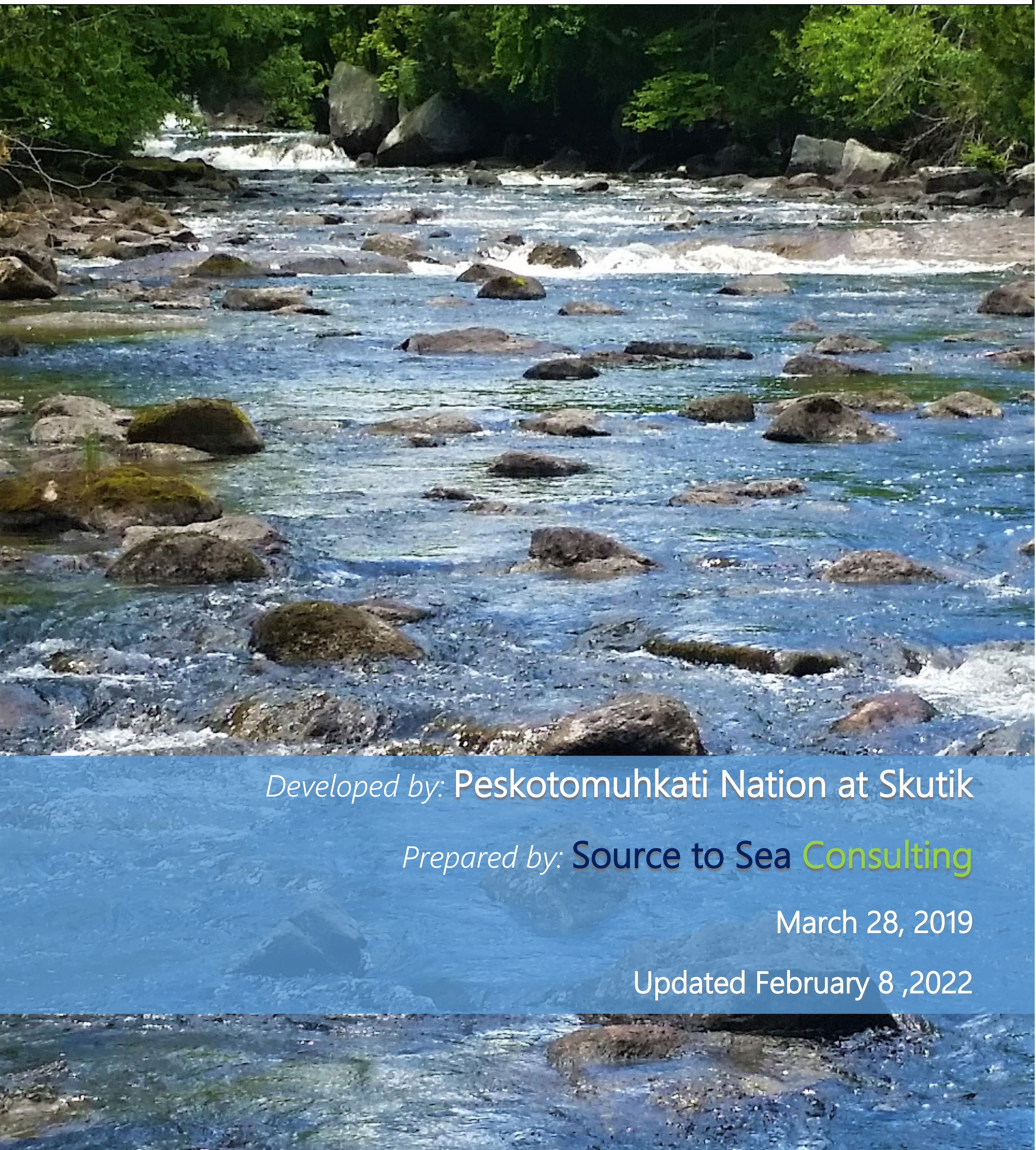
Skutik Watershed

Strategic Sea-Run Fish and River Restoration Plan



Developed by: Peskotomuhkati Nation at Skutik

Prepared by: Source to Sea Consulting

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Peskotomuhkati Nation at Skutik

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Peskotomuhkati Nation at Skutik

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Cover photo: Upper Skutik River by George Aponte Clarke

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Acknowledgements

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Figure 1: Skutik (St. Croix) River Watershed with Location of Dams and Tribal Trust Lands

Source: Sipayik Environmental Department

Executive Summary

The Skutik River (also known as the St. Croix and Schoodic River) once teemed with sea-run fish, the foundation of a robust ecosystem inextricably tied to the people of the Peskotomuhkati Nation. Historically, sea-run fish abounded, including American eel, American shad, Atlantic salmon, alewife, blueback herring, sea lamprey, sea-run trout, striped bass, and shortnose sturgeon. These diverse species supported fish, wildlife, and human communities alike. Over the past several centuries, however, the river has been degraded, habitat has been severed, and the once robust sea-run fish populations have been decimated by overfishing, water pollution, construction of dams, inadequate fishways, and closure of fishways. At the same time, the St. Croix River system holds vast potential for restoration of native sea-run fish. The primary vision of the Peskotomuhkati Nation is to restore access to habitat and rebuild populations of sea-run fish returning to the watershed.

There is lots of opportunity. For example, the alewife has always been a key-stone species ecologically and for the Peskotomuhkati people. There were so many that long ago sailing ships from far away would anchor in the river and fill their hulls with barrels of alewife (Davis 1974, Flagg 2007). During much of the 19th century and most of the 20th, the Skutik River experienced low alewife abundance. The largest run was 2.6 million in 1987; that was equal to only 24.7 fish per acre of spawning habitat. The lowest run counted was 900 fish as a result of the Maine legislature closing the Woodland and Grand Falls fishways to alewife; that amounted to 0.009 fish per acre. In 2020, the run was 600,969 alewives or 5.7 fish per acre. In contrast, in Maine, 79% of commercially harvested rivers have had over 200 fish per acre, 61% over 300, 23% over 500, and 7% have had over 1000 fish per acre of alewife spawning habitat.

While the Peskotomuhkati Nation is pleased that the Skutik River alewife run is beginning to recover, there is no reason to settle for the stunted stocking rates that have persisted for too long. The Skutik River has the greatest production potential of any watershed in Maine, Atlantic Canada, northeastern United States, and probably North America. It just needs care and assistance to help it recover.

The contemporary need for a restoration plan was born out of previous efforts on the Skutik River and elsewhere. Extraordinary ecological potential, combined with commitment by multiple parties on both sides of the river, suggest that past restoration challenges can be overcome. Despite these efforts, and some recent passage improvements, there are at present no comprehensive plans to address sea-run fish recovery. The Peskotomuhkati Nation saw an imminent need for restoration planning and capacity to restore sea-run fish to the Skutik River system.

The Restoration Plan defines a framework for recovery of the Skutik River and the ecosystem and human connections that have been damaged. It is a comprehensive roadmap to restore indigenous sea-run fish through actions aimed at the public-private collaborations necessary to achieve them. The Plan takes an iterative approach and is flexible for adjustments as restoration actions are implemented and evaluated. Under the guidance of this Plan, the Peskotomuhkati Nation and its restoration partners will be able to return indigenous sea-run fish to the Skutik River, revive its ecosystem, and restore lost connections between the river and the sea and the natural bounty they provide.

The Skutik River is the heart of Peskotomuhkati territory. It flows 185 kilometers (110 miles) along the U.S. – Canada border—Maine (to the south) and New Brunswick (to the north)—and drains an area of 4,271 square kilometers (1,649 square miles) flowing into Passamaquoddy Bay, the Bay of Fundy, and Gulf of Maine. Today, there are three tribal communities in the region—the Passamaquoddy Tribe at Pleasant Point/Sipayik and the Passamaquoddy Tribe at Indian Township in Maine and the Peskotomuhkati Nation at Skutik in New Brunswick. They are all one people. A renewed Skutik River watershed will provide myriad ecological, economic, cultural, and social benefits throughout the region. Restoring sea-run fish will provide food for a wide variety of fish and wildlife inhabiting Passamaquoddy Bay and the Gulf of Maine. The Skutik River has been, and can be again, the food factory for Passamaquoddy Bay. While habitat and ecosystem restoration are the primary concerns, the Peskotomuhkati Nation recognizes that the health of human communities is intricately linked to the health of the ecosystem. Therefore, a core aim of this Plan is to restore sea-run species to such an extent that they can support the Peskotomuhkati needs.

The Peskotomuhkati Nation recognizes that restoration on a watershed scale requires maintaining relationships, building partnerships, and coordination among many different interests and areas of expertise. The content of the Restoration Plan has been informed by the work of many other individuals, agencies, and entities, including the Schoodic Riverkeepers, Conservation Council of New Brunswick, Eastern Charlotte Waterways, Atlantic Salmon Federation, St. Croix Estuary Project, Nature Trust of New Brunswick, and Downeast Salmon Federation. The Nation will continue to engage relevant landowners, local municipalities, and those who own the dams. Finally, it will reach out to other indigenous and nonindigenous organizations with a wealth of relevant experience for advice, including the Penobscot Nation, the Department of Fisheries and Oceans Canada (DFO), Environment and Climate Change Canada (ECCC), the U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA).

The Restoration Plan was developed through a process of information gathering that included extensive literature review and numerous interviews with individuals having experience with the Skutik River and its ecosystem. The information and actions in this Plan build on previous efforts and ongoing discussions among the restoration partners identified above, including regular conference calls and meetings focused on Skutik River restoration since 2013. Previous work performed, supported, and provided by the Peskotomuhkati Nation, along with traditional knowledge, was an important part of the Plan and actions proposed. Considerable information was obtained through the work, research, and monitoring performed by state, provincial, and federal agencies, the St. Croix International Waterway Commission, and several local conservation groups. The Restoration Plan is organized into the following parts:

- **Section 1.0 – Introduction:** This section introduces the Restoration Plan along with important background on the system and restoration partners.
- **Section 2.0 – The Skutik River:** This section describes the Skutik River setting and provides context for the proposed restoration actions. It discusses the need for and anticipated benefits of restoration.
- **Section 3.0 – Baseline Assessment:** The baseline assessment of the sea-run fish of the Skutik River provides information for each of the ten indigenous species. It summarizes the past, present, and desired future status of the resource, reviews habitat, establishes a baseline for restoration, and shows the restoration potential that exists.
- **Section 4.0 – Restoration Goals and Objectives:** This section reviews the restoration goals and objectives of the Peskotomuhkati Nation.
- **Section 5.0 – Restoration Strategy:** The core of the Plan, this section presents the strategies to achieve desired restoration outcomes organized into “components” that consist of a set of related strategies and “proposed actions.” The components were established to help with organization and prioritization and do not need to be followed in sequence or independent of one another.

- **Section 6.0 – Related Planning and Coordination:** In this section, the Plan summarizes a set of related activities essential to project success: a coordination and cooperation plan that also considers public engagement and a restoration monitoring and management plan to track restoration activities, monitors accomplishments, and enables evaluation and modification of restoration activities along the way.

The Restoration Plan focuses on restoring the full assemblage of indigenous sea-run species to their natal waters (rivers and coastal areas) primarily through improvements to upstream and downstream passage and through other measures to improve or restore access to habitat where necessary. The goal of the Peskotomuhkati Nation is to establish the following condition:

> **A full assemblage of indigenous sea-run fish throughout the Skutik River watershed with stable populations of sea-run fish that can fulfill their ecological role and support ecological, economic, social, cultural, traditional, and spiritual objectives.**

The following objectives have been established as a means to achieve the restoration goal and fulfill the Nation's vision for the Skutik River system:

- As a priority, achieve the maximum ecological production capacity (MEPC) of the watershed so the Skutik River can once again be a significant "food factory" sending trillions of juvenile herring to Passamaquoddy Bay and supplementing the food supply there sufficiently to increase the fisheries.
- Improve fish access to historic upstream habitat by addressing fish-passage limitations to achieve maximum production of the Skutik River system.
- Work to ensure safe, timely, and effective upstream passage for indigenous sea-run fish throughout the watershed.
- Improve survival of sea-run fish species by avoiding or minimizing mortality during downstream migration, particularly though turbines and spilling onto rock.
- Restore Atlantic salmon to the watershed.
- Restore vital connections between the river, indigenous fish, and the Peskotomuhkati Nation in order to preserve and restore traditional food sources for physical, cultural, and spiritual sustenance.
- Allow upriver fish to be harvested for social, cultural, traditional, and nutritional purposes.
- Once river herring population growth has stabilized and the MEPC achieved, support commercial harvest by the Peskotomuhkati Nation and potentially others.
- Restore ecological connections between riverine and marine ecosystems and their resources.
- Improve the ecological health, vitality, and commercial potential of Passamaquoddy Bay, the Bay of Fundy, and the Gulf of Maine.
- Foster connections between and generate opportunities for people and communities within the Skutik River system.
- Create opportunities for river-centric economic activities including harvest (river herring, eel, shad), angling (shad, striped bass, rainbow smelt), boating, and general recreation.

The Restoration Plan is a strategic document focused on improving access to habitat as well as other actions to restore sea-run fish to the Skutik River system. The Plan is organized into components and associated action items. For the most part, the components are aligned both geographically and temporally. At the same time, actions that stand to yield a quick outcome, produce an immediate benefit, or become a time sensitive opportunity will be prioritized to help generate momentum and buy-in for further components to restoration. Therefore, organization of the components and associated action items is meant to be flexible, and their implementation does not have to be followed in any particular order or sequence. Additionally, the Peskotomuhkati Nation will build upon the components and related action items as progress is made toward the Peskotomuhkati Nation's restoration goal stated above. In general, the Restoration Plan aims to provide safe, timely, and effective passage for indigenous sea-run fish species throughout the entire ecosystem and promote activities that support and increase the likelihood of restoration success. The core components of the Restoration Plan are:

- **Component I –Lower Sub watershed and Estuary:** This component targets the lower sub watershed and its tributaries, including Magurrewock Stream and Mohannes Stream, from Salmon Falls upstream to Woodland Dam and downstream through the estuary to Pleasant Point. Lower tributaries, both above and below Salmon Falls, that have known barriers to sea-run fish migration or have identified restoration potential would be the focus of this initial component.
- **Component II – Milltown Generating Station and Dam:** NB Power, the owner, commenced the regulatory process to decommission its Milltown Generating Station and remove Milltown dam in the Fall of 2020. Therefore, the focus of this component will be on post-removal considerations.
- **Component III – Woodland and Grand Falls Dams:** Fishways at both dams do not have the capacity or design to pass the desired number and species of fish. At the time of this update, both fishways have deteriorated significantly since built in 1966, are near collapse, and in need of replacement. Currently, these fishways do not provide safe, timely, and effective passage for the fish they were designed to pass. Downstream passage is also a significant concern. Alternative designs of fish passage need to be put in place to pass the diadromous fish species. Addressing fish passage at Woodland and Grand Falls is a critical component of this Restoration Plan.
- **Component IV – East Branch:** Significant amounts of habitat exist in the East Branch of the Skutik River. About one third of the alewife-spawning habitat in the watershed is above Vanceboro and Forest City Dams. The fishways at those dams need to be upgraded to pass the desired number and species of fish. There may be shad spawning habitat below Vanceboro. Canoose Stream offers restoration potential for alewife with the dam or salmon without the dam. Atlantic salmon habitat was mapped by IF&W in the tributaries along the free-following section between Grand Falls flowage and Vanceboro Dam. There may be sea-run trout habitat there too. Improving access to habitat in the East Branch is a core component of the Restoration Plan.
- **Component V – West Branch:** Significant habitat exists in the West Branch of the Skutik River above West Grand Dam. Formerly, a migration barrier had been put in the fishway to prevent river herring from passing above the dam. However, this situation was remedied through a Federal Energy Regulatory Commission (FERC) order in January 2020. At the Syslabodsis Dam, the fishway does not attract and pass fish, if at all, and needs improvement. Improving access to habitat above West Grand Dam is a core component of the Restoration Plan.
- **Component VI – Stocking Programs:** Although past stocking programs were unsuccessful, the Nation believes there is potential to restore Atlantic salmon to the river and would like restocking efforts to be pursued. Initial efforts should focus on the lower tributaries where there is accessible habitat available with minimal obstructions to upstream and downstream passage, and recent indications of salmon presence. The Shad in the Classroom program, developed by the U.S. Fish and Wildlife Service and through partnerships with elementary and middle school districts in the mid-Atlantic states, would be a good program to initiate in the Skutik River system. Not only would such a program help revive runs of shad, it has the additional benefit of community engagement.

The Skutik River and its watershed have changed greatly in the past 300 years. The natural resources of the river, its habitats, and biological and human communities have been severely altered due to water quality degradation, overfishing, and construction of dams. Restoration of the Skutik River and its indigenous population of sea-run fish will require long-term commitments on the part of citizens, governments, and nongovernmental organizations. Many parts of that commitment are already in place. The Restoration Plan provides a roadmap to recover the Skutik River and the ecosystem and human connections that have been damaged.

1.0 Introduction

1.1 Background

The Skutik River (also known as the St. Croix and Schoodic River) once teemed with sea-run fish, the foundation of a robust ecosystem inextricably tied to the people of the Peskotomuhkati Nation. Over the past several centuries, the river has been degraded, habitat has been severed, and the once robust sea-run fish populations have been decimated by overfishing, water pollution, and the construction of dams. At the same time, there is tremendous hope in the potential of the river and a strong vision for its revival. Restoring habitat, access to it, and rebuilding populations of sea-run fish in the watershed are primary goals of the Peskotomuhkati (also referred to as the Passamaquoddy) Nation, and the central aims of the Skutik River restoration project. This Restoration Plan defines a strategic restoration framework for the Skutik River system, its ecosystem, and human connections that have been damaged, and provides a roadmap going forward for its recovery.

The Skutik River, Passamaquoddy Bay, and adjacent tributary watersheds are part of the traditional territory of the Peskotomuhkati. Those waterbodies are recognized as ecologically important by the governments, scientists, and marine planners of the United States and Canada. Without adequate access to freshwater habitat and adequate passage back to the sea, sea-run fish populations will not be able to complete their life cycles and will continue to fail to meet their ecological, cultural, or economic potential. The government of Canada, the Province of New Brunswick, and partners within the Peskotomuhkati Nation, Canada, and the United States have recognized the need to recover depleted sea-run fish populations to the Skutik River. The Skutik River is an international boundary water (Canada – United States) and with government support, many groups worked to see basic fish passage restored on the river in 2013. Nonetheless, there is more to be done if the full vision of the Peskotomuhkati Nation is to be realized.

The Peskotomuhkati Nation, U.S. and Canadian resource agencies, and other interests on both sides of this boundary water recognize the perpetual challenges of shifting this trend. They also recognize the opportunities that would abound if sustainable populations of sea-run fish could be restored to the Skutik River system. Despite these efforts, and some recent passage improvements, there are at present no comprehensive plans to address sea-run fish recovery. Therefore, there is an imminent need for restoration planning and building of capacity to restore sea-run fish in the Skutik River system.

To advance current and guide future restoration efforts, the Peskotomuhkati Nation developed this *Strategic Sea-run Fish and River Restoration Plan* (Restoration Plan or Plan) for the Skutik River watershed. The Restoration Plan focuses on restoring the full assemblage of indigenous sea-run species to their natal waters (rivers and coastal areas) primarily through improvements to upstream and downstream passage and through other measures to improve or restore habitat where necessary.

The contemporary need for a restoration plan was born out of previous efforts on the Kennebec and Penobscot Rivers in Maine, and the Skutik River. The success on those Maine rivers redefined river restoration. Extraordinary ecological potential, combined with commitment by multiple parties on both sides of the border, suggest that restoration challenges can be overcome. Actions advised in this Restoration Plan will see key species restored to their native spawning grounds, improved quality of those spawning grounds and other habitats, and enhanced prey availability for Committee on the Status of Endangered Wildlife in

Canada (COSEWIC) and Species at Risk Act (SARA) species that will benefit from successful habitat restoration. A renewed Skutik River watershed will provide myriad ecological, economic, cultural, and social benefits throughout the region.

While habitat and ecosystem restoration are the primary concerns, the Peskotomuhkati Nation recognizes that the health of human communities is intricately linked to the health of the ecosystem. Therefore, a core aim of this Restoration Plan is to restore sea-run species to such an extent that they can support the Peskotomuhkati's cultural, ceremonial, nutritional, traditional, and economic needs. This Plan will also highlight persistent issues and strengthen human relationships in the region to ensure long-term sustainability of restoration aims.

Recognizing a range of matters to be considered in order to achieve desired outcomes within a complex setting, the Restoration Plan takes an iterative approach and will be flexible for adjustments as restoration actions are implemented and evaluated. It will rely upon the involvement and commitment of many partners representing a range of interests, capacities, and areas of expertise. Together, under the guidance of this Restoration Plan, the Peskotomuhkati Nation and its restoration partners will be able to return indigenous sea-run fish to the Skutik River, revive its ecosystem, and restore lost connections between the river and the sea and the natural bounty they provide.

1.2 Restoration Partners

For countless generations, the Peskotomuhkati people have occupied the shores and forests of Passamaquoddy Bay and adjacent watersheds (also known as the Quoddy region), which are part of the traditional territory of the Peskotomuhkati. The region has in the past experienced and now continues to experience numerous threats and challenges to the ecology and integration of the resources important to the Nation and all others in the region.

Recognizing the importance of the Quoddy region's rivers, estuaries, and bays, the Peskotomuhkati Nation has developed this Plan to restore its aquatic resources through a comprehensive set of activities and actions. While the primary concern is habitat and ecosystem restoration, the Peskotomuhkati Nation recognizes that the health of human communities is inextricably linked to the health of the ecosystem. Therefore, the Plan also aims to restore connections between the aquatic resource and Peskotomuhkati people and all others in the region.

The Peskotomuhkati Nation is confident that a focused effort engaging major parties could yield collaborative restoration success, like recent restoration successes on the Kennebec River and more recently the Penobscot River. Despite decades-long legal battles and management challenges, unlikely stakeholders—industry, the Penobscot Nation, six nongovernmental groups, state and federal resource agencies, businesses, citizens, and others—agreed to large-scale restoration on the Penobscot River. The state of Maine, U.S. federal agencies, private interests, and other partners invested substantial resources to recover migratory fish native to those systems. Further examples of their success include:

- River herring populations neared zero just seventeen years ago on the Penobscot and Kennebec Rivers.
- River herring runs on the Kennebec rose from less than 500 to an estimated 3.5 million and continue. The success supports a valuable local, commercial fishery, while allowing enough escapement to meet conservation and ecosystem service goals.

- American shad and the American eel have also benefitted.
- Endangered sturgeon are now regularly seen jumping out of the water in the Kennebec River, including as far upstream as the state capital, Augusta. Soon after the restoration successes on the Kennebec and Penobscot Rivers, research showed that sturgeon were migrating 150 km (93mi) to the Penobscot River in the spring and returning in the fall - new insight on sturgeon migration
- Following the Penobscot River Restoration Project, completed in 2016, alewife numbers counted on the lower river have increased from less than 10,000 to more than 2 million annually. American shad numbers have risen from approaching zero at the first dam (Veazie Dam) to about 4,000 passing Milford Dam, now the first on the river, in 2018.

The Skutik, in comparison, is reported to be capable of supporting 27 to 58 million river herring with dams in place, good passage, and no fishing (commercial harvest) (LimnoTech Report, 2020), and 70.8 to 117.4 million river herring in the absence of human impacts such as dams and harvest (Gibson et al. 2017). Only time will tell, but there is general agreement that the Skutik River watershed has the highest potential capacity for alewife production in the northeastern United States, Atlantic Canada, and some say North America. Put in the context of other major restoration efforts, the potential is one and a half times that of the Penobscot River, twice that of the Kennebec River, and more than both systems combined.

Key stakeholders have repeatedly cited this vast potential as a key reason for efforts to restore the sea-run fish that once fueled a robust ecosystem and helped support communities throughout the region. Numerous public and private entities have expressed their interest in a re-energized, coordinated effort to take the next steps toward restoration such as preparing a watershed-based restoration plan and a collaborative strategy for its successful implementation. The Schoodic River Statement of Cooperation (SOC), between Wabanaki leaders and four U.S. federal agencies (Appendix A), was established on June 5, 2013. It is currently being updated to formally include representation from Canada. The SOC provides a strong basis for restoration.

As noted above, the Peskotomuhkati Nation, two U.S. federal agencies, conservation organizations, and citizens worked together to achieve an historically significant step in 2013 with the passing of LD 72[1] and reopening of the Grand Falls Dam fishway. The effort engaged many entities with missions, responsibilities, or interests in the restoration of native sea-run fisheries including the Peskotomuhkati Nation at Skutik, Passamaquoddy Tribe at Pleasant Point, Passamaquoddy Tribe at Indian Township, Penobscot Nation, Houlton Band of Maliseets, Alewife Harvesters, Maine Lobstermen's Association, U.S. Fish and Wildlife Service, National Marine Fisheries Service, several conservation groups such as Maine Rivers, the Downeast Salmon Federation, Atlantic Salmon Federation, Penobscot East Resource Center, Conservation Council of New Brunswick, and the Canadian government, to name a few, to advocate for restoration of alewives to the basin. In April 2013, the Maine Legislature passed LD 72, taking a meaningful step toward renewing access for native sea-run fish to their native freshwater spawning habitat. Continuing discussions among parties to the SOC, Canadian agencies, and others provide an encouraging basis from which to build momentum for collaborative restoration.

The Peskotomuhkati Nation recognizes that restoration on a watershed scale requires maintaining relationships, building partnerships, and coordination among many different interests and areas of expertise. This Restoration Plan is an important early step for outlining an integrated approach to Skutik River restoration. The content of the Plan has been informed by the work of many other individuals, agencies, and entities, including the Schoodic Riverkeepers, Passamaquoddy Tribe at Indian Township, Passamaquoddy

[1] Maine LD 72, "An Act to Open the St. Croix River to River Herring," April 2013

Tribe at Pleasant Point, Penobscot Nation, Conservation Council of New Brunswick, Eastern Charlotte Waterways, Atlantic Salmon Federation, St. Croix Estuary Project, Nature Trust of New Brunswick, and Downeast Salmon Federation. It will engage relevant landowners, local municipalities, and various dam owners. Finally, it will reach out to other indigenous and nonindigenous organizations with a wealth of relevant experience for advice, including the Penobscot Nation, Department of Fisheries and Oceans Canada, Environment and Climate Change Canada, the U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration.

Key restoration interests have been actively engaged on the Skutik River for several decades. Much of this effort originated in 2011 during efforts made to document habitat, document passage issues, and obtain historical information about the river and the sea-run fish (E. Bassett, personal communications, 2019) after which St. Croix River and alewife restoration became part of the Sipayik (Pleasant Point) Environmental Department's mission and goals. Inspired by the video *Siqonomeq* (*Alewife*) made in 2012, the Schoodic Riverkeepers organization was formed (Appendix B). On June 14, 2012, all three Passamaquoddy chiefs signed the "State of Emergency in the Saint Croix River" (Appendix C) and on September 26, 2012, the Passamaquoddy Joint Tribal Council passed the "St. Croix River and Alewife Resolution" (Appendix D). The Schoodic Riverkeepers have been actively advocating for the restoration of the Skutik River ever since and helped form important partnerships with U.S. federal agencies. In August 2012, NOAA, the USFWS, and the U.S. Environmental Protection Agency (EPA) agreed to provide consultation and assistance to the tribe regarding alewives and the Skutik River (Appendix E).

Since 2013, following the efforts that brought about passage of LD 72, a group of Peskotomuhkati and agency representatives have convened by teleconference on a monthly basis and in person annually, in what are now referred to as the "Next Steps Calls" for the St. Croix River. The commitment and goals written into the SOC were the motivators for all the partners/participants. In the beginning the Next Steps group meetings were coordinated by Alex Hoar (USFWS since retired) and the participants were representatives to the signatories on the agreement: Passamaquoddy Pleasant Point, Passamaquoddy Indian Township, NOAA, USFWS, EPA, and BIA. The Schoodic Riverkeepers were not signatories to the SOC but were a driving force behind the scenes and were always directly involved in the monthly and annual meetings (Paul Bisulca, Brian Altvater, Ed Bassett, and others). They worked closely with the Next Steps group and the tribal government. Alex Hoar and Paul Bisulca were both very instrumental in making it possible for the SOC and all other organizing activities. DFO and the Peskotomuhkati Nation also regularly participated in the Next Steps calls. Currently, the calls are coordinated by Erica Stewart of DFO. A new SOC has been drafted to include a array of State, Provincial, and Canadian and U.S. Federal agencies, hopefully to be signed in 2021.

The Peskotomuhkati Nation, and others interested in Skutik River restoration, were also inspired by successes on the nearby Kennebec and Penobscot Rivers. There, sea-run fish restoration efforts resulted in dramatic increases to sea-run fish populations as well as a host of related ecological, economic, recreational, and community benefits. The Penobscot River Restoration Project, managed by the Penobscot River Restoration Trust (see www.penobscotriver.org), which members were the Penobscot Nation and six conservation groups, improved access to more than 3,200 kilometers (2,000 miles) of historic habitat for eleven species of indigenous sea-run fish by rebalancing fish passage and hydroelectric power generation on the river (www.penobscotriver.org). Prior to the project, few river herring or shad made their way upstream of the first dam on the river, Veazie Dam. Now, following the removal of the Veazie and Great Works Dams, more than 2 million river herring and nearly 4,000 shad pass through the Milford Dam fish lift (MDMR 2018).

Benton, Maine, where more than 5 million river herring now arrive annually, has a robust commercial alewife harvest following the removal of the Edwards Dam in 1999 and Ft. Halifax Dam in 2008 on the Kennebec River.

The Peskotomuhkati Nation envisions continuing to work with these interested parties as the project proceeds, and to develop relationships with new partners in Canada and the United States. This includes forming a restoration technical committee to oversee the recommended steps laid out in this Plan and to evaluate and adjust actions as opportunities and challenges arise and new information is developed or obtained. A communications and coordination plan should be developed to organize and inform restoration partners and advisors and ensure effective cooperation among plan developers, scientists, and field managers. Furthermore, the Restoration Plan should not be implemented in isolation from other watershed constituents and rights-holders. It is important that fish restoration activities, rationale, and progress be communicated internally and externally to the public and other interests within the watershed and throughout Peskotomuhkati territory.

1.3 Planning Development and Structure

Developing a strategic plan is a critical early step for a project of this magnitude. This strategic plan will help guide restoration actions, prioritize resources, ensure adequate capacity, and engage financial and community support. The Peskotomuhkati Nation is beginning with the Skutik River because it is the largest watershed in Peskotomuhkati territory, is most closely associated with Peskotomuhkati people, and restoration activity is already significantly underway and will benefit from additional planning. Restoration activities will eventually cover all relevant rivers across the territory; this Plan will serve as a template for future restoration efforts.

The Restoration Plan proposes actions to provide safe, timely, and effective passage for indigenous sea-run fish species throughout the entire ecosystem. Safe, timely, and effective passage includes improvements to upstream and downstream passage and other measures to improve/restore habitat where necessary in order to provide access to their natal waters (rivers and coastal areas). The Plan focuses on improving access to habitat as well as other actions that would support and increase the likelihood of restoration success. Collectively, the actions proposed herein will:

- see key species restored to their native spawning grounds;
- improve quality of spawning grounds and other habitats;
- enhance prey availability for COSEWIC, SARA, and ESA species that benefit from successful habitat restoration; and
- strengthen human relationships in the region to ensure long-term sustainability of restoration aims.

The Plan was informed through a process of information gathering that included extensive literature review and numerous interviews with individuals having experience with the Skutik River and its ecosystem. Skutik River restoration has been an ongoing discussion for decades and several plans and assessments have been developed in the past (Anon 1988, SCIWC 1993, Flagg 2007, Dill et al. 2010). The information and actions in this Plan build on previous efforts and ongoing discussions among the restoration partners identified above, including the regular "Next Steps" calls and "Partners" meetings that have been focused on Skutik River restoration since 2013. Previous work performed, supported, and provided by the Peskotomuhkati Nation, along with traditional knowledge, was an important part of the Plan and actions proposed. Considerable information was obtained through the work, research, and monitoring performed by state, provincial, and federal agencies, the St. Croix International Waterway Commission (SCIWC), and several local conservation groups. It is the intent of the Peskotomuhkati Nation to continue to work with these entities, building from previous assessments and restoration efforts as this Plan is implemented and restoration initiated.

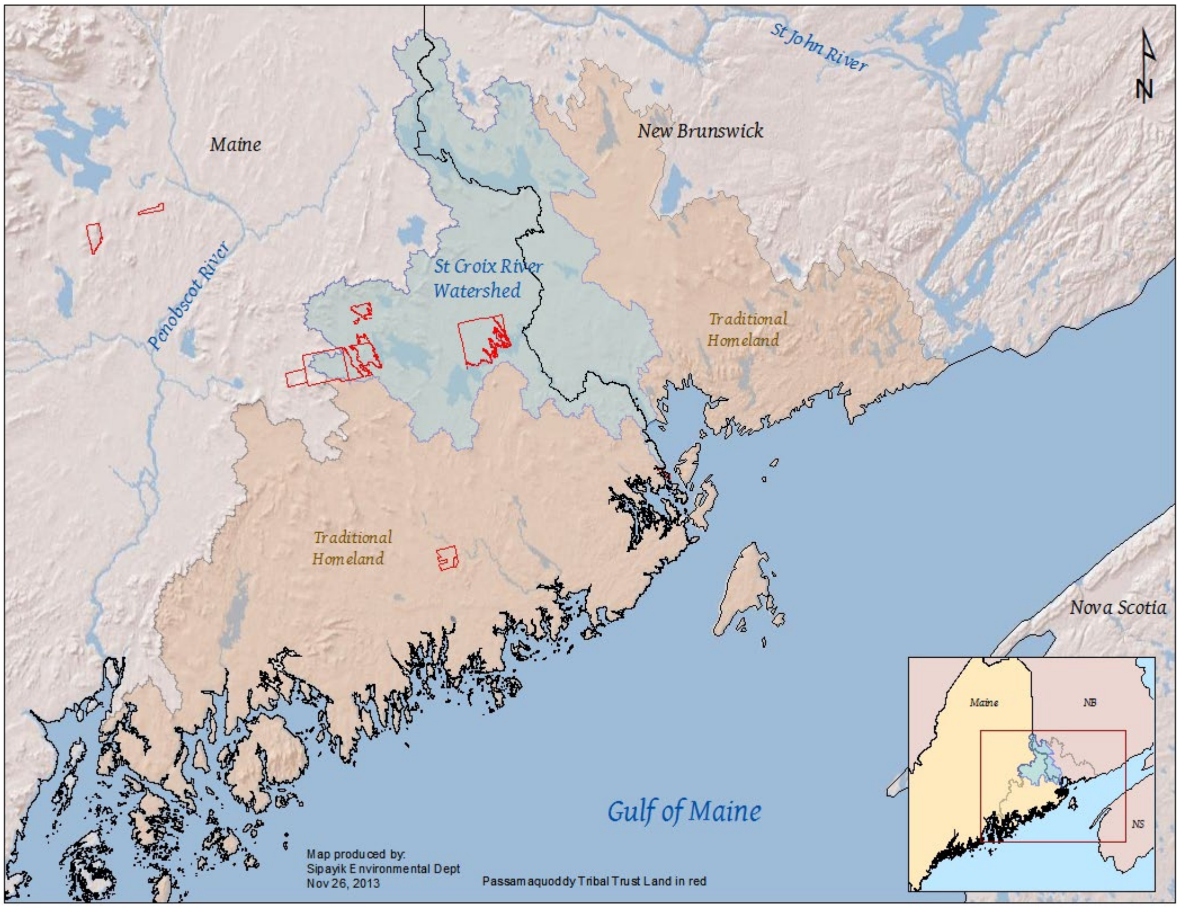
The information gathered and considered has been organized by the following parts of the Plan. Section 2.0 describes the Skutik River setting and provides context for the proposed restoration actions. Section 3.0 is a baseline assessment of the sea-run fish of the Skutik River providing information on each of the ten indigenous species, including historical presence and abundance, current presence and abundance, habitat, and restoration potential. This includes summarizing past and present status of the resource, establishing a baseline for restoration, and showing the restoration potential that exists. Section 4.0 states the restoration goal and objectives guiding this Plan. Section 5.0, the core of the Plan, presents the desired restoration strategies. These are organized into components, which consist of a set of related strategies and proposed actions. The components were established to help with organization and prioritization of restoration activities and do not need to be followed in sequence or independent of one another. Finally, Section 6.0 of the Plan summarizes a set of related activities essential to project success: a coordination and cooperation plan that also considers public engagement and a restoration monitoring and management plan to track restoration activities, monitor accomplishments, and enable evaluation and modification of restoration activities along the way.

2.0 The Skutik River

2.1 Setting and Context

The Skutik (St. Croix) River is the heart of Peskotomuhkati territory. It flows 185 kilometers (110 miles) along the U.S. – Canada border—Maine (to the south) and New Brunswick (to the north)—and drains an area of 4,271 square kilometers (1,649 square miles).

Figure 2: Peskotomuhkati (Passamaquoddy) Homeland



Source: Sipayik Environmental Department. Peskotomuhkati (Passamaquoddy) Homeland showing the location of the Skutik (St. Croix) River Watershed (blue shaded area in middle). Also showing the location of some of the tribal lands held in "trust" by the U.S. government (red outline).

The northern reaches are drained by the East Branch of the Skutik River through the Chiputneticook Lakes (East Grand and Spednic) and the Mattawamkeag River, a tributary to the Penobscot.

The West Branch of the Skutik, draining Sysladobsis, Junior, West Grand, and Big Lakes, joins the Skutik at Grand Falls and then continues to Skutik Estuary and the ocean at Passamaquoddy Bay. The territory is densely forested, pocked with many bogs, wetlands, and lakes. There are numerous lakes and waterbodies throughout the watershed comprising an estimated 43,949 hectares (108,601 acres) of surface water (see Appendix H, Ballard and Hoar 2021). Of the estimated 108,601 acres of surface water, 86,555 acres are deeper than ten meters (approximately thirty-five feet), indicating they could support cold-water fish populations (freshwater salmonids, smelt, and lake herring). Many of those lakes are flanked by wetland habitat, permanently or seasonally inundated areas with vegetation adapted to hydric soils. Extensive salt marsh stands are found along the coast. Lotic, or flowing water habitat, is prolific throughout the Passamaquoddy tribal homeland.

The Peskotomuhkati people originally occupied an area of roughly 9,977 square kilometers (6,200 square miles) between what is now referred to as Downeast Maine and Southeastern New Brunswick. In today's terms, tribal lands formed a rough triangle with Ellsworth, Maine, as the point to the southwest, Point Lepreau, New Brunswick, to the northeast, and Haynesville, Maine, to the northwest. Today, there are three tribal communities present in the region—Passamaquoddy at Pleasant Point/Sipayik and Passamaquoddy at Indian Township in Maine, the Peskotomuhkati Nation at Skutik in New Brunswick. The Penobscot Nation in Maine has tribal trust land in the West Branch.

The Peskotomuhkati are a coastal and forest people with a strong marine tradition and pronounced seasonal lifestyle between the inland forest in winter and the coast in summer. This lifestyle was dependent upon many variables including the weather, the timing of the migration of sea-run fish, and the movement of big game. Sometimes, the seasonal lifestyle followed other courses due to spiritual journeys, the health of the community, or individual will, so there was variation in this seasonal movement.

Peskotomuhkati made use of a wide network of footpaths, canoe routes, and portages connecting watersheds and penetrating hundreds of miles inland. Birch bark canoes enabled easy mobility for hunting, trapping, and fishing on fresh- and saltwater. This facilitated travel up and down the seacoast and across the Bay of Fundy into Nova Scotia. In addition, certain lands surrounding traditional village sites located at or near the head of tide and along riverbanks were burned and managed for hunting and planting purposes.

Traditionally, deer, caribou, moose, and other small game were hunted in fall and winter, usually by smaller family groups, inland from the ocean. Snowshoes were used for hunting big game in deep snow or over frozen bogs. Cold winters allowed Peskotomuhkati hunters (sometimes using dogs) to drive and pursue game across open bog and lake areas that may have otherwise been inaccessible during the ice-free season.

In the spring, summer, and fall much effort was focused on the prolific marine resources available in the area. Peskotomuhkati spent this time of year harvesting fish and shellfish from the coastal Gulf of Maine. Many different technologies were used to catch fish, such as nets, traps, and weirs. At times, during seasonal spawning migrations, or when in large schools, fish were plentiful enough to be pulled from shallow waters by hand. Fish were eaten in great quantity, including purely marine species like pollock, anadromous species like sturgeon, salmon, shad, and alewife, and about two to three thousand years ago, species like swordfish. One of the most prodigiously used was the American eel, which was considered a special food. Catadromous fish with freshwater residence of ten to twenty years, eels were present in nearly every river, wetland, and lake year-round.

Shellfish resources were readily available and easily harvested. Peskotomuhkati shell middens along the coast indicate that shellfish made up most of the diet near coastal settlements. Marine mammals made up a portion of the diet as well and were prominently placed in Peskotomuhkati tradition. The traditional hunting of porpoise came to function in the dual role of providing a protein source and a trade good (rendered porpoise oil).

Freshwater fish were also caught with spears, nets, and traps. Lake trout, bullhead, and landlocked rainbow smelt would have been available, particularly while spawning in the spring (smelt) and fall (lake trout). During certain times of the year freshwater and marine waterfowl were eaten as well.

The Skutik River system, including the estuary, is home to ten species of native sea-run fish, including alewife, blueback herring, American eel, American shad, Atlantic salmon, rainbow smelt, sea lamprey, sea-run trout, short-nose sturgeon, and striped bass. Information dating back to the 1600s, along with archeological evidence, demonstrates that Atlantic salmon, American shad, American eel, and river herring were all once abundant throughout the Skutik River system (Perley 1851, Atkins 1870, Anon 1988, SCIWC 1993, MacKay and Reader 2005, Flagg 2007, Dill et al. 2010, Paul 2018). French explorer Samuel de Champlain stated that at Salmon Falls in spring time there were herring and bass in such great abundance that vessels could be loaded with them (MacKay et al. 2003). These migratory species are members of a robust ecological community, each with its own role in the ecosystem as well as economic, recreational, and cultural value.

Many of these sea-run fish species were harvested in great numbers, supporting commerce and trade. Mammals, birds, and fish in Passamaquoddy Bay and the Skutik River also fed on these fish. The migrations provided a source of nutrient exchange between freshwater and the ocean. The Skutik Estuary thronged with fish, osprey, eagles, and other species that fed on the abundant marine forage to be found here. These vast and dependable annual migrations were a vital resource for people throughout the region.

Beginning in the 1800s, however, overharvesting, degraded water quality (toxins, low dissolved oxygen, elevated water temperatures, and wood debris), and dams left the Skutik River sea-run fish populations in decline, distress, or extirpated. Periodic attempts were made to address these challenges through the construction of fishways and through new laws and management practices pertaining to water quality and fish harvesting. Additionally, shifts in regional economic activities led to changes in water quality and fish harvesting as well. Despite construction of fishways and improvements in water quality, numerous barriers remain that prevent or diminish upstream and downstream passage of native sea-run fish and thereby limit access to critical habitat. Furthermore, changes in fisheries management practices and policies, such as the eighteen-year closure of fishways to prevent upstream alewife migration beginning in 1995, have severely depleted the number of sea-run fish populations present in the system, and eliminated some species all together. This has led to a highly degraded and unbalanced ecosystem in need of intervention.

2.2 Need for Restoration

The Skutik River once supported one of the largest runs of river herring and other sea-run fish in Atlantic Canada and northeastern United States, but current runs are a small fraction of historical numbers. As with other river systems, many factors contributed to decimation of the sea-run, including industrial and municipal discharges, overfishing, introduction of nonnative fish, installation of screens and/or stoplogs to block fish passage, and the cumulative impact of constructing multiple dams for power generation (National Research Council 2004, Saunders 2006, Limburg and Waldman 2009). Furthermore, water storage on both the main stem and two branches of the Skutik River affects the timing and rate of migration through the system. Inadequate fish passage is a key remaining impediment to sea-run fish restoration.

There are eight major dams on the main stem, East Branch, and West Branch of the river with several other key migratory barriers on tributaries that significantly limit the movement of sea-run fish through the system (see Figure 1). On the main stem, there are three hydropower-producing dams: Milltown (slated for removal by end of 2023), Woodland, and Grand Falls (listed from head-of-tide moving upstream). Three dams sit on the West Branch: West Grand Dam, Farm Cove Dike, and Sysladobsis Dam. Finally, there are two dams on the

East Branch: Vanceboro and Forest City. The Canoose Dam is on a significant tributary between the Grand Falls and Vanceboro Dams. The result is a system in need of immediate attention.

Dams on the Skutik River have cumulative impacts on fish populations. They significantly limit access for sea-run fish moving between the Gulf of Maine and key inland spawning and rearing habitats. With these barriers in place, several sea-run fish species cannot complete their life cycles. Currently, access to spawning and rearing habitat for the full assemblage of sea-run fish that co-evolved in the Skutik River system is the biggest impediment to a healthy and self-sustaining ecosystem. Dams also directly harm fish. Mortality due to downstream passage problems is severely affecting sea-run fish populations as well. Cumulatively, dams have made a significant contribution to the demise of Skutik River sea-run fish. Alewife populations, for example, have been reduced by over 99% from historical levels.

This disruption in migration causes a loss of ecosystem composition, function, and quality. It affects the entire ecosystem, not just the individual populations of fish, and results in a lost ecologic connection between inland waters, upland resources, the Skutik estuary, Passamaquoddy Bay, Bay of Fundy, and Atlantic Ocean. This damages key ecologic functions and relationships that depend upon exchanges between inland waters and the sea. Negative effects are wide-ranging: the loss of protein as well as cultural and traditional uses for Peskotomuhkati people; loss of forage fish for groundfish in Passamaquoddy Bay and the Gulf of Maine; loss of recreational and economic values for communities; and loss of food for marine mammals and birds. In sum, sea-run fish populations in the Skutik have dwindled, yet a potential for restoration remains that would yield wide-ranging ecological, social, and economic benefits.

2.3 Benefits of Restoration

Returning the full assemblage of sea-run fish would yield wide-ranging ecological, economic, cultural, and community benefits throughout the region. The benefits from restoring the Skutik River could extend beyond the watershed, helping to replenish populations of sea-run fish throughout the Peskotomuhkati territory.

2.3.1 Ecological Benefits

The Skutik River historically supported vast populations of at least ten species of indigenous sea-run fish. It is hard to imagine a river so teaming with fish. Gibson et al. (2017) estimated alewife spawner abundance to be between 70.8 and 117.4 million alewife, in the absence of fishing (commercial harvest) or any other human impacts such as dams. The Skutik River watershed has the highest alewife production potential of any in Atlantic Canada, the Northeast, and probably North America. Historically, the Skutik River was a food factory that delivered trillions of juvenile alewife to ocean fish, sea birds, and marine mammals in Passamaquoddy Bay that were vital to the Peskotomuhkati through time. The baseline conditions in the river and at sea have changed. There are multiple dams on the river and upstream passage is via old fishways that when new were inherently inefficient and a limiting factor. The alewife run at Milltown Dam has been increasing in recent years and on June 20, 2021 was 548,031. The Skutik River is not the food factory for Passamaquoddy Bay that it used to be and the Bay is not as productive as it once was. Still there is great potential. LimnoTech (2020) estimated the annual alewife spawner population to be between 27 and 58 million alewife, under current baseline conditions including no commercial harvest. With this in mind, the stated Peskotomuhkati goal seeks to achieve an ecological condition in the future that provides far better benefits than today.

River herring are a keystone species that provide food for a wide variety of fish and wildlife inhabiting the Gulf of Maine, including commercial species such as haddock, pollock, and tuna; recreational species such as striped bass and bluefish; and federally protected species such as bald eagles and whales. Juvenile fish provide important food for kingfishers, eagles, osprey, river otters, and waterfowl. Researchers such as Ted Ames (recipient of the 2005 McArthur Award) believe the declines in the inshore populations of groundfish are directly related to the loss of the anadromous forage base and that restoration efforts, such as the ones being pursued on the Skutik and Penobscot, offer hope to re-establish these struggling groundfish stocks (Ames 2005). Improving connectivity and restoring ecologic functions, such as sediment transport, nutrient exchange, and temperature regime, would help restore habitat for "lower river" species such as shortnose sturgeon, striped bass, and rainbow smelt (Barber 2018, Ames and Lichter 2013). River herring are important forage fish that diversify prey options and form the foundation of robust marine and freshwater ecosystems.

Restoring sea-run fish to the Skutik River will help increase the resiliency of sea-run fish populations and the entire Gulf of Maine ecosystem. The outer Bay of Fundy, along with the rest of the Gulf of Maine, is experiencing severe stress from climate change. Restoring keystone species, like the alewife, is a critical step in ensuring that the ecosystems are as robust as possible and able to support marine species under the new climate regime changing coastal waters. Growing the population of each species also increases chances for genetically resilient fish. Finally, improving fish passage can shorten the time it takes for fish to migrate upstream, thereby reducing stresses associated with time spent in warmer water typical of impediments, and increases access to areas offering cold water refugia.

2.3.2 Social and Cultural Benefits

The Peskotomuhkati people have been inextricably linked to the migration of sea-run fish for generations, spanning thousands of years. Vast, healthy, self-sustaining populations of sea-run fish are an important part of Peskotomuhkati history, integral to the people's spiritual and physical health, and still play important social, economic, ceremonial, and religious roles today. Yet for decades the Peskotomuhkati people have been unable to exercise their treaty reserved fishing rights, as migratory fish are blocked from reaching their native habitat. The loss of sea-run fish negatively impacts the Peskotomuhkati Nation's opportunities to maintain and enhance these essential connections with the river and its sea-run fish both today and for future generations. The significance of this relationship is clearly described in documents, including the "Vision and Mission Statement of Schoodic Riverkeepers" (Appendix B), the Passamaquoddy Tribal Sovereign Declaration "State of Emergency in the St. Croix River" (2012) (Appendix C), and the "St. Croix River and Alewife Resolution Joint Tribal Council of the Passamaquoddy Tribe" (2012) (Appendix D). Restoration of the Skutik River will help render meaningful the Passamaquoddy Tribe's federally recognized rights and reinvigorate impacted cultural, traditional, and spiritual practices dependent on a healthy river.

2.3.3 Economic Benefits

A restored Skutik Riverwill renew recreational opportunities related to sea-run fish and improve community ties to the river. Restoration will offer a recreational fishery for American shad, as seen on other rivers following similar restoration efforts. It will also help to bring striped bass and rainbow smelt upriver on their annual migrations, adding to or enhancing valuable recreational fisheries. Restoration could even bring about the potential to someday renew fly-fishing for Atlantic salmon on the Skutik River.

Increased runs of river herring support business, supplying valuable bait for the lobster industry and food for commercially important fish species such as cod and halibut. In many cases, river herring harvests directly benefit municipalities in watersheds where runs thrive. River herring are often used as lobster bait. In the United States, the lobster fishery consumed 1.6 million pounds of river herring in 2012, worth $426,320 (USD). In comparison to Atlantic herring, the primary lobster bait, alewives cost nearly twice as much per pound but make up only 1.7% of the lobster bait sold. Using Maine Lobstermen's Association data, the CapLog Group found the average price per bushel of alewives to be $19 (USD) in 2011. In their 2011 analysis of the economic benefits of a bait fishery for alewives on the St. Croix, the CapLog Group found direct net present benefits amounting to $1.8 million (USD) from an optimally managed fishery under a preferred set of parameters. Their analysis examined a range of harvest amounts, regrow periods, and growth rates as well as other harvest/management options. They estimated an additional $1.2 to $4 million (USD net present value) in indirect benefits due to a lower cost along with higher quality (fewer fish used to maintain catch rates) of using alewives as bait. They added that these are partial estimates of value as other ecosystem services associated with alewives were not considered in their analysis (CapLog Group 2011).

Restoration may also offer new opportunities for community based commercial fisheries as seen elsewhere. Since the Edwards Dam on the Kennebec River was removed in 1999, the alewife population in the Sebasticook tributary has increased to between one and three million fish annually. In 2019, it was the biggest river herring run in the United States. In 2005, the Maine Department of Inland Fisheries and Wildlife issued twenty-six permits to net the fish for lobster bait, providing a "new" inland commercial fishery, as well as a convenient and highly abundant source of fresh bait for lobstermen. Reported harvest on the Sebasticook River in 2006, seven years following the removal of the Edwards Dam, was 3,946 bushels of alewives, with a market value of at least $39,000. The state of Maine has approved an ordinance granting the town of Benton "town rights" to this new fishery, restoring a community tradition that was lost in the middle of the nineteenth century. Currently, the town harvests between 350,000 and 500,000 fish per year. The town typically nets about $20,000 from the sale of surplus alewives during harvesting (Ellis 2018). In addition, the presence of an abundant and seasonally concentrated bait fish has benefits for other recreationally and commercially important species, including cod, other groundfish, and striped bass, by providing a ready food source.

The Peskotomuhkati goal supports harvest in the upper section during restoration. The goal supports harvest in the lower section after the maximum ecological production capacity of the watershed has been achieved. Modeling showed that harvest in the upper section would have negligible impact on the rate of restoration, while harvest in the lower section would have a significant impact on it. This is primarily because fish harvested high in the watershed have already spawned and harvest in the lower part of the river would be of fish still with eggs. By supporting harvest first in the upper section, and later in the lower section, the alewife population will much more quickly attain the level of production necessary to once again be a significant "food factory" for Passamaquoddy Bay in support of those important fisheries.

3.0 Baseline Assessment—Sea-run Fish of the Skutik River

As a point of comparison to the current status of sea-run fish, restoration planning considers the "baseline" from which to assess restoration. The baseline could be current conditions, a desired historical/past condition, or some combination thereof. Working from a baseline enables restoration proponents to set desirable future conditions that differ from or improve upon past and/or existing conditions, whatever the desired outcome.

Historically, the indigenous fish community of the Skutik River included up to ten species of fish that had to migrate to and from the sea to complete their life cycle. Many of these sea-run fish species abounded and were harvested in great numbers, supporting livelihoods, commerce, and trade. Mammals, birds, and fish in the Skutik River, Passamaquoddy Bay, and Gulf of Maine also fed on these fish. The migrations provided a source of nutrient exchange between freshwater and the ocean. These vast and dependable annual migrations provided sustenance for the people throughout the region.

While we recommend that past conditions guide the Skutik River restoration, returning to these historical conditions is not the focus of this restoration effort. The Peskotomuhkati Nation recognizes that myriad factors will affect the restoration potential of target species, such as range and quantity of habitat, habitat access, migration barriers, fish-passage efficiency and capacity, existing infrastructure and development, water quality, regulations, policies, and existing management plans. However, these factors should not be an excuse to stop short of new efforts using best practices to try to achieve restoration as close to the desired historical levels as possible. The river users and governments that have supported them spared no expense in degrading the traditional homeland of the Peskotomuhkati Nation. Passamaquoddy people would like to see no expense spared in the restoration of the Skutik watershed and ecosystem.

Historical conditions will be used to establish a context for restoration efforts to aim toward, one that envisions a healthy and robust ecosystem, including sustainable populations of the full assemblage of indigenous sea-run fish species for the Peskotomuhkati Nation, an alewife fishery, and recreational fisheries for several species. In striving toward these baseline conditions, it is important to understand the status of each species native to the watershed. What follows is a summary, based on currently available information, of each indigenous species examining historical presence and abundance, current presence and abundance, historical and available habitat, and past management effort.

3.1 River Herring—Alewives/Gaspereau and Blueback Herring (*Alosa pseudoharengus* and *Alosa aestivalis*)

3.1.1 Historical Presence and Abundance

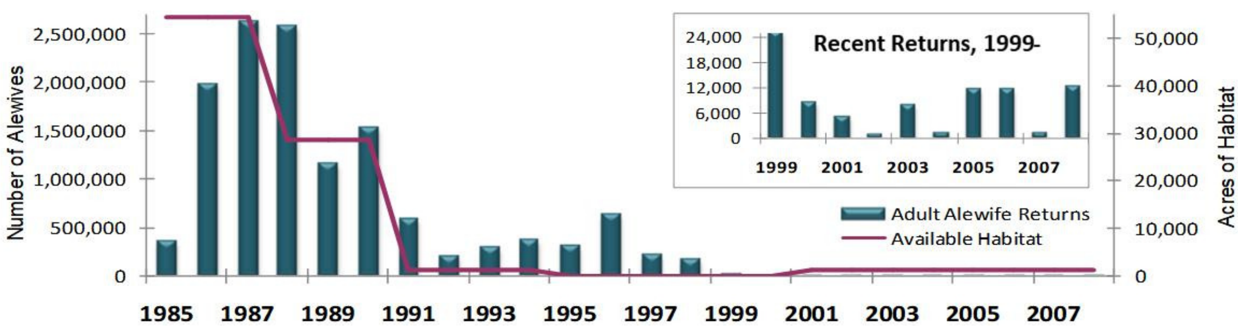
To Peskotomuhkati people, alewives/gaspereau are the "fish that feed all." For the purpose of this Plan, we will use the term "river herring" to include alewives/gaspereau and blueback herring. They were eaten fresh as adults and juveniles on their spawning migration, smoked for later consumption, and used as fertilizer for growing corn, squash, and beans. Alewives also fed other species Peskotomuhkati Nation people relied on for sustenance: cod and other groundfish, porpoise and whales, striped bass, and fish-eating waterfowl. Revered species with ceremonial significance, like bears and eagles, also consumed alewives alongside Passamaquoddy people.

The Peskotomuhkati word *Skutik* means "place of fire," a name reflective of the numerous fish smokehouses once present and the abundance of alewives within the Skutik River system. This abundance has been well documented throughout archeological records, historical documents, early reports about the fishery, and more recent studies, plans, and reports. For example, evidence of alewife harvest and consumption has been found in archeologic studies at Mud Lake Stream (Spiess and Halliwell 2012, Paul 2018) and elsewhere throughout the watershed. Historical reports dating back to 1604, when Champlain's colony was present, note alewife harvests in the millions. Further evidence includes an 1803 written report documenting that "about 3,000 barrels of alewives are annually taken at the falls," referring to Salmon Falls in the Parish of St. Stephen, New Brunswick (Davis 1974). The Flagg (2007) report *Historical and Current Distribution and Abundance of the Anadromous Alewife in the St. Croix River* says 370 alewives fill a barrel and it takes 120 alewives to fill a bushel, making a barrel of alewives equivalent to three bushels. Using this factor, 3,000 barrels would equal about 1,110,000 alewives harvested.

A similar report by John Frost, who came to Pleasant Point in 1763 to trade with Peskotomuhkati people, says he took part in harvesting thousands of barrels of sea-run fish at Salmon Falls (Kilby 1888). In 1797, Frost signed a sworn deposition for the Boundary Commission stating that in May of 1765 or 1766 he went to Magaguadavic Falls in a seventy-ton sloop to fish for salmon, shad, and alewives. After seven or eight days and only catching one barrel full he went to the St. Croix and joined two other vessels already fishing there, one thirty and the other forty-five tons. There they caught 800 to 1,000 barrels of fish, mostly alewives with some salmon, shad, and bass (Kilby 1888). This again indicated the bounty off fish present in the river, with three boats taking between 1 and 2 million fish in a matter of days.

The first declines in fish populations were noted in the 1820s after the first dams were built in the Calais area (Perley 1825, Flagg 2007). While numbers have fluctuated over time due to dams, pollution, and loss of spawning habitat (Atkins 1870, Joint Commission 1896), their presence in large quantities was often noted until the 1960s (Dill et al. 2010). With improvements to water quality, fish passage, and restoration stocking their numbers rebounded in the 1980s. In 1986, five years following fish-passage improvements at Milltown Dam, the alewife population rose from 170,000 to 2 million, eventually reaching a high of 2.6 million in 1987 (Flagg 2007) following the return of four- and five-year-old fish. However, when the fishways at Woodland and Grand Falls were closed in 1995 the population crashed and by 2002 it had reached an all-time low of 900 (Flagg 2007), a decline of 99.7%.

Figure 3: Skutik Alewife Spawning Habitat and Adult Returns 1985 – 2008



Source: FB Environmental, *St. Croix River: State of the Watershed* (2008)

3.1.2 Current Presence and Abundance

Once the fishways at Woodland (2008) and Grand Falls (2013) were reopened alewife numbers began to increase, with trap counts at Milltown Dam yielding a ten-year average (2008 to 2017) of 47,142 alewives (Goreham and Almeda 2017). In 2018, 270,659 alewives were counted at Milltown (MDMR 2018). In 2019, 480,670 were counted as four- and five-year-old fish start returning that were spawned in the habitat opened in 2013. In 2020, that number climbed to 600,969 alewives. This helps demonstrate the restoration potential for alewives.

3.1.3 Habitat

The Skutik River watershed has available a 42,535 hectares (105,107 acres) of spawning and rearing habitat for sea-run alewives and blueback herring (Table 1). Much of it is water behind dams. Historically, there were no dams and that amount of spawning and rearing habitat was less, yet the watershed produced huge numbers of fish. As previously discussed, some accounts have indicated that upward of 3,000 barrels of alewives were harvested annually at Salmon Falls (Davis 1974, Flagg 2007). River herring production has been and continues to be a function of the extensive lake habitat in the watershed.

Alewife spawning habitat has been traditionally calculated as the surface area of waterbodies. For the Skutik River watershed, spawning and rearing habitat was summed that is currently accessible, or could be accessible with proper fish passage. Table 1 summarizes the surface area of each waterbody within reaches of the Skutik River that are bounded by dams; i.e., Milltown Dam to Woodland Dam, Woodland to Grand Falls Dam, and so on. The entire data set, methods, and sources are presented in Appendix H in *Alewife Spawning Habitat in the St. Croix River Watershed*. Previous reports and unpublished working documents did not included certain portions of the watershed for various reasons; e.g., by agreement (Dill et al. 2010), policy (state of Maine and consequently DFO-CA), in Canada (state of Maine), where excluded (state of Maine, Dill et al. 2010,), or were not necessary for purposes of modeling (Barber 2018, Barber et al. 2018). The accounting used in this Plan is the most complete and accurate to date. It includes all portions of the watershed that have alewife spawning and rearing habitat in both Canada and the United States.

Table 1: Summary of the Available and Potentially Available Spawning Habitat for River Herring in the Skutik River Watershed

Reach	Area (Hectares)	Area (Acres)
Below Milltown Dam (Salmon Falls)	206	509
Above Milltown Dam (Salmon Falls) and below Woodland Dam[1,2]	16	40
Above Woodland Dam and below Grand Falls Dam[3]	510	1,261
Above Grand Falls Dam and below Vanceboro and West Grand Dams[3]	9477	23,418
Subtotal: All reaches below Vanceboro and West Grand Dams	**10,003**	**25,228**
Above West Grand Dam[3]	14,356	35,474
Above Vanceboro to Forest City Dam[3]	10,400	25,699
Subtotal: Mainstem, West Branch, and East Branch below Forest City Dam	**34,759**	**86,401**
Above Forest City Dam[3]	7,570	18,706
Combined Total	**42,329**	**105,107**

Sources:

(1) Dill et al. 2010. Included Vose Pond in Maine and Mohannes Stream in New Brunswick. Excluded above West Grand dam and above Vanceboro dam in keeping with their objectives.
(2) Fraser A. and L. Sochasky 2021. Found Mohannes Stream in New Brunswick to be inaccessible.
(3) Billard and Hoar (2021). (Appendix H)

3.1.4 Restoration Potential

The Skutik River has the greatest production potential of any watershed in Maine, Atlantic Canada, northeastern United States, and probably North America. The alewife has always been a key-stone species ecologically and for the Peskotomuhkati people. There were so many that long ago sailing ships from far away would anchor in the river and fill their hulls with barrels of alewife (Davis 1974, Flagg 2007). During much of the 19th century and most of the 20th, the Skutik River experienced low alewife abundance. The largest run was 2.6 million in 1987 (Figure 3); that was equal to only 24.7 fish per acre of spawning habitat. The lowest run as 900 fish as a result of the Maine legislature closing the Woodland and Grand Falls fishways to alewife; that amounted to 0.009 fish per acre. In 2020, the run was 600,969 alewives or 5.7 fish per acre. In contrast, in Maine, 79% of commercially harvested rivers have had over 200 fish per acre, 61% over 300, 23% over 500, and 7% have had over 1000 fish per acre of alewife spawning habitat.

While the Peskotomuhkati Nation is pleased that the Skutik River alewife run is beginning to recover, there is no reason to settle for the stunted stocking rates that have persisted for too long. The Skutik River has the greatest production potential of any watershed probably in North America. It just needs care and assistance to help it recover.

There is great potential for increasing migratory fish returns to the Skutik River. Factors common to most rivers undergoing restoration include : the number of returning spawners, access to spawning habitat, and carrying capacity of the habitat. For the Skutik River there are several key factors that need attention. For example, there are a large number of dams. A significant percentage of fish fail to pass each dam. The cumulative effects of that means that a small percentage of the alewives that enter the river make it to the spawning grounds. The energy each fish must spend to swim up the fishways at multiple dams is a critical factor. Fish spend far less energy and progress upstream more quickly in an open river. Each fishway on the river has certain capacity to pass fish at one time, per day, etc. If the fishway is undersized, fish have to wait. Predators are often present while they wait. And, during outmigration of adult and juvenile fish, mortality through turbines and spilling on rocks has a large negative effect on the restoration potential. The first dam on the river, Milltown, is scheduled to be removed by the end of 2023. The first dam has the biggest impact and its removal will be a huge improvement.

While opportunities exist to address a range of factors affecting sea-run fish populations, passing multiple dams is one of the most significant impacts in need of attention. Addressing the cumulative impacts of multiple dams on upstream and downstream fish passage is critical to the recovery of native sea-run fish species and achieving the goal of the Peskotomuhkati Nation.

3.1.4.1 Returning Spawners:

Data collected from the top of the Milltown fishway since 1981, along with data published from Damariscotta Lake in Newcastle, Maine, let us create a linear model that accounts for many of the limitations on alewife recovery on the St. Croix. Walton (1987) characterized the parent-progeny relationship between spawner escapement and juvenile escapement for alewives at Damariscotta Lake between 1977 and 1984. Estimates were that each female that entered the lake produced an average 1,204 juveniles per female or each lake acre supported 3,155 juveniles emigrating to the ocean. Juveniles per female assumes there are no limits on how many fish the habitat can support. Juveniles per acre assumes that there is a limit, or density dependence, in how many juveniles an acre can support (based on things such as food and predation). Damariscotta Lake is a useful data set because the data are based on empirical counts of juveniles leaving the lake the same year, thus providing a better foundation for mortality calculations.

Mortality, the number of fish that die in a year, is a multiplier, usually applied annually, to estimate losses of fish from a year class. Annual mortality is the percentage of fish that do not live from one year to the next, lost through predation, fishing, and migration mortality. Mortality varies by age class, where the youngest fish have the highest mortality and the rate of loss declines with age; however, older fish become less numerous as well. In this context, annual mortality is the combined percentage lost for the entire population, as represented by aging a subsample of alewives caught at the top of Milltown Dam. High mortality among the population could limit the production potential of the returning alewife run.

Years of counting fish and collecting scales at the top of Milltown Dam have produced a count at age data set that can be used to estimate annual mortality for the alewife run.

- Mean annual mortality = 69.6%, median = 71.1% for fifteen years of data between 1990 and 2018.
- Mean annual mortality for 2017 and 2018 = 59.2%.
- Maximum annual mortality year was 1990 = 86.3%.

With the information above we can build a simple population model to estimate the current carrying capacity of the Skutik River. Most alewife populations studied in the last decade have exhibited density dependence. Assuming the upper Skutik River can support about 3,200 juvenile alewives per acre, we modeled total returns using the following steps:

1. Multiplied the juveniles per acre by spawning habitat. The model was constrained to habitat below Forest City Dam and below West Grand Dam to simulate conditions that existed at the time.
2. Removed the portion of the population equivalent to the annual mortality at each age step, e.g., Age2 = Age1 – (59% * Age1).
3. To get total run size estimates we summed the Age5, Age6, and Age7 alewives. These age classes are the ones found most frequently in the Milltown alewife monitoring samples.

Our first observation was that the population is extremely sensitive to annual mortality. We found a sharp decrease in the number of returning fish as annual mortality increased. Our estimates were an order of magnitude different (millions versus hundreds of thousands) when using 59% mortality versus 71% mortality. At 86% mortality only about 10,000 fish returned; however, at 59% (the 2017-18 annual mortality rate) 3 million fish returned. Reducing the number of repeat spawners, a symptom of high annual mortality, reduces the number of experienced breeders, the number of eggs laid, and the standing stock of fish carried over from year to year.

Our second observation is that habitat access is critical for the Skutik alewives. The highest mortality (86.3%) was recorded four years after the initial closure of habitat. Large numbers of fish were still returning to the river but there was limited habitat available in the stretches of river below Grand Falls Dam. If alewives are density dependent, then having more habitat available allows juveniles to grow to a critical size required for their survival to the next year. Although we applied an average annual mortality rate per year, the highest mortality occurs between young of year and Age1. The larger the juvenile that leaves the lakes the more likely that fish is to survive.

One of the critical questions is how many fish are required to fill the available habitat. Monitoring at Milltown since 1981 has demonstrated quite clearly that critical habitat for alewives in the Skutik River is above Grand Falls Dam and in the East and West Branches. Without ample, safe, timely, and effective access to these parts of the watershed population numbers will remain low.

Models can estimate how a system might respond to proposed/desired and undesired changes. However, river systems are complex and offer many choices for which way to go. Furthermore, planners and managers should keep in mind that the locations of fisheries impact how models work. “Forward projecting” models that consider the order of fishing and mortality events may be best for restoration planning and fisheries management (Gibson, personal communication, 2017—partners meeting notes). Models are useful for focusing attention on questions that still need to be answered. We discovered some of those questions to be:

- How many alewife adults are required for 3,155 juveniles to emigrate from each lake acre? We are effectively asking how many fish are required to fill up the available habitat, which may be different from carrying capacity. This is the critical number of fish that have to be passed at Grand Falls.
- How safe, timely, and effective is fish passage currently at the various St. Croix River dams? The little data that exists points to the three lowest dams not performing at their design criteria (see above).
- Is poor downstream passage adding to the annual mortality rate? The model indicates that the population is very sensitive to annual mortality, which is difficult to influence between ages one and four but repeat spawner downstream passage can be addressed. Improving downstream passage would improve survival of older, more fecund, experienced fish that will help the population grow and decrease juvenile mortality between Age0 and Age1.
- How many fish need to return to support a sustainable harvest? If there is a desire to establish an alewife fishery on the Skutik, when and where should that occur. We believe a harvest would be possible after the ecological production level is attained and can be sustained with harvest.

3.1.4.2 Carrying Capacity:
The following is a general definition of carry capacity.

> The carrying capacity of an environment is the maximum population size of a biological species that can be sustained by that specific environment, given the food, habitat, water, and other resources available.

Carrying capacity varies from one watershed to another, and within those watersheds. The values of the variables that define it vary spatially and over time. Best practices have been recommended for accommodating that variability when specific key information does not exist for a watershed or the waterbodies within it. An accepted practice is to apply the carry-capacity estimate at the watershed scale and avoid applying it at the sub-watershed scale (Gibson et al. 2017). That is the approach taken here.

Carrying capacity is a measure of production. It is useful in regulating fisheries inland and at sea. Carrying capacity is also a measure of production potential. An estimate of the potential production of alewife in the Skutik River watershed has particular utility for the restoration of alewife, and other sea-run fish species. Carrying capacity is expressed as biomass produced per species per unit area; e.g., metric tons/hectare. Fish per unit area is another common expression of carrying capacity. Biomass can be converted to number of fish by dividing biomass by the average weight of a fish; e.g., for alewife 0.5 lbs. or 233 grams. Using fish per acre to calculate carrying capacity, the formula is carrying capacity = (fish per acre) x (acres of spawning habitat).

For fish-per-acre, the Restoration Plan adopted median value for alewife presented in DFO Canadian Science Advisory Secretariat, Maritimes Region, Research Document 2016/105 (Gibson et al. 2017). That median value is 845 fish-per-acre.

For acres of spawning habitat, the Restoration Plan adopted the acreage presented in Billard and Hoar 2021, which is provided in Appendix H. That document presents the total potential spawning habitat for alewife in the Skutik River watershed. Potential spawning habitat is considered surface area of waterbodies (lakes and flowages) that are currently accessible to alewife and areas above dams that could be accessed with proper fish passage. The total acreage of alewife spawning habitat in the watershed is 105,107 acres.

Not surprisingly, calculations of alewife "acres-of-spawning-habitat" for the Skutik watershed have varied over time for reasons that are not always apparent. Values have varied significantly within the same general time frame from one application to another. Some authors have not revealed the acreage value they used, just the resulting carrying capacity estimate. Billard and Hoar (2021) compiled a tally of alewife spawning habitat for the entire watershed, in Canada and the United States, that is both contemporary and comprehensive. In the interest of transparency and use by others, it is made available in Appendix H.

The following provides a summary perspective of carrying capacity and background on what the Plan has replied on regarding the estimate of carrying capacity and particularly fish per unit area.

During much of the 19th century and most of the 20th, the Skutik River experienced low alewife abundance. Since annual returns are so low, answering what is the "right" carrying capacity for the Skutik River should not stand in the way of implementing the Restoration Plan. There are many things to do independent of carrying capacity. It will become an important consideration if new fishways are designed and constructed at Woodland and Grand Falls Dams, if the Skutik River has supplemented the food supply of Passamaquoddy Bay enough, and if to begin harvest of alewives. There is much to gain by implementing the Plan.

Dill et al. (2010), in *An Adaptive Plan for Managing Alewife in the St. Croix River Watershed, Maine and New Brunswick* (Adaptive Management Plan), reflected on population-goal considerations for the Skutik River that are still poignant and timely.

> Historic changes in access to spawning habitat make it difficult to envision the size of a restored St. Croix alewife population or the number of spawners needed to maintain it. Establishing an estimate of the minimum number of spawning alewife for lake habitat … requires: 1) an estimate of the carrying capacity of the habitat and 2) criteria for establishing a minimum spawning population size. Neither is currently known for the St. Croix watershed, although general information about alewife, as well as regional proxies, are available that could be used to establish the goal. However, given that abundance is currently very low, … this plan can be started without establishing a long-term goal … The following information provides an approach to calculating … a rough approximation of that goal.

Carrying capacity of alewife habitat has been estimated by Gibson and Myers (2003a, 2003b) based on meta-analyses of eight alewife populations in New England and Atlantic Canada. These estimates can be used when watershed–specific data are not available, but also demonstrates that alewife habitat carrying capacity is highly variable among rivers. Based on their analyses, "typical" habitat (the median: ½ of the rivers would have higher capacities and ½ lower) has a carrying capacity of 55 mt/km^2 (0.2 t/acre), but 10% of rivers would be expected to have carrying capacities below 33 mt/km^2 (0.15 t/acre) and 10% would be expected to have a capacity greater than 93 mt/km^2 (0.41 t/acre). If the St. Croix is "typical", these values would imply that the carrying capacity of the accessible habitat under this plan would be 23.4 million alewife [2]…, a value that is high relative to other estimates for this portion of the watershed. White and Squires (1989) estimated the range of carrying capacity for the same portion of the watershed to be 7.5 million to 9.5 million alewife, and estimates of the carrying capacity of the entire watershed (roughly 4 times the area to which access will be provided under this plan) were 20 million alewife (Watt 1987) and 23.6 million alewife (Flagg 2007)[3]. However, these older estimates were based on the carrying capacity of heavily exploited systems and it is not clear that the analyses fully accounted for the influence of commercial fishing. (Dill et al. 2010)

Table 2. Abundance reference levels (median plus quartiles) per acre of habitat for alewife fisheries based on reference values used in DFO's Maritimes Region (converted from Gibson et al. 2017, Table 3.3.1, p 37).

Reference point	Symbol	25th	median	75th
Spawner abundance in the absence of fishing or other human impacts (number/acre)	$ESC_{100\%}$	637.1	**845.7**	1,122.7
Spawner abundance at MSY[1] (number per acre)	ESC_{msy}	94.6	**125.6**	166.7
10% of the spawner abundance in the absence of fishing (number/acre)	$ESC_{10\%}$	63.7	84.6	112.3

[1] Maximum Sustainable Yield (MSY), [2]Escapment (ESC)

Based on the analyses in Gibson et al. (2017)[4], in the absence of fishing (harvest) or other human impacts, a "typical" (median) alewife population would be expected to reach a size of 845.7 fish/acre, although this value is expected to be highly variable among rivers (Table 2). This is the proxy for carrying capacity used.

There is currently no commercial alewife fishery in the Skutik River watershed, and any new fishery in Maine would need to be consistent with Atlantic States Marine Fisheries Commission (ASMFC) guidance. But for a moment, notice how dramatically the fish-per-acre values are reduced in Table 2 to provide for fishing at maximum sustainable yield (MSY). Fishing tends to crop the older most fecund fish thereby decreasing production. The age structure changes, there are fewer large fish, gonad weight is reduced, and fewer repeat

[2] The 23.4 million value applies only to all lakes and flowages from Salmon Falls upstream to West Grand Dam and Vanceboro Dam, and not beyond. The total acreage used was 24,638. The fish per acre value used was 958.

[3] It has been common for different values to be used to calculate the carrying capacity of the Skutik River watershed. This has sometimes led to confusion and misunderstanding. For Flagg (2007) used essentially the same watershed area (99,205 acres) as Dill et al. (2010) (98,552 acres). Flagg's source was the *Five Year (1993-1997) Operational plan for the development and Management of the Diadromous Fishes of the St Croix River*. Flagg used 117.5 and 235 fish per acre to calculate carrying capacity. Dill et al. (2010) used 958 fish per acre.

[4] Reviewed by the DFO Canadian Science Advisory Secretariat, Maritimes Region.

spawners than in an unfished population. With commercial harvest, there would be much fewer fish spawning, fewer juvenile alewife migrating to the Bay to supplement the food supply there in support of the Bay fisheries, that sustained the Indian community through time.

Besides fishing, there are other human effects that reduce the proxy. For example, the presence of dams reduces the fish-per-acres value - even with a fishway. The best passage is an open river. Dill et al. (2010) showed that as many as 74.8% of the alewife that pass Milltown never pass Woodland Dam and stay in the reach between the two dams where there is essentially no spawning habitat. (See Appendix H). Historically, predation has probably always occurred at Salmon Falls by seals, striped bass, cormorants, eagles, and sea gulls, but predation is heightened because time spent is increased in the area of the first dam. In addition, there is predation higher in the watershed by smallmouth bass which is an introduced species. There is morality of post-spawned adult and juvenile alewives while out-migrating through the hydroelectric dams. The list goes on. The point is that there is no information on how much the human factors present on the Skutik River reduce the fish-per-acre value, except closure or failure of the fishways. As history has shown, fishway closure can shut down sea-run fish restoration. Fishway failure or collapse will be no different.

In the absence of information on whether or not the Skutik River is a “typical” (median) watershed, and on the degree to which the various human effects reduce the “typical” (median) fish-per-acre value, it is reasonable and prudent to adopt 845 (845.7 round down) (Table 2) fish per acre as the proxy to carrying capacity for alewife in the Skutik River watershed. Specifically, that proxy is for alewife spawner abundance. If and when information does become available, that will be a good time to reconsider this. Until then, the median alewife carrying capacity (maximum ecological production potential) is estimated to be 88,888,990 spawning adult alewives (88,888,990 = 845.7 fish per acre x 105,107 acres of spawning habitat).

With these values in place for reference and accepting the Skutik River to be a “typical” (median) watershed, the Peskotomuhkati Nation can work toward its stated goal of there being “a full assemblage of indigenous sea-run fish throughout the Skutik River watershed with stable populations of sea-run fish that can fulfill their ecological role and support ecological, economic, social, cultural, traditional, and spiritual objectives.”

3.1.4.3 Dynamic Modelling

Barber (2018) and Barber et al. (2018) modeled nutrient cycling by alewife in a portion of the Skutik River watershed. Specifically, nutrient cycling by alewife was modeled in the mainstem, Grand Falls flowage, and Spednic Lake on the East Branch. For that purpose, *Dynamic Modelling for Alewife Populations and Passage* (DMAPP) was developed to model change in nutrient cycling in response to changes in upstream and downstream passage at select dams. The DMAPP model estimates passage of adult alewife into spawning habitat in the Skutik River. Sixteen scenarios (Appendix G) were run with varying rates of upstream and downstream passage. Scenarios were included where: (1) Milltown Dam was “removed” and (2) all dams were “removed.” The arbitrary theoretical maximum return to the Skutik River was set at 27 million fish. The returns deemed as necessary to grow and sustain the Peskotomuhkati’s goals for ecosystem and cultural services require 90% downstream passage. Upstream passage required will be 75% upstream passage at all dams or Milltown’s removal plus at least 50% upstream passage at the other dams. According to the model, downstream passage is far more limiting to alewife population growth than upstream passage. Table 3 provides a summary of the outputs from these model runs and provides, as a guide, a forward-looking picture of fish-passage improvements needed in order to meet restoration goals.

Table 3: Summary of DMAPP Outputs for Skutik River Passage Scenarios

	Downstream			
	50%	**70%**	**90%**	**100%**
Upstream 50%	<1,000	~25,000	~225,000	
Upstream 75%	<1,000	<50,000	~6M	
Upstream 50% (Milltown dam removed)	~10,000	<50,000	~4.75M	
Upstream 75% (Milltown dam removed)	~10,000	<1M	~12M	
Upstream 100%				~27M

Source: Barber et al., 2018

While carrying capacity can help gauge restoration potential, these numbers are constrained by several factors, most notably passage at key barriers. In particular, the restoration potential of river herring is limited by the three dams on the lower river—Milltown, Woodland, and Great Falls. Even with fishways there are significant limitations to passing fish due to capacity, design, condition, or poor management of the fishways, or all four. Technical matters concerning design and condition will be discussed under the restoration strategy section. Fishway capacity, however, is critical in determining potential since it dictates how many fish are moving upstream under present conditions.

In addition, it is important to keep in mind that spawning escapement will be affected by harvests above any of the dams on the river. Therefore, it is important to carefully consider the exploitation rate of a fishery in order to maintain the desired spawning escapement. A precautionary approach that considers all sources of mortality is recommended when determining the target number of fish for restoration.

3.1.4.4 Habitat Access: The first dam on the river, Milltown, is the lynchpin regarding upstream passage. As discussed elsewhere, Milltown Generating Station and Dam are slated for decommissioning and removal by the end of 2023. Past observances have seen at times fish choked-off from entering the fishway due to the number of fish attempting to pass. The number of fish returning to Milltown and wanting to pass upstream is unknown. However, based on monitoring at the fish trap, which indicated how many fish were making it into and up the fishway, the maximum fishway capacity was 106,300 (plus or minus 800) fish per day (Watt 1987a in Dill et al. 2010), which is close to the original design capacity of 100,000 fish daily. It is possible that the fishway capacity may at times limit the rate of alewife migration into the river (White and Watt 1989 in Dill et al. 2010, Willis, personal observation). Preliminary data collected via research sonar (DIDSON) in 2016 indicated that up to 50% of the fish approaching the Milltown ladder did not ascend it (T. Willis, personal observation).

After Milltown, fish must pass two more dams before reaching significant spawning habitat. The Adaptive Management Plan (Dill et al. 2010) reports that the maximum capacity of the Woodland Dam fishway is 87,000 alewives per day and of the Grand Falls fishway is 40,500 alewives per day. Using data from 1984 to 1986 (Table 2), the estimated percentages of the total run of fish passing each dam are as follows: between 25.2% and 65.5% of the run that passed Milltown ascended Woodland Dam. Between 48.1% and 83.3% of the fish that passed Woodland ascended Grand Falls indicating that Woodland may be having a bigger impact on passage (Dill et al. 2010). Overall, between 23.5% and 42.5% of the fish that passed Milltown passed Grand Falls. Using 50% as a simplistic but realistic estimator for all three passage facilities, and 2017 as a benchmark, we could estimate that roughly 300,000 fish arrived at Milltown, of which 150,000 ascended the ladder, assuming it was operated correctly and at maximum efficiency. Of those, 75,000 ascended Woodland and 35,000 ascended Grand Falls. Obviously, this is well below passage levels seen at Milltown in 1987.

Table 3: Alewife Passage at Lower Skutik River Dams

DAM	1984 Total	1985 Total	1986 Total
Estimated alewives passing:			
Milltown	153,000	369,000	1,985,000
Woodland	78,000	93,000	1,300,000
Grand Falls	65,000	87,000	625,000
Percent passing:			
Milltown that were migrating upstream	no data	no data	no data
Woodland that passed Milltown	51.00%	25.20%	65.50%
Grand Falls that passed Woodland	83.30%	93.50%	48.10%
Grand Falls that passed Milltown	42.48%	23.58%	31.49%

Source: Dill et al. (2010). Proposal for Public Discussion, submitted to the International St. Croix River Watershed Board, April 23, 2010. Table 2, Page 7 of 24.

3.1.4.5 Discussion: Capacity of fishways is likely to be an issue as restoration plans move forward. An examination of the changes in fish numbers following passage improvements at Milltown Dam in 1981 indicated a dramatic increase once the four- and five-year-old fish returned. Indeed, a similar trend is occurring with 611,907 alewife counted at Milltown in 2020, seven years following the opening of the Grand Falls fishway. Milltown Dam removal, slated to begin in 2022, is well timed to avoid capacity issues at the Milltown/Salmon Falls site as alewife returns continue to increase. However, capacity issues at Woodland and Grand Falls Dams continue to pose a limiting factor to restoration. A key restoration question is which barriers to prioritize for passage improvements and what can be done to move much more fish upstream.

Some would say that it is logical to use the design specs of fish passage to set population expectations for the watershed. But, that would belie the fact that the Plan has a different perspective and has adopted a different approach to estimating the potential carrying capacity of the watershed. (See Carrying Capacity at section 3.1.4.2.). Clearly the old and dilapidated fish passage system at Woodland and Grand Falls Dams is a constraint, a limiting factor, to sea-run fish restoration. It should not be an acceptable constraint or limiting factor on the degree to which the Peskotomuhkati goals can be achieved that are stated up front in this Restoration Plan. The fish passage system, and the dams they are on, needs to be wholly redesigned with the objective of assisting, rather than hindering, achievement of those restoration goals. LimnoTech (2020) produced a final report that could lead in that direction. The report is titled *Exploring Upstream and Downstream Fish Passage Improvements on the Lower St. Croix River*. It was prepared for the International St. Croix River Watershed Board, under contract number: GS10F150BA. It is dated January 28, 2021. After years of pointing out the multiple issues with the status quo, an effort is underway to affect change.

That said, it is fitting to frankly recount the situation with the fish passage system on the mainstem that is unsafe and nearing collapse. Using Grand Falls as the most restrictive valve to fish passage, that ladder was designed to pass a maximum 2.27 million alewives fifty years ago. It is doubtful that Grand Falls could pass that many alewives today given structural issues that have developed over time.

- Woodland, by design, should be able to deliver 4.9 million alewives into the Woodland Dam head pond and at least provide the potential for 2.27 million alewives reaching Grand Falls. However, the three years of data available from the mid-1980s showed Woodland to be working at about 50% efficiency. Still, if Milltown is working at design capacity, and especially once Milltown Dam is removed, it should be possible to get enough fish to Woodland for 2.27 million alewives to ascend to Grand Falls.
- Milltown's design capacity is 100,000 fish per day. Given that, it could pass about 5.6 million fish annually under ideal conditions. Milltown's efficiency has never been tested. An attempt in 2016 by the University of Southern Maine and Sipayik Environmental Department estimated 50% of the alewives approaching Milltown's fish ladder entrance actually entered the ladder. Again, it is unlikely that Milltown fishway is performing optimally after thirty-seven years. The removal of Milltown Dam and restoration of Salmon Falls, however, will allow for significantly increased passage at Salmon Falls.

Downstream passage is a consistent problem on the Skutik through the four main-stem dams. Part of the assessment of sustainability put forth by the ASMFC in arguing to reopen alewife harvests after the 2012 closure was assessment of repeat spawners. Poor downstream passage, forcing adults to out-migrate through turbines or over spillways, leads to elevated adult mortality, which reduces the incidence of repeat spawners. Investigating outmigration mortality and working with dam owners and U.S. federal agencies to improve outmigrant survival are important and necessary issues to address. Preventing downstream mortality can save more fish than improving upstream passage (Gibson, personal communication, 2017). Repeat spawners carry more eggs and are more likely to successfully spawn than first time spawners.

3.2 Atlantic Salmon (*Salmo salar*)

3.2.1 Historical Presence and Abundance

Atlantic salmon commercial fisheries started during the 1600s, following a long aboriginal tradition of harvesting Atlantic salmon at head falls sites on major and many minor rivers along the north Atlantic coastline. For the Wabanaki, salmon were a preferred sustenance fish, harvested annually by spear as they attempted to ascend steep falls on rivers.

The 1896 *Report of the Joint Commission Relative to the Preservation of Fisheries in Waters Contiguous to Canada and the United States* identified the Skutik River as "one of the most prolific salmon streams on the Atlantic Coast" (Joint Commission 1896). Atlantic salmon were once so plentiful that they were easily caught using dip nets at Salmon Falls near Calais, Maine, and St. Stephen, New Brunswick. Others reported Atlantic salmon in "extraordinary numbers" and being "exceedingly abundant," with harvesters catching 100 barrels per day and upward of 100 fish per individual (Perley 1825). Atlantic salmon were reported throughout the watershed, above Grand Lake Stream and Vanceboro. The archeologic record shows evidence of salmon at Salmon Falls and Mud Lake (Paul 2018). Perley (1851) was told by Mr. Edward Sydney Dyer, a Calais resident who lived at Salmon Falls, that the average salmon catch at Salmon Falls was 200 salmon per day for three months (18,000 annually) in each season. A major fishing village had been located on the Skutik at what is now Milltown, upriver from the Union Dam.

As with alewives, declines in Atlantic salmon were noted in the mid-1800s. Overexploitation, degradation of water quality, and damming of rivers were large contributors to the decline in abundance. By 1850, fewer than 200 fish were being caught (Joint Commission 1897). Atlantic salmon populations in the Skutik, along with all other sea-run fishes seeking inland spawning habitat, were decimated in 1825 when the Union Dam closed off passage across the entire Skutik River.

Early attempts to revitalize the salmon came forty-four years later when a fishway was installed in Union Dam. In 1881 a large salmon stocking program was started, ending in 1909 with almost no evidence of success (Marshall 1976). By the 1880s pollution had become a major problem in the Skutik, causing anoxic conditions in large stretches of the lower river.

Another mid-century stocking program kept Atlantic salmon present in the Skutik through the early 1960s. This program ended in 1966; however, some Atlantic salmon remained in the river into the 1980s, with 400 reported in 1987 (Conservation Council of New Brunswick 2002). Despite these efforts, the river was closed to commercial harvest in 1984 and the aboriginal food fishery and recreational fishery were closed in 1998.

Table 4: Atlantic Salmon Egg Production, Stocking, and Returns Summary—Skutik River

Atlantic salmon egg production in New England facilities—Skutik River (1993-2007)—(Appx. 13)

No. sea-run females	39
Egg production	291,000
Egg/female	7,400

Atlantic salmon stocking summary for New England by river—Skutik River (1981-2007)—(Appx. 15)

Number of fish stocked by life stage							
Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
0	1,268,000	498,000	158,300	0	808,000	20,100	2,752,400

Documented Atlantic salmon returns New England rivers—Skutik River (1981-2008)—(Appx. 17)

Hatchery origin				Wild origin				
1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	**TOTAL**
720	1,124	39	12	880	1,340	78	34	4,227

Source: U.S. Atlantic Salmon Assessment Committee(USASAC), Annual Report No. 30-2017 (2018)

Stocking of Atlantic salmon resumed in the late 1980s through 2000s through a partnership of the SCIWC and DFO. SCIWC seeded parr throughout the lower river using St. John origin fish. Redds were found but few fish survived. Predation by smallmouth bass was a suspected cause due to the presence of smallmouth bass in salmon spawning habitat (L. Sochasky, personal communication, 2019). Water temperature may also have been a factor (J. Trial, personal communication, 2019). According to tables in the *Annual Report of the U.S. Atlantic Salmon Assessment Committee* (USASAC 2018), the following numbers related to salmon stocking may be informative.

No naturally occurring returning adults were released above Milltown Dam between 1997 and 2006 and no wild salmon returned between 2000 and 2006. Assessment was stopped in 2005; no salmon have been documented in the Skutik since 2006.

3.2.2 Current Presence and Abundance

The COSEWIC assessment found Atlantic salmon numbers to be extremely low and declining. According to DFO (http://dfo-mpo.gc.ca/species-especes/profiles-profils/atlanticsalmon-OBF-saumonatlantique-eng.html) the COSEWIC has assessed the Outer Bay of Fundy (OBoF) Atlantic Salmon Designatable Unit (DU) as endangered. Specifically: "Population models from the Recovery Potential Assessment (RPA) for this DU indicate that between 1997 and 2012 the number of 1SW (one-sea-winter) and MSW (multi-sea-winter) salmon have declined (68-73% and 52-68%, respectively) for a net decline of all mature individuals of about 64%. This decline represents a continuation of historical declines." DFO estimated a total return of 565 Atlantic salmon in the OBoF rivers in 2012. The causes of the widespread decline of Atlantic salmon are not well understood. The next step is for DFO to consider listing the OBoF Atlantic salmon as endangered. This would immediately put into effect restrictions, development of a recovery strategy, and subsequent action plan(s) with measures to mitigate known threats. Additionally, the habitat necessary for OBoF Atlantic salmon survival and recovery would be protected. Atlantic salmon habitat is currently protected under the fisheries protection provisions of the Fisheries Act.

While no Atlantic salmon have been reported in the Milltown fish trap since 2006, some wild fish have been seen in Dennis Stream (J. Carr and L. Sochasky, personal communication, 2019). Dennis Stream joins the St. Croix below Milltown Dam. The Atlantic Salmon Federation has been electrofishing several sites in Dennis Stream for Atlantic salmon fry and parr on and off since 2000. The surveys indicate that salmon are accessing the stream and spawning, although numbers vary from year to year and site to site. In some years, this may be due to low water levels. Since 2015, the number of fish caught has been low, but water levels have been low, and salmon may be using other areas with deeper water and better cover. A counting fence was set up on the Dennis and operated in 2001 and 2002. Only one wild salmon was captured at the fence over the two seasons. Anglers encountered (not fishing at the time) have reported seeing parr in the last few years. Surveys and anecdotal information also indicate the presence of American eel, blacknose dace, brook trout, chub, and smallmouth bass (G. Chafe, personal communication, 2019).

3.2.3 Habitat

There is Atlantic salmon habitat throughout the Skutik River watershed, both in lower tributaries like Dennis Stream and in upper reaches of the river in the West Branch and main stem. From 1994 to 1997, SCIWC performed fish habitat surveys on the main stem of the river. The data were compiled and organized by habitat type and substrate. Habitat characterized as riffle – cobble/gravel is preferred salmon spawning habitat. Units are considered prime where the cobble/gravel component is greater than 40% of the substrate. Habitat characterized as riffle – rock/boulder is preferred salmon nursery habitat. Units are considered prime where the rock/boulder component is greater than 40% of the substrate. Salmon may also use shallow rock, boulder, and cobble areas for nursery habitat. The surveys identified a total of 427 habitat units of which 28% were riffle units (754,097 square miles out of 3,758,147 square miles). The riffle units were split about even between cobble/gravel and rock/boulder substrate. In each category, the amount of prime habitat was very high: 90% of cobble/gravel units and 90% of rock/boulder units. The vast majority of both key habitat types are located above Grand Falls Dam: 318,096 square miles or 83% of cobble/gravel and 303,239 square miles or 93% of rock/boulder. The full summary table can be found in Appendix F.

3.2.4 Restoration Potential

The return of Atlantic salmon to the Skutik River system is a core goal of the Peskotomuhkati Nation. In the lower river, both the Megurrewock River and Dennis Stream hold potential for restoration given past evidence of the presence of salmon in these tributaries as well as habitat availability. Importantly, Dennis Stream has no dams between spawning habitat and the ocean, and Megurrewock has one, the Milltown, slated for removal in 2022. Beavers could be an impediment to upstream passage on Dennis Stream. Recent habitat access enhancements in the Megurrewock increase the potential for salmon restoration there assuming beavers continue to be managed and additional barrier removal projects are pursued.

A stocking program in the Dennis Stream focusing on one- to two-year smolt could jumpstart efforts there and in the system as a whole. Up- and downstream fish-passage improvements would be necessary at Woodland, and Grand Falls Dams to ensure safe, timely, and effective passage into the area of the watershed with the most spawning and rearing habitat. Effort should be made to ensure salmon have access to tributaries where smallmouth bass are less likely to be present. The idea of a fall run has also been suggested whereby the timing of the run would be less likely to coincide with smallmouth bass feeding activity. Since water temperature could be a factor, access to areas in the watershed with cold water refugia should also be targeted.

As a guide, DFO (Jones et al. 2014) proposed recovery targets for the OBoF DU and considered abundance and distribution components with a short-term focus placed on seven priority rivers, comprising 56% (22.62 million square miles) of the productive habitat in the DU. Establishing 54.4 million eggs in these priority rivers would produce an estimated 23,500 adults.

Conservation requirements for the Skutik River are estimated to be 7.39 million eggs based on 3.079 million square miles of productive juvenile habitat (Anon 1988) and an egg distribution of 240 eggs per 100 square miles, which results in the production of three smolts per 100 square miles based on Elson (1975) and CAFSAC (1991). This uses an assumed smolt survival of 0.43 meaning 2.33 parr are needed to produce a single smolt. Using information from the neighboring Magaguadavic River and evaluations by Marshall and Cameron (1995) approximately 1,710 multi-sea-winter fish (MSW) and 680 one-sea-winter (1SW) fish could produce these egg requirements (Jones et al. 2014).

Going forward, if passage were improved at the three lower dams, the Grand Lake Stream fish hatchery might provide ready infrastructure to retry a salmon hatchery program. Atlantic salmon are sensitive to low dissolved oxygen conditions, acidic waters, siltation, and contaminants. If a hatchery style restoration is to be attempted, a thorough habitat assessment should occur beforehand or in tandem to make sure physical conditions can support egg planting or releases of parr or smolt. Habitat enhancement should also be considered where most of the necessary habitat elements are present to support salmon eggs or parr rearing. Pool formation, tree planting, and gravel/cobble additions could be used to create the habitat that is lacking for Atlantic salmon in Dennis and Megurrewock.

Smolt production is a key factor for any salmon restoration effort. The adult stocking program from the early 2000s resulted in very low recruitment although studies were not completed to assess whether this was due to the fish or the habitat. Finding the redds to be in good condition, the MDMR set fry traps and was able to document good emergence from the eggs (R. Spencer, personal communication, 2019). For comparison, on the Penobscot River, smolt stocking of two smolts per unit for a total of 600,000 smolts in prime habitat yielded 500 to 1,000 adults (R. Spencer, personal communication, 2019).

Predation by smallmouth bass and pickerel is a potential source of loss for hatchery reared salmon. Assessing the density of warm water predators in potential salmon rearing habitat and/or assessing their feeding habits with an eye to documenting competition or predation will help identify whether co-occurrence is a barrier to hatchery program success. Removal of warm water predators from these habitats should also be considered. Elimination is likely to be impossible, but regular removals may lead to low enough abundances of warm water predators to allow salmon restoration to take hold.

Egg planting is a new salmon restoration technique that has shown some promise in the Kennebec River watershed in Maine. Egg planting involves mimicking the natural redd building process with high pressure field pumps and hatchery fertilized eggs. The Penobscot Nation received a grant in 2012 to use egg planting as a restoration tool in their watershed. If this technique is considered in the Skutik, a collaboration should be pursued with the Penobscot Nation Resources Program.

3.3 American Shad (*Alosa sapidissima*)

3.3.1 Historical Presence and Abundance

Shad were likely available as spring spawners as well as summer residents through coastal weirs. For the ancestral Peskotomuhkati shad were probably the most prized of the seasonal migrants to the Maine Coast. Shad are large, from four to ten pounds, compared to one to two pounds for alewives or blueback herring, and were far more numerous than salmon. Villages located at head-of-tide falls, including those at Salmon Falls, where the Milltown Dam is located, likely formed as a result of opportunity and need. The historically large runs of shad would have required the cooperation of many families to process and cure thousands of fish.

American shad were also reported to once have “filled ships” (Anon 1988) and as “almost incredible” with “more than 100 in a single net” (Perley 1851). Historical records from Charlotte Co. New Brunswick show limited harvest of shad by Europeans in inner Passamaquoddy Bay, with spotty landings between the 1890s and 1950s between St. Stephen and the St. John River. However, lack of fish passage and poor water quality, particularly the amount of sawdust and wood debris in the river, killed the shad run (Soctomah 2009). Shad were very plentiful until 1825 when dams, pollution, and loss of spawning habitat led to their virtual extermination (Joint Commission 1896).

3.3.2 Current Presence and Abundance

Today, little evidence remains of how prolific American shad likely were in Maine rivers. However, spawning populations of American shad are found in the St. John River, New Brunswick, and most adult American shad migrate to the Bay of Fundy after spawning in rivers to the south. According to the SCIWC, there were no reports of shad from 1981 to 2009 (Goreham and Almeda 2017). In 2017, fifty-six shad were caught in the Milltown fish trap. Shad recovery has been notable on both the Kennebec and Penobscot Rivers in Maine following the removal of lower river dams on both rivers.

American shad are managed as a controlled recreational fishery in Maine. Shad can only be caught in coastal waters using hook and line with a daily possession limit of two per day. In freshwater, shad possession is also limited to two per day with no size limits. American shad are not actively managed or harvested by the Passamaquoddy at Sipayik.

3.3.3 Habitat

Like all anadromous fish, shad spend most of their lives in the ocean and return to freshwater to spawn. In the spring, adult shad migrate into coastal rivers from Florida to Newfoundland as water temperatures reach the mid-fifty degrees Fahrenheit mark. Shad may travel hundreds of kilometers upstream to spawn. American shad spawn in main-stem waters and do not often move up into the tributaries of the large rivers that they ascend. Spawning generally takes place over sandbars or rocky riffles in about two meters of water. Shad eggs are neutrally buoyant, floating suspended in open water until they hatch in about four to twelve days.

3.3.4 Restoration Potential

With improvements to Skutik River water quality, access to habitat is the key impediment to the shad's recovery. Shad are known to avoid using fishways and are sensitive to conditions below a fishway and resulting attraction flow. Some have also thought that shad may avoid fishways when they are occupied by other fish species. Given that most of the shad habitat in the Skutik River is above the lower three dams, fish-passage improvements that consider the unique needs of American shad at all these sites are imperative.

Shad stocking is a well-established method for revitalizing shad populations. Stocking was used in restoring the Androscoggin and Kennebec Rivers and some of the biggest efforts are centered in the Mid-Atlantic on large, historic shad rivers like the Susquehanna. Fry stage shad were raised in Waldoboro, Maine, at the MDMR's shad hatchery to supplement restoration efforts in the late 1990s and early 2000s. Results from this and other shad stocking efforts were found to be equivocal in their efficacy and frequently relied on shad from distant locations, raising concerns about how the genetic pool of fish would be affected. Efforts were also criticized for a lack of due diligence in checking for remnant shad populations before stocking over them (Bailey 2013). Criticisms aside, the simple methods required to raise shad from egg to fry stage helped to encourage using shad as an outreach tool such as Shad in the Classroom as discussed in Section 5.6.2.

3.4 Rainbow Smelt (*Osmerus mordax*)

3.4.1 Historical Presence and Abundance

Rainbow smelt have notable ecologic, economic, and social benefits. Sea-run rainbow smelt serve as an important forage fish for commercially and culturally significant marine species such as Atlantic cod, Atlantic salmon, trout, Atlantic gray seal, and striped bass (Enterline et al. 2012). Early historical accounts reported that smelt were abundant and a major food source for Wabanaki people in the spring (James Smith 1622 in Kendall 1916 from Enterline et al. 2012). Currently, rental ice shack fisheries provide local economic activity on tidal rivers including the Kennebec River in Maine. Recently, there has been a modest commercial harvest on the Pleasant River in Columbia Falls, Maine, and New Brunswick and Nova Scotia continue to support commercial fisheries as well (Enterline et al. 2012).

Records show that smelt were widely harvested through the 1800s along the Atlantic Coast for food, fertilizer, livestock feed, and export (Enterline et al. 2012). Smelt numbers began to decline in the late 1800s and dropped dramatically in the mid-1900s (Squires et al. 1976 from Enterline et al. 2012). NOAA listed rainbow smelt as a federal species of concern under the U.S. Endangered Species Act in 2004. Expected causes to their decline include limited access to spawning habitat due to dams and blocked culverts, poor water quality, and degraded habitat (Enterline et al. 2012). The situation in the Skutik is consistent with trends found throughout Maine (Flagg 2007). However, population declines appear to be less in Maritime Canada than in the United States and it appears that the population may be shifting north. DFO reported commercial landings between 1.5 and 2.5 million pounds in eastern New Brunswick between 1988 and 1998

(DFO 2011 in Enterline et al. 2012). More information can be found in the 2012 *Anadromous Rainbow Smelt Regional Conservation Plan* (Enterline et al. 2012).

Smelt were the first fish to arrive in coastal rivers in the spring. Historical accounts noted that rainbow smelt were restricted below Milltown with an annual catch of around 10,000 to 40,000 (Anon 1988). In many locations they never left, persisting under the ice throughout the winter season. In January, February, and March smelt could be taken by hook and line in large estuaries like the Kennebec, Penobscot, Union, and Skutik. As the first fish to appear in the rivers, smelt were valued but probably not as prized as later arrivals like shad. They would have been easily dipped from the shallows in many small streams along the coast. There was an active commercial smelt fishery in the Skutik River region and inner Passamaquoddy Bay from the 1870s through the 1890s.

3.4.2 Current Presence and Abundance

Little information was found documenting the current status of rainbow smelt in the Skutik River, and there is no known fishery at present. However, from 2007 to 2009, MDMR conducted surveys documenting limited to strong spawning runs in neighboring Cobscook Bay. Additionally, winter surveys conducted by MDMR and the Downeast Salmon Federation from 2009 to 2011 documented commercial fishing operations on the main stems of many Washington County, Maine, rivers in which fish in spawning condition were being caught (Enterline 2012).

Smelt can only be caught via hook and line or dip net in Maine waters, with a few notable exceptions. In addition, no more than two quarts of smelt are legal to possess during the spawning season, between March 15 and June 30. Dip netting from within the stream is illegal. In Washington County there are provisions for commercial smelt fishing between January 1 and April 1 in the East Machias, Pleasant, and Narraguagus Rivers. In these locales there are no bag limits and gill nets and bag nets are permitted.

3.4.3 Habitat

Smelt spawning runs can vary in terms of habitat use, spawning substrate, spawning period, and water temperature range (Enterline et al. 2012). The largest aggregations are in rivers with extensive habitat below head of tide. The Kennebec River in Maine is one of the only major rivers that still hosts smelt camp operations that offer river ice fishing. In April smelt begin their spawning run, crowding riffles and head-of-tide falls en masse. Smelt are found to spawn in shallow riffles where water velocity increases in stream channels; more information on smelt habitat can be found in the Massachusetts Division of Marine Fisheries Technical Report TR-33 (Chase et al. 2008). Numerous tributaries to the lower Skutik River are identified as having smelt habitat in the Maine Stream Habitat Viewer (https://webapps2.cgis-solutions.com/MaineStreamViewer/), including Boyden Stream (Perry, Maine), Marsh Brook (Robbinston, Maine), and Beaver Brook (Calais, Maine).

3.4.4 Restoration Potential

Supporting and supplementing smelt runs is a relatively simple affair involving transfer of fertilized eggs on egg mats to below head-of-tide habitat. The most recent studies show that Cobscook Bay and the Perry shore have strong to limited smelt spawning runs (Enterline et al. 2012). Little information seems available for smelt runs in New Brunswick. Planting eggs from the Cobscook Bay runs could be used to augment the Skutik from the U.S. side. It would be helpful to attempt egg mat placement from the Canadian side of the river as well if suitable donor populations can be found.

Some scientists question the long-term efficacy of egg mat transfers. Egg transfers require large numbers of eggs, which in a region with failing populations may be difficult to secure (Chase et al. 2008). It is also difficult to evaluate the effectiveness of egg transfers because there is no way to mark the eggs or evaluate survival, since available marking techniques would harm the eggs. Massachusetts Division of Marine Fisheries staff recommended hatchery rearing of eggs and larval release to increase egg survival (Chase et al. 2008). Furthermore, larvae can be marked to facilitate an assessment of stocking efficacy in the future.

3.5 American Eel (*Anguilla rostrata*)

3.5.1 Historical Presence and Abundance

American eels were once a staple of the Native American diet throughout eastern North America and as far west as the Lake Ontario drainage. Historical reports noted that eels were "widespread" averaging about 220,000 pounds per year in the Skutik (Anon 1988). Weirs are present on historical plans dated 1832 and 1837 (Paul 2018). Eels also show up in the archeological record. Lewey Island (now underwater) was an ancient and important Peskotomuhkati fishing village. It was a place to trap and harvest eels. This island had narrow channels in the river where sea-run fish would pass. Eels had to pass through here to migrate out to sea to spawn. This island was flooded in 1841 by the Princeton Dam. This roll dam still exists but is now underwater. It is located on the West Branch of the Skutik just downstream of the U.S. Route 1 bridge between Princeton and Indian Township and is still underwater from the Grand Falls Dam flooding. The traditional fishing village was destroyed by both dams.

Eels were prolific, relatively easy to procure, and generally available in all but the coldest months. Yellow eel harvest was a major source of sustenance and products for the Peskotomuhkati well into the European contact period. Some scholars (Allen 2007) believe eels were sacred animals and all of the parts were used in daily or ceremonial life. During September and October, sometimes later, large eels migrated downstream, and it was during this period that silver and yellow eels were taken in large quantities. Eels were eaten fresh and dried or smoked for winter subsistence. During spring thaws after difficult winters, if a driven Wabanaki could get through the ice over shallow lakes and wetlands, eels could be felt out in mud and harvested. Eel skin had myriad uses because it was tough, and it shrank when it dried. Eel fat was used as a sunscreen, insect repellent, and water proofing agent. Heads, hearts, and other internal organs were used as bait.

3.5.2 Current Presence and Abundance

American eel populations have declined by as much as 99% in the last twenty years due to hydropower plants, overfishing, and other unknown causes. Young eels, called elvers when they ascend rivers, fetch a high price on the Asian market, and American eels in this young life phase have been heavily harvested in the United States during the past thirty years or more. American eels are known to pass Milltown Dam although counts at the trap have been low; five were reported in 2017. However, there is no passage for elvers at any of the Skutik River dams and there are little or no downstream passage considerations. Elvers have been seen climbing the Grand Falls fishway following trickles of water seeping through cracks only to reach "dead-ends" (Lee Sochasky, personal communication, 2019). A commercial harvest of adult (silver) eels was reported to be in operation for several years at Woodland and Grand Falls Dams until access to the site was restricted.

In 2017, Woodland Pulp, LLC commissioned a study on American eel abundance and distribution that was conducted using electrofishing methods by Kleinschmidt Associates. The purpose of this study was to determine the sizes and relative abundance of eels below Vanceboro Dam and West Branch Storage Projects to begin to assess fish-passage requirements. Sampling occurred below Vanceboro Dam and Woodland Dam and in Grand Lake Stream above Big Lake. A total of eighty-nine eels were caught below Woodland Dam and two below Vanceboro. These results were consistent with data collected below Vanceboro Dam (0) and

Woodland Dam (201) in 2005 by Yoder et al. A total of twenty-two eels were caught on Grand Lake Stream; no previous data existed for this stream. These data indicate that recruitment remains low below Vanceboro; however, data collected below Vanceboro were too limited to be conclusive (Kleinschmidt 2017). The lengths of eels caught at Vanceboro were slightly larger than those found below Woodland, suggesting that some upstream movement of the population may be occurring (Kleinschmidt 2017). The size range and maximum size of eels in Grand Lake Stream were notably larger than those caught at the other sites. This, in addition to the higher relative abundance in Grand Lake Stream, could indicate stronger recruitment to the West Branch (Kleinschmidt 2017). Kleinschmidt also concluded that more data would be needed before target sizes of eels could be determined for fish-passage design.

3.5.3 Habitat

The American eel is the only catadromous species in the Gulf of Maine. Catadromous species spend most of their lives in fresh or brackish water but spawn in the ocean. American eels, *Anguilla rostrata*, are distributed in the Atlantic Ocean from Greenland to Brazil. Along the Atlantic Coast of the United States, eels between Maine and Florida are considered part of a single management unit because they represent a single breeding population. Eels from South America, Greenland, and other places may breed with each other on their Caribbean spawning grounds. Thus, there are no distinct watersheds or regional “stocks” as there are for anadromous species such as Atlantic salmon.

Eels spawn in the Sargasso Sea, a warm water area in the middle of the North Atlantic between the Azores and West Indies. At approximately sixty millimeters in length, eel larvae develop into the first juvenile phase and a more recognizably eel-like form called glass eels, so named because they lack pigmentation. Glass eels actively migrate across the continental shelf and move into estuaries and tidal rivers in late winter and early spring, apparently by detecting temperature gradients and the scents associated with freshwater. Within weeks of entering estuaries and tidal rivers the small eels begin to feed and develop pigmentation, at which time they are called elvers and resemble miniature adults in coloration and other physical features. Elvers may migrate upstream to freshwater or remain in marine estuaries but subsequently develop into sexually immature adults, known as yellow eels. In the Gulf of Maine, migration of glass eels and elvers toward the coast occurs mainly from April to July, though some will migrate into early fall.

American eels can absorb oxygen through their skin as well as their gills, making it possible for them to travel over land, particularly in wet grass or mud, which may help them move around barriers in streams. Small eels can climb vertical walls, including low dams, as long as surfaces are damp and textured.

The final inland resident stage is called the yellow eel and includes all eels greater than ten centimeters (four inches). Yellow eels may gradually move upstream over many years, with most movement occurring during spring and fall when water temperatures are moderate. However, larger yellow eels may settle in specific areas and have been found to occupy distinct home ranges. Yellow eels remain in this stage of maturity for as few as three or as many as thirty-plus years. Upon reaching maturity, eels migrate out of the freshwater or estuary systems. On the downstream journey, eels may have to pass through turbines at hydroelectric dams where mortality may be 50% or more for some types of turbines, with 80% to 100% being injured. Eels often must pass by several hydroelectric dams before reaching the sea, and the cumulative mortality at all dams may be very high. Larger eels have a much greater chance of being injured by turbines, and unfortunately, these eels are usually females. American eels are sensitive to low dissolved oxygen levels in water typically found below dams and many eels have been infected with a parasitic nematode, *Anguillicoloides crassus*, that may negatively affect their ability to migrate to the Sargasso Sea to spawn.

3.5.4 Restoration Potential

There is extensive eel habitat in the Skutik River system assuming up- and downstream passage issues can be addressed. Recovery of the eel population would be important culturally and economically for the Peskotomuhkati Nation. Glass eels fetch a high price on the Asian market, and American eels at this young life phase have been heavily harvested in the United States during the past thirty years or more. Glass eels are primarily used as seed in grow-out aquaculture operations. Glass eel prices spiked after the Japan tsunami of March 11, 2011 ($1,000 to $2,000 per pound) and remained high through 2014. Dramatic declines in the northern portion of the American eel's range are important since sub-populations in this region carry the highest reproductive potential. The following recommendations should be considered for this restoration potential to be fully realized.

- Improving downstream passage for silver eels and limiting yellow eel harvest are long-term management steps that would improve the health of the species overall. Impediments to downstream eel passage need to be assessed for the Skutik, Dennys, East Machias, Machias, Narraguagus, and Union Rivers. The Skutik and Union are likely the two with the most serious passage impediments.
- Eels spend a protracted period in freshwater and require reaching a minimum size before spawning; however, successful spawners do not then become available to the fishery. Instituting a harvest slot regulation, e.g., only eels greater than fourteen inches and less than eighteen inches can be taken, provides eels closest to spawning a measure of protection. The value of this measure is that eels of twenty-four inches and up in size have invested one to two decades into growth and may be within just a few years of emigration. A maximum size limit protects these animals that are most important to continuing survival of the species.
- Responsible harvest of yellow eels is possible within tribal lands. However, harvest should focus on rivers and bodies of water where the resource is most abundant. Determining where those areas are will require population census research by either the tribe or an outside entity.
- The European Union European Eel Recovery Plan (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2014:640:FIN) contains provisions that call for 35% of all captured glass eels to be used in restocking efforts. In Maine and New Brunswick as well, some portion of captured glass eels could be transported upstream alive, beyond major passage barriers, and released in good to prime eel rearing habitat.
- A hallmark of depleted fisheries is the rush to increasingly efficient gear for capturing target species. Inefficiencies allow more of the target species to escape capture and complete their life cycle, ensuring the next generation can support continued fishing pressure. The Maine lobster fishery is a prime example of inefficient gear at work, where all but the largest lobsters can exit a trap as easily as they enter it. Limiting harvest by the Peskotomuhkati community to dip nets for glass eels and limited density traps for yellow eels is an important step. Adhering to, if not exceeding, ASMFC guidelines on minimum and maximum harvest sizes is another way to institutionalize inefficiency important to preserving eel populations.
- Traditionally, Native American groups used a rotational system in harvesting resources. An area would be used and then left fallow for a time to allow resources such as trees, fields, plants, and fish time to recover. Alternatively, "family" parcels or tracts for winter camps were sparsely populated so the area could recover between seasons. The Wabanaki tradition of moving between winter hunting

grounds, which supported extended families, and coastal fishing villages, which supported the tribe, is an example of limiting resource use in both time and harvest pressure. Taking a similar strategy with glass and yellow eels would identify watersheds that could be left fallow for a year to allow maximum glass eel escapement.

3.6 Sturgeon—Atlantic (*Acipenser oxyrhynchus*) and Shortnose (*Acipenser brevirostrum*)

Both shortnose and Atlantic sturgeon have been of cultural importance to the Peskotomuhkati during the millenniums that they have resided in the Quoddy Region. Sturgeon bones (skutes) have been recovered from ancient villages along the Skutik Estuary and Passamaquoddy Bay. Caught with spears and nets, sturgeon were available to be fished during all the warm seasons, unlike alewife and salmon that were available only briefly each year. Sturgeon were the largest diadromous fish caught. A shortnose can be 1.4 meters (4.5 feet) long and weigh 23 kilograms (50 pounds). An Atlantic can be 4.9 meters (16 feet) long and weigh 363 kilograms (800 pounds). One fish provided many meals. Seven to nine cuts of meat were carved out and the thick skin was used for clothing and utility items (Donald Soctomah, personal communication September 11, 2020). Another sign of sturgeon importance are the place names that refer to the species. For example, the Peskotomuhkati word for the area of modern day St. George is reported to mean "the place where sturgeon are caught." In addition, a stone object resembling a sturgeon was found at an inland settlement, known as N'tolonapemk, that provides another sign of the cultural importance and spiritual reverence of sturgeon to the Peskotomuhkati over time. The unique "sturgeon" object was fashioned from stone that is about 4,300 years old. It measures about 11½ centimeters (4½ inches) in length. The object was likely a tool, probably a net gauge. A salmon, an alewife, or any number of other fish, or a seal or porpoise were not the maker's shape of choice, but the sturgeon was – an animal revered as a grandfather in the community.

Figure 4. Sturgeon effigy found in five pieces widely scattered at N'tolonapemk. Shown left to scale. Each piece weathered differently making the fragments different colors. When the object was made, it would have been all one piece and all the same color.

There is plenty of evidence that both species have been present in Passamaquoddy Bay and were a Peskotomuhkati food source for millenniums. Their bones (scutes) have been recovered from a number of shell middens at ancient settlements. In 2015, a tagged sturgeon was recorded during an acoustic survey of Passamaquoddy Bay. It has yet to be determined if the larger tributaries of the Skutik River Estuary and Passamaquoddy Bay would be accessible for shortnose sturgeon spawning. The Skutik, Magaguadavic, or Letang Rivers were dammed long ago, without fishways capable of passing sturgeon. The Digdeguash and

Lepreau Rivers have large falls that may act as barriers; and, the Dennis, Waweig, and New Rivers are smaller streams in comparison.

There is no current indigenous knowledge on whether shortnose sturgeon spawned in Skutik, Magaguadavic, or Letang Rivers, and there have been very few archaeological studies along the tributaries. While there is evidence that the Peskotomuhkati customarily fished for sturgeon in the marine environment, there is no evidence that they fished for sturgeon in freshwater. No sturgeon bones have been found at inland sites. There are several possible reasons for this. The chances of catching a shortnose sturgeon in freshwater would have been low. Spawning migrations are singular events by individual females and attracted males rather than schools of sturgeon; and, spawning migrations occur primarily at night with fish returning downstream after spawning. In addition, the female spawns only periodically, rather than every year, over the course of her 60-year life span.

Both species of sturgeon tend to spend the winter in deep holes with low water velocity in an estuary. There have been no studies to determine if either species winters in the Skutik Estuary or Passamaquoddy Bay. There is recent evidence that many of both species migrate considerable distances between estuaries to feed and return for the winter season. We know that Atlantic sturgeon tend to spawn in rivers larger than those in the Quoddy Region. We do not know if those in the Quoddy Region during the warm seasons spend the winter in the St. John River in New Brunswick or elsewhere.

We know that sturgeon are powerful swimmers based on their regular coastal migrations of over 100 miles, and an early account that two men in a canoe could expect to be pulled vigorously over 100 yards by sturgeon speared during night fishing. We also know that sturgeon are not agile swimmers due to their primitive pectoral fins. During interbasin migrations, shortnose sturgeon regularly foray up coastal tributaries as far as the first barrier – often as far as 10 kilometers (Zydlewski et al. 2011). Milltown Dam, at the head of tide on the Skutik River, has been a barrier for nearly two centuries; it is scheduled to be removed by the end of 2023. Only time will tell if shortnose sturgeon will ascend the Skutik in search of spawning habitat. This would be an important study to undertake. It would answer several questions, including if shortnose sturgeon can ascend the cascade known as Salmon Falls, on which the dam was built.

3.7 Striped Bass (*Morone saxatilis*)

There was limited reference to striped bass in historic reports and accounts related to Skutik River fisheries and there were no records of a striped bass fishery in the Skutik River according to Anon (1988). Since striped bass are common in most estuaries in Maine and Maritime Canada it is reasonable to assume that they were historically present in larger numbers in the Skutik River estuary. The historic Salmon Falls at Milltown was likely a cascade, like the other 17 or so falls on the river, and may have been a natural barrier to passage for striped bass limiting their extent to the tidal areas in Calais and St. Stephen.

Striped bass ascend rivers in the spring and spawn in early summer depending on water temperatures (Anon 1988). Spawning habitat can include middle reaches or large unobstructed rivers and estuaries, but lower salinity (less than three parts per thousand) is needed for eggs to survive. This could prove to be a limiting factor for striped bass to spawn in the Skutik estuary. Striped bass are highly prized sport fish throughout the Atlantic Coast and there has been a recreational fishery in the lower Skutik River. This fishery is likely sustained by migratory fish from systems east and west of the Skutik, including the St. John River where there is more extensive spawning habitat and a native population exists (Anon 1988).

3.8 Sea Lamprey (*Petromyzon marinus*)

The sea lamprey is a diadromous fish species endemic to the Atlantic Coast that is common in most coastal rivers, including in Maine and Maritime Canada. Although historical reports and accounts do not reference the presence of sea lamprey in the Skutik River, the species has been present. Twelve sea lamprey were reported in the Milltown fish trap between 2012 and 2017, despite the Milltown fishway being difficult for it to ascend. Like other anadromous species, sea lamprey migrate from the sea to freshwater to spawn. It is reasonable to expect that sea lamprey were present in larger numbers, prior to damming and industrial development of the Skutik River watershed. The sea lamprey population was likely-substantially reduced and perhaps extirpated as a result of dams being constructed with inadequate fish passage that limited or barred access to its spawning habitat upriver.

The sea lamprey is a Keystone Fish Species that provides unduplicated ecological services. For example, when they migrate upstream, prespawned adults import marine-derived nutrients and minerals to tributaries that have low productivity. As part of its life cycle, each sea lamprey dies after it spawns. During carcass decomposition, those nutrients and minerals are released to the freshwater aquatic and riparian ecosystem. In addition, sea lamprey eggs and larvae are prey their entire life cycle in freshwater and thereby deliver direct positive benefits to the fish community. Other ecological contributions of sea lamprey are related to nest construction and diversification of the streambed.

3.9 Sea-run brook trout (*SALVELINUS FONTINALIS*)

Historical reports and accounts did not reference the presence of sea-run brook trout in the Skutik River. However, it is a diadromous fish species endemic to the Atlantic Coast[5] that is reported to exist in the Dennys and Orange Rivers, and East Stream (Day, G, 2017), and Sipp Brook in Perry, Maine Bassett, E, Personal Comminication, 2019. All of these waterways are tributaries to neighboring Cobscook Bay and considered part of the interconnected ecosystem of the Passamaquoddy Bay. Tidal flows enabled nutrient exchange and aquatic and marine mammal species migration between the Cobscook and Passamaquoddy waters but was blocked with the building of the tidal power dam that runs between the town of Perry and Eastport in the early 1900's. A major artery connecting the two bays was dammed on the Pleasant Point Reservation. The sea-run brook trout waterways (above) are not far from the St. Croix Estuary and River. Given the presence of sea-run brook trout, it is reasonable to expect sea-run brook trout to be present in the Skutik River Estuary and to ascend the Skutik River after Milltown Powerhouse and Dam are removed. According to map prepared by the Maine Department of Inland Fisheries and Wildlife, brook trout spawning habitat exists in the West and East Branches of the Skutik River. It is plausible that a spawning population of sea-run brook trout could colonize the Skutik River after Milltown Dam is removed. Sea-run brook trout have not been able to ascend the Skutik River during its spawning period in the fall because the Milltown fishway has not been operated during that season. Any new fishways at Woodland or Grand Falls should be designed and operated to accommodate sea-run brook trout.

4.0 Restoration Goals and Objectives

The Peskotomuhkati Nation aims to restore the health and integrity of the Skutik River system. The Nation would like to take a broad view of restoration with goals that aim high and go beyond fish passage. The

[5] See Table 1 in Turek, J., A. Haro, and B. Towler. 2016. Federal Interagency Nature- like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. Interagency Technical Memorandum. 46 pp. IN: Appendix C, page 6, of USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

Nation envisions a healthy Skutik River ecosystem made complete by sustainable runs of the full assemblage of indigenous sea-run fish throughout the watershed as well as renewed social, cultural, traditional, and economic connections between its people and the river. To further this vision, the Nation established goals and objectives to guide restoration efforts that they derived from the assessment of restoration potential contained herein. Restoration goals and objectives may differ, however, from restoration potential due to political, regulatory, financial, and institutional constraints.

For this project, the Peskotomuhkati Nation expressed their interest in pursuing Skutik River restoration as follows:

> The primary objective is to restore fish to their native river spawning grounds, starting with the alewife (Siqonomeq, Gaspereau), as a critical keystone species. Restoring keystone species like the alewife is a critical step in ensuring that the ecosystem is as robust as possible to support marine species while they adapt to changing coastal waters. Our primary concern is habitat and ecosystem restoration; we recognize that the health of human communities is inextricably linked to the health of the ecosystem. The project will see key species restored to their native spawning grounds, improved quality of those spawning grounds and other habitats, and strengthened human relationships in the region to ensure long-term sustainability of project aims. A central, but longer-term, aim of this project is to restore sea-run species to such an extent that they can once again support cultural sustenance harvesting by the Peskotomuhkati. Achieving success will also provide a healthy food source for their neighbors. The degradation of their territory has had a major effect on all aspects of Peskotomuhkati life. Restoring access to traditional food through culturally appropriate harvesting methods is critical to the health and well-being of the Peskotomuhkati and others who call this territory home.

Additional goals for the Skutik watershed shared by restoration partners are broad, including such outcomes as all fish everywhere; restore the health and integrity of the river system; restore Peskotomuhkati connections to the river and resources; establish a fishery; establish the importance of fishing rights as they relate to tribal rights in general; and free the river.

Another example of the vision for the Skutik is the Schoodic Riverkeepers' mission statement:

> Reverse and restore the damage done to Homeland. Natural ecosystems and related natural communities have an inalienable and fundamental right to exist, flourish, and evolve. Water has the right to be clean and flow unobstructed and fish have a right to spawn and live out natural histories and life cycles. Restore indigenous fish and wildlife to their homelands. Preserve and restore traditional food sources for physical, cultural, and spiritual sustenance (February 20, 2013).

While restoration goals expressed by other interests tend to vary, they remain consistent with the overall vision of a restored river system. The following feedback provided at the September 14-15, 2016, *Workshop on Modelling Alewife Population Dynamics Using the St. Croix River as a Case Study* (DFO 2016) gives an indication of this:

- **USFWS**: Wants to establish alewives throughout the system, including a sea-run food supply in West Grand Lake in the area of land held in trust by the U.S. Department of the Interior for the benefit of the Penobscot and Passamaquoddy (Peskotomuhkati) Tribes. This would be in support of their possible future resettlement on those lands and recognition of the state advisory against eating resident fish. In addition, to contribute most significantly to alewife restoration goals, the USFWS wants passage of the entire run throughout the watershed in perpetuity (USFWS 2010).

- **NOAA**: Committed to restoring indigenous species but available habitat has changed and therefore may no longer support those species. In addition, NOAA has repeatedly expressed support for free and open access to river herring throughout the Skutik watershed. Fully restored, river herring runs have the potential of being the largest run in the Gulf of Maine (NOAA 2013). Restoration of river herring would have substantial benefits both economically and ecologically and is an essential step to restoration of diadromous fish in the Gulf of Maine (NOAA 2008). NOAA fully supports accelerated and unimpeded recovery through complete, safe, and timely passage at all anthropogenic barriers in the St. Croix watershed (NOAA 2010).
- **DFO/Canada**: The mandate is to restore passage for all the indigenous species. Restore the ecosystem in both freshwater and marine environments realizing it is not the same now as when first created (e.g., head ponds) to satisfy aboriginal treaty rights. If there are surplus fish then a commercial fishery may be promoted. The goal is for maximum abundance per species of sea-run fish identified for restoration. Salmon are not a current target but could be in the future.
- **MDMR**: Target alewife restoration throughout the river system.

4.1 Goals

From this expressed and shared vision, the Peskotomuhkati Nation developed the following overall restoration goals and set of objectives for the Skutik River system:

- The full assemblage of indigenous sea-run fish has been restored throughout the Skutik River watershed.
- Stable populations of sea-run fish fulfill their ecological role throughout the watershed.
- Stable sea-run fish populations support ecological, economic, social, cultural, traditional, and spiritual objectives for the Peskotomuhkati Nation.
- The ecological production capacity of the watershed has been maximized for alewife.
- Juvenile alewife produced in the Skutik River have supplemented the food supply in Passamaquoddy Bay and ground fish are increasing in number and size.

4.2 Objectives

The following objectives have been established as a means to achieve the restoration goals and fulfill the Nation's vision for the Skutik River system:

- Improve access to historic upstream habitat by addressing fish-passage limitations to achieve maximum production of the Skutik River system.
- Work to ensure safe, timely, and effective upstream passage for indigenous sea-run fish throughout the watershed.
- Improve survival of sea-run fish species by lowering mortality during downstream migration.
- Restore Atlantic salmon to the watershed.
- Restore vital connections between the river, indigenous fish, and the Peskotomuhkati Nation in order to preserve and restore traditional food sources for physical, cultural, and spiritual sustenance.
- Restore river herring to carrying capacity and then support a harvest by the Peskotomuhkati Nation and potentially others.

- Restore enough river herring to allow upriver fish to be harvested for social, cultural, traditional, and nutritional purposes.
- Restore ecological connections between riverine and marine ecosystems and their resources.
- Improve the ecological health, vitality, and commercial potential of Passamaquoddy Bay, the Bay of Fundy, and the Gulf of Maine.
- Foster connections between and generate opportunities for people and communities within the Skutik River system.
- Create opportunities for river-centric economic activities, including angling (shad, striped bass, rainbow smelt), boating, and general recreation.

5.0 Restoration Strategy

Through this comprehensive restoration strategy, the Peskotomuhkati Nation aims to achieve the goals and objectives stated above. Achieving the desired outcomes will take time, a committed effort, and the necessary capacity, resources, and financial means. This will require a strategic effort that balances priorities among the major action items along with careful coordination to seize upon the timeliest opportunities. For organizational purposes, restoration actions have been presented as a set of components. Collectively, the components form the strategy necessary to restore the Skutik River system.

For the most part, the components are aligned both geographically and temporally. At the same time, actions that stand to yield a quick outcome, produce an immediate benefit, or become a time sensitive opportunity will be prioritized to help generate momentum and buy-in for further components to restoration. Therefore, organization of the components and associated actions is meant to be flexible and their implementation does not have to be followed in any particular order or sequence. For example, work in Component IV focused on passage on the Canoose River could be pursued concurrently with activities on the lower tributaries identified in Component I.

Additionally, the components of the restoration and related action items will be built upon as progress is made toward the ultimate restoration goal. For example, the Peskotomuhkati Nation will initiate a comprehensive assessment of streams and barriers along the eastern shore of the Skutik. This survey will build upon similar efforts by Sipayik and USFWS on the U.S. portion of the watershed, the results of which have been compiled in the *Saint Croix Barrier Priorities Atlas* (USFWS 2015). Sites in the Barrier Atlas were classified by the degree of restriction they represent for aquatic organism passage. The Peskotomuhkati Nation envisions a similar product emerging from the stream surveys, and the results will provide opportunities for habitat enhancements, stream restoration, and improvements to habitat access. Therefore, at this time, it is premature to propose specific stream restoration and enhancement activities, but those prioritized will eventually become components of the overall Skutik River restoration strategy.

5.1 Component I—Magurrewock Stream, Lower Main Stem, and Estuary

Component I would target activities on Magurrewock Stream and the main stem of the Skutik River below Milltown Dam, including the estuary down to Pleasant Point. Lower tributaries, both above and below Milltown Dam, that have known barriers to sea-run fish migration or identified restoration potential would be the focus of this initial component. Component I projects could include:

- Continuing the Stream Connectivity Project by 1) expanding on work done to improve sea-run fish passage in Magurrewock Stream on Moosehorn National Wildlife Refuge, 2) performing a steam flow analysis to determine if there is sufficient flow during the alewife spring run from Magurrewock Stream to attract enough alewife to fully stock Vose Pond (40 acres) and Nashs and Magurrewock Lakes (856 acres) if connected, 3) preparing a conceptual design and cost estimate for connecting Nashs and Magurrewock Lakes to the Skutik River through Magurrewock Stream, and 4) plan for and connect Magurrewock Stream to the Skutik River to increase alewife production in the lower Skutik.
- Exploration of the restoration potential in Dennis Stream and Billy Weston Brook in St. Stephen, New Brunswick.
- Addressing potential barriers to sea-run fish migration on several streams in Maine between Pleasant Point and Calais identified during barrier survey work performed by Sipayik and USFWS as part of the *Saint Croix Barrier Priorities Atlas* project (USFWS 2015).
- Revisiting restoration projects identified by the St. Croix Estuary Project (ACAP St. Croix). In the mid-2000s, ACAP St. Croix identified some projects in the estuary that would directly benefit sea-run fish among other recommended projects to address water quality (MacKay and Reader 2005). One project, restoration of the Dover Hill Marsh ("the Cove") in St. Stephen, New Brunswick, which would improve habitat for striped bass and other species, should be revisited as part of the Restoration Plan.
- Beginning a sea-run rainbow smelt stocking program to develop a recreational fishery in the estuary.

The focus under Component I would be on existing habitat restoration efforts and barrier removals as well as small barriers on tributaries with no main-stem dam below them. Target species would be alewives, blueback herring, rainbow smelt, and striped bass. The rationale would be to focus on those efforts that could yield quick benefits without major actions on the main stem of the river and to focus on species that would recover quickly in these areas. Furthermore, by focusing on species such as rainbow smelt and striped bass, recreational fisheries could be established with minimal effort that would build connections to the river and add profile to the restoration cause. At the same time, the Nation will explore efforts to restore Atlantic salmon, some of which are discussed further in Sections 5.1.3 and 5.6.1, in Dennis Stream.

5.1.1 Magurrewock Stream

The dams in the Magurrewock have blocked sea-run connectivity since the early 1800s. The following actions, summarized by Ed Bassett (personal communication, 2019), should be supported in order to continue to improve fish passage there.

5.1.1.1 Lower Magurrewock: In the lower Magurrewock, the Moosehorn National Wildlife Refuge built several dams in the mid-1900s for waterfowl management. These newer dams blocked sea-run connectivity. Following new management objectives, the refuge worked with Sipayik to remove two Magurrewock Dams and replace them with large bottomless arch culverts and open connectivity for sea-run fish up to the stream just below the outlet of Nash's Lake. Important gains in habitat access for sea-run fish resulted. Magurrewock Stream also has a beaver population that can interfere with fish passage if not managed.

> **Proposed Actions >** The Moosehorn Refuge manager has committed to keeping beaver dams open during the fish-passage season; beaver deceiver solutions will be assessed to achieve fish passage and reduce labor costs of keeping beaver dams open; beaver will be trapped if they become a problem.

The lower Magurrewock (between the railroad and second dam) has large, wide, shallow wetlands that get flooded and often stay flooded in spring. This lower area could provide habitat for spawning alewives; however, use of the wetlands for spawning is unknown at this time. The size of these flooded wetlands does fluctuate depending on rain events, which has not been factored into the population estimate. Several barriers with fishways are present in the lower Magurrewock that need further evaluation. The first dam, just a few meters upstream of U.S. Route 1, has a wide Denil fish ladder. It does pass fish, but the efficiency of the ladder is unknown. The second dam (dike) has an Alaskan steep pass fishway. As with the first dam, it does pass sea-run fish, but its efficiency is unknown.

Proposed Actions > Evaluate fish passage at these two dams and make necessary improvements.

Just above the second dam is a fork in the stream where the Nash's and Howard Lake tributaries split off. There is a potential to improve fish passage in both tributaries.

5.1.1.2 Nash's Lake:

After the fork, the Nash's tributary goes through woods and open bog wetlands. Each bog may be a spawning ground but there is some indication of beaver dams on Google Earth images. The Popple Flowage road crossing has a new bottomless arch culvert that is excellent for fish passage. However, the spawning capacity of Popple is unknown. Farther upstream is the Vose Pond road crossing, which also has a new arch culvert under it that provides excellent fish passage. If beaver are properly managed, sea-run fish should be able to get to Vose Pond. Vose Pond is forty acres and has the potential to support 9,400 to 33,800 spawning alewives based on 235 and 845 alewives per acre, respectively. In spring 2018 there were 250 alewives stocked in Vose.

The woods and bogs upstream toward Nash's Lake should be good for fish passage. The refuge boundary is upstream of Vose Pond. Farther upstream is a bridge and just below it is an old rock dam at the original outlet. Alewives should be able to get to this point under their own power. However, there is a beaver dam just above the bridge. The outlet of Nash's Lake runs through a wooded section (not the original stream channel). This section of stream is very narrow with rocks and tree roots. This section should be evaluated for fish-passage issues. The original lake outlet is completely blocked by a large stone dam (built in the early 1800s); there is no longer a stream there. Nash's is a historic sea-run fish lake that had alewives prior to dams. Nashs and Magurrewock Lakes appear to be one waterbody with a combined acreage of 856 acres. (See Appendix H - Billard and Hoar 2021). They have the potential to support 201,160 to 723,320 spawning alewives based on 235 and 845 alewives per acre, respectively. The big stone dam significantly raised the water level of the lake (four-and-a-half to six meters or fifteen to twenty feet). Higher water elevations created a new stream outlet diversion that flows through a wooded section of lowland on the backside of a knoll just south of the dam. The new outlet has a small rock/sandbag dam that was used in the past by residents to control lake levels. This small dam is probably no higher than one-and-a-half meters (five feet) and is often found to be breached.

Proposed Actions > Evaluate passage issues into Nash's Lake and consider options for improving fish passage.

5.1.1.3 Howard Lake:

Howard Lake is 213.3 hectares (527 acres). Recent assessments show that there is a logjam below the outlet, and it appears the logjam is sitting on top of a narrow constriction in a wooded section of the stream, which is most likely a site of an old remnant dam (E. Bassett, personal communication, 2019). Although some fish may be able to swim through the logjam, it will likely prevent passage for sea-run fish.

Downstream of the logjam there is a small dam on private land under a bridge. The status of this dam should be investigated as it is hidden from view under the bridge; however, the landowner has gated and posted the property. This small dam is built with sandbags on the cement footings of the bridge. With sandbags in place the dam could be a blockage high enough to prevent sea-run fish from passing upstream.

There are three water control dams in the Moosehorn Refuge below this dam. All these structures are equipped with fish ladders for passage; however, the effectiveness of these ladders is unknown. Each ladder needs regular maintenance for adjusting for changing water levels as well as beaver debris.

Proposed Actions > Remove the logjam with manual labor.

Proposed Actions > Assess and work to remove the dam under the bridge.

Proposed Actions > Evaluate the effectiveness of the three water control structures.

5.1.2 Lower Tributary Streams in Maine

5.1.2.1 Boyden Stream and Lake, Perry, Maine:

Maine Stream Habitat Viewer (https://webapps2.cgis-solutions.com/MaineStreamViewer/) identifies a potential blockage on Boyden Stream (ID# D1741) off South Meadow Road. This barrier blocks 2.6 kilometers (1.63 miles) of stream habitat for rainbow smelt and 719.1 hectares (1,776.9 acres) of pond habitat for alewives. At the outlet to Boyden Lake, there are remnants of an old wood/sandbag dam, which appear to be modified from time to time, along with beaver activity, which could pose a barrier to fish passage into Boyden Lake. The Passamaquoddy Water District has operations in the vicinity and the Sipayik Environmental Department monitors this stream for fish passage almost daily during the run of river herring (E. Bassett, personal communication, 2019). This area is also identified as a Beginning with Habitat Focus Area.

Proposed Actions > Continue to monitor the stream for fish-passage issues. Assess potential for barrier removals or stream improvements to enable access to spawning habitat in Boyden Lake for alewives and improve access to stream habitat for rainbow smelt.

5.1.2.2 Marsh Brook, Robbinston, Maine:

Marsh Brook is a small tributary stream located in Robbinston, Maine, which splits into an East and West Branch, both of which drain small ponds/lakes that could support alewife production (Maine Stream Habitat Viewer (https://webapps2.cgis-solutions.com/MaineStreamViewer/). A culvert (ID #35405) is located below U.S. Route 1 as the stream enters the Skutik River estuary, blocking 48.5 hectares (120 acres) of alewife habitat. Farther upstream on the Eastern Stream are two more culverts, one at Brewer Road (ID# 35021) and another at Sherman Road (ID# 35020) that were identified as known barriers to sea-run fish. These culverts block 13.6 hectares (33.6 acres) of the habitat in the drainage.

Proposed Actions > Assess potential for barrier removals on Marsh Brook in Robbinston, Maine, to enable access to alewife spawning habitat in that drainage.

5.1.2.3 Barrier Removal on Shattuk Lake Outlet Stream:

While information about this site is a bit unclear, there appears to be a barrier at the outlet to Shattuk Lake in Robbinston, Maine, according to Maine Stream Habitat Viewer (https://webapps2.cgis-solutions.com/MaineStreamViewer/) and the *St. Croix Barrier Priorities Atlas*. The small wooden structure (ID# D2526) has a spillway 0.5-meter (1.7 feet) long and 0.8-meter (2.6 feet) high that is used to control lake levels. Biologist John Sewell reported that the lake was drained and killed to reclaim the fishery for trout. The current status of the lake and structure is unknown, but it could potentially block 9.8 hectares (24.1 acres) of alewife spawning habitat.

Proposed Actions > Assess the barrier and consider its removal if necessary.

5.1.2.4 Barrier Removal on Beaver Brook, Calais, Maine:
There is a culvert on U.S. Route 1 just north of Shattuck Road that impedes access up Beaver Brook (ID# 35398) and could be blocking access to 54.2 hectares (134 acres) of alewife spawning habitat.

Proposed Actions > Assess the barrier and consider its removal if necessary.

5.1.3 Lower Tributary Streams in New Brunswick

There are two significant tributary streams in St. Stephen below Milltown Dam that hold potential for sea-run fish restoration. While past assessments (J. Carr and G. Chafe, personal communication, 2019) have indicated both habitat for and the presence of sea-run fish, including Atlantic salmon, alewives, and rainbow smelt, there are currently no active efforts or management programs to support these populations. Given their location and potential for sea-run fish, the following actions should be an early step in the overall Skutik River restoration program.

Proposed Actions > Survey Dennis Stream and Billy Weston Brook for salmon habitat and identify areas in need of habitat improvement or restoration.

Proposed Actions > Consider the opportunity for Atlantic salmon egg planting or smolt stocking in Dennis Stream.

Proposed Actions > Explore potential for establishing a hatchery on Dennis Stream as wild Atlantic salmon have been known to be present there in the past.

5.1.4 Restoration of the Dover Hill Marsh ("the Cove"), St. Stephen, New Brunswick

Revisit past plans to restore the Dover Hill Marsh in the area just upstream of the international bridge also known as "the Cove" in St. Stephen, New Brunswick. In the mid-2000s, ACAP St. Croix, working with design professionals, developed a plan to restore an old marsh present here prior to the lumbering era (MacKay and Reader 2005). These initial plans included the following recommended actions:

- Restore the historic marsh to provide habitat for fish and invertebrate forage species, as well as mammals, birds, and plants.
- Integrate the restoration into Dover Hill park by providing paths and access to the water that would attract visitors to the area.
- Establish a demonstration hatchery that would provide the beginning of restoration of striped bass, attract tourists, and serve as an educational tool.
- Improve water quality by filtering riverbank seepages and nonpoint source inputs.

Proposed Actions > Re-initiate plans to restore the Dover Hill Marsh following plans previously developed by ACAP St. Croix to help support restoration of sea-run fish and a striped bass recreational fishery.

5.1.5 Rainbow Smelt Stocking and Recreational Fishery

Initiate efforts to stock rainbow smelt in the estuary with the goal of establishing a recreational fishery similar to rivers elsewhere in Maine and New Brunswick. Several streams in Cobscook Bay have strong smelt runs and are donor candidates for eggs to transplant to the Skutik River. There is also a smelt hatchery at Harmon Brook Farm in Canaan, Maine, that could be contracted to raise smelt to larval size for release.

Proposed Actions > Assess whether rainbow smelt are present below Milltown to provide a restoration baseline.

East Bay Brook in Cobscook Bay is the nearest candidate stream with known densities of smelts (Enterline et al. 2013). Similar rainbow smelt populations should be present in New Brunswick. Potential donor populations may be located in Dennis Stream, Oak Bay, and the Waweig River. Local knowledge should be accessible to identify other nearby smelt populations.

Proposed Actions > Investigate whether smelt eggs can be collected from East Bay Brook, at what level egg collection would be sustainable for the East Bay Brook population, and whether those eggs could be moved across the U.S. – Canada border.

Egg survival is the limiting factor for smelt restoration efforts that involve egg transfers. Single digit survival rates are not uncommon, and survival into the low twentieth percentile is considered exceptional (Chase et al. 2008). Methods should be developed to maximize survival and efficacy of the effort, including natural and artificial substrate mats and hatchery rearing and release methods.

Proposed Actions > Develop a sphagnum moss-based egg collection mat that can be deployed in smelt spawning habitat to collect and transport eggs to the Skutik River.

Proposed Actions > Explore using facilities, or copying methods, at the Harmon Brook Farm smelt hatchery to raise eggs to larval size for release into the Skutik River.

5.2 Component II—Milltown Dam Fish Passage

In June 2019 NB Power announced it's intention to decommission and remove the Milltown Dam and Generating Station. At time of writing NB Power has registered its New Brunswick Environmental Impact Assessment and is engaging in United States federal, state, and local permitting processes. NB Power intends to start decommissioning activities in the Spring of 2022. The focus of Component II will be on ensuring an effective removal of the dam and that Salmon Falls is reconstructed essentially in its original form as a cascade, like the 16 other "falls" on the river, and that passage of all sea-run target fish will be evaluated to ensure it is satisfactory. Removal of Milltown Dam was assessed in 2019 as the preferred option for optimal fish passage given that the Milltown fishway would not be able to support fish passage at desired restoration levels.

5.2.1 Milltown Dam

Milltown Dam, currently owned by New Brunswick (NB) Power, was built in 1881 at the location of the historic Salmon Falls. The concrete structure has a spillway height of 7.3 meters (24 feet) and overall length of 183 meters (600 feet). The powerhouse contains six fixed-blade turbines and has a generating capacity of three to four megawatts. Its pool and weir fishway, rebuilt in 1980 for Atlantic salmon and alewives, is considered to be in good condition, but has several issues regarding passage efficiency and safe downstream fish passage. The fishway passes several of the target fish. In 2020 it passed 611,907 river herring and 26 American shad. The last Atlantic salmon passed Milltown in 2005. There is no passage for American eels and numbers in the trap are typically very low (Hoar 2017).

5.2.2 Fishway Capacity

The design capacity for Milltown is 100,000 fish per day. The maximum recorded passage over the seven- to eight-week alewife run was 2.6 million in 1987. There is some concern about the ability of Milltown to pass the number of fish desired to achieve restoration goals. If 2019 (five years following the reopening of Grand Falls fishway) brings a run of alewives similar to the run five years following rehabilitation of the Milltown fishway in 1981, the dam is likely to be a bottleneck. Looking further ahead, Milltown will certainly not have the necessary capacity to support sea-run fish approaching the restoration levels desired. Fishway capacity also needs to consider other sea-run fish, including American shad that currently pass Milltown in small numbers, Atlantic salmon that historically passed Milltown, sea lamprey that are passing at very low numbers, and American eels.

5.2.3 Fishway Efficiency

There are several issues with the efficiency of the Milltown Dam fishway. First, it is not designed to pass all targeted species of fish, yet a variety of fish attempt to pass as noted in the annual trap counts conducted by the International Joint Commission. Furthermore, it cannot pass the number of alewives targeted in the Restoration Plan.

One of the key issues is the operating flow and attraction flow of the fishway. While several attempts have been made to modify and adjust attraction flow, USFWS and NOAA fishway design engineers and biologists have concerns about the amount of flow through the fishway, the varying amounts of flow through open turbine bays, the air entrapment in the fishway discharge, and the pattern of water flow in the forebay. One concern is spill through the gatehouse on the U.S. side of the river; it spills upward of 70% of the time during the migration period, creating a false attraction on the westside of the river, opposite the fishway, which could lead to passage delay and increased predation (Hoar 2017). The spillway spills 25% of the time but sends flow toward the Canadian shore, potentially drowning near and far-field attraction flow, creating velocity barriers, and flooding the fishway entrance and rendering it inoperable (Hoar 2017).

An auxiliary water supply pipe was installed by NB Power to supplement flow into the first pool of the fishway. This provides a jet from the entrance intended to attract fish by providing “near-field” attraction flow.

Additionally, an upwelling of water and other patterns of flow in the forebay have been noted and may also contribute to limiting the number of fish attracted to the fishway. Milltown is a run-of-river facility and certain flow conditions can cause hydraulic challenges below the dam that may prevent fish from finding the fishway opening. In particular, some attempts have been made by NB Power to adjust flow through the powerhouse, which may have improved passage (Hoar 2017). Since the number of alewives returning below Milltown Dam is unknown, the effects of these attraction flows on overall efficiency of the fishway are also unknown.

5.2.4 Downstream Passage

As noted above, restoration can often be most affected by improving downstream survival and passage at dams. Currently, there is no downstream passage facility upstream of the powerhouse intake, leaving post-spawned adult and juvenile alewives to pass downstream through the turbines, spill gates, and overflow weir onto hard surfaces (Hoar 2017). There is downstream passage at the gatehouse, but this is below most of the facility and could be a source of injury and mortality to fish. Furthermore, there is no attraction flow or physical structure to guide fish to the downstream facility or to keep fish away from the other areas where they could pass downstream but not safely.

5.2.5 Recommendations

Since Milltown is the first dam on the river, it has the biggest impact on sea-run fish migration. Addressing passage at the first dam on a river is often seen as critical for sea-run fish restoration. The Peskotomuhkati Nation supports the removal of Milltown Dam which will maximize upstream fish passage for the full assemblage of indigenous sea-run fish. However, the amount of habitat upstream of Milltown is very limited (less than 1% of total alewife habitat in the system). This creates the case for addressing fish passage at multiple barriers in the Skutik River, especially those identified in the next component—Woodland and Grand Falls Dams. In concert with recommended fish-passage improvement at these two facilities, given that more than 98% of the habitat in the watershed is above Grand Falls, the following approaches to Milltown should be considered.

> **Proposed Actions >** Engage NB Power to support the removal of Milltown Dam by providing a technical review of their Environmental Impact Assessment and reviewing and contributing to other document and studies (such as a Canadian Fisheries Act authorization)
>
> **Proposed Actions >** Work with partners to develop monitoring plans to assess effective passage of sea-run fish following removal of Milltown.
>
> **Proposed Actions >** Work with partners to develop a counting program for the spring alewife migration to replace the count that has occurred at the Milltown fishway.

5.3 Component III—Woodland and Grand Falls Dams Fish Passage

As is well known, neither Woodland Dam nor Grand Falls Dam has the capacity to pass the desired number of fish using existing fishways, and both fishways are in very poor repair. Currently, these fishways do not provide safe, timely, and effective passage for the fish they were designed to pass. Downstream passage is also a significant concern. Additional means of fish passage are needed to pass other targeted fish. For example, neither dam has upstream eel passage and the existing fishways are not suitable for passing shad.

Both dams are licensed in the United States through congressional authorization and therefore there is no Federal Energy Regulatory Commission (FERC) oversight or requirement under the Federal Power Act. Woodland Dam began operations in 1905 and Grand Falls in 1914. The two dams operate together to generate approximately thirteen megawatts (eighteen megawatts is nameplate) used on site or sold to the grid.

5.3.1 Woodland Dam

The 14.3-meter (47-foot) high Woodland Dam is believed to have the longest Denil fish ladder in the world. The 222.5-meter (730-foot) long fishway, located in the United States, was built in 1966 and has reached the end of its useful life. It was designed to pass Atlantic salmon and possibly river herring and American shad as well. The design capacity is about 87,000 alewives per day, and it has passed upward of 1.3 million fish in a season. Its current condition is poor, with significant structural issues and stability concerns. Flow out of the fishway and spill over the dam, at times through separate channels, may result in false attraction, issues for fish entering the fishway, and delayed passage (Hoar 2017). This poses additional concerns given the length of the fishway, especially if there is fallback of fish. The lack of an operation and maintenance plan is an additional concern. There is no eel passage at Woodland and the downstream passage facility is located close to the mill's water intake pipe.

5.3.2 Grand Falls Dam

A Denil fishway is located at Grand Falls in the United States at the powerhouse with a design capacity of 40,500 fish. Assessments have shown that it may have reached the end of its useful life. It has known structural issues and is deteriorating (Hoar 2017). There are issues with attraction flow due to excess spill over the dam. Many downstream migrating fish end up passing through the turbines since trash rack spacing is too large, and there is not an adequate downstream migrant facility. There is no eel passage at Grand Falls.

While the problems are known, specifics on the solutions are less clear. Accordingly, addressing passage at these sites may take time. There are very few, and no significant, tributaries between the two dams; the vast majority of habitat for many targeted fish is above these dams. Therefore, meaningful restoration is only possible if significant alterations are made at both these locations.

5.3.3 Recommendations

As noted in the 2010 Adaptive Management Plan, data from the 1980s show that only 23.6% to 42.5% of the fish passing Milltown make it above Grand Falls Dam, with many of the fish remaining below Woodland Dam. A total of 1,985,000 fish passed Milltown in 1986, resulting in 1,300,000 (65.5%) passing Woodland and 625,275 (31.5%) passing Grand Falls (Dill et al. 2010). Therefore, to reach the minimum initial target of river herring in the upper watershed—3,000,000 spawners—fish passage will need to be dramatically improved. With Milltown Dam slated to be removed in 2022, Woodland Dam will become the first barrier faced by migrating fish, adding to the importance of significant fish passage improvement.

> **Proposed Actions >** Since Woodlands and Grand Falls fishways cannot accommodate the numbers of fish passing Milltown Dam currently (and thus will not be able to accommodate increased numbers once Milltown Dam is removed), it is recommended that new fish passage be installed at Woodland and Grand Falls Dams. Analysis should be undertaken to assess the feasibility of several options at each site: (1) fish elevator, (2) fish bypass channel, (3) partial dam removal, (4) full dam removal. Fish elevators and nature-like bypass channels have proven effective at passing multiple species of sea-run fish. Both require careful consideration, analysis, and engineering. Cost differential should also be considered as well as operation and maintenance requirements for both active and passive systems. Available land is also a factor when considering a nature-like bypass channel, which requires enough length to meet gradient standards required for passage. It is understood that for Woodland Pulp Mill to meet its discharge permit mixing zone requirements, a certain amount of flow may need to be maintained at the mill. Therefore, options that allow some retention of water upstream of Woodland Pulp would be preferred, if feasible. A fifth potential option corresponding with dam removal at Woodland could also be considered: on-land wastewater treatment at Woodland Pulp.

> **Proposed Actions >** Work with Woodland Pulp to improve existing downstream passage by modifying the dam in ways that guide fish away from the spillway and away from gatehouse intakes. Target is 90% downstream passage efficiency at both Woodland and Grand Falls Dams.

> **Proposed Actions >** Capacity to monitor fish migration upstream of Milltown is limited. The Peskotomuhkati Nation should work with Woodland Pulp and others to establish a fish-passage monitoring program, including capacity to implement and oversee these activities.

5.4 Component IV—Upper East Branch

According to studies in the Adaptive Management Plan (Dill et al. 2010), between 23.6% and 42.5% of the annual river herring run pass Grand Falls Dam and make their way into habitat in the East and West Branches of the Skutik River. Approximately 27% of historical river herring habitat exists above Grand Falls Dam and below Vanceboro Dam on the East Branch and West Grand Dam on the West Branch. Significantly, more than 72% of habitat is in the lakes and tributaries above Vanceboro and West Grand Dams. Significant prime spawning and nursery habitat for Atlantic salmon exists in the upper watershed as well (SCIWC 1994-1997). Fish habitat surveys conducted by the SCIWC from 1994 to 1997 estimate that 87.5% of preferred riffle habitat in the East Branch is above Grand Falls Dam and 16% is above Vanceboro Dam.

Proposed Actions > Based on the amount of habitat in the upper watershed, restoration should focus on habitat access in tributaries as well as on the main stem. Canoose Stream and flowage is one area of great potential. Addressing the barrier at Canoose flowage would significantly improve access to habitat in that subwatershed. Canoose could be a place to initiate a river herring stocking program.

Both Vanceboro and Forest City Dams, owned by Woodland Pulp, would benefit from fishway improvements as there are issues with attraction flow, downstream passage, and a lack of eel passage. There is a significant amount of habitat upstream of both dams and the effectiveness of the fishways is unknown. Both dams fall under FERC jurisdiction in the United States; however, the fishways for both dams are in Canada. Operation and management plans are lacking for both facilities.

Vanceboro is a 4.9-meter (16-foot) high storage facility built in 1836 and currently owned by Woodland Pulp. Its vertical slot fishway lacks an auxiliary water supply to provide appropriate attraction flow to the entrance, and eddies form below the entrance (Hoar 2017). Downstream passage needs evaluation.

Forest City Dam was built in 1908 and rebuilt in 1949 as a non-generating storage facility owned by Woodland Pulp. It is 2.75 meters (9 feet) high and falls under FERC jurisdiction. Its vertical slot fishway was built in 1970. Fish-passage issues include lack of eel passage, an eddy that can form below the fishway, and poor attraction flow coming from the fishway entrance (Hoar 2017). Downstream passage has not been tested and needs further evaluation.

Proposed Actions > Currently, there is discussion about DFO developing fish-passage prescriptions for Forest City based on input from USFWS. Additional assessment and fish counting are needed at Vanceboro to assess upstream passage efficiency and the rate of injury and mortality of fish passing downstream. In light of these actions we recommend the following:

- Evaluate up- and downstream effectiveness of fishways at both facilities. The goal is at least 75% upstream passage efficiency and 90% downstream passage efficiency.
- Provide eel passage.
- Address attraction flow issues.
- Assess and address downstream fish passage.
- Develop fishway prescriptions for both facilities.
- Develop operation and maintenance plans for fishways at both facilities.

5.5 Component V—West Branch

Significant habitat exists in the West Branch of the Skutik River above West Grand Dam. Flagg (2007) calculated that 14,360 hectares (35,483 acres) of alewife spawning habitat is above West Grand Dam with a production potential of 235 fish per acre or 8,338,505 fish. That habitat comprises about 35% of historical alewife habitat in the Skutik River system (Flagg 2007).

5.5.1 West Branch Project

Woodland Pulp owns and operates the West Branch Project consisting of West Grand (including Farm Cove Dike) and Sysladobsis Dams. The facilities provide water storage for flood control and downstream hydroelectric generation. On March 15, 2016, FERC announced an “Order Issuing a New License” to Woodland Pulp to “continue operating and maintaining the West Branch Project No. 2618,” which is now in effect. The license terms include a prescription from the U.S. Department of the Interior requiring new fishways for eels at the two dams and Farm Cove Dike. On April 26, 2019 the FERC order mandated the fishway at West Grand be opened to sea-run fish by June 10 2019. Woodland complied and opened the fishway. As discussed below, significant collaboration has occurred since to further improve fish passage.

The four-meter (13.3-foot) West Grand Dam was built in 1810. Fish passage is provided by a 2.5-meter (8-foot) high rock-filled cribwork vertical slot fishway built in 1971-72 and designed to pass landlocked Atlantic salmon. There is a significant landlocked salmon fishery in the West Branch. Gates are operated to provide additional attraction flow to the fishway during fish-passage season. Downstream passage is provided at each dam through minimum flow gates. Farm Cove Dike was added to the project in 1879. It has a timber-crib pool and weir fishway built in 1958 and rebuilt in 2010. An eel passage plan is being developed by Woodland Pulp.

Sysladobsis Dam, which was built in 1861 and rebuilt in 1910, is also a nonpower dam owned and operated by Woodland Pulp as part of the West Grand Project. The 2.75-meter (9-foot) high dam has a timber-crib pool and weir orifice fishway. Landlocked salmon is the primary target species; a plan for eel passage is being developed by Woodland Pulp.

5.5.2 Fish Passage in the West Branch

To achieve its vision of a healthy Skutik River system, the Peskotomuhkati Nation is exploring and implimenting options for restoring sea-run fish to the West Branch, allowing fish to reach areas traditionally and currently important to the Nation.

Significant improvements have been made to multi-species fish passage in the West Branch over the past several years. These improvements were supported by advocacy by the Schoodic Riverkeepers, Passamaquoddy Tribal Leadership, the USFWS, and the National Marine Fisheries Service (NMFS). On January 28, 2020, the Federal Energy Regulatory Commission (FERC) issued an order *Approving Fishway Operation And Maintenance Plan* that required the removal of the migration barrier at West Grand Dam. As a result, alewife can again pass upstream of West Grand Dam in the West Branch. Significantly, fish passage for sea-run fish at West Grand Dam will be accomplished through annual consultation and a co-operative working relationship between the Tribe, Maine and Federal agencies. This cooperative arrangement is the first of its kind for the Passamaquoddy and fish passage in the Skutik River (Ed Bassett, personal communication, March 2021).

Addressing passage for all indigenous sea-run fish far into the West Branch is a high priority for the Peskotomuhkati Nation. Specifically, another core component of the Restoration Plan is for sea-run fish to repopulate the waters along the shores of the acreage held in trust for Indian use by the U.S. Department of the Interior, Bureau of Indian Affairs (BIA). To accomplish that, the fishway at Sysladobsis Dam needs to pass fish upstream timely and effectively, but its location may be inhibiting fish passage. The Sysladobsis fishway is on the bank opposite the spillway which provides the main attraction flow. There is no auxiliary water supply associated with the fishway to attract fish to it. Consequently, its performance needs to be evaluated and any issues remedied.

5.5.3 Recommendations

The U.S. government holds land in the West Branch for the benefit of the Peskotomuhkati Nation and Penobscot Nation. Specifically, the BIA holds approximately 20,639 hectares (51,000 acres) for the benefit of the Passamaquoddy and approximately 1,376 hectares (3,400 acres) for the benefit of the Penobscot Nation. Furthermore, the Peskotomuhkati Nation believes that the entire watershed, areas drained by both the East and West Branches, must be viewed as an interconnected whole, and should be an interest to both the United States and Canada for purposes of fisheries management. As expressed in the *Vision and Mission Statement of the Schoodic Riverkeepers* (February 20, 2013) and *Schoodic River Statement of Cooperation* (June 5, 2013), Peskotomuhkati Nation interests include:

- Reconnecting the Peskotomuhkati/Passamaquoddy, particularly young people, with the culturally important natural resources that the river and bay provide.
- A reliable, safe-to-eat, sea-run food supply in the waters near the shores of the tribal reservation and trust land to provide sustenance and food security to future generations in light of a state-issued advisory against eating resident fish due to contamination.
- Opportunity for Passamaquoddy, particularly at Pleasant Point, to resettle on trust land in the West Branch due to rising sea levels and for other reasons as provided for in the Maine Indian Claims Settlement Act.

Further, a 2012 resolution from the Joint Tribal Council of the Passamaquoddy Tribe, states that “sea-run alewife are a vital link in the food chain of the St. Croix River and are known as the ‘fish that feeds all’ and has sustained the Passamaquoddy for thousands of years;” that “the Passamaquoddy have a unique cultural and historical relationship with the river ecosystem and the fishery within the river;” that “the Passamaquoddy have the duty to protect and preserve the river system, the indigenous food fishery, sustenance fishing and saltwater fishing rights of the Passamaquoddy people so that future generations will continue to survive;” and that blockage of fish passage in the river “has harmed the Passamaquoddy People by severely diminishing an important traditional and sustenance food source and disturbing the cultural practices of the tribal members.” (Included as Appendix D)

Proposed Action > Given strong interest in restoring sea-run fish to the West Branch of the Skutik River, the Peskotomuhkati Nation should continue to pursue and advocate for safe, timely, and effective fish passage for the full assemblage of indigenous sea-run fish for the West Grand Project.

Proposed Actions > Future analysis should build upon informative and useful information already developed in response to numerous FERC relicensings at other venues. Importantly, it should be a priority to analyze the status and options for imminent and ongoing proceedings with potential long-lasting implications for restoration.

5.6 Component VI—Stocking Programs

5.6.1 Atlantic Salmon Stocking

Although past adult stocking programs were unsuccessful, the Nation believes in the potential to restore Atlantic salmon to the river and would like restocking efforts to be pursued. Initial efforts should focus on the lower tributaries where there is accessible habitat available with minimal obstructions to upstream and downstream passage, and recent indications of salmon presence. Specifically, Dennis Stream is below Milltown Dam and redds have been found there in the past.

Several options exist for a salmon stocking program. These may include establishing a fall run of Atlantic salmon. The timing of a fall run may avoid some of the challenges associated with smallmouth bass predation. Each of the options has relative advantages and challenges. Restoration proponents should consider trade-offs between life stages to be stocked as well as program costs and infrastructure needs. Finally, it is important to keep in mind that actual production will be highly variable due to the complexity involved in stocking salmon as well as the high degree of natural variability in the system. Natural variability includes stream water temperature, predation, and at-sea mortality. "Unnatural" sources of mortality include upstream and downstream passage mortality, factors that can be controlled to some extent.

Fry survival can vary greatly within rivers and understanding this variability can improve recovery efforts. This is due to various factors within a watershed, including both quality and quantity of habitat, and differences in habitat aside from physical habitat alone. Sweka and Mackey (2010) have shown that cumulative drainage area can be a useful means for determining spatial variation of parr density and therefore planning stocking efforts. They found that as drainage area increases parr density decreases and that variation is greater at smaller cumulative drainage areas. Methods developed by Sweka and Mackey (2010) can be used to assess the potential of a stream reach to support Atlantic salmon parr and prioritize efforts. They suggest that cumulative drainage area can help determine a potential upper limit to parr density while explicitly recognizing that other factors could decrease parr density (Sweka and Mackey 2010). Alternatively, proceeding with stocking in various locations throughout the watershed and between the dams, then looking at the success of parr production, may give the best answers to where the quality habitat is and therefore where to focus stocking efforts. Given the high degree of complexity, the Peskotomuhkati Nation intends to consult with the numerous experts, researchers, and practitioners available to help advise and guide a salmon stocking program on the Skutik River.

Option 1: Adult rearing in sea pens, with support of OBoF aquaculture facilities

Adult salmon would be raised in Passamaquoddy Bay using hatchery stock and existing aquaculture facilities. Upon maturity, adults would be released to swim upriver and spawn. The target would be about 4,000 adult fish based on estimates of female fecundity and distribution of eggs.

<u>Advantages</u>: This approach will bypass significant marine survival issues, which are not fully known or understood. Raising adults in sea pens provides a degree of control over the desired number of returning adults.

<u>Challenges</u>: Past adult stocking did not result in necessary smolt recruitment. This approach leaves open questions about habitat quality, water temperature, and predation, all concerns raised from previous stocking efforts. Additionally, this method is more costly and will take more time to implement as adults are raised to maturity.

> **Proposed Actions >** An adult sea-pen program will be investigated and considered for the Skutik River system. Consultation with the aquaculture industry should be pursued to assess opportunities, costs, and feasibility.

Option 2: Pre-smolt fry/parr stocking

This approach is currently being employed by the Downeast Salmon Federation on several river systems in Washington County, Maine. Raising juvenile salmon in a rigorous environment resembling stream conditions to create strong individuals is important to this approach's success. Circulating water systems not only provide these conditions, but also allow for the addition of olfactory signals that would help juveniles home to desired spawning habitat.

Advantage: Fry/parr can be more widely distributed throughout the system and in numbers greater than smolts. This could allow for a higher degree of survival, especially if the system can be overwhelmed with juveniles. Some studies have shown that stocking early life stage individuals allows more time to develop the fitness characteristics necessary for long-term survival. According to the USASAC (2018), naturally reared smolts resulting from fry stocking typically have a higher marine survival rate than hatchery reared smolts (USASAC 2018).

Challenges: Rehabilitating existing or building new infrastructure may be necessary for this operation. While less expensive than adult stocking, it is still more expensive than an egg planting program, discussed below. Fry/parr stocking may have the benefit of increasing fitness and therefore marine survival when compared to smolt stocking due to the longer time spent developing in natal waters. However, smolt production remains a key question with this approach. Stocking fry/parr in higher numbers may increase the chance for in-river survival and allows for uniform dispersal of the fish throughout quality rearing habitat. It would be useful to genetically identify fish and monitor returns to see which strains perform best.

> **Proposed Actions >** A fry/parr stocking program will be investigated and considered for the Skutik River system using the Downeast Salmon Federation as a resource. Infrastructure needs should be assessed, and existing infrastructure investigated for suitability. The Huntsman Marine Center is one option to explore.

Option 3: Atlantic salmon egg planting

This approach currently is being employed in the Kennebec and Penobscot Rivers. It requires fewer resources and less infrastructure and is lower cost. Egg planting has been increasing as an approach due to the apparent success in producing more wild-like smolts (USASAC 2018). Eggs are planted in large numbers throughout quality habitat but are not as widely dispersed as with fry/parr stocking methods. As with fry/parr stocking, increasing the amount of time salmon spend in natal habitat should increase their ability to adapt to natural variation, including marine survival, but smolt production is uncertain given previously stated habitat concerns. Another advantage of egg planting is the shorter amount of time needed to start a program.

> **Proposed Actions >** Evaluate the potential for Atlantic salmon egg planting in the lower tributaries where habitat access is better and then monitor returns as an early step in Skutik River restoration.

Other considerations: Regardless of approaches taken, several actions should also be pursued to help ensure the success of Atlantic salmon restoration in the Skutik River system.

> **Proposed Actions >** Habitat enhancement should also be considered where most of the necessary habitat elements are present to support salmon eggs or parr rearing. Pool formation, tree planting, and gravel/cobble additions could be used to create the habitat that is lacking for Atlantic salmon in Dennis and Megurrewock.

> **Proposed Actions >** Returning adults should be radio tagged at the first barrier on the river so their behavior can be assessed to improve the process of future releases. This is particularly important to detect additional barriers to salmon using the lower river habitats or to identify the process of straying to upriver habitat. A challenge, however, could be getting adults headed to the Megurrewock from the Canadian trap to an American truck. A zipline was used in the past to move fish across the river. An alternative would be to simply tag, release, and see where they go.

Proposed Actions > Monitoring for adult salmon should be established at the second barrier on the river, where they can be stopped and moved to a truck for upstream transport. Returning adults choosing to stray above Woodland can be assisted to minimize delay and mortality by transporting them to prime spawning habitat to minimize delay and mortality at remaining barriers. These fish should also be radio tagged and tracked to determine if Megurrewock spawning habitat is attractive to ripe salmon. Genetic identification will help ensure fish are returned to the habitat where they were spawned.

Proposed Actions > Predation by smallmouth bass and pickerel is a potential source of loss for hatchery reared salmon. Assessing the density of warm water predators in potential salmon rearing habitat and/or assessing their feeding habits with an eye to documenting competition or predation will help identify whether co-occurrence is a barrier to hatchery program success. Removal of warm water predators from these habitats should also be considered. Elimination is likely to be impossible, but regular removals may lead to low enough abundances of warm water predators to allow salmon restoration to take hold.

5.6.2 American Shad Stocking

The Shad in the Classroom program, developed by the USFWS and partnerships with elementary and middle school districts in the mid-Atlantic states (https://naturalsciences.org/learn/learning-resources/shad-in-the-classroom), would be a good program to initiate in the Skutik River system. Not only would such a program help revive runs of shad, it has the additional benefit of community engagement. Egg rearing tanks are set up and shad are brought into classrooms in the spring. Associated lessons delivered in class cover the history, biology, and ecology of local rivers using shad as the vehicle to tie these lessons together. Children monitor the tanks and egg development until the fry are old enough to release as part of a civic stocking effort. Whether or not this effort contributes to the shad population, instituting a Shad in the Classroom program would help raise the profile of any restoration effort in the public eye (Narvaes and Lucas 2012). (http://udspace.udel.edu/bitstream/handle/19716/12988/ShadInSchools_Report2012.pdf?sequence=1&isAllowed=y)

We see the first step in any American shad restoration effort as information gathering. Can we estimate the number of shad that reach Milltown Dam? Prior to 2010 shad were thought to be extinct in the river; however, their numbers in the trap have been growing annually. Shad were also thought to be extinct in the Penobscot River until investigations associated with the Penobscot River Restoration Project determined that most of the fish approaching the Veazie fish ladder in 2011 were American shad, even though an American shad had never been caught in the trap (Grote et al. 2014a). Radio and acoustic tagging studies of shad caught below Veazie Dam showed that a remnant population was spawning in the river below the dam (Grote et al. 2014b). The Penobscot has much more rearing habitat below head of tide than the Skutik, so a spawning remnant population is less likely; however, this assumption has proved erroneous for other locations in the past.

Once biological surveys have sufficiently informed the effort, a shad hatchery should be considered, and the following questions addressed:

- What river would source fish come from?
- Is the goal to build the population or raise educational awareness?

These two questions will guide the scale and scope of a hatchery supplementation effort. Additional issues that need consideration are: If enough shad are present in the St. Croix and can be captured, can those fish form the core of a hatchery spawning process? Is the Penobscot close enough to the St. Croix to contribute eggs to a hatchery effort without damaging natural genetic differentiation? Are there sources of shad in Canada? Given the timing of the shad run, will Shad in the Classroom work for educators in the area?

> **Proposed Actions >** Investigate and consider initiating a Shad in the Classroom program in the Skutik River watershed.
>
> **Proposed Actions >** Investigate the size of the Skutik remnant shad population.
>
> **Proposed Actions >** Conduct a field survey to determine potential shad spawning habitat – before stocking, and in anticipation of Milltown removal
>
> **Proposed Actions >** Investigate raising shad in a tribal hatchery for release into the St Croix

5.6.3 Rainbow Smelt

Supporting and supplementing smelt runs is a relatively simple affair involving transfer of fertilized eggs on egg mats to below head-of-tide habitat. The most recent studies show that Cobscook Bay and the Perry shore have strong to limited smelt spawning runs (Enterline et al. 2012). Little information seems available for smelt runs in New Brunswick.

> **Proposed Actions >** Planting eggs from the Cobscook Bay runs to augment the Skutik from the U.S. side. Attempt egg mat placement from the Canadian side of the river as well if suitable donor populations can be found. Massachusetts Division of Marine Fisheries staff recommended hatchery rearing of eggs and larval release to increase egg survival (Chase et al. 2008). Furthermore, larvae can be marked to facilitate an assessment of stocking efficacy in the future.

6.0 Related Planning and Coordination

6.1 Monitoring and Management Plan

Monitoring should build upon existing efforts and relationships. The monitoring plan should consider key components of the Restoration Plan (e.g., communications, and not just those that are fish/habitat centric). In addition, monitoring should involve the collection and evaluation of relevant data and information for each strategy, and the objective from which it was derived, for all key components of the Restoration Plan. Annual monitoring and reporting of upstream passage at all the main-stem dams should be a priority, with East and West Branch dams second priority. Monitoring should consider the restoration timeframe for each species and its progress.

The Peskotomuhkati are preparing a systematic program of monitoring, sampling, and fish counts that will be essential throughout the restoration period. This will help gauge results and inform restoration actions, adjustments, decision making, and prioritization. The monitoring plan will identify the metrics that will be used for monitoring and evaluating progress. The strategies chosen and designed to achieve restoration objectives should be monitored and their intended effects evaluated. Regarding sea-run fish, examples may include fish-passage efficiency; percent increase in run size; age and sex ratio of adult returns; number of adult returns; number and injury rate of adults/juveniles migrating downstream; and density of target fish in select habitat.

Proposed Action > Integrate the Restoration Plan and the Skutik River Monitoring Plan.

A technical committee may be established to provide input and guidance. Restoration actions will be enhanced, and success increased if actions are assessed and refined along the way. Monitoring and evaluation will help ensure that restoration decisions and actions are modified, discontinued, or continued based upon the information gathered on performance and data collected on species responses to restoration strategies. This approach relies on establishing strategies and related work plans that are based on predicted results, assessment plans to collect data necessary to evaluate a management strategy, and a feedback mechanism to inform and improve management as results are obtained.

Proposed Action > Establish a technical committee to help guide and offer advice on restoration and monitoring activities.

In summary, the Restoration Plan should be a living document that is reviewed and updated periodically. As time passes and restoration progresses, new information will become available resulting from monitoring, community engagement, and partner dialogue as well as unanticipated circumstances and opportunities that may arise. Regular communication about the fish restoration planning process should be maintained as overall success will depend in large part upon stakeholder engagement and integration.

6.2 Communication and Coordination

The Peskotomuhkati Nation will develop a process by which additional partners and the public at large can be engaged in the restoration process. As time passes and restoration progresses, new information will become available resulting from monitoring, community engagement, and partner dialogue as well as unanticipated circumstances and opportunities that may arise. Regular communication about the sea-run fish and river restoration process should be maintained as overall success will depend in large part upon stakeholder engagement and integration.

Restoration interests should help develop a compelling and informative communications plan to build the broad and diverse support that is critical for a successful restoration. This should include informing the public about the importance of sea-run fish to people, fish, and wildlife in the Skutik River system and enhancing communication among scientists and policy-makers. Communications should use a variety of tools including publications, websites and social media, events, and direct outreach to identified stakeholder groups.

Outreach should convey clear and understandable information about the “health” of the watershed and why a robust ecology that includes the full assemblage of native sea-run fish at sustainable levels is important. Strategic communications should be integrated throughout a restoration strategy. In-basin, “kitchen-table” outreach is a foundation for the success of a basin-wide restoration. Cultivating and developing relationships with people and sectors representing fishing guides, commercial fishing interests, lake owners, recreational interests, and others—many of whom are easily identified through past participation in restoration debates—will be essential. Ongoing discussions with stakeholders such as Woodland Pulp and New Brunswick Power also remain critical.

The Schoodic Riverkeepers, for instance, have been highly effective in building grassroots support in the local community and beyond. For instance, in 2012, they organized an “Alewife Run” to highlight fisheries restoration and developed a video called *Siqonomeq* that helped build local and statewide support for reopening the Woodland flowage to alewives. They also provide a venue for sharing information and facilitating discussion on fish restoration activities. Schoodic Riverkeepers ideally will continue to perform and further develop their essential leadership role in, among other things, community building and outreach.

Regular coordination and communication on restoration and monitoring should also occur among plan developers, scientists, decision makers, and field managers.

Proposed Actions > Develop and implement a plan for cooperation and public engagement.

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Appendices

Appendix A: Schoodic River Statement of Cooperation
June 5, 2013

Schoodic River Statement of Cooperation
Between Wabanaki Tribal Leaders and four Federal Agencies:
U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, NOAA's National Marine Fisheries Service, and Bureau of Indian Affairs

It is on this great day, June 5th, 2013, that the Wabanaki Tribes of Maine and their Federal Trustees celebrate the restoration of fish passage for alewives and other sea-run fish in the St. Croix River here at the Grand Falls Dam. For close to two decades, passage for alewives and other sea-run fish has been blocked on the St. Croix River, resulting in significant declines in abundance. Of equal importance, closure of the fishway has diminished a food source and negatively impacted the cultural sustenance of the Passamaquoddy people. Their strong connection to the river serves as the foundation for many tribal traditions, and today, with the opening of the fishway on Grand Falls Dam, the Passamaquoddy celebrate the homecoming of the *Siqonomeq*.

Through an extraordinary partnership of the Wabanaki Tribal Leaders, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the NOAA's National Marine Fisheries Service, and the Bureau of Indian Affairs, one important component of the Passamaquoddy Bay ecosystem will now have the opportunity to recover.

This incredible accomplishment would not have been achieved without the unique government to government relationship that exists between Indian Tribes and the Federal government. This is embodied in Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments). On November 5, 2009, President Barack Obama released a memo for the heads of all executive departments and agencies reaffirming the continued implementation of E.O. 13175. The government-to-government relationship has been the cornerstone in the government's work to safeguard the rights and interests of Indian tribes. The United States recognizes the political rights of Indian tribes to self-government and to exercise sovereign powers over their members and territory, and protects those rights by working with Indian tribes on a government to government basis.

The Wabanaki Tribal Leaders, the US Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the NOAA's National Marine Fisheries Service, believe that through continued cooperation and coordination our strong government-to-government relationship can continue into the future and benefit restoration of the St. Croix River, the Passmaquoddy Bay ecosystem, and the critical cultural and economic relationship of the Passamaquoddy people to this unique river.

Simply put, cultural sustenance is not possible without sustainability. The Wabanaki people and the Federal Trustees pledge to continue to work together toward the common goal of restoration of this magnificent river, all its native inhabitants, and the return of the critical cultural connection between the Passamaquoddy people and the Passamaquoddy Bay ecosystem.

June 5, 2013
Date

Chief Joseph Socobasin
Passamaquoddy Tribe
Indian Township Reservation

John K. Bullard
Regional Administrator
NOAA's National Marine Fisheries Service,
Northeast Region

Wendi Weber
Regional Director, Northeast Region
U.S. Fish and Wildlife Service

Chief Reubin Cleaves
Passamaquoddy Tribe
Pleasant Point Reservation

Scott Meneely
Acting Deputy Regional Director
Bureau of Indian Affairs
Eastern Region

H. Curtis Spalding
Regional Administrator
U.S. Environmental Protection Agency
Region 1

Appendix B: Vision and Mission Statement of the Schoodic Riverkeepers
February 20, 2013

Schoodic Riverkeepers

Vision and Mission Statement of the Schoodic Riverkeepers

(February 20, 2013)

Tribal members have experienced and witnessed much change over the course of their lives. Individuals bring unique perspectives, life teachings and stories to the collective group. Our individual strength comes from our core Passamaquoddy values which originate from elders, relatives and traditions. As a group we contribute our values and strengths, striving to preserve and enhance the lives and traditional culture of the Passamaquoddy.

Employing traditional technologies and utilizing trade routes over land and water the Passamaquoddy established a nature-based economy that enabled the Passamaquoddy to live in balance and thrive within our Ancestral Homeland for many thousands of years. Tribal members deeply understand that Nature provides all the necessary resources for our continued survival – resources that are not infinite and therefore must be nurtured and protected for future generations. We have developed a personal and tribal sacred trust responsibility to protect and preserve the environment and natural resources within our Ancestral Territory. We are stewards of the land, water and all life. This truth was known by our Ancestors.

We have shared this earth with all other creatures. The Creator has blessed the Passamaquoddy with an abundance of fish and wildlife upon which our culture is defined and without which we would not have survived. Over the past 500 years tribal members have witnessed the over-exploitation of the indigenous food fish and natural resources and the damage done to Nature's ecosystems within our Homeland. The Schoodic Riverkeepers dedicate our efforts and work toward reversing and restoring the damage done to our Homeland. We recognize our mission can only be accomplished in concert with others who have similar goals.

As stewards of this land and water we believe that the Natural ecosystems and related Natural Communities have an inalienable and fundamental right to exist, flourish and evolve. We also recognize that water has a right to be clean and flow unobstructed and that the fish have a right to spawn and to live out their natural history and life cycles.

Specifically, we will work toward restoring the indigenous fish and wildlife such as Atlantic Salmon, Shad, Blueback Herring, Alewife and American eel to their historic homelands. We strive to endorse only appropriate technology that will enhance and not damage the natural ecosystems that these and other indigenous fish and wildlife need to survive. We desire to preserve and restore traditional food sources – our physical, cultural and spiritual sustenance.

We, the Schoodic Riverkeepers believe that much of our Ancestral Homeland is in a state of distress and we fully agree with and support the June 14, 2012 Tribal Sovereign Declaration of Emergency signed by the Passamaquoddy Chiefs and the September 26, 2012 Joint Tribal Council St Croix River and Alewife Resolution. We pledge to work to raise awareness to this situation and improve conditions for the betterment of future generations.

Appendix C: State of Emergency in the St. Croix River Passamaquoddy Tribal Sovereign Declaration June 14, 2012

Passamaquoddy Tribal Sovereign Declaration

State of Emergency In the St. Croix River

With countless past generations and future generations in our hearts and minds we the undersigned Passamaquoddy Chiefs declare a state of emergency. This state of emergency exists within the heart of our Passamaquoddy Homeland.

We have come to learn that our ancient Life-Giver the Schoodic River (now known as the St. Croix River) is in a state of serious distress and immediate action must be taken to remedy this distress. We have a sacred relationship with the River and life contained within the River. We recognize that the St Croix River Ecosystem and related Natural Communities have an inalienable and fundamental right to exist, flourish and evolve. We also recognize that the River has a right to be clean and flow unobstructed and that the fish have a right to spawn and to live out their natural history and life cycles.

We have shared this river with indigenous sea-run fish such as Atlantic Salmon, Shad and Alewife. The Creator has blessed the Passamaquoddy with an abundance of food fish upon which our culture is defined and without which we would not have survived. We are now saddened to learn that the Atlantic Salmon, Shad and Blueback Herring are near extinction in this River and that the Alewife are threatened with extinction.

For the past 17 years Maine has harmed the Passamaquoddy People by blocking anadromous fish from accessing its ancient and traditional spawning grounds in the upper St. Croix River. This action severely diminished a traditional food source and disturbed our cultural practices. We insist the State of Maine immediately remove this blockage and allow these fish to pass. Failing this, we urge the International Joint Commission to exercise its authority and open this blockage.

Chief Cleaves, Sipayik ____________

Chief Socobasin, Motahkomikuk ____________

Chief Akagi, Qonasqamkuk ____________

Date: June 14, 2012

Appendix D: St. Croix River and Alewife Resolution Joint Tribal Council of the Passamaquoddy Tribe September 26, 2012

Indian Township
Tribal Government

St. Croix River and Alewife Resolution
Joint Tribal Council of the Passamaquoddy Tribe 9/26/12#1

Whereas: since time immemorial the Schoodic River watershed, now known as the St. Croix River, has been the natural spawning ground and ancient homeland for several species of sea-run fish such as Atlantic Salmon, Shad, Blueback Herring and Alewife, and

Whereas: the quantities of sea-run fish ascending the St. Croix River was so great that historical records described it as something "almost miraculous", and

Whereas: the river's watershed created an ideal nursery environment for spawning fish, making the St. Croix a river of great fertility and productivity which generated an abundance of nutrients and food for countless other fish and wildlife species within the watershed and within the saltwater regions of the Passamaquoddy Bay and the Bay of Fundy, and

Whereas: sea-run alewife are a vital link in the food chain of the St. Croix River and are known as the "fish that feeds all" and has sustained the Passamaquoddy for thousands of years, without which we may not have survived, and

Whereas: the Passamaquoddy have a unique cultural and historical relationship with the river ecosystem and the fishery within the river, and

Whereas: the Passamaquoddy have the duty to protect and preserve the river system, the indigenous food fishery, sustenance fishing and saltwater fishing rights of the Passamaquoddy people so that future generations will continue to survive, and

Whereas: the St Croix River ecosystem and related Natural Communities have a fundamental right to exist, flourish and evolve, and the river has a right to be clean and flow unobstructed, and the fish have a right to spawn and to live out their natural history and life cycles, and

Whereas: man's activities have seriously upset the productivity and natural balance of the river ecosystem and life cycles of the native fishery and has put this unique river ecosystem into a state of distress, and immediate action must be taken to remedy this distress, and

Whereas: Atlantic Salmon, Shad and Blueback Herring are now near extinction and the Alewife are threatened with extinction, and

Whereas: marine species such as cod, haddock, pollock, whales and porpoise are dependent on such a high energy food source as the alewife, and

Whereas: for the past 18 years Maine law has blocked sea-run alewife from accessing its natural and ancient spawning grounds in the St. Croix River watershed, and

Whereas: this blockage has harmed the Passamaquoddy People by severely diminishing an important traditional sustenance food source and disturbing the cultural practices of the tribal members, and

Whereas: the Joint Tribal Council agrees with and supports the June 14, 2012 Passamaquoddy Chief's Declaration of a State of Emergency within the St. Croix River, and

Whereas: the Joint Tribal Council believes that Maine's law blocking sea-run Alewife on the St. Croix River has resulted in a devastating loss of sea-run fish in Passamaquoddy waters and has reduced the productivity of the ecosystem and the availability of native food sources thus disturbing Passamaquoddy culture in a way that is contrary to the Settlement Act

So, Now therefore be it Resolved

That: the Joint Tribal Council insist the State of Maine immediately remove this blockage and allow the sea-run alewife to pass to access their ancestral spawning territory. Failing this, we urge the International Joint Commission to exercise its authority and open this blockage, and

That: the Tribal Representative to the Maine Legislature is authorized to submit, sponsor and support legislation requiring the Grand Falls dam fish passage be ordered open for sea-run alewife, and

That: the Tribal Chiefs are authorized to take appropriate action to open the fishway at Grand Falls for the free passage of sea-run alewife and to restore the indigenous fishery within the St. Croix River Watershed

Be it finally Resolved

That: all previous Joint Tribal Council Resolutions pertaining to the Alewife are null and void. This resolution supersedes all previous Joint Tribal Council decisions relating to alewife passage in the St. Croix.

CERTIFICATION

I, the undersigned Clerk of the Joint Tribal Council of the Passamaquoddy Tribe, do hereby certify that a meeting of the Joint Tribal Council of the Passamaquoddy Tribe was held at the Pleasant Point Passamaquoddy Reservation on September 26, 2012, and do further certify that a quorum of the Joint Tribal Council of the Passamaquoddy Tribe consisting of either the Sakom/Chief or the Leptanet/Vice-

Chief of each Reservation and not fewer than eight voting members, including at least four voting members from each Reservation, was determined by a roll call taken and recorded at the beginning of the meeting and present at the time of the action certified hereby, and that the foregoing Resolution was circulated in writing to all members of the Joint Tribal Council present at the said meeting prior to being voted upon at the meeting, and that the foregoing Resolution was duly moved, seconded and adopted by the affirmative vote of 10 members, who at the time of the vote constituted a majority of the 10 members of the Joint Tribal Council then present and voting.

Dated: Oct 1, 2012, 2012 ATTEST: [signature]

Mary J. Lola, Clerk
Joint Tribal Council
Passamaquoddy Tribe

Appendix E: Letter Requesting Consultation from U.S. Federal Agencies
Passamaquoddy Joint Tribal Council
August 3, 2012

Passamaquoddy Tribe
Joint Tribal Council

Motahkmikuk (207) 796-2301
Sipayik (207) 853-2600

August 3, 2012

Wendi Weber, Regional Director
U.S. Fish and Wildlife Service
300 Westgate Drive
Hadley, MA 01002

John Bullard, Regional Administrator
NOAA Fisheries Service
55 Great Republic Drive
Gloucester, MA 01930

Curt Spalding, Administrator
Environmental Protection Agency
5 Post Office Square – Suite 100
Boston, MA 02109

Re: St. Croix River Herring Fish Passage

Dear Director Weber and Administrators Bullard and Spalding:

It is our understanding that you and your respective staffs are aware of the Maine Wabanaki tribes' opposition to Maine's law which calls for the blockage of upstream passage for river herring at the Grand Falls dam on the St. Croix River. This action by Maine was first ordered in 1995, and although in 2008 a lower dam in the river at Woodland was opened to river herring passage, only 2 % of historic spawning habitat was made available.

On August 1st we met with Maine Governor LePage to discuss a June 21st letter, which addressed this issue of fish passage, signed by the five Wabanaki Chiefs. And although the Governor in our meeting offered his support for a limited reintroduction of six alewives per acre above Grand Falls, his offer fell far short of the full opening of the Grand Falls fishway, which we Chiefs believe is necessary for a viable, self-sustaining run of river herring in waters on and around Passamaquoddy reservation lands.

Notwithstanding our personal support for river herring restoration, there remain some members of our community who do not fully understand this issue and that has raised some difficulty in the past. Accordingly, we have with some success embarked on an internal education process through film and community action. Nevertheless, more needs to be done, and we request that your agencies assist us with that process by making available the staff necessary to meet with and explain to the Passamaquoddy community: the science surrounding the reintroduction of river herring to the St. Croix River, how the tribe and federal agencies may work together to better protect one of our key resources, the significance of EPA's July 9th letter to Attorney General Schneider, and what tribal sustenance fishing impact might result from the proposed listing of this species under the Endangered Species Act.

If your respective agencies support this request, we ask that a meeting with Passamaquoddy elected officials and community members be scheduled before the end of August in order to dovetail with internal activities related to this issue. We also ask that staff coordination be directed to our point person, Ed Bassett (207)853-2600 edb@wabanaki.com.

Respectfully,

R. Clayton Cleaves
Passamaquoddy Chief
Pleasant Point Reservation

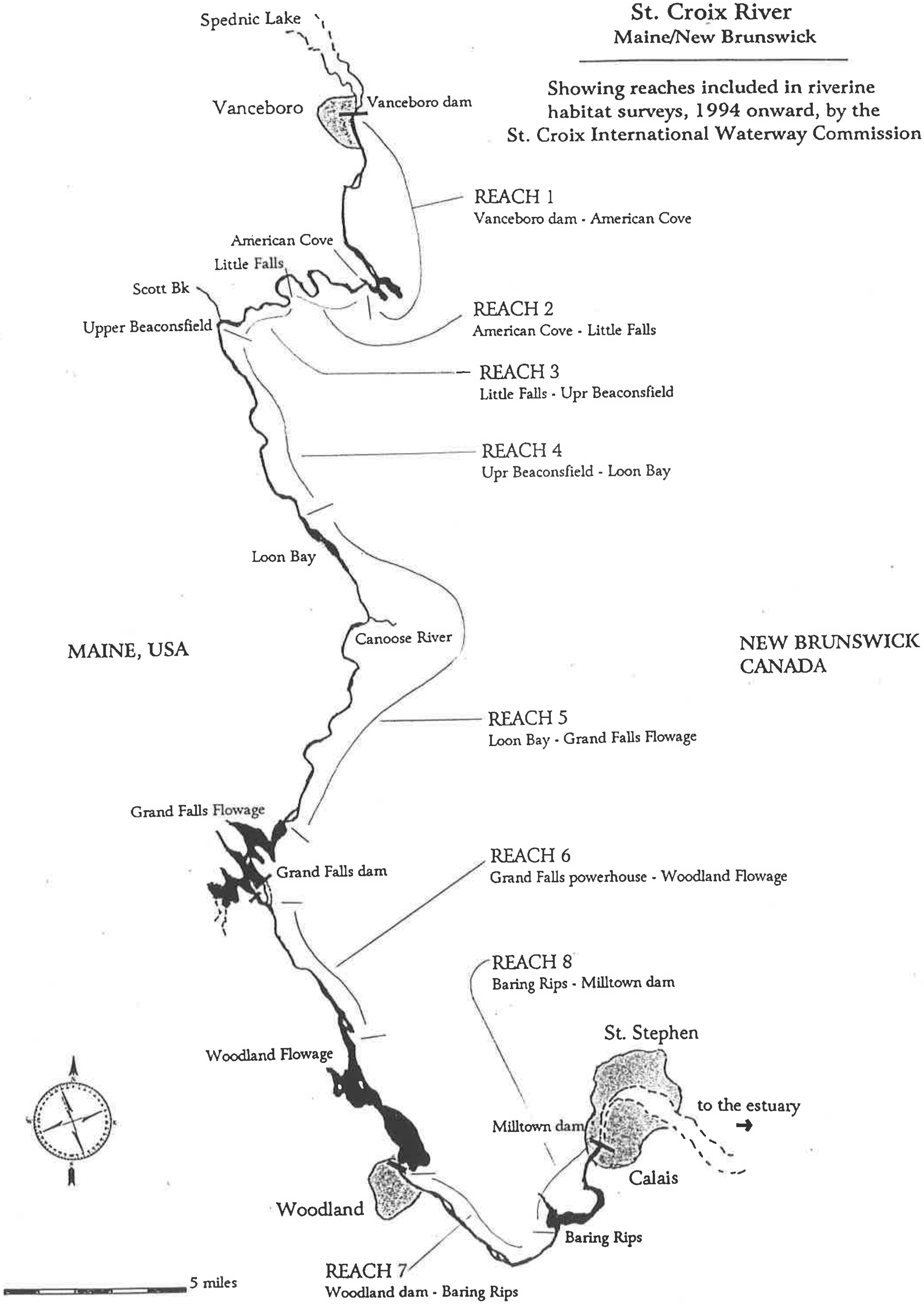
Joseph Socobasin
Passamaquoddy Chief
Indian Township Reservation

Appendix F: 1994 – 1997 Fish Habitat Surveys St. Croix River, New Brunswick and Maine

St. Croix International Waterway Commission

St. Croix River
Maine/New Brunswick

Showing reaches included in riverine habitat surveys, 1994 onward, by the St. Croix International Waterway Commission



1994-1997 Fish Habitat Surveys
St. Croix River, New Brunswick and Maine

compiled by the St. Croix International Waterway Commission

	Reach 1 Vanceboro Dam - American Cove*	Reach 2 American Cove - Little Falls	Reach 3 Little Falls - Upr Beaconsfield	Reach 4 Upr Beaconsfield - Loon Bay	Reach 5 Loon Bay - Grand Falls Flow.*	Reach 6 Grand Falls - Woodland Flow.*	Reach 7 Woodland Dam - Baring Rips*	TOTAL All Reaches
General Totals								
Number of units and subunits	65	29	67	107	70	30	59	427
Area of units (m2)	384711	304630	394255	804288	760233	305072	804958	3758147
Length of main channel surveyed (km)	7.35	5.11	6.36	10.82	5.83	6.65	6.25	48.37
Riffle - Total Habitat								
Total # riffle units	18	8	26	40	12	4	12	120
Total area of riffle units	118865	59736	138048	277570	64918	24690	70270	754097
Riffle units / total units	0.28	0.28	0.39	0.37	0.17	0.13	0.21	0.28
Riffle - Cobble/Gravel								
Total # units classed as riffle C/G	5	0	16	24	6	3	8	62
Total area of riffle C/G units (m2)	32170	0	96659	181778	27118	23410	49034	410169
# riffle C/G units with C/C>40%	4	0	15	24	4	3	6	56
area of riffle C/G units with C/C>40%	24220	0	94159	181778	17938	23410	40075	381580
Riffle - Rock/Boulder								
Total # units classed as riffle R/B	13	8	10	16	6	1	4	58
Total area of riffle R/B units (m2)	86695	59736	41389	95792	37800	1280	21236	343928
# riffle R/B units with B/R/C>40%	12	7	9	15	4	1	4	52
area of riffle R/B units with B/R/C>40%	85561	56866	36475	94912	29425	1280	21236	325755
Run - Total Habitat								
Total # run units	22	16	27	46	35	19	37	202
Total area of run units (m2)	181851	222050	189894	464626	402804	259714	707217	2428156
Run units / total units	0.34	0.55	0.40	0.43	0.51	0.63	0.64	0.48
Run - Boulder/Rock/Cobble								
# run units with B/R/C>40%	9	10	16	11	17	7	20	90
Area of run units with B/R/C>40%	62700	83180	75918	113980	116301	108274	312263	872616
Run - Moderate/High Woody Debris								
# run units with mod/high woody debris	17	15	18	34	19	8	18	129
Area of run units with mod/high woody debris	139247	221690	151054	374431	251628	186120	445089	1769259
Run - High B/R/C and Mod/High Debris								
# run units with B/R/C>40% and mod/hi debris	8	9	9	9	8	3	5	51
Area run units w. B/R/C>40% & mod/hi debris	60712	77200	45343	90430	60188	71630	87245	492748

* These reaches have not yet been surveyed for their full length (generally a flowage or lower section has not been included)

Riffle C/G is preferred salmon spawning habitat; units are considered prime where C/G >40% substrate. Riffle R/B is preferred salmon nursery habitat; units are considered prime where R/G >40% substrate
Salmon may also use shallow Run R/B/C for nursery habitat. Smallmouth bass prefer Run with high bottom structure such as R/B and or high woody debris (logs).
Total area was calculated as length x average wet width; other derivations are based upon percents of this value
Substrate key: B(oulder) >461cm or 18" R(ock) 180-460cm or 7-18" C(obble) 54-179cm or 2-7" G(ravel) 2.6-53cm or 0.1-2"
Surveys were conducted in July-August 1994 (Reaches 3-5), July 1995 (Reaches 1-2) and September-October 1997 (Reaches 5-7). River flows were 655-715cfs (summer average) at Reaches 1-5.20, above average (835cfs) at Reaches 5.21-5.31 Flows were 1022-1336cfs (below summer average) for Reaches 6-7.
For additional information on these surveys contact the St. Croix International Waterway Commission. In Canada: #8-#1 Highway, St. Stephen NB E3L 2Y7. In USA: Box 610, Calais, ME 04619. Tel (506) 466-7550.

Appendix G: Dynamic Modelling for Alewife Populations and Passage (DMAPP)

A model that estimates adult alewife spawner passage into habitat on the Skutik River (Barber et al. 2019)

DMAPP Model Outputs

SKUTIK RIVER PASSAGE SCENARIOS FOR ALEWIFE

BETSY BARBER 2019

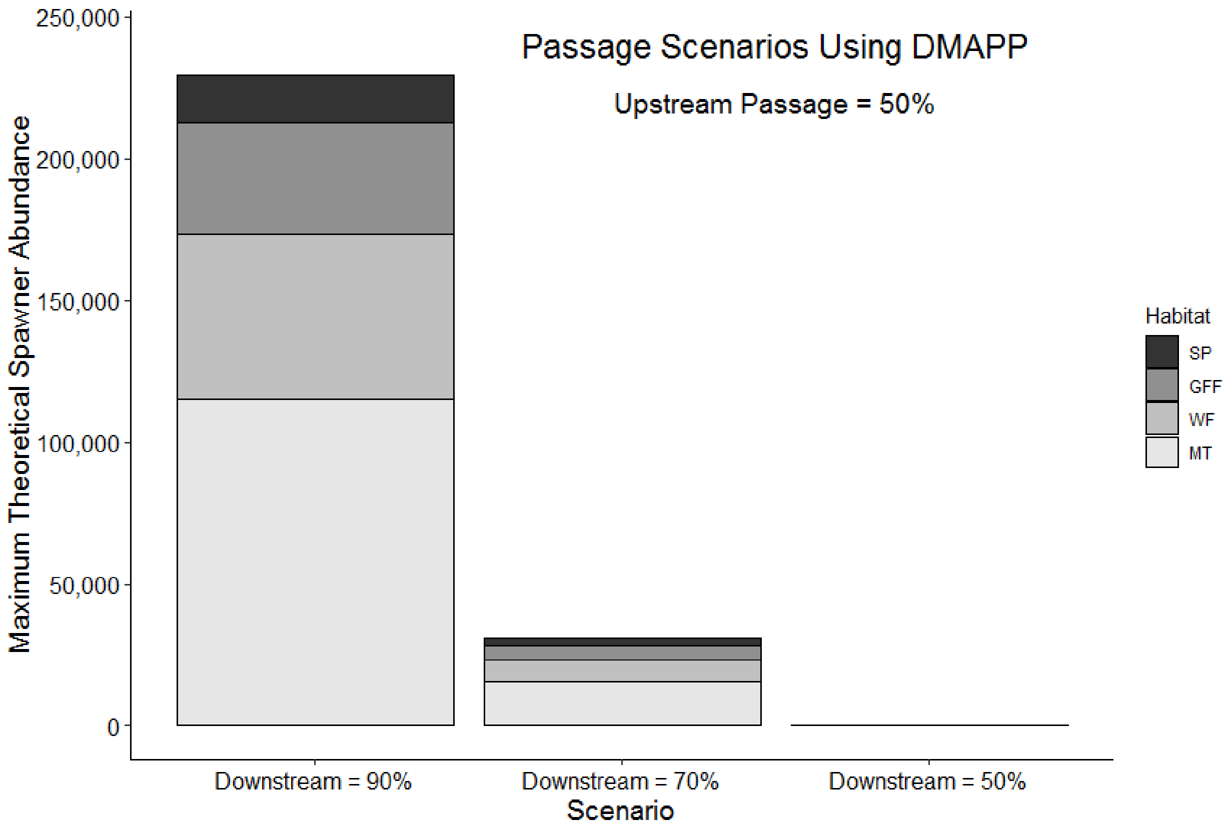


Figure 1. Maximum theoretical spawner abundance of alewives in the St. Croix River as estimated by DMAPP (Dynamic Modelling for Alewife Populations and Passage, Barber et al. 2019). Passage scenarios were ran for 100 years. Spawner abundance is listed for spawning habitat available between each pair of dams located on the main stem of the river (MT = habitat between Milltown Dam and Woodland Dam; WF = habitat between Woodland Dam and Grand Falls Dam; GFF = habitat between Grand Falls Dam and Vanceboro Dam; SP = habitat between Vanceboro Dam and Forest City Dam). Upstream adult passage was set to 50% successful passage at all four dams on the main stem. Downstream adult and juvenile passage was varied between 90-50% successful passage at all four dams.

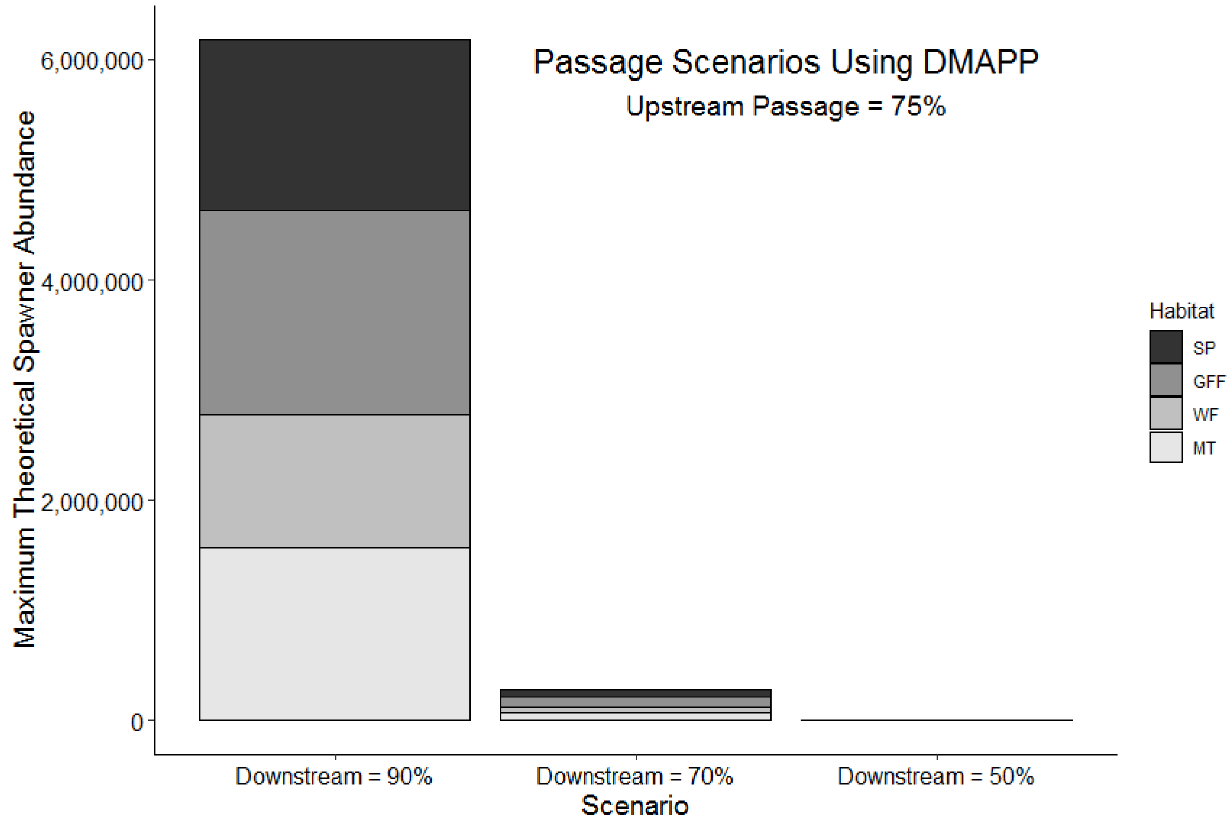


Figure 2. Maximum theoretical spawner abundance of alewives in the St. Croix River as estimated by DMAPP (Dynamic Modelling for Alewife Populations and Passage, Barber et al. 2019). Passage scenarios were ran for 100 years. Spawner abundance is listed for spawning habitat available between each pair of dams located on the main stem of the river (MT = habitat between Milltown Dam and Woodland Dam; WF = habitat between Woodland Dam and Grand Falls Dam; GFF = habitat between Grand Falls Dam and Vanceboro Dam; SP = habitat between Vanceboro Dam and Forest City Dam). Upstream adult passage was set to 75% successful passage at all four dams on the main stem. Downstream adult and juvenile passage was varied between 90-50% successful passage at all four dams.

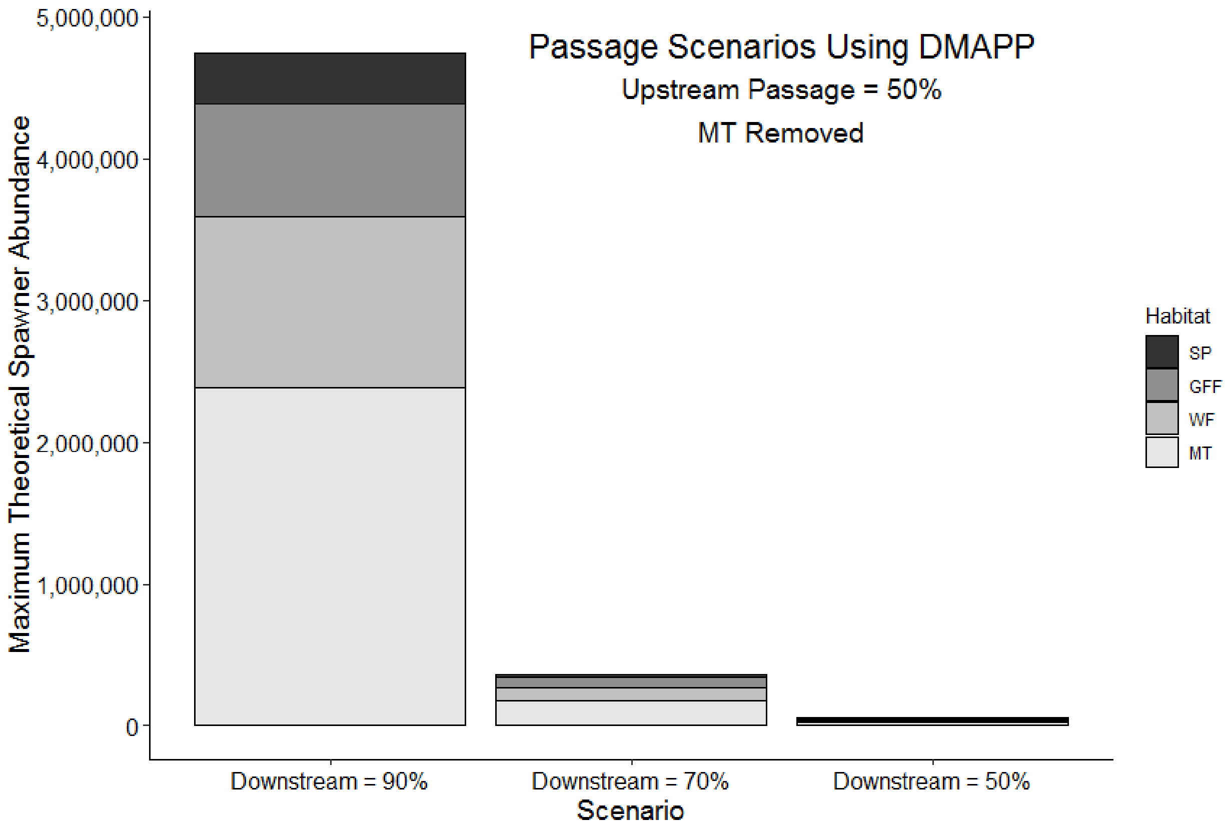


Figure 3. Maximum theoretical spawner abundance of alewives in the St. Croix River as estimated by DMAPP (Dynamic Modelling for Alewife Populations and Passage, Barber et al. 2019) with Milltown Dam removed. Passage scenarios were ran for 100 years. Spawner abundance is listed for spawning habitat available between each pair of dams located on the main stem of the river (MT = habitat between Milltown Dam and Woodland Dam; WF = habitat between Woodland Dam and Grand Falls Dam; GFF = habitat between Grand Falls Dam and Vanceboro Dam; SP = habitat between Vanceboro Dam and Forest City Dam). Upstream adult passage was set to 50% successful passage at three remaining dams on the main stem. Downstream adult and juvenile passage was varied between 90-50% successful passage at these three dams.

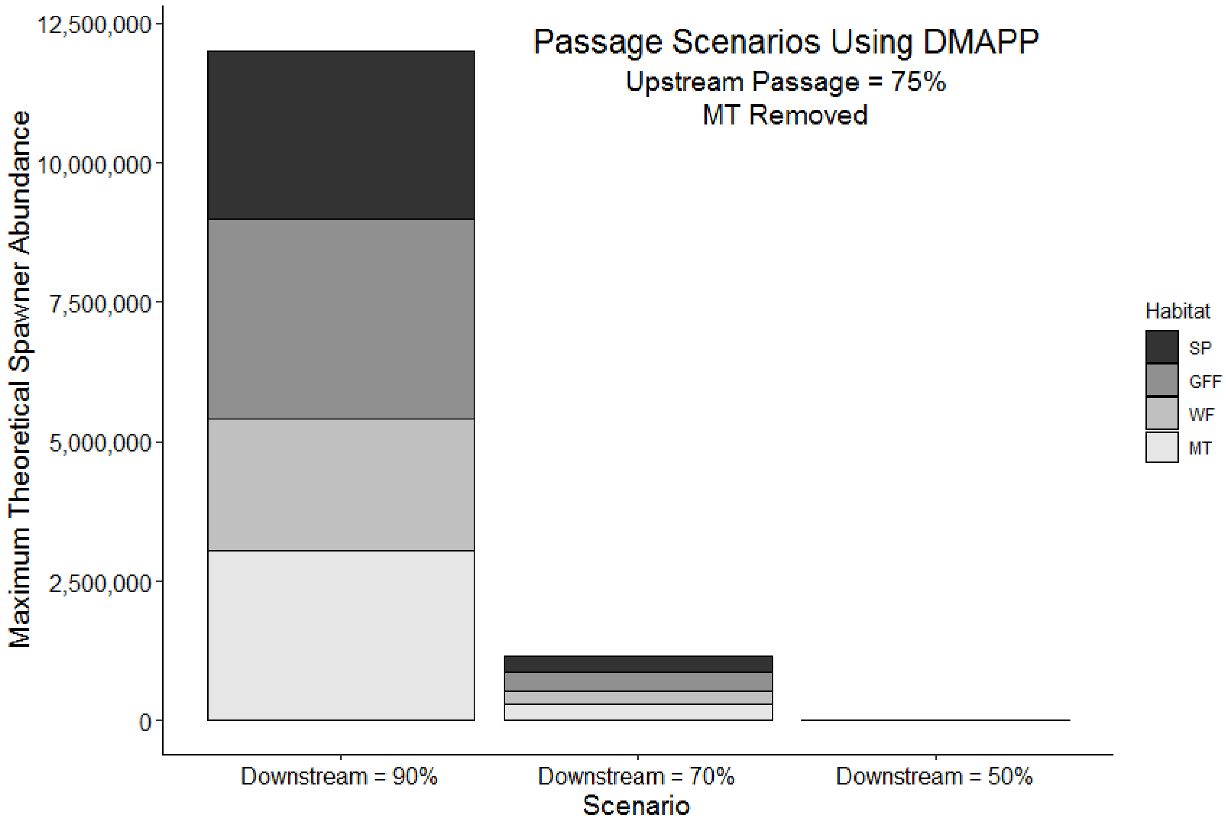


Figure 4. Maximum theoretical spawner abundance of alewives in the St. Croix River as estimated by DMAPP (Dynamic Modelling for Alewife Populations and Passage, Barber et al. 2019) with Milltown Dam removed. Passage scenarios were ran for 100 years. Spawner abundance is listed for spawning habitat available between each pair of dams located on the main stem of the river (MT = habitat between Milltown Dam and Woodland Dam; WF = habitat between Woodland Dam and Grand Falls Dam; GFF = habitat between Grand Falls Dam and Vanceboro Dam; SP = habitat between Vanceboro Dam and Forest City Dam). Upstream adult passage was set to 75% successful passage at three remaining dams on the main stem. Downstream adult and juvenile passage was varied between 90-50% successful passage at these three dams.

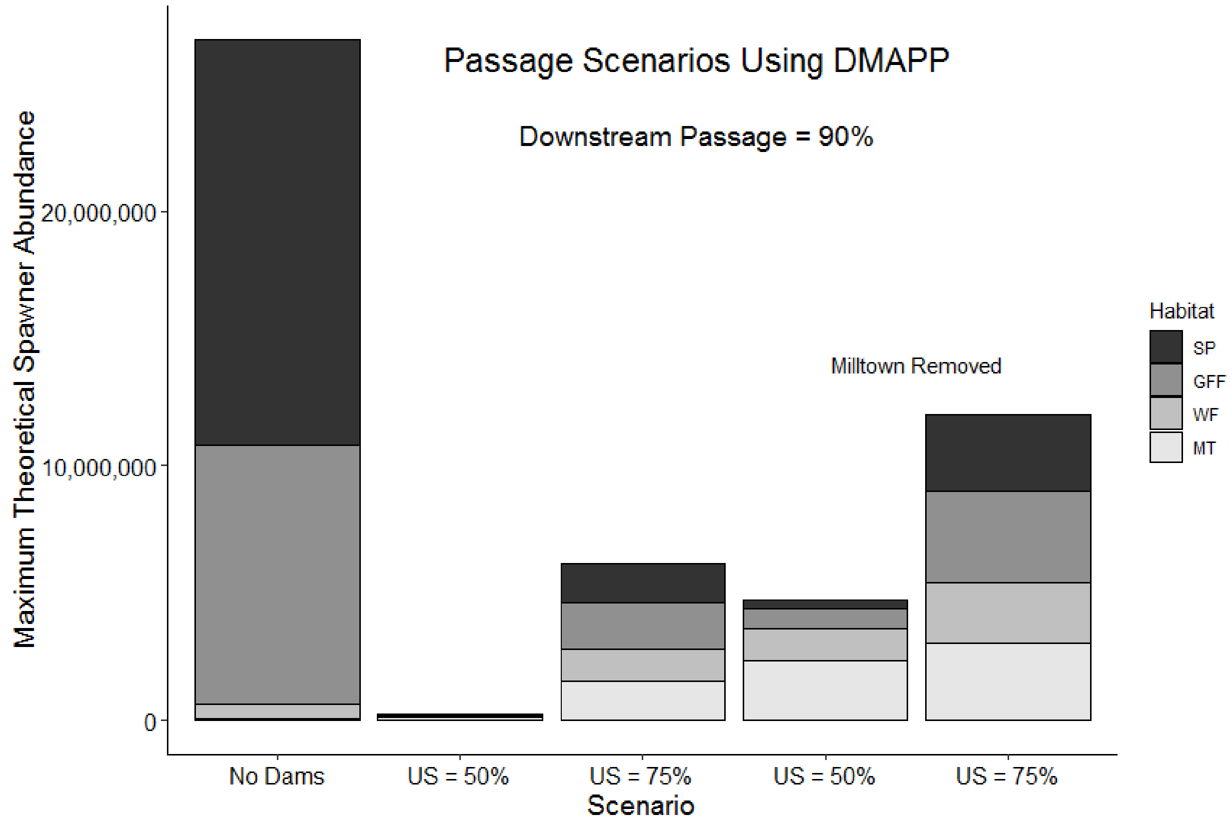


Figure 5. Maximum theoretical spawner abundance of alewives in the St. Croix River as estimated by DMAPP (Dynamic Modelling for Alewife Populations and Passage, Barber et al. 2019) for several passage scenarios that were each ran for 100 years. Spawner abundance is listed for spawning habitat available between each pair of dams located on the main stem of the river (MT = habitat between Milltown Dam and Woodland Dam; WF = habitat between Woodland Dam and Grand Falls Dam; GFF = habitat between Grand Falls Dam and Vanceboro Dam; SP = habitat between Vanceboro Dam and Forest City Dam). For the first scenario, upstream and downstream passage rates were set to 100% successful passage for all four dams, which represents no effect of dams on population growth. For scenarios 2-5, downstream adult and juvenile passage was set to 90% successful passage at all four dams on the main stem. Upstream passage (US) was varied between 50 and 75% successful passage. For scenarios 4 and 5, passage at Milltown Dam was set to 100% success to represent removal of this dam.

Appendix H: Alewife Spawning Habitat in the St. Croix River Watershed

An unpublished document that presents total potential alewife spawning habitat in the St. Croix River watershed on both sides of the border between the United States and Canada. The name and surface acres of each accessible waterbody in the watershed are presented in tables.

Alewife Spawning Habitat in the St. Croix River Watershed[6]

Mark Billard[7] and Alex Hoar[8]
July 8, 2021

The purpose of this document is to present the total potential spawning habitat for Alewife in the St. Croix River Watershed. For the purposes of this document, potential spawning habitat for Alewife is considered surface area of waterbodies that are currently accessible and areas above dams that could be accessed with proper fish passage.

This document is currently unpublished. It was initially prepared as an internal working document in 2018 by Fisheries and Oceans Canada, Science Branch, Maritimes Region (DFO-Science). The impetus was their work estimating the carrying capacity / maximum Alewife production capacity of the St. Croix River watershed. For that, they needed to know the surface area of all accessible ponds, lakes, and flowages in the St. Croix River watershed with potential Alewife spawning habitat. DFO-Science performed the data collection and presented those data in three tables in this document. The result spans both sides of the international border and includes the entire watershed, unlike similar efforts. The name of each waterbody is provided along with its surface-water acreage. If there was doubt whether a waterbody was accessible for Alewife spawning, the names of those waterbodies were preserved in a separate table.

DFO-Science provided their working document upon request during the summer of 2020 to Ed Bassett of Passamaquoddy Tribe at Pleasant Point, Maine, and Alex Hoar to aid them in similar work they were doing on the St. Croix River. The original document has been revised into its current state by Alex Hoar based in part on an order issued by the U.S. Federal Energy Regulatory Commission in 2020 that caused spawning habitat the West Branch to become accessible to Alewife, a field study in 2021 that showed lakes on Mohannes Stream in New Brunswick to be inaccessible, and other additional information.

Methods

The following documents the methods of DFO-Science. Data for the lakes were gathered from shapefiles assessed in ArcMAP version 10.4.1. Shapefiles for the Maine component of the watershed were provided by Ernie Atkinson of the Maine Government (personal communication, 2018). Shapefiles for the New Brunswick component of the watershed were downloaded from the New Brunswick Hydrographic Network from Service Noveau Brunswick. Some additional smaller waterbodies not included in the shapefiles were gathered from lakesofmaine.org. Surface area of all waterbodies were checked in ArcMAP against Vivid base maps from 2014-2016 provided by DigitalGlobe. Data from the Vivid base map was used over other sources if any conflicts between lake sizes arose. Revised acreages were taken from State of Maine's Lake

[6] Referred to as: Billard, M. and A. R. Hoar. 2021. Alewife Spawning Habitat in the St. Croix River Watershed. 7 pp. Fisheries and Oceans Canada, unpublished data.

[7] Mark Billard, Fisheries and Oceans Canada, Science Branch, Maritimes Region, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS B2Y 4A2

[8] Alex Hoar, retired U.S. Fish and Wildlife Service, Skutik River Advisor to Peskotomuhkati at Skutik, 42 Cottage St., Amherst, MA 01002, USA

Survey database of maps maintained by Maine Inland Fisheries &Wildlife (IF&W). The acreages in IF&W's Lake Survey database differ from sources used by DFO-Science and may tend to be slightly lower. There are a myriad of reasons for this ranging from varying water levels at the time of mapping to technical error. See: https://www.maine.gov/ifw/docs/lake-survey-maps/washington. (Last accessed June 30, 2021).

Results

The total surface area of surface water in the St. Croix watershed is estimated at 108,601 acres, not including free flowing water. Of that, 105,107 acres are classified as potential Alewife spawning habitat in Table 1. Table 2 has all waterbodies and their areas in acres that are suitable habitat for Alewife in the St. Croix River watershed. Table 3 has all waterbodies in the St. Croix watershed that are inaccessible to Alewife, are impractical to access, and where access is unclear.

Table 1. A summary of the available and potentially available spawning habitat for Alewife in the St. Croix River watershed, which extends downstream of Salmon Falls.

Reach	Area (Acres)
Below Milltown Dam (Salmon Falls)	509
Above Milltown Dam (Salmon Falls) and Below Woodland Dam	40
Above Woodland Dam and Below Grand Falls Dam	1,261
Above Grand Falls Dam and Below West Grand and Vanceboro Dams	23,418
Above West Grand Dam	35,474
Above Vanceboro Dam and Below Forest City Dam	25,699
Above Forest City Dam	18,706
All	**105,107**

Table 2. All the waterbodies and their areas in acres that would be suitable habitat for Alewife in the St. Croix River watershed. Waterbodies are arranged within reaches, which are bounded by dams. The country each waterbody is located in is included. If the waterbody straddles the border, it is denoted as INTL for International.

Reach	Waterbody	Jurisdiction	Area (acres)
Below Milltown Dam (Salmon Falls)	Cranberry Lake	CAN	97
	Foster Lake	CAN	119
	Gallop Lake	CAN	42

	Indian Lake	CAN	44
	Middle Lake	CAN	72
	Moore's Mills Lake	CAN	135
Total			**509**
Milltown Dam (Salmon Falls) > Woodland Dam	Vose Pond[1]	USA	40
Total			**40**
Woodland Dam > Grand Falls Dam	Woodland Falls Flowage	INTL	1,261
Total			**1,261**
Grand Falls Dam > West Grand and Vanceboro Dams	Big Lake	USA	10,451
	Canoose Flowage	CAN	1,074
	East Musquash Lake	USA	811
	Enoch Lake	USA	20
	Farrow Lake	USA	283
	Grand Falls Flowage	INTL	6,286
	Hound Brook Lake	USA	310
	King Brook Lake	CAN	79
	Lambert Lake	USA	521
	Lewy Lake	USA	468
	Little River Lake	USA	74
	Little Tomah Lake	USA	146
	Long Lake	USA	607
	Malcome Bog	USA	13
	Monroe Lake	USA	43
	Orie Lake	USA	43
	Patten Pond	USA	127
	Simon Pond	USA	15
	Simsquish Lake	USA	141
	Tomah Lake	USA	59
	Unnamed Pond	USA	40
	Upper Canoose Flowage	CAN	181
	Upper Flood Lake	USA	33
	West Musquash Lake	USA	1,593
Total			**23,418**
Above West Grand Dam including Sysladobsis Lake and tributary ponds	Bottle Lake	USA	258
	Duck Lake	USA	258
	Horseshoe Lake	USA	246
	Junior Lake	USA	4,208
	Keg Lake	USA	371
	Lombard Lake	USA	277
	Lower Chain Lake	USA	173
	Lower Oxbrook Lake	USA	331
	Lower Pug Lake	USA	101

	Middle Chain Lake	USA	220
	Mill Privilege Lake	USA	112
	Norway Lake	USA	130
	Pleasant Lake	USA	1,550
	Pocumus Lake	USA	2,213
	Pork Barrel Lake	USA	30
	Scraggly Lake	USA	1,640
	Shaw Lake	USA	244
	Sysladobsis Lake[2]	USA	5,406
	Upper Chain Lake	USA	712
	Upper Oxbrook Lake	USA	426
	Upper Pug Lake	USA	66
	Upper Sysladobsis Lake	USA	1,054
	Wabassus Lake	USA	981
	West Grand Lake	USA	14,467
Total			**35,474**
Above Vanceboro Dam	Bolton Lake	CAN	692
	East Brook Lake	CAN	350
	Fifth Lake	CAN	886
	First Lake	CAN	191
	Foster Lake	CAN	270
	Grassy Lake	CAN	394
	La Coote Lake	CAN	266
	LaCoute Lake	USA	138
	McAdams Pond	CAN	31
	Modsley Lake	CAN	1,018
	Moose Lake	CAN	34
	Mud Lake	CAN	107
	Musuqash Lake	CAN	347
	Pirate Lake	CAN	30
	Sixth Lake	CAN	369
	Skiff Lake	CAN	1,536
	Liddle Lake	CAN	341
	Spednic Lake	INTL	17,492
	Third Lake	CAN	132
	Thompson Lake	CAN	147
	Tuttle Lake	CAN	55
	Wauklehegan Lake	CAN	873
Total			**25,699**
Above Forest City Dam	Big Greenland Pond	USA	88
	Bracket Lake	USA	563
	Deering Lake	USA	491
	East Grand Lake	INTL	16,008
	Little Greenland Pond	USA	42
	Longley Lake	USA	79

	Mud Lake	INTL	235
	North Lake	INTL	999
	Sucker Lake	USA	201
Total			**18,706**
All Reaches	**Total**		**105,107**

[1]Vose Pond is located on Magurrewock Stream in the U.S. Fish and Wildlife Service Moosehorn National Wildlife Refuge in Barring, Maine. The Alewife spawning habitat it provides was made accessible from the St. Croix River when two new bottomless arched culverts were installed in 2017 by the Refuge in partnership with the Passamaquoddy at Pleasant Point, Maine.
[2] In 2013, Alex Hoar organized a team of USFWS and NMFS fish passage engineers to review all nine dams with fishways in the watershed, including Dobsis dam in Lake Sysladobsis. The engineers reported that the fishway was likely dysfunctional. It lacked attraction flow and is located at the far end of the dam from the spillway, which provides the only attraction flow. Therefore, it was deemed impassable. However, the 8,057 acres of spawning habitat above the dam is counted because some fish may get up through the fishway and recommendations were made to make it passable. The owner, Woodland Pulp, has a proposal before FERC to replace the dam with a bridge and a nature-like fishway, according to Scott Beal of Woodland Pulp.

Impassible or unclear portions of the St. Croix watershed

Several portions of the St. Croix watershed are blocked to Alewife by barriers other than the dams listed above. These areas are discussed in this section.

In this revised tally, DFO-Science's misunderstanding that Mud Falls is a natural barrier has been corrected. DFO-Science was plain that it adopted IF&W's long standing policy that Mud Lake Falls, just below Forest City Dam, is a natural barrier to Alewife. DFO also used video evidence of the falls under high flow conditions to support this conclusion. DFO cited Flagg (2007). This is a misconception. Flagg (2007) did not say Mud Falls is a natural barrier. A local IF&W biologist had been saying it during the 1980s and it eventually became common lore. Flagg cited to that person as incorrect in espousing that Alewife are an invasive species that was not capable of ascending Salmon Falls, Grand Falls rapids, and Mud Lake Falls prior to building of dams. Fact is, there is no evidence in modern times of passage upstream of Mud Falls. There simply have not been enough Alewife in the system for that. Therefore, spawning habitat upstream of Mud Falls is included in this revised tally. There is no harm in this conservative approach. To not do so would underestimate the potential size of the restored Alewife population because 17% of the waterbody surface area would be excluded. Further to that, underestimating the target population would potentially undersize the new fishways needed at Woodland and Grand Falls Dams. Consequently, the rate of restoration would be slowed and the production potential of the watershed would be limited by the capacity of the fishways.

The following three paragraphs are included essentially as written by DFO-Science. In addition to the Milltown, Woodland, Grand Falls, West Grand, and Vanceboro dams, two smaller dams block portions of the watershed and do not provide fish passage. Lowell dam blocks a single lake (Lowell Lake) of 122 acres. Clifford dam blocks a series of four lakes and ponds with a total area of 1,529 acres. Clifford dam is located above Grand Falls dam, while Lowell dam is above West Grand Lake dam.

A third small dam, Dobsis in Lake Sysladobsis, exists and has a fishway. DFO-Science wrote that sources indicate the fishway is passable based on reports of a wild salmon and smelts spawning above it (Maine Department of Inland Fisheries 1996). A blog post from 2009 states there is a fish ladder there. Satellite imagery from the Vivid Base map in ArcMAP also shows what looks like a small dam and fish ladder. A total of 8,057 acres of spawning habitat is above Dobsis Dam.

A portion of the St. Croix watershed is diked off and without examining the site it is not clear whether fish can pass these barriers. 1,745 acres of water are in the diked off area. The waterbodies in this portion of the watershed are in the first two sections of Table 3.

Table 3. All the waterbodies in the St. Croix watershed that are inaccessible to Alewife, are impractical to access, or are unclear whether or not they can be accessed.

Reach	Lake Name	Jurisdiction	Area	Accessible	Barrier
Below Milltown Dam	Beaver Lake	USA	90	Unclear	
	Flower Land Pond #1	USA	44	Unclear	
	Moneymaker Lake	USA	26	Unclear	
	Pine Lake	USA	27	Unclear	
	Rand Lake	USA	18	Unclear	
Total			**205**		
Above Milltown Dam and Below Woodland Dam	Conic Lake	USA	40	Unclear	
	Howard Lake	USA	527	Unclear	Owner reported Alewife
	Kendricks Lake[1]	CAN	76	No	Beaver dams
	Potters Lake[1]	CAN	118	No	Beaver dams
	Unnamed Pond	USA	11	Unclear	
	Unnamed Pond	USA	53	Unclear	
	Nashs and Magurrewock Lakes	USA	856	Unclear	No fishway and natural stream may be blocked
Total			**1452**		
Above Grand Falls Dam	Carloe Pond	USA	12	No	Clifford Dam
	Clifford Lake	USA	1,247	No	Clifford Dam
	Hoese Pug Lake	USA	58	No	Clifford Dam
	Silver Pug Lake	USA	212	No	Clifford Dam
Total			**1,529**		

Above West Grand Dam	Lowell Pond	USA	125	No	Lowell Dam
Total			**125**		
All Reaches	**Total**		**3,494**		

[1] Kendrick's and Potter's Lakes are located on Mohannes Stream in New Brunswick (NB), CA near Barter Settlement. It flows into the St. Croix River roughly 5.5km (3.4mi) upstream of the Milltown Dam. Dill et al. (2010) reported it accessible for Alewife spawning in two lakes. That was questioned and a field survey was conducted in June 2021 during the historic height of the Alewife run. A report was prepared by Allan Fraser and Lee Sochasky for Chief Akagi dated June 28, 2021. Potters Lake was documented to be full of vegetation and recorded by NB as a wetland. Access to Kendricks Lake was documented to be blocked by multiple beaver dams. Under the conditions during the field work, Fraser and Sochasky reported that neither Mohannes Stream or the lakes are accessible.

Information Sources and References

Data on the Canadian portion of the St. Croix watershed were gathered from the New Brunswick Hydrographic Network from Service Nouveau Brunswick, and processed in ArcMAP (http://www.snb.ca/geonb1/e/DC/NBHN.asp). Accessed 06/02/2018

Data on the American portion of the St. Croix watershed were gathered from LakesofMaine.org. Accessed 06/02/2018

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Flagg, L. N. 2007. Historical and Current Distribution and Abundance of the Anadromous Alewife (*Alosa pseudoharengus*) in the St. Croix River. Maine Atlantic Salmon Commission, Department of Marine Resources, Augusta, Maine.

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