Fisheries Management in Napu'saqnuk (St Mary's) River and Alignment with Atlantic Salmon (*Salmo salar*) Conservation Through an Ecologically Significant Area Case Study.

By

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Abstract

There are escalating threats to freshwater ecosystems, including pollution, invasive species, land use changes, and climate change. Recognizing the importance of habitat protection in conserving freshwater biodiversity, this study focuses on Ecologically Significant Areas (ESAs) as a designated tool under the *Fisheries Act* in Canada. ESAs serve as proactive, project-based regulatory designations to safeguard sensitive, highly productive, and rare fish and fish habitats in intertidal and freshwater habitats. While ESAs do not directly regulate fishing activities, the study emphasizes the need to assess the alignment of existing fisheries management practices with the draft conservation and protection objectives (CPOs) of ESAs. Information was gathered from diverse sources, including expert knowledge, peer-reviewed papers, official government documents, grey literature, and websites. The project draws insights from the Recovery Potential Assessment (RPA) conducted in 2013 by the Department of Fisheries and Oceans (DFO) for the Southern Upland Atlantic salmon population and the DFO's guidance on assessing threats and ecological impacts for species at risk published in 2014 was used a guide for conducting a threat assessment. Overall, the low-risk assessment of fishing in the St. Mary's River presents an opportunity for proactive regulation, ensuring the long-term health of Atlantic salmon populations.

Keywords: Ecologically Significant areas; Atlantic Salmon, Recreational fishing; Commercial fishing; Fisheries Management.

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Chapter 1: Introduction

Freshwater ecosystems constitute less than 1% of Earth's surface, a stark contrast to the vast marine environment that covers about 70% of the planet (Reid et al., 2019). In this limited portion of the Earth's expanse, Canada stands as a global reservoir, housing 20% of the world's freshwater habitats, vital for diverse aquatic life (Desforges et al., 2022). Despite freshwater's relatively small surface area compared to the world's oceans, these ecosystems are home to 12% of all described species, including 33.3% of vertebrate species. Notably, freshwater habitats host more ray-finned fish species (15,150) than marine environments (14,740) (Arthington et al., 2016; Carrete Vega & Wiens, 2012). However, the high biodiversity of freshwater ecosystems faces an uncertain future (Desforges et al., 2022).

Freshwater ecosystems face ongoing threats from various human-induced pressures, including pollution, the introduction of invasive species, changes in land use, and the escalating impact of climate change (Angeler et al., 2014; Reid et al., 2022). These pressures have led to a significant and concerning decline in freshwater biodiversity, with an 84% decrease since 1970, surpassing declines observed in marine and terrestrial environments (World Wildlife Federation [WWF], 2020). Consequently, freshwater habitats are now a top priority for restoration and protection (Piczak et al., 2023).

Habitat protection is generally employed to conserve biodiversity by minimizing or eliminating human disturbances (Crivelli, 2002). Despite evidence supporting the benefits of habitat protection in mitigating anthropogenic stressors, freshwater-protected areas are underused compared to marine-protected areas (Saunders et al., 2002; Suski and Cooke, 2007). This is because freshwater protection is commonly grouped with terrestrial protection, which may be ineffective for conserving freshwater ecosystems as it fails to address the specific requirements of conserving both the river network and its surrounding terrestrial drainage area (Moravek et al., 2023). In light of this, in alignment with the Kunming-Montreal Global Biodiversity Framework, to which Canada has committed, the goal is to protect and restore 30% of degraded terrestrial, inland water, coastal, and marine ecosystems by 2030 (Convention on Biological Diversity [CBD], 2022; Moravek et al., 2023). This is the first time CBD is recognizing inland waters as a distinct realm, separate from terrestrial ecosystems (CBD, 2022; Cooke et al., 2023). The CBD initiative aims to enhance biodiversity, ecosystem services, ecosystem functions, ecological integrity, and ecological connectivity (CBD, 2022).

One of the tools designated to achieve this goal is the creation of Ecologically Significant Areas (*Fisheries Act*). In Canada, ESAs are the primary spatial regulatory tool for intertidal and freshwater protection of fish and fish habitats. ESAs are proactive, project-based regulatory designations aimed at safeguarding species that are sensitive, highly productive, and/or rare and unique. While there are currently no established ESAs in Canada, case studies are underway to identify potential candidates that meet the criteria (DFO, 2023; *Fisheries Act*). One such case study examines a potential ESA in Nova Scotia, Canada, at the Napu'saqnuk (St. Mary's) River including the estuary. The St. Mary's River holds historical and cultural significance to locals and Indigenous peoples for recreational, cultural services, and resource collection (Membertou Geomatics Consultants, 2005; St. Mary's River Association [SMRA], 2022). However, like many river systems in Canada and around the world, the St. Mary's River continues to face the effects of anthropogenic stressors (Nova Scotia Department of Lands and Forestry [NSDL&F], 2019).

In Atlantic Canada, Atlantic salmon populations have been declining for decades, despite the implementation of regulations to mitigate this decline (DFO, 2013). Recovery rates have not met the desired levels, necessitating an assessment of all potential threats to Atlantic salmon (DFO, 2013). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is currently working on a new assessment of several species, including various populations of Atlantic salmon. This new assessment is expected to be finalized in April 2024 (COSEWIC, 2023). Migratory species are highly vulnerable to environmental changes as they traverse multiple habitats during various life stages (Lennox et al., 2019). These species encounter numerous challenges that can hinder the successful completion of their life cycle, such as habitat fragmentation due to dam construction, which can impede Atlantic salmon's ability to reach spawning grounds. As a result, populations of migratory species have experienced significant declines, jeopardizing the provision of crucial ecosystem services to both humans and the natural environment (Dean et al., 2022).

Fishing is a beloved pastime, a critical occupation, and a necessity for some communities' survival. The St. Mary's River witnesses three types of fishing: recreational, commercial, and First Nations Food, Social, and Ceremonial (FSC) fishing. FSC is fishing for community substance. It is not expected to be harmful and falls outside of the scope of this project (Membertou Geomatics Consultants, 2005; Murray et al., 2009). Commercial and recreational fishing have fishing methods that are potentially harmful and unsustainable to important species in the ecosystem (Breau, 2013; Fuller et al., 2008; He et al., 2021; Van Leeuwen et al., 2023). It is important to note that ESAs are not designed to directly regulate fishing activities (DFO, 2023), which are subject to other measures such as quotas, size limits, and periodic closures (*Maritime Province Fishing*

Regulation). Nevertheless, it is crucial to assess whether existing fisheries management practices align with the draft conservation and protection objectives of ESAs and to identify any gaps in this alignment.

The primary objective of this graduate project is to analyze recreational and commercial fisheries to determine whether they adhere to the draft conservation and protection objectives for the St. Mary's Rivers ESA. This will involve examining the potential impact of these fisheries on the culturally and socially significant Atlantic salmon. Where such alignment is lacking, the project will explore opportunities to enhance management practices, ensuring that these objectives are met and contributing to the preservation of this ecologically and culturally significant area. This research aims to fill gaps in existing knowledge regarding the intersection of fisheries management, ecological conservation, and cultural significance in the St. Mary's River watershed.

CHAPTER 2 METHODOLOGY

2.1 POSITIONALITY

Before delving into the research findings, it is important to understand the author's positionality. My educational background is in the natural sciences, having completed my undergraduate degree in Marine Biology at the University of New Brunswick. Presently, I am a graduate student at Dalhousie University, specializing in marine management, which emphasizes an interdisciplinary approach to the stewardship of marine resources. This project was carried out to inform the Ecologically Significant Area work conducted at the Department of Fisheries and Oceans (DFO) Integrated Planning unit.

2.2 LITERATURE REVIEW AND EXPERT DISSCUSSION

To assess the impact of fisheries in the St. Mary's River on the Atlantic salmon population and identify ways to better align management with the goals of ESAs for the protection of Atlantic salmon, a literature review was conducted. This review involved gathering information from various sources, including peer-reviewed literature, official government documents, grey literature, and websites. Subject matter experts were also consulted from the Nova Scotia Department of Fisheries and Aquaculture (NSDFA) and from DFO to gain insights into fisheries within the St. Mary's watershed and their potential interactions with Atlantic salmon.

Key areas of focus during the literature analysis and expert discussions included the fisheries operating within the watershed, the open seasons for these fisheries, the types of gear used, the status of the Atlantic salmon population, the life history of Atlantic salmon, and the effects of specific gear types on Atlantic salmon. Once all the information was collected and organized, we created an interaction matrix to determine whether fisheries overlap spatially and temporally with Atlantic salmon throughout their life cycle. The results from the interaction matrix will be compared and contrasted with the draft conservation and protection objectives of the ESA case study in the St. Mary's River to assess their alignment.

It is essential to note that the on going work led by DFO on the ESA case study work involves engaging with all relevant stakeholders and rights holders, including the Mi'kmaq community. However, for this specific project, owing to time constraints, only provincial and federal staff were consulted. The majority of the information was drawn from existing literature. Due to the above-mentioned restrictions, FSC fishing is not discussed in this paper.

2.3 ANALYSIS

In 2013 the DFO conducted a recovery potential assessment (RPA) for the southern upland (SU) Atlantic salmon population evaluating many factors to helping make informed management decisions. Fishing was analyzed for the population in general with commercial bycatch, recreation bycatch, and recreation fishing as low, and illegal targeting of Atlantic salmon while fishing under a general license as medium level threat (DFO, 2013). This project's aim is to expand on this work by looking at specific fisheries for both commercial and recreational fishing to assess the extent to which fisheries impact Atlantic salmon populations in the St. Mary's watershed. An evaluation of fisheries was conducted using the "Guidance on Assessing Threats, Ecological Risk, and Ecological Impacts for Species at Risk," published by the DFO in 2014 (DFO, 2014). The framework was adapted to better align with the research objectives of this project and adjusted it to fit the limited data on fisheries in the area and Atlantic salmon. This model was chosen as it enables a focused risk assessment for each gear type and how it may affect Atlantic salmon if they interact. This project does not include a population-level analysis due to insufficient data for accurate determination. The next steps and future considerations are based on addressing data gaps, recognizing the limitations of this study, and incorporating input from subject matter experts. This approach provides a foundation for informed decision-making regarding the preservation of this vital ecosystem.

Table 1. Methodology for threat assessment for effects of fisheries on Atlantic salmon population in the St. Mary's Watershed based on DFO 2014

Threat Evaluation Criteria	Method	Project-Specific Definition

Likelihood of Occurrence	DFO (2014a) definition: "Likelihood of Occurrence refers to the probability of a specific threat occurring for a given population over 10 years or 3 generations. —categories: known, likely, unlikely, remote, unknown." The categorization of each fishery into its respective classification was reliant on expert judgment due to the constraints posed by limited available data.	The likelihood of whether the fishing gear is or could be present in the next 10 years.
Level of Impact	DFO (2014a) definition: "Level of Impact refers to the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population—categories: Extreme, high, medium, low, unknown." The assessment of the impact level was conducted through a comprehensive analysis, incorporating expert insights and a review of pertinent literature concerning the effects of fishing gear. The predominant body of literature consulted, although not specifically centered on the St. Mary's River, provided valuable insights. However, it is essential to note that certain assumptions were necessary in extrapolating potential effects to the context of the St. Mary's River, given the limited studies available on this particular river system.	The level of impact the fishing gear could potentially cause if an Atlantic salmon should interact with it.
Causal Certainty	DFO (2014a) definition: "Causal certainty reflects the strength of evidence linking the threat to the survival and recovery of the population. Evidence can be scientific, traditional ecological knowledge or local knowledge.—categories: very high, high, medium, low, very low." The degree of causal certainty was ascertained through a comprehensive evaluation of the available data and information derived from both scholarly literature and expert knowledge	The strength of evidence linking the fishing gear to the survival and recovery of the population. Evidence can be scientific, traditional ecological knowledge or local knowledge.

CHAPTER 3 BACKGROUND AND LITERATURE REVIEW

In understanding the context of fisheries effect on Atlantic salmon in the St. Mary's River, this background and literature review aims to provide an overview of information relevant to this topic. By synthesizing and critically examining the existing knowledge base, this review sets the stage for the current study, shedding light on gaps, inconsistencies, and areas requiring further exploration.

3.1 Ecologically Significant Areas

ESAs are a proactive and long-term conservation tool for conserving and protecting fish and fish habitats (DFO, 2023). ESAs are designated with distinct geographical boundaries and can encompass zones with varying levels of protection, customized to the requirements of fish and their habitats and the ESAs conservation and protection objectives (DFO, 2023). The criteria for designating an ESA encompass highly productive, sensitive, rare and/or unique areas described in the ESA framework (DFO, 2023). ESAs can be applied to marine, estuary, and freshwater habitats across Canada and uniquely serve as a spatial regulatory tool for intertidal and freshwater environments. They also offer the flexibility to extend their application to riparian zones (Collison & Gromack, 2022; DFO, 2023). ESAs are governed under the *Fisheries Act*.

In 2012, amendments to the *Fisheries Act* raised concerns among various stakeholders and rights holders, including Indigenous Peoples, environmental groups, and industry (DFO, 2021a). The concerns predominantly revolved around the lack of clarity, strength, and equity in protecting fish and fish habitats for future generations (DFO, 2021a). Due to these concerns, the government addressed this by amending the *Fisheries Act* in 2019 to provide clear, robust, and equitable protection for all fish and fish habitats (DFO, 2021a).

These revisions include clearer and stronger regulations for establishing ESAs, accompanied by a framework designed to be used to successfully implement an ESA (DFO, 2021a; DFO, 2023). Individual ESAs possess specific conservation and protection objectives designed to maintain a low-risk tolerance. The potential draft conservation protection objectives within ESAs are collaboratively developed in consultation with Indigenous Peoples, provinces, territories, stakeholders, and non-governmental organizations (DFO, 2023). These objectives shape the activities that are permitted and restricted within each designated ESA.

It is important to emphasize that ESAs do not serve as a management tool for regulating fishing but are intended to manage projects. ESAs can work in conjunction with other relevant legislation, fortifying the protection of fish and fish habitats for long-term stability. This may involve complementing other conservation and management tools at the federal, provincial, or territorial levels (DFO, 2023).

ESAs offer a wide array of benefits, including heightened protection for aquatic species at risk, preservation of carbon sinks, habitat conservation, and the maintenance of ecosystem connectivity. Additionally, they contribute to nature-based climate change solutions and enhance climate change resiliency (DFO, 2023). The core objectives of ESAs comprise predetermined conservation and protection objectives, clearly outlined in regulations before the consideration of proposed activities. They also require a risk assessment by the DFO. For example, even projects typically considered low-risk may require a review within an ESA (DFO, 2023).

3.2 Napu'saqnuk (St. Mary's) River

The St Mary's River flows through Mi'kma'ki, the traditional territory of the Mi'kmaq People, encompassing much of Atlantic Canada and the entirety of Nova Scotia (Membertou Geomatics Consultants 2005; Paul, 2022; The Confederacy of Mainland Mi'kmaq [CMM], 2007). The St. Mary's watershed is located in Eskikewa'kik (Skin-dresser's Territory, or the 'Eastern Shore'), and it stands as one of Nova Scotia's largest watersheds (CMM, 2007). Figure 1 illustrates the study area of this project. Based on this map all relevant fisheries within this area were considered for this project.

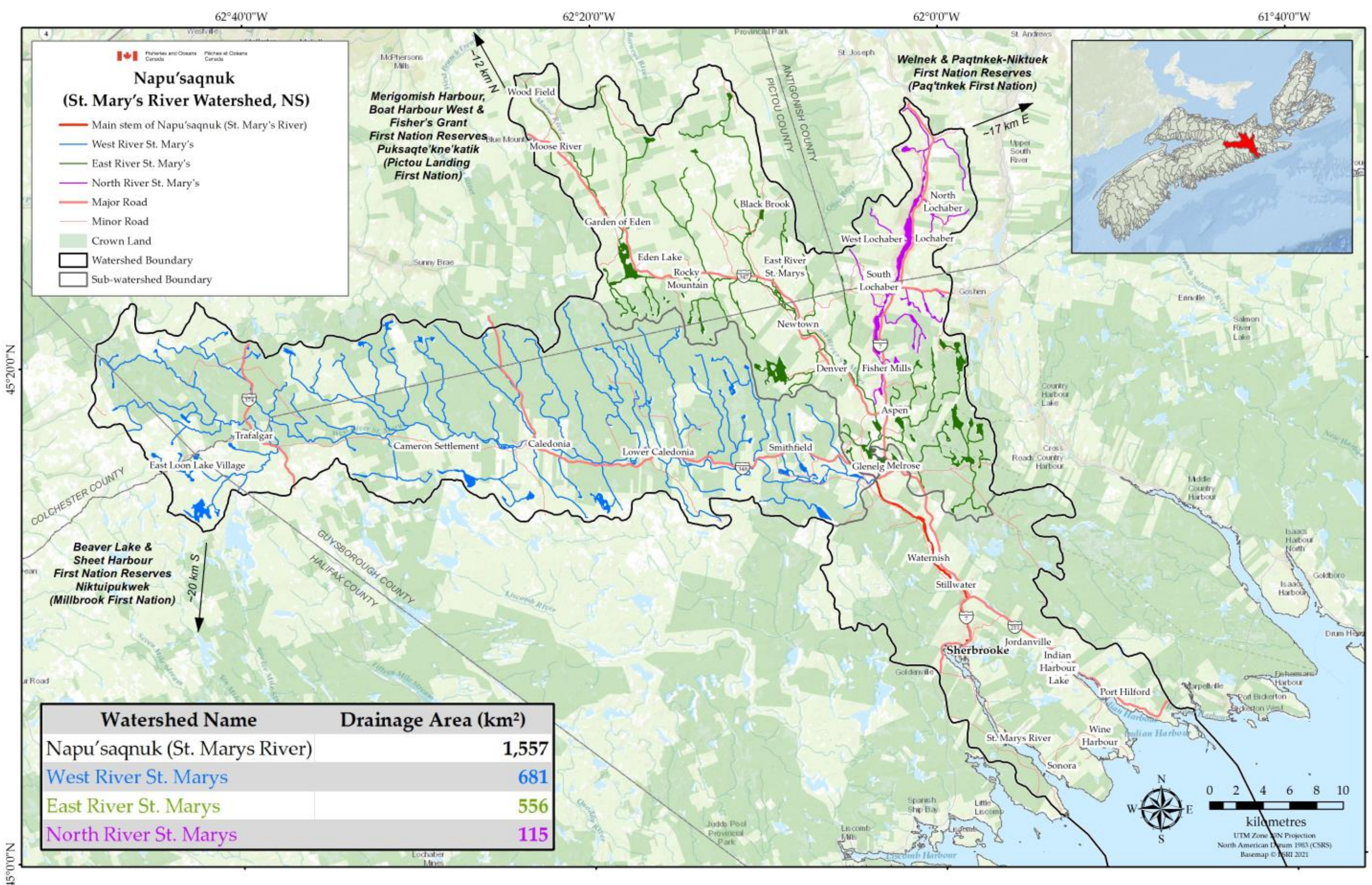

Figure 1. Napu'saqnuk (St. Mary's) watershed, NS boundary as defined by Fisheries and Oceans Canada. Image credits: Fisheries and Oceans Canada. The watershed boundary is not the ESA boundary, it is a study area boundary.

Moreover, the St. Mary's River ranks as one of Nova Scotia's lengthiest river systems, stretching over 250 km from its headwaters to the Atlantic Ocean (Mitchell, 2009; SMRA, 2022). This river comprises two primary branches, the East and West branches, in addition to a smaller North branch. The East and West branches converge near Glenelg, forming a 19 km mainstream that eventually flows into the Atlantic Ocean (Mitchell, 2009; SMRA, 2022).

The St. Mary's River presents a unique opportunity, as its waterways remain pristine and relatively untouched by agricultural, industrial, or urban runoff (McBride et al., 2014; SMRA, 2022). However, this pristine river system has not been immune to threats and is likely to face ongoing challenges (NSL&F, 2019). Historical habitat degradation, overfishing, and other destructive activities within the St. Mary's River and in surrounding areas have led to population declines in both freshwater and anadromous species (Arthington et al., 2016; Desforges et al., 2022; NSL&F, 2019)

Within the St. Mary's River the following species of ecological importance have been identified: Atlantic salmon, Brook trout (*Salvelinus fontinalis*), American eel (*Anguilla rostrate*), Gaspereau (*Alosa pseudoharengus* and *Alosa aestivalis)*, Rainbow smelt (*Osmerus mordax*), and Brook floater (*Alasmidonta varicose*) (Hunter & Mitchell, 2013). While conservation efforts are currently in progress, including measures such as liming the river to mitigate acidity following the acid rain crisis in the 1970s, there is a growing imperative to implement more comprehensive safeguards for this unique and ecologically vital river system (DFO, 2013; McCormick et al. 2009).

3.3 Mi'kmaq Significance

Before being named St. Mary's, the region was known as Napu'saqnuk by the Mi'kmaq People, who inhabited the area for millennia prior to the colonization of the early 16th and 17th centuries. The name Napu'saqnuk, pronounced Nabo-soo-kunuk, translates to "a place of stringing beads" (Paul, 2022; Transcriptions of Father Pacifique Guide to Micmac Place Names, 1934). During the era preceding European contact, Napu'saqnuk was a vital route for inland travel and a primary source of sustenance for Mi'kmaq communities, particularly given the challenging climate in Mi'kma'ki (Prosper et al., 2011). Subsistence activities such as hunting and fishing were crucial, guided by the cultural principle of 'Netukulimk,' which mandates the protection of natural resources by extracting only what is necessary and avoiding wastefulness (Denny & Fanning, 2016; McMillan & Prosper, 2016; Prosper et al., 2011).

This intricate relationship between the Mi'kmaq and the land encompasses multifaceted aspects of resource use, conservation, and spiritual connections (Denny & Fanning, 2016; McMillan & Prosper, 2016; Prosper et al., 2011). Resources obtained from the land serve diverse purposes, including medicinal, subsistence, ceremonial, and conservation needs (Membertou Geomatics Consultants, 2005). Ecological knowledge has been transmitted through generations, from elders to youth, encapsulated in the concept of 'kisaku kinutemuatel mijuijij' (CMM, 2007; Denny & Fanning, 2016; McMillan & Prosper, 2016; Membertou Geomatics Consultants, 2005; Prosper et al., 2011). A Mi'kmaq Ecological Knowledge Study conducted for a proposed Petrochemical Plant and LNG Facility recognized the St. Mary's River as one of the most historically significant Mi'kmaq communities in Antigonish and Guysborough Counties (Membertou Geomatics Consultants, 2005). The river, as emphasized in the study, held historical significance as an excellent location for salmon fishing and is home to two ancient Mi'kmaq burial grounds, alongside a St. Anne's chapel used for gatherings (Membertou Geomatics Consultants, 2005).

3.4: Socioeconomic Significance of Fishing

The St. Mary's River watershed holds cultural, social, and economic significance with respect to both recreational and commercial fishing (SMRA, 2022). For many engaged in commercial fishing, it is not merely an occupation but a way of life deeply rooted in tradition. Recreational fishing is also enjoyed among both local residents and visiting tourists (Lynch et al., 2016).

The seafood industry assumes a pivotal role, directly or indirectly, in all communities throughout Nova Scotia. Seafood products not only satisfy local consumption but also feature prominently in national trade and international exports to over 60 countries, positioning Nova Scotia as the leader in Canada's seafood industry. This sector annually generates in excess of a billion dollars in revenue and supports tens of thousands of jobs (Pisces Consulting Limited, 2022).

The importance of the seafood industry extends to the tourism sector as well. In the Eastern Shore region, it contributes to tourism revenue, accounting for 1% of the total tourism revenue in Nova Scotia. In Guysborough County, the seafood industry provides employment for between 10% and 25% of the local workforce and stands among the top four counties in terms of landing weight (Pisces Consulting Limited, 2022).

The St. Mary's River plays a pivotal role in the regional tourism sector, recognized as a primary industry encompassing diverse services and businesses, such as accommodations, transportation, food and beverage, cultural services, recreation, and entertainment (Tourism Nova Scotia, n.a.).Residents of the area express a profound appreciation for the pristine natural ecosystem, as seen by a 2009 socioeconomic survey conducted by the St. Mary’s River Association within the St. Mary's River watershed. This survey, with 132 respondents, indicated that values associated with conservation, nature, water quality, scenic beauty, a serene lifestyle, education, historical heritage, and the opportunity to engage with nature were more frequently emphasized than purely commercial interests (Murray et al., 2009).

Survey respondents highlighted the crucial role of restoring Atlantic salmon in the river, emphasizing benefits to tourism and recreation, while ecological and conservation considerations assumed a secondary role. Angling emerged as the most popular recreational activity, with both tourism and angling consistently recognized as primary drivers of economic growth and resilience (Murray et al., 2009). It is noteworthy that the majority of respondents were male (66.4%), aged between 41 and 70 (60.8%). A significant portion (64.1%) considered tourism opportunities closely related to their work. Regarding preferred recreation areas, the East and North branches of the river were identified as favorites, with the East Branch receiving the highest favorability at 85.8%, followed by the North Branch at 32.5%, the West Branch at 22.1%, while the Main Branch garnered 28.6% favorability (Murray et al., 2009). It is noteworthy that bias could be applicable as the study was done for the St. Mary's River by the St. Mary's River Association.

In 2020, Nova Scotia Department of Environment and Climate Change (NSECC) conducted Wilderness Areas Consultations on six proposed wilderness area sites in Nova Scotia. The Archibald Lake Wilderness Area in Guysborough County, which falls within our study site, was among the areas consulted. During this consultation, numerous individuals expressed the region's critical importance for adult and juvenile Atlantic salmon, expressing concern about any alterations that could compromise the existing quality of the river (NSECC, 2020). The area has experienced long-term and generational use, indicated by some respondents when expressing a tradition of visiting with their families. Comments reveal a strong attachment to the region and an appreciation for its unique wilderness. Additionally, many respondents view the area as a prime tourist destination, advocating for its ecological preservation to enhance its appeal (NSECC, 2020).

3.5 Atlantic salmon in the Nova Scotia Southern Upland Region

Atlantic salmon is a migratory species within the Salmonidae family, closely related to Brown trout and distantly related to Pacific salmon (DFO, 2018). Atlantic salmon predominantly demonstrate anadromous migratory behavior, as they are born in freshwater, migrate to the ocean, and later return upstream to their natal grounds for spawning (DFO, 2013). They are known for their remarkable homing instinct with most Atlantic salmon navigate back to their natal stream when the time for spawning approaches (DFO, 2013; Bowly et al., 2013a). The duration of their sea migration varies, with one-sea-winter salmon returning after a single winter at sea, while multi-sea-winter salmon remain in the ocean for multiple years (DFO, 2013). Those Atlantic salmon that forgo the migration to the sea are termed landlocked salmon and are distributed across maritime populations (DFO, 2013).

COSEWIC has identified 16 designatable units (DU) within Canada based on attributes that make the population both discrete and evolutionarily significant (COSEWIC, 2019; COSEWIC, 2020). Guidelines for DU identification encompass distinctions in genetics, life history, characteristics, and geographic distribution (COSEWIC, 2010; COSEWIC, 2020). The SU DU includes all rivers draining into the Atlantic Ocean along Nova Scotia's eastern and southern shores from the northeast mainland near Canso to Cape Split (COSEWIC, 2010; DFO 2013). At the time of writing this project, COSEWIC is re-evaluating Atlantic salmon designation (COSEWIC, 2023; Lehnert et al., 2023). Additional, frameworks are being implemented to review and adjust DUs for Atlantic salmon to better reflect discrete and evolutionarily discreteness of the different populations (Lehnert et al., 2023)

COSEWIC classified the SU DU as endangered in November 2010 (COSEWIC, 2010). In the three generations leading up to DFO, 2013 study, one-sea-winter and multi-sea-winter fish experienced declines of approximately 59% and 74%, respectively, resulting in an overall decline of mature adults by about 61% (DFO, 2013). Historically, 63 rivers in the SU DU supported spawning; however, a 2008 survey covering 51 of these rivers found only 20 with detected juveniles (Bowlby et al., 2013). The primary threats to this population include acidification, pollution, logging, flooded spawning and rearing habitats, barriers, and poor marine survival (Bowlby et al., 2013; DFO, 2013). The sharp decline in Atlantic salmon since the 1970s, attributed largely to the acid rain crisis and the species' biological sensitivity to changes in habitat quality, has been particularly impactful (Bowlby et al., 2013; McCormick et al., 2009). Acidic conditions, while not necessarily lethal for adult salmon, lead to progeny mortality, rendering these habitats unusable (Bowlby et al., 2014). Population dynamic modeling conducted by DFO in 2012 for the SU Atlantic salmon, focusing on four river indexes, suggested that a 20% increase in freshwater productivity would significantly reduce the risk of extinction, even with persistently high at-sea mortality (DFO, 2013). Although prospects for the future of Atlantic salmon in North America carry hope, the current situation remains dire (Dadswell et al., 2021).

3.5.1 Southern Uplands Atlantic Salmon General Life History

Spawning Atlantic salmon embark on a migratory journey from the sea to rivers spanning April to November, with the peak migration observed between May and August (O'Connor et al., 2006; Gibson et al., 2009). This upstream migration comprises two distinct phases: the migratory phase characterized by steady movement interspersed with periods of rest, and the holding phase indicating prolonged residence upon reaching the natal spawning ground (Thorstad et al., 2011). Crucial for the success of this migration are habitat properties, including river discharge, pool depth during the holding phase, and unobstructed migration routes (Bardonnet and Bagliniere, 2000; DFO, 2013; Power, 1981; Thorstad et al., 2011).

Before spawning, female salmon construct redds, nests designed to protect eggs and alevins (hatched salmon still connected to the yolk sac) from disturbances such as debris (DFO, 2013; Gibson, 1993; White, 1949;). Factors influencing the success of egg development encompass river discharge, water depth, velocity, substrate composition, stable cold temperatures, and uncontaminated water (Beland et al., 1982; LaPointe et al., 2004; Moir et al., 1998). Upon successful development, eggs hatch in spring, and alevins remain in the redd until the yolk sac is absorbed to completion, a process that can take several weeks (Scott & Crossman, 1973). Juvenile salmon, or parr, disperse in search of food but remain close to the redd for protection. Parr exhibit territorial behavior, staying near a "home stone" for cover from predators, stream currents, and defense against other parr (Guay et al., 2000; Beland et al., 2004; Linnansaari & Cunjak, 2013). On average, juvenile Atlantic salmon spend one to two years in freshwater before migrating to the sea (Gibson et al., 2009).

For survival at sea, Atlantic salmon undergo morphological, behavioral, and physiological changes into smolts (Duston et al., 1991; McCormick et al., 1998). Smoltification is triggered by day length, water temperature, and river discharge which is essential for the successful transition from parr to smolt (Friedland et al., 2003 McCormick et al., 1998; Power, 1981). Smolts spend variable time in the estuary and are influenced by oceanographic conditions (Halfyard et al., 2013; Bowlby et al., 2014). Smolts require clear passage and proper water discharge for successful migration to the sea. Migration patterns in the estuary exhibit cylindrical and ebb tide patterns in the SU population (Lacroix & Knox, 2005; Moore, 1998).

In the marine environment, Atlantic salmon prefer water temperatures between 4˚C to 10˚C, and avoid temperatures less than 2˚C (Power, 1981; Reddin & Friedland, 1993). Their migratory paths are influenced by temperature preferences and warmer coastal waters can lead to earlier returns. Prey availability, including fish and invertebrates, impacts salmon distribution and Atlantic salmon often search for high energy prey items (Hansen & Quinn, 1998; Hislop & Shelton, 1993; Lacroix &Knox, 2005; Rikardsen &Dempson, 2011; Thorstad et al., 2011). Adult Atlantic salmon return back to their river to spawn and after they have spawned are termed kelts.

3.6 Atlantic salmon in the St. Mary's River

Despite the considerable decline in Atlantic salmon populations over the past fifty years, the St. Mary's River stands out as one of the largest wild Atlantic salmon runs in the SU DU region (DFO, 2013). Despite the St. Mary's River having one of the largest populations in the SU DU, it has witnessed declines from historical levels. A 2010 study in the St. Mary's River reported return rates of 1% for one-sea-winter salmon and 0.09% for multi-sea-winter salmon (DFO, 2013). The decline in Atlantic salmon populations can be attributed to factors such as overfishing, habitat loss, and the impacts of climate change (DFO, 2013). A survey covering four rivers in the SU DU, including the St. Mary's River, conducted between 1974 to 2010, revealed a decline in adult abundance ranging from 88% to 99% (DFO, 2013). An electrofishing survey on juveniles indicated a 25% reduction in density between the study years of 2000 and 2008/2009 (DFO, 2013).

The post-spawning fate of kelts in the St. Mary's River has limited documentation. However, an acoustic tagging study in 2010 and 2011 on 24 kelts revealed that all kelts overwintered in the river system and migrated back to the sea in the spring (Gibson & Bowlby, 2013). Migration dates varied, with some kelts moving as early as March 24th, while the majority returned between April 22nd and May 11th (Bowlby et al., 2013). Limited information or records exist on kelt use of the estuary, suggesting rapid movement toward the sea. One study on the SU population (in the nearby LaHave river) reported the majority moving through the estuary within five weeks (Hubley et al., 2008).

Tagging studies suggest a coastal-near shore migratory route for St. Mary's River salmon, extending northward to the Labrador Sea. Distances covered vary between consecutive spawners and alternate spawners, with the latter potentially traveling as far as West Greenland, see figure 2 (Friedland et al., 2003; Montevecchi et al., 2002; Ritter, 1989).

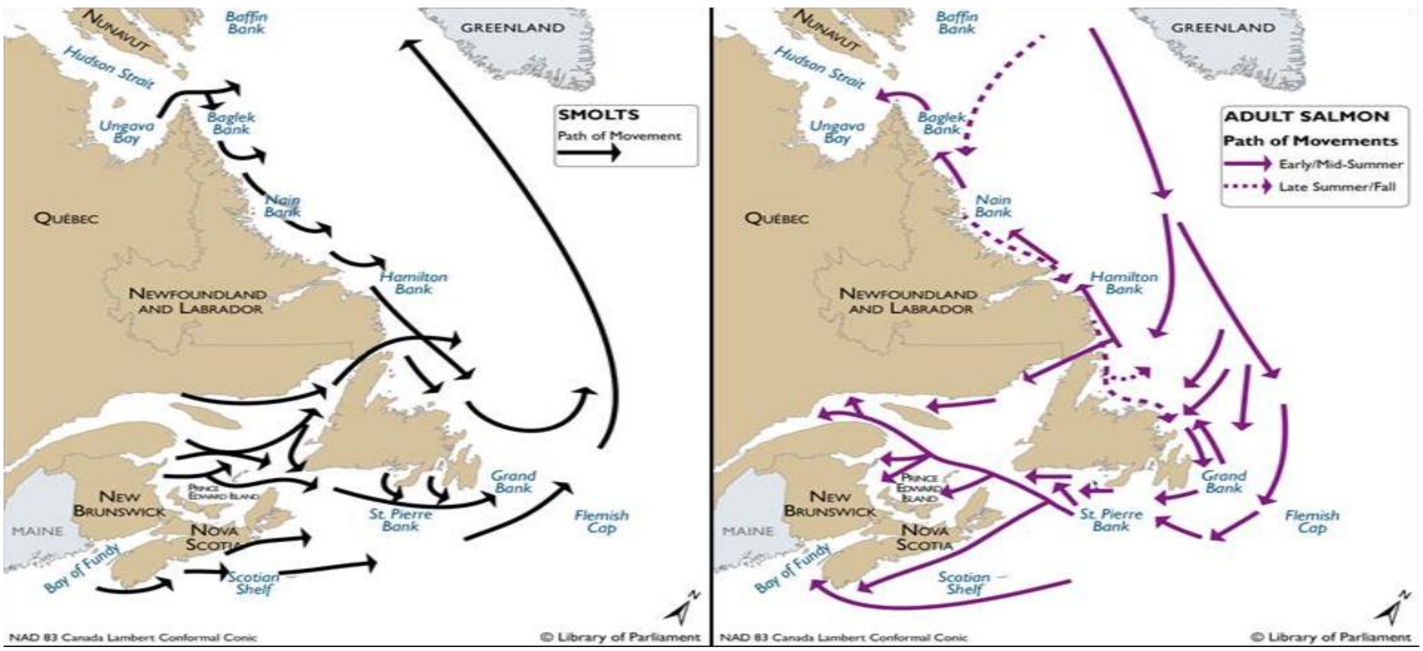

Figure 2. Potential migration routes for Atlantic salmon in Canada. Sources: Map prepared by Library of Parliament, Ottawa, 2016, using data from Natural Resources Canada.

3.7 Fishing in Napu'saqnuk (St. Mary's) River

Similarly to many rivers in Nova Scotia, the St. Mary's River is fished for a variety of reasons. Both recreational and commercial fishing occurs as there is plentiful opportunity with the high amount of biodiversity (*Maritime Provinces Fishery Regulations;* Mitchell, 2012). Different techniques and gear types are used to effectively utilize this resource (*Maritime Provinces Fishery Regulations*).

3.7.1 Fish in Napu'saqnuk (St. Mary's) River

The St. Mary's watershed contains rich biodiversity characterized by an abundance of fish and invertebrate species (Mitchell, 2012). The favorable condition of the watershed has proven conducive to the survival of numerous species, even those facing the threat of extinction in other regions of Nova Scotia (Mitchell, 2012). Survey data spanning from 1969 to 2010 has identified several common species in the watershed, including the American eel, Atlantic salmon , Brook trout, Common shiner (*Luxilus cornutus*), Creek chub (*Semotilus atromaculatus*), Gaspereau, Lake chub (*Couesius plumbeus*), and White sucker (*Catostomus commersonii*) (Mitchell, 2012).

Less common species observed include the American shad (*Alosa sapidissima*), Banded killifish (*Fundulus diaphanous*), Blacknose dace (*Rhinichthys atratulu*), Brown trout (*Salmo trutta*), Brown bullhead (*Ictalurus nebulosus*), Common minnow (*Phoxinus phoxinus*), Golden shiner (*Notemigonus crysoleucas*), Ninespine stickleback (*Pungitius pungitius*), Northern redbelly dace (*Chrosomus eos*), Rainbow smelt, Sea lamprey (*Petromyzon marinus*), Threespine stickleback (*Gasterosteus aculeatus*), Atlantic tomcod (*Microgadus tomcod)*, White perch (*Morone americana*) and Yellow perch (*Perca flavescens*) (Mitchell, 2012). Furthermore, bivalves such as Brook floater, Eastern elliptio (*Elliptio complanata*), Eastern floater (*Pyganodon cataracta*), Eastern lampmussel (*Lampsilis radiate*), and Eastern pearlshell (*Margaritifera margaritifera*), alongside the triangle floater (*Alasmidonta undulata*), contribute to the ecological diversity of the St. Mary's watershed (Davis, 2007).

While Piper Lake within the west branch of the St. Mary's River witnessed the presence of invasive smallmouth bass in 2019, an eradication effort initiated in 2020 has seemingly been successful, with no further sightings reported (Lung, 2021; A. Lowles, personal communication, September 25, 2023). Invasive species like chain pickerel and smallmouth bass are presently believed to be absent from the watershed. However, the invasive European green crab has been documented in the area. (C&P Sherbrooke, personal communication, June 28, 2023).

3.7.2: Fisheries Occurring

The study area sees both commercial and recreational fishing activities in both tidal and freshwater (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023; *Maritime Provinces Fishery Regulations*). According to Schedule II (subsection 2(1)) item 58 of the *Maritime Provinces Fishery Regulations*, the designated boundary/reference point for inland waters in the St. Mary's rivers is the highway bridge at Sherbrooke (*Maritime Provinces Fishery Regulations*).

It is important to note that certain fisheries operating in the region, such as groundfish, snow crab, and swordfish/other tuna, are situated too far offshore to be within the scope of this study (C&P Sherbrooke, personal communication, June, 28, 2023). Exclusions were made for fisheries not expected to occur, specifically the striped bass, Brown bullhead, Lake and Round whitefish and White sucker recreational fishery and the Green crab commercial fishery (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June, 28, 2023). The identification of fisheries in the St. Mary’s watershed is presented in Table 2 and Table 3. This selective approach ensures a focused analysis of relevant fisheries within the study's geographical and regulatory context.

Table 2. Recreational fishing that could be occurring in the St. Mary’s River. Blue shading represents inland fishing and yellow shading represents tidal fishing. (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023: J. Sitland, personal communication, August 28, 2023;*Maritime Provinces Fishery Regulations*)

Species	Gear Type	Fishing season (Open season)	Licencing	Reporting
American eel	Angling	April 1- September 30	General angling licence. (NSDFA)	Licence stubs should be returned at the end of the season to NSDFA.
Gaspereau				
Perch (White and Yellow)				
Shad				
Smelt				
Brook trout				
Gaspereau	Dip net	March 15 to July 10 08:00 each Sunday to 08:00 the following Friday	No licence required	None
Smelt	Dip net	Open April 1 to June 15	No licence required	
American eel	Spearing	Open all year	No licence required	
	Eel pot	January 1 - December 30	Licences required, but all existing	

			licences are terminal*.	
	Angling	Open all year	No licence required	
Gaspereau	Angling	Open all year	No licence required	
	Gill net	Generally June or July to mid-March. Weekly closed time – Friday 12pm – Sunday 8am	DFO licence required. All current licences are terminal*.	
	Dip net	Open all year	No licence required	
Mackerel	Angling/Handline	April 1 - December 31		
Perch (White and Yellow)	Angling	April 1-september 30		
Shad	Angling	Open all year		
	Gill net, drift net	May 1- July 31		
Smelt	Spearing	Open all year		
	Dip net	April 1 to June 15		
	Gill net	October 16 - February 28		
	Angling	August 1 to May 31		
Tomcod	Gill net, bag net, box net	October 16 - February 28		
Tomcod	Angling, spearing	Open all year		
Trout (Brook trout, Brown trout)	Angling	April 1- September 30		
Bivalves/clams	Hand picking/ Hand tool	Clams: April 1- December 31		

		Oysters: September 15 -November 30		
Scallop	Hand Picking/ Hand Tool	January 1 - August 14 and from September 16 - December 31		

*Terminal means that new licences are not given out and individuals with licences can fish with it but cannot transfer the licence (*Maritime Provinces Fishery Regulations)*

Table 3. Commercial fishing that could be taking place in the St. Mary's River (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023*;* J. Sitland, personal communication, August 28, 2023*; Maritime Provinces Fishery Regulations*)

Species	**Location**	**Gear Type**	**Fishing season**	**Licencing**	**Reporting**
Atlantic herring, Mackerel, Gaspereau (Bait)	All maritime regions	Set/Fixed gillnets	January 1 – December 31	Must hold a commercial licence for crab, eel, groundfish (longline, handline), hagfish, lobster, swordfish (longline), tuna or whelk. Bait for personal use only (can't be sold).	Monthly bait reporting log
American eel (adult)	Inland or tidal waters	Pots, fyke nets/traps, longlines, set lines, weirs, dip nets	Pots in inland or tidal waters, or eel traps in tidal waters = closed Dec 30—31 Traps or weirs in inland waters	Commercial licence	Freshwater fishery logbook report must be submitted by Nov 30.

			closed November 1 – August 14		
American eel (elver)	Inland or tidal waters	elver trap (fyke net),stationary wings, pot, push trawls, dip nets	Open all year	Commercial licence	Elver log
Gaspereau (Alewife, Blueback herring)	Coastal fishery	Dipnets, gillnets, square nets, trap nets, weirs	March 15 -July 10	Commercial licence	Freshwater fishery logbook report
Herring		Weir, trapnet, gill net, purse sines	Open year round, some localized gillnet closures. Weirs and trap nets operate from June-November, Gillnet from May-November, and Purse seine from June-November Open year round, some localized gillnet closures. Weirs and trap nets operate from June-November, Gillnet from May-November, and Purse seine from June-November	Commercial licence	Herring weir self reporting monitoring document

Smelt	Coastal fishery	bog nets, box nets, gill net	Inland waters Angling: Open from April 1 to September 30 provided a sport fish season is open in those waters Dip nets: Open April 1 to June 15 Spears: Closed all year Tidal waters Angling: Open August 1 to May 31 Dip nets: Open April 1 to June 15 Spears: Open all year	Commercial licence	Freshwater fishery logbook report
Shad	Coastal fishery	square nets, and trap nets dip nets, gill net	August 1 to March 31	Commercial licence	Freshwater fishery logbook report
Rock Crab	Crab fishing area 24	Crab/Lobster traps	July 1 to December 31	Commercial licence	Logbooks/landing reports
Bivalves/clam	Coastal fishery	Hand tools	April 1- December 31 (clams) January 1 to September 13 (oysters)	Commercial licence	Logbooks/landing reports
Scallops	Scallop fishing area (SFA) 29-	Scallop drags or rakes	May 1 to June 30 and September 16 to April 30	Commercial licence	Logbooks/landing reports

	Inshore and Offshore				
Lobster	Lobster fishing area 31B	Lobster Trap	Apr. 19-June 20	Commercial licence	Logbooks/landing reports

3.7.3 Fishing Methods (Gear types, Technique)

Fishing gear within the St. Mary's River can be classified into four main categories: Nets, Hook and Line, Traps, and Hand Tools (*Maritime Provinces Fishery Regulations*).

Nets come in various shapes and sizes, and their application can be passive, like those fixed to the seabed, or active, such as those dragged behind a boat like some gillnet, they also vary in terms of their selectivity. For example, dip nets are highly selective, and designed for targeting a single species. Gillnets, on the other hand, are used to catch fish that swim through and become entangled, often by their gills (Fuller et al., 2008; He et al., 2021; J. Sitland, personal communication, August 28, 2023).

Hook and line is the most commonly associated fishing method, prevalent in the St. Mary's River. It often involves a rod and reel, although hand lines are also used occasionally. Both methods entail a single hook connected to a line, which is cast into the water (A. Lowles, personal communication, September 25, 2023; Fuller et al., 2008; He et al., 2021)

Traps are utilized for capturing invertebrates like lobsters or crabs. These are typically enclosed spaces baited to attract the target species and often equipped with escape vents to allow non-target species to escape if they become trapped. In the St. Mary's River, eel pots are common, following a similar design but intended for American eel (C&P Sherbrooke, personal communication, June, 28, 2023; Fuller et al., 2008; He at al., 2021). There is also lobster traps and crab traps in the St. Mary's estuary but likely not at a high frequency (C&P Sherbrooke, personal communication, June, 28, 2023)

Hand tools are employed for fishing bivalves like clams, oysters, and scallops. This method entails diving and using tongs or a rake to collect the species, or simply hand-picking them. Spearfishing, another technique in this category, involves diving with a spear to directly target species (Fuller et al., 2008; He et al., 2021).

The diverse range of authorized fishing gear in Nova Scotia mirrors the region's dedication to sustainable fisheries management, accommodating the varied ecological niches and target species in its coastal waters. Regulations and monitoring mechanisms ensure that gear types are used in a manner that balances economic interests while safeguarding the marine ecosystem for future generations (Fuller et al., 2008).

> For example, the *Maritime Provinces Fishery Regulations* includes prohibitions on certain gear and fishing techniques (*Maritime Provinces Fishery Regulations*):

1. No use of artificial light or flames for fishing, including light-emitting lures.
2. Prohibition on the use of net-lines or trawls for fishing.
3. Prohibition on fishing by jigging, snaring, spearing, or using a bow and arrow.
4. Prohibition on the use of dynamite.
5. Prohibition on using a gaff to land a sportfish caught by angling.
6. Prohibition on fishing with more than one line or a line with more than three separate hooks in non-tidal waters

An additional technique associated with recreational fishing is catch and release, which, in most cases, it is the only type of fishing allowed, often with varying bag limits and catch quotas. This approach employs several techniques to enhance the health and survival of fish (A. Lowles, personal communication, September 25, 2023; *Maritime Provinces Fishery Regulations*).

As described by the Angler's Handbook they include (Fisheries and Aquaculture, 2023):

- Using artificial flies and lures instead of live bait.
- Utilizing circle hooks or barbless hooks.
- Avoid exhausting the fish by using proper equipment.
- Minimizing air exposure.
- Not lifting the fish by the tail or squeezing the pectoral fins.
- Avoiding contact with the gills and gently returning the fish to the water.

3.7.4 How fishing may impact Atlantic salmon present in the watershed

Fishing activities can have a diverse impacts on Atlantic salmon, with a primary concern being the potential reduction in their fitness upon interacting with fishing gear (Raby et al., 2011). These interactions can be broadly categorized into intentional fishing and bycatch (Fuller et al., 2008; He et al., 2021). Neither recreational nor commercial fishing for Atlantic salmon is permitted in any capacity in the St. Mary's River

(*Maritime Provinces Fishery Regulations*). However, intentional fishing for Atlantic salmon does occur in the St. Mary's River, particularly through angling, which is addressed in Section 3.10 on IUU fishing.

Catch-and-release angling has been implemented as a regulatory strategy with the aim of maximizing socioeconomic value while minimizing the impact on the fish population (Lennox et al., 2017; Policansky, 2002). Concerns have been raised regarding potential delayed mortality resulting from capture events and the prospect of physical, cognitive, or psychological damage inflicted by fishing gear, thereby diminishing the fish's fitness (Lennox et al., 2017; Thorstad et al., 2011).

Lennox et al. (2017) conducted a meta-analysis of catch-and-release studies, consolidating data from various studies to discern the significant effects on the population. Their findings indicate that salmon often survive catch-and-release events at a rate of 93%, but several factors influence this survival rate (Lennox et al., 2017). Notably, the type of gear, specifically the hook type, emerges as a critical factor in predicting post-release mortality. Fishing with flies, in contrast to lures or bait, results in significantly higher survival rates, attributed to the smaller hooks on flies (Lennox et al., 2017). This emphasis on hook type is reflected in Atlantic salmon fishing regulations (Warner and Johnson, 1978). Regulations disallow fishing with barbed hooks, as they have shown marginally higher mortality rates compared to barbless hooks (Bartholomew & Bohnsack, 2005).

High water temperatures have also been identified as a factor decreasing Atlantic salmon survival after catch-and-release events (Ayers, 2023; Lennox et al., 2017). Survival rates generally range between 88% and 100% at temperatures of 18℃ or lower, dropping considerably in temperatures between 20℃ and 25℃, ranging from 84% down to 57% survival (Keefe et al., 2022; Lennox et al., 2017; Van Leeuwen et al., 2020). This decrease in post-release survival is attributed to the combined stressors of warm water, low water levels, and low dissolved oxygen, leading to the depletion of aerobic and anaerobic muscular resources, scope, and cardiac function (Anderson et al., 1998; Breau, 2013; Havn et al., 2015; Wilkie et al., 1996; Wood et al., 1983). To address this stressor, some rivers in Nova Scotia have warm water closures implemented (DFO, 2019a). The Margaree River has witnessed more frequent closures in recent years due to rising water temperatures (Ayers, 2023; DFO, 2012; DFO, 2019a). Angling in temperatures exceeding 20℃ has been shown to reduce survival, making warm water protocols a potential avenue for population preservation (see Chapter 6) (Ayers, 2023; DFO, 2012; DFO 2019a).

In 1984, the commercial fishery for the SU population was closed, aligning with global efforts to mitigate severe declines in Atlantic salmon populations (DFO, 2013). Despite this closure, commercial fishing for other species persists in Atlantic salmon habitats, and the less selective nature of commercial fishing gear increases the likelihood of bycatch (Davis, 2002; Fuller et al., 2008; *Maritime Provinces Fishery Regulations*). Bycatch, defined as the unintentional capture of non-target species either retained or released from fishing gear is a concern (Crowder & Murawski, 1998; Davis, 2002). Some gear types, such as nets, have the potential to be damaging, as Atlantic salmon caught in them may attempt to escape by thrashing (Fuller et al., 2008; J. Sitland, personal communications, August 28, 2023). While certain nets, like set nets or fyke nets, are less damaging and allow for easier release. Herring gillnet fishing poses a moderate risk to salmon as bycatch and a moderate to high risk for delayed mortality even if the fish is released back into its environment (Davis, 2002).

3.8 Provincial and Federal licensing and regulations

In Canada, the management of fisheries exhibits regional variation, reflecting the diverse needs of each area. In Nova Scotia the responsibilities for recreational and commercial fisheries is divided between the federal and provincial governments (*Maritime Provinces Fisheries Regulations*). The federal government, under the authority of Subsection 91(12) of the *Constitution Act, 1867,* holds exclusive legislative power over Coastal and Inland Fisheries, encompassing fish and fish habitat protection (*Constitution Act, 1867)*.

The province wields exclusive jurisdiction over properties, civil rights, and the management of public lands, as stipulated by Section 92 of the *Constitution Act, 1867*. In Nova Scotia, the *Fisheries Act, 1985*, oversees various policies and regulations, including the Maritimes Region Commercial Fisheries Licensing Policy and *Maritime Provinces Fishery Regulations* (*Fisheries Act*). Complementary provincial documents, such as the Angler's Handbook, guide recreational fishers on authorized practices (NSDFA, 2023). Additionally, the management of inland species and trout has been given to the province through a memorandum of understanding (A. Lowles, personal communication, September 25, 2023).

Fisheries and Oceans Canada manages anadromous, catadromous, and other marine species, while the NSDFA handles the licensing of recreational freshwater species (*Fisheries Act*). Within the St. Mary's River, specific fishing areas are identified in *Maritime Provinces Fishery Regulations*, with enforcement overseen by DFO's Conservation and Protection Officers and the Department of Natural Resources and Renewables provincial conservation officers (*Fisheries Act*).

For recreational fishing in Recreational Fishing Area 2, regulations include a special trout management area with specific gear restrictions (*Maritime Provinces Fishery Regulations)*. Also, in the St. Mary's River, certain Atlantic salmon holding pools are closed from June 15 to September 30 for additional protection. Special Management Areas, identified through the Recreational Fishery Advisory Council, may impose restrictions on bag limits, season lengths, fish retention lengths, and gear types. Research indicates that these areas contribute to higher-quality fisheries, serving as a tool for conservation in response to population declines attributed to factors like overfishing, habitat loss, and acidification (*Maritime Provinces Fishery Regulations;* NSDFA, 2023*)*.

In the St. Mary's River, two sections (Upstream from the highway bridge at Sherbrooke to the 347 Bridge near Aspen on the East River and upstream to the highway bridge at Review Glenelg and Melrose Lakes on the West River) are designated as special management areas and enforce regulations such as a delayed opening of the fishing season to allow for kelts to exit the estuary, a reduced bag limit of three trout from September 1 to September 30, and catch-and-release only during the month of September (A. Lowles, personal communication, September 25, 2023; *Maritime Provinces Fishery Regulations;* NSDFA, 2023).

3.9 Fishing as a Means of Drive for Conservation and Research

St. Mary's River Association (SMRA), which originated as an informal committee in the 1970s, and is comprised of passionate anglers dedicated to preserving and enhancing the St. Mary's River ecosystem (SMRA, n.d.). Similarly, the Nova Scotia Salmon Association (NSSA) is an organization that unites anglers and conservationists committed to aquatic environmental welfare (NSSA, n.d.a). Serving as an umbrella organization, NSSA represents and connects entities like the St. Mary's River Association (NSSA, n.d.a). Its primary roles involve advocacy in regulatory discussions and conducting research and habitat restoration (A. Lowles, personal communication, September 25, 2023). Another contributor to research and conservation is the Atlantic Salmon Federation (ASF) who is actively involved in the St. Mary's River ESA case study and engaged in extensive watershed work (ASF, 2019.).

These organizations have evolved into key participants in restoration and conservation efforts, collaborating with both governmental and non-governmental entities (NSSA, n.d.a). Conservation-minded anglers have notably impacted river systems through initiatives such as freshwater productivity enhancement, watershed liming, and large-scale habitat restoration efforts initiated by NSSA and SMRA (NSSA, n.d.b) For instance, a successful project restored seven kilometers of the St. Mary's River by building habitat enhancing structures within the west branch, supported by the NSSA’s Adopt-A-Stream program, and the Atlantic Salmon Conservation Foundation, with additional funding from the Coastal Restoration Fund (NSSA, n.d.b; NSSA, 2020; The foundation for conservation of Atlantic Salmon, 2020; DFO, 2021b). Also, a "ribbon of green" initiative led by the Nova Scotia Nature Trust aims to protect land along the river, with 525 hectares already designated for conservation (NSSA, n.d.). The initiative, part of the St. Mary’s River Conservation Legacy Campaign, seeks to conserve critical habitats for wood turtles and Atlantic salmon (Nova Scotia Nature Trust, n.d.).

Future objectives for the Nova Scotia Nature Trust, SMRA, and provincial officials involve expanding protection in alignment with the provincial goal of providing nature-based recreation while safeguarding natural and cultural heritage (Nova Scotia Nature Trust, n.d.). Furthermore, various groups are actively engaging with different segments of the SU population of Atlantic salmon, aiming to instill responsibility and environmental awareness. These efforts seek to encourage individuals to be more mindful of their personal impact on the environment (Nova Scotia Nature Trust, n.d).

3.10 Illegal, Unreported, and Unregulated Fishing

Illegal, unreported, and unregulated (IUU) fishing presents a global challenge characterized by fishing activities conducted beyond authorized boundaries and in violation of regional fisheries management organizations (RFMOs) regulations (DFO, 2005; DFO, 2019c). This includes fishing within national borders and on the high seas. It is estimated that IUU fishing accounts for around 30% of all fishing activities and has been identified as a contributor to the depletion of fish stocks (DFO, 2005; DFO, 2019c).

As defined by the DFO (DFO, 2019c):

Illegal fishing refers to:

- Fishing by national or foreign vessels within a country's Exclusive Economic Zone without permission, or, undertaking fishing activities that contravene that country's laws or regulations.
- Fishing by a vessel flying the flag of a State party to a relevant Regional Fisheries Management Organization (RFMO) that contravenes conservation or management measures adopted by that organization or part of international law.
- Fishing that violates national laws or international obligations.

Unreported fishing refers to:

- Fishing that has not been reported, or has been misreported, to the relevant national authority or RFMO.

Unregulated fishing refers to:

- Fishing within the regulatory zone of a RFMO of a vessel without a nationality, or by a vessel flying the flag of a state not party to the organization (Flag of convenience), which contravenes the conservation and management measure set out by the RFMO.
- Fishing outside of regulated zones, which is inconsistent with efforts under international law to conserve living marine resources.

For the purpose of this project, the primary focus centers on two main types of IUU fishing: illegal fishing, which violates the *Fisheries Act* and other federal laws, and unreported fishing, which ranges from inaccuracies in recreational fishing records to the omission of specific species caught. In essence, it encompasses any fishing activities that defy the regulations set forth by Nova Scotia's Regional fishery management organization; DFO and NSDFA.

One of the foremost challenges in addressing IUU fishing is the inherent difficulty in accurately quantifying its prevalence. While the Global South often bears the brunt of its negative effects, IUU fishing remains a concern in Global North nations, including Canada. Estimating the extent of IUU fishing is intricate due to the secretive nature of these activities, with wrongdoers rarely publicizing their actions (DFO, 2005; DFO, 2019c).

Sherbrooke's Conservation and Protection office acknowledges the occurrence of IUU fishing, with instances of unauthorized nets and equipment encountered during their operations (C&P Sherbrooke, personal communication, June 28, 2023). Detecting illegal sport fishing is comparatively more straightforward, with indications including gear types, favored fishing locations, and seasonal timing. Illegal fishing using angling gear is known to occur in the St. Mary's River (C&P Sherbrooke, personal communication, June 28, 2023)..

Deterrents to illegal fishing, including monetary fines, are already in place. Under the provisions of the Acts and Regulations that apply to the fishery of the *Fisheries Act*, violations of specified permissions or licenses can lead to fines of $750 CAD (*Contraventions Act, Fisheries Act*). Furthermore, the Maritime Provinces Fishery Regulations outline 205 fines related to illegal fishing, some of which are applicable to illegal salmon fishing, such as "Unlawfully fishing for any fish" and "Unlawfully catching and retaining any fish," each incurring a $200 CAD fine (*Contraventions Act, Fisheries Act*). Most anglers know these regulations however, a small portion of individuals may remain unaware of these regulations. For some individuals monetary fines are ineffective deterrents (C&P Sherbrooke, personal communication, June 28, 2023).

CHAPTER 4 RESULTS AND ANALYSIS

Results were based on the literature and conversations with subject matter experts. As it was not possible to gather complete data on each individual fishery, the most logical way to analyze the fishery was by the authorized gear type. Below an Ecological Risk Assessment was completed, see table 5-9

Table 4 shows an interaction matrix which captures potential spatial and temporal overlap of Atlantic salmon with fishing gear, however, from this eggs and alevins were removed as fishing is highly unlikely to interact with salmon at this life stage. The only possibly type of gear that could interact with eggs or alevins are eel pots but they are unlikely to spatially overlap. Thus, these changes better reflect potential interactions in the St. Mary's watershed (A. Lowles, personal communication, September 25, 2023; C&P Sherbrook, personal communication, June 28, 2023)

Interaction Table Caveats

<u>Freshwater recreational fisheries</u>: The most common fishery is Brook trout and is the fishery most likely for interaction with Atlantic salmon. Brown bullhead, White suckers, and Lake / Round whitefish were removed from this matrix as they are not targeted for recreational fishing (A. Lowles, personal communication,

September 25, 2023). Other fisheries have the potential to overlap but it is very unlikely as these fisheries are not often targeted (A. Lowles, personal communication, September 25, 2023). As dip nets are highly selective those fisheries are highly unlikely to interact (A. Lowles, personal communication, September 25, 2023; Fuller et al., 2008; He et al., 2021; J. Sitland, personal communication, August 28, 2023).

Tidal recreational fisheries: As salmon move downstream, being caught in any funnel-style net such as a fyke net is not possible as nets are set to catch fish moving upstream (A. Lowles, personal communication, September 25, 2023). However, there is a marginal chance that interaction could occur from some fixed netting, such as gillnets or traps. As Dip nets are highly selective those fisheries are highly unlikely to interact (A. Lowles, personal communication, September 25, 2023; Fuller et al., 2008; He et al., 2021; J. Sitland, personal communication, August 28, 2023). As Brook trout is the most common target species they have the most likely chance of interacting with salmon.

Commercial fishing (both freshwater and tidal): Commercial fishing is not abundant in this region but still does occur. The majority of the gear used is unlikely to interact when overlap does occur, as most are set gear and/or do not overlap in the water column.

Table 4. Spatial and temporal overlap with fisheries occurring in the St. Mary's river and estuary and Atlantic salmon lifecycle stages (egg and alevin stages removed because no interactions are expected to occur with any fishing gear, even though there is spatial/temporal overlap) (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023*; Maritime Provinces Fishery Regulations*) . The legend for this interaction matrix can be found below the table.

Fishery		Spatial/temporal overlap with salmon life stages									
Species	Gear Type	Parr (1-2 years)	Smolt (April-July)	Smolt (April-July)	Post-smolt (July-Nov)	Adults returning to spawn (April - November)	Adults returning to spawn (April - November)	Spawning (Oct-Nov)	Post-spawning Kelt Nov-April (FW overwinter)	Downstream migration including time in estuary (March-June)	Adults (at-sea)
American eel	Angling										
Gaspereau	Angling										
Perch (White and Yellow)	Angling										
Shad	Angling										
Smelt	Angling										
Brook trout	Angling										
Gaspereau	Dip Net										
Smelt	Dip Net										
American eel	spearing										
	pots										
	Angling										

	angling										
Gaspereau	Gillnet										
	Dipnet										
Mackerel	Angling/handline										
Perch (White and Yellow)	Angling										
Shad	Angling										
	Gillnet										
Smelt	Spearing										
	Dipnet										
	Gillnet										
Tomcod	Spearing										
Tomcod	Angling										
Brook trout	Angling										
Bait (Atlantic herring, Mackerel, Gaspereau)	Set/Fixed gillnets										

American eel (adult)	dip nets										
American eel (adult)	eel pots, fyke nets/traps, longlines, set lines, and weirs.										
American eel (elver)	dip nets, pots, fyke nets, push trawls										
Gaspereau (Alewife, Blueback herring)	dip nets										
Gaspereau (Alewife, Blueback herring)	gill nets, square nets, trap nets, or weirs										
Herring	Purse Net, Gillnets (set and drift), weirs, trap net										

Smelt	gill nets, bag nets, and box nets.										
Shad	dip nets, gill nets, square nets, and trap nets										
Rock Crab	Crab traps or Lobster traps										
Bivalves/clam	Hand tools, dredging,										
Scallops	Inshore: Scallop drags or rakes Offshore: Scallop drags										
Lobster	Lobster trap										

Legend	
	Freshwater
	Estuary
	Sea
	Inland fisheries (recreational)
	Tidal fisheries (recreational)
	Commercial
	Likely to interact
	Overlap spatially/temporarily but unlikely to interact
	Overlap spatially/temporarily but Highly unlikely to interact

Table 5. The likelihood of whether the fishing gear could interact within Atlantic salmon in the next 10 years in the St. Mary's River or estuary (DFO, 2014).

Likelihood of fishery interacting with Atlantic salmon	Definition
Unknown	No data to conclude fishery and Atlantic salmon interact

Remote	Interaction between fishery and Atlantic salmon does not occur or rarely occurs
unlikely	Interaction between fishery and Atlantic salmon could occur in some circumstances but not all.
likely	Interaction between fishery and Atlantic salmon will occur in most circumstances
always	Interaction between fishery and Atlantic salmon will always occur

Table 6. The level of impact fishing gear could potentially cause if an Atlantic salmon should interact with it (DFO, 2014).

Level of Impact	Definition
Extreme	Fishing gear will have a severe impact on Atlantic salmon with the potential for extirpation.
High	Fishing gear will have substantial impact and would jeopardize the survival of Atlantic salmon
Medium	Fishing gear will have a moderate loss impact and is likely to jeopardize the survival of Atlantic salmon
Low	Fishing gear will have Little impact and is unlikely to jeopardize the survival of Atlantic salmon
Unknown	No prior knowledge, literature or data to guide the assessment of impact.

Table 7. The strength of evidence linking fishing gear to the survival and recovery of the population. Evidence can be scientific, traditional ecological knowledge or local knowledge (DFO, 2014).

Causal Certainty	Definition	Rank

Very low	There is a plausible link with no evidence that fishery is leading to Atlantic salmon decline or jeopardy to survival or recovery	5
Low	There is a theoretical link with limited evidence that fishery is leading to Atlantic salmon decline or jeopardy to survival or recovery	4
Medium	There is some evidence linking the threat to population decline or jeopardy to survival or recovery	3
High	Substantial evidence of a causal link between fishery and Atlantic salmon decline or jeopardy to survival or recovery	2
Very high	Very strong evidence that fishery is occurring and the magnitude of the impact on Atlantic salmon can be quantified.	1

Table 8. Threat risk matrix as described in DFO, 2014

		Level of Impact				
		Low	Medium	High	Extreme	Unknown
Likelihood of Occurrence	Known	Low	Medium	High	High	Unknown
	Likely	Low	Medium	High	High	Unknown
	Unlikely	Low	Medium	Medium	Medium	Unknown
	Remote	Low	Low	Low	Low	Unknown
	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Table 9. Threat- level assessment of each fishing gear type used in the St. Mary's River and estuary (DFO, 2014).

Gear Type			**Causal Certainty**	**Threat Risk**

	Likelihood of Interaction	**Level of Impact**		
Angling	Likely	Medium	3	Medium
Dip Net	Remote	low	5	Low
Spearing	Remote	Extreme	5	Low
Gill Net	Unlikely	High	4	Medium
Hand Picking/ Hand Tool	Remote	low	5	Low
Lobster traps, Crab traps, pots	Unlikely	Low	5	Low
longlines, set lines	Unlikely	Medium	4	Low
fyke nets/traps, Square Net,bog nets, box nets	Unlikely	Low	4	low
Weirs	Unlikely	Low	5	low
stationary wings, push trawls	Unlikely	Low	4	Low
Scallop drags or rakes	Unlikely	Low	5	Low

Breakdown for threat-risk assessment:

Angling**:** Given that angling is a prevalent activity in the St. Mary's River, the likelihood of inadvertently (or intentionally, in the case of IUU fishing) catching salmon is a possibility. The threat level is assessed as medium, accounting for the potential non-compliance with fishing protocols. While the threat could be mitigated when anglers adhere to gear restrictions, temperature protocols, and closures, it is acknowledged that full compliance is not guaranteed, and deviations from regulations increase the threat (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

Dip Net, Handpicking/Hand Tools: These gear types are highly selective, minimizing the likelihood of interacting with Atlantic salmon. In the rare event of interaction, Atlantic salmon can be released without harm (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

Spearing: This gear type is highly selective, making interactions with Atlantic salmon extremely rare. However, if such an interaction occurs, it has the potential to cause severe damage, as it involves cutting the fish to some extent (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

Scallop Drags or Rakes, Weirs, Lobster Traps, Crab Traps, Pots: These gear types are slightly selective, making interactions with Atlantic salmon unlikely. In the rare chance of interaction, Atlantic salmon can be released with little to no harm. It's important to note that there is no available data suggesting such interactions occur in the St. Mary's River (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

Longlines, Set Lines: While these gear types are slightly selective, they have the potential to hook salmon. However, their rarity in the watershed makes interactions with Atlantic salmon unlikely. In the event of interaction, Atlantic salmon can potentially be released with little harm, although the non-selective nature of these gear types could pose a risk (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023)

Stationary Wings, Push Trawls, Fyke Nets/Traps, Square Net, Bog Nets, Box Nets: These gear types are slightly selective, with a potential but unlikely risk of catching Atlantic salmon. Their design, targeting fish moving upstream, is less likely to interact with adult Atlantic salmon, which are larger. In the rare event of interaction, Atlantic salmon can potentially be released with little harm (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023)

Gill Net: Although uncommon in the watershed, gill nets are not very selective and have the potential to cause significant harm to Atlantic salmon, particularly in the gill area. However, there is currently no available data indicating such interactions in the St. Mary's River (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

4. 1 Analysis

The impact of fishing gear on Atlantic salmon populations in the St. Mary's River is influenced by two critical factors: the selectivity of the gear and the responsible practices of individual fishers (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J.

Sitland, personal communication, August 28, 2023; Lennox et al., 2017). However, it can be challenging to understand how every angler on the St. Mary's River conducts their activities and whether they adhere to regulations and best fishing practices. Therefore, the results presented here primarily focus on the selectivity of gear and the likelihood of interaction with Atlantic salmon. Certain fishing tools, such as handpicking, hand tools, and dip nets, are considered highly selective and cause minimal to no harm to Atlantic salmon. This selectivity arises from the fisher's ability to precisely choose which organisms they capture, minimizing the risk to non-target species (A. Lowles, personal communication, September 25, 2023; He et al., 2021).

Angling, on the other hand, is not inherently a selective fishing technique, as it has the potential to catch Atlantic salmon. Nevertheless, available data suggests that the survival of Atlantic salmon following catch and release is notably high, particularly when caught by experienced anglers who employ responsible handling and release methods (Dempson et al., 2002; He et al., 2021; Lennox et al., 2017; NSDFA, 2023).

In the case of nets, their level of impact varies. Bycatch of Atlantic salmon in nets is relatively unlikely. This is due to the strategic placement of nets to intercept fish moving upstream, typically they are made to catch smaller fish like gaspereau. When Atlantic salmon are migrating up stream, they have already gone to sea to feed and grow, resulting in a larger size. Consequently, they are less likely to be caught in the nets, as they are capable of avoiding them (He et al., 2021; (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023). Another factor in favor of minimizing the impact of nets is their regular daily inspection and maintenance, which ensures the swift release of unintended catches (*Maritime Provinces Fishery Regulations*). However, it should be noted that when Atlantic salmon do become trapped, certain types of nets, like gillnets, can be damaging to them (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023).

Overall, gear selectivity and responsible fishing practices, including catch and release techniques, are pivotal in minimizing the impact of fishing on Atlantic salmon which is shown in earlier studies with these conclusions (Dempson et al., 2002). In the St. Mary's River, responsible practices would contribute to the long-term conservation of this vital species.

CHAPTER 5 DISCUSSION

The primary objective of this project was to evaluate the compatibility of fishing activities in the St. Mary's River with draft conservation and protection objectives aimed at sustaining and enhancing the Atlantic salmon population in the St. Mary’s River. Based on available evidence, it appears that fishing in the St. Mary's River and estuary does not exert a substantial adverse impact on the Atlantic salmon population (DFO, 2013; A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023; J. Sitland, personal communication, August 28, 2023). However, it is essential to acknowledge that this conclusion is drawn with an awareness of existing data gaps, preventing us from presenting these results as definitive.

The predominant fishing method in the St. Mary’s River is angling (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023). When anglers adhere to established regulations regarding timing, location, and gear restrictions, angling can be conducted without significant harm to Atlantic salmon (A. Lowles, personal communication, September 25, 2023; DFO, 2013; Lennox et al., 2017). Although fishing may not inherently benefit fish populations, anglers' attention and dedication to habitat conservation can have a positive impact (A. Lowles, personal communication, September 25, 2023). For example, anglers participating in restoration efforts contribute to this positive influence (DFO, 2021b). Scientific literature indicates high survival rates when adhering to protocols, such as fishing in temperatures below 20 °C, making angling overall unlikely to cause substantial declines in fish populations (Lennox et al., 2017). The challenge lies with individual anglers who do not comply with protocol, necessitating potential mitigation strategies, including increased enforcement and adjusted penalties (C&P Sherbrooke, personal communication, June 28, 2023).

Restricting bycatch gear, particularly gill nets, might be more feasible since it is easier to detect their use. Although gill nets have been identified as a threat to Atlantic salmon, they are not frequently used within the St. Mary's River watershed (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023). In the past four years, there have been no recorded instances of commercial gill net fishing directly in the St. Mary's River (DFO, personal communication, October 19, 2023). The closest gill net fishing activities occur in Port Hilford and Port Hilford Brook, and these are unlikely to negatively impact wild Atlantic salmon migrating to and from the St. Mary's River, mainly due to the presence of the dam at Sixth Lake. Nevertheless, exploring more stringent regulations governing the use of gill nets could prevent potential future interactions between Atlantic salmon and this gear (DFO, personal communication, October 19, 2023).

Fishing in the St. Mary’s River does not appear to be a major threat. This is in alignment with conclusion drawn in DFO, 2013 where non-fishing related activities proved more of a threat than fishing (DFO, 2013). This becomes particularly relevant when considering the myriad other substantial challenges confronting this watershed, including the effects of climate change and habitat degradation. For example, the potential threat of gold mining, which has historically occurred in Nova Scotia, poses a greater risk to the watershed. Mining residues, such as arsenic, mercury, and lead, continue to affect surrounding environments (Wong et al., 1999). Mining, given its potential future presence near the St. Mary’s River watershed, poses a greater threat than fishing (SMRA, 2024). It alters hydrology and temperature, causes habitat modification and loss, and introduces pollutants (Eisler & Wiemeyer, 2004; Kossoff et al., 2014; Luoma & Rainbow, 2008; Sergeant, et al., 2022; Woody et al., 2010).

Though fishing is assessed as low risk future consideration of the watershed should be discussed. The St. Mary's River, not being a significant hub for commercial fishing or the use of potentially damaging gear, presents a unique opportunity to introduce regulations and restrictions before any detrimental fishing practices become prevalent in the river system. However, these conclusion were made based on limited data which should be explored further.

5.1 Limitations

This project grappled with data limitations, evident in the gaps present throughout its duration. The conclusions drawn relied on information provided by the federal government and provincial government. Data constraints stemmed from underreporting or limited reporting practices within both commercial and recreational fishing sectors. The depth of information necessary to comprehensively understand the impact of fishing on Atlantic salmon in the region was lacking. Given these constraints, the study utilized the best available evidence to estimate the effect of fisheries on Atlantic salmon. Key considerations included the location of fisheries within the watershed (marine, estuary, or freshwater), the gear types employed, their selectivity, and the known extent of fishing effort in the watershed.

In regards to commercial fishing, licences typically cover extensive areas, often spanning multiple counties. The scarcity of site-specific data poses challenges, and while individual fishing locations are reported, this information is not consistently accessible to the public, particularly in areas with fewer fishers. Consequently, determining whether fishing activities occur in specific rivers, such as the St. Mary's, proves challenging due to the absence of river or coordinate specifications in many fishing logs (DFO, personal communication, October 19, 2023; J. Sitland, Person communication, August 28, 2023).

Recreational fishing faces its set of limitations. Certain fisheries, like recreational mackerel fishing, do not mandate reporting. While others like fishing Brook trout has the potential for underreporting or misreporting due to personal error or negligence. Additionally, in rivers where salmon fishing is prohibited, there is no mechanism to report salmon caught as bycatch as the log does not have the option to select salmon as bycatch (A. Lowles, personal communication, September 25, 2023)

Lastly, The project's progression was constrained by time limitations of the Master of Marine Management program, impacting the depth and scope of the analysis.

5.2 Opportunities for Future Research

Future research endeavors should actively seek the involvement of the Mi'kmaq community in discussions concerning fishing activities in the St. Mary's watershed. This collaborative approach would ensure a more holistic and culturally sensitive exploration of the complexities surrounding fisheries management in the region. Lastly, with data gaps comes the opportunity to identify areas where more knowledge is needed. Here, data gaps were noted in several areas in regards to fisheries management and the below recommendation were made to try and fill in the data gaps in.

CHAPTER 6 RECOMMENDATIONS

These recommendations are designed to address current limitations, enhance data collection, and promote sustainable fisheries management practices within the context of the St. Mary's River watershed. These recommendations were developed based on the literature and input from subject matter experts. These recommendations would likely fall under the resource management department jurisdiction at the DFO or at the provincial level with the Nova Scotia Department of Fisheries and Aquaculture.

1. Enhance Reporting Mechanisms:
    a. Implement innovative solutions, such as the development of a mobile application, to facilitate real-time updates of recreational logs throughout the fishing season. This approach would improve the accuracy and timeliness of data collection.
    b. Modify reporting requirements for commercial fishing by including specific coordinates in logbooks. This addition aims to provide a more detailed and geographically precise understanding of commercial fishing activities within the St. Mary's River watershed.
    c. To increase compliance, monetary fines could be attached to the reporting or lack of proper reporting could affect the possibility of not getting a licence for the next season.
2. Regulate High-Bycatch Gear:
    a. Establish and enforce regulations governing the use of gear types with a high potential for bycatch, such as gill nets. This proactive measure aims to mitigate potential threats to Atlantic salmon and other non-target species, aligning with conservation and protection objectives.
    b. This should be explored in partnership with resource management.
3. Enhance Bycatch Reporting:
    a. Facilitate the reporting of salmon caught as bycatch in recreational fishing logbooks. By incorporating this information into existing reporting systems, a more comprehensive understanding of unintentional salmon catches can be obtained, contributing to improved management strategies.

4. Implement Warm-water Regulations
    a. A warm water regulation should be implemented in the St. Mary's River so that when the minimum water temperature for two consecutive days is 20 degrees Celsius all fishing is stopped until suitable conditions are once again reach (DFO, 2012).
    b. A good example of this is "Protocol for In-season Conservation Measures for Atlantic Salmon during Environmentally Stressful Conditions in the Margaree River" and a similar strategy could be followed (DFO, 2019a)

CHAPTER 7: CONCLUSIONS

The depletion of global freshwater biodiversity is rapid (Desforges et al., 2021). Despite abundant freshwater habitats in Canada, they have received limited attention. Anthropogenic pressures, including pollution, invasive species, land use changes, and climate change, threaten these ecosystems (Angeler et al., 2014; Reid et al., 2019; Reid et al., 2022).

Ecologically Significant Areas (ESAs) under the *Fisheries Act* have the ability for protecting Canadian freshwater habitats that are highly productive, sensitive, rare and/or unique (DFO, 2023). Despite no established ESAs, ongoing case studies, like the one for the St. Mary's River in Nova Scotia, indicate a commitment to identifying ecologically important areas (DFO, 2023; *Fisheries Act*). The St. Mary's River is significant for local communities and Indigenous peoples and faces anthropogenic stressors (NSDL&F, 2019).

The primary goal of this graduate project is to assess fisheries within the St. Mary's Rivers for alignment with draft conservation and protection objectives, in relation to the ecologically important Atlantic salmon. The project aims to identify opportunities to enhance management practices where alignment is lacking and to contributing to the preservation of this ecologically and culturally significant area. This research addresses knowledge gaps in fisheries management in the St. Mary's River watershed.

The literature review was conducted to explore the impact of St. Mary's River fisheries on Atlantic salmon populations and to identify avenues for better alignment with ESA goals. This work is building on the 2013 recovery potential assessment (RPA) by the DFO, which considered fishing as a low threat in general (DFO, 2013). This project focused on specific fisheries within the St. Mary's watershed with the aim to assess the impact of these fisheries on Atlantic salmon populations, using the DFO's guidance from 2014 to understand the ecological implications of fishing activities in the St. Mary's Watershed (DFO, 2014).

The impact of various fishing gear on Atlantic salmon populations was evaluated, considering gear selectivity and responsible fishing practices. Angling, the predominant fishing method, poses a medium threat due to potential non-compliance with protocols, although survival rates post-release are generally high. Highly selective gear types, such as dip nets and hand tools, present minimal risk to Atlantic salmon, while less selective gear types, like gill nets, could potentially cause significant harm, although their infrequent use in the watershed diminishes this risk (A. Lowles, personal communication, September 25, 2023; C&P Sherbrooke, personal communication, June 28, 2023).

The discussion delves into the challenges posed by data gaps, limiting the conclusiveness of findings. Future considerations should involve stricter regulations for potential threats, including gill nets, as well as the integration of the Mi'kmaq community in discussions to ensure a more comprehensive and holistic approach to fisheries management.

Despite limitations arising from data constraints and time, this study contributes valuable insights into the impact of fishing activities on Atlantic salmon in the St. Mary's River. The main recommendation in regards to fisheries management in the region is to enhance reporting, regulate high bycatch gear and implement a warm water protocol. Overall, fishing in the St. Mary's River, with its low-risk assessment, presents an opportunity for proactive regulation and conservation efforts before detrimental practices become prevalent, safeguarding the long-term health of Atlantic salmon.

Laws and Regulations

Constitution Act, 1867

Contraventions Act (S.C. 1992, c. 47)

Fisheries Act, R.S.C. 1985, c. F-14

*Maritime Provinces Fishery Regulations, SOR/**93-55***

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