St. Mary's River Association

Habitat Assessment and Restoration Plan

East River St. Mary's

MacInnis Natural Resource Services Inc.
1/1/2021

Introduction

The East River St. Mary’s is one of three branches of the St. Mary’s River. Draining an area of approximately 355 square kilometers the East River St. Mary’s begins in Pictou County, flowing south easterly into Guysborough County where it meets the North Branch and West Branches in Glenelg. Historically the East River St. Mary’s has been the most productive of the three branches. Comparatively speaking the water quality in the East River is much higher quality than the other branches, making it a good candidate for habitat restoration and stock enhancement work. The St. Mary’s River Association (SMRA) was formed in 1979 to address environmental issues in the watershed and out of concern that the Atlantic salmon stock was in jeopardy. This plan follows behind a similar planning and restoration initiative completed over the last several years on the West Branch St. Mary’s River. A planning document was produced in 2015 followed by 6 consecutive seasons of extensive restoration work.

This document has three objectives; (1) to provide an overview of current instream habitat conditions in the East River St. Mary’s, (2) to provide a stepwise plan using established river restoration techniques to address issues of habitat degradation and to improve productivity and (3) to outline a sufficient monitoring plan to measure the effectiveness of restoration and to better inform SMRA and stakeholders about the status of Atlantic salmon in the river. An assessment of the East River St. Mary’s and most of its tributaries was conducted during several field trips between June 2021 and November 2021. Overall, the habitat conditions in the East River appear to be stabilizing and signs of recovery were observed throughout most reaches of stream. However, given the under-performance of Atlantic salmon numbers in the watershed this report recommends the implementation of a five year restoration program designed to enhance the recovery of instream habitat.

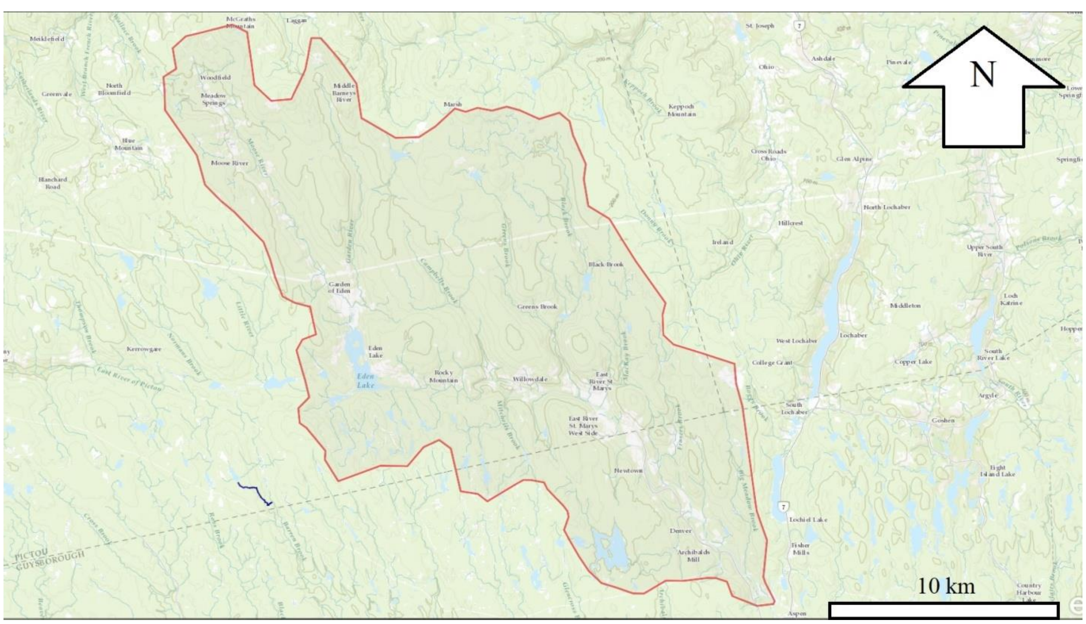

Figure 1:Topographic map of the East River St. Mary’s with the watershed boundaries marked in red.

Despite many signs of improving conditions there are still issues impacting habitat that need to be addressed. Most sites that require restoration activities have been significantly impacted by existing infrastructure such as bridges and roads and natural recovery of these reaches is unlikely. The impacts caused by these sites can be mitigated using established restoration techniques and may include the installation of rock sills, deflectors, and bank stabilization.

The Watershed and Tributaries

Historically speaking the numbers of returning Atlantic salmon to the St. Mary's River have been declining since the early 1800s. In more recent years (1970 to present) the continued declines of Atlantic salmon have triggered the closure of sports fishing and Indigenous harvests. The closures of salmon fisheries were a result of the local salmon population failing to meet the conservation targets established by the Department of Fisheries and Oceans. Reasons for the decline in Atlantic salmon can likely be attributed to the changes to the watershed landscape and alterations to the instream habitat during the past two centuries as well as the impacts of acid rain in the later part of the 20th century.

Changes to fish populations like that experience in the St. Mary's River in the 1980s to the early 2000s are like the result of habitat degradation that occurred much earlier (1950s to 1980). There is generally a lag time in fish population response to changes in habitat quality. Conversely, the recovery of fish populations also lags the recovery of instream habitats. An analysis of historical aerial photographs of several reaches of the East River demonstrated that issues such as channel migration, over-widening of channel width and loss of pool habitat likely reached a peak in the early 1990s, therefore it is not surprising that population figures reached all-time lows during the early 2000s, subsequently leading to the closures of fisheries. Since the early 1980s regulations that protect fish habitat such as the Fisheries Act of 1984 have likely contributed to the recovery of some beneficial watershed processes. The prohibition of logging within the 30 meter buffer zone of all watercourses has likely contributed to improved ecological processes such as thermal regulation (e.g. tree shade) and improved complexity of instream habitat (e.g. the accumulation of large woody debris). Activities such as channelization (e.g., bulldozing streams into single thread channels and eliminating wide meanders) and tree harvesting within the riparian zone which were common during the post-war period were no longer permitted after the implementation of the Fisheries Act. Other regulations such as the protection of wetland habitats and the requirements for all road crossings over fish habitat to install fish passage have also begun to reverse a century of decreasing habitat availability and production.

Two other socio-economic factors have also occurred over the past few decades; first the decline in farming within the watershed has allowed reforestation of floodplains to occur in many areas and secondly the reduction in harmful, acidic industrial emissions has occurred since the 1990s. While the legacy impacts of acid rain continue to have some effect, the overall harm to fish populations is likely reducing with each passing year. With these factors in mind this report recommends approaching restoration from a process-based perspective, favoring the development of important ecological features such as riparian zones and large-woody debris over the highly prescription engineered designs that were used in the West Branch St. Mary's.

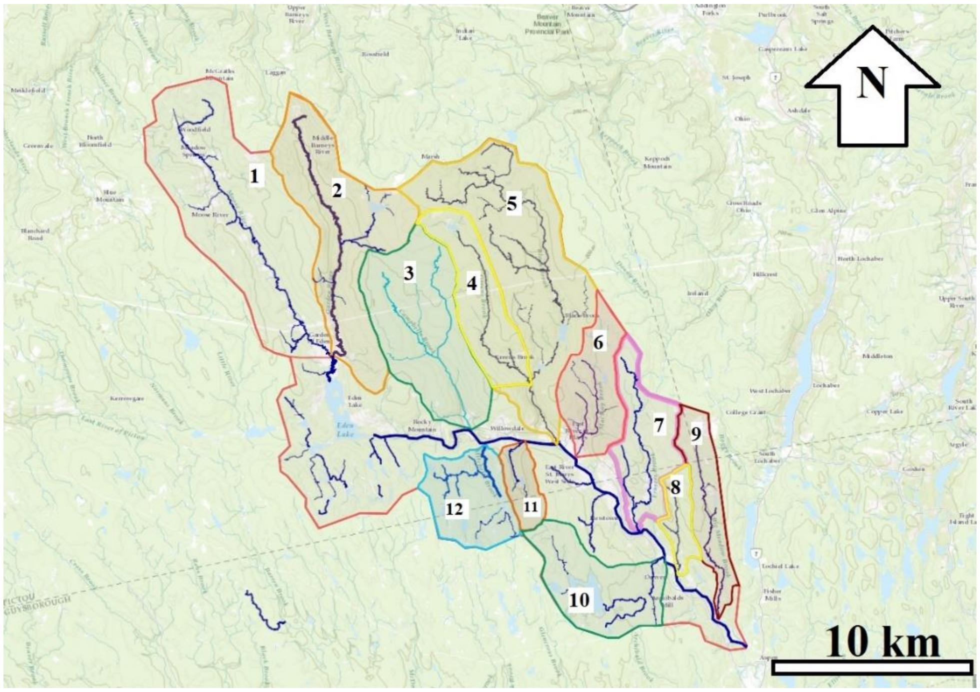

Figure 2: Figure 2: A Map of the East River St. Mary's Watershed with the sub-watersheds delineated and numbered. See table below for overview of sub-watershed characteristics.

The field surveys and habitat assessments used in this report found that instream habitat conditions have only recently started to display signs of recovery within the main channel of the East River. Signs of improving habitat conditions such as narrowing channel widths, improved instream cover and well-sorted spawning substrates were observed throughout the East River suggesting that a large-scale, continuous restoration project like the project recently completed on the West Branch would not be required. Rather the findings of this report suggest that the largest gain for habitat improvement could be achieved by focusing on extensive instream restoration of the tributaries using low-tech structures (e.g. digger logs and riparian zone plantings). Instream restoration within the main channel can be accomplished by focusing on high-priority sites where existing land-use and infrastructure (bridges and roads) will limit the ability for instream habitat recovery to occur naturally. Just as fish population response lags habitat degradation so to does the response of the population to improved habitat conditions. There is strong likelihood that the current habitat conditions could support a greater Atlantic salmon population than the current estimates suggest. The monitoring plan contained in this document will outline a strategy for SMRA to collect data to better understand current Atlantic salmon returns. Monitoring will occur on both restoration sites and several control sites.

Table 1

Tributary #	Tributary Name	Watershed Size	Main channel length	Potential area for habitat restoration	Number of Road Crossings
1	Moose River	53.37 sq. kilometers	15.19 km	10,000	7
2	Garden River	35.87 sq. kilometers	13.2 km	50,000 sq meters	2
3	Campbells Brook	30.85 sq. kilometers	4.5 km	5,000 sq meters	1
4	Greens Brook	16.70 sq. kilometers	6.8 km	5,000 sq meters	1
5	Black Brook	61.81 sq. kilometers	11.5 km	35,000 sq meters	1
6	MacKay Brook	14.24 sq. kilometers	4.14 km	N/A	1
7	Frasers Brook	15.14 sq. kilometers	5.77 km	15,000 sq meters	2
8	Harry Gunns Brook	5.23 sq. kilometers	3.36 km	N/A	1
9	Big Meadow Brook	11.44 sq. kilometers	6.5 km	N/A	2
10	Archibald Mills Brook	19.19 sq. kilometers	4.9 km	N/A	2
11	Leitch Lake Brook	5.22 sq. kilometers	2.46 km	N/A	0
12	Mitchells Brook	14.67 sq. kilometer	2.82 km	N/A	

Table 2: Overview of sub-watersheds.

Overview of habitat assessment and restoration recommendations

The condition of habitat in the East River St. Mary's can be attributed to the interactions between human development both historically and presently. Prior to 1950 much of the watershed had been cleared for pastoral agriculture and many tributaries and reaches of the East River had been altered during log drives and through the construction of dams. Since the first half of the 20th century most of the small rural communities throughout the watershed were abandoned or taken out of agricultural production. Like most watersheds in Nova Scotia, the most productive farmlands found in river valleys and floodplains have been maintained to varying degrees. The conversion between grazing agriculture and machine harvesting has played an important role in the present-day conditions and issues found within the watershed. Historical grazing practices made little consideration for watercourses and thus most riparian zone corridors were impacted by vegetation loss and animal impact. Currently most flood plain land is used to produce hay crops or corn for dairy operations. Due to the mechanized nature of modern agriculture many riparian zones have been able to establish strips of woody vegetation along the streambanks however streambank erosion is prevalent throughout these reaches due to the relatively young age of the trees and shrubs. The resistance to erosion along streambanks is directly related to the age and width of buffer zones. Where streambank erosion was observed either the vegetation was too young, or the buffer zone was too narrow to slow down erosion rates. In most cases where severe bank erosion was found there was a complete absence of streambank vegetation.

Given the relative immaturity and spatial coverage of the floodplain and riparian forests, the recovery of instream fish habitat has been compromised. Streambank erosion is a natural process which can maintain pools and rejuvenate spawning grounds with new gravels and cobbles. The issue with streambank erosion in the East River St. Mary's is that the rate of erosion has hastened and the benefits of erosion such as the accumulation of large woody debris are not occurring as a beneficial rate. These two factors can lead to a preponderance of instream silts, extensive channel migration and disruption of pool, riffle and run sequences. Addressing streambank erosion via traditional techniques such as armor rocking can eliminate issues such as siltation, but they also limit the future recovery of the broader ecosystem. Therefore, bank stabilization projects should be limited to reaches of stream where channel migration can not be tolerated such as bridge crossings and some agricultural areas. To maximize the benefits of banks stabilization projects should incorporate large woody debris (e.g. root wads) wherever possible and low-impact options for stabilization such as log revetments and hand-built log cribs should be completed wherever permission is granted. Benefits to low-impact approaches include less financial investment, a focus on manual labour (e.g. jobs) and a greater potential for long-term ecosystem recovery.

On a broader-scale issues affecting hydrology are present throughout most of the watershed. The activities for these changes are primarily related to clearcutting practices which disrupt and alter hydrologic regimes creating changes to flow volumes during bankfull discharge events also known as channel forming flows. Changes to the landscape that alter vegetation cover have a direct and immediate impact on the rate of surface runoff, a driver of bankfull discharge volumes. Within the sub-watersheds, large clearcuts can have a significant impact on hydrologic conditions leading to channel instability. It is important to recognize that the condition of instream habitat is a direct result of the hydrologic inputs (flow rate and volume) and how the river responds to those inputs within the confines of geological characteristics (valleys) and the presence, absence, or abundance of biological communities such as forests and wetlands. The full recovery of our aquatic ecosystems is dependent on the development of biological communities and minimizing significant macro-level changes. Therefore, to maximize the benefits of restoration efforts the scope of eligible activities should be expanded to include management orientated activities. From a conservation perspective, most of the East River St. Mary's watershed is “unrestored” however real-world restoration must take place within the limits of financial budgets and human capital, as such in areas where natural features are present and geomorphic recovery is being observed recommendations will be focused on preserving those natural features.

It is widely accepted that past ecological conditions were much more conducive to the Atlantic salmon's life cycle. It is important to conceptualize what those pre-European settlement environments would have looked like. Some evidence can be found in historic maps of Nova Scotia from 1867 and through new LiDar imaging technology. While it is difficult to get a quantitative description of habitats and fish populations it is obvious that the historic and highly productive ecosystems were characterized by wetlands, fully saturated floodplains, and braided channels. While re-establishing historic aquatic ecosystems throughout the entire watershed is limited by infrastructure such as roads, dwellings, and agriculture there are also many places where full ecosystem recovery is possible. Furthermore, full recovery in some reaches is possible without any intervention but may not occur should significant changes to land cover occur (clearcutting, wetland drainage).

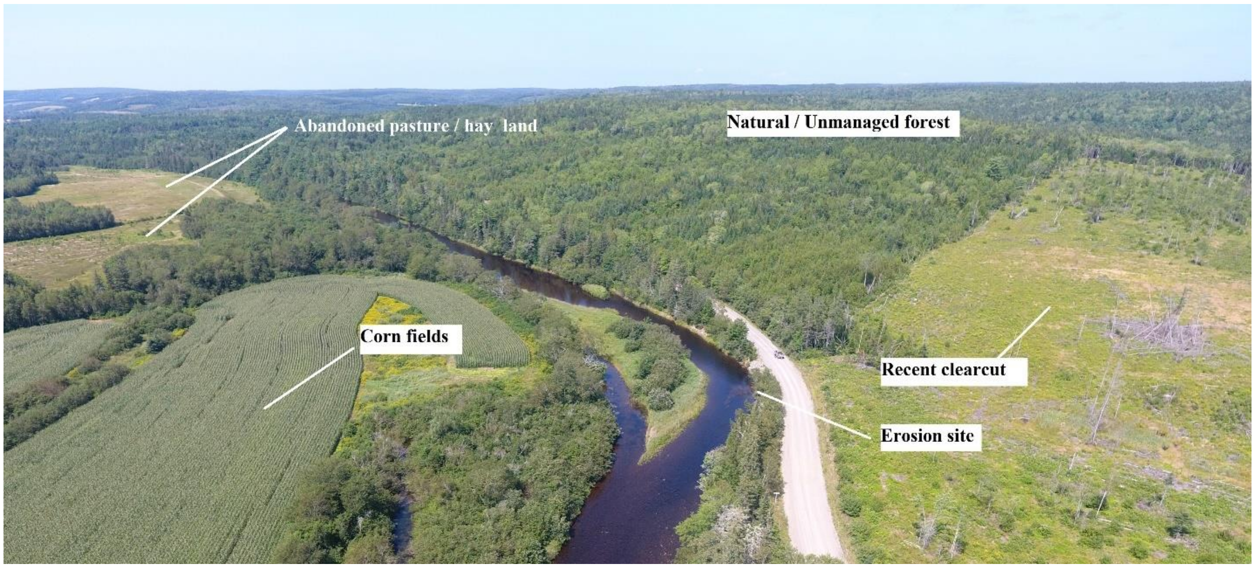

Figure 3: Land-use practices vary throughout the watershed.

The most scalable restoration activity that can occur immediately is to engage landowners where natural recovery of ecosystem processes has been observed and to develop plans for promoting the long-term facilitation of recovery. Completing monitoring activities such as electrofishing and sharing those results with landowners may help gain support and interest. Many landowners are surprised to learn that Atlantic salmon are still returning to the tributaries discussed in this report. Secondly the completion of immediate and high impact restoration sites such as the ones identified near Greens Brook Mountain Rd on the main channel of the East River (Loveless property) and the lower section of Blacks Brook will help attract community support.

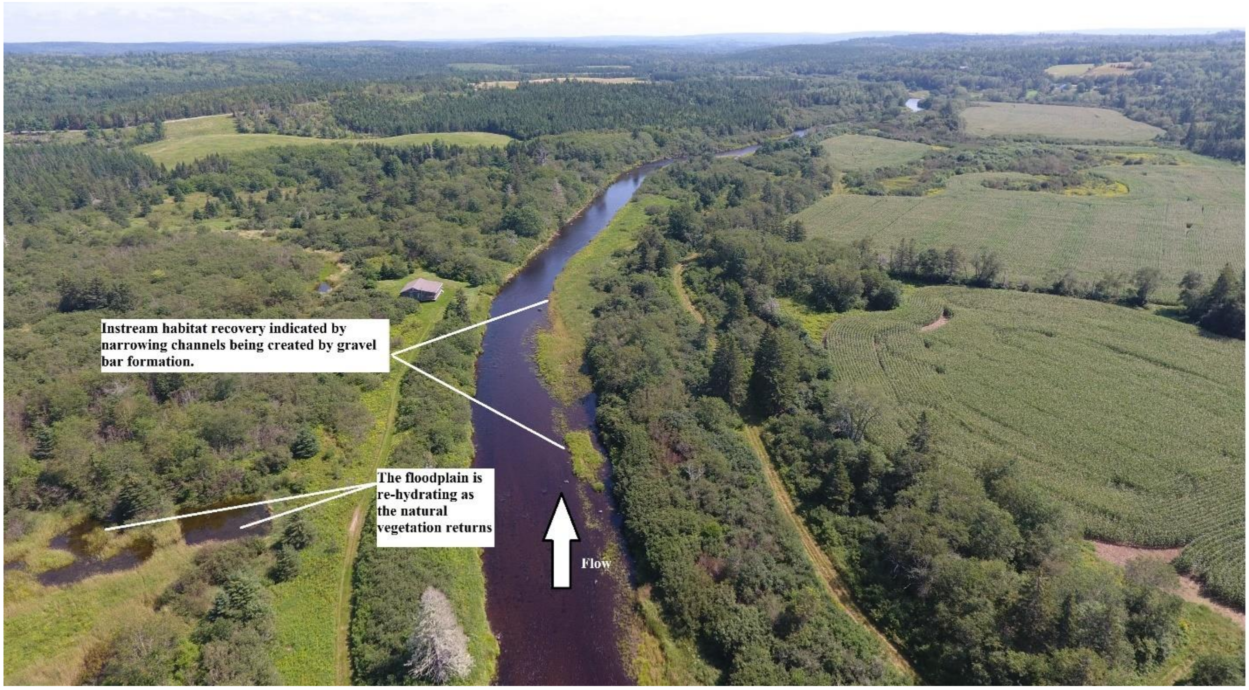

Figure 4: An aerial photo of the East River St. Mary's below the East River Road in Denver.

The assessment of fish habitat and recommendations for restoration are presented in greater detail in the next section of this report. To provide a thorough and sensible review of the habitat and subsequent restoration activities these topics will be addressed on a tributary-by-tributary basis for the sub-watersheds and a reach-by-reach basis for the main channel. The report will conclude with a five-year restoration and monitoring plan for SMRA to implement the recommendations contained in this report. The restoration activities presented in this plan are prioritized based on several metrics including landowner permission, severity of degradation and the potential to prevent serious adverse effects to occur or exacerbate.

While restoration work is proposed in several tributaries within the East River, not all the tributaries had potential for restoration work therefore priority for assessment and planning work were given to streams and reaches within the East River St. Mary's watershed that had potential for instream restoration work. For example, watersheds such as Greens Brook and Archibald Mills Brook largely contain habitat that is inaccessible to salmon and trout due to barriers to fish passage.

Overview of Restoration Plan

This restoration plan is focused on providing a step-wise year to year plan for the St. Mary's River Association to guide their future river restoration activities. The plan focuses specifically on what is possible to complete in the next five years (2022-2026) assuming similar levels of volunteer commitment and financial support that have been typical for their organization over the past decade. A five year plan also represents the most feasible time frame for river restoration work to be planned for. The changing nature of river systems generally makes planning specific activities in the long term a difficult task. This plan does contain recommendations for SMRA to engage in the promotion of landscape activities that are more conducive to creating hydrological stability within the East River St. Mary's watershed. These management-based recommendations will require commitment beyond the scope of five years to create meaningful impacts on the aquatic ecosystem. The implementation of this five-year plan should expand community interest in SMRA's river restoration program which will help foster public awareness of Atlantic salmon conservation opportunities in the watershed.

Table 3

Year	Planned Restoration Activity and description of restoration results	Square Meters Restored	Financial Budget
2022	**East River (Site 001, Loveless property)** Restoration will be completed to address stream bank erosion and to establish a wooded riparian zone. Techniques used to complete this project include bank stabilization using rock and root wads and through tree planting native floodplain tree species to create a buzzer zone. This project will improve summer water temperatures and will minimize sediment supply that is impacting downstream spawning habitat.	8500	$140,000
	Frasers Brook Work on Frasers Brook will be completed using field crew and will involve the installation of digger logs and deflectors above the East River Road crossing. The work will involve the restoration of approximately 2.5 kilometers of channel. The goal of this project is to improve spawning and pool habitat.	15,000	$60,000
	Garden River – Culvert Remediation This project will be focused on restoring fish passage at the Garden River – MacIntosh Road crossing. Currently several undersized and improperly installed culverts are causing habitat degradation and blocking fish migration. The Department of Transportation will need to be engaged.	30,000*	$100,000
	Total	**53,000 sq. m**	**$300,000**
2023	**East River – Site 002 (Newtown / Hwy 347)** This project is directly above the East River – Highway 347 crossing and will involve bank stabilization and potentially the installation of an upstream sill to prevent channel migration above the bridge. Presently the channel is causing excessive erosion upstream of the bridge which is causing siltation. This site is not	2,000	$45,000

	excessively large but the issues are having a significant impact downstream and the intersection with the highway bridge leaves little room for natural channel migration to occur.		
	Garden River – Instream Restoration Beginning downstream from MacIntosh Road, this project will be completed using a restoration crew and hand tools. The impact of the improperly installed culverts on MacIntosh Road have caused severe channel braiding and improper sediment distribution. The installation of deflectors and digger logs will help reestablish a natural and stable meander pattern.	20,000	$80,000
	Black Brook – Lower Section Erosion Control This site is located about 200 meters above the Black Brook – East River St. Mary's confluence and requires bank stabilization and riparian zone establishment. This project can be completed by installing armor stone and root wads to stabilize the bank erosion and through tree planting to establish a riparian zone.	4000	$45,000
	Total	**26,000 sq. m**	**$170,000**
2024	**Black Brook – Above Highway 347** This project will involve the installation of single-tiered wood deflectors which are designed to decrease channel width, increase pool habitat, and improve spawning conditions. This work will be completed using hand tools and a restoration crew.	30,000	$120,000
	East River – Site 003 Below East River Rd This project will focus on the main channel of the East River and the goal is to narrow the channel through the installation of single-tiered deflectors. These deflectors are designed to encourage the formation of gravel bars, thus narrowing the channel. Currently the channel is 30 meters wide and should be closer to 20 meters width.	10,000	$40,000
	East River – Site 004 Below Black Brook Bank stabilization work to be completed with machines and armor rocking / root wad structures.	5,000	$40,000
	Total	**45,000 sq. meters**	**$200,000**
2025	**East River – Site 005 Below West Side Rd Bridge** This project will address significant erosion issues located approximately 400 meters downstream of the West Side Rd bridge. Historical channelization activities likely done to protect road infrastructure and farming have created an over-widened channel that lacks a natural meander pattern. Restoration will be	10,000	$70,000

	achieved through the installation of a series of log deflectors and bank stabilization work on severely eroding banks.		
	East River – Site 006 Archibald Farm Property This project will be completed primarily using heavy equipment and will involve the installation of armor rock with root wads. Deflectors will also be built using machines where necessary. Access could be difficult through some sections of this project site so crew work (e.g. log deflectors) may be required to complete project.	20,000	$100,000
	Moose River Project will be completed using restoration crew to install log deflectors to improve meander sequencing. Riparian zone enhancement will be completed through tree planting. The installation of deflectors should help promote the establishment of gravel bars which will address issues such as scoured substrate (e.g. bedrock bottom).	10,000	$40,000
	Total	**40,000**	**$210,000**
2026	**East River – Site 007 Site West Side Rd** Streambank erosion throughout this site is causing excessive siltation to downstream spawning habitat. The erosion is leading to a lateral channel migration at the expensive of thalweg development. Adding stability to the erosion sites by using stone and root wads will help slow down lateral channel migration and should facilitate the scouring of pool habitat.	15,000	$80,000
	East River – Site 008 Below Garden of Eden Lake The headwaters of the East River which flow out of the Garden of Eden Lake have potential for habitat restoration using a restoration crew and hand tools. Structures such as single-tier deflectors and bank logs can be used throughout this section and will help create a more stable meander pattern.	10,000	$60,000
	Total	**25,000 sq. m**	**$140,000**
Total for Five Year (2022-26) Restoration Plan		**189,000 sq. meters**	**$1,020,000**
*Indicates the square meters of habitat with restored fish access.			

Moose River Sub-watershed

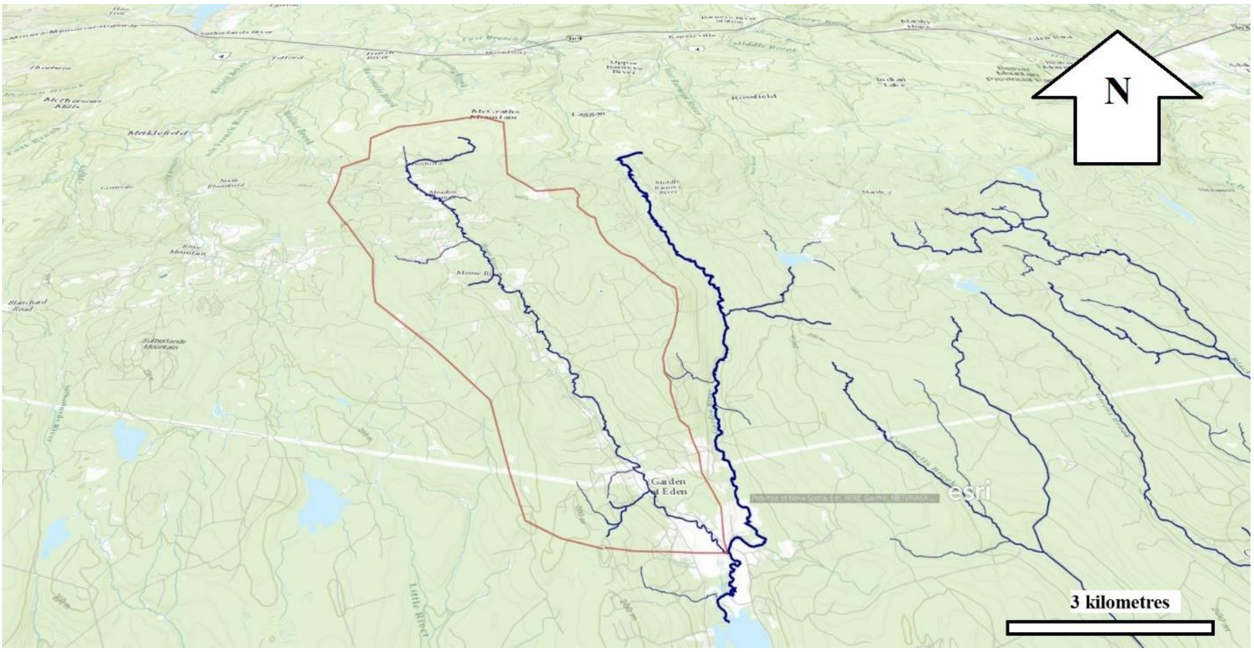

Figure 5: Topographic map of the Moose River watershed with boundaries delineated in red.

Watershed Characteristics	Applicable restoration techniques	Challenges with implementing restoration
- The primary land-use practices in this watershed are agricultural and commercial forestry. - Much of the lower reaches received agricultural funding in the 1970s and 1980s to stabilize bank erosion and protect blueberry fields. - The river appears to have sufficient pool frequency and quality to support adult life stages of Atlantic salmon and Brook trout. - Spawning habitat could be improved through the installation of log structures. Long-term ecosystem resiliency can be supported through riparian zone plantings.	- Tree planting and riparian zone protection. - Bank stabilization. - Rock sills and deflectors. - Log structures such as digger logs and log deflectors. - Potential for wetland restoration in upper reaches of watershed.	- Upper portion of watershed is partly inaccessible for machines and crews which could limit the potential for restoration in those areas. - Agricultural practices have encroached on sections of the floodplain limiting the potential for full restoration. - Sections of Moose River are low gradient >1% slope limiting the use of some structures such as digger logs.

Figure 6: Many sections of Moose River in reach #2 appeared to be narrowing naturally as indicated by the vegetated gravel bars.

Figure 7: Controlled stream bank erosion above a section of bedrock bottomed stream.

Figure 8: Exposed bedrock indicating significant down-cutting of stream bed during past century.

Figure 9: Stream bank stabilization work that occurred in the 1980s as part of an agricultural program.

Garden River Sub-watershed

Garden River contains excellent juvenile rearing habitat for Atlantic salmon and excellent habitat for all life stages of Brook trout. The biggest detriment to Atlantic salmon and brook trout populations in this system is a barrier to fish passage located where Garden River crosses MacIntosh Rd. This road crossing contains several under-sized culverts which are positioned directly above the channel as well as in the broader flood plain. A remediation plan is required.

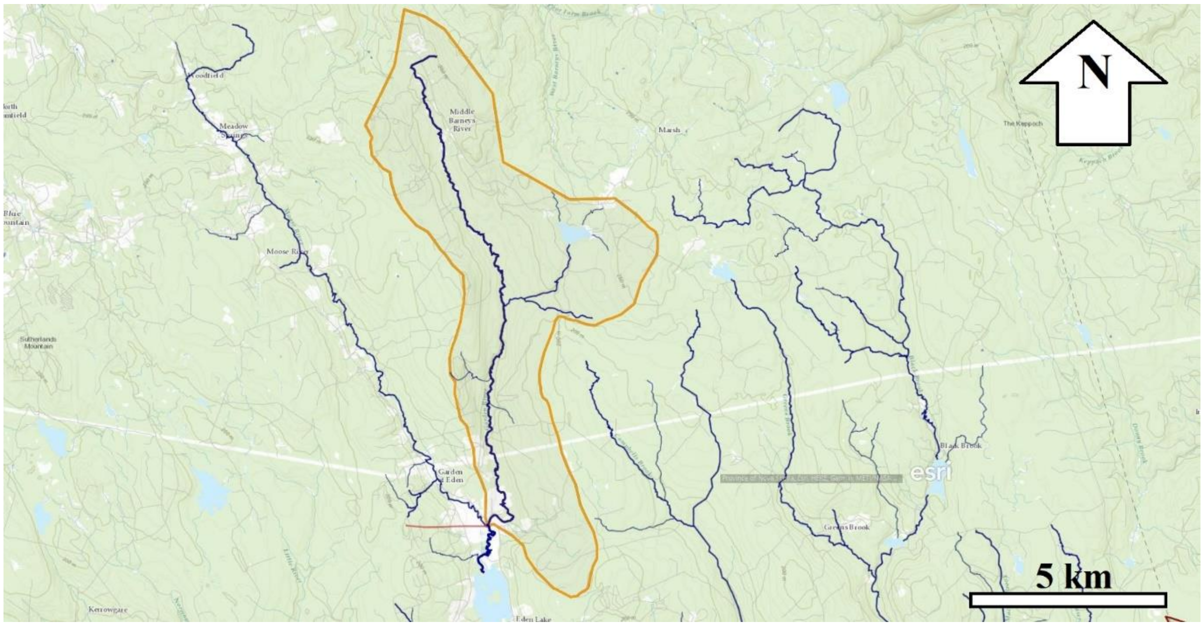

Figure 10: Garden River watershed

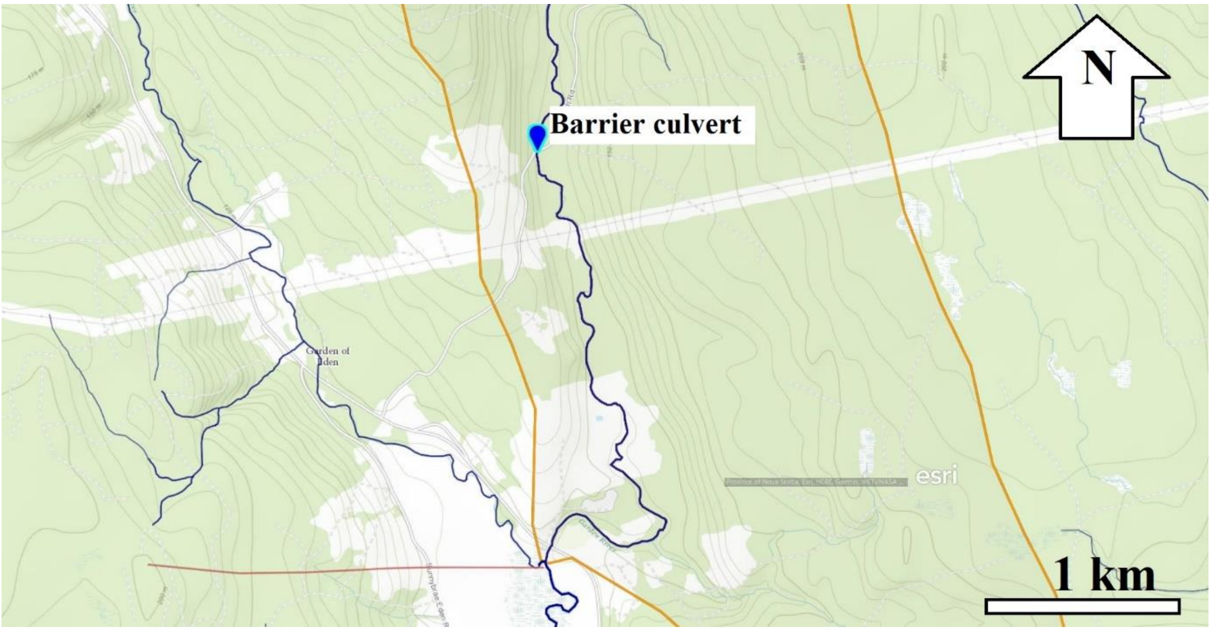

Figure 11: Topographic map with a pin dropped to indicate the location of the barrier culvert relative to Garden River's confluence with the East River. The culvert is creating geomorphic instability and limiting fish passage.

Watershed Characteristics	Applicable restoration techniques	Challenges with implementing restoration
- Primary land-use within Garden River watershed are industrial forestry, small woodlot management and blueberry crop production. - Lower 1/3 of the river has been fragmented by barrier culverts where Garden River crosses the MacIntosh Road. - The river appears to have sufficient pool frequency and quality to support adult life stages of Atlantic salmon and Brook trout. - Excellent spawning habitat present in some reaches. Substrate throughout lower 3 reaches is suitable for restoration work. - Long-term ecosystem resiliency can be supported through riparian zone plantings especially in reach #2.	- Replacement or mitigation of barrier culverts located at the Garden River – MacIntosh Road crossing. - Tree planting and riparian zone protection. - Bank stabilization. - Rock sills and deflectors. - Log structures such as digger logs and log deflectors. - Potential for wetland restoration in upper reaches of watershed.	- Upper portion of watershed is partly inaccessible for machines and crews which could limit the potential for restoration in those areas. - Agricultural practices have encroached on sections of the floodplain limiting the potential for full restoration.

Figure 12: Looking upstream through the main culvert. Partial fish passage was available at this time (Sept 2021).

Figure 13: Looking east on the down-stream side of the Garden River – MacIntosh Road Crossing. Pictured on the left is an overflow culvert.

Figure 14: Looking upstream above the Garden River – MacIntosh Road crossing. Salmon parr were observed.

Figure 15: Looking downstream from the barrier culvert Garden River.

Figure 16: Meeting with the landowner, Calvin Fraser to discuss history of culvert installations and road wash-outs.

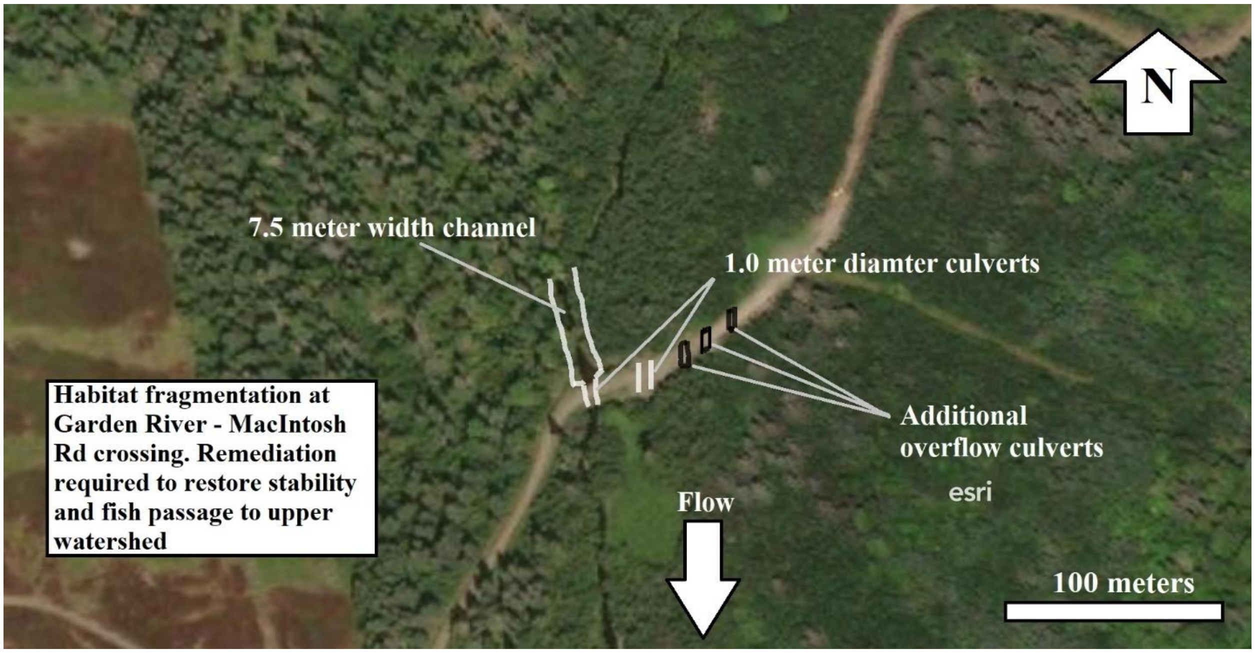

Figure 17: Partial barrier culvert located at -62.30295W, 45.44278N with layout of overflow culverts.

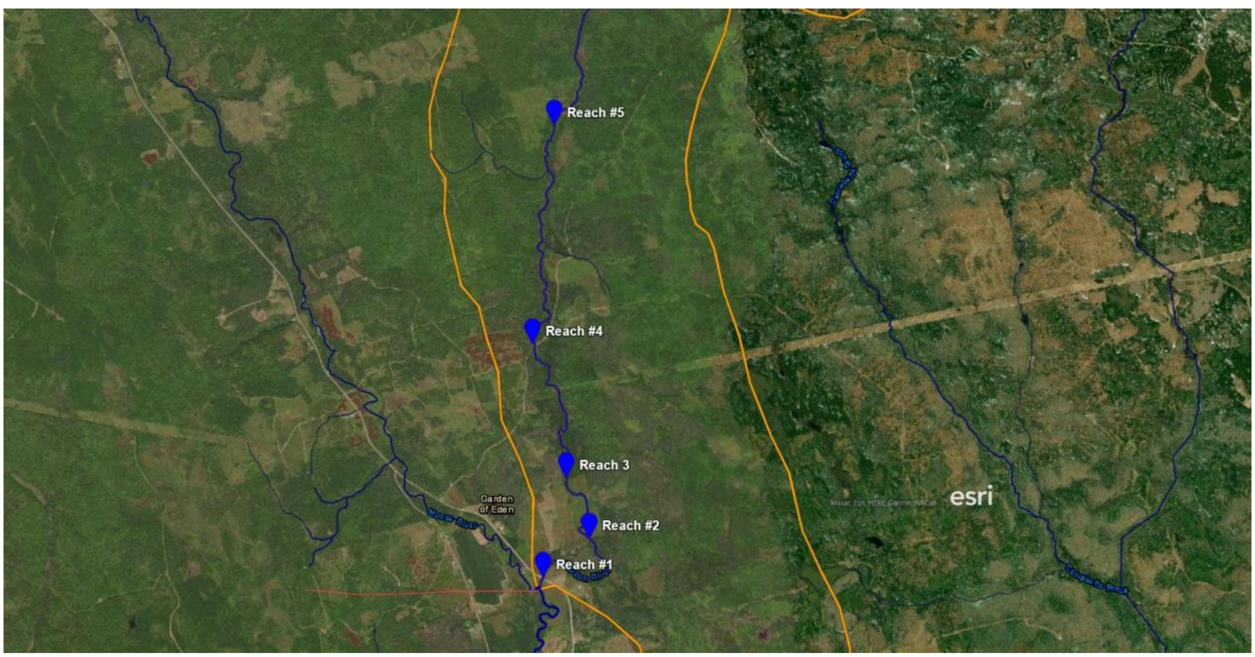

Figure 18: Satellite image of Garden River with bottom of each reach pinpointed.

Campbells Brook

Campbells Brook is an important salmon spawning and nursery tributary with salmon redds being observed in the fall of 2020. Most of the channel meanders through an active beef farming operation. According to the landowner (Westland MacLellan) they received funding from a provincial government program in the early 1980s that was aimed at reducing streambank erosion through farmland. This work has eliminated most erosion issues through the lower three reaches of the brook; however the extensive nature of the armor rocking created an imbalance between the scour energy in Campbell's Brook and the sediment supply. This reduced spawning substrate and promoted channel incision. The bank stabilization projects likely attributed to the overall absence of large woody debris that was observed in the channel in 2011. Fortunately, the impact of bank stabilization work has lessened in recent years following riparian zone protection.

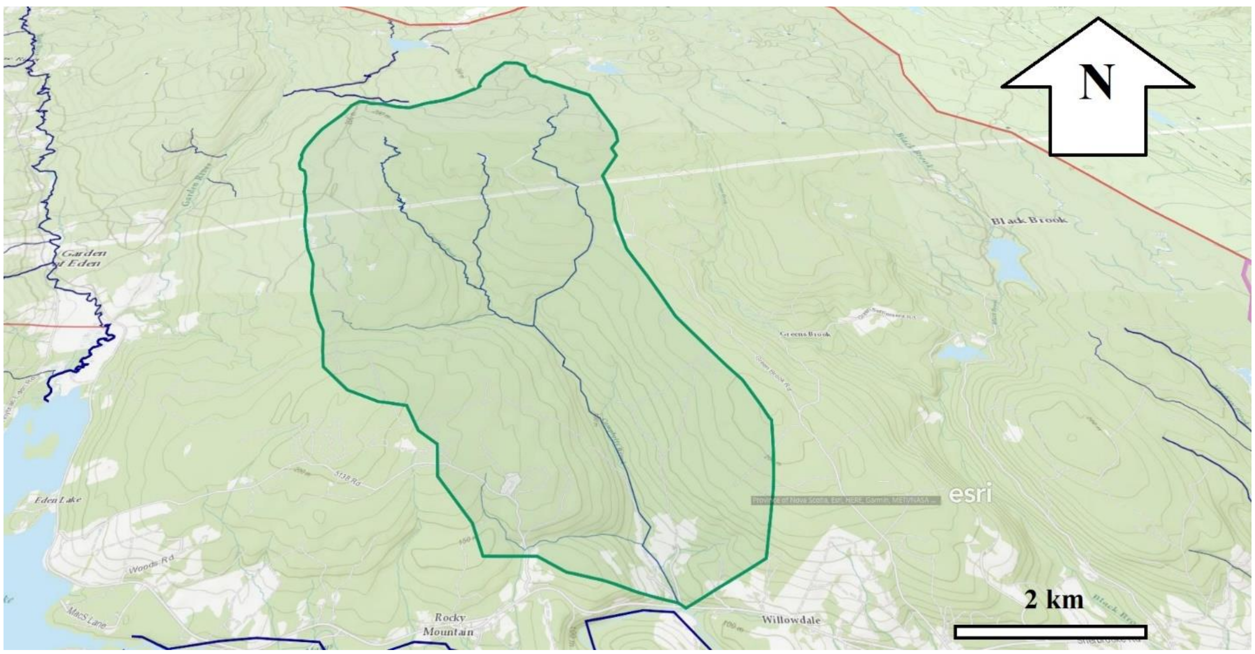

Figure 19: Topographic map of Campbells Brook

The habitat throughout most of this tributary was surveyed as part of a restoration plan completed by SMRA in 2011. The restoration plan entitled "*DETAILED SURVEYS AND RESTORATION PLANNING FOR TWO STREAMS IN THE ST. MARY'S RIVER WATERSHED"* provides a good characterization of the baseline habitat conditions and limiting factors that were present in Campbell's Brook about a decade ago:

The channel is dominated by riffle habitat. There is little riparian cover, obvious crossing of the stream by cattle, and over-widening of the channel. It is also notable by a lack of large woody debris. Substrate is large and indications are that the stream has considerable power of flow. Limiting factors in this stream are: (1) Lack of habitat diversity, (2) Reduction of use of upstream *sections of this stream, due to access difficulties, (3) Lack of cover for protection from predators, (4) and likely also includes temperature extremes and ice scour.*

In 2021, the impacts of the 4 previously identified limiting factors has lessened from positive changes to the channel geomorphology, driven primarily by the return of riparian zone vegetation which has occurred following livestock fencing and through the accumulation of large woody debris which has promoted the formation of gravel bars and improved meander pattern of the channel. Both instream cover and overhead cover have improved as well, limiting the impact of predation on trout and salmon. As the extent of the riparian zone expands and colonizes the newly formed gravel bars the instream habitat should improve and further stabilize.

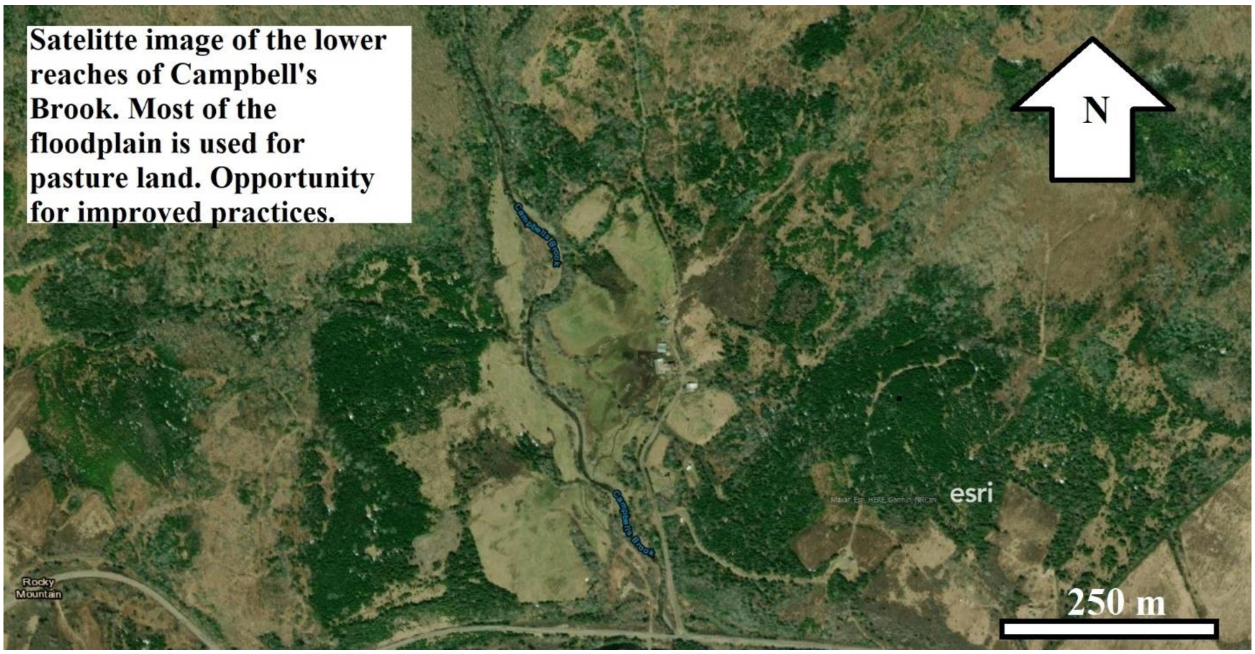

Figure 20: Satellite image of Campbells Brook.

The accumulation of large-woody debris increases 'channel roughness' decreases the rate of sediment transport through the river system. Previous surveys in 2011 observed scouring throughout much of the lower reaches, with some sections containing bedrock stream bottom. Scouring is a result of an imbalance in sediment supply and the energy of water transport. By increasing channel roughness, energy during high-flow events is disrupted which allows for sediments such as boulders, gravel, and cobble to settle and form gravel bars. As this process unfolds over a series of years the meander patterns become more sinuous, a term to describe the extent of a channel's meander pattern spread across the floodplain. Generally, high channel sinuosity is associated with stable channel habitats and healthy aquatic ecosystems. As channel sinuosity improves so to does the survival of eggs and all life stages of juvenile Atlantic salmon. Greater sinuosity also improves pool depth and ensures proper pool frequency (one pool per six channel widths).

The 2011 report concluded by saying that "restoration of Campbell's Brook will be intensive and expensive due to the requirement of rockwork and machine time". This assessment was prior to the implementation of a riparian zone project that was completed around 2013 that was part of a wood turtle conservation project. Since the fencing project, the riparian zone vegetation has improved and now contains alders, choke cherries and other pioneer floodplain tree and shrub species. It remains unclear what affect the riparian zone recovery has had on the accumulation of large woody debris, regardless the frequency of embedded wood has greatly increased during the past decade. Moving forward there is still work that can be done to improve fish habitat and overall watershed processes within the lower reaches (accessible stream) of Campbell's Brook. Potential activities to further improve habitat include the installation of log deflectors and high-density plantings of willow trees along areas that have been armor rocked in the past. Adding willow trees to these banks may limit the ricochet effect that armor rock can have on instream flows, particularly during bankfull discharge events. What is now needed to improve the habitat in Campbell's Brook is to engage the landowner and inquire about partnering on improving management practices, such as improved livestock fencing and improved grazing practices. Tree planting is also recommended, with a focus on planting rooted willow cuttings throughout the entire lower reaches wherever armor rock has been used to stabilize bank erosion.

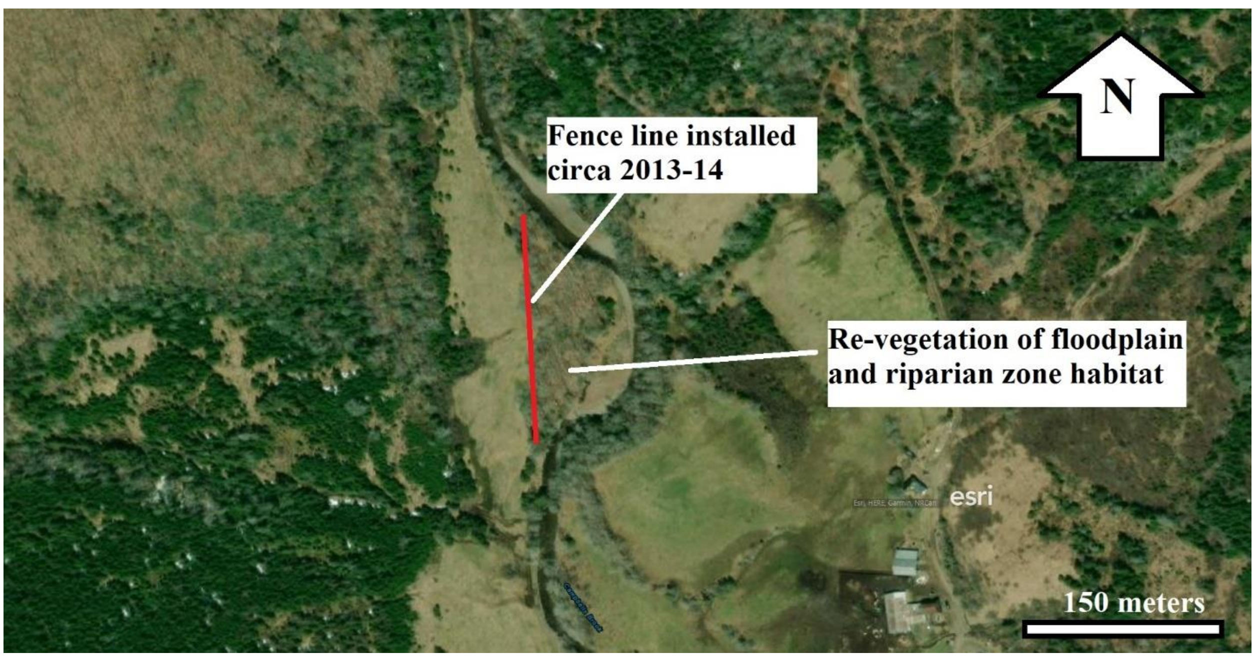

Figure 21: Satellite image of the riparian zone restoration work completed for wood turtle conservation.

The upper sections of Campbell's Brook have limited access, whether by machine or on foot. The steep slopes along both sides of the river valley have discouraged most type of resource based activities, including forestry. With an intact riparian zone, poor access and steep gradient the upper reaches of Campbell's Brook are not worth consideration for short to mid terms restoration priorities in the watershed. The highest potential for instream salmon production on a per meter basis can be found in the lower reaches and that is where restoration effort should be spent.

Summary Table for Campbell's Brook

Watershed Characteristics	Applicable restoration techniques	Challenges with implementing restoration
- Primary land-use within Campbells Brook is pastureland for beef cattle. Some land is under forest management and the rest is unmanaged forest. - Atlantic salmon redds were observed throughout the lower section of Campbells Brook in 2020 and water PH is good. - The river appears to have sufficient pool frequency and quality to support adult life stages of Atlantic salmon and Brook trout. - Significant bank stabilization work was completed in the 1980s likely as part of a agricultural program - Improved river functions can be gained through livestock fencing, riparian zone planting and through large-woody debris structures such as deflectors. - Lower section of the river has been primarily fenced off through a wood turtle conservation initiative in the last decade.	- Replacement or mitigation of barrier culverts. - Tree planting and riparian zone protection. - Bank stabilization. - Rock sills and deflectors. - Log structures such as digger logs and log deflectors. - Improving livestock grazing practices by implementing rotational grazing and installing water troughs.	- Upper portion of watershed is partly inaccessible for machines and crews which could limit the potential for restoration in those areas. - Agricultural practices have encroached on sections of the floodplain limiting the potential for full restoration. - The landowner is quite pleased with the stability of instream habitat that followed the extensive bank stabilization projects in the 1980s and riparian zone protection in the early 2010s.

Greens Brook

Greens Brook sub-watershed has a drainage basin of 16.7 square kilometers and is a tributary to the Black Brook. There is some potential for restoration work but the potential to have a major impact on the salmon returns in the East River watershed is limited by a natural barrier falls (figure 23) located approximately 150 meters downstream from the Greens Brook Settlement Road (-62.20211W, 45.42214N). Most of the watershed is inaccessible to salmonids due to the natural barrier and therefore the scope of restoration work is quite narrow. Upstream from the barrier falls the habitat is primarily low-gradient and highly inundated with wetlands. During the early 1900s the watershed was almost entirely cleared for agriculture and evidence of past attempts at draining the wetlands and floodplains still exist.

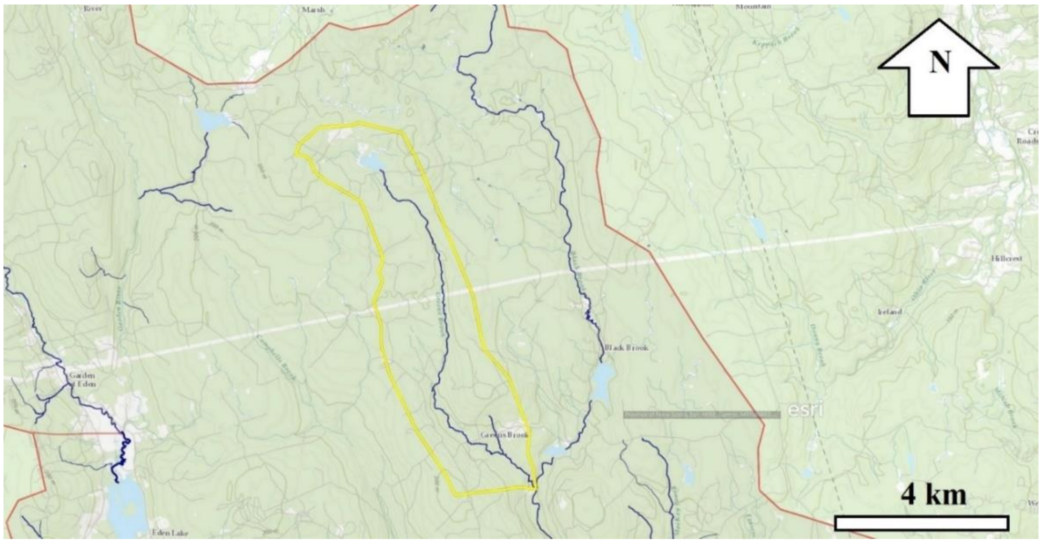

Figure 22: Topographic map of Greens Brook watershed (delineated in yellow).

Figure 23: Significant barrier falls below Greens Brook Settlement Rd.

Figure 24: Greens Brook directly above Greens Brook Settlement Rd.

Figure 25: Greens Brook approximately 400 meters upstream from Greens Brook Settlement Rd.

Figure 26: Return of floodplain vegetation after the agricultural land had been abandoned.

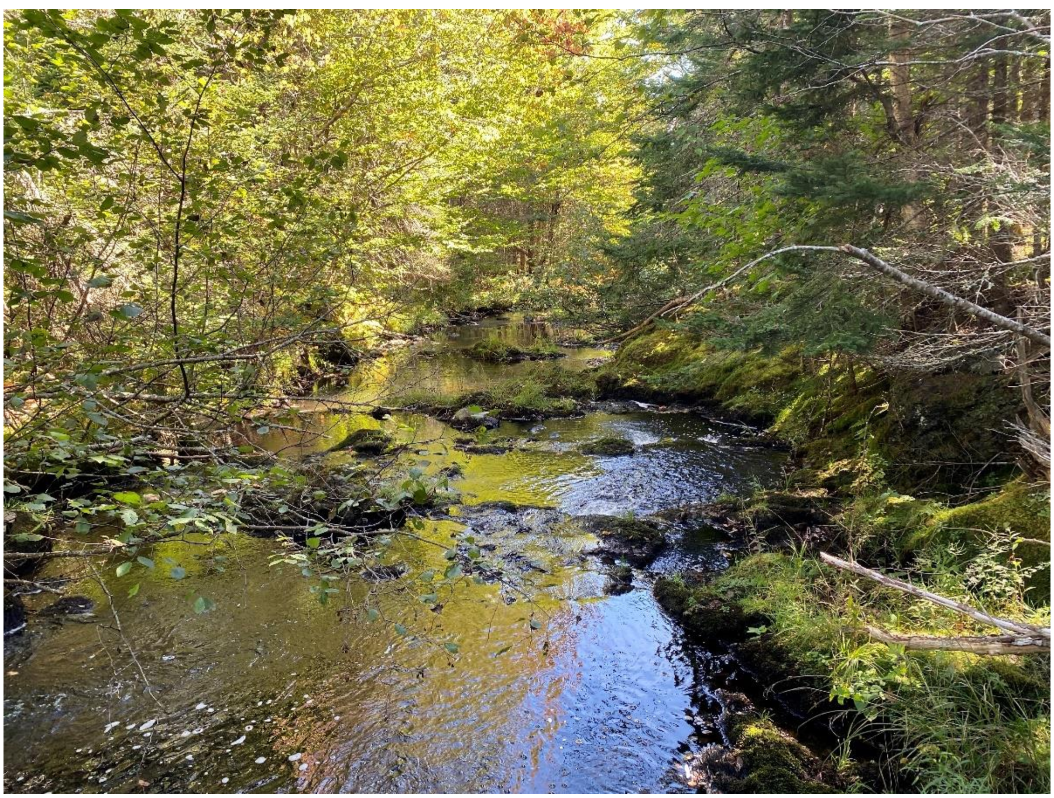

Figure 27: Historical channelization is beginning to recover following floodplain reforestation.

Figure 28: Looking downstream on Greens Brook, substrate has been scoured to bedrock.

Figure 29: Forestry Road construction creating siltation near the Greens Brook - Black Brook confluence.

Black Brook

The Black Brook watershed (figure 30) has an area of 61 square kilometers of primarily forested landscape characterized by steep slopes and waterfalls. The lower three kilometers of Blacks Brook contain an abundance of accessible Atlantic salmon habitat, above this mark the channel flows over a significant waterfall which is a complete barrier to fish passage. There is no local knowledge of seatrout or Atlantic salmon being able to migrate above the falls. The lower 3 kilometers of channel has a bankfull width of approximately 11.5 meters and there is potential for restoring over 33,000 square meters of habitat in this area. Restoration could be completed primarily with crew work, installing structures such as single-tier deflectors and riparian zone enhancement. The condition of instream fish habitat in Black Brook varied from reach to reach. Some sections contained signs of recovery, while other areas showed signs of instability (steep riffles and diagonal bars across the riffles, figure 3x and 3x)

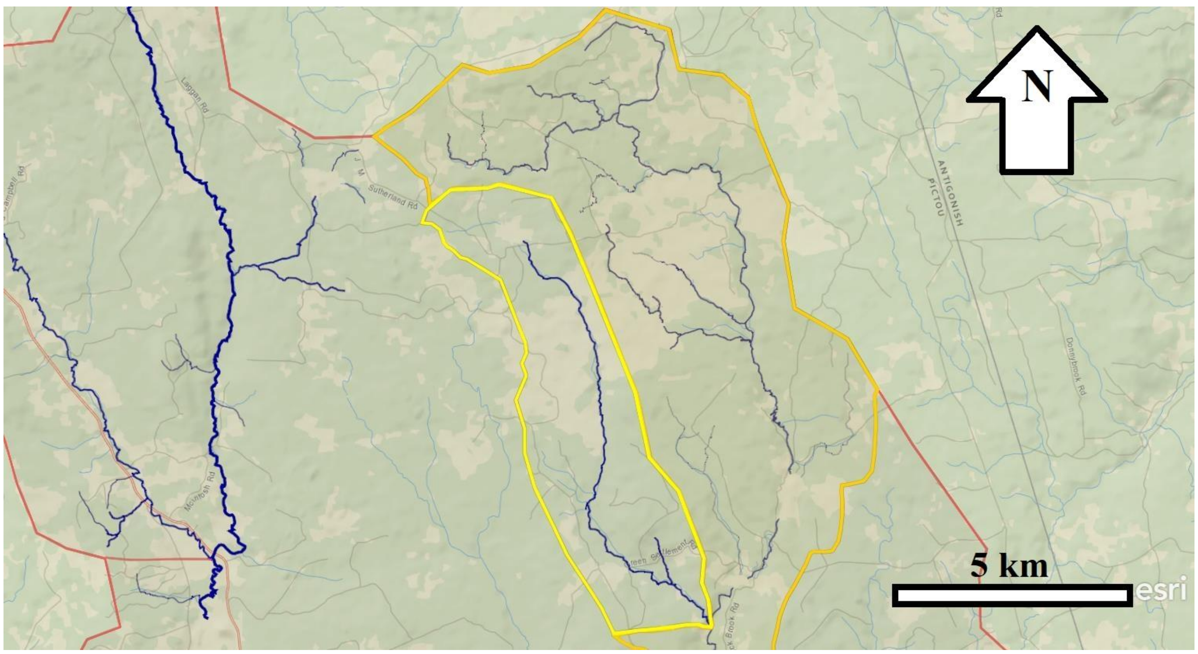

Figure 30: Topographic map of Black Brook watershed (border highlighted in orange). Greens Brook a tributary to Blacks is highlighted in yellow on the western portion of the watershed.

Restoration work in Black Brook can be divided into two sections; the first is above the Highway 347 bridge and the second section is below the Highway bridge to where Black Brook joins the main channel of the East River St. Mary’s. This plan recommends that work in the lower section of Black Brook take place during the 2023 field season, this work will be completed primarily using heavy equipment which will place armor stone and root wads. Following this work a tree planting crew should be used to plant a 10-meter-wide buffer zone along the stream. If the proposed culvert remediation on Garden River does not proceed in 2022 this project on Black Brook would make a suitable alternative for SMRA to pursue. The planned work on Black Brook that is proposed for above Highway 347 could be completed during the 2024 field season.

Figure 31: Satellite image of lower Black Brook

The design of bank stabilization work on this project should be completed within the context that the potential for significant lateral channel migration at this erosion site is limited. The bank height along the erosion site is quite high and the chances of the channel cutting a new path into the field is unlikely. The channel in this site also runs along the easternly terrace of the floodplain (see figure 32) therefore it is likely that extensive lateral channel migration is unlikely to exceed 0.5 meters annually and will likely begin to stabilize before another 2 meters of bank is lost. An emphasize on establishing a 5 to 10 meter buffer zone through tree planting is required.

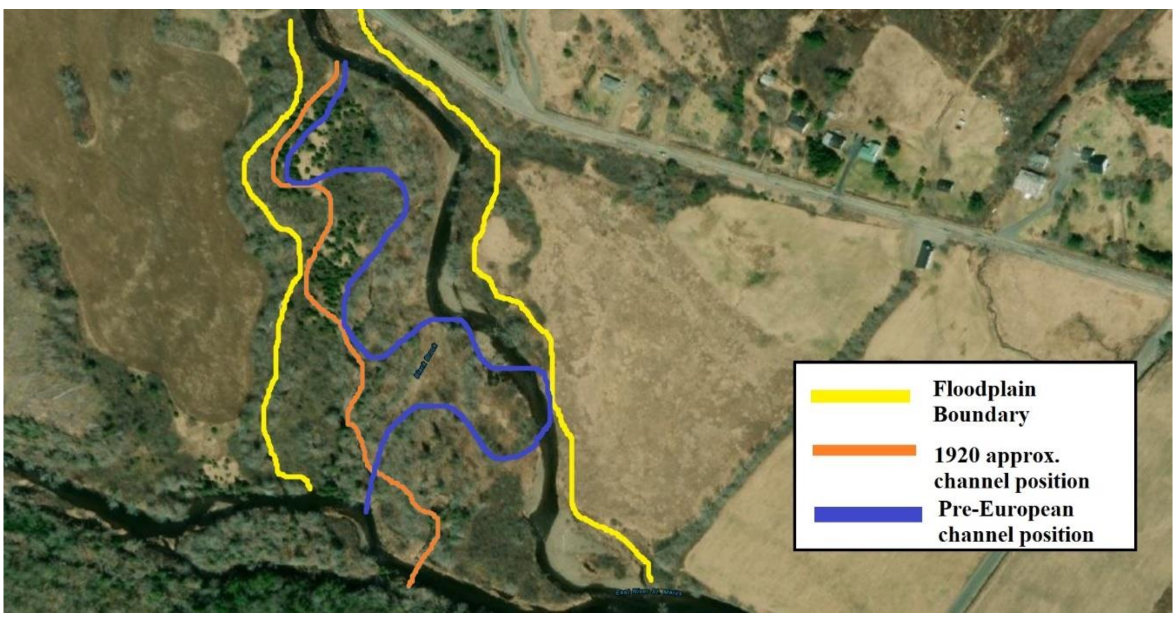

Figure 32: A review of LiDar imaging found that this reach of channel has been highly mobile. Evidence of past channelization work was found below the bridge and along the farm land.

Figure 33: Wide diagonal bars like the one shown above indicate channel instability.

Figure 34: Looking upstream above the bank erosion site. Black Brook has been transporting significant sediment loads in recent years.

Figure 35: Above the erosion site, bank erosion and accumulation of large woody debris.

Figure 36: Large gravel bar accumulating 40 meters above the Black Brook – East River confluence.

Figure 37: Looking upstream at bank erosion site. Photo taken 40 meters above confluence with East River.

Figure 38: Looking upstream at severe bank erosion.

Figure 39: Close up look at eroding bank on Black Brook. Average bank height was 2 meters.

Figure 40: Looking upstream on Black Brook, approximately 50 meters above confluence with East River.

Figure 41: Looking downstream on the East River below the confluence with Black Brook.

Fraser's Brook Sub-watershed

Fraser's Brook

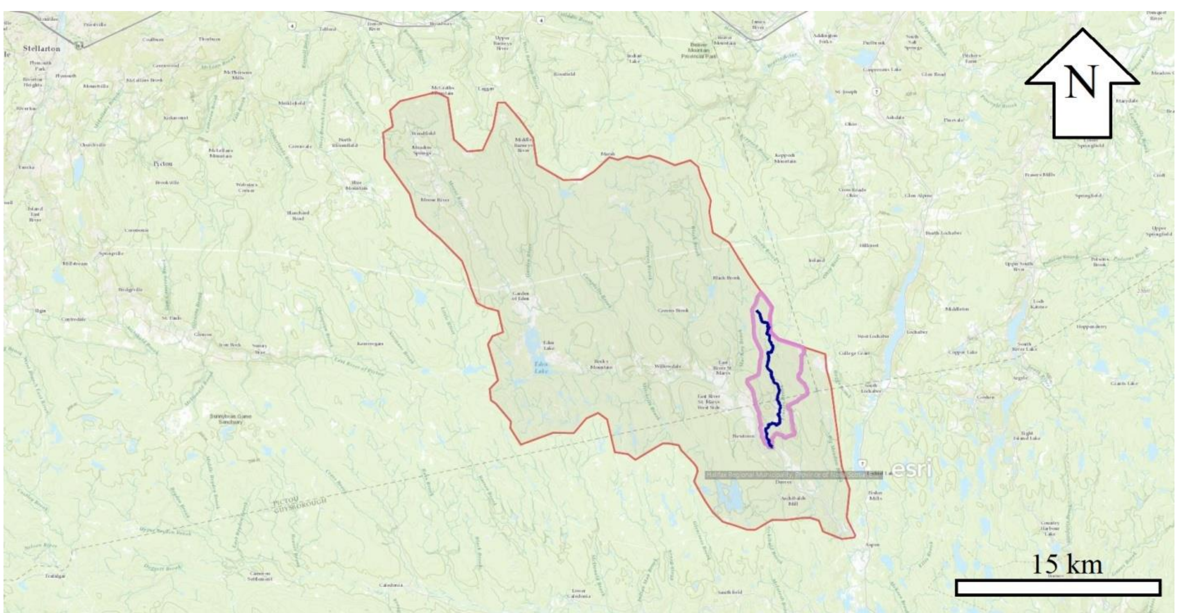

Figure 42: Topographic map displaying Frasers Brook relative to the rest of the East River watershed.

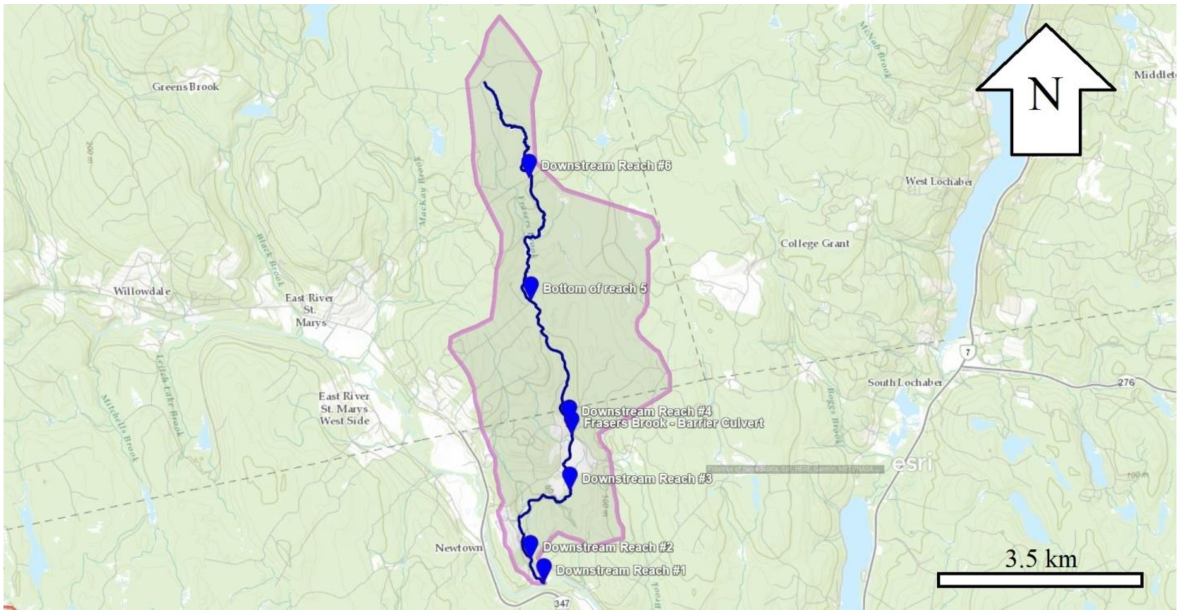

Figure 43: Topographic map of Frasers Brook with five potential restoration reaches indentified.

Figure 44: Signs of past channelization. Looking upstream on Frasers Brook.

Figure 45: Debris accumulation below forestry harvest.

Figure 46: Looking upstream along Frasers Brook. Forest harvesting occurred with the protected buffer zone.

Reach #	Stream Length	Calculated Bankfull Width	Potential Habitat (sq. meters)	General Characteristics and restoration potential
1	1500 m	7.15	10,710 sq. m	This reach contains several pools, spawning habitat and lots of instream cover (e.g. woody debris). The riparian zone and floodplain have been impacted by residential and agricultural activity. There is a privately owned bridge to a residence on the west side of the brook therefore restoration work is not recommended in this section.
2	2000 m	7.10	14,200 sq. m	
3	1200 m	6.58	7,900 sq. m	
4	3400 m	6.32	21,488 sq. m	
5	2400 m	5.24 m	12,576 sq. m	
6	2100 m	3.82 m	7,900 sq. m	

East River Main Channel

Beginning at the outflow of the Garden of Eden Lake, the East River St. Mary's runs south-easterly towards the community of Aspen where it joins the North Branch of the St. Mary's River and flows into Glenelg Lake. Signs of habitat recovery were observed throughout most of the East River, however issues such as bank erosion, channel incision, infrastructure floodplain encroachment and a lack of instream woody debris are all contributing to both a slow rate of recovery and in some cases a lack of recovery potential. Based on SMRA's experience with instream restoration it is recommended that instream restoration begin on the East River in 2022. Approximately ten sites have been identified as potential restoration locations along the river. The restoration plan found on pages 7-9 specifies the completion of 8 separate sites in the next five years. It is our experience that 80% of identified sites end up receiving restoration treatment. Issues such as access to the river, whether physically (e.g., machine access) or legally (e.g. landowner permission) usually prohibit the completion of some potential projects. The implementation of the recommended restoration actions on the East River St. Mary's will enhance the recovery potential of the river and in doing so increase the carrying capacity for Atlantic salmon. The historic use of log drives and channelization on the East River have left reaches of the channel severely over-widened and straight. A common symptom of these channel modifications is instream habitat that is "simplified". Ecosystem resilience and productivity is directly tied to the level of instream complexity. Fortunately, several techniques are available to restoration practitioners which can improve complexity through the promotion of meander sequencing and the re-establishment of pool, riffle and run patterns.

Figure 47: The accumulation of large-woody debris promoting the development of downstream gravel bars, a process required to narrow channel widths.

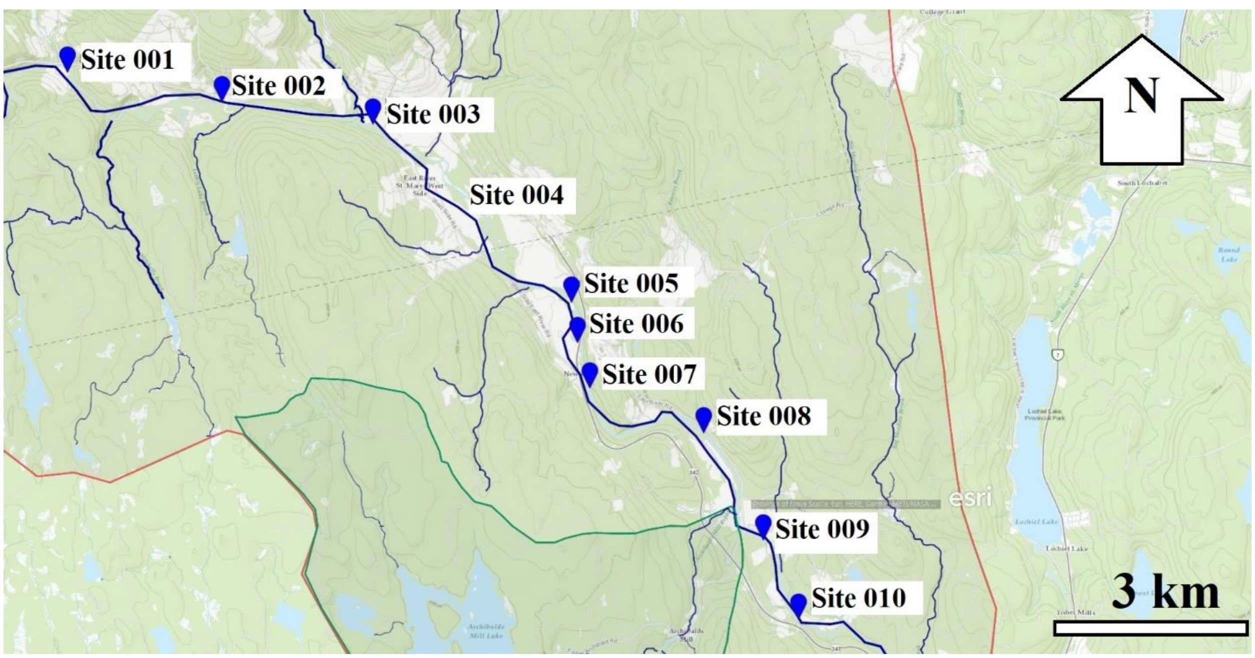

Figure 48: Topographic map of East River watershed with main channel restoration sites.

Table 4

Site #	Upstream Coordinates	Length of channel	Area Restored	Overview of restoration work required
001	45.39464N -62.22114W	200 meters	3,600 sq. meters	Bank rocking and roots wads with log deflectors installed using crew.
002	45.39122N -62.19556W	550 meters	10,450 sq. meters	Bank stabilization, riparian zone enhancement and log deflectors.
003	45.38861N -62.17048W	200 meters	4000 sq. meters	Log deflectors installed with crew plus bank rocking.
004	45.38396N -62.15782W	400 meters	8,000 sq. meters	Banks stabilization using rock and root wads. Some deflectors may be used.
005	45.36782N -62.1375W	400 meters	9,200 sq. meters	Log deflectors installed using crew.
006	45.36309N -62.1365W	150 meters	3,500 sq. meters	Bank stabilization and rock sills using heavy machinery.
007	45.35778N -62.13446W	200 meters	4,800 sq. meters	Potential bank rocking, tree planting and the installation of log deflectors.
008	45.35252N -62.11552W	500 meters	12,500 sq. meters	Bank stabilization using rocks and root wads. Tree planting and log deflectors.
009	45.33996N -62.1056W	400 meters	10,000 sq. meters	Bank stabilization and riparian zone enhancement.
010	45.33068N -62.09976W	250 meters	6,250 sq. meters	Bank stabilization, log deflectors and tree planting.

Figure 49: Looking upstream on the East River above the confluence with Mitchells Brook.

Figure 50: Looking downstream at the Black Brook – East River confluence. Gravel bars are forming.

Figure 51: Looking downstream on the East River approximately 500 meters above site 02.

Figure 52: Looking downstream on the East River at the bottom of site 2.

Figure 53: Looking downstream on the East River approximately 400 meters below site 2.

Figure 54: Downstream from the Black Brook – East River St. Mary's Confluence. Large woody debris accumulating in the channel helping scour pool depth and providing cover for trout and salmon.

Figure 55: Aerial photograph of East River St. Mary's looking upstream. Photo taken near the East Side East River Rd.

Monitoring Program (2022-2026)

A common critique of instream restoration projects is that they are conducted without sufficient baseline data and the post-project results are seldom measured. Furthermore, when it comes to data related to Atlantic salmon populations in the St. Mary's River watershed, information is quite scarce and only one entity is completing any annual monitoring. Therefore, a key component to this restoration plan is to provide SMRA with a stepwise monitoring program that utilizes equipment that the group recently purchased through a government grant. Monitoring will focus on electrofishing data, which primarily measures juvenile salmon abundance. This technique is widely used by DFO, NS Inland Fisheries and the Nova Scotia Salmon Association. The density of young of the year (YoY) fry are an indicator of the past season's spawning success and spatial distribution. While the density of Atlantic salmon parr and smolts is an indicator of juvenile survival and age class distribution. Metrics such as fork length (i.e. length of fish) can provide information regarding growth rates and primary productivity in each site. Another important metric to monitor is water temperature. Deployable water temperature probes should be installed on all 12 tributaries, and several should be installed in the main channel. McKeens Brook, an important tributary to the St. Mary's River was included in the electrofishing sites to serve as a control site.

Electrofishing Sites:

Table 5

Site #	**Watercourse Name**	**Latitude**	**Longitude**
01	Moose River	**45.43187N**	**- 62.31641W**
02	Moose River	**45.43582N**	**- 62.31788W**
03	Moose River	**45.47663N**	**- 62.35355W**
04	Garden River	**45.42637N**	**- 62.30145W**
05	Garden River	**45.44031N**	**- 62.30138W**
06	Garden River	**45.44812N**	**- 62.30225W**
07	Campbells Brook	**45.39629N**	**- 62.2229W**
08	Campbells Brook	**45.40074N**	**- 62.22605W**
09	Greens Brook	**45.42103N**	**- 62.20014W**
10	Black Brook	**45.39046N**	**- 62.17319W**
11	Black Brook	**45.39397N**	**- 62.17539W**
12	Black Brook	**45.40259N**	**- 62.18197W**
13	Frasers Brook	**45.35623N**	**- 62.12687W**
14	Frasers Brook	**45.37342N**	**- 62.11875W**
15	Frasers Brook	**45.37622N**	**- 62.11877W**
16	McKeens Brook	**45.28512N**	**- 62.05486W**
17	McKeens Brook	**45.27975N**	**- 62.03786W**
18	East River St. Mary's	**45.39094N**	**- 62.19304W**
19	East River St. Mary's	**45.38793N**	**- 62.16928W**
20	East River St. Mary's	**45.34066N**	**- 62.10724W**

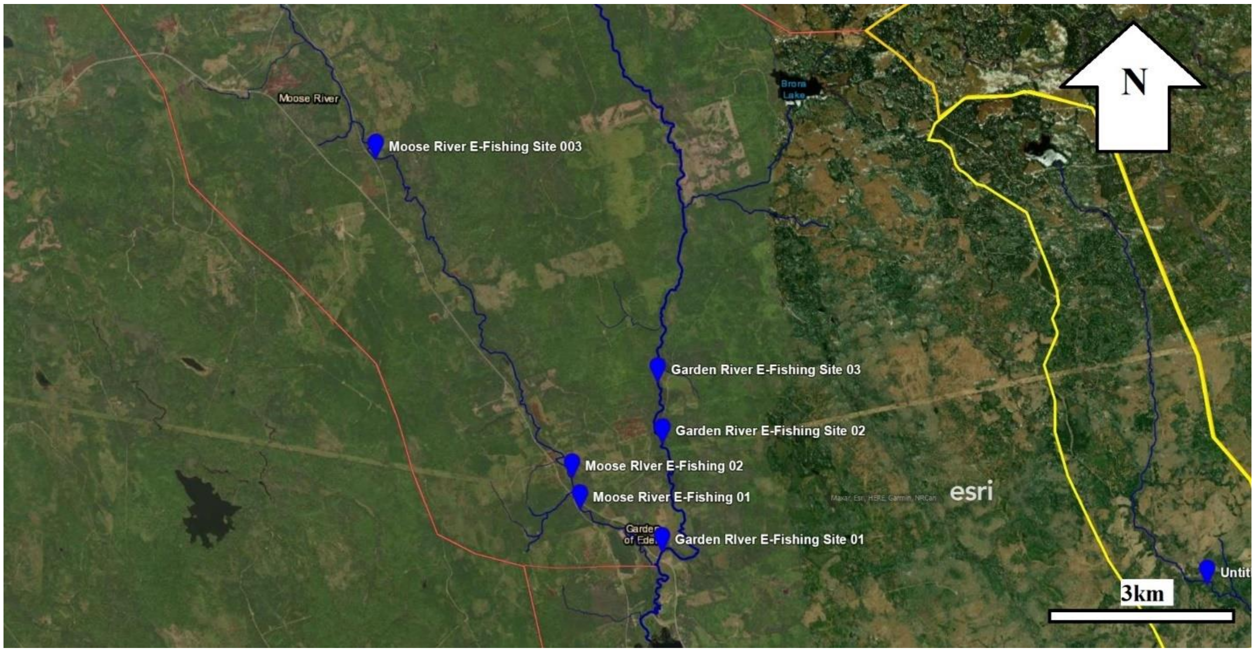

Figure 56: Electrofishing sites 01 to 06 in Garden River and Moose River.

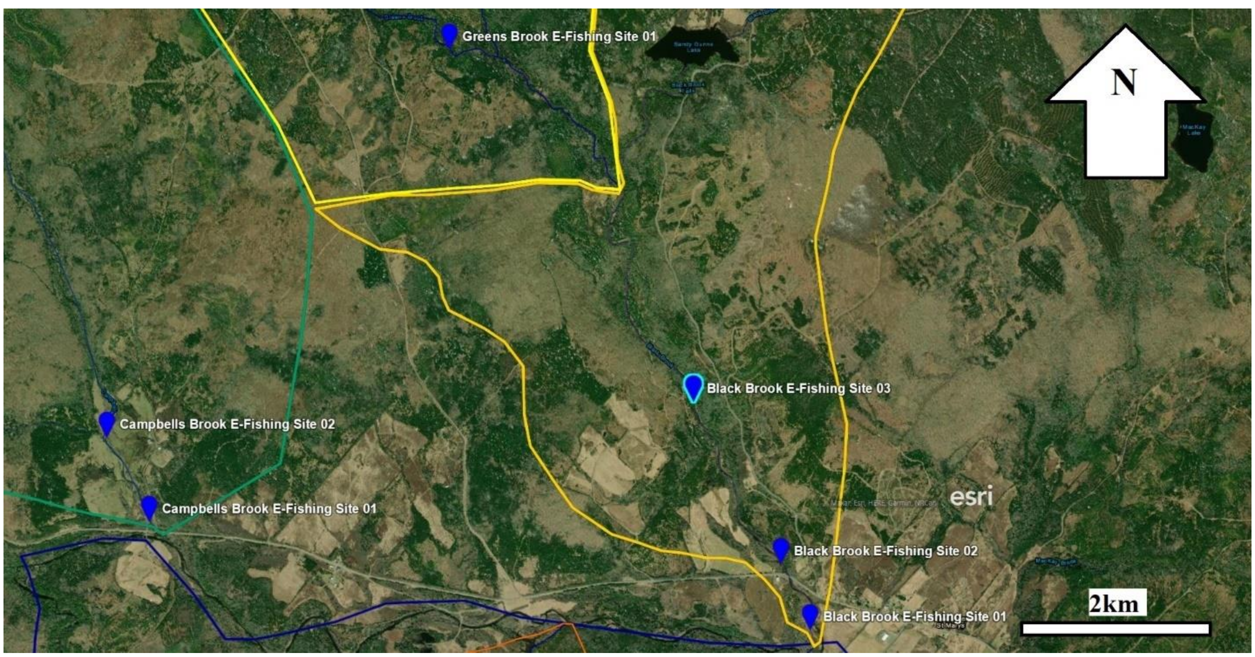

Figure 57: Electrofishing sites 07 to 12 in Campbells Brook, Garden Brook and Black Brook.

Figure 58: Electrofishing sites on Frasers Brook.

Figure 59: Electrofishing sites on McKeens Brook.

Electrofishing is a labour intensive process as it requires two people to hold the barrier nets (one downstream and one upstream), two field technicians are required to scoop shocked fish and a fifth person is required to operate the electrofishing unit. The 20 sites identified in this monitoring plan should take a crew of five field technicans one complete week to complete. For optimal results the electrofishing surveys should be completed in early July. Approximately $5000 will be required to cover annual wages to complete this monitoring plan. Funding should be accessible to cover this work through the Nova Scotia Sportfish Habitat Fund's Adopt a Stream program.