affects as well. Many of the trees observed in habitat locations were shade intolerant species, such as balsam popular (*Populus balsamifera L.*), box elder (*Acer negundo*), and white ash (*Fraxinus americana*). These sites typically had working farm fields or land clearings directly adjacent. Farming has occurred in the study area for over 150 years. Starting around 1870, with the arrival of railroads and potato starch factories, farming grew to a larger scale and Aroostook County became known the "potato empire" (Ellis, 1938). The intensity of farming has declined considerably since the peak in the 1940's (Johnston & Cardenas, 2012). During the site visits about half of the adjacent fields were in agriculture production and others were open hay fields. The predicted habitat sites are probably early successional forest after farming disturbances. One of the reference sites had indicators of a past farming land use. A small foundation with a non-native shrub was observed in the reference site understory. In this site, black ash saplings were more abundant more than in the other reference sites. Little is known about black ash stand dynamics and disturbance history (Costanza et al., 2017), but this site indicates that many of the habitat locations could lead to black ash stands if allowed or encouraged.

Limitations

Land use history affects may have been demonstrated better if the remote sensing time series layers were updated to capture a broader time scale. Currently, the model uses three dates between 20-year time span of 1987 to 2011. Employing an earlier date may have captured the observed historical farming effects. Including a more recent date may have capture the land use history of trails and other clearings. The initial objective of this model was to predict distribution of basket quality black ash. This objective is based on the hypothesis that the location of basket quality brown ash in Maine can be predicted with independent variables that can be mapped such as topography, soil drainage, forest type and distance to water. This hypothesis is not supported. The predicted habitat locations rarely had basket quality black ash. The presence of the high-quality ash stands may be due, in part, to land use history including the continuous generational Wabanaki caretaking within black ash stands.

Applications

Practical, applied, and on the ground support is a priority for Tribal forestry departments (Dockry et. al. 2023). Tribal natural resource management requires knowing the distribution and abundance of black ash trees to develop an EAB response plans. The habitat prediction model in combination with hyperspectral imagery that can identify the presence of ash trees could further support identifying basket quality black ash distribution. Hyperspectral imagery is successful at identifying black ash (Furniss et al., 2022). Though the cost of hyperspectral imagery over a large landscape may be cost prohibited for many Tribal forestry departments. Multispectral imagery is a less expensive alternative and may be more ideal for large scale mapping (Furniss, 2021). While GIS tools that extract and extrapolate information reduce time and financial expenditures for Tribal invasive species response planning, collaboration with Wabanaki ash harvesters remains crucial. In developing these tools, the intent is to not remove the Wabanaki black ash harvester from their knowledge, but to help foster a relationship between Tribal forestry employees and the traditional harvester. Employing the habitat suitability model, multispectral imagery in collaboration between Tribal forestry department and Wabanaki black ash harvesters could lead to culturally targeted invasive species management approaches that incorporate Indigenous perspectives.

GIS tools such as the habitat suitability models can be helpful for Native harvesters. The state of Maine is predominately privately owned, with 94% private ownership (Rumpf, 2015). Wabanaki harvesters' cross private property to access their traditional harvest locations, and report access reduction due to private property posting (Ginger et al., 2012). Federal and State conservation lands such as national parks, land trusts, and state parks are moving towards restoring indigenous access and harvesting. The habitat suitability model could be a complementary tool for Wabanaki harvesters in identify new ash locations on unfamiliar landscape. Even without the ability to predict current ash stands, the Wabanaki harvester found the model useful in helping to narrow down search locations.

Future Work

Black ash grows within sensitive ecological niches such as wetlands, riparian river zones, and vernal pools, and these trees serve as a foundation species that regulates ecosystem processes and community structure (Ellison et al.,2005). Black ash stands within mesic sites such as river floodplains and vernal pools are considered ideal basket quality sites as reported by Wabanaki basket makers. In these sites, soils tend to be well drained and anaerobic conditions are not constant throughout the growing season. While black ash thrives in these conditions, the trees experience more competition from other tree species when compared with wetter sites (Benedict & Frelich, 2008; Looney et al., 2018). EAB induced ash mortality will create large canopy gaps, which will increase light availability and reduce moisture. The other tree species present will have an advantage while the remaining ash trees are stressed under an EAB infestation (Cappaert et al., 2005; Iverson et al., 2016).

Black ash shows very little response when EAB densities are low (Cappaert et al., 2005; McCullough et al., 2019). As EAB densities increase, black ash will start to decline and over the period of 6 to 8 years overstory mortality occurs (Siegert et al., 2021). With black ash mortality, sites will likely experience shifts in stand structure and composition, such as a transition to a non-forest condition dominated by shrubs and grasses (Klooster et al., 2014). With fewer trees, the water table will be projected to rise and ecological functions will change (Slesak et al., 2014). Red maple (*A. rubrum*), elm (*U. Americana*), swamp oak (*Quercus bicolor*) are possible candidates for tree replacement within Minnesota ash stands (Looney et al., 2017). Swamp oak (*Q. bicolor*) ranges does not extend to Maine (Clark, 1965). Elm is uncertain to reach canopy height due to a concern that as disease resistance elm densities increase, disease tolerance will lower (Slavicek & Knight, 2012). Red maple seems the best candidate, but planting red maple within basket quality black ash stands may pose an issue for Native people.

Basket quality black ash stands host a variety of culturally important trees, shrubs, and herbaceous species. Fiddleheads, bloodroot, wood nettles, red elderberry, hop hornbeam, cow parsnip, and more were observed within black ash stands. Fiddleheads, in particular, hold a culturally significant place for many Native Americans (Sutton, 2023). Every spring, Wabanaki fiddlehead gathering parties are common and fiddleheads are served at most community meals. Little is known on how black ash stand dynamics affect herbaceous and shrubs growth and species diversity. From our observation, the red maple dominant stand had decreased available light reaching the forest floor and herbaceous species diversity. Ash mortality is found to enhance the rate of succession to shade-tolerant species (Dolan & Kilgore, 2018). More research is needed to understand how tree replacement species affect both temporal and spatial gradient of light availability and how these shift affects culturally significant plants found within basket quality black ash stands.

IRM within GIS Research

Through IRM, GIS research can serve to be accountable to Tribes and support tribal sovereignty. This requires a much deeper commitment to valuing Indigenous communities' ways of knowing and being. Wabanaki knowledge is distinct from other Indigenous epistemologies in terms of location and relationship to specific place. With knowledge tied to localized land relationships, Wabanaki black ash knowledge does not carry the same values when generalized beyond its context. For example, regional and cultural differences exist between the many tribal Nations that hold a relationship with black ash. Wabanaki knowledge of black ash is not the same as another tribe's knowledge of black ash. Creating Wabanaki black ash knowledge data and sharing this data sets across all Indigenous communities is inappropriate and may create poor quality results. While the basket quality black ash suitability model generalized Wabanaki knowledge and extrapolate the knowledge across large land bases, creating predictors variables, testing the model accuracy, and maintaining the model application with Wabanaki basket makers ensured the GIS model was culturally relevant.

Reflexive and collaborative approaches are essential for Indigenous data ownership, reporting and application. Understanding the colonial legacies within western research tradition towards Indigenous knowledges are essential to understand how to affect change. Institutional control and ownership of Indigenous knowledges and data are tools to disenfranchise Indigenous people (Carroll et al., 2019). Both biophysical and geospatial research rarely include ethics and responsibility to Indigenous people and their data (David-Chavez & Gavin, 2018; Jennings et al., 2023). Through employing IRM and being a part of the Wabanaki basket making community, I understood this history and ensured the Wabanaki basket makers data and the habitat model remained with Wabanaki black ash harvesters.

Ethical responsibility for Indigenous data should not fall solely to the responsibility of the researcher. Currently institutions are not doing enough to prevent harm coming to Indigenous participants (Cragoe, 2019). Most academic institutions required researchers, who work with human subjects, to seek approval from institutional review board (IRB). Even with IRB approval, researchers can acquire, publish, and own Indigenous data regardless of Indigenous wishes (Harding et al., 2012). Indigenous scholars have developed CARE Principles as guidelines when working with native people and their data (Carroll et al., 2020). CARE is an acronym for Collective Benefit, Authority to Control, Responsibly and Ethics. CARE Principles were developed to support Indigenous data governance where Indigenous people retain the ability to govern the collection, ownership, and application of their data (Carroll et al., 2020). This is an emerging field with few examples of implementation, especially within Indigenous geospatial research (Dogan & Wood, 2023). Education and awareness of Indigenous data governance is the first step for these tools to have widespread impact (Carroll et al., 2020; Dogan & Wood, 2023; Jennings et al., 2023; Williamson et al., 2023). Institutions, like universities, play a large role in educating future scientists. Formally endorsing CARE Principles and requiring formalized data sharing agreements between researchers and Indigenous partners are steps Universities can take to strengthen relationships with tribes and support indigenous sovereignty (Williamson et al., 2023).

Conclusion

GIS tools can be very powerful in analyzing the areas of habitat most vulnerable for invasion. They can evaluate large portions of land quickly and effectively for the areas that are of highest priority. GIS that incorporates Indigenous knowledge can be a tool to help build tribal capacity and response planning but the precision, accuracy, and application of these programs should always be in collaboration with Indigenous knowledge holders. The basket quality black ash habitat suitability model in collaboration with hyperspectral imagery can aid in identifying the spatial distribution of basket quality black ash. Future research should focus on combining these tools to help both tribal forestry departments as well as Wabanaki ash harvesters. Predicting species occurrence in a landscape gives agency and decision makers data that can provide timely management intervention and adaptation to invasive species and climate change (Baumflek et al., 2015; Lötter & le Maitre, 2014).

Employing IRM and centering indigenous people within geospatial research ensures research approach, outcomes, and application are tribally driven and culturally relevant. Including Wabanaki perspective with the habitat assessment identified a new avenue for research. Black ash within Maine will be severely impacted by EAB. Current research focuses on pest management, seed saving, and maintaining ecological functions in the wake of ash mortality (D'Amato et al., 2023b, 2023a; Duan et al., 2018; Looney et al., 2017; McCullough, 2020). Through having a Wabanaki harvester as co producer of the knowledge reported within this study, he identified concern for the future of black ash habitats. Black ash stands are valued for more than just black ash trees. The current species assemblages found within these stands are highly valued. While the ability for black ash to resist EAB is not promising, more time and future research may identify ways for black ash and EAB to co-exist. If this happens, research should be conducted to ensure basket quality ash stands are able to host black ash trees once more.

CHAPTER 5

Reflection

Woliwaskeq nil nutapeks Metaksonekiyak naka Naqotkuk naka Sipayik.

I'm citizen of the Houlton Band of Maliseet Indians and I'm a PhD Candidate at the University of Maine in the School of Forest Resources. Those two identities have struggled to coexist within me.

At the Tobique First Nation's reserve, I was hanging out with some friends and talking about mapping indigenous knowledge. I was talking about all the wonderful possibilities GIS mapping can offer. I was riding that wave of "science is so great". This is a reinforced idea within Western science education. As students, we are often told we are the "cream of crop", we will the "experts" in our field. As I was talking, a Maliseet elder asked me to explain in detail what I was doing. I explained that we could map medicinal plant locations and create tools to protect these areas. She immediately told me "Stop, you shouldn't be doing that". She said that I would abuse native knowledge and potentially harm our community. This elder told another elder and they were in agreement. In that moment, I had two elders that didn't trust me. In Native American communities' trust is very important. When you first meet another native person, a typical introduction includes what native community you are from and your family lineage. Just saying that I'm Maliseet isn't enough to be trusted and accepted.

When those two elders told me to stop, I felt a wall being created between us. I became someone not to trust, someone that would cause harm to our community. I became the other, "the scientist". Scientists do not have a great reputation within Native American communities. Scientists have appropriated, delegitimized, dis-empowered, and misinterpreted indigenous knowledge and native people. Native people have been denied a voice within Western science. Indigenous knowledge is seen as antidotal, not accurate, and is often treated as inferior to Western science. The scientist is the actor within this framework. In that moment I became the “scientist, the agent of appropriation”. That night lying in bed, I couldn’t ignore the elder’s comments. I felt sad and unsure of my path. Should I continue on to graduate school? Will my research be harmful to my community? These thoughts stayed with me for a couple of days. My native identity is tied to my community. I didn’t want my career choice to separate me from being Maliseet and I struggled in reconciling the two feelings.

As I look back, I can still feel the pain of being treated as the “other” but I’m thankful for that experience because I carry those elder’s concerns within me. Her voice is always with me when I’m doing science. That moment also taught me that when I spend time with Native people to downplay my research and be cautious when I identify myself as a scientist.

Throughout my graduate research, I’ve experienced the tension and uncertainty within the duality. I’ve been told by natural resource professionals “get your doctorate, we need more Wabanaki PhDs. We need more people like you leading research within our communities.”

I was in Sipayik, talking to my husband’s uncle. He asked me about my research and I was telling him that I created a habitat suitably model to increase basket makers access black ash stands. He said, “that’s good but that will never help me. That’s pointless for people like me.” While I had grown a thicker skin, I still felt deflated. One of my driving force is to create research that benefits Wabanaki people. I asked myself, “what is the point of what I’m doing?”

I understand why my husband’s uncle would say that. Science also has a history of taking knowledge from Indigenous people without benefiting the community where the knowledge originated. Rarely do we see an applied outcome that come back and benefits indigenous people directly. I knew that that’s not the kind of scientist I wanted to be but I didn’t know how I would get there.

One study I work on is restoring Wabanaki sweetgrass gathering in Acadia National Park. Sweet grass is a medicinal plant used within native spirituality and we weave it into our baskets. Sweetgrass has a sweet hay scent that becomes stronger as the grass dries. The grass typically grows in salt marshes mixed in with other salt marsh grasses. Harvesting sweetgrass is work.

We harvest in the middle of summer when the weather is hot and the grass is dry. Salt marshes are extremely buggy and have that refreshing sulfuric aroma. The mosquitoes and the smell don't deter native people though. Harvesting sweetgrass is an expression of our culture. Wabanaki people have continued to harvest within those same locations over generations. Our ancestors, our grandparents, our language, our knowledge are all embedded within our practice. We also face reduced access to traditional sweet grass areas. Often, Wabanaki people need to cross private land to access these saltmarshes. With a shift in Maine's open land tradition to more posting of no trespassing signs, sweetgrass gatherers have reported being verbally threatened and having dogs come after them when they are picking in their traditional sweetgrass locations.

In 2016, National Parks issued a rule change. Previously, if a Tribal Nation did not have a very specific agreement with a National Park, there was no harvesting of plants or plant parts within park boundaries. Picking a handful of berries was allowed but that was it. With the 2016 rule change, federally recognized Native American tribes can harvest traditional plants within the park. Each species gathered requires an Environmental Assessment (EA) to ensure no detrimental impact is associated with gathering. This leaves Native Americans at a disadvantage because the research that typically supports an EA does not exist. Would the person, probably a trained scientist, writing the environmental assessment disregard Wabanaki knowledge of sweetgrass and sweetgrass gathering in their findings? We didn't know.

The sweetgrass study looks at how Wabanaki sweetgrass gathering is a sustainable practice and the findings will provide the research needed for the EA. As a Maliseet person and a scientist, I knew that this research could have a huge impact for Wabanaki people. My research collaborator and I decision on research approach and methodology would massively influence the outcomes. I was excited that my voice matter and I felt a responsibility to ensure my voice was a voice for my community.

We choose a participatory action research and Indigenous research methodology where Wabanaki gatherers are included within each process of the study. Our process is iterative.

That means, each year, we can change our process to better reflect gather's knowledge. Initially we were a part of a study that controlled where gatherers harvested in the salt marsh because the intent was to create an objective systematic way of determining harvest locations. This approach didn't work. Gatherers told us they wouldn't harvest in the locations that was chosen for them. In creating our own study, the methods we chose was to follow gatherers around in the salt marsh. They choose harvest locations and we measure pre and post-harvest stem counts. We also audio record gatherers as we ask them a series of questions pertaining to sweetgrass. This process allows us to understand the collective knowledge of gatherers. Instead of determining everything for them, the sweetgrass are able to express the depth and breadth of their knowledge.

Wabanaki people know harvesting sweet grass is beneficial to the plant. Picking sweet grass increases the sweet grass population. There is a reciprocal relationship that is formed between the grass and the people. We also harvest sweet grass by the root. This aspect of the harvest seems to bother some people. Wabanaki harvesters have stories of getting unsolicited advice on the correct way to pick sweet grass. Usually, it's a well-meaning scientist will say "you know, you shouldn't be harvesting sweet grass by the root. That's not a sustainable practice and you harming the plant".

One summer, as part of the research process, we had a gatherer meeting where park officials, gatherers, and scientist met together to go over what happened the previous year and collectively decide our path for the next year. I felt some apprehension for this meeting. I was going to own my role as a scientist in front of native people. My collaborator and I had created a power point presentation to discuss the findings. Everything was going well. The presentation was creating discussion with in the group. This is the most we hoped for. Towards the end of the presentation, we included preliminary results of the 1st year sweet grass response after harvest. I was looking forward to showing everyone the numbers. We felt very pleased by the results. In all but one of the harvested plots, sweet grass stems not only grew back to the stem density from the previous year but the stem density increased in population. As my collaborator was talking about the stem count response, I heard some noise behind me. I turned and saw a Wabanaki gatherer was clapping. At first, I was confused. In all the presentations I've done no one has ever clapped for statistical results. Then I saw another gatherer taking a picture of the presentation slide with his phone. The majority of Wabanaki gatherers were smiling and looking happy. Finally, the "science" was supporting what Wabanaki people have known for generations. Picking sweet grass by the root is good for the population. At the time, I was happy with gatherers' response. In reflection, I realized the experience was more meaningful to me than I had first thought. In that moment I was proud to identify myself as an Indigenous scientist in front of other native people.

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APPENDICIES

APPENDIX A:

SWEETGRASS GATHERERS AND THEIR TRIBAL CITIZENSHIP

Gatherer	Tribal Citizenship
Molly Jennette Neptune Parker	Passamaquoddy
Geo Soctomah Neptune	Passamaquoddy
Jennifer Neptune	Penobscot
Carol Dana	Penobscot
Tania Morey	Mi'kmaq
Rhonda London	Maliseet
John Neptune	Penobscot
Pat Almenas	Penobscot
Kim Byrant	Penobscot
Gal Frey	Passamaquoddy
Gabe Frey	Passamaquoddy
Gabe Paul	Penobscot
Nicole Paul	Passamaquoddy
Rocky Bear	Maliseet
Paula Love Thorne	Penobscot
Natalie Lolar	Passamaquoddy
Kyle Lolar	Penobscot

APPENDIX B:

Baseline monitoring of Sweetgrass populations

in Bass Harbor Marsh, Acadia National Park 2017 Progress Report

Glen Mittelhauser

Maine Natural History Observatory December, 2017

Sweetgrass (Anthoxanthum nitens [= Hierochloe odorata]) is a perennial grass native to North America that reproduces vegetatively, primarily by numerous, deep rhizomes. Sexual reproduction is rare (White 2002) and fewer than 5% of seeds are fertile. Sweetgrass can be recognized by its shiny, light green leaves and identification can be confirmed by crushing the leaves and smelling the sweet, vanilla-like fragrance. This sweet aroma is from coumarin found in the leaves and rhizomes. It grows in a wide variety of habitats with full or partial sunlight including salt marshes, riverbanks, fens, swamps, marshes, and occasionally disturbed roadsides. It usually does not form dominant stands, but instead grows among other grasses and shrubs (Shebitz and Kimmerer 2005).

Sweetgrass is harvested by Native Americans and used as a ceremonial smudge, medicinal plant, and in tradi- tional basketry. Sweetgrass populations may be in decline in some traditional harvesting areas in northeast- ern North America, although the causes of many declines were thought to be from development or significant changes in habitat rather than overharvest (Shebitz and Kimmerer 2004). Harvesting is usually conducted one stem at a time, by pinching the base of the stem just about the ground so as not to disturb the roots or rhizomes (Baumflek et al. 2010).

Overharvest of Sweetgrass or removal of the roots and rhizomes may reduce the viability of a population (Sheb- itz 2005, Baumflek et al. 2010). Reid (2005) found that at 50% harvest levels, Sweetgrass stem densities at har- vested sites were similar to unharvested sites after 2 years, although a doubling to tripling of stem densities the year after harvest were documented at some study sites. All study sites recovered to pre-harvest shoot density by the end of the growing season after the first year but not the second year of harvest (Reid 2005), suggesting that Sweetgrass can recover quickly from relatively high annual harvest rates but populations may need a year of recovery between harvest. Reid (2005) also documented increased mortality of shoots at harvested sites, but suggested that the high mortality rates may be the result of disturbance caused by methods used to break up the mulch layer to conduct a post-harvest shoot count during the second year of the study.

With the potential for traditional harvesting of Sweetgrass populations in Acadia National Park in the near future, the Park requested collecting some baseline data on Sweetgrass populations. During 2016, we inventoried the abundance and distribution of Sweetgrass in Acadia National Park on Schoodic Peninsula and Mount De- sert Island and found it to be most common and widely distributed in Bass Harbor Marsh (Mittelhauser 2016). During 2017, we focused our research on 40 25x25m grid cells where Sweetgrass was reported as common or occasional in sections both north and south of Route 102. Our goal was to set up a baseline of stem counts in permanent plots that can be used to document changes in Sweetgrass stem counts in future years. This report summarizes our baseline surveys of Sweetgrass populations in Bass Harbor Marsh during 2017.

METHODS

Sweetgrass stem count were conducted in Bass Harbor Marsh, Mount Desert Island in 20 25x25m grid cells north of Route 102 (Figure 1) and 20 grid cells south of Route 102 (Figure 2). These plot locations were chosen because they were identified as having common or occasional abundance of Sweetgrass during 2016, and access to these sites is fairly simple from Route 102. All plot assessments were conducted between 25 June and 30 July.

For each grid cell we monitored, we walked the perimeter (assessed from the GPS) and temporarily marked the more abundant locations with Sweetgrass along the grid boundary lines. We then assessed the best way to run a transect between the temporary markers that passed through the most Sweetgrass within the grid cell. Since Sweetgrass was often patchy and also formed narrow populations running parallel to moisture and salinity gra- dients, the transect did not always cross through a bulk of the Sweetgrass population within a grid cell, but the

transect did pass through some Sweetgrass populations. Both ends of the transect, always located on the bound- ary of the grid cell, were GPS-ed in UTMs using NAD83 and also marked with an orange fiberglass pole, sunk so that only 6 inches of pole emerged above the ground and marked with a plastic research tag with the grid cell number. A small 1 foot long piece of rebar was also placed adjacent to the fiberglass pole, fully sunk into the ground, so that the transect ends can be found with a metal detector in the future even if the fiberglass poles are lost. The ends of the transects were on were on adjacent or opposite sides of the grid cell and were at least 10

m long. A 10 meter long belt transect was placed along the transect line described above. The starting point of the belt transect was the point furthest to the south for transects running north/south or furthest to the west for transects running east-west, although we later modified this method so that the belt transect starting point was the side that had the greatest Sweetgrass stems. A tape measure was stretched between the transect ends and a temporary fiberglass pole was placed 10 meters from the starting point of the belt transect while being careful not to trample vegetation within 1 meter on either side of the belt transect. The belt transect always started at the boundary line of the grid cell, was 10 meters long, and entirely contained within the grid cell. Along each belt transect, we systematically placed 1x1 meter subplots, with a subplot located every meter on alternating sides of transect (the odd consecutively numbered subplots to the left of the tape measure and the even numbered sub- plots to the right of the tape measure).

Subplots were numbered consecutively from the start of the belt transect. Subplot numbers included a prefix of the grid cell number, a dash, followed by the consecutive number of the subplot (1 to 10). The first meter square subplot frame was placed to the left of the tape measure, with one corner at the fiberglass pole and one side along the measure. The quadrats were 1 meter on each side, with marks so that it can be subdivided into quarters to help simplify stem counting.

Each 1x1 meter subplot was sampled non-destructively for visual estimates of cover for Sweetgrass. If no Sweet- grass was present in the subplot, we estimated categorical cover (0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%- 95%, and 95%-100%) of other species. If Sweetgrass was found in the subplot, we estimated its categorical cover, made stem counts of Sweetgrass for the entire subplot, measured Sweetgrass stem heights in 4 locations in each subplot, and also estimated rough categorical cover for all other species present in the subplot. To assist with esti- mating cover estimates, we used calibration templates of known size in the field for 1%, 2.5%, and 5% cover.

RESULTS

We documented Sweetgrass populations in 40 grid cells in Bass Harbor Marsh during 2017 (Table 1). We documented an average of 129 Sweetgrass stems occupying 7% cover per m2 across all grid cells monitored, with an average stem height of 39 cm (Table 2). We documented a total of 40 taxa in our monitoring plots (Appendix 1), and the raw data from each plot are stored in an Excel file, archived at Maine Natural History Observatory and Acadia National Park.

Table 1. Bass Harbor Marsh Sweetgrass Monitoring during 2017, with grid number, date of assessment, field crew (GHM = Glen Mittelhauser; MB = Maggie Barr; CM = Celeste Mittelhauser), and transect start and end coordinates in UTMs, NAD1983.

Grid #	Date	Observers	Transect Start	Transect END
150	12-Jul-2017	GHM, MB	0552497, 1900926	0552480, 4900948
209A	11-Jul-2017	GHM, MB, CM	0552628, 4900725	0552630, 4900752
225A	12-Jul-2017	GHM, MB	0552608, 4900826	0552608, 4900850
245	12-Jul-2017	GHM, MB	0552623, 4900822	0552612, 4900825
307A	11-Jul-2017	GHM, MB, CM	0552625, 4900716	0552633, 4900725
326	11-Jul-2017	GHM, MB, CM	0552619, 4900676	0552625, 4900687
343	11-Jul-2017	GHM, MB, CM	0552595, 4900650	0552600, 4900664
361	11-Jul-2017	GHM, MB, CM	0552604, 4900624	0552607, 4900649
369	29-Jun-2017	GHM, MB	0552574, 4900614	0552549, 4900604
370	29-Jun-2017	GHM, MB	0552576, 4900611	0552600, 4900613
379	29-Jun-2017	GHM, MB	0552600, 4900589	0552592, 4900600
379A	29-Jun-2017	GHM, MB	0552607, 4900575	0552802, 4900599
388	29-Jun-2017	GHM, MB	0552600, 4900562	0552598, 4900575
389	29-Jun-2017	GHM, MB	0552625, 4900563	0552601, 4900577
400	27-Jun-2017	GHM, MB	0552658, 4900525	0552650, 4900514
409	27-Jun-2017	GHM, MB	0552656, 4900499	0552657, 4900525
448	27-Jun-2017	GHM, MB	0552699, 4900385	0552684, 4900401
454	27-Jun-2017	GHM, MB	0552650, 4900364	0552669, 4900372
457	12-Jul-2017	GHM, MB	0552649, 4900300	0552640, 4900307
462	14-Jul-2017	GHM, MB	0552688, 4900295	0552690, 4900275
477	14-Jul-2017	GHM, MB	0552775, 4900210	0552700, 4900226
479	26-Jul-2017	GHM, MB, CM	0552626, 4900190	0552630, 4900176
483	14-Jul-2017	GHM, MB	0552728, 4900180	0552725, 4900193
484	26-Jul-2017	GHM, MB, CM	0552623, 4900176	0552626, 4900159
491	26-Jul-2017	GHM, MB, CM	0552632, 4900151	0552631, 4900125
495	14-Jul-2017	GHM, MB	0552750, 4900134	0552732, 4900150
497	26-Jul-2017	GHM, MB, CM	0552626, 4900113	0552637, 4900126
509	18-Jul-2017	GHM, CM, M, S	0552784, 4900101	0552797, 4900088
509A	18-Jul-2017	GHM, CM	0552800, 4900091	0552812, 4900080
511	26-Jul-2017	GHM, MB, CM	0552675, 4900053	0552669, 4900046
520	25-Jul-2017	GHM, MB, CM	0552700, 4900050	0552689, 4900049
521	25-Jul-2017	GHM, MB, CM	0552723, 4900044	0552714, 4900050

Table 1 Continued

526	25-Jul-2017	GHM, MB, CM	0552849, 4900028	0552859, 4900050
537	25-Jul-2017	GHM, MB, CM	0552861, 4899975	0552854, 4900001
540	25-Jul-2017	GHM, MB, CM	0552788, 4899949	0552776, 4899968
544	27-Jul-2017	GHM, MB	0552688, 4899949	0552700, 4899947
546	27-Jul-2017	GHM, MB	0552734, 4899940	0552734, 4899951
554	27-Jul-2017	GHM, MB	0552741, 4899925	0552750, 4899919
578	27-Jul-2017	GHM, MB	0552750, 4899753	0552739, 4899775
581	21-Jul-2017	GHM, MB	0552751, 4899729	0552726, 4899730

Table 2. Mean (± SE) Sweetgrass stem counts, cover estimates, and stem heights for each of the grid cells monitored during 2017 in Bass Harbor Marsh. Data for each grid cell was averaged across 10 1x1 meter quadrats.

Grid #	Sweetgrass Stem Count	Sweetgrass Cover (%)	Stem Height (cm)
150	119±26	5±1	48±13
245	44±12	2±0	36±7
326	96±23	5±1	43±7
343	74±27	3±1	22±17
361	126±23	8±2	43±8
369	125±30	6±2	27±7
370	169±21	6±1	30±6
379	162±41	6±1	32±7
388	90±37	2±1	17±13
389	133±44	10±3	36±17
400	44±13	2±1	15±11
409	177±46	6±2	25±4
448	39±11	1±1	33±6
454	193±35	5±1	32±6
457	46±12	1±0	34±7
462	168±46	8±4	36±11
477	114±16	7±1	46±18
479	314±40	22±3	52±7
483	94±29	4±1	34±21
484	117±51	4±2	41±7
491	248±39	12±2	42±4
495	87±21	6±1	40±10
497	214±16	16±3	49±9
509	72±14	6±1	45±6

Table 2 Continued

511	92±16	9±2	52±6
520	189±48	24±4	61±10
521	175±21	19±3	53±5
526	166±20	9±1	74±62
537	148±23	6±1	49±7
540	293±58	15±3	42±8
544	152±21	15±2	49±4
546	167±24	9±1	40±7
554	78±13	3±1	42±10
578	87±13	7±2	46±5
581	76±9	3±1	39±9
209A	169±27	6±1	31±6
225A	76±15	2±1	27±4
307A	74±32	2±1	15±14
379A	79±13	4±1	33±13
509A	90±13	5±1	48±7
Grand Total	129±10	7±1	39±12

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APPENDIX: C

Sweetgrass Questions outline

Ecology

Does this look like a place you would harvest sweet grass?

Do you always pick by the ocean?

What do you look for when you search for sweet grass?

- Channel in estuary
- Certain type of grass
- Certain color of grass

Where would you typically go to look for sweet grass?

Is that the size you typically like?

- How high?
- How wide?

How do you identify sweet grass over other grasses?

Does sweet grass grow with other types of grasses?

Is standing water ever present where you pick sweet grass?

Has the sweet grass changed? Like the individual grasses or size of patch?

Harvesting Practices

Would you consider this a lot of sweet grass?

Do you like this patch?

Do you pick sweet grass by the root?

Does harvesting affect the sweet grass patch?

- Over harvesting
- Under harvesting

Do you move where you harvest from year to year?

If you saw someone had harvested where you want to harvest would you still pick there?

How much sweet grass would you normally pick?

Social dynamics

How did you learn to pick sweet grass?

Do you usually pick with family members?

Has that changed over the years?

Do you still pick in the same spots you used to?

If reduced access is express, does the sweet grass patch seem to change?

What do you use sweet grass for?

What does sweet grass mean to you?

Outreach/education

Would you like to see this place used to bring people and teach them how to identify sweet grass?

If the park service is to use this as an education opportunity, what would you want to general public to know?

Would you share the sweet grass creation story with the general public?

Would you share your spiritual beliefs around sweet grass with the general public?

Do you want this interview to be accessed by other Wabanaki people?

Would you want this to be included in the TEK digital portal?

Permit process

Would you come back here to pick?

Are you interested in harvesting other medicines in the park?

What sort of relationship would you like to have between the park and Wabanaki harvesters?

Law enforcement?

Natural resource professionals?

Are you concerned about sweet grass being overharvested here?

Are you concerned about accountability of other harvesters?

Over harvesting?

What sort of internal accountability could exist to help?

How should harvesters be chosen for picking sweet grass in Acadia National Park?

APPENDIX: D

Taxa found with in sweetgrass monitoring plots with mean % coverage.

	Mean % Coverage					
	Harvest Plots (N=32)			Control Plots (N=10)		
Species	2017	2018	2019	2017	2018	2019
Agrostis sp.	2%	4%	7%	1%	5%	7%
Aster sp.	3%	4%	6%	3%	6%	5%
Calamagrostis canadensis	3%	3%	4%	0%	0%	0%
Calystegia sp.	2%	3%	4%	7%	4%	4%
Carex paleacea	23%	28%	31%	18%	9%	34%
Carex viridula	0%	0%	0%	0%	0%	0%
Festuca rubra	4%	2%	6%	3%	2%	3%
Gallium sp.	0%	1%	1%	0%	0%	0%
Hierochloe odorata	13%	23%	13%	21%	26%	17%
Juncus arctica	5%	50%	7%	5%	1%	7%
Juncus gerardii	0%	0%	0%	1%	0%	2%
Myrica gale	5%	0%	0%	11%	0%	0%
potentilla	0%	0%	1%	0%	0%	0%
Rosa sp.	1%	0%	0%	2%	1%	0%
Solidago sempervirens	3%	9%	7%	3%	20%	15%
Spartina alterniflora	0%	0%	5%	0%	0%	0%
Spartina patens	0%	0%	0%	0%	0%	0%
Spartina pectinata	11%	10%	7%	16%	22%	12%
Spirea alba	0%	3%	0%	0%	0%	0%
Typha latifolia	6%	3%	7%	3%	3%	21%
Triglochin sp.	3%	2%	3%	0%	1%	2%
Vaccinium macrocarpon	1%	1%	0%	0%	0%	0%
mud	5%	10%	14%	9%	5%	15%
dried vegetation	34%	19%	25%	14%	10%	26%
veg.cover	39%	55%	53%	53%	54%	59%

APPENDIX E:

SWEETGRASS CULTURAL PROTOCOL
Advice for Good Relations with Culturally Significant Relative

Still a Draft*

Ancestral Homelands

I really feel that sense of going home when I go there, and I've felt like that since I was a kid.
Geo Neptune (Passamaquoddy)

The Passamaquoddy Tribes at Motahkomikuk Indian Township and at Sipayik, the Penobscot Nation, Mi'kmaq Nation, Houlton Band of Maliseet Indians are collectively known as the Wabanaki Nations. The Wabanaki Nations have lived for thousands of years in the lands and waters now called Maine. Despite colonization and attempted genocide—including the forced removal of children—the Wabanaki Nations have endured as sovereign and self-determining peoples, with distinct and diverse languages, cultures, governments, and economic structures.

Wabanaki Peoples are active stewards of these lands and waters and have extensive knowledge and expertise in caring for and sustaining the environment for all human and other than human lives. These are Ancestral Homelands which have been cared for, cultivated and tended to by Wabanaki Peoples for generations.

National Parks and Indigenous Peoples

It's stolen land, and getting reconnected to it is like…You see how the grass responds, its revitalizing it.
Gabe Frey (Passamaquoddy)

All America's National Parks are on traditional Indigenous lands. While they comprise only a fraction of the land that was stolen from Indigenous peoples, they are significant in the larger story of Indigenous dispossession.[1] Every National Park has a human history and is a cultural landscape actively created through long-term Indigenous stewardship and relations.

Acadia National Park was created in 1916. This designation radically changed Wabanaki access to these lands. It meant that seasonal camps for hunting, fishing and gathering were prohibited. Passed by Congress, the 1916 *National Park Service Organic Act* enshrined a logic of

[1] David Treuer (2021), "Return the National Parks to the Tribes" *The Atlantic* May Issue.

conservation and preservation (non-impairment) and brought uniformity to the administration of the Parks system. Neither ‘conservation’ or ‘non-impairment’ were defined in the Act.

Acadia National Park is leading the way in creating new initiatives that recognize these legacies of exclusion. Acadia National Park is actively working with the Wabanaki Nations to establish new and meaningful relationships that center the reconnection of these lands with Wabanaki Peoples.

Background to the Project

The energy that you harvest sweetgrass with, is in the sweetgrass itself… harvesting or picking sweetgrass is an act of love.
Suzanne Greenlaw (Maliseet)

Sweetgrass is a perennial grass that grows in salt water marshes along the Maine coast. It is a culturally significant species. For Wabanaki Peoples sweetgrass (put in the various Wabanaki words for sweetgrass) is a relative and its strength and vitality has been integral to Wabanaki culture for generations. Sweetgrass is used in a variety of ways including for basketry and for ceremony.

In 2019 Acadia National Park and a collective of Wabanaki Sweetgrass Gatherers from the Tribal Nations named above initiated a project to assess the environmental impact of traditional harvesting practices on sweetgrass in a designated marsh in the National Park. Led by Suzanne Greenlaw (Maliseet) and Michelle Baumflek with Acadia Cultural Resources Specialist, Rebecca Cole-Will, the project conclusively demonstrated that the traditional and contemporary Wabanaki cultural practices of harvesting supported the health of the sweetgrass and of surrounding species. The project demonstrated that sweetgrass responds positively to being harvested and actively requires harvesting and care to better thrive. The Wabanaki Sweetgrass Gatherers included: Molly Neptune Parker, Geo Neptune, Nicole Altavator, Gal Frey, Gabe Frey, Rhonda London, Rocky Bear, John Neptune, Gabe Paul, Sarah Sockbeson, Pat Alamenas, Jennifer Neptune, Carol Dana, Kim Bryant, Natalie Lolar, Kyle Lolar, Tania Morey, Paula Thorne.

The Cultural Protocol

It is not just some plant or some grass. It is a relative. It has a purpose in our culture.
Nicole Paul (Penobscot)

Cultural protocols center Indigenous cultural values. They provide guidance and advice for decision-making and appropriate actions that center Indigenous expectations and relationships. Protocols are flexible tools that are adaptable to specific contexts and local interests. In contexts of research and the sharing, usage and storage of Indigenous knowledge, data and cultural practices, protocols outline expectations around Indigenous rights in cultural knowledge and resource use.

Protocols can create the basis for Indigenous re-worlding. In the absence of formal legal intellectual property mechanisms for recognizing and protecting Indigenous rights in knowledge and cultural practices, protocols help build better and more respectful relationships with Indigenous peoples. Protocols center Indigenous sovereign interests to support the formation of different equitable relationships.

This Sweetgrass Cultural Protocol [give the Wabanaki name] developed out of concerns that the collective of Wabanaki Sweetgrass Gatherers were expressing about how unique and specific knowledge and expertise shared in this research would be used by others. Sweetgrass harvesting is a unique cultural practice that has been developed and refined over hundreds of years. Care and love for the grass by the gatherers, and by the grass for the gatherers, makes a reciprocal relationship of giving and caring. For gatherers the health of sweetgrass is a priority. Gathering is a careful and culturally connected practice. Sweetgrass gathering is taught over time from Ancestors to Elders to Children who then teach the next generations.

Why a Protocol not an Agreement

This Protocol provides guidance. It is not legally binding. It reflects the broader concerns of the collective of Wabanaki Sweetgrass Gatherers across the five different sovereign tribal Nations named above. As sovereign entities, Tribal Nations enter into individual government to government agreements with the National Park Service and Department of Interior. Government to government agreements will be necessary in particular areas for safeguarding sweetgrass in Acadia National Park, especially in the context of permits and future co-management activities. This Protocol conveys advice and guidance to support those agreements as appropriate. It does not replace this direct sovereign agreement making process.

The Role, Significance and Value of Traditional Ecological Knowledge/Indigenous Knowledge

They proved what we said all along. We make it healthier and better. It is a reciprocal relationship. The grass needs us as much as we need the grass. We value each other.
Jenn Neptune (Penobscot)

Indigenous knowledge, or traditional ecological knowledge (TEK) are terms that can be used interchangeably. It is a dynamic way of knowing involving generations of knowledge in one location, generally passed down through oral tradition. TEK is very context-specific; information is not disseminated across a whole species range. While Indigenous Peoples manage areas collectively, and work as a whole, there's a lot of variation of knowledge and variation of practice. This kind of variation can be a challenge within Western science contexts. Often statistical analysis does not corroborate easily with TEK in part because of the variation. There's also friction between Western science and TEK in the words that are used. Western science has a very cold perspective language, trying to remain abstract, disconnected and removed in an attempt to appear neutral and objective. TEK reflects a different way of connection and value systems. Indigenous cosmology, relationships and inherent contextual knowledge are included as key elements. For example, in a simple harvest or gathering lesson, there are ethics, morals, biology, species diversity and harvesting impacts that are included. In Western science, it's more segregated; there's often a scientist who disseminates information and then a resource manager who uses that information. The researcher may not be there year after year or season after season and so can miss important localized changes. The researcher might also only focus on one species not others around it, nor the health of the soil or the water also affecting the life of the species. A researcher can have extensive species knowledge without having "use knowledge." Harvesters, on the other hand, return year after year, often to the same place and it's a closed loop; they see the impact of their activity and adjust so it's sustainable.[2]

In December 2022, the White House Council on Environmental Quality (CEQ) and the White House Office of Science and Technology Policy (OSTP) jointly released new guidance including an implementation memorandum for federal agencies focusing on recognizing and including Indigenous Ecological Knowledge in federal research, policy and decision making.[3] This guidance formalizes the inclusion of Indigenous knowledge as providing important information for research and decision-making. It asks that Indigenous knowledge is properly credited and acknowledged.

In keeping with this federal guidance, this Protocol provides specific assistance in recognizing, including and acknowledging Indigenous knowledge for the cultural care of sweetgrass in Acadia National Park.

Indigenous Cultural and Intellectual Property

Indigenous Cultural and Intellectual Property (ICIP) generally refers to moral and legal rights and interests that Indigenous Peoples assert in order to protect Indigenous Peoples' knowledge, data and cultural practices from misuse. Misuse means when knowledge, data and cultural practices are used in ways that were not intended and are disrespectful. Misuse includes, but is not limited to: derogatory treatment, including the use of Indigenous Peoples' knowledge, data and cultural practices in a way that undermines the originally intended meaning; appropriation, involves the use of Indigenous Peoples' knowledge, data and cultural

[2] Adapted from Suzanne Greenlaw interview in WildSeeds.

[3] https://www.whitehouse.gov/ceq/news-updates/2022/12/01/white-house-releases-first-of-a-kind-indigenous-knowledge-guidance-for-federal-agencies/

practices for purposes that are unintended by the original creator/s and can cause cultural, emotional, and psychological harm to Indigenous Peoples; and misattribution, including not properly acknowledging, naming or recognizing knowledge holders and where information has come from, including missing or incorrect attribution and association of Indigenous Peoples.

The Wabanaki Sweetgrass Gatherers assert the perpetual right to be recognized, acknowledged, named, and associated with this project, the project results, the project data and all products connected to this project.

Education

"We learn from our Elders and you don't ever stop learning"
Kyle Lolar (Penobscot)

On June 15, 2001, the Maine State Legislature enacted a landmark law, now known as the Wabanaki Studies Law, which requires schools to teach Maine K–12 students about Wabanaki territories, economic systems, cultural systems, governments, and political systems, as well as the Wabanaki Nation's relationships with local, state, national, and international governments. The Wabanaki Studies Law, now codified at 20-A M.R.S. § 4706(2), is critical to overcoming stereotypes and ignorance about Indigenous peoples, which are harmful to Wabanaki students and non-Native students alike.

This law was created to address the lack of education about Wabanaki Nations in schools, in the first instance. However, misunderstanding and lack of education exist in other contexts across the State. This project provides an important opportunity to initiate education programs focused on:

- The value and significance of Traditional Ecological Knowledge as and in science;
- Sweetgrass as a culturally significant species,
- Wabanaki plant and animal relationships of care and;
- Unique Wabanaki environmental stewardship.

For the development of future relationships and to advance the federal guidance on TEK , there is a significant need for education and training in two key areas.

1. **Acadia National Park staff** need specific education and training around Wabanaki histories, cultural practices and environmental stewardship.
2. **Visitors to the National Park** many of whom travel from other states and around the world to visit Acadia. There is a clear opportunity to increase education, awareness and understanding about Wabanaki rights and interests in keeping with the Wabanaki Studies Law.

Educational Opportunities for Acadia National Park Service Staff

The Wabanaki Nations have different relationships to the National Park and are not 'visitors'. Special care and awareness by National Park Service staff is required to understand the Park as Wabanaki Homelands, and the special relationships that Wabanaki Peoples retain to these lands and waters. Specialized cultural awareness training should be developed and delivered to all Acadia Park Service staff. This training should be provided to all new incoming staff and there should be continued learning opportunities. This training should have specific modules that address areas including but not limited to: sweetgrass gathering methodologies and practices; archaeology and Wabanaki history; Indigenous cultural and intellectual property; Indigenous worldviews and care of species.[4]

This Protocol recommends the development of Park specific education and training to better support Wabanaki stewardship of culturally specific species. This education and training will also be critical for future co-management relationships to develop. There is a responsibility that Acadia National Park has to educate staff internally whilst simultaneously building new educational opportunities for its non-Native visitors.

Visitors to National Park

For Wabanaki Sweetgrass Gatherers to feel safe and respected as they regain cultural rights to gather and maintain cultural practices, visitors to Acadia must also be provided with information about these changing relationships in the Park. This awareness building could happen through four different kinds of information dissemination activities.

1. A Sweetgrass Information Guide could be developed as a small informational pamphlet that could be provided to visitors that enter through regulated Park entry points and at the Visitor Center locations. The same information guide could be added to the Acadia NP website.
2. The Sweetgrass Protocol Film could be incorporated into a Visitor Center installation and also made available on the Acadia NP website.
3. More Wabanaki speakers and regular topics could be scheduled as part of the Schoodic Research Institute events.
4. Friends of Acadia National Park could also feature the Sweetgrass Protocol film and commit to a new initiative to incorporate more educational activities as part of its responsibilities.

Representation and Permission to Use Images

Over the course of this research, a variety of photographs of Wabanaki Sweetgrass Gatherers have been taken. Some of these have been used in reports with individual and group permission. The Wabanaki Sweetgrass Gatherers decided that they do not want these photographs used in other contexts, or circulated without their consent. Individual permission must be obtained for future use. Any use of the photographs should ensure that individuals are

[4] In 2023, the National Park Foundation began offering training on tribal consultation.

properly named with their Tribal citizen affiliation/s and the name of the research project. The Wabanaki Sweetgrass Gatherers will collectively decide on several photographs that Acadia Park Service can share, with proper attribution, in other contexts where this research project is featured and celebrated.

Film Footage

Andreas Burgess was commissioned to make the Sweetgrass Protocol Film (title) that reflects Wabanaki Sweetgrass Gatherer's voices and unique expectations – from caring for sites to privacy when gathering and use of sweetgrass as cultural practice. The film footage remains the property of the Wabanaki Sweetgrass Gatherer and hard drives of the footage will be provided to each THPO for safe-keeping and future use. Footage can be used by Gatherers for other purposes as needed with acknowledgement of Andreas Burgess as the original film-maker.

Ownership of Research Data

Indigenous Peoples' Data means information and knowledges recorded on any medium and in any format generated by Indigenous Peoples as well as by governments, private sector, and other institutions on and about Indigenous Peoples, their governments, or non-human relations. Indigenous Peoples' Data comprise information, specimens, and knowledges about non-humans with which they have relations; information about Indigenous individuals; and, information and knowledges about Indigenous Peoples as collectives. Indigenous Peoples' Data ranges from traditional and contemporary writings and performances to languages, oral traditions, and ceremonies, living and nonliving specimens and environmental data.

Indigenous Peoples' Data collected in this project will be held by each Tribal Nation and use will be determined through Tribal decision-making processes. Tribal Nations will retain full control, governance and decision-making capacity over this data shared in the Project. Agreements around future use of data will be negotiated through General Agreements and other mechanisms that are determined through community-driven processes.

Permit System

The National Park Service requires that there is a permit system in place to gather sweetgrass. The exact details of the permit system will be specific to each Tribal Nation and will require an independent government to government agreement.

The following recommendations are made for the development of any permit system:

1. The Permit system should be co-developed with Gatherers;
2. The Permit system should not overburden the Tribal Nation or the THPO;
3. The Permit system should be straight forward and easy for a Gatherer to use;
4. The Permit system should factor in limited access to computers and printers to print off permits.

Law Enforcement

Question: How would you want law enforcement to engage with you when you are out here [in the marsh]? Suzanne Greenlaw (Maliseet)
Answer: I wouldn't. Gabe Frey (Passamaquoddy)

There is an uneasy relationship between Sweetgrass Gatherers and National Park Service Law Enforcement. Gathering is a cultural and spiritual practice that needs to be respected and requires privacy. All National Park Service Law Enforcement Rangers should be educated about sweetgrass gathering and specific notifications should be made when the season for gathering has started. National Park Service Law Enforcement Rangers should be made aware of sweetgrass gathering locations to support informed patrolling. Only when absolutely necessary should Law Enforcement Rangers approach gatherers in a salt-marsh. Such circumstances could include: [To discuss with Gatherers]

The Protocol recommends the co-development of a specific training module for Acadia National Park Service Law Enforcement Rangers to support Rangers in recognizing and respecting privacy around sweetgrass harvesting. This could include key signals that harvesting is underway and be part of a strategy around protecting gatherers privacy when in the marsh.

Monitoring

"The grass remembers you"
Jenn Neptune (Penobscot)

The National Park Service requires yearly monitoring of sweetgrass to help ensure the ongoing health of the species. Monitoring strategies should be co-developed with Gatherers to limit the potential of monitoring to feel like surveillance of Gatherers. The Park staff and the Wabanaki Sweetgrass Gatherers are all aligned in supporting the health and future of the grass and to safeguard against over-picking. Monitoring could include annual tribal Nation reporting of sweetgrass harvesting amounts to the Park Service and identification about changes in the marsh, including changes in water levels and the population of other species.

As sweetgrass marshes are homes for many other relatives (plants and animals) – jointly conceived monitoring processes would include more holistic accounts of changing conditions in the marsh.

Harvesting in the Good Way

"You never over-pick or over-harvest…just take a little bit for the season." Gabe Paul (Penobscot)

Harvesting in a good way means being careful and sustainable, leaving the sweetgrass root systems to re-generate and re-grow. Not everyone has been taught how to harvest in a way that supports the health of sweetgrass. For some people, the teachings from Elders skipped a generation. The Sweetgrass Gatherer Collective will provide any guidance and support to other tribal citizens that is needed.

Towards Co-Management/Stewardship

"This is our heaven." Tania Morey (Tobique First Nation- Neqotkuk)

On November 15, 2021, Secretary Haaland and Secretary of Agriculture Vilsack issued Secretary's Order 3403: *Joint Secretarial Order on Fulfilling the Trust Responsibility to Indian Tribes in the Stewardship of Federal Lands and Waters*. The Secretary's Order also directs agencies to increase opportunities for Tribes to participate in traditional stewardship of present-day federal lands and waters. This includes the integration of thousands of years of Indigenous knowledge and sustainability practices into federal management and operations, subject to the interest of each Tribal Nation.

Sweetgrass gathering is only one of many traditional cultural practices that can be reactivated on these Wabanaki Homelands. Jointly conceiving new National Park practices around land stewardship actively brings Indigenous knowledge, voice and expertise into Acadia National Park in deliberate ways that recognize Indigenous worldviews and relationships. First steps towards meaningful engagement and partnership will lead to the development of long-term co-management models that recognize, value and protect Indigenous knowledge and living cultural practices. Formal co-management will need government to government agreements to be in place.

Given the history of land dispossession in Maine, building a new pathway towards co-management/stewardship will require the National Park Service to center Wabanaki rights and interests in planning, education and policy.

BIOGRAPHY OF THE AUTHOR

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