A CONSERVATION STRATEGY FOR ATLANTIC SALMON IN PRINCE EDWARD ISLAND

by

Daryl Guignion

Community Environmental Liaison
University of Prince Edward Island
&
Oak Meadows Inc.

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PRELUDE

It was a great privilege to be asked to develop an Atlantic salmon conservation strategy for Prince Edward Island. I already had extensive knowledge about the Island's rivers and streams because at a younger age, I was an avid hunter, trapper, angler, educator and a consummate lover of nature. However, the challenge to amalgamate much of the knowledge pieced together by oral history, treasured colleagues, priceless documents, and community leaders and cover hundreds of kilometers of our beautiful watercourses was an opportunity of a lifetime.

Every day spent in the field over the past eight months was a wonderful experience but two events stand out in my mind. The first occurred the morning after I had electrofished a section of the Trout River in Tyne Valley to remove fish prior to the excavation of a sediment trap. The landowner, Dan McLean, approached me the next morning and said, "You know, that young salmon you electrofished yesterday died last night." In order to verify that the young-of-the-year (YOY) age class of salmon occurred in that stream reach, I had allowed, no even encouraged, the netters to try and recover a shocked fish that had settled to the bottom – strictly against my personal protocol for electrofishing. I did not make the excuse to Dan that theYOY salmon had less than a one in a hundred chance of ever surviving to return to the river and spawn, but I will not forget his "look" nor the realization that a code of conduct is made to be followed regardless of circumstance and was reminded of how easy it is to lose landowner confidence.

A second memorable event took place on November 19, 2008. I was counting salmon redds on the Mill River, walking upstream from Bloomfield Park to Howlan. It was a cold day and a storm was brewing but visibility was great, with little glare off the water. I had already observed several grilse and salmon digging redds. When I heard loud splashing ahead, the situation called for a stealthy approach over a rather steep bank to investigate. In front of me, perhaps three to four metres away, was an 8-10 lb salmon and another gigantic fresh-from-the-sea silvery female cutting a redd. As I slowly eased to the stream edge, she must have spotted my movement for she swam over to within a meter of where I was standing. This magnificent fish raised her head and a good portion of her body out of the water and seemed to stare directly at me. Her eye rolled upward in the socket and she literally appeared to make eye contact for a few seconds. She then returned to her redd, gave a tremendous splash with her tail that sent a plume of sediment downstream, and swam with the male salmon under alder branches upstream. Once before, many years ago, I had a similar experience when I successfully landed a large female salmon on the York River in Gaspé (prior to my current catch and release philosophy). That salmon has always haunted me and when this incredibly beautiful silvery fish from the Mill River looked me in the eye, deep in my soul I know that I have to do everything possible to give the offspring from her 24,000 eggs a fighting chance at survival.

EXECUTIVE SUMMARY

It is believed that prior to European settlement, Prince Edward Island had about seventy rivers with Atlantic salmon (*Salmo salar*) runs. In 1960, that number had dropped to a possible fifty-five rivers, and in a comprehensive survey of all large streams on Prince Edward Island in 2000-2002, some salmon remained in thirty-three of them. In the six years since that comprehensive survey, salmon runs have been lost from eleven more rivers and in seven others, the populations are precariously low. In other words, with the current rate of loss, in a few year years Atlantic salmon would likely disappear from Prince Edward Island. Unfortunately, along with the demise of salmon runs, populations of other fish that must return to fresh water to spawn, such as smelt (*Osmerus mordax*), sea run brook trout (*Salvelinus fontinalis*), gaspereau (*Alosa pseudoharengus*) and blue-backed herring (*Alosa aestivalis*) are also declining in some rivers.

Watershed and angling organizations on Prince Edward Island have been working diligently to restore Atlantic salmon habitat and salmon populations for almost forty years. The Atlantic Salmon Conservation Foundation is a long awaited source of funding for these groups. To ensure that maximum benefit is gleaned from future projects, it is vitally important to first lay out a management strategy. In this way, funding and effort can focus on projects which will provide the greatest long term benefits. It will also ensure that there are baseline data from which to measure success of future projects. In 2008, the P.E.I. Council of the Atlantic Salmon Federation obtained funding from the Atlantic Salmon Conservation Foundation to develop a comprehensive conservation strategy for Atlantic salmon on Prince Edward Island. The task was daunting, but made manageable with help from provincial government agencies, non-government groups such as the Atlantic Salmon Federation affiliates, branches of the P.E.I. Wildlife Federation, several watershed groups and innumerable students and assistants.

The main objectives of the project were to:

- Consolidate information and data about river systems containing Atlantic salmon on Prince Edward Island;
- Develop a classification system for management of Atlantic salmon on Prince Edward Island;
- Outline habitat problems and management requirements for individual rivers with salmon stocks;
- Provide advice for changes needed for rehabilitation of salmon populations in rivers where runs had recently disappeared;
- Suggest possibilities for increasing salmon angling opportunities in future.

In 2008, habitat was assessed in river reaches that were known to have had salmon populations in 2002 and problems and critical zones were documented for each stream. Data from extensive electrofishing surveys conducted in 2002, 2007 and 2008 were analyzed to document changes in Atlantic salmon distribution and abundance. In 2008, a redd survey to determine salmon spawning effort was conducted in all rivers where Atlantic salmon were known to occur.

The existing Atlantic salmon habitat on Prince Edward Island was found to be seriously compromised by <u>two primary limiting factors</u>:

1. The impact of beaver (*Castor Canadensis*) blockages which prevent salmon from reaching preferred spawning and nursery sites and sometimes prevent young salmon from going to sea. Beaver dams also alter habitat and can negatively impact water quality;
2. Sediment infilling streams to the extent that bottom substrate, especially gravel and cobble, is no longer available to provide suitable habitat necessary for successful spawning and nursery phases of Atlantic salmon's fresh water life cycle;

<u>Other limiting factors include</u>:

3. Poor water quality, sometimes resulting from run-off from agricultural activities but also caused by man-made or beaver impoundments. The more impounded water on a river, the poorer the water quality (in particular, depressed oxygen and elevated water temperature) in summer;
4. Other river blockages, such as road culverts (public and private) and fish ladders that do not pass fish;
5. Poor riparian zone vegetation. For instance, in the innumerable inactive beaver impoundments across Prince Edward Island, trees have been killed from the flooding and no longer provide overhead shade for streams;
6. Need for regulation changes, such as a complete moratorium on angling harvest for at least five years.

The major elements of the classification scheme developed are shown below. A list of suggested management strategies is included for each river (Section 5.0).

<u>Class I – Wilderness rivers</u>: Cains Brook, Carruthers Brook (Mill River), Cross River, Naufrage River, North Lake Creek, Pisquid River, Priest Pond Creek, St. Peters River, Trout River (Coleman), and West River.
The runs of Atlantic salmon in these rivers should be sustainable if beaver populations are removed and sediment input is controlled.

<u>Class II – Rivers where Atlantic salmon and beavers may co-exist:</u> Clarks Creek, Dunk River, Midgell River, Morell River and Vernon River.
Beaver management zones are clearly indicated for each of these rivers. Failure to adequately control beaver populations will certainly lead to the demise of salmon runs in at least three of these rivers.

<u>Class III – Rivers in which Atlantic salmon are on the verge of disappearing:</u> Bristol Creek, Cardigan River, Head of Hillsborough, Little Trout River, North River, Trout River/Bank Brook (Tyne Valley), and Wilmot River.
Inadequate management of beaver populations and sediment input are major limiting factors that have put these seven rivers in jeopardy of losing their salmon runs. Specific recommendations in Section 5.3 require immediate attention or salmon runs in most of these rivers are doomed.

Class IV – Rivers in which Atlantic salmon populations have disappeared since 2002: Bells Creek, Black River, Bradshaw River, Brudenell River, Cow Creek, Hay River, Little Pierre Jacques River, Marie River, Souris River, Valleyfield River and Wheatley River.
Beaver blockages appear to be a main reason for declines in salmon numbers but several of these drainage basins still have many land use problems. For most of these rivers, there is little hope for recovery of Atlantic salmon populations but suggested beaver management zones and habitat improvement will surely help sea run brook trout, smelt, gaspereau and blue-backed herring where the populations of these fish remain.

Class V – Rivers in which Atlantic salmon populations disappeared before 2002: Twenty-one rivers fall into this category and this list would not include the many rivers that have lost salmon runs prior to 1960. No attempt was made to extend the study to include these forty or so streams that had Atlantic salmon at some time in the past. These rivers retain great importance for other anadromous fish species and community watershed groups but a closer examination was beyond the scope of the project.

The key to solving environmental problems is first to be aware of what they are and then to have the will, finances, and vision at both community and government levels to implement solutions in a timely manner. Many efforts have been made to improve environmental quality and land use activities on Prince Edward Island, such as:

- Strides have been taken by row crop producers to keep soil and nutrients on their farms and out of watercourses;
- New programs, such as ALUS, are being adopted to help protect our watercourses;
- Advances have been made by the P.E.I. Dept. Transportation & Public Works regarding road construction and maintenance and they do assist watershed groups;
- Funding available to watershed groups from the provincial government has been dramatically increased;
- A wide variety of watercourse restoration activities are taking place across the province;
- We now have the legislation and organizations in place to acquire and/or protect special areas;
- A new provincial forest policy promotes multiple sustainable uses of our woodland resources;
- A wetland policy protects those essential areas;
- We have a newly created 15 metre buffer zone along our watercourses.

These steps have not arrested the precipitous decline in Atlantic salmon populations in Prince Edward Island and therefore, the author suggests the following recommendations. It should be borne in mind that all of the following general recommendations will not only benefit Atlantic salmon, but will also prove beneficial to other anadromous fish such as sea trout, gaspereau, blue-backed herring and smelt. River specific recommendations are found throughout section 5.1.2 to 5.4.7.

1. A revised beaver management policy should be blended with a new anadromous fish policy with input from representatives of the recreational and commercial fisheries, various provincial government departments, the Department of Fisheries and Oceans, the P.E.I. Trappers Association, the P.E.I. Wildlife Federation, watershed groups and landowners to establish a better balance of resource management and landowner riparian zone protection.

2. All beavers and their dams should be removed from Class I rivers within the next one to five years and the rivers maintained free of beavers. In Class II and Class III rivers, the identified "beaver management zone" means that beavers and their dams will be removed from these zones when they interfere with movement of any year class of anadromous fish in any season.

3. If watershed groups and/or the Forest, Fish and Wildlife Division cannot afford the time and resources to maintain "beaver free" zones in all seasons as indicated in section 5.2 for each river, then government should increase their staffing requirements or transfer the responsibility and resources to specific watershed groups to hire or train a professional trapper to do the suggested management of beaver populations.

4. The Atlantic Salmon Advisory Committee established by the Department of Fisheries and Oceans should be asked to take a lead role in the management of "beaver-free" zones. This Committee, composed of representatives from non-government organizations and government agencies, can meet regularly to discuss fish passage issues on each salmon river, should assign responsibilities for monitoring designated "beaver-free" zones, and could facilitate the removal of dams and beavers in these areas. The preparation of an annual report, with maps outlining beaver activity in designated beaver management zones, would be beneficial.

5. Grassed waterways on agricultural land, or regions where grassed waterways would be appropriate, should be considered an extension of the riparian zone since both are watercourses for part of the year and may influence water quality in streams. These sites should become a priority for ALUS (Alternative Land Use Services) funding if improvements are desired.

6. Government assistance should be available to aid in water diversion from grassed waterways (and sites where grassed waterways are recommended) into constructed wetlands or "on land" sediment traps to encourage filtration and sediment reduction for the adjacent stream.

7. After an exhaustive culvert stream crossing inventory is completed, there should be government monies allocated over a five year period to replace or repair stream crossings that are ineffective in permitting fish passage.

8. The local watershed groups should try to engage landowners and respective government departments to develop long term solutions to point sources of sediment reaching watercourses at stream-road crossings (e.g. Cape Breton Road on Clarks Creek).

9. The environmental section of the Prince Edward Island Department of Transportation and Public Works should be asked for input before highway upgrades and maintenance occurs in any of the Class I, Class II, or Class III drainage basins. In these regions (and eventually province-wide), grading should be done using a "grade all" machine that produces a flat ditch bottom which is less prone to soil erosion than the traditional v-shaped ditch.

10. All major "man-made" impoundments on Prince Edward Island should be classified using parameters such as structural integrity, drawdown capability, fish passage capability, summer and winter water quality and lentic:lotic watercourse ratios. Those that rank high should be properly maintained while others may have to be decommissioned unless resources for repairs are greatly increased or dam washouts may occur.

11. Government should identify an individual to regularly check, and if necessary clean, each provincially-managed fishway once per month from March to December to ensure that they are functioning to pass fish. An annual written report of these monitoring and maintenance activities should be submitted to the Forests, Fish and Wildlife Division.

12. Watershed groups should work closely with the Department of Environment, Energy and Forestry to ensure that the right native species of grasses, trees and shrubs are planted in the best locations in riparian zones to provide good vegetation survival, maximum diversity, bank stability, stream shading or sun exposure, and seasonal wildlife foods.

13. In former pond basins where dams no longer exist, growth of deep-rooted grasses should be encouraged, natural stream meanders could be reinforced with cobble along the "long" shoreline (opposite point bar), and planting of shrubs such as red-osier dogwood (*Cornus stolonifera*) that stabilize without blocking flow would be desirable.

14. The U.P.E.I. Biology Department should be asked to offer an annual course in May in integrated watershed management with an expanded applied section on instream habitat improvements for salmonids. All watershed groups working on rivers with salmon populations should be encouraged to have at least one of their employees take or audit this course.

15. Since written reports may not be readily available or read by community folks who do much of the watershed work, consideration should be given to the development of "how-to" videos". It would also be beneficial to make current (and future) reports and manuals available online (e.g. government web site).

16. In all rivers on Prince Edward Island with Atlantic salmon, tributaries that would likely have smolts should be visited in early April with the intent to identify and remove any blockage that would prevent migration of smolts to sea.

17. Consideration should be given to making a few head of tide salmon holding pools found on rivers such as North Lake Creek, Priest Pond and Naufrage River, barbless fly or lure fishing only, from April 15 until May 1 or delay opening the angling season altogether at these sites until May 1. This would prevent injury to salmon before their return to sea.

18. Tasteful signs, encouraging anglers to be cautious, should be posted in areas of critical fish habitat.

19. There should be a province-wide no kill, barbless hook, catch and release policy for salmon at least for the next five years. In future, if a put and take fishery is developed on either the Morell River or Dunk River, this policy could be altered for that one river.

20. A long term funding arrangement for support of the Cardigan Fish Hatchery is urgently needed to provide wild fish for the salmonid enhancement program on Prince Edward Island.

21. The City of Charlottetown should be required to develop and implement a comprehensive water conservation plan before a new well field is permitted in the North River drainage basin.

1.0 INTRODUCTION

At first glance, Prince Edward Island does not seem a likely place to have viable Atlantic salmon (*Salmo salar*) populations. With such a small surface area of 575,600 ha (1,422,300 acres) and approximately 260 drainage basins, it might appear that the short, low gradient streams would not provide adequate salmon habitat. Indeed, the highest hills on the Island barely reach 150 metres in height and many of the streams that boast salmon runs are short and drain relatively flat terrain.

Prior to European settlement, most of the larger rivers on Prince Edward Island would have contained runs of Atlantic salmon. By 1960, there were approximately fifty-five rivers with remaining runs of salmon. What is most disturbing to many people is the sharp drop in the number of salmon rivers in recent years. A 2000-2002 survey of all large streams on Prince Edward Island documented salmon runs in thirty-three rivers. Since that survey was completed, we have lost salmon runs from eleven additional rivers. Today, salmon can be found in only twenty-two streams, many of which are on the verge of losing their salmon run.

There are a number of factors which could be having an impact on Atlantic salmon populations in Prince Edward Island. Return rates from sea have dropped from historical levels for all Atlantic salmon in North America. While this is a serious concern, it does not explain why salmon populations in some rivers on Prince Edward Island are remaining stable and others are decreasing. Something is happening in the fresh water environment to depress salmon populations. Sedimentation in watercourses is a major environmental issue in Prince Edward Island and can certainly affect habitat for juvenile and adult salmonids. Other contaminants, for example pesticides, have resulted in fish kills in a number of Prince Edward Island streams. Diminished water quality, for example depressed oxygen levels and elevated summer water temperatures, has been documented in several Prince Edward Island watercourses, particularly those with large or numerous impoundments. Throughout North America, dams prevent salmon from accessing spawning areas and can pose a barrier to salmon smolts going to sea. Prince Edward Island has no shortage of man-made and beaver constructed dams and the impact of these structures on resident and anadromous fish populations is well documented.

A number of watershed and angling organizations have been working diligently to restore Atlantic salmon habitat and salmon populations in Prince Edward Island. Without their efforts, the number of rivers which have lost salmon runs would be considerably greater than it is today.

1.1 Objectives

The Atlantic Salmon Conservation Foundation is a long awaited source of funding for groups carrying out stream restoration projects. To ensure that maximum benefit is obtained from future projects, it is vitally important to first lay out a management strategy. With funding from the Foundation, the P.E.I. Council of the Atlantic Salmon Federation initiated a study to assess salmon rivers and develop a conservation strategy for Atlantic salmon in Prince Edward Island. The primary objectives of the study were:

- to consolidate information and data for river systems with Atlantic salmon on Prince Edward Island;
- to develop a classification system for Atlantic salmon on Prince Edward Island;
- to outline habitat management strategies for individual rivers with salmon stocks;
- to offer suggestions for changes needed to rehabilitate salmon populations in rivers where stocks have been recently extirpated;
- to suggest possibilities for increasing angler opportunities.

1.2 Methodology

The many books and research papers available on habitat and populations of Atlantic salmon in North America and Europe provided background information for this report. Both the federal Department of Fisheries and Oceans (DFO) and various pertinent provincial departments were important sources of information, with some contributions dating back to the 1800s. I was especially pleased to consult and work with members of various watershed groups across the province, several of whom not only volunteered historic information, but also helped with electrofishing and redd surveys.

In the mid-1980s, Ron Gray (DFO biologist) convinced me and others that the path to angling opportunities for Atlantic salmon on Prince Edward Island was through semi-natural rearing. Many non-government groups welcomed the opportunity to work closely with both federal and provincial governments, and an era of cooperation and impressive dedication was launched. This semi-natural rearing initiative required major efforts in data collection, habitat enhancement, and applied management. The successes and failures of the initiative contributed greatly to the suggestions in the current document.

Many student projects (special topics, honors programs and graduate research) in the University of Prince Edward Island Biology Department and Holland College have contributed greatly to our knowledge of Atlantic salmon on Prince Edward Island. Information was also available from researchers at U.P.E.I. that have been conducting field and laboratory studies on Atlantic salmon and other salmonids for almost four decades.

Field work conducted for this project included:

1. A habitat assessment was carried out in rivers where salmon populations were recorded between the years 2000 and 2002. These rivers were identified in an electrofishing survey of all major rivers in Prince Edward Island (Guignion et al. 2002).
2. A follow-up electrofishing survey on rivers which contained salmon in 2002 was conducted in 2007 and expanded in 2008 to include provincial index sites (as described in MacFarlane 2009) to document changes in distribution of Atlantic salmon since the 2000-2002 data collection.
3. In 2008, sections of river where Atlantic salmon populations do or should occur (with the exception of small tributaries) were walked, habitat problems and critical zones noted and many G.P.S. readings taken to document observations. On watercourses such as the Morell River, various river reaches were covered by canoe. Sections of some rivers, for

example the Midgell, were visited as many as three times to ascertain if new beaver dams were established during the summer which would prevent instream movement of salmon and other fish such as gaspereau.

4. In autumn 2008, a salmon redd survey was conducted on rivers known to have Atlantic salmon populations to locate spawning and nursery areas as well as blockages that would prevent instream fish movements.

Figure 1. Electrofishing in the West River.

2.0 BACKGROUND

2.1 Prince Edward Island Physiography and Historical Information

Watercourses on Prince Edward Island may be called rivers, creeks or even brooks regardless of their size. All are small by mainland standards and the largest, the Dunk River and Morell River, are only about 25 m wide near the head of tide. Some streams as small as 3 metres in width as they approach salt water still have salmon runs. Springs are abundant on watercourses, and the numerous first and second order streams tend to make the total stream length within a watershed surprisingly long (Table 1). Only the uppermost reaches of streams run dry in summer because of the high proportion of spring water (about two-thirds of base flow) in most systems. Streams on Prince Edward Island generally have a high pH (normally from 6.5 – 8.5), and where wooded riparian zones are continuous, they possess cool summer water temperatures within the optimal range for salmonids. Nutrient levels in most streams are high (sometimes too high) and productivity is excellent.

Atlantic salmon populations probably became established on Prince Edward Island as ice disappeared after the last glaciation period. With ice melt and rising sea levels, the Island became isolated from the mainland some 5,000 years ago (DeGrace 1999). Limited numbers of other anadromous or freshwater fish were able to colonize Prince Edward Island, and Atlantic salmon and brook trout (*Salvelinus fontinalis*) had little competition within freshwater habitat and colonized most of the larger stream systems. Currently, some sticklebacks, American eels (*Anguilla rostrata*) and in a few rivers, white perch (*Roccus americanus*), red bellied dace (*Chrosomus eos*) and slimy sculpins (*Cottus cognatus*) are the only other common fishes. Other fish which use freshwater ecosystems for spawning and early growth include gaspereau or alewives (*Alosa pseudoharengus*), blue-backed herring (*Alosa aestivalis*), rainbow smelt (*Osmerus mordax*) and more recently, expanding populations of introduced rainbow trout (*Salmo gairdneri*).

Figure 2. The Midgell River estuary.

Prince Edward Island has a long coastline (1600 km) and is indented with numerous bays and estuaries, largely the result of drowned river valleys from glacial times. Many estuaries, especially on the northern coastline, have low tidal energy - the height difference between high and low tide is about twice as high on the south shore as compared to the north shore - and long water residence times. The water residence times, warm water temperatures, and high concentrations of nutrients from freshwater cause many estuaries to become over-enriched. The prolific growth of aquatic vegetation, such as sea lettuce (*Ulva lactuca*), is now common in summer. Later, as decay occurs, especially during calm weather, hypoxic events (low oxygen levels) may become widespread, having a negative impact upon shellfish and finfish. The expansive nutrient-rich estuaries provide essential habitat for growth of many anadromous and marine species which are of importance to the recreational and commercial fisheries and in these areas, nutrient problems need to be addressed.

Table 1. Total area, stream length, forest area and percent forest cover per drainage basin for Class I, Class II, Class III, Class IV and Class V Atlantic salmon rivers in Prince Edward Island.

River	**Area (ha)**[a]	**Stream Length (km)**[b]	**Area Forested (ha)**[c]	**Percent Forested (%)**
Class I				
Cains Brook	2983	34.77	1935	65
Carruthers Brook (Mill River)	4978	47.6	2856	57
Cross River	4508	48.6	3695	82
Naufrage River	4430	60.0	3242	73
North Lake Creek	5147	49.7	3582	70
Pisquid River	3864	38.6	2290	59
Priest Pond Creek	2397	25.5	2063	86
St. Peters River	3396	42.5	1874	55
Trout River (Coleman)	5271	46.8	2021	38
West River	10174	138.6	5153	51
Class II				
Clarkes Creek	4350	38.4	2161	50
Dunk River	14189	152.9	3671	26
Midgell River	6076	77.5	4057	67
Morell River	17166	177.9	9897	58
Vernon River	7179	70.6	3241	45
Class III				
Bristol Creek	4263	33.5	2508	59
Cardigan River	3004	34.5	1846	61
Head of Hillsborough	3693	33	2242	61
Little Trout River	2337	25.3	1365	58
North River	7421	43.4	1326	18
Wilmot River	6540	54.3	742	11
Trout River/Bank Brook (Tyne Valley)	3224	47.9	2004	62
Class IV				
Bells Creek	2336	19.2	699	30
Black River	1709	14.9	475	28
Bradshaw River	3944	34.2	643	16
Brudenell	3711	32	1461	39
Cow Creek	2252	28.4	1834	81
Hay River	2331	26.4	1959	84
Little Pierre Jacques	2613	24.9	1358	52
Marie River	2618	28.3	1245	48
Souris River	3067	30.8	1835	60
Valleyfield Rive	8646	78.2	5522	64
Wheatley River	3647	33.3	706	19

[a]PEI Watershed Layer, [b]PEI Watercourse Network, [c]PEI Corporate Landuse Inventory 2000

The first Atlantic salmon hatchery on Prince Edward Island was completed in 1879 and located on the Dunk River, a short distance from the head of tide (Dupuis 2008). In its first year of operation, salmon broodstock from the Dunk River and River Phillip in Nova Scotia were used as a source of eggs. The trend in the Maritimes over the next few decades was to regularly transfer salmon eggs from hatchery to hatchery for dispersal. Hence, many of the young salmon released on Prince Edward Island came from New Brunswick, especially the Miramichi River and St. John River, or Nova Scotia (Margaree hatchery or Bedford hatchery). Movement of Atlantic salmon eggs was a “two way street” as indicated in this note from the 1934 Federal Government Hatchery Report: “2,419,800 eggs from Morell River. 500,000 each shipped to Grand Falls, Restigouche and Antigonish hatcheries”. One has to wonder how a river the size of the Morell could regularly provide the number of eggs collected. For instance, a 1935 note from the Federal Government Hatchery Report states: “1935 – 3,516,000 eggs taken from Morell River. 1,240,000 shipped to Bedford N.S. hatchery (eyed). Note: 1,032 salmon caught between Oct 11 and Nov 18, one night during the season holes were cut in the retaining net and 284 salmon escaped before repairs could be made.”

Salmon caught for broodstock in the Morell River were held in net cages located at the end of the Hatchery Road (clay road off Route 322). According to Miles Matheson who became a fisheries officer for the area in 1967, the salmon were “milked” on site and the spent salmon returned to the river. He also told me that the last year they operated the trap on the Morell River only seventeen fish were caught (Matheson, pers. comm.).

Until the mid 1900s, Atlantic salmon were stocked in numerous rivers on Prince Edward Island and occasionally ended up in small streams such as Hyde Creek in Cornwall or Fox River (Wilmot, near Murray Harbour). As might be expected, without continued stocking, with ongoing environmental problems and the arrival and spread of beavers (especially since 1960), Atlantic salmon runs have disappeared from many streams on Prince Edward Island. It is impossible to determine accurately how many Prince Edward Island streams once had annual runs of Atlantic salmon, either through stocking or original populations, since many of the streams lost their salmon populations many decades ago. I have documented salmon adults or juveniles in 55 drainage basins, in 1960 or later, using electrofishing surveys, angling observations, information from written reports, and oral reports from informed sport fishermen and mill operators. Obviously, many other streams on Prince Edward Island had Atlantic salmon runs that disappeared before 1960. A more detailed account of salmon presence in Prince Edward Island streams and an indication of when they may have disappeared can be found in Cairns et al. (2009).

In 2008, there were thirty active watershed groups on Prince Edward Island (Ledgerwood, pers. comm.). Members of these groups are obviously concerned about salmonid populations, especially brook trout. There is a strong desire to improve habitat and populations of salmonids but direction and expertise are sometimes lacking. Normally, habitat improvement for Atlantic salmon will also benefit populations of brook trout. However, if groups are not aware of critical habitat for Atlantic salmon, such as spawning and nursery areas, “enhancement work” may not favour salmon populations. The federal Department of Fisheries and Oceans has jurisdiction over anadromous fish on Prince Edward Island but various provincial agencies, such as the Department of Environment, Energy and Forestry, Department of Transportation and Public Works, and Department of Agriculture play leading roles in helping to improve water quality in watercourses.

2.2 Brief History of Land Use on Prince Edward Island

When Europeans first arrived on Prince Edward Island, they found a landscape densely covered with forests, later described as part of the Acadian Forest Region. On the uplands hardwoods prevailed, with yellow birch (*Betula alleghaniensis*), sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) being particularly common. Many of the shaded stream valleys had an abundance of eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and red spruce (*Picea rubens*). The western part of the province had pockets of dense northern white cedar (*Thuja occidentalis*) and American elm (*Elmus Americana*), white ash (*Fraxinus americana*), and tamarack (*Larix laricina*). Black spruce (*Picea mariana*) and red maple (*Acer rubrum*) were common in many regions, with white spruce (*Picea glauca*) dominating the windy, salt sprayed coastal landscape.

European settlement of Prince Edward Island was initially connected with transportation routes – the coastline and navigable waterways. After the Island was surveyed into lots by Samuel Holland in 1765, many more roads were built to supplement water routes and winter ice roads. With population growth and the prominence of the shipbuilding industry of the mid 1800s, much forest land was cleared for agriculture and the forests were high graded to build sailing ships and supply cargoes of lumber. By the late 19^{th} century, Prince Edward Island had a population of about 100,000, widely distributed throughout the tiny province. Power to run the grist mills, starch mills, lumber mills, woolen mills and even electrical generation plants came from water. Mills were located where a good "head of water" could be obtained by damming off a stream. Lumber mills often dumped their sawdust directly into the river and most mills would act as a partial blockage to anadromous fish. Former mill operators describe how salmon would try to jump up the "paddle wheel" as the pond was refilling and before the bypass was again operable.

Some of the original mill ponds were later used primarily for recreational purposes and many new ponds were developed during the last half of the 20^{th} century. The Agricultural Rural Development Act (ARDA) provided funds to help with dam construction. Private individuals built dams, as did non-government groups such as Ducks Unlimited, often in collaboration with the provincial Fish and Wildlife Division or private landowners. Fish passage at many of these ponds was compromised – some did not have fish ladders and those that did could not accommodate anadromous fish such as smelt. A pond-building technique that initially released large amounts of sediment to downstream habitat was the traditional "run around bypass" pond, where the connection between the pond and stream below was a bulldozed trench the width of a tractor blade. With time, much erosion occurred in these crude bypass structures. However, many of these bypass ponds still remain and provided the entry to the pond was constructed far enough upstream from the dam (thus lower gradient for stream flow), the bypass channels still allow passage of all species of fish, including smelt.

When several ponds are constructed close together on the same watercourse, water quality can become compromised in summer and winter. For instance, near the headwaters of the Glenfinnan River, the late Harold Jenkins owned nine ponds. Two additional ponds immediately downstream are owned by the provincial government. This creates an exceptional area for waterfowl and other wildlife species. While water quality within the impoundments can become inhospitable for salmonids in summer, water temperatures and dissolved oxygen downstream quickly recover because of the input of spring water. The recovery of summer stream water temperatures depends upon the system. For example, elevated water temperatures in outflowing water at Larkin's Pond on the Naufrage River do not recover to acceptable levels for brook trout until large springs join the main river some four kilometres downstream (MacFarlane 1999). Man-made and beaver blockages in the Grovepine branch of the Fortune River have caused summer water temperatures to exceed tolerable levels for salmonids and oxygen levels likewise fall well below minimum accepted concentrations. As a result, water quality is compromised in much of the main branch of the Fortune River, down to the head of tide.

Figure 3. MacMillans Pond on the Vernon River.

Agriculture has had a profound impact on the Prince Edward Island landscape over the past couple of centuries. Original settlement patterns led to mixed farms throughout the province, albeit some were on poor quality land. The late 1800s were a time of peak deforestation in favour of farming, but over the next half century, forests reclaimed much of the hilly or wet farmland. Oats was in demand for horses, both on and off Prince Edward Island but when oats would no longer grow, the land had to be abandoned. Until about 1960, long crop rotations, small fields and mixed farming were the norm. In the 1970s, the "development plan" pumped enormous quantities of "ten cent dollars" (the Province's portion of the cost was 10%) into the economy and thousands of farmers sold their land. Larger fields, fewer farmers, bigger machinery, shorter crop rotations and a reliance on monoculture became prevalent. Soil erosion has always been a problem because of the nature of the soil on Prince Edward Island. However, the new trends in agriculture exacerbated the extent of soil erosion and nutrient enrichment in surface water. New guidelines and regulations have been adopted after many studies and reports, but wind and water erosion, as well as nutrient inputs to both surface and ground water, remain major environmental challenges.

3.0 ATLANTIC SALMON HABITAT ON PRINCE EDWARD ISLAND

O'Grady et al (2000) suggest that "a stream's capacity to support salmonids is primarily dictated by a combination of four factors: mean (x) summer volume discharge, stream bed gradient or slope, the nature of the bed material and the quality of the riparian zone." On Prince Edward Island, the spring-fed streams usually maintain good summer flows but stream volume may be impacted in some drainage basins by extraction of water, either for row crop irrigation or water extraction for municipal use. Most watercourses have at least some reaches where stream bed gradients are too low for good salmon production. Bed material is often lacking adequate gravel and cobble and is inundated with much sediment. The quality of riparian zones along salmon rivers on Prince Edward Island may vary dramatically from reach to reach or stream to stream. Long sections of some rivers have few pools and poor juxtaposition of spawning, nursery and parr habitat. Classic over-wintering habitat is lacking in many stream reaches. Blockages that may affect instream movement or migration patterns of Atlantic salmon or other anadromous fish are common in most rivers and water quality problems are present in some watercourses.

3.1 Riparian Zones

Settlement and transportation were closely tied to the coastline and rivers on Prince Edward Island and watercourses often served as property boundaries. Springs and brooks were highly valued for watering livestock. Most of the original forest cover was removed along accessible streams and natural succession favoured white spruce and alder (*Alnus rugosa*) growth. A few of our streams still have small sections bordered by original Acadian forest vegetation, such as the "horseshoe" on the West River. Some river reaches have considerable numbers of yellow birch lining their banks, as seen on portions of Carruthers Brook, Trout River (Coleman) and Cains Brook, but the woodland along most streams is usually a mix of conifer and shade-intolerant hardwoods. Most of the white spruce are short lived on Prince Edward Island (40-60 years) and these conifers frequently collapse into streams. This large woody debris can be a great asset to the stream ecosystem if managed properly, not simply cut and piled above high water mark. New riparian buffer zone legislation severely limits any cutting or disturbances in a 15 metre buffer zone on each side of a watercourse.

Watershed groups have often planted trees in the riparian buffer zone as part of their habitat enhancement programs. Some groups even have small nurseries where trees are kept until large enough to reduce browsing problems from snowshoe hare (*Lepus americanus*) and meadow voles (*Microtus pennsylvanicus*). Currently, the provincial Department of Environment, Energy and Forestry grows trees and shrubs specifically for riparian planting by watershed groups. With available expertise within government and watershed groups, and with goals to re-establish native grass, trees, and shrubs that should normally grow well in each micro-climate, our riparian buffer zones should continue to improve in diversity and usefulness for all wildlife species.

In some instances, planting of trees and shrubs might prove counter productive, especially for brook trout populations. Brook trout often spawn in areas with deep-rooted grasses on stream banks. Overhanging grasses and undercut banks provide cover for the adult fish and in spring, the flooded grasses provide critical cover for young-of-the-year (0+) brook trout adjacent to the stream. Critical habitat for salmonids should be carefully recorded in each stream before extensive planting occurs.

> **Recommendation**
> *Watershed groups should work closely with the Department of Environment, Energy and Forestry to ensure that the right native species of grasses, trees and shrubs are planted in the best locations in riparian zones to provide good vegetation survival, maximum diversity, bank stability, stream shading or sun exposure, and seasonal wildlife foods.*

There is potential for severe erosion where ephemeral streams naturally flow through fields during spring runoff. Frequently, large quantities of soil end up in the adjacent watercourse due to run-off between autumn ploughing or harvest of row crops and spring planting. It would be desirable to encourage all landowners to consider these depressions (grassed waterways or otherwise) as part of the riparian buffer zone for the adjacent watercourse. Such ephemeral streams would be best diverted into wetlands or large sediment traps dug specifically to slow and temporarily hold large quantities of water so that settling of fines can occur.

> **Recommendation**
> *Government assistance should be available to aid in water diversion from grassed waterways (or sites where grassed waterways are recommended) into constructed wetlands or "on land" sediment traps to encourage filtration and sediment reduction for the adjacent stream.*

3.2 Blockages to Instream Fish Movements

For populations to thrive, anadromous fish species require the capability of instream movement in each life stage and in each season of the year. In many of the remaining salmon rivers in Prince Edward Island, the principal limiting factor for Atlantic salmon, as well as other anadromous fish, is the presence of blockages to fish movements. Some rivers have tributaries or even sections of the main stem blocked. Allowing blockages to fish migration to remain is akin to playing Russian roulette with our anadromous fish populations. With past management strategies, there was no way of knowing when a year class or even a complete run of Atlantic salmon might disappear because they could not reach appropriate spawning habitat.

3.2.1. Roadway Stream Crossings

Prince Edward Island has an enormous number of locations where private or public roads cross streams. At these road crossings, some culverts are poorly installed, at times suspended several feet in the air on the downstream side. Others have collapsed because of excess weight or have washed out in flood conditions. Even when properly installed, water flow can be so rapid in the culvert that some fish species cannot navigate upstream. Watershed groups, with the aid of a global positioning (G.P.S.) unit and a check sheet could help by doing a complete inventory of all stream crossings on all tributaries of the rivers that they are working on. On drainage basins where watershed groups are not active, the province should assign personnel to complete such a province-wide inventory.

Recommendation:
After an exhaustive culvert stream crossing inventory is completed, there should be government monies allocated over a five year period to replace or repair stream crossings that are ineffective in permitting fish passage.

While replacing hundreds of culverts may seem to be a very expensive venture, the cost of not repairing or replacing “blown out” culverts can be much more costly and the damage to the downstream fish habitat can be devastating.

3.2.2 Man-made Impoundments and Fish Ladders

There are some 600 man-made impoundments (dams) on Prince Edward Island. At one time, many impoundments were built to provide water power for operation of various types of mills but more recently they have been constructed for other purposes (Section 2.2).

Impoundments are costly to build and to maintain, as the infrastructure disintegrates over time. Many impoundments are old and infilled with sediment, others have limited fish passage, and some act as impenetrable barriers to anadromous fish movements. Fish ladders, if incorporated into the dam structure, will often not pass fish like rainbow smelts. They may become blocked by beaver sticks or natural debris or stop logs may not function properly. These ladders are sometimes not checked for months at a time to ensure that they are functioning properly. Drawdown capability (the ability to draw down the pond) is often not present and water quality in the impoundment can be problematic (ASE Consultants and U.P.E.I. Biology Department 1997).

Recommendation
All major “man-made” impoundments on Prince Edward Island should be classified using parameters such as structural integrity, drawdown capability, fish passage capability, summer and winter water quality and lentic:lotic watercourse ratios. Those that rank high should be properly maintained while others may have to be decommissioned unless resources for repairs are greatly increased or dam washouts may occur.

Recommendation
Government should identify an individual to regularly check, and if necessary clean, each provincially-managed fishway once per month from March to December to ensure that they are functioning to pass fish. An annual written report of these monitoring and maintenance activities should be submitted to the Forests, Fish and Wildlife Division.

3.2.3 Beaver Blockages

There have been many scientific papers written on the role of beavers in drainage basins. Some authors suggest that beavers improve habitat for salmonids, especially in cold water streams. Other authors have not been so complimentary. The impact of beavers on stream habitat and thus fish populations on Prince Edward Island will vary dramatically depending on stream size, gradient, and trapping pressure. Beavers find that small streams, such as headwater tributaries where many brook trout spawn, are easy to dam. Larger streams such as the Dunk River downstream from Scales Pond or the Morell River downstream from Grants Bridge are too wide and water velocity too great for beaver dams to hold, so the animals have to rely on bank denning at deep pools. Beaver dams on reaches of streams with steep gradients provide little surface area of water and the animals soon have to move on to find food. However, beaver dams that are constructed on low gradient portions of streams can flood enormous areas of adjacent land, killing trees and shrubs. These dams may hold back water for many years, cause extensive damage to forest or agricultural land, and often convert forests to brush marshes.

Some managers argue that with many trappers and high pelt prices, beaver populations can be managed on watercourses through regular trapping pressure. However, on Prince Edward Island, the number of trappers has been declining for decades and pelt prices remain low. Consider the following case: With high pelt prices in the 1980s and with many more trappers than today, beaver populations expanded to such an extent in the Grovepine/Big Brook Branch of the Fortune River that a stream crew had to remove approximately 180 beaver dams to restore somewhat normal flow patterns (Cheverie, pers. comm.). Needless to say, with these multiple blockages, water quality and access to spawning sites was compromised so severely that Atlantic salmon and most sea run trout disappeared from the system. This story of beaver dams blocking the movements of many species of anadromous fishes has been repeated over and over across Prince Edward Island. Most of the remaining Atlantic salmon rivers, with the exceptions of the North River and West River, have many beaver blockages. Thus, without a sudden change in beaver management strategies, most will soon join the long list of rivers where salmon have been extirpated because of the 1949 introduction of beavers to Prince Edward Island.

Beaver dams may block both upstream and downstream passage of fish. The author has witnessed dead salmon smolts entangled in beaver dams when moving downstream in spring as well as numbers of grilse and salmon prevented from moving upstream in autumn (and occasionally downstream in spring). On numerous occasions, the author has seen movements of other anadromous fish species, such as the rainbow smelt, alewife and brook trout, completely blocked by beaver dams. Many die trying to navigate these obstacles and in some cases, blockages are completely impassable and population levels are affected.

One compromise that was agreed to many years ago on the Morell River involved the establishment of a “beaver-free” zone in the lower reaches of the river (approximately one-third of the total length of all stream tributaries. In the upper reaches, beavers could only be killed by trappers during the open season. We learned quickly that the old beaver dams on the upper reaches did not wash out and subsequently, the trees preferred by beaver, such as trembling aspen (*Populus tremuloides*), could not regenerate in the altered wet soils. Having created poor beaver habitat, the animals then moved to "beaver free" zones where they proceeded to alter much of the treed riparian buffer zone, changing some areas into extensive grassy beaver meadows (Section 5.2.4). Killing of beavers during the summer was prohibited and with inadequate trapping during the open season, eventually every major branch of the Morell River in the beaver-free zone was blocked with beaver dams.

At a February 21, 2009 meeting between members of the Souris Branch of the P.E.I. Wildlife Federation and the P.E.I. Trappers Association, beaver and anadromous fish conflicts were discussed. Five issues became blatantly obvious during the course of the active discussion.

- Too little dialogue was occurring among concerned interest groups and much distrust existed.
- Life history information about various fish and wildlife species and their inter-relationships were not well understood.
- Trappers expressed a passionate sense of entitlement but were willing to accept altered regulations such as a longer trapping season. They were adamantly opposed to watershed groups killing beavers in summer even though they were informed about extensive damage that beavers are causing to anadromous fish populations, private woodland property and numerous private and public road crossings.
- Trappers seemed unaware of beaver dam locations on several rivers with active watershed groups. They would like groups to provide them with the location of beaver colonies, but watershed groups often finish work for the summer before some beavers set up their dams in autumn.
- Trappers seemed unaware of the location of beaver dam locations on rivers without an active watershed group, for example the Midgell River. Both the manager and director of the provincial Fish and Wildlife Section were informed of G.P.S. locations and the problems that these dams would cause to anadromous fish if the beaver colonies were not removed. This may reflect the result of the manager's comment, "I only have six people working for me" and obviously each of them already has a full platter or it may require more communication with trappers.
- Some trappers feel that they would trap in remote places for free while others feel financial assistance would be necessary. I believe that the P.E.I. Trappers Association should have some policy that is agreeable to its membership.

Recommendation

A revised beaver management policy should be blended with a new anadromous fish policy with input from representatives of the recreational and commercial fisheries, various provincial government departments, the Department of Fisheries and Oceans, the P.E.I. Trappers Association, the P.E.I. Wildlife Federation, watershed groups and landowners to establish a better balance of resource management and landowner riparian zone protection.

Recommendation

The Atlantic Salmon Advisory Committee established by the Department of Fisheries and Oceans should be asked to take a lead role in the management of "beaver-free" zones. This Committee, composed of representatives from non-government organizations and government agencies, can meet regularly to discuss fish passage issues on each salmon river, should assign responsibilities for monitoring designated "beaver-free" zones, and could facilitate the removal of dams and beavers in these areas. The preparation of an annual report, with maps outlining beaver activity in designated beaver-free zones, would be beneficial.

3.2.4 Water Quality

Water depth and water quality may affect fish movement and survival. Normally, we expect that our first and second order streams will flow throughout the summer. However, in many watersheds, lack of extensive forest cover and wetlands often contributes to fast snow melt and "flashy" streams. Some upland springs can dry up in summer. These conditions can lead to reduced summer flow and in some cases, ephemeral streams. Streams may also run dry for other reasons, such as over-extraction of ground water which happens on a regular basis in the upper reaches of Winter River, the drainage basin which provides Charlottetown's municipal water supplies.

Water quality parameters, such as temperature and dissolved oxygen, not only act as a barrier to fish movement, but can also be a significant cause of mortality in some river reaches if a refuge is not available. Younger age classes of salmonids cannot afford to move to a cooler water refuge or the consequences may be death by predation from larger fish (MacMillan 1998). Levels of oxygen too low for salmonid survival may occur in summer, when the water temperature is high, or in winter when vegetation decay under the ice can severely reduce oxygen levels, especially in lower depths.

An indepth study of the impact of man-made and beaver impoundments on fish species on Prince Edward Island was commissioned by the federal Department of Fisheries and Oceans (ASE Consultants and U.P.E.I. Biology Department 1997). Since then, little action has been taken on recommendations geared to remedy water quality problems in our freshwater streams. For instance, there were occasions during the summer of 2008 that all of the salmon rivers draining into St. Peters Bay - Morell, Marie, Midgell and St. Peters - had some tributaries or their main stem impacted by low oxygen and high temperature levels.

3.3 Sediment Input into Watercourses

Sediment is a term used to describe soil particles made up mostly of clay, silt and sand. Clay particles are so tiny that they feel greasy between the fingers. Silt is the size of dust and sand is considerably larger and has a gritty texture. Often clays become suspended in the water column and can be carried great distances before settling out. Sometimes silt will be deposited in depressions on fields or in still water. Sand is heavier so it drops out of the water column sooner but can often be seen bouncing along the bottom on its way downstream to rest in a pool or other slow water. In his comprehensive book, "Sediment in

Streams", Waters (1995) summarizes the effects of deposited sediment on fish habitat as follows:

> Beyond the problems of successful reproduction and sufficient food resources for growth, both of which are susceptible to the deleterious effects of sediment, is the problem of deposited sediment effects on physical habitat – space of adequate quantity and quality to provide for fish needs. These needs include roughness elements on the streambed to provide winter protection for fry against aquatic predators, foraging territories, and sufficient water depths to provide overhead cover for juveniles and adults. Stream features affording these elements constitute rearing habitat; all are subject to severe reductions caused by deposited sediment.
>
> The rearing habitat for juveniles is the most critical. It is well known that the greatest mortality of a given year class or cohort occurs in young stages, and that the strength of a year-class is most often set in some early critical phase (Elliott 1989). Consequently, the sedimentation of juvenile rearing habitat is decisive in it's capability to ultimately damage adult fish populations.

Cassie and Arseneau (2002) reported that in the maritime rivers studied, the percent fines on stream bottoms were much higher in the Morell River, Prince Edward Island. Cairns (2002) estimated densities of brook trout and Atlantic salmon from electrofishing surveys in various Prince Edward Island rivers. He suggested that brook trout may avoid some of the negative effects of sediment by using ground water seeps in which to spawn but sediments where salmon spawn are probably sufficient to affect successful reproduction.

Figure 4. After heavy rainfall in August, the Crabbe Road section of North River rose by about 2 metres, causing extensive erosion and sediment input to the river.

In many drainage basins, the presence of sediment is very detrimental to salmon spawning and nursery areas. Even though the eggs are laid in a depression that has been dug in gravel substrate in relatively fast water (and therefore more or less cleaned of sediment), sand, silt and clay particles can infiltrate the redd (egg nest). The developing fish embryos need a good flow of oxygenated water to obtain enough oxygen and get rid of metabolic wastes. If enough sediment particles plug up the pores between gravel particles, and clay coats the egg membranes, excessive mortality can occur before hatching.

Sediment in many of our rivers will often "glue" the gravel/cobble/boulders in place, leaving little exposed space for shelter or food. Thus, sediment may severely reduce the quality of stream habitat and even prevent salmon parr from finding desirable over-wintering cover. In some sections of streams, for example the Emerald reach of the Dunk River, sediment is so deep that it is treacherous to walk in the river wearing chest waders for fear of getting stuck.

3.3.1 Impact of Agriculture

In drainage basins where salmon runs still exist on Prince Edward Island, the percentage of land base in forest cover varies from only 18% in North River to 86% in Priest Pond Creek (Figure 1). Most of the drainage basins in northeastern Prince Edward Island are heavily forested and thus have relatively little impact from agriculture. The greater the percentage of land in a drainage basin in row crops, the greater the likelihood that sediment will be a problem in streams. Factors that may play a role in determining how much sediment from agricultural activities in a drainage basin ends up in watercourses are:

a) percent slope of fields in row crops;
b) level of soil organic matter in cultivated fields;
c) length of crop rotation;
d) use of winter cover crops and recommended levels of mulching on harvested potato fields;
e) presence of appropriate grassed waterways draining into wetlands or other filtering vegetation;
f) autumn ploughing or cultivation of potato land;
g) unusual weather events when cropland is inadequately protected (winter thaws, heavy rains after planting or harvest, strong winter winds with frozen exposed soil);
h) amount of cultivated land with appropriate strip cropping and terracing.


Figure 5. Drainage from a potato field in Mill River carved a gully as it exited a highway culvert, carrying sediment to the stream.

Riparian buffer zones may help to reduce the amount of sediment reaching watercourses if they are situated on relatively flat terrain, are wide and have appropriate vegetation, but when enough water concentrates, it will carry clay and silt particles of sediment very long distances. Clay particles may remain suspended in run off water for days and eventually reach salt water off the P.E.I. coast.

In Prince Edward Island, some sediment will always reach watercourses in areas of intensive row cropping. However, if farmers followed the recommendations in the Action Committee on Agricultural Runoff Control report (1999), sediment input should not be great enough to cause major stream habitat deterioration or fish kills and nutrient levels would be reduced in our watercourses.

3.3.2 Beavers and their Activities

Beavers dams on Prince Edward Island can be built anywhere from the head of tide to the sources of the uppermost tributaries. Each dam is constructed of sticks, usually alders, and plastered with mud to make the dam more or less impermeable to water. Lateral channels are usually dug within in the beaver impoundment to assist in transport of food and to provide escape routes while the animals are on land. Water often spills over the dam in several locations and each of these "braids" can carve a new channel until the braid reaches the old stream bed. Sediment drops out of the water column as the water slows and as a result, deposition occurs on the stream bottom of the beaver impoundment. Within a couple of years, trees within the impoundment die and are often blown over to expose sediment from root masses. Downstream from the beaver dam, sediment accumulates from the new channels cut by the braids, and should the beaver dam ever wash out, much sediment can be washed downstream. The stream within a breached inactive beaver impoundment is usually wide and shallow with no overhead shade and little instream cover.

Beavers are also known to plug outlets to ponds constructed with "drop inlets" or block bypass channels where the pond water exits. When blockages occur, water level rises and may erode a notch in the top of the dam. In extreme cases, the dam washes out, causing extensive movement of soil material into the watercourse. Frequently, beavers will dam culverts at road crossing sites. I spoke with one backhoe operator who told me that recently, he has been getting more frequent calls to remove beaver blockages from culverts (he cleared out one culvert no less than five times during summer 2008). Often, a "beaver fence" is constructed around a culvert opening to prevent beavers from plugging it. However, being ingenious at construction, the beavers frequently flood the road or cause the soil around the culvert to soften which may lead to culvert replacement or in worse case scenarios, cause the road to wash out, carrying massive quantities of sediment downstream.

In 2005, a report was drafted for the Souris and Area branch of the P.E.I. Wildlife Federation entitled, "A Fish and Fish Habitat Stewardship Strategy for Prince Edward Island. Pilot Project: Eastern Kings, P.E.I." (Foster 2005). This project was supported by the federal Department of Fisheries and Oceans and the provincial Department of Environment, Energy and Forestry. The report does an excellent job of describing the impact of beavers in rivers in eastern Kings County and offers management suggestions, as outlined in the paragraphs below (Foster 2005).

> Beaver dams present a serious fish habitat issue in the six priority watersheds and their management will be critical to the success of the stewardship plan. Beaver dams not only interfere with fish movement, they alter riffle-pool complexes and runs, increase stream depth, cause stream braiding, increase water temperature, and block sediment transport. Abandoned and active beaver dams rarely get blown out in the spring time due to the Island's short stream systems and low gradient topography. In the past, beaver management has been promoted on the lower reaches. However, we now recognize the importance of first and second order streams to salmonids in terms of spawning and maintenance of water quality.
>
> Intensive beaver management will be given high priority to ensure the continued survival of salmon in five of the seven rivers. Beaver management areas have been identified and mapped based on existing knowledge of salmonid habitat. Within these zones, regular monitoring will be required to identify beaver dams. Volunteers serving as "river monitors" will contact the Department of Environment, Energy and Forestry when dams are located and the Department will arrange to have the dams AND the beavers removed. These management zones can change if additional information becomes available.
>
> Both Cross River and North Lake Creek continue to have excellent habitat and good runs of Atlantic salmon. While beavers are present in these systems, they have not yet achieved the high numbers found in surrounding rivers, e.g. Bear River and Hay River. Considering the precarious status of Atlantic salmon on Prince Edward Island, it is imperative that the entire stream length of both Cross River and North Lake Creek be considered a "beaver management" area. It would be naïve to assume that all beavers can be prevented from living within these watersheds. However, with regular monitoring and the cooperation of local trappers, the influence of beaver in these watersheds can be kept to a minimum.

Unfortunately, in northeastern Kings County, salmon no longer exist in Hay River, Bear River, Cow Creek, Fortune River or Souris River and beaver blockages are preventing salmon from accessing most of the Naufrage River and Priest Pond Creek. The two gems recommended to be completely free of beavers and beaver dams in their complete drainage basins (Cross River and North Lake Creek) still have beaver blockages. The objectives of the Foster report have not been achieved and the salmon and beaver conflicts have grown grievously worse.

3.3.3 Unpaved Roads, Stream Crossings and Road Maintenance

Some drainage basins, for example the West River, have many sites where unpaved roads and stream crossings are point sources of large quantities of sediment after every heavy rainfall or during snow melt in winter or spring thaws. Upgrading of unpaved roads (which often means shale resurfacing) can, in the long term, reduce erosion if side slopes of ditches are shaped properly, mulch is immediately applied, proper spacing occurs between check dams, and hydro-seeding is done soon after the upgrades are completed. Unfortunately, it is rare that all of the above are done and regular maintenance, such as cleaning check dams after heavy rainfall events and in spring, is not usually conducted until check dams overflow with sediment.

Figure 6. Clay roads are prone to erosion and check dams must be cleaned regularly.

Sometimes, clay roads become so eroded that the road shoulders are higher than the center of the road, for example the Cape Breton Road on Clarks Creek or Greenans Road on the Dunk River. This situation can be very challenging, especially if extra water is diverted from adjacent fields via grassed waterways onto the road surface.

Recommendation:
The local watershed groups should try to engage landowners and respective government departments to develop long term solutions to point sources of sediment reaching watercourses at stream-road crossings.

3.3.4 Old Pond Basins and Unstable Stream Banks

When man-made dams wash out or are breached, the former pond basins are often covered with several feet of deposited sediment. The amount of sediment that collects over many years in pond basins can be mind boggling. When Mooneys Pond on the Morell River was cleaned out to develop a semi-natural rearing facility, 1,100 tandem truck loads of spoils were removed. This did not include the upper end of the pond which was left untouched because hymacs were getting stuck. By the time Marchbanks Pond on the Wilmot River was about 75% cleared of sediment, 4,400 tandem truck loads of sediment had been excavated (Hill, pers. comm.).

When dams are breached, water flowing through the pond basin rapidly cuts trenches into the sediment until more solid substrate is reached. The banks of the new channel are often steep and unstable for many years. Grasses and alders soon colonize, but in flood conditions, the banks can become undercut and clumps of alders uprooted, causing even more erosion. Partial blockages from overgrown alders or uprooted vegetation will often result in additional erosion from the adjacent bank during flood waters.

Recommendation:

In pond basins where dams no longer exist, growth of deep-rooted grasses should be encouraged, natural stream meanders could be reinforced with cobble along the "long" shoreline (opposite point bar), and planting of shrubs such as red-osier dogwood (Cornus stolonifera) that stabilize without blocking flow would be desirable.

3.4 Limiting Factors in Spawning and Nursery Areas

For a comprehensive list of habitat suitability indices for Atlantic salmon and other anadromous fish on Prince Edward Island, see Appendix I. The challenges in spawning and nursery habitat are presented in the descriptions of each drainage basin (section 5.0).

Atlantic salmon return from sea to their natal river to spawn. Female Atlantic salmon dig redds (nests) in gravel, usually at the tail end of pools where the water starts to speed up. The female "cuts" a depression with her tail in the substrate and deposits eggs which are then fertilized by the male (which may be a grilse, multi-sea winter fish or even a precocial parr). It is preferable that the gravel is deep enough to deposit eggs 20 to 40 cm below the surface. Gravel size may vary but a mixture of stones from thumb to fist sized seems desirable. Cobble or large woody debris in the substrate can prevent gravel movement during flood conditions. Gravel which has a lot of sediment in it will be cleaned by the digging action of the female. However, if a continuous input of fines occurs, they will infiltrate the gravel over the course of egg incubation and may limit the amount of oxygen supplied to the developing embryos. When working in the LaHave River in southwestern Nova Scotia, Gray et al. (1989) reported the following characteristics of ten spawning areas which consistently had high salmon fry densities. "Substrate composition: 5-10% sand (mean 6.4); 40-80% gravel (mean 58.0); 10-40% cobble (mean 11.7)." The authors continue with their description of good spawning habitat as "… those areas which had less than 10% sand; 40-80% gravel with 10-40% cobble and occasional boulders (less than 20%); stream velocities of 58-98 cm/sec and stream depths of 30-48 cm at spawning; stream gradient were usually greater than 0.5% and stream sections consisted of at least 50% riffle and run."

The first challenge facing Atlantic salmon returning to spawn in Prince Edward Island streams is navigating around or over stream blockages. Rarely are fallen trees, even big "jackpots of woody debris, obstacles to fish passage but beaver dams frequently block movement upstream (section 3.2.3). When such blockages occur, salmon often spawn in less desirable locations. If the blockage is near the head of tide, no spawning occurs in the river that year and the year class of salmon is subsequently absent.

In many rivers, traditional salmon spawning sites are known to be used each year. For instance, salmon traditionally spawn immediately downstream from the former bridge crossing at Leards Pond on the Morell River. These are mostly large fish and spawning success is probably high, since the stream bottom is relatively clean (because of Leards Pond acting as a gigantic sediment trap) and the substrate composition appears ideal for spawning. In the late 1980s, it was observed that salmon of Rocky Brook (Miramichi River) origin, stocked from the semi-natural rearing pond on the Morell River, concentrated their spawning much further upstream than Leards Pond, sometimes in tributaries a mere 2 metres wide. The Rocky Brook origin fish usually completed spawning one to two weeks earlier than fish using traditional sites.

Some Prince Edward Island streams have few holding pools for adults and salmon may resort to spawning in shallow, swift water near any available cover or often, at the top end of shallow pools. Reaches of many streams have gravel so shallow that numerous “scrapes” are made in poor quality substrate before a suitable depth of gravel is found above the subsurface hardpan. The distribution of suitable spawning gravel has been shown to limit salmonid populations (Kondolf and Wolman 1993) and this is probably affecting spawning success in many Prince Edward Island streams.

Good nursery areas for newly hatched Atlantic salmon should occur immediately downstream from spawning sites. Young-of-the-year salmon prefer a gravel substrate from 1.6 – 6.4 cm in diameter in rather shallow water (Symons and Heland 1978). Older parr choose habitat that has a high component of larger cobble/boulder material which normally occurs where higher stream velocities prevail. Un-embedded cobble substrate in salmon streams is of critical importance as sheltering areas for parr in autumn and winter (Cunjak 1988; Rimmer et al. 1984) and for sheltering in summer (Gries and Juanes 1998).

Figure 7. Atlantic salmon parr.

The optimal temperature for incubation of Atlantic salmon eggs is about 6˚C (Peterson et al. 1977). On Prince Edward Island, water temperatures are much lower than this during egg incubation. Upper reaches of many streams do not freeze over because of the amount of spring water input. However, when redd surveys were being conducted on Prince Edward Island in late November 2008, there were several days when water temperatures were between 1˚C and 2˚C and surface ice was present. Witzel and MacCrimmon (1983) have noted that water temperature within trout redds can be considerably warmer than on the substrate surface. It would be expected that the deeper the salmon eggs are buried, the warmer they would remain during incubation, especially if there are any ground water seeps in the nearby upstream areas. Some stream reaches have multiple springs in the adjacent riparian zone or seeps on the stream bottom which flow into the watercourse all winter. Water coming from springs up to several hundred metres from streams can be noticeably warmer at the stream entry point than the rest of the river water. Some research suggests that low dissolved oxygen levels in long residence ground water could have negative impacts on incubating salmonid eggs (Youngson et al. 2004). However, with the nature of the fractured sandstone bedrock on Prince Edward Island, ground water is unlikely to have low levels of oxygen and concentrations recorded in springs on the Morell and other rivers have been high.

All streams on Prince Edward Island are affected, to some degree, by sediment and in many watercourses, poor quality substrate is likely limiting salmon populations. Sections of stream that have the best habitat for juvenile salmonids are usually found downstream from impoundments or sediment traps designed for regular removal of sediment. In other reaches of stream, it is common to have gravel, cobble and even boulders partly or completely covered by bottom sediments. This limits the number of juvenile salmon that can use this habitat in summer and may play a major role in winter survival with disappearance of sheltering sites within the streambed. In early summer, 2008, I surveyed two river systems, Clarks Creek and North River, and documented a considerable quantity of potential spawning and nursery habitat. However, during the salmon redd survey in November, both systems were found to have much of the quality habitat covered with sediment, likely from torrential rainfall events in late summer. On the other hand, in rivers like North Lake Creek, the amount of sediment does not appear to change (unless a beaver impoundment is established), salmon spawn in the same places each year and nursery areas in the runs downstream from the redds have abundant young-of-the-year salmon the following summer. Unusually heavy rainfall events occurred in 2008, especially in August, but this will likely become the norm in future as global climate change takes place. Therefore, one of the major thrusts for improving Atlantic salmon populations on Prince Edward Island has to be soil stabilization in all seasons on the uplands and sediment consolidation or removal within the stream system.

3.5 Interactions with other Freshwater Fish Species

According to federal government reports, rainbow trout were first stocked in Pisquid Pond and O'Keefes Lake in 1924. Rainbow trout broodstock were taken from these sites and fry were frequently moved from mainland hatcheries and released in various locations on Prince Edward Island. Many rivers are suspected to have received their stocks of rainbow trout as escapees from aquaculture operations located on various drainage basins or estuaries. In some watercourses, such as the Dunk River, Wilmot River, Bradshaw River, and West River, rainbow trout flourished and in some parts of these rivers, their population levels are now comparable to those of brook trout. In other rivers where rainbow trout were released, such as the Morell River and St. Peters River, the populations have disappeared. Currently, there are rainbow trout in nine of the remaining twenty-two rivers which have Atlantic salmon on Prince Edward Island.

Rainbow trout share similar habitat to Atlantic salmon and it has long been suspected that they might out-compete other salmonids in certain circumstances. For instance, in 2002 following at least two farm pesticide runoff events in which thousands of fish died in the Wilmot River, a much higher percentage of rainbow trout survived than brook trout (Gormley 2003). I have observed that in cold headwater streams, brook trout normally appear to be more abundant than rainbow trout, while in very warm reaches of some rivers, where summer water temperatures range from 20-25˚C, Atlantic salmon are much more abundant than brook trout. To date, little information is known about the interaction and competition between rainbow trout and Atlantic salmon on Prince Edward Island and therefore, studies should be conducted to determine whether or not rainbow trout are actually detrimental to salmon populations.

Recommendation

Research should be conducted, perhaps as a Masters study, to determine the impact of introduced rainbow trout on populations of Atlantic salmon and brook trout on Prince Edward Island.

Other fish species, such as smelts, gaspereau and blue-backed herring share the same river reaches as juvenile Atlantic salmon in spring and are undoubtedly a benefit to the salmon. The prodigious quantities of eggs deposited by these species will, in many locations, be eaten by salmon parr or trout. It is not unusual for anglers fishing the Morell River in June to catch trout and young salmon filled with eggs. At one time, the runs of smelts, gaspereau and blue-backed herring on the Morell River were so large that sections of the river would become slippery from the volume of deposited eggs. In rivers where blockages prevent upstream migration of these fish, salmonids can be deprived of an abundant food source.

3.6 Over-wintering Habitat

The lack of suitable over-wintering habitat may be a limiting factor for Atlantic salmon in some Prince Edward Island rivers. During the winter of 1996-1997, I was involved in a study in which incubation baskets containing gravel and salmon or trout eggs were buried in various regions of the Morell River. Gravel from each site was sieved before being placed in the incubation baskets. By mid-June 1997, sediment had infiltrated all of the baskets and in some cases, a "plug" was formed at the top which prevented juvenile salmon from emerging. If it is assumed that most parr would require winter sheltering space under or beside large cobble-sized substrate, then the amount of sediment and embeddedness of cobble would certainly degrade over-wintering habitat in many river reaches on Prince Edward Island. Salmon parr have been encountered in pools during winter electrofishing activities, but with large trout also present, life must be rather precarious for the smaller salmon parr in these areas.

Winter weather conditions which influence river water levels, and often sediment impact into streams, can vary dramatically from year to year or sometimes even from county to county. From 2000-2005, there were no mid-winter thaws that lasted for more than a day or two and stream water levels under such conditions can lower substantially as the water table drops and ground water input into the stream decreases. There are no data available on Prince Edward Island to suggest how such climatic conditions would affect Atlantic salmon. However, I have observed that in years with minimal mid-winter thaws, brook trout had hatched before spring run-off and the densities of juvenile brook trout were high the following summer.

On larger rivers on Prince Edward Island, the upper reaches, being spring fed, are usually free of ice in winter. In lower reaches, slow water areas such as pools may be ice covered but sections with spring water input and faster moving riffles may stay open, even when air temperatures are many degrees below 0˚C. In some cases, frazil ice forms when the water temperature approaches 0.0˚C and water is bounced into the cold air with the turbulence found in riffles. Downstream, the super-chilled frazil ice then tends to clump and stick to any object, often coating even a small branch or stone to become a grotesque structure sometimes a foot or two in diameter. The formation of frazil and anchor ice likely occurs in other salmon rivers in winter, as reported by Cunjak and Caissie (1993) in the Northwest Miramichi River in New Brunswick.

I do not know how frequently frazil ice or anchor ice occurs in Prince Edward Island streams in winter or how it affects Atlantic salmon redds or juveniles. However, in the winter of 1992-93, the phenomena was observed on three different days on the Morell River, once below Mooneys Pond and on two different occasions, upstream from Indian Bridge. On all occasions, every object within the stream channel appeared to be coated with enormous quantities of ice and the river was overflowing its banks, yet the river depth returned to normal levels downstream from springs. This anchor ice phenomenon can result in considerable movement of sediment and gravel when bright sunshine causes the ice to lift and move downstream, dropping its substrate cargo in areas "warmed" by inputs of ground water. In both locations on the Morell River where this was observed, good summer populations of Atlantic salmon parr occur and the Mooneys Pond site had many redds during the previous autumn.

3.7 Migration to Sea

After spawning, adult salmon drop downstream to deep pools or a pond to spend the winter. In many of our Prince Edward Island streams, these kelts (black salmon) are frequently seen in pools near the head of tide during the first week of the angling season which starts on April 15th of each year. At this time, rainbow smelt have started their upstream ascent in many watercourses and they provide abundant food for the kelts. The seaward movement of Atlantic salmon smolts is dependent upon water temperature and on Prince Edward Island, at least on the Morell River, this outward migration seems to be particularly prominent during the first two weeks of May. From the former semi-natural rearing site at Mooneys Pond, exiting smolts were counted and although a few might leave the pond at any time during day or night, the bulk of movement appeared to be between sundown and midnight, especially on warm, wet nights. Movement downstream from Mooneys Pond was rapid, with marked smolts (adipose fin clipped) arriving near the head of tide within two to three days. We have no information as to how long it took salmon smolts to leave the Morell River estuary, but there is a relatively short window of time to reach the sea for good sea survival (Bley 1987), and various researchers have found that there is no period of adjustment needed before moving into salt water (McCleave 1978, Moose et al. 1995). In the Morell River estuary, it is unlikely that either birds or mammals would have much luck preying upon migrating smolts because of the high number of anglers, both on shore and in boats during the first month of the angling season. However, in some Prince Edward Island estuaries, angling activity is light and both double-crested cormorants (*Phalacrocorax auritus*) and harbor seals (*Phoca vitulina*) are abundant. If there is a strong run of rainbow smelts, the estuarine impact of the predator gauntlet on salmon smolts or post smolts may be diluted; if not, it might be desirable to consider daytime disturbance of the birds so they move to other feeding areas during the smolt run.

Prior to stocking smolts on the Morell River, care was taken to ascertain that no blockages would prevent the fish from moving downstream. Dead salmon parr, smolts and even adults have been found entangled in beaver dams. On one occasion, a beaver dam below Kennys Bridge not only prevented smolts from descending in spring but many kelts from the previous autumn were also present in the beaver impoundment in early June. In such cases, even if the dam were breached, the “window of opportunity” for smolt movement to sea would have closed.

> **Recommendation**
> *In all rivers on Prince Edward Island with Atlantic salmon, tributaries that would likely have salmon smolts should be visited in early April with the intent to identify and remove any blockage that would prevent migration of smolts to sea.*

3.8 From Sea to Fresh Water

Salmon returning from sea no longer have to run the gauntlet of salmon berths – the last of which were bought back in St. Peters Bay several decades ago. With the exception of a few fish in the Dunk, Morell and West rivers, the salmon returning to Prince Edward Island waters are late-run fish which often do not appear in fresh water until October and November. Thus, the salmon do not have to contend with estuaries which go anoxic during summer months. However, this does not mean returning salmon have a free ride through the estuaries. In some places, for example the entrance to Charlottetown harbor, large numbers of seals can pose a threat to the migrating fish.

In some rivers, such as Carruthers Brook, regular deep pools occur close to spawning sites, providing shelter for Atlantic salmon before they spawn. In other streams, there is a scarcity of pools which likely limits spawning distribution and makes waiting salmon vulnerable to predation, especially by bald eagles (*Haliaeetus leucocephalus*).

In order to detect trends in salmon spawning attempts, redd surveys were conducted each year on all major tributaries of the Morell River for almost a decade and thereafter, they were done more sporadically. Likewise, various other rivers were occasionally surveyed for redds but no complete salmon redd survey of Prince Edward Island salmon streams has been attempted until 2008. The “window” for doing redd surveys usually extends from about the second week in November until freeze-up. Before November 11, a traditional starting time for redd surveys on the Morell River, some salmon will not yet have spawned. However, if there is an early freeze-up, conducting redd surveys in December may not be practical. Normally, streams on Prince Edward Island are late to freeze because of the large proportion of 7˚C ground water in autumn. However, in 2008, very cold weather came early, along with considerable snow and ice. The cold weather was interspersed with heavy rainfall events so conducting redd surveys was challenging. With the help of volunteers, assistants and students from Holland College (they surveyed all three tributaries of the Morell River) all rivers with salmon runs were checked. Complete surveys for Priest Pond Creek, Trout River

(Coleman), Cains Brook and Carruthers Brook were not practical, although sections of each of these streams were checked to ensure that blockages were not preventing salmon from reaching preferred spawning regions. Table 2 indicates numbers of redds counted on each drainage basin in 2008 and presents data from other years when several rivers were surveyed. The locations of redds in each river is shown on maps in section 5.0. Redd maps are not included for those rivers where salmon redds could not be found.

All individuals helping to count redds in 2008 were given a "trial run" by the author to ensure consistency in data collection, namely:

- Good visibility (substrate clearly seen);
- Polarized glasses worn by surveyors;
- Where practical, counts were done by two people walking upstream;
- Redds counted had an obvious deep depression at the upstream end;
- Redds counted were 0.5 metres or more in width and 1.0 metre of more in length;
- Scrapes were distinguished from redds (usually the result of hardpan under gravel) and not counted.

Along with counting salmon redds, surveyors also noted major trout spawning areas and blockages which could prevent movement of fish within the stream reach. Beaver blockages often stop upstream migration of salmon, and redd counts reflect how far fish can go before the blockage occurs. For instance, no salmon redds were observed on the Vernon River in 2008, likely because of a blockage near the head of tide. Also, salmon were prevented from ascending to some traditional spawning areas in Bristol Creek, Cross River, Head of Hillsborough, Midgell River, Naufrage River, Priest Pond Creek, St. Peters River and Trout River/Bank Brook (Tyne Valley).

Figure 8. Atlantic salmon stacked in a pool downstream from Mooneys Pond, Morell River, awaiting autumn spawning season.

Table 2. Number of Atlantic salmon redds counted in Prince Edward Island rivers in 1992, 1993, 2004, 2005 and 2008.

River	**Number of Salmon Redds**				
	2008	**2005**	**2004**	**1993**	**1992**
Class I					
Cains Brook	58*	n/a	n/a	n/a	n/a
Carruthers Brook (Mill River)	152*	n/a	n/a	311	n/a
Cross River	120	n/a	n/a	n/a	n/a
Naufrage River	100	n/a	53	32	n/a
North Lake Creek	200	68	84	36	200
Pisquid River	38	17	14	n/a	n/a
Priest Pond Creek	11*	n/a	n/a	n/a	n/a
St. Peters River	53	n/a	n/a	93	n/a
Trout River (Coleman)	2*	n/a	n/a	58	33
West River	141	n/a	18*	165	274
Class II					
Clarks Creek	0	n/a	n/a	n/a	n/a
Dunk River	17*	n/a	n/a	6	n/a
Midgell River	69	n/a	64	77	n/a
Morell River	328	n/a	71*	377	917
Vernon River	0	n/a	n/a	n/a	n/a
Class III					
Bristol Creek	7	11	15	41	n/a
Cardigan River	0	n/a	n/a	n/a	n/a
Head of Hillsborough	0	n/a	n/a	n/a	n/a
Little Trout River	11	12	5	n/a	n/a
North River	18	n/a	n/a	n/a	n/a
Wilmot River	0	n/a	n/a	n/a	n/a
Trout River/Bank Brook (Tyne Valley)	14	n/a	n/a	n/a	n/a

* Incomplete Count

Data for 2008 – collected by D. Guignion, Kirk Roach, Fred Cheverie, Erica MacIsaac, Cathy Gallant, Christina Pater and Holland College students

Data for 1992 and 1993 – collected by Dave Biggar, Cindy Crane, Todd Dupuis, D. Guignion and Rosanne MacFarlane

Data for 2004 and 2005 – collected by D. Guignion and Rosanne MacFarlane

4.0 RIVER CLASSIFICATION FOR ATLANTIC SALMON IN PRINCE EDWARD ISLAND

The number of rivers in Prince Edward Island from which populations of Atlantic salmon have disappeared continues to increase. A half century ago, at least fifty-five watercourses had runs of Atlantic salmon. By 2002, salmon remained in only thirty-three rivers, many of which had very low populations. Since 2002, runs have disappeared from eleven more rivers and seven others have perilously low numbers of salmon. Many streams that still have salmon runs have serious habitat problems. Often, only one year class is present in the river which usually indicates that salmon populations are barely hanging on.

It would be beneficial to develop a classification scheme that would identify management strategies for all salmonids and other anadromous fish in the eighty or so largest streams on Prince Edward Island. That task would require blending necessary ingredients, such as topics covered in the present report with harvest and future population enhancement opportunities. If such a venture were undertaken, all potential stakeholders, such as landowners, government agencies and non-government groups with vested interests should be asked for input.

The current task was to focus on a conservation strategy for Atlantic salmon. However, all anadromous fish are so inextricably connected with each other and the environment, that any scheme which would work for Atlantic salmon should also benefit the other species.

All of the rivers on Prince Edward Island that currently or recently had Atlantic salmon runs are categorized in the following scheme. Data and specific recommendations for each are provided in Section 5.0. Table 1 indicates the total area in hectares, stream length, area and percentage under forest cover for each drainage basin in Class I, II, III and IV rivers.

4.1 Class I Rivers - Wilderness Rivers

These rivers (Figure 9) have annual runs of salmon that should be sustainable barring catastrophic events (e.g. beaver populations not controlled or massive inputs of pesticides and/or sediment into watercourses). Some of these drainage basins are located in areas of the province with extensive forest (Table 1), while others with more cleared land have major portions of the river with relatively good riparian buffer zones. All of the proposed wilderness rivers still have reasonable populations of Atlantic salmon and with the proposed specific recommendations in section 5.1, there is reason to be optimistic that such populations will remain stable or increase. Populations of other anadromous fish (alewives, blue-backed herring, rainbow smelt and brook trout) should respond positively to improved habitat and blockage removals if these obstacles have not already been eliminated from the drainage basin.

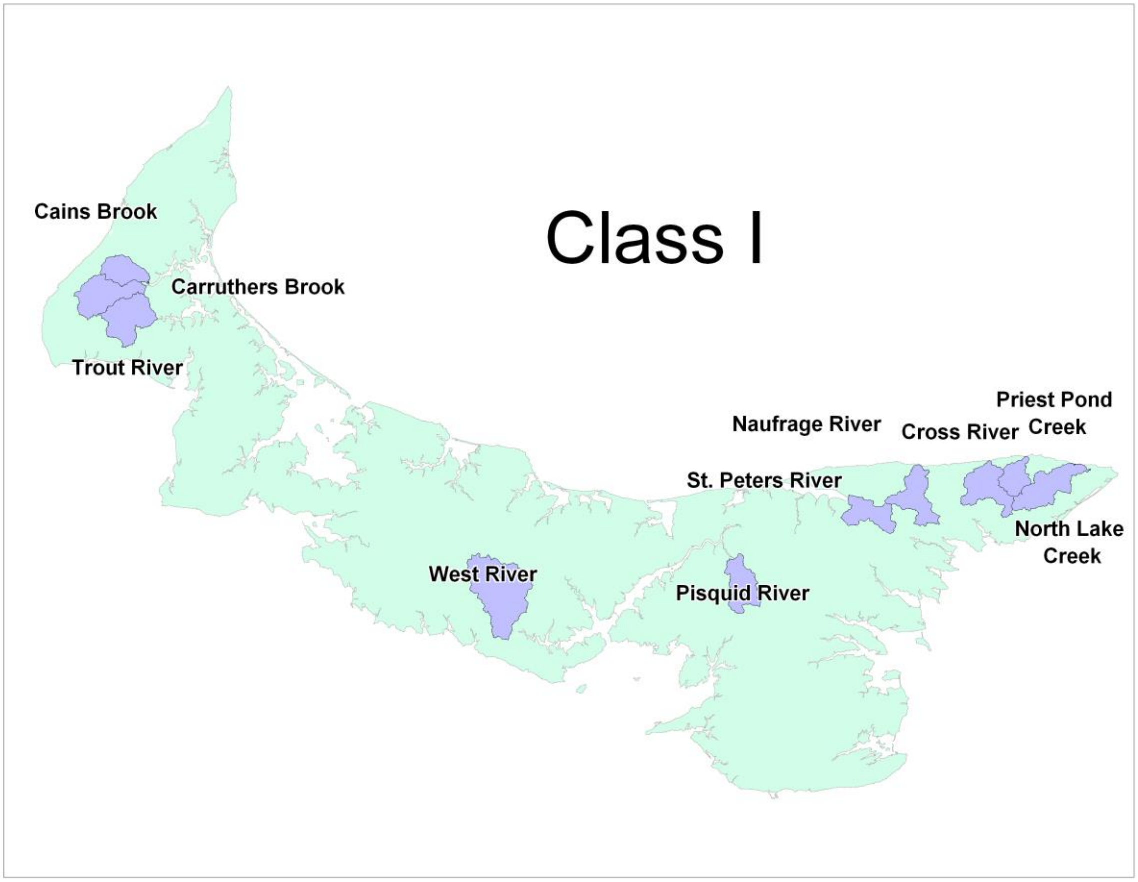


Figure 9. Class I salmon rivers in Prince Edward Island.

At present, the following list of rivers should be considered for this wilderness river category. As habitat and populations of salmon are improved in other rivers, they should be considered for inclusion. Detailed recommendations for each river are found in section 5.1.

- Cains Brook
- Carruthers Brook (Mill River)
- Cross River
- Naufrage River
- North Lake Creek
- Pisquid River
- Priest Pond Creek
- St. Peters River
- Trout River (Coleman)
- West River

4.2 Class II Rivers – Where Salmon and Beavers may Co-exist?

All of these streams should continue to have salmon runs if water quality conditions and beaver populations are managed to a greater extent than is currently happening. Responsibility and resources should be provided to each watershed group to hire or train a

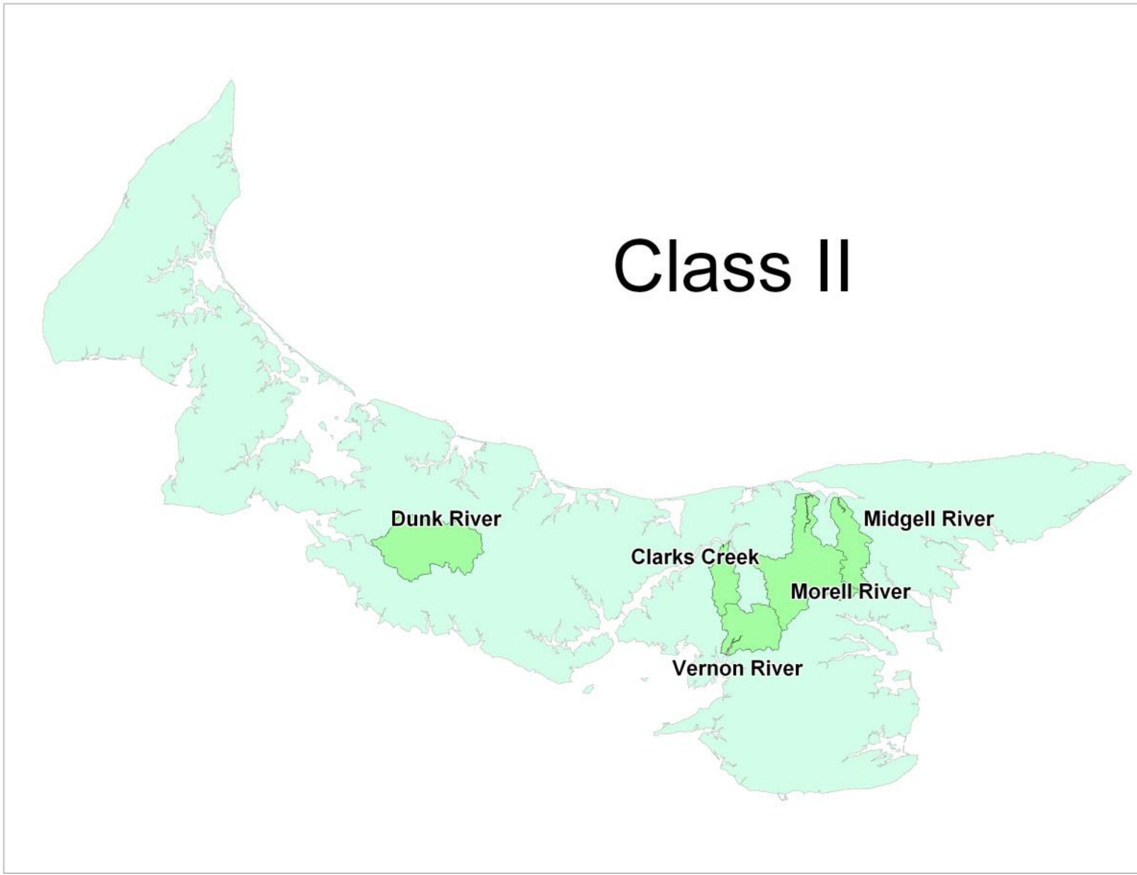


Figure 10. Class II salmon rivers in Prince Edward Island.

professional trapper to do the required management. In the past, water quality has been an issue in sections of several of these streams (temperature, oxygen, or pesticides) and all need specific management (Section 5.2). Populations of salmon in both Vernon River and Clarks Creek remain in jeopardy since no redds were counted in 2008 and thus one year class will be missing. Geographic locations of Class II rivers are shown in Figure 10.

- Clarks Creek
- Dunk River
- Midgell River
- Morell River
- Vernon River

4.3 Class III Rivers – Atlantic Salmon on the Verge of Disappearing

Populations of Atlantic salmon in these streams are very low. Unless immediate intervention occurs, runs in most of these rivers cannot be expected to survive more than a few years. Blockages to instream movement and/or sediment input plague most of them.

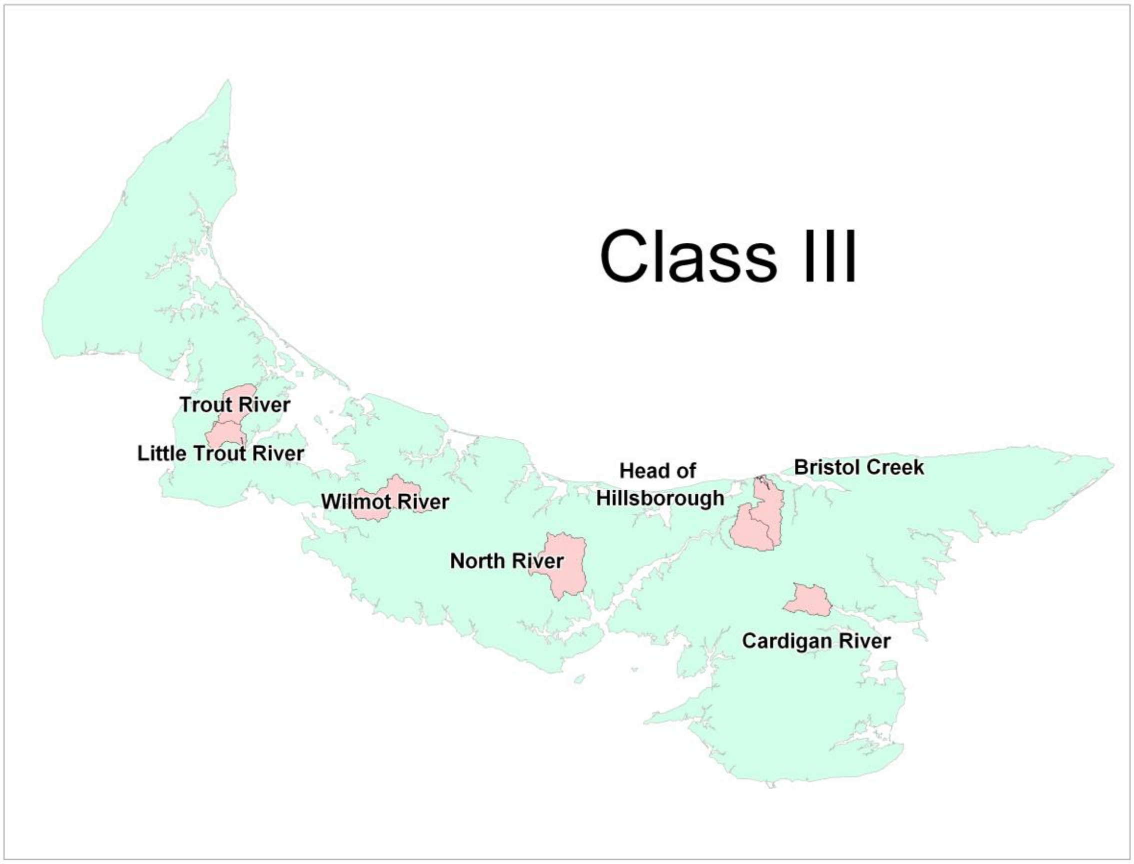


Figure 11. Class III salmon rivers in Prince Edward Island.

Recommended management for each is found in section 5.3 and geographic locations are shown in Figure 11.

- Bristol Creek
- Cardigan River
- Head of Hillsborough
- Little Trout River
- North River
- Trout River (Tyne Valley)/ Bank Brook
- Wilmot River

4.4 Class IV Rivers – Salmon Populations that have Disappeared since 2002

Populations of Atlantic salmon have disappeared from the following eleven rivers within the past six years. In many of these rivers, beaver blockages appear to have been the main reason for the disappearance of salmon, but some of the following drainage basins also have severe land use problems. If community groups continue with their efforts to re-establish and maintain good instream and riparian zone habitat and the limiting factors that caused the

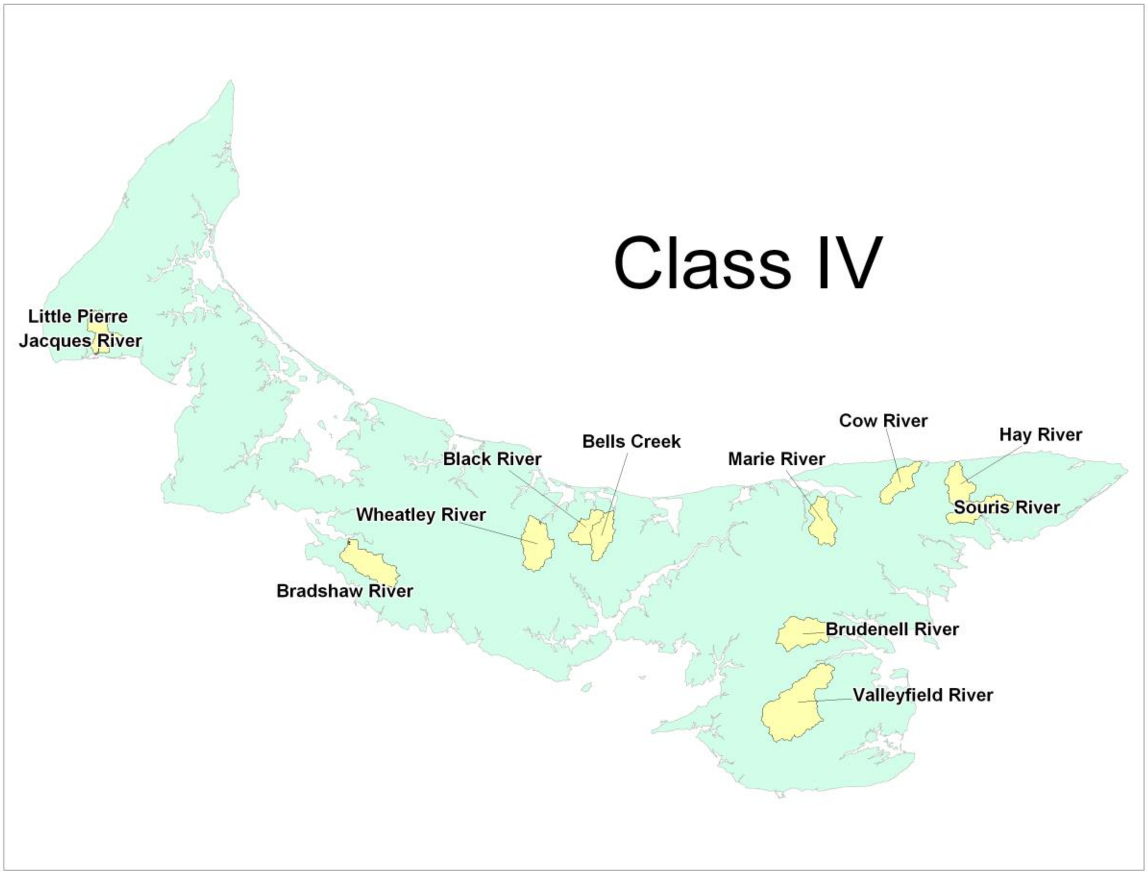


Figure 12. Class IV salmon rivers in Prince Edward Island.

salmon populations to disappear are mediated, some of the streams would be good candidates for restocking. Section 4.7 is an outline of how research could potentially play a role in the recovery of salmon populations in some Prince Edward Island rivers. Geographic locations of these rivers are shown in Figure 12.

- Bells Creek
- Black River
- Bradshaw River
- Brudenell River
- Cow Creek
- Hay River
- Little Pierre Jacques River

- Marie River
- Souris River
- Valleyfield River
- Wheatley River

4.5 Class V Rivers - Salmon Populations that Disappeared Before 2002

Prince Edward Island rivers that have lost salmon sometime during the past four to five decades are listed below. This list is likely not exhaustive, since it is rare that conversations with older anglers do not reveal other sites where salmon were caught. An interesting article with historical information about Atlantic salmon on Prince Edward Island is found in the October issue of Island Magazine (Dupuis 2008). Geographic locations of these river systems are shown in Figure 13.

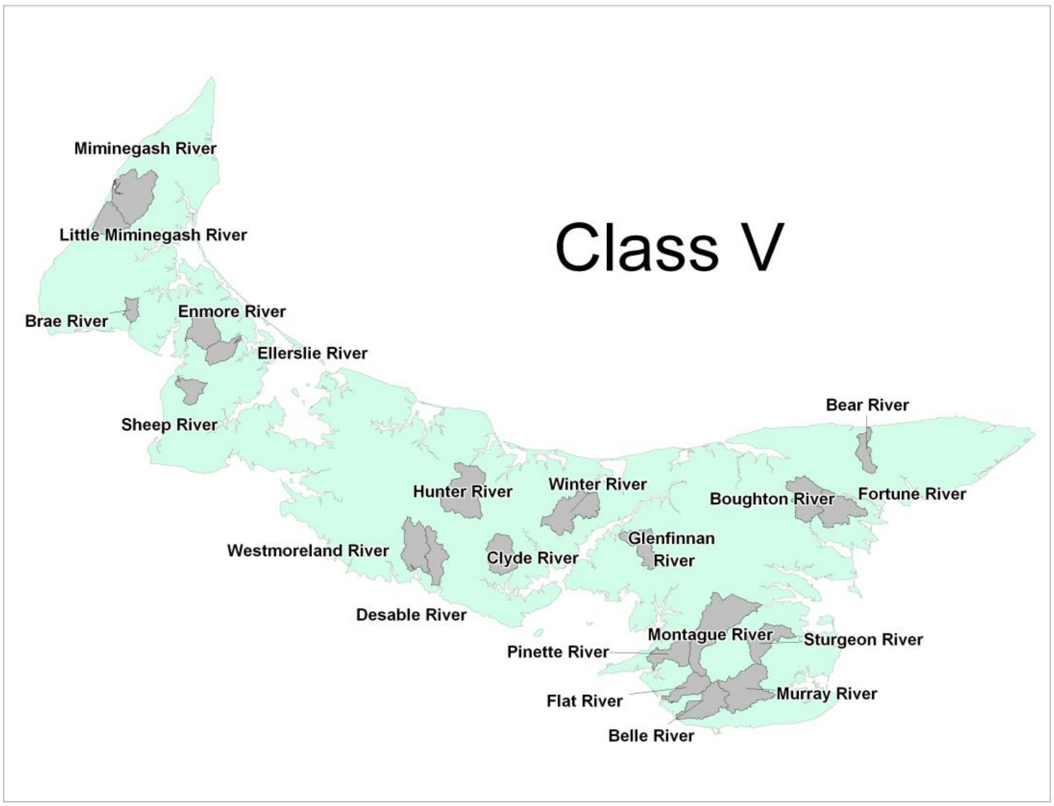


Figure 13. Class V salmon rivers in Prince Edward Island

- Bear River (I caught parr in this river in the late 1960s)
- Belle River (local landowner)
- Boughton River (the late Mr. Ross spoke of salmon trying to ascend the paddle wheel area of Ross's Mill)
- Brae River (Shawn Hill has a photo of multi-sea winter fish caught by a local angler on the Brae)
- Clyde River (reported to be a good river to poach; Mike Read caught salmon parr here)

- DeSable River (parr reported by late John Matheson)
- Ellerslie (Smith and Saunders research)
- Enmore River (electrofishing surveys)
- Flat River (local anglers and one salmon reputedly caught in autumn 2007)
- Fortune River (Fr. Charlie Cheverie reported salmon in the Fortune River)
- Glenfinnan River (great runs of multi-sea winter fish reported by the late Harold Jenkins)
- Hunter River (local anglers)
- Little Miminegash River (I caught parr here in the early 1970s)
- Miminegash River (I caught parr here in the early 1970s)
- Montague River (could have been strays from the Vallyfield River)
- Murray River (local anglers)
- Pinette River (local anglers)
- Sheep River (Albert Arsenault indicated that this river was known to have salmon)
- Sturgeon River (local anglers)
- Westmoreland (reported to the author by the former mill operator Jack Leard)
- Winter River (I was told by a person of aboriginal descent that the native people used to harvest salmon in the Winter River)

4.6 Class VI Rivers – Candidate Rivers for Semi-Natural Rearing

There are streams on Prince Edward Island that are large enough to provide locations for extensive angling if populations of salmon were available. The “kinks” of semi-natural rearing of Atlantic salmon were worked out using the Morell River as a research zone during the 1980s. If the will and resources are available, it would be relatively easy to re-establish excellent angling opportunities using established techniques and proper genetic stock. Spin-offs values to the economy would be substantial, as was the case when semi-natural rearing was being properly carried out in the Morell River. If resources, science, and knowledgeable personnel are not available and utilized, it would likely prove to be a waste of time and money to go this route again. The continued operation of a hatchery like the Cardigan facility would be imperative for this type of venture.

- Dunk River
- Morell River

4.7 Class VII Rivers – Research Rivers

An integral part of a salmon recovery program should include a research and monitoring component. Data on habitat changes and populations of salmonids should be collected on an annual basis for all rivers where work is being done. Some rivers should be considered research rivers where relevant questions can be answered, such as:

What impact is rainbow trout having on Atlantic salmon populations?
What are the limiting factors that seem to be preventing good over-wintering salmon parr survival on some rivers?
Why is hatching success so low in some rivers or tributaries?
What is the optimal and minimal depth of gravel in spawning areas?

How does pool location affect spawning locations?

Answers to these and other questions will lay the groundwork for future management direction in a Prince Edward Island salmon strategy. Regular monitoring of some parameters, such as seasonal water temperature, could be done by the watershed groups if data loggers were provided. It would be encouraging if researchers with graduate students could tackle some of the more perplexing problems.

Figure 14. Brook trout (top) and Atlantic salmon (middle) from the Morell River and a rainbow trout (bottom) from the Brudenell River.

5.0 MANAGEMENT SUGGESTIONS FOR ATLANTIC SALMON RIVERS IN PRINCE EDWARD ISLAND

There are many factors which can limit the population of Atlantic salmon in a particular river, including access, quality and quantity of spawning, nursery and over-wintering habitat, water quality, and predation. The key to successful management and maintenance of sustainable populations is not only being aware of the limiting factors, but also knowing which ones will likely have the biggest impact on fish abundance in a particular river or section of river. Once the most prominent limiting factors are known, they should be addressed first. For instance, it makes little sense to add digger logs in a stream reach to increase spawning or nursery sites if beaver blockages downstream prevent salmon from reaching the enhanced habitat.

On Prince Edward Island, the two most crucial limiting factors for Atlantic salmon populations are sedimentation and river blockages, especially beaver dams. Both of these problems are evident in all of our salmon rivers, but one or the other may be more prominent, depending on the river. In the long term, there are many other problems which also have to be considered once these crucial ones are addressed. In setting up the present classification scheme, I have put a lot of weight on extensive field work and dialogue with landowners and community watershed groups about present and past problems. In addition, years of electrofishing data and autumn redd surveys give a clear picture as to salmon population status in rivers or river reaches.

Salmon rivers have been classified into various categories. For each category, a table summarizes much of the data collected over the past eight years (Tables 3, 4, 5 and 6). From 2000-2002, I electrofished sections of approximately 80 rivers on Prince Edward Island (Guignion et al. 2002) and pertinent data from those efforts are summarized in each of the tables under the column labeled as 2002. I have also been given oral reports of Atlantic salmon being angled in recent years in rivers in Class V, such as the Fortune River, Flat River, Pinette River and Valleyfield River. While I certainly do not question the authenticity or value of such reports, these are likely instances of stray salmon and do not represent a run of salmon ascending a river, with the possible exception of the Valleyfield River (Section 5.4.6).

In 2007, I again electrofished sections of all rivers where juvenile salmon were reported in the 2002 data or found in various surveys between 2002 and 2007. Those data are presented under the heading of “2007” in tables 3, 4, 5 and 6. In 2008, all Prince Edward Island index river sites (MacFarlane 2009) were again electrofished and the data for salmon added to the 2008 column in tables 3, 4, 5 and 6. In 2008, Atlantic salmon redd counts were conducted in all rivers that salmon juveniles were known to be present in 2002 or 2007. If redds were found, their locations and the location of redds found in previous years are shown on watershed maps to indicate critical habitat for spawning and nursery areas.

The management suggestions offered reflect the data that have been collected in this and other research efforts. As habitat and fish populations are monitored and more information becomes available, the strategy for each river should be reviewed and adapted as required.

Table 3. Density of juvenile salmonids in Class I rivers in Prince Edward Island in 2002, 2007 and 2008.

River	Sector	Salmonid Density (#Fish/100m2)								
		Brook trout			Rainbow trout			Atlantic salmon		
		2002	2007	2008	2002	2007	2008	2002	2007	2008
Cains Brook	MacAuslands	73.6	205.5	n/a	0.0	0.0	n/a	60.2	76.8	n/a
	Upstream 1 km	65.2	n/a	n/a	0.0	n/a	n/a	2.0	n/a	n/a
Cross River	MacInnis Pond	45.2	44.7	n/a	0.0	0.0	n/a	171.2	36.4	n/a
	Souris Line Road	23.0	68.4	n/a	0.0	0.0	n/a	53.7	0.0	n/a
Mill River	Bloomfield Park	92.8	n/a	n/a	0.0	n/a	n/a	318.0	n/a	n/a
	Howlan	n/a	n/a	54.4	n/a	n/a	0.0	n/a	n/a	162.2
	Forestview	n/a	24.2	89.8	n/a	0.0	0.0	n/a	162.8	78.4
Naufrage River	Hermitage Road	1.0	7.4	n/a	0.0	0.0	n/a	18.7	58.7	n/a
	Larkins Pond	0.0	yes	n/a	0.0	0.0	n/a	21.0	no	n/a
North Lake Creek	Head of Tide	173.3	n/a	n/a	0.0	n/a	n/a	2.2	n/a	n/a
	Dixons Pond	35.3	80.0	n/a	0.0	0.0	n/a	21.0	109.0	n/a
Pisquid River	East Branch	164.3	93.0	n/a	0.0	1.0	n/a	0.0	12.0	n/a
	Forestry Bridge	30.7	27.4	n/a	12.4	6.2	n/a	9.4	17.7	n/a
Priest Pond Creek	Pensioners Road	36.0	25.6	n/a	0.0	0.0	n/a	19.1	30.8	n/a
	Bull Creek Road	38.4	45.6	n/a	0.0	0.0	n/a	0.0	9.5	n/a
St. Peters River	Below Quigleys Pond	5.6	<1	n/a	0.0	0.0	n/a	169.8	88.7	n/a
Trout River	Bannys Hole	98.7	94.9	n/a	0.0	0.0	n/a	31.9	61.1	n/a
West River	Cudmores	157.2	122.6	109.1	10.6	17.3	18.1	9.9	24.7	3.6
	Below Carraghers Pond	n/a	n/a	64.0	n/a	n/a	70.6	n/a	n/a	0.0
	Howells Brook at Riverdale Bridge	n/a	n/a	67.2	n/a	n/a	6.0	n/a	n/a	0.0

Yes - indicates salmon or trout present in a spot check
No - indicates salmon or trout not present in a spot check

Table 4. Density of juvenile salmonids in Class II rivers in Prince Edward Island in 2002, 2007 and 2008.

	Sector	Salmonid Density (#Fish/100m2)								
		Brook trout			Rainbow trout			Atlantic salmon		
		2002	2007	2008	2002	2007	2008	2002	2007	2008
Clarks Creek	Auburn Road	12.9	n/a	n/a	17.5	n/a	n/a	0.0	n/a	n/a
	Cape Breton Road	n/a	2.0	n/a	n/a	8.3	n/a	n/a	52.5	n/a
Dunk River	Hal Mills Brook	n/a	n/a	41.2	n/a	n/a	27.3	n/a	n/a	0.0
	Northeast Tributary	n/a	n/a	34.9	n/a	n/a	70.5	n/a	n/a	0.0
	Scales Pond	yes	n/a	n/a	yes	n/a	n/a	yes	n/a	n/a
	Greenans Bridge	n/a	39.3	51.8	n/a	24.3	17.4	n/a	0.0	0.0
	Walls Bridge	73.3	n/a	yes	131.9	n/a	yes	0.0	n/a	yes
	Breadalbane	52.5	n/a	n/a	109.7	n/a	n/a	0.0	n/a	n/a
Midgell River	MacDonalds Pond	0.9	0.0	n/a	0.0	0.0	n/a	19.4	66.7	n/a
Morell River	Kennys Bridge	n/a	n/a	34.3	n/a	n/a	0.0	n/a	n/a	8.9
	Below Cranes	82.1	29.6	16.9	0.0	0.0	0.0	21.3	62.4	14.9
	Old Cardigan Road	n/a	yes	n/a	n/a	no	n/a	n/a	yes	n/a
Vernon River	Glencoe Road	98.1	152.6	n/a	4.3	36.3	n/a	0.0	6.2	n/a
	MacMillans Pond	yes	yes	n/a	no	no	n/a	yes	yes	n/a

Yes - indicates salmon or trout present in a spot check
No - indicates salmon or trout not present in a spot check

Table 5. Density of juvenile salmonids in Class III rivers in Prince Edward Island in 2002, 2007 and 2008.

River	Sector	Salmonid Density (#Fish/100m2)								
		Brook trout			Rainbow trout			Atlantic salmon		
		2002	2007	2008	2002	2007	2008	2002	2007	2008
Bristol Creek	Forestry Road	80.6	150.7	yes	0.0	0.0	no	0.0	0.0	yes
Cardigan River	Below hatchery	70.8	33.8	n/a	42.9	68.6	n/a	22.2	55.2	n/a
	Straghbohgie Road	n/a	n/a	yes	n/a	n/a	no	n/a	n/a	no
Head of Hillsborough	Below Warrens Dam	34.4	<1	n/a	20.2	3.5	n/a	0.0	21.4	n/a
Little Trout River	Shale Pit	56.7	53.4	58.6	0.0	0.0	0.0	15.9	0.0	0.0
	Richmond	n/a	62.2	28.3	n/a	0.0	0.0	n/a	0.0	0.0
North River	Springvale (Rt 2)	72.6	161.6	n/a	13.0	109.8	n/a	0.0	47.4	n/a
	Loyalist Road	128.9	n/a	yes	0.0	n/a	yes	0.0	n/a	no
	Coles Brook	n/a	n/a	yes	n/a	n/a	yes	n/a	n/a	yes
Bank Brook/Trout River (Tyne Valley)	Robinsons Pond	49.2	5.6	52.1	0.0	0.0	0.0	21.3	4.5	4.6
Wilmot River	Arsenaults Pond	97.5	n/a	34.2	39.8	n/a	35.5	0.0	n/a	0.0
	Cairns Road	144.5 3.8*	n/a	146.3	43.9 21.6*	n/a	52.7	0.0 0.0*	n/a	0.0
	Marchbanks	n/a	83.0	yes	n/a	63.0	yes	n/a	0.0 yes	no

Yes - indicates salmon or trout present in a spot check
No - indicates salmon or trout not present in a spot check
* indicates post-fishkill survey

Table 6. Density of juvenile salmonids in Class IV rivers in Prince Edward Island in 2002, 2007 and 2008.

River	Sector	Salmonid Density (#Fish/100m2)								
		Brook trout			Rainbow trout			Atlantic salmon		
		2002	2007	2008	2002	2007	2008	2002	2007	2008
Black River	Route 6	7.1	13.2	n/a	0.0	0.0	n/a	1.0	0.0	n/a
	Brackley Point Rd	64.2	n/a	n/a	0.0	n/a	n/a	0.0	n/a	n/a
Bells Creek	Route 25A	105.5	n/a	yes	0.0	n/a	no	1.0	n/a	no
Bradshaw River	West Bedeque Rink Road	162.6	n/a	yes	57.6	n/a	yes	1.0	n/a	no
Brudenell River	Mellishs Pond	175.9	186.7	n/a	32.3	24.3	n/a	2.4	0.0	n/a
	Dewars Pond	n/a	n/a	yes	n/a	n/a	yes	n/a	n/a	No
Cow Creek	Highway Site	30.0	n/a	yes	0.0	n/a	no	39.8	n/a	No
	Selkirk Road	56.0	yes	yes	0.0	no	no	8.7	no	no
Hay River	Lesperance Site	50.0	31.3	yes	0.0	0.0	no	14.9	0.0	No
Little Pierre Jacque River	Bridge Site	56.8	yes	n/a	0.0	no	n/a	0.0	no	n/a
Marie River	Below Websters Dam	0.0	1.0	n/a	0.0	0.0	n/a	0.0	0.0	n/a
Souris River	East Branch at Forks	13.3	n/a	n/a	99.7	n/a	n/a	0.0	n/a	n/a
	West Branch	113.2	n/a	89.1	120.3	n/a	15.0	0.0	n/a	0.0
	East Branch	n/a	n/a	81.8	n/a	n/a	114.9	n/a	n/a	0.0
Valleyfield River	MacRaes Dam	yes	yes	yes	yes	yes	yes	no	no	no
	Egolfs Dam	24.5	n/a	n/a	23.5	n/a	n/a	0.0	n/a	n/a
Wheatley River	Upstream from Rackhams	n/a	n/a	94.2	n/a	n/a	0.0	n/a	n/a	0.0
	Below Rackhams	9.6	n/a	n/a	0.0	n/a	n/a	0.0	n/a	n/a

Yes - indicates salmon or trout present in a spot check
No - indicates salmon or trout not present in a spot check

5.1 Class I – Wilderness Rivers

With the current rate of loss of Atlantic salmon in various drainage basins, it should be clear that if management strategies do not change, it is a certainty that salmon (and likely other anadromous fish) range and population size will continue to decrease on Prince Edward Island. Following are general management suggestions for the ten wilderness rivers listed in section 4.1. These recommendations would probably be most beneficial to Atlantic salmon runs if implemented in the order that they appear.

5.1.1 General Management Suggestions

5.1.1.1 Watershed Management

The presence of a strong community group to oversee river management activities is critical in any restoration project. The group should undertake a multi-faceted public relations program that will involve the local community, with particular emphasis on involvement of landowners. Applications for funding should indicate the number of watersheds on which work is planned so funding agencies have a better understanding of the scope of work for each watershed group.

Partnerships have to be forged and cooperation encouraged between all resource management agencies (Department of Fisheries and Oceans, Federal and Provincial Departments of Environment and other responsible agencies) as well as non-government organizations such as watershed groups, Ducks Unlimited and Island Nature Trust. Land use activities within these drainage basins that accentuate best management practices should be given priority for financial support as it becomes available, for example ALUS (Alternative Land Use Services) program. With increasing funds being provided to the provincial Watershed Management Division, it is a good opportunity to identify priority watersheds and work closely with other government divisions, such as the Forests, Fish and Wildlife Division, to achieve provincial goals.

A long term watershed management plan as currently advocated by the provincial Department of Environment, Energy and Forestry (Water Resources Branch) is essential, provided the group does not get tied up in planning while salmon runs disappear. See Appendix II for an outline of a simple project management strategy that should work.

Watershed groups working on “salmon” rivers care deeply about fish species but unfortunately, groups seldom have enough expertise to know what habitat changes, if any, should be made to enhance salmonid populations.

> **Recommendation**
> *The U.P.E.I. Biology Department should be asked to offer an annual course in May in integrated watershed management with an expanded applied section on instream habitat improvements for salmonids. All watershed groups working on rivers with salmon populations should be encouraged to have at least one of their employees take or audit this course.*

Recommendation

Since written reports may not be readily available or read by community folks who do much of the watershed work, consideration should be given to the development of "how-to" videos". It would also be beneficial to make current (and future) reports and manuals available online (e.g. government web site).

5.1.1.2 Fish Access

The primary objective for all wilderness rivers should be the maintenance of unobstructed fish passage throughout the watercourse - for all age classes of anadromous fish in all seasons.

A) All beavers and their dams should be removed from wilderness rivers and steps should be taken to prevent their re-establishment in future years. The complete removal of beavers should occur quickly in small rivers, like Priest Pond Creek, but larger rivers with several tributaries and numerous old and new beaver blockages could take considerably longer. It would be desirable to have trappers help with the beaver removal through heavy trapping during the open season. However, trappers will not catch all of the beavers and there may be little interest in trying to do so. Therefore, the watershed groups should be given the authority, with input from DFO and the provincial Fish and Wildlife Section, to establish a time frame and identify resources and personnel needed for beaver removal on each drainage basin.

After beavers are removed, each dam which retains considerable quantities of water should be taken down slowly after spring runoff. Breaching should occur at the old stream channel site and each notch should be as wide as the natural stream channel. Consolidation of exposed mud banks with brush mats and/or jute webbing should occur soon after the water drops. Timing and types of trees and shrubs (grass should recolonize quickly) to be planted will vary with site and length of time the beaver dam was holding water. In areas where old beaver dams have remained for years, the stream channel will be difficult to follow. All of the trees will be dead and the soil may require many years before trees will recolonize and any planted trees will probably be unable to survive. Groups should consult the provincial Department of Environment, Energy and Forestry for advice on the species of trees required and the timing of planting needed to restore riparian zone vegetation in old, inactive beaver impoundments.

B) Other blockages affecting instream movements of anadromous fish should be removed or fixed (e.g. hanging culverts and fish ladders) if feasible.

Recommendation

All beavers and their dams should be removed from Class I rivers within the next one to five years and the rivers maintained free of beavers. In Class II and Class III rivers, the identified "beaver management zone" means that beavers and their dams will be removed from these zones when they interfere with movement of any year class of anadromous fish in any season.

5.1.1.3 Sedimentation

A) All major sources of sediment should be controlled and stream management should focus on stabilizing or removing excess sediment. Sediment traps (instream or sediment bypass ponds) should be excavated in specified locations between July 1 and September 30. Brush mats should be placed where suitable and expanded as needed in future years.
B) During spring run-off in April, watershed groups should identify each farm field and road crossing that is contributing sediment to the streams and work with landowners and government agencies to find remedies (e.g. directing run-off water into wetlands or excavating sediment basins, replacing culverts if necessary, etc.). All Class I streams should be considered priority rivers for funding through ALUS and the provincial Watershed Management Program.
C) Immediate dialogue has to be initiated with the provincial Department of Transportation and Public Works to fix problem stream crossings and reduce quantities of sediment entering streams from the maintenance or upgrading of clay roads.

5.1.1.4 Riparian Zone Management

Long term riparian zone management should stress planting of native grasses, trees and shrubs suitable to microclimates within a zone wider than the current 15 metres. Care must be taken to determine critical habitat for trout, as well as salmon before much planting occurs. Grassed waterways on agricultural land, or regions where grassed waterways would be appropriate, should be considered an extension of the riparian zone since both are watercourses for part of the year and may influence water quality in streams. These sites should become a priority for ALUS funding if improvements are desired. On all adjacent government-owned land, a 60 metre buffer zone similar to the conservation zone on the Morell River should be established immediately. Island Nature Trust and the Nature Conservancy of Canada should be encouraged to purchase (or otherwise protect) land along reaches of these rivers, especially where old growth forest occurs.

5.1.1.5 Fish Habitat Restoration Activities

Large woody debris has often been removed from streams to promote “flushing” of sediment, without dealing with the root causes of sediment input. Large woody debris is essential in streams and should only be removed after consultation with qualified stream managers. Unnatural “wooly” white spruce hanging over the stream should be removed and the trunk material can be left as digger logs or cover. The numerous “crossing logs” left by stream groups may assist trappers catching certain furbearers, but these logs perched a metre or so above the stream every couple of hundred feet is severe overkill and a nuisance to stream workers. With the landowners’ permission and a forester’s advice, government might consider issuing permits to remove some of the old field white spruce that lean over the stream, die prematurely and collapse into the stream, often causing bank erosion. On the other hand, old growth forest species bordering streams should have no selective cutting.

Each wilderness river will have individual requirements for habitat restoration. All reaches of each of the rivers should be assessed for the basic habitat requirements, as outlined in

Section 3.0, and a plan developed outlining the time frame and resources required for its implementation.

5.1.1.6 Atlantic Salmon Management and Regulation

With rapidly declining runs of Atlantic salmon on Prince Edward Island, it seems irresponsible to continue allowing harvest, at least until the trend of decreasing populations and loss of runs has been reversed.

> **Recommendation**
> *There should be a province-wide no kill, barbless hook, catch and release policy for salmon at least for the next five years. In future, if a put and take fishery is developed on a river, this policy could be altered for that one river.*

If the recommendations in this report are followed and limiting factors for habitat and populations of Atlantic salmon are addressed, then there will be a need to restock rivers capable of sustaining runs of Atlantic salmon. There may also be demand for recreational opportunities and the economic benefits that accrue from stocking Atlantic salmon.

> **Recommendation**
> *A long term funding arrangement for support of the Cardigan Fish Hatchery is urgently needed to provide wild fish for the salmonid enhancement program on Prince Edward Island.*

Some streams, such as North Lake Creek, Priest Pond Creek and the Naufrage River have a few pools near the head of tide where kelts hold in large numbers in spring before their return to the ocean. When trout season opens on April 15, anglers fish these pools with bait, supposedly for trout but they reportedly catch and injure many salmon.

> **Recommendation**
> *Consideration should be given to making a few head of tide salmon holding pools found on rivers such as North Lake Creek, Priest Pond and Naufrage River, barbless fly or lure fishing only from April 15 until May 1 or delay opening the angling season altogether at these sites until May 1. This would prevent injury to salmon before their return to sea.*

On some sections of the Morell River, West River, Carruthers Brook and perhaps Cains Brook, there is a strong likelihood that anglers, during the first and second months of the angling season, could inadvertently cause damage to young-of-the-year salmon by walking on sites where salmon remain in gravel.

> **Recommendation**
> *Tasteful signs, encouraging anglers to be cautious, should be posted in areas of critical fish habitat.*

5.1.2 CAINS BROOK

Cains Brook flows into the Mill River estuary at MacAuslands Pond. Although considerably smaller than the two nearby streams, Trout River and Carruthers Brook, all three rivers drain into Cascumpec Bay and are the principle salmon producing systems in Prince County.

Almost a decade ago, MacAuslands dam "washed out", allowing anadromous fish access upstream. Within two years, good populations of juvenile salmon were counted in lower portions of the Cains Brook (Table 3). In 2008, salmon redd counts were incomplete because of early freeze-up but not before 58 redds were counted in the river (Figure 18), some further upstream than juveniles had been encountered in early electrofishing activities. Much of this river is clothed in a heavily wooded riparian zone and the stream has good substrate structure. Thus, salmon populations should continue to expand throughout the river, provided that blockages do not impede fish movements.

5.1.2.1 Recommendations

1. Remove all beavers and their dams from all tributaries.
2. Walk, and if possible fly, the complete drainage basin and note where blockages and sediment input occurs.
3. Like Carruthers Brook, this stream has some remnant old growth riparian woodland. When doing instream work, crews should try to retain large woody debris with little disturbance. A river management plan, with detailed reach-by-reach treatment, should be developed with informed input from biologists.
4. Start work with landowners regarding the establishment and/or enhancement of a riparian buffer zone wider than required by provincial regulations.

Figure 15. Cains Brook at the former MacAuslands Dam.

Figure 16. Large woody debris in Cains Brook.

Figure 17. Cains Brook spawning zone.

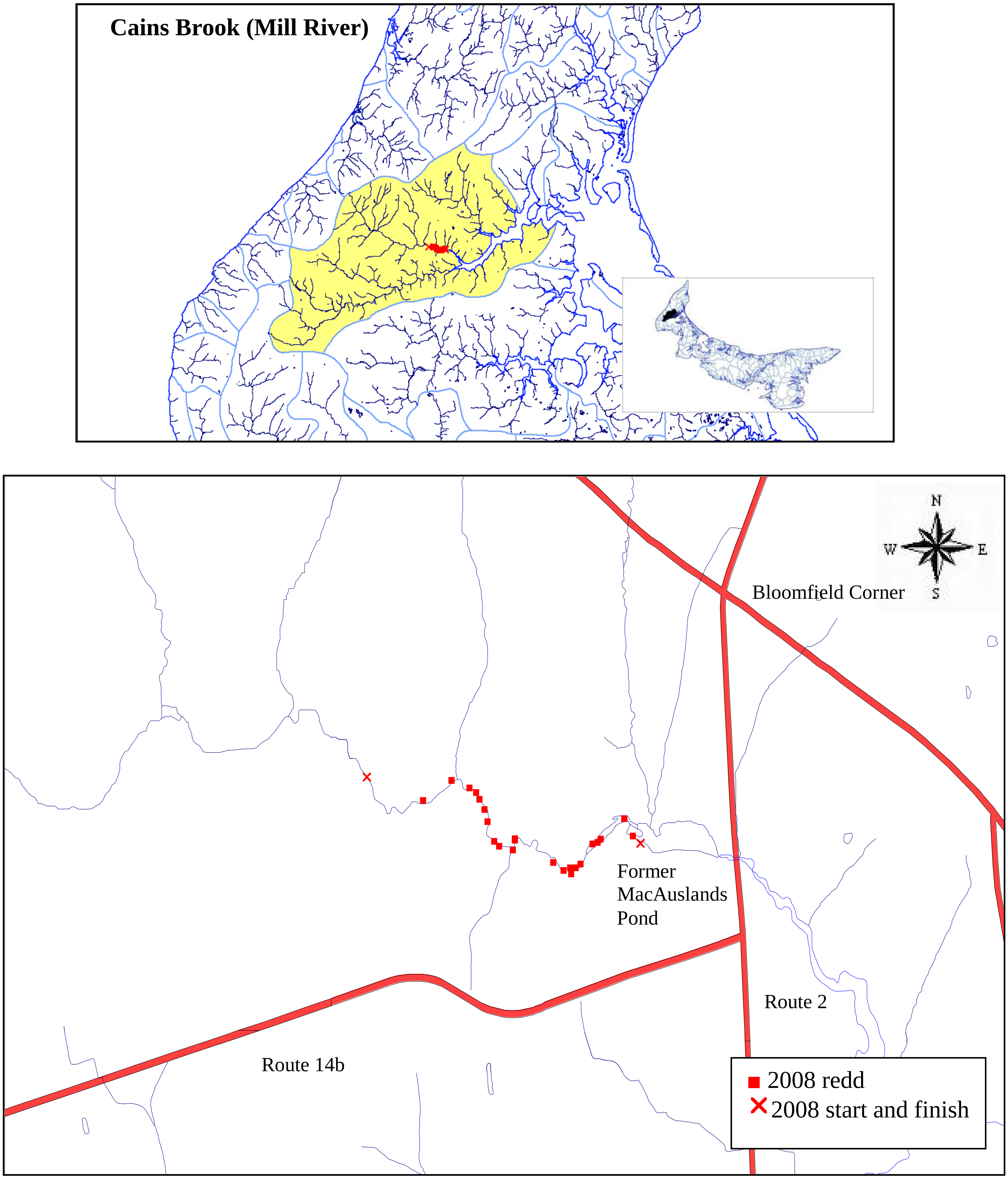


Figure 18. Location of salmon spawning sites in Cains Brook (Mill River) in 2008. Note: Incomplete Survey.

5.1.3 CARRUTHERS BROOK (MILL RIVER)

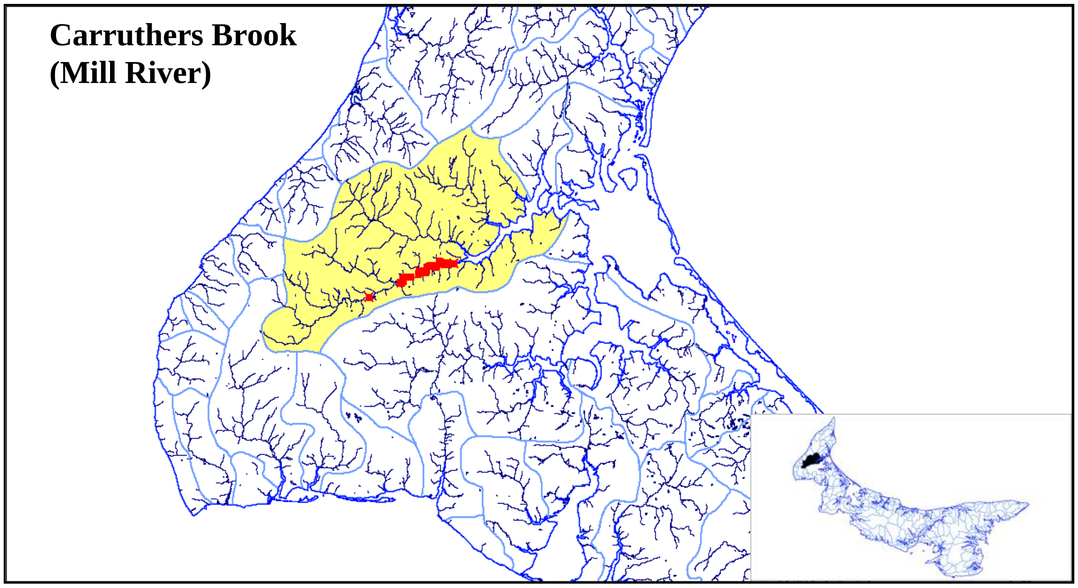
This is the gem for natural salmon production on Prince Edward Island, with high numbers and various year classes of salmon being present in most regions (except where there are beaver blockages). The run includes grilse but also some very large multi-sea winter (MSW) fish. Juvenile densities are the highest found on Prince Edward Island and with control of beaver populations, many additional kilometers of productive juvenile habitat could be accessible. In 2008, I was unable to complete the salmon redd survey on this brook because of “freeze-up” but 156 redds were counted and at least three kilometres of good spawning area was not surveyed (Figure 21). On November 19, 2008, spawning was still evident and several MSW fish were observed, including one 25-30 lb silvery female salmon “cutting” a redd, accompanied by a male estimated to be about 10 lbs.

5.1.3.1 Recommendations

1. Remove beavers and their dams from all tributaries starting with the southwest branch upstream from Howlan (Rails to Trails Crossing). There should be an excellent opportunity to work closely with landowners who have had very negative experiences with beavers flooding both woodland and farmland on this tributary.
2. No instream work should be undertaken before an indepth management plan is devised. In spring 2009, all tributaries should be walked to note input sites for sediment and location of blockages. Most of the river from Bloomfield Park to Howlan is in good shape, but sediment is a problem in some areas. Fewer than a dozen fields are cultivated close to the river and it should be possible to control sediment from these locations by diverting drainage to settling basins and created wetlands. One major instream sediment trap may be required about one kilometer downstream from Howlan near what appears to be an old dam site. It might be desirable to have an aerial flight (perhaps also for other candidate wilderness river drainage basins) before the leaves appear to fully appreciate the beaver problems and formulate possible work schedules. Considerable diplomacy will be required to ensure that the watershed group, landowners and government agencies work closely on this drainage basin. It may be premature to fund major projects for this river in 2009, other than sediment containment within the streams and from input sources, as well as beaver management.
3. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.

Figure 189. Carruthers Brook in Howlan.

Figure 20. Spawning and nursery habitat in the lower reach of Carruthers Brook.



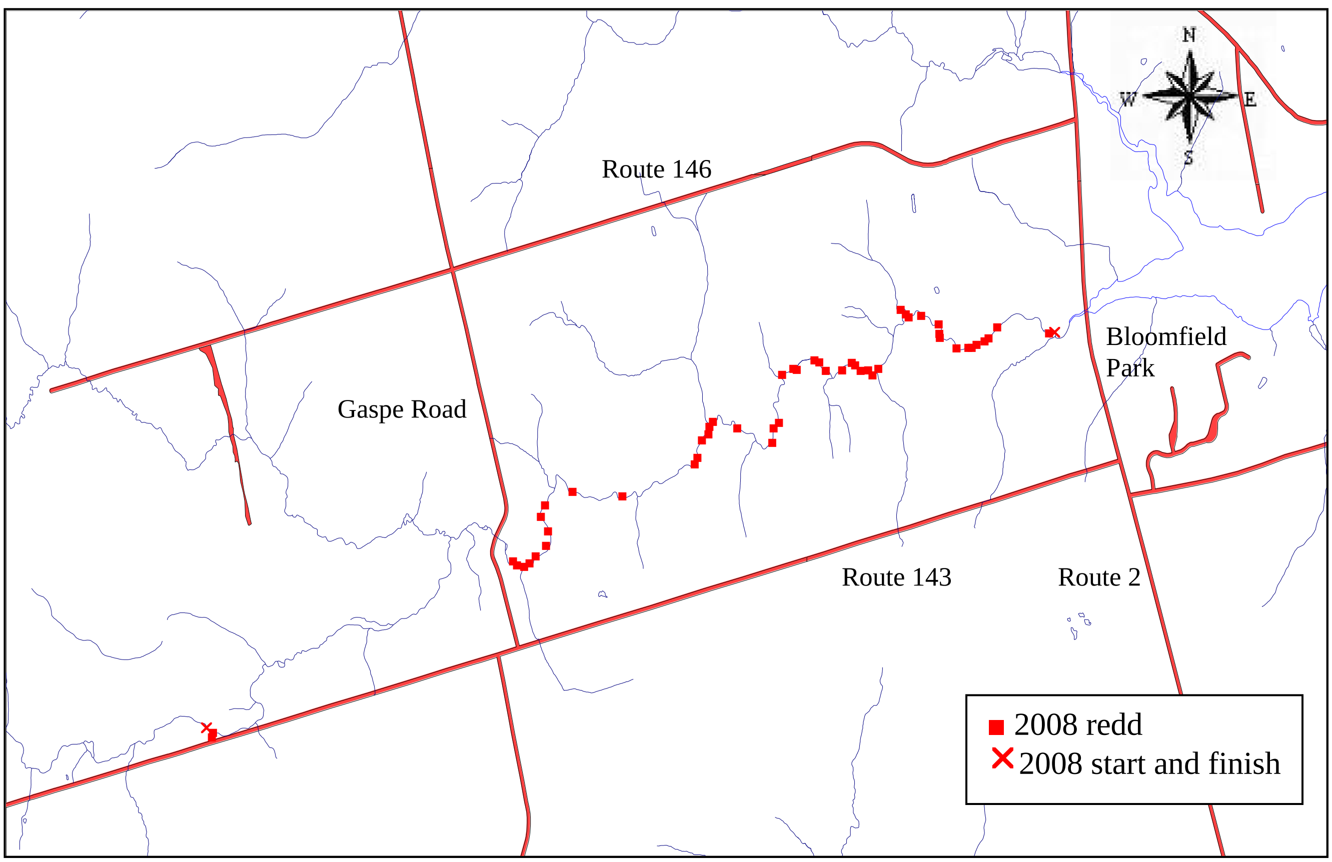


Figure 21. Location of salmon spawning sites in Carruthers Brook (Mill River), 2008. Note: Incomplete survey.

5.1.4 CROSS RIVER

Cross River has long been known as an excellent river for angling, especially in Big Pond, a barrier-beach pond adjacent to the coastal sand dunes. There is very little sediment input to the river from highways, private road crossings or agriculture. However, trying to keep beavers from plugging up various tributaries is a daunting task. In 2008, the local watershed group thought that they had been able to keep most of the lower section of the river beaver free, but by November, salmon were unable to ascend to reaches formerly used for spawning. Downstream from McInnis Pond, there is excellent salmon parr habitat, with much large cobble/boulder substrate. Since salmon could not reach their normal spawning areas further upstream, the number of fish spawning in this reach increased greatly this year. Unfortunately, this section of river does not appear to have a lot of good young-of-the-year nursery habitat. With management as proposed below, it should be possible to triple the length of stream used as spawning and nursery areas by Atlantic salmon.

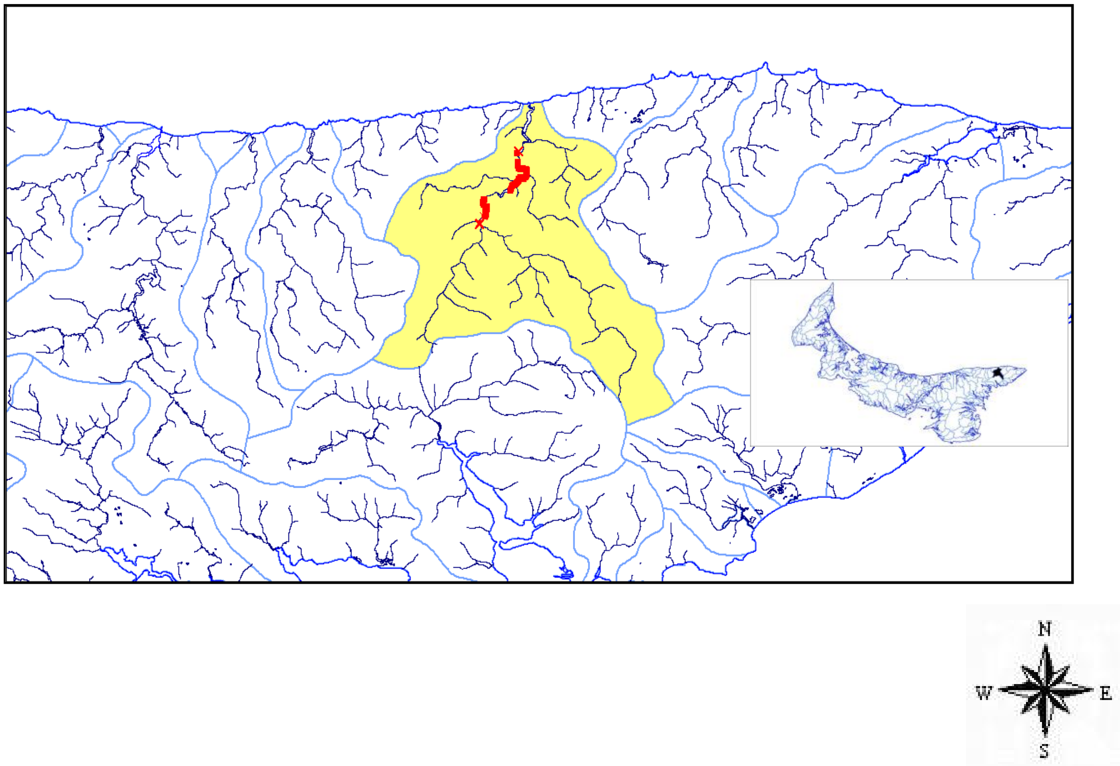
5.1.4.1 Recommendations

1. Remove beavers and their dams from all tributaries. There are several active beaver dams upstream from MacInnis Pond and these dams, plus the beavers, need to be removed as soon as possible. Many brush mats and some digger logs will be required.
2. The cold water tributary draining from New Zealand that Susan Saville’s crew “cleaned” several years ago will require considerable effort to restore because of the number of blockages. Careful manipulation of large woody debris and installation of brushmats and digger logs will be needed in this reach.
3. Considerable instream work needs to be done upstream from the second crossing of the Souris Line Road (to the east). This will require landowner permission and a large sediment trap is essential on the west side of the Souris Line Road before blockages are removed.
4. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
5. An access trail should be maintained along the full length of the main stem.

Figure 22. Large woody debris in Cross River.

Figure 23. Good riffle habitat in Cross River.

Cross River



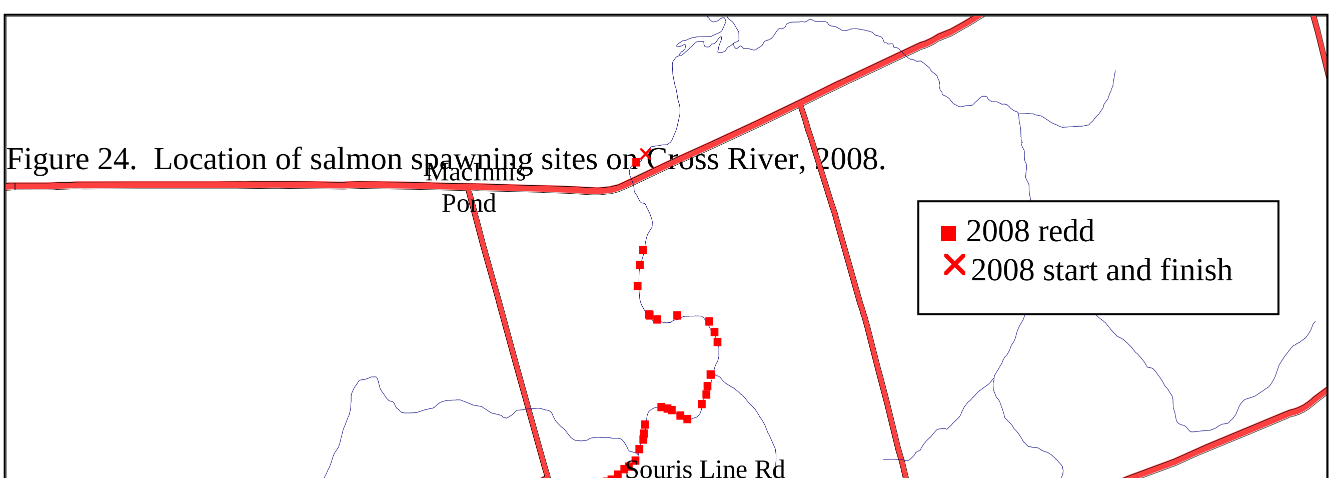


Figure 24. Location of salmon spawning sites on Cross River, 2008.

5.1.5 NAUFRAGE RIVER

The Naufrage River regularly has a modest late run of primarily multi-sea winter fish. Spawning in recent years has only occurred downstream from Larkins Pond (Figure 26). The five kilometer zone from Larkins Pond to the head of tide has good substrate and provides excellent parr habitat. Water leaving the pond in summer is above desirable temperature levels for considerable periods of time. A beaver dam that has intermittently blocked the river between the Hermitage Road and Larkins Pond can be devastating to anadromous fish runs. Whenever the beaver dam is in, fish such as gaspereau cannot make the run to Larkins Pond, a favourite spawning site. Salmon and trout can also be blocked from upstream migration. The habitat units downstream from this blockage would be inadequate for maintenance of a salmon run.

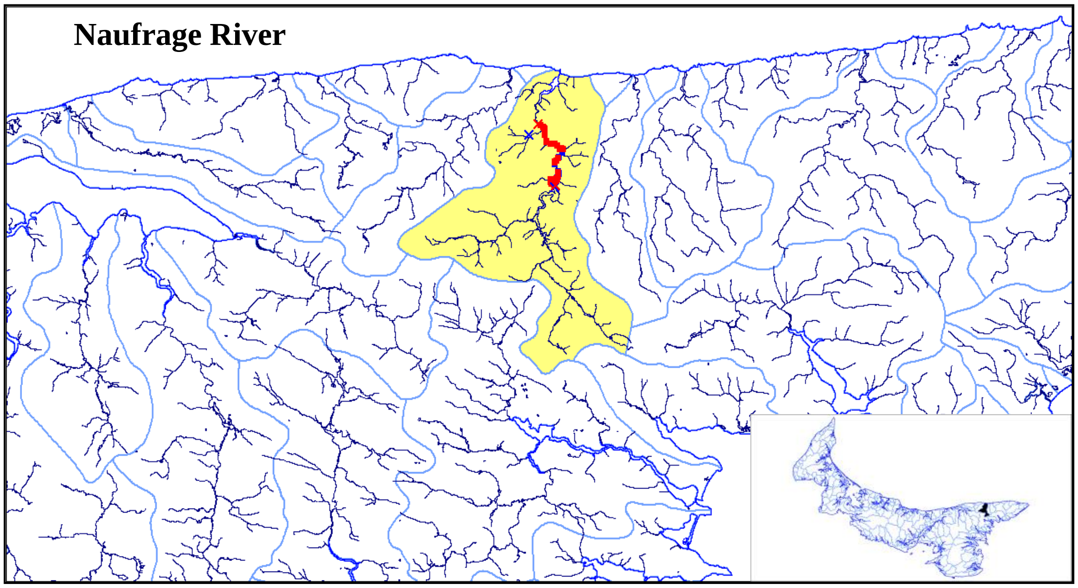
Upstream from Larkins, the river branches into two main tributaries. The south branch extends beyond the Church Road and is relatively cool. A considerable amount of stream enhancement was done in the 1990s, but alders and beavers have made a dramatic comeback. The west branch also had enhancement work done but the beavers have now taken over this tributary. Water quality in summer is currently compromised before leaving Larkins Pond but should improve if the pond is dewatered once every 5-6 years. If salmon could use one or both of these branches for spawning and nursery areas, the salmon run on the Naufrage River would likely increase substantially.

5.1.5.1 Recommendations

1. Remove beavers and their dams from all tributaries and maintain the Naufrage River beaver-free. Start this work on the south branch because results can be obtained relatively quickly; the west branch will require extensive work and probably several years to restore good fish habitat and get the beaver population under control.
2. Maintain the structures previously installed by the Souris Branch of the P.E.I. Wildlife Federation and add digger logs as needed.
3. Enhance habitat in the west branch up to the many headwater springs.
4. Keep current sediment traps regularly cleaned.
5. For the 2009 season, try to remove all beavers and their dams from the entire south branch and add brush mats as required.

Figure 195. Naufrage River - excellent salmon parr habitat.

Figure 206. Larkins Pond on the Naufrage River. *Photo by Ben Hoteling*.



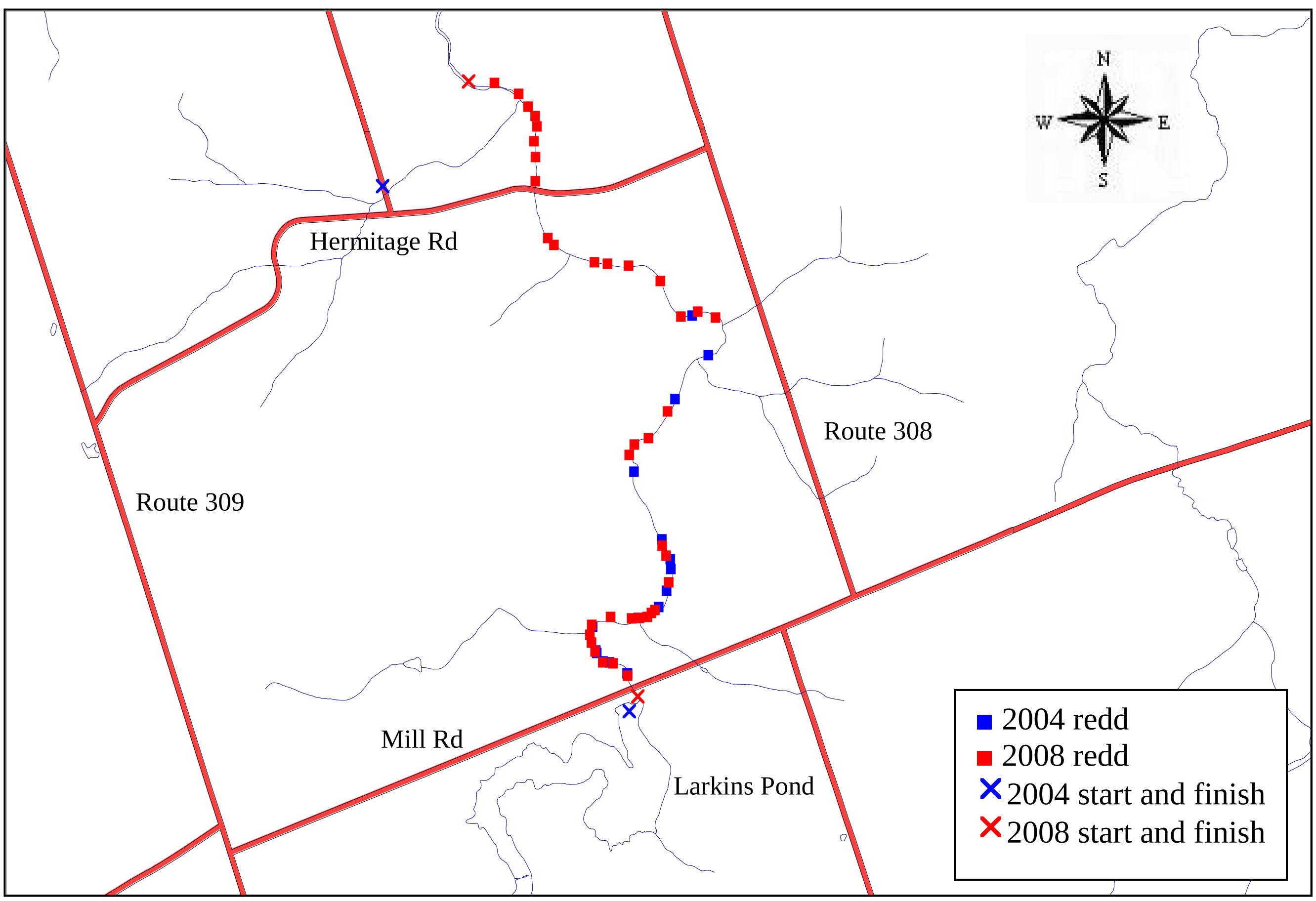


Figure 27. Location of salmon spawning sites in Naufrage River, 2004 and 2008.

5.1.6 NORTH LAKE CREEK

There is currently one watershed group, the Souris Branch of the P.E.I. Wildlife Federation, working on all rivers in northeastern P.E.I., including North Lake Creek, Priest Pond Creek, Cross River and Naufrage River.

Beavers were well established in the streams of northeast Prince Edward Island by the late 1980s. By that time, the Souris Branch of the Wildlife Federation had to deal with the incredible infestation of beaver dams in the Grovepine-Big Brook branch of the Fortune River. The decline of the Fortune River from one of the best angling streams on Prince Edward Island to one with poor sea runs of trout, and Atlantic salmon runs completely gone, has left a lasting impression. When enhancement work started on the northeastern streams, beavers were considered a major bottleneck for anadromous fish. Numerous dams were removed, often year after year, and trappers were asked to target beaver colonies that were blocking fish movements. An amazing amount of stream restoration work was done, spearheaded first by Larry Avery, later continued by Susan Saville and currently overseen by Fred Cheverie. Stream enhancement crews labored for years, always confronted with more beavers and their ubiquitous dams. By 2008, in utter frustration, the Souris group asked for and received permission to kill some of the beavers because they were blocking runs of all anadromous fish on several rivers. The 2008 autumn run of salmon spawned successfully in four of the rivers. All of the rivers had some beaver blockages removed so salmon could ascend to at least a portion of their former spawning area. The remaining rivers – Hay, Bear and Cow – remain plugged with many beaver blockages and salmon runs are now gone. North Lake Creek used to have excellent salmonid habitat along its entire length. Restoration and management activities have re-established good salmon densities up to the Baltic Road (Figures 28 and 31). With a few more years of tender loving care, this beautiful river could be restored to its original grandeur and offer tremendous recreational capabilities.

5.1.6.1 Recommendations

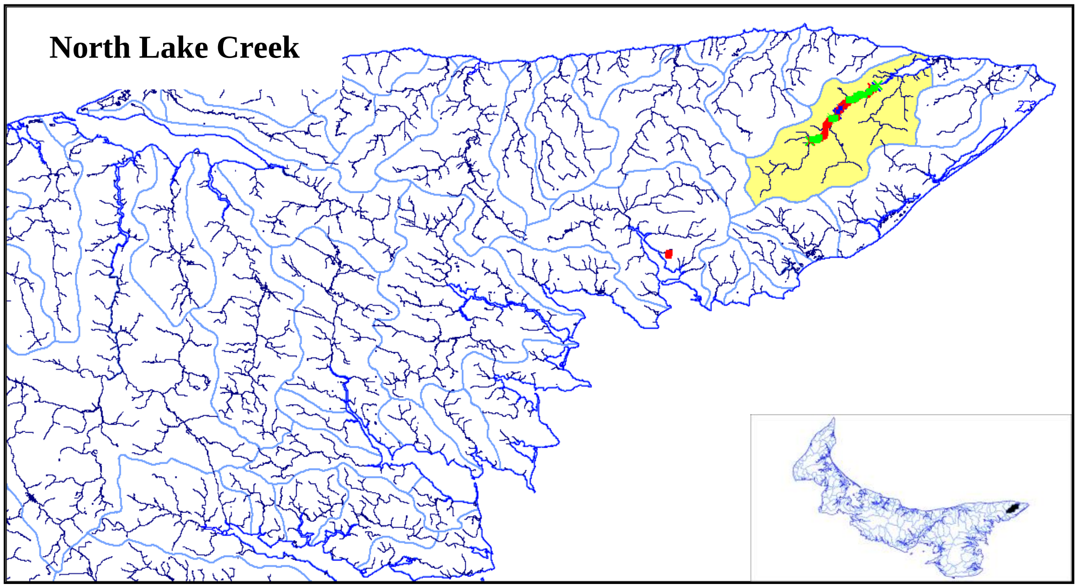
1. Remove beavers and their dams from all tributaries.
2. From the Baltic Road to Squeaky Head and Fountain Head springs, do an instream assessment of habitat and develop a work plan to improve these reaches for salmonids. Start the process of installing brush mats from the Baltic Road in 2009 and work towards the headwater springs over the next three years. Document the annual expansion (if any) of salmon spawning sites into these reaches of stream. Make sure that all major springs are accessible to trout and provide cover nearby.
3. Maintain the section of stream from the Baltic Road to head of tide more or less as is, with annual upkeep of deteriorating structures.
4. Check Alder Brook for habitat alterations such as digger logs and adult holding pools and add these as needed.
5. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
6. Maintain the current hiking trail along the river and extend it to Squeaky Head and Fountain Head Springs. Self guiding interpretative signage would be a desirable addition after the basics are completed. Some of the downed trees may have to be

removed from Squeaky Head and signs posted about the dangers associated with walking in this spring.

Figure 218. North Lake Creek near the Baltic Road. Excellent habitat for all year classes of juvenile fish.

Figure 229. Restored salmon habitat at "Susan's Run" in North Lake Creek.

Figure 30. Fred Cheverie admiring a beaver dam in North Lake Creek in 2005.



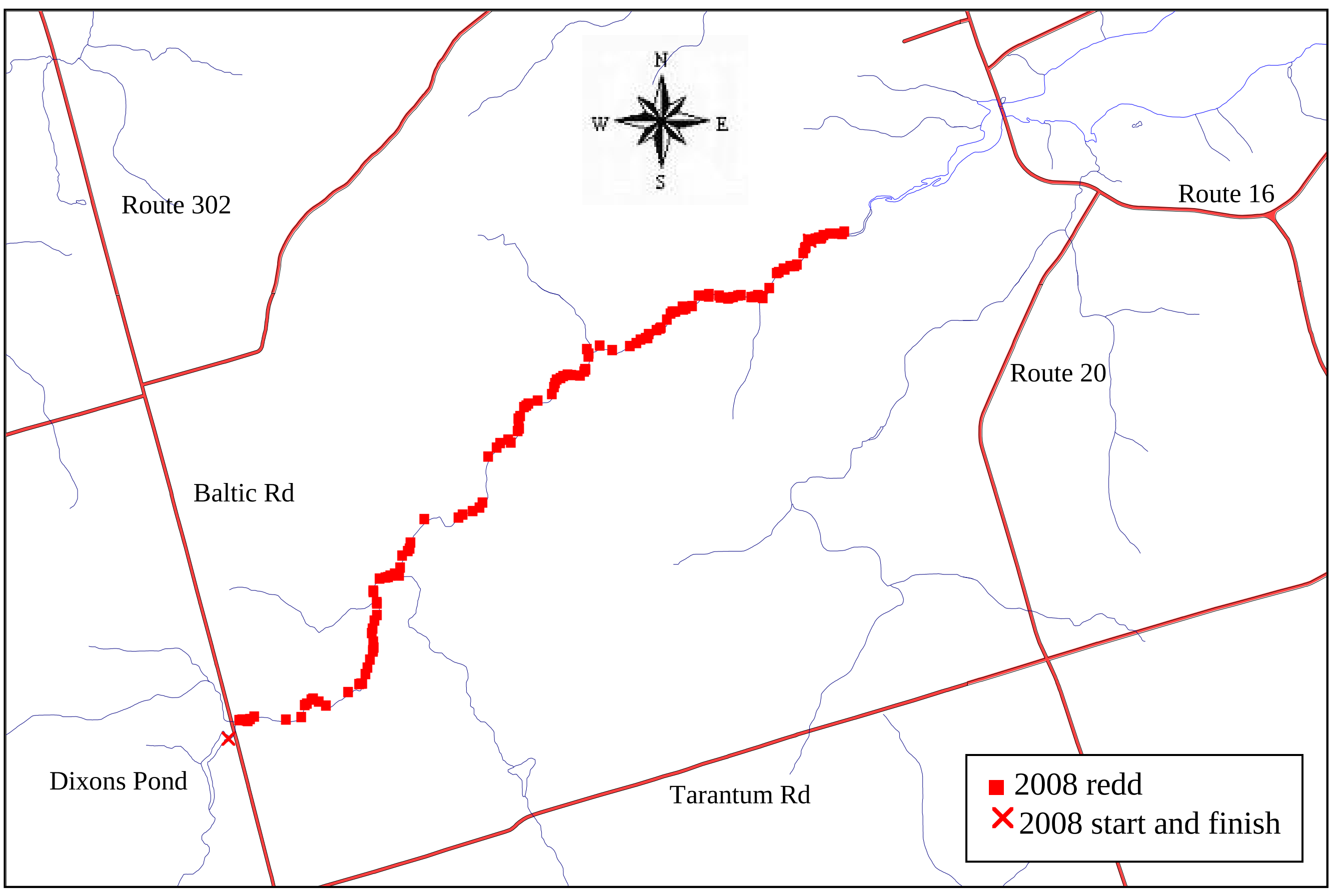
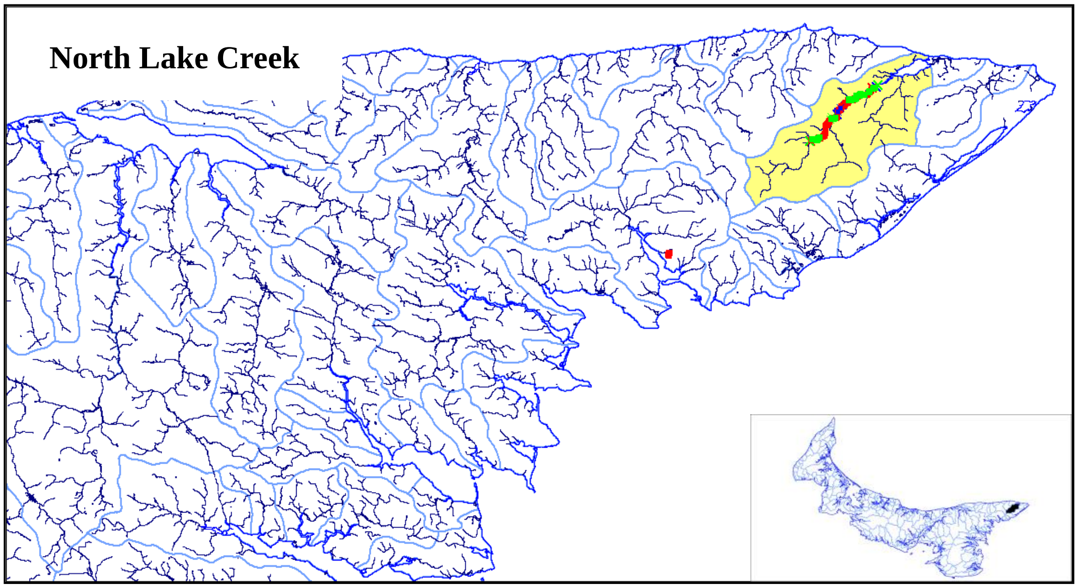


Figure 31. Location of salmon spawning sites in North Lake Creek in 2008.



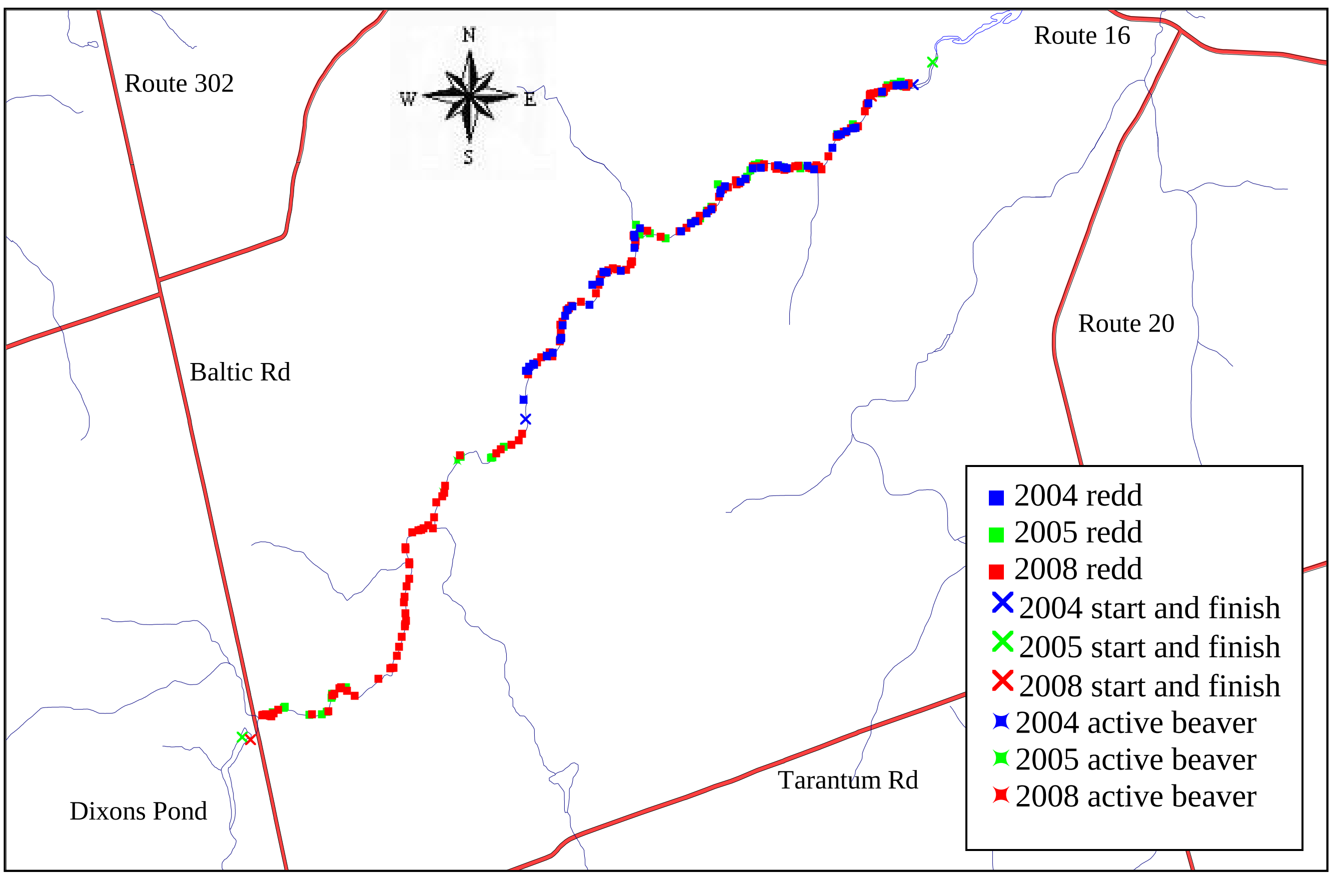


Figure 32. Location of salmon spawning sites in North Lake Creek, 2004, 2005 and 2008.

5.1.7 PISQUID RIVER

This river still has a modest run of Atlantic salmon, a few of which spawn below Leards Pond in a zone that is flooded at high tide (Figure 35). Sediment problems have plagued the local watershed group. Much of the material originates from clay roads, but in recent years, it has also come from expanded potato production. Both Ducks Unlimited impoundments have been decommissioned so summer water quality has improved. Juvenile salmon populations are higher on the steeper gradient south branch and the local watershed group has done a good job of working with landowners and government agencies to improve habitat for salmon parr. Long stretches of the south branch riparian zone is owned and managed by the Provincial Department of Environment, Energy and Forestry and has striking forest cover. Sediment traps in the river have to be cleaned regularly but hopefully, cooperation with the Department of Transportation and Public Works and landowners will eventually reduce the instream sediment load.

At present, a local beaver trapper, Clarence Ryan, takes care of nuisance and excess beavers blocking the tributaries. As long as he continues his good work, anadromous fish numbers should continue to flourish. Because other rivers draining into the Hillsborough River have lost their run of Atlantic salmon, for example Glenfinnan River, or appear about to lose salmon populations, as is the case in the Head of Hillsborough and Clarks Creek, this river should be classed as a wilderness river and all beavers removed from the watercourse. If this does not have the acceptance of the local watershed group, the Pisquid River could be placed in the Class II river category. Beavers and their dams would be removed within an identified management zone to permit seasonal movements of all year classes of salmon and other anadromous fish. The number of salmon returning each year is so small that even one year with a blockage to preferred spawning locations could lead to the demise of the salmon populations.

5.1.7.1 Recommendations

1. Continue with present management strategies and add instream structures to create adult salmon holding pools every 200-300 metres, especially near spawning sites.
2. The sediment bypass pond near the Kelly Mountain Road needs to be cleaned out as soon as possible.
3. The river reach from the High Bridge road (Route 216) downstream to the Forks should be assessed for problems as it should have more spawning activity and become a better nursery area.
4. If spawning habitat could be opened up near the Dromore Road, the excellent parr habitat downstream should have more juveniles in future.
5. Even if the river is placed in a Class II category, a minimum beaver-free zone should be maintained for at least a kilometer upstream from the Dromore Road down to the head of tide on the south branch and on the east branch from the Dunphy Road sediment trap to the forks.

Figure 23. Pisquid River forks upstream from Leards Pond.

Figure 34. A salmon redd downstream from the forks on Pisquid River.

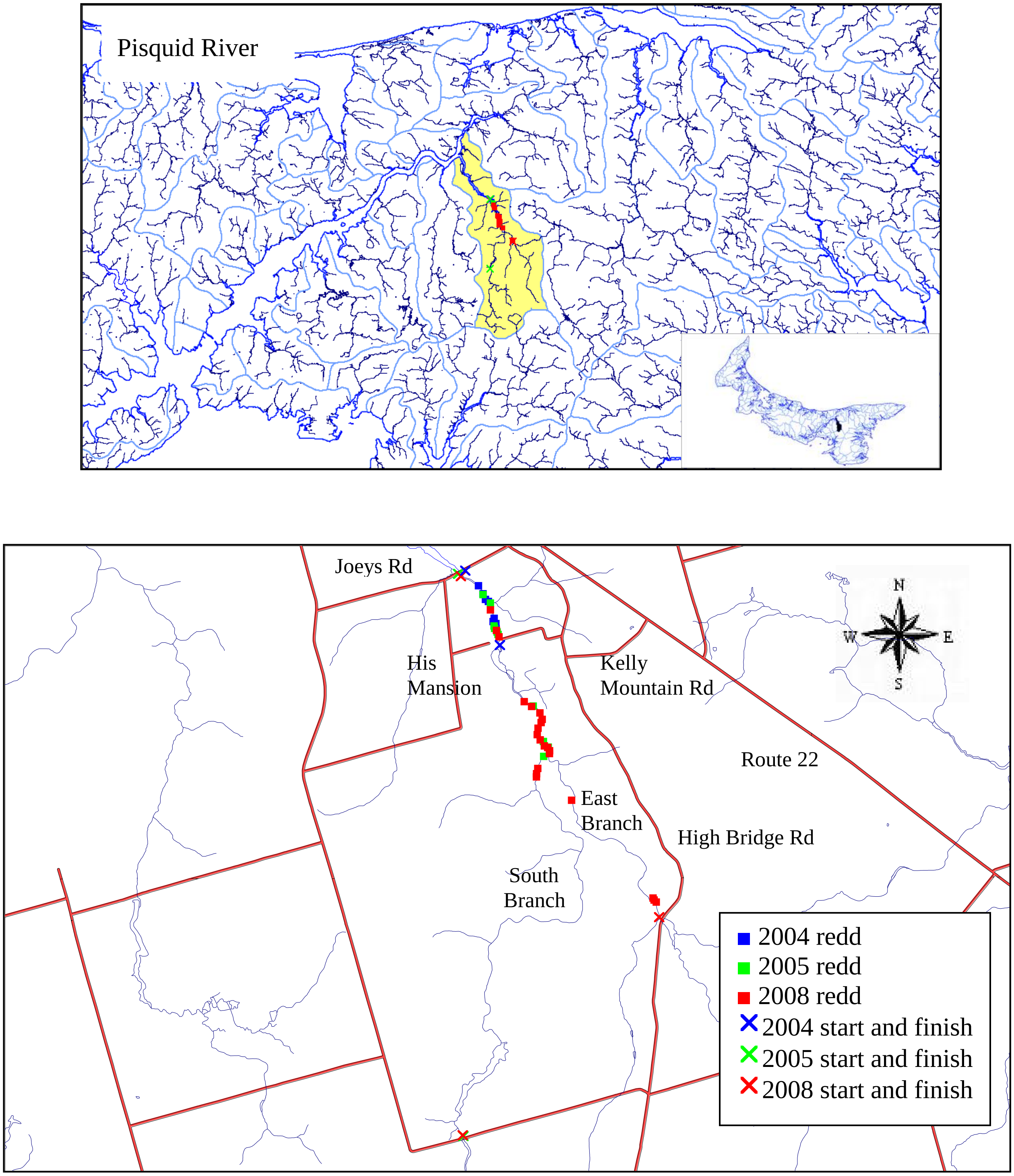


Figure 35. Location of salmon spawning sites in the Pisquid River in 2004, 2005 and 2008.

5.1.8 PRIEST POND CREEK

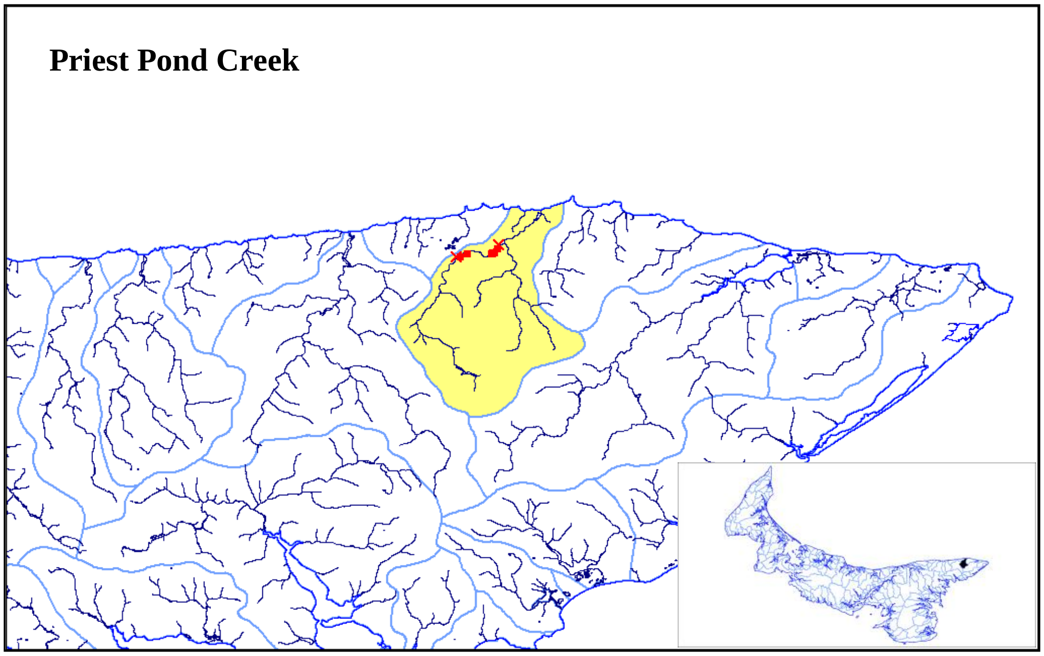
This rather small stream (Figure 38) drains mainly forested ecosystem and has practically no sediment input from agricultural activities. Work has been done to stabilize the road crossings of both the Pensioner's Road and Bull Creek Road. Some sediment input originates from the clay road crossing at Dixons Pond but the only major threat to anadromous fish are beaver blockages between the head of tide and Dixons Pond. Karen Gormley (2003) used this river as one of her study sites and at that time, gaspereau were observed as far upstream as Dixons Pond, near the headwaters of the system. In 2006, a culvert with a beaver fence was installed at the Bull Creek road crossing which became a complete barrier to all anadromous fish. This barrier to fish passage was removed in 2007, but additional beaver dams became established. Electrofishing of two sites in 2007 yielded no young-of-the-year salmon and it is likely that river blockages are responsible for the missing year class. At present, with the current number of beaver blockages, this river probably has too few habitat units (100 m^2 surface area) available to ensure continued salmon presence but this could be easily remedied by following suggested management guidelines. By 2008, only the downstream portion of the stream was available for use by anadromous fish because of blockages, in spite of beaver trapping and beaver dam removal in the interim.

5.1.8.1 Recommendations

1. Remove beavers and their dams from all tributaries. It might not be feasible to do this upstream from Dixon's Dam if the landowner objects.
2. Maintain the reach from Dixon's Pond to head of tide free of obstructions to fish movements. Start working upstream at the Bull Creek Road and when beaver flowages are located, remove beavers and their dams. Install as many brush mats as are necessary to stabilize sediment in the former beaver flowages. Make sure that there is at least one adult salmon holding pool every 200-300 metres (pools created by large digger logs may suffice).
3. The south branch has not yet received any restoration work and needs a stream assessment, some instream work and brush mats. It has good gradient and many springs. The first kilometer from the main stream should become good habitat for Atlantic salmon and sea run brook trout.
4. An annual check from the upper end of the barrier beach pond to the sea should be made to ensure that no blockages exist.
5. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
6. Maintain a good hiking trail along the south branch and along the main stem up to Dixons Pond.

Figure 36. Priest Pond Creek - south branch.

Figure 37. Priest Pond Creek - south branch.



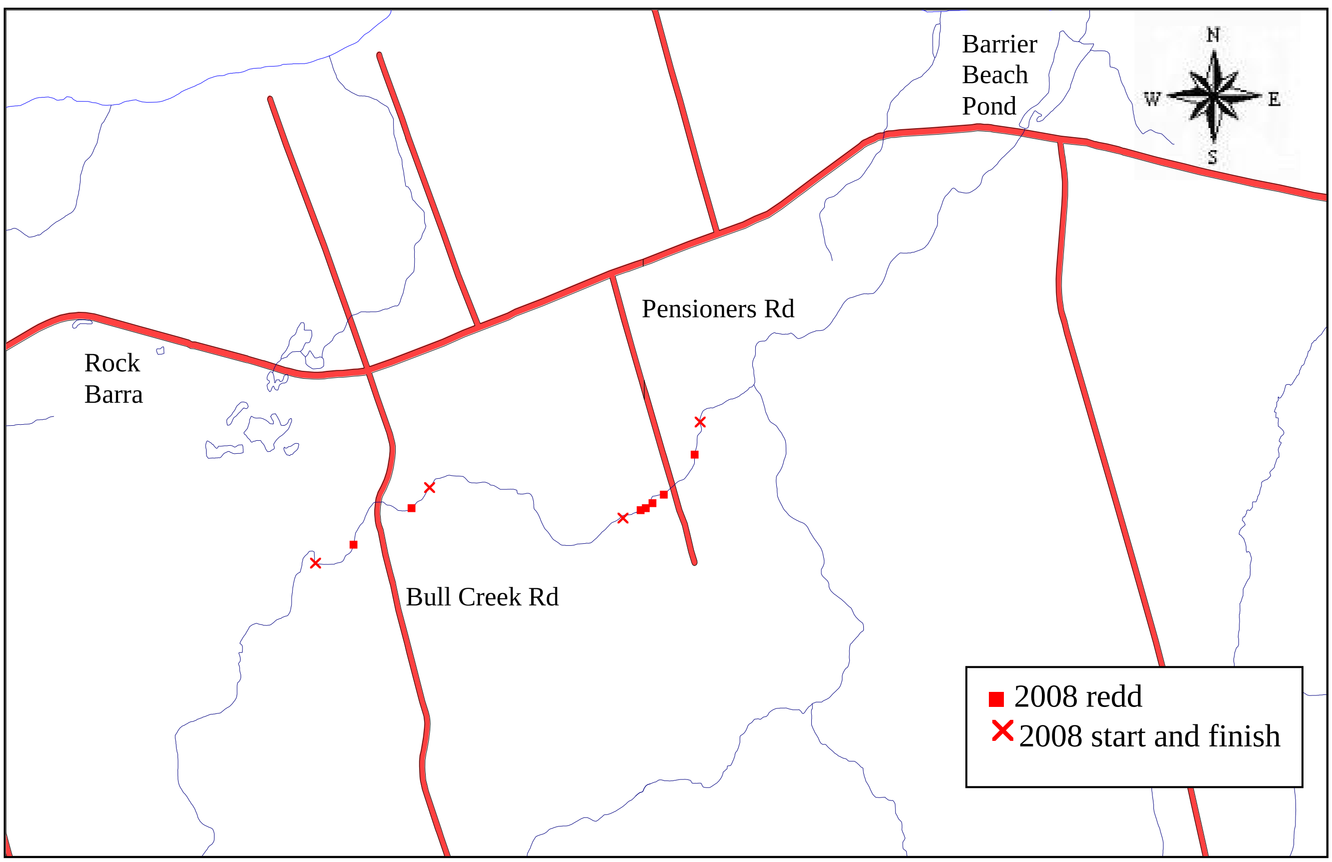


Figure 38. Location of salmon spawning sites in Priest Pond Creek in 2008. Note: Incomplete survey.

5.1.9 ST. PETERS RIVER

There is currently a new watershed group that has started to work on this system. Excellent work done on much of the river during the 1990s has reaped dividends, with a good run of Atlantic salmon and other anadromous fish. Serious water quality issues and many beaver blockages now jeopardize the future run of salmon to this river. Time is of the essence to permit year round access for anadromous fish and to restore water quality. If an energetic trapper could keep the main branch downstream from Five Houses (Route 327) and the complete Strathcona tributary free of beavers and their dams in all seasons, this river could be placed in Class II category. See Figure 44 for such a potential management zone. However, from past experience, this would be a formidable task and a Class II classification would likely continue to compromise all anadromous fish runs.

5.1.9.1 Recommendations

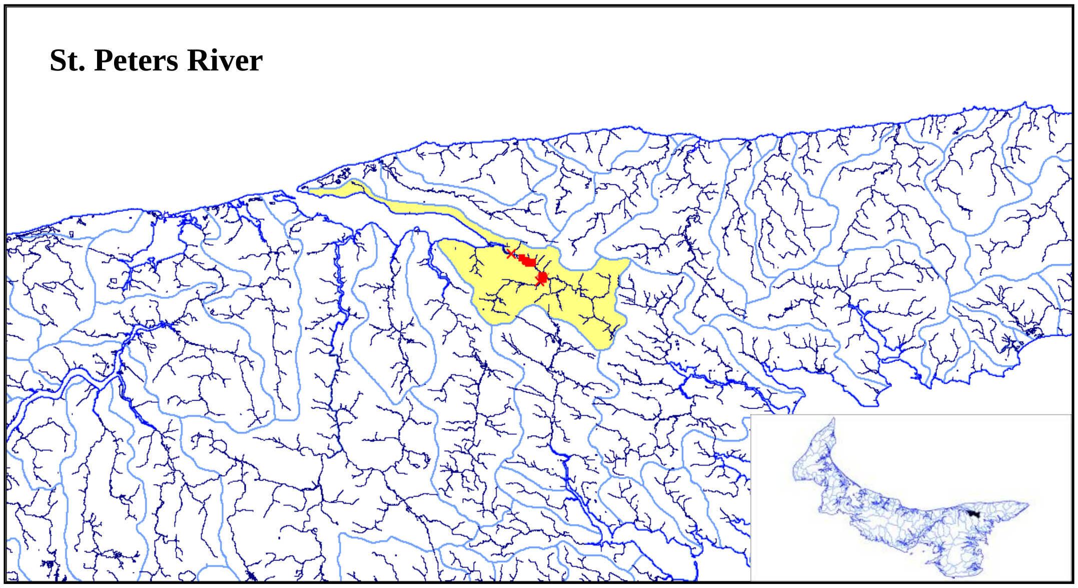
1. Remove all beavers and their dams from the watercourse and maintain it beaver-free (Figure 44). Beaver dams create problems in all reaches of the river. For example, during the summer of 2008, one dam blocked the river at the head of tide (this one was periodically removed by workers which permitted salmon to spawn in November 2008) and others blocked both tributaries upstream from Quigley's Pond. Water in the huge beaver dam at Five Houses had such low levels of dissolved oxygen in late summer, 2008, that fish habitat in the east branch was compromised for salmonids. Like most of our smaller rivers, if beaver management continues in a fashion similar to that of the past decade, runs of salmon and other anadromous fish will be severely reduced or eliminated.
2. The School Road continues to contribute sediment to the river, as did the improper stabilization undertaken as part of upgrades to the St. Peter's Highway in 2007 and 2008. The Department of Transportation and Public Works should be encouraged to reduce sedimentation from the School Road, and the instream sediment trap previously established downstream from the road could be re-excavated in future.
3. It is essential to encourage the growth of an energetic watershed group that will once again monitor conditions and carry out necessary restoration work in a timely fashion.
4. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
5. In 2009, all beavers and beaver dams should be removed from the Strathcona tributary and main branch down to the "head of tide". All of this area must be kept free of beaver dams throughout the year. A good access trail along the river should be maintained indefinitely.

Figure 39. St. Peters River - beaver dam near the head of tide.

Figure 40. Strathcona branch of St. Peters River - one of many beaver dams.

Figure 41. St. Peters River - Salmon parr habitat downstream from Quigleys Pond.

Figure 42. Pool and riffle downstream from Quigleys Pond.



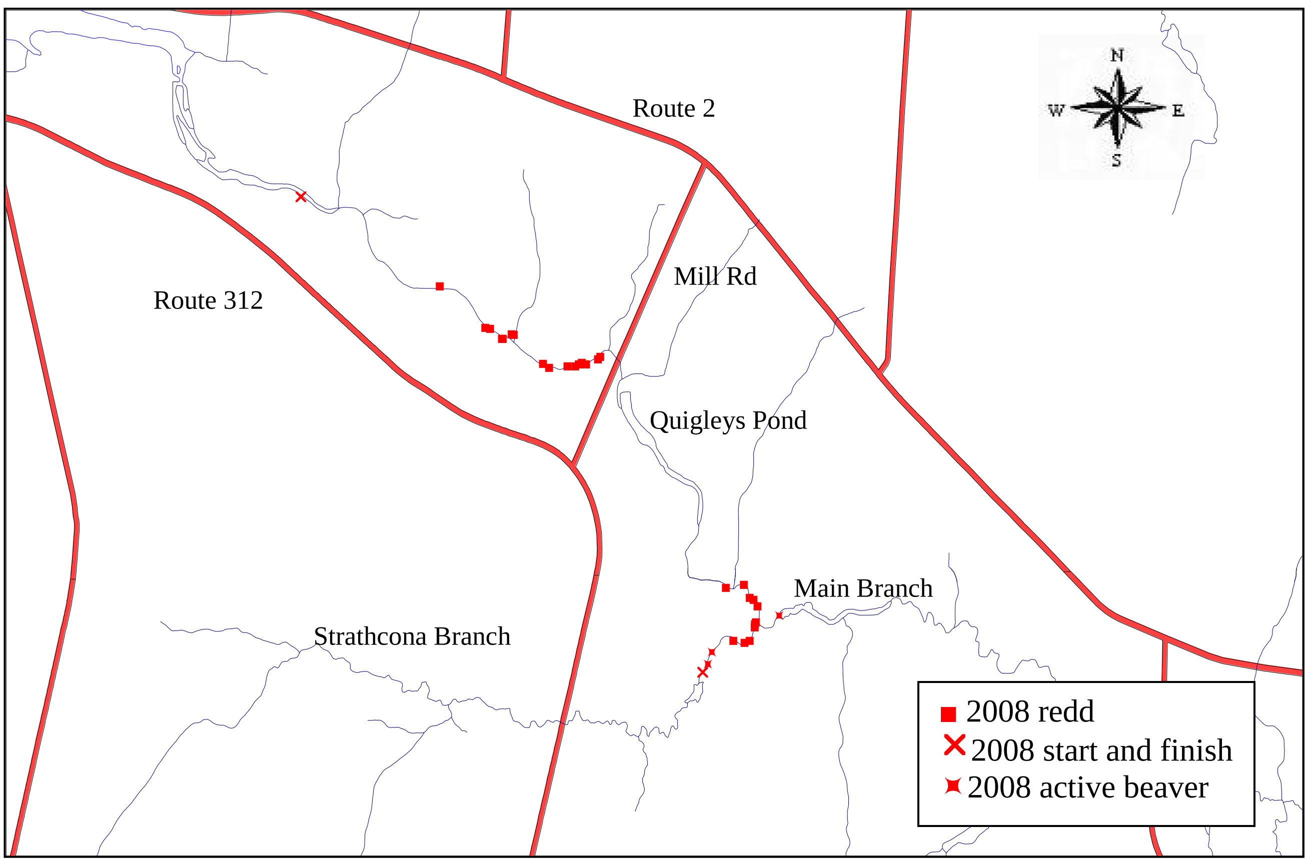


Figure 43. Location of salmon spawning sites in St. Peters River in 2008.

Figure 44. Minimum beaver-free (management) zone in the St. Peters River if its category is changed from Class I to Class II.

5.1.10 TROUT RIVER (COLEMAN)

This is the watershed (Figure 48) where the late David Biggar spent many years improving habitat and runs of trout and salmon. His activities included work with landowners and other user groups. Much of his focus was on youth, community involvement, quality recreation and media awareness of environmental problems and potential solutions. He raised salmon and trout in the semi-natural rearing site at Profits Pond and although salmon returns were never spectacular, he can certainly be given much of the credit for the good runs of salmon that now return to the three rivers that flow into Cascumpec Bay – Trout River, Carruthers Brook (Mill River) and Cains Brook. In November 2008, there were no salmon redds seen on Long Creek, west of Route 2, which leads from Profitts Pond. Cold temperatures and high water prevented the survey from continuing downstream to the Gard Road. This section of river should be electrofished in summer of 2009 to determine if any early run salmon remain. The 2008 redd survey had to be terminated because of cold weather but I did see salmon redds just below the railway trestle near Leards Pond. Thus, the river was free of blockages to this point and normal spawning likely occurred along the main stem of the river as well as in the stream flowing through the old pond basin.

5.1.10.1 Recommendations

1. Remove beavers and their dams from all tributaries. Note: Leards Pond was drawn down because it was compromising the water quality downstream. Before the drawdown, water temperature data loggers were installed upstream at the Kennedy Road, at the entry point to the pond, of both inflowing streams, at various locations within the pond and downstream. The problem was clearly and indisputably the numerous beaver dams upstream which caused water temperatures in summer to rise to intolerable levels before entering the pond.
2. The Kennedy Road branch will require a massive long term effort to restore suitable riparian zone vegetation for salmonids. This tributary used to flow through primarily forested landscape (now brush marsh) and sediment input from agricultural activities and roads is minimal.
3. The Barclay Brook tributary flows through rather level terrain but is surrounded by intensive agriculture and a spring survey of sediment input sites would be desirable. Projects funded through the ALUS program are planned for the near future (Shawn Hill, pers. comm.). A sediment trap, perhaps near the stream crossing at Route 148, would be desirable in future.
4. The north branch of Trout River which flows through the town of O'Leary also has serious land use problems, including old beaver flowages. A sediment trap should be installed one-half kilometer upstream from the "gravel pit". Brush mats and digger logs should be added between the sediment trap and the main river.
5. Note: Trout River is not a large river and without juvenile salmon production in the three main tributaries (#2, #3 and #4 above), future salmon populations may be in jeopardy.
6. The structures installed by the late David Biggar will need to be upgraded and seasonal checks of the main branch will be required.

7. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
8. For 2009, the group could profitably focus efforts on the North Brook branch while starting to reduce beaver populations and preparing groundwork for a wider riparian buffer zone on the upper tributaries.
9. The angling opportunities, beautiful reception cabin, scenic trail, planted riparian zone, and myriad of birds make this an attractive destination for residents and visitors. The local watershed group should be given encouragement and support wherever possible.

Figure 45. North Brook - drains from O'Leary into Trout River.

Figure 46. Barclay Brook - agricultural fields border the stream upstream from Rte 140.

Figure 47. Dave Biggar, a pioneer in salmonid enhancement on Prince Edward Island, developed a program of public awareness, youth education and angler opportunities centered on Trout River.

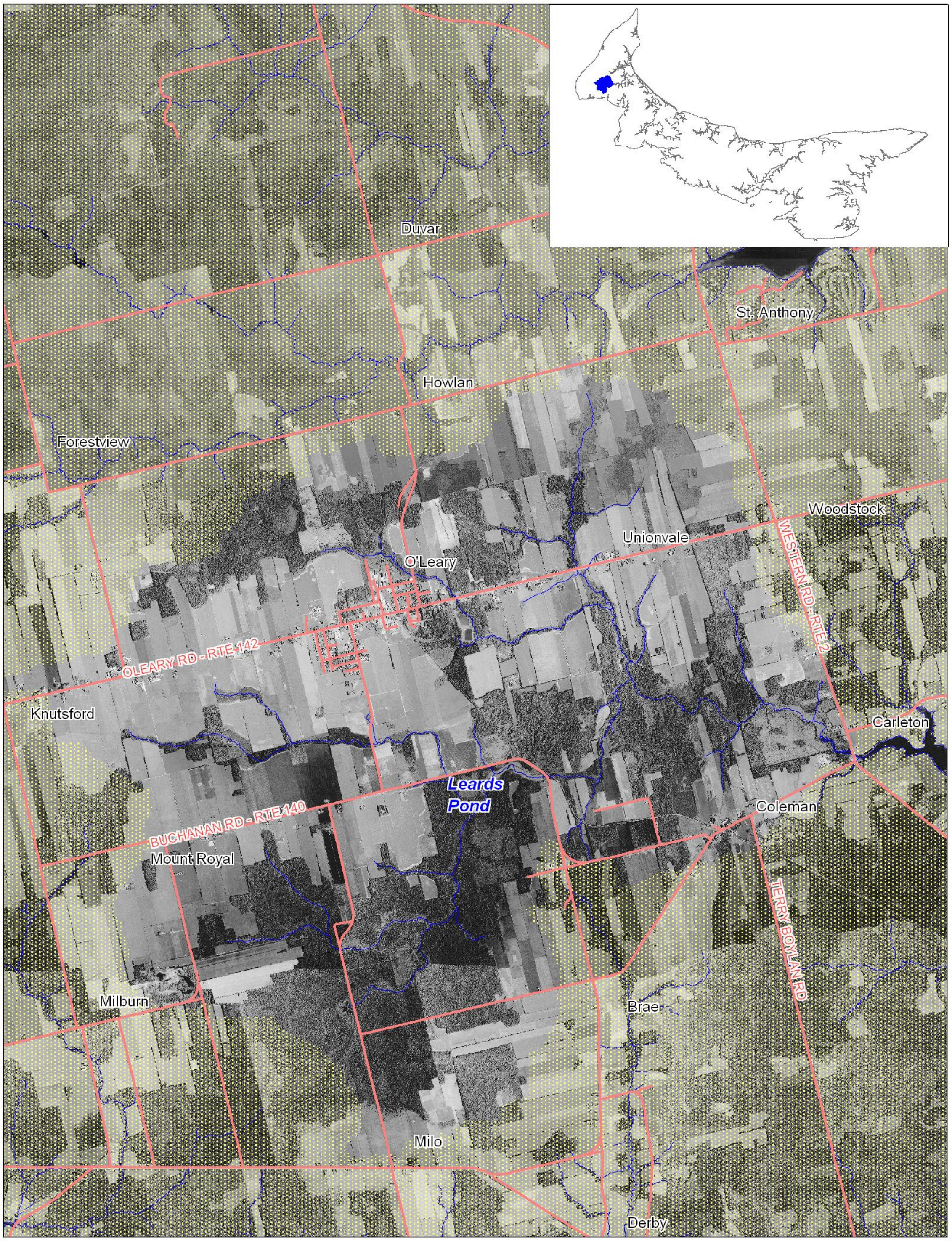


Figure 48. Trout River (Coleman) drainage basin.

5.1.11 WEST RIVER

Many sections of the West River are so attractive that anglers will often comment on the beauty and tranquility of the area, as well as the quantity of wildlife. Some early run fish, mostly grilse, returned to the West River in 2008, likely from fish raised in a "spring pond" adjacent to Black Brook. The number of redds counted (141) was comparable to other good years but older anglers will attest to former spectacular runs of sea trout and Atlantic salmon (Figure 52). One certainty is that if sediment is contained within the various tributaries and further sediment input is substantially reduced, many more kilometers of quality juvenile habitat will again be available for Atlantic salmon production.

5.1.11.1 Recommendations

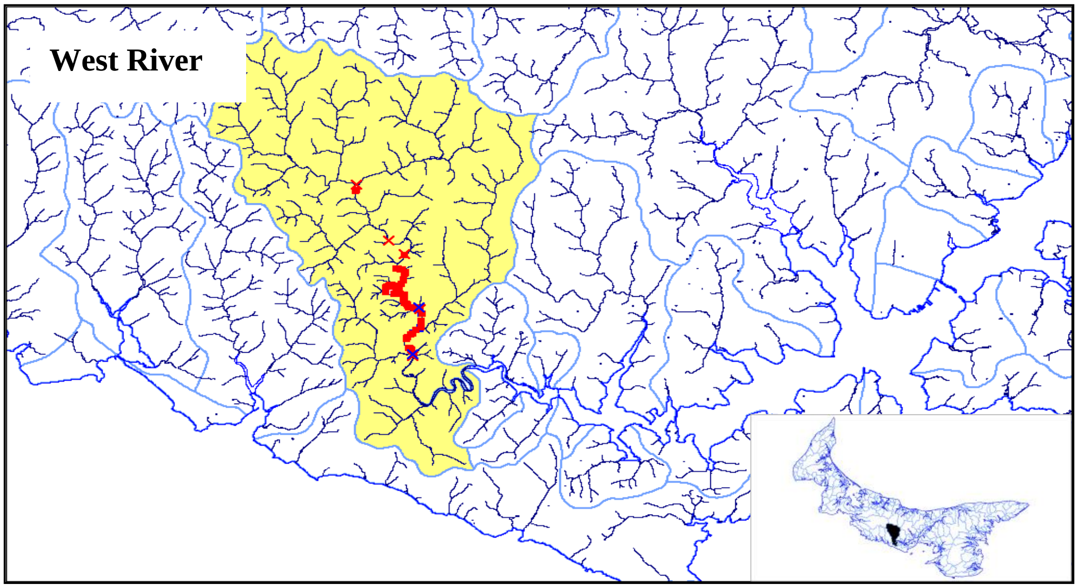
1. Remove all beavers and their dams from all tributaries (limited problems with beavers on this river).
2. West River has massive quantities of sediment entering various tributaries from public and private roads, agricultural operations, and developments. There are also many sites that no longer contribute significant amounts of sediment to the river but sediment is being held by debris or trapped in pools. Recommended sites for sediment traps for 2009, or as soon as feasible, include:
    a. Downstream from the aquaculture operation near Brookvale*;
    b. South (downstream) one-half kilometer from the junction of Route 13 and Route 235;
    c. One-half kilometer north of the junction of Route 235 and Route 13;
    d. Upstream end of Carraghers Pond*;
    e. One-half kilometer downstream from Green Bay Bridge (Route 249)*;
    f. On Howell's Brook upstream 300 m from Route 245*;
    g. On Howell's Brook, downstream from the Wynn Road*.
    h. Upstream and downstream from the Riverdale Bridge: two land-based wetlands or excavated basins to catch run-off from agricultural fields. Input is needed from the Department of Agriculture and landowner approval would be required.
    i. Clean existing instream sediment trap at Cudmores on Route 249 near the junction of Route 237.
    j. *The P.E.I. Department of Transportation and Public Works should be asked to assist with these sediment traps
3. Activities undertaken by the Department of Transportation and Public Works in summer 2008 have caused severe sediment inputs, especially from the Quinn Road. Subsequent stabilization attempts have been rather ineffective for various reasons, including infrequent removal of sediment from ditch check dams.
4. The "Horseshoe" section of river between Riverdale and Green Bay is arguably the finest section of relatively undisturbed wild river on Prince Edward Island. The old growth forest adjacent to the river should be considered a provincial treasure and if available, immediately acquired (one section may presently be for sale) by an organization like the Island Nature Trust or otherwise protected in perpetuity.

5. Consideration should be given to making the West River, upstream from the head of tide, a catch-and-release, barbless hook only, angling river. It would soon become a favoured destination for resident and non-resident anglers for both sea run trout and Atlantic salmon.
6. Start work with landowners regarding the establishment and enhancement of a riparian buffer zone wider than required by provincial regulations.
7. Start planning for instream work to enhance spawning and nursery areas after sediment problems are dealt with. Several years ago, Todd Dupuis excavated holes at appropriate sites in reaches of hardpan, filled them with spawning gravel and in doing so, attracted salmon to successfully spawn in those areas (Dupuis, pers. comm..). This procedure should be tried (and results monitored) in various reaches where hardpan substrate is extensive.
8. A hiking trail from St. Catherines to Brookvale could become immensely popular (with landowners' approval).

Figure 49. West River - the Riverdale "horse shoe".

Figure 50. Quinns Brook, downstream from Carraghers Pond. Brush mats are positioned to consolidate sediment and deepen the stream channel.

Figure 51. A hymac excavating a portion of the old Crosbys Mill pond. *Photo by John Jamieson.*



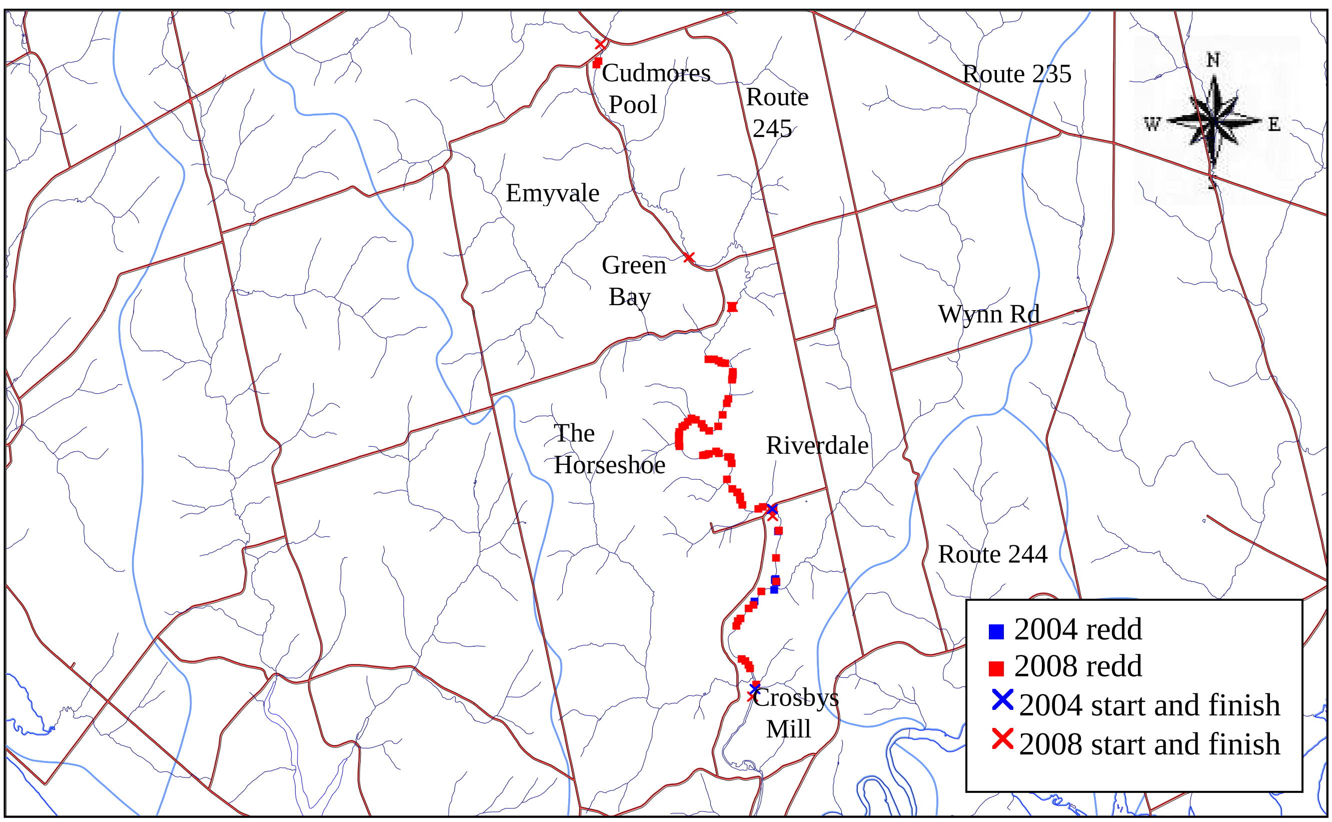


Figure 52. Location of salmon spawning sites in the West River in 2004 and 2008. Note: The 2004 survey was incomplete.

5.2 Class II Rivers – Where Salmon and Beavers may Co-exist?

Like Class I rivers, most of these rivers will require careful management of stream blockages, sediment input, and riparian zones and they will each require a strong watershed management group with landowner involvement. All crown-owned land in these drainage basins should have at least a 60 metre wooded riparian zone along each side of the stream. Individuals may wish to donate riparian zone land or in special cases, organizations like the Island Nature Trust may purchase key properties along streams. Ownership is less important than long term protection of diversified natural riparian zone vegetation. All of these streams will require a lot of "love and tender care" to bring them back to their full potential for salmon production. The complete removal of beavers would benefit anadromous species of fish but it may be possible to retain beavers on a portion of each drainage basin. These rivers have considerable areas of stream with low gradients which can provide good wetland habitat for species other than Atlantic salmon. This will require active management of beavers by trappers, government agencies, and watershed groups. The beaver policy has to be modified and beaver-free zones (as shown on maps for each drainage basin) maintained in all seasons or Atlantic salmon will surely disappear from several of these rivers.

Recommendation
If watershed groups and/or the Forest, Fish and Wildlife Division cannot afford the time and resources to maintain "beaver free" zones in all seasons as indicated in section 5.2 for each river, then government should grant the responsibility and resources to each watershed group to hire or train a professional trapper to do the suggested management of beaver populations.

5.2.1 CLARKS CREEK

Major habitat deterioration has occurred on Clarks Creek because of beavers and sediment input. Two main tributaries flow into Jays Pond near the head of tide (Figure 53). The east branch which once had excellent salmon habitat from Callaghans Pond downstream to the forks but is now inundated with active and inactive beaver dams and has copious quantities of instream sediment. Much hard work will be required to restore quality habitat. The south branch which flows out of Wiseners Pond is warm during the summer. The large surface area of the pond causes much evaporation and outflow is often very limited in summer (MacFarlane 1999) so springs downstream quickly restore cooler water temperatures. The stream between Wiseners Pond and the Auburn Pond has relatively low gradient with many meanders. Downstream from the Auburn Pond is steeper gradient and there is a reach of excellent gravel/cobble substrate. Unfortunately, sediment input continues at highway crossings (sediment may have originated from fields and is carried down the road or along ditches), from unstable, poorly rooted stream-side vegetation, and beaver impoundments. The Cape Breton Road has long been a major source for sediment. None of the remedies adopted to date has been able to stop the sediment input. After heavy August rainfall in 2008, most of the stream bottom from Route 214 downstream to Jays Pond dam was inundated with sediment. No salmon redds could be seen on this system in 2008.

5.2.1.1 Recommendations

1. Work closely with the Department of Transportation and Public Works, the Department of Agriculture and landowners to control sediment input. Without immediate action, the Atlantic salmon population appears doomed. Excavate instream sediment traps downstream from sediment input sites at both the Auburn and Cape Breton road crossings. Ensure that grassed waterways in agricultural fields do not drain onto roadways (e.g. Cape Breton Road) but rather into wetlands or "on land" sediment basins.
2. Maintain the east branch from Callaghans Pond downstream to Route 21 and all reaches on the south tributary north of Auburn Pond, including Jays Pond, free of beavers and their dams.
3. Add appropriate grass, trees and shrubs to stabilize shorelines at old beaver flowages where needed.
4. Install digger logs and pools at regular intervals along both branches after sediment problems are dealt with.
5. Check sediment traps regularly and if needed, remove sediment from the traps until input sources are corrected.
6. Dig a large sediment trap at the upper end of Jays Pond to prevent further infilling.
7. Densities of young salmon are relatively low and delays to restoration work could mean disappearance of the runs. The deterioration of instream habitat may already have progressed too far for salmon runs to recover but enhancement work should improve sea run trout populations. It would not appear feasible to try to restore habitat quality without beaver removals and considerable effort from the government agencies mentioned above.

8. The minimum “beaver-free” zone likely necessary for recovery of Atlantic salmon is shown in Figure 53.

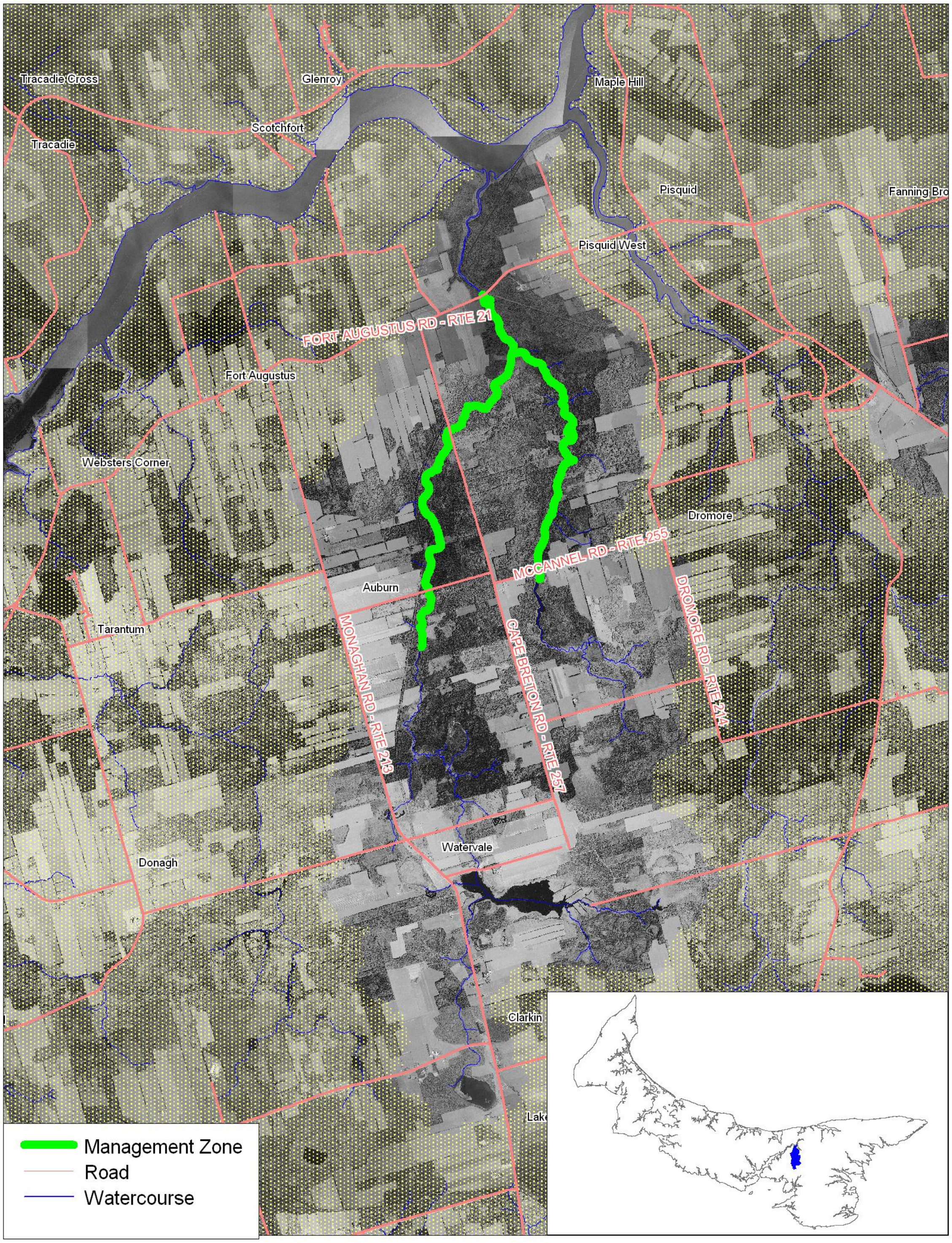


Figure 53. Minimum beaver-free (management) zone in Clarks Creek.

Figure 54. Sections of Clarks Creek have good juvenile salmon habitat.

Figure 55. Old beaver dams concentrate sediment in long sections of Clarks Creek.

Figure 56. An old beaver impoundment in Clarks Creek.

Figure 57. Instream sediment compromises fish habitat in much of Clarks Creek.

5.2.2 DUNK RIVER

The Dunk (Figure 61), one of our largest rivers on Prince Edward Island, shares tough challenges with all streams that flow through regions of intensive row cropping on adjacent farmland. Because so much of the drainage basin is cleared for agriculture (Table 1), the river tends to be "flashy". Sediment input comes from every major tributary and it is remarkable that any salmon remain. In 2007, a massive mid-summer fish kill upstream from Scales Pond appeared to take a heavy toll on the successful early-run Rocky Brook stock that the late David Biggar had released from his semi-natural rearing operation at Profit's Pond. However, some salmon parr did survive downstream from Scales Pond and dead adults were not collected, even though they were reported in the river at the time. Unfortunately, only seventeen (17) salmon redds were counted in the river below Scales Pond in autumn 2008 (Figure 60). The substrate in this section of river is primarily hardpan and there might be limited hatching success because of the shallowness of the redds. Upstream from Scales Pond, the amount of fine sediment in bottom substrate would likewise tend to reduce hatching success. A redd survey was not conducted upstream from Scales Pond in 2008 because of weather conditions. After each heavy rainfall or snow melt the river becomes turbid and it would have been difficult to get an accurate count. However, grilse were observed in this zone by Brad Potter (Potter, pers. comm.) when electrofishing in October 2008. The pond at Breadalbane has been removed and both branches upstream have had a considerable amount of stream work completed. Beavers are active in all three major tributaries upstream from Scales Pond.

5.2.2.1 Recommendations

1. Try to get a larger, more broad-based group involved in watershed activities.
2. With the assistance of government agencies and landowners, develop strategies to reduce sediment input to the streams and draft a long term watershed management plan for every reach of the river.
3. Install sediment traps on all major tributaries and remove sediment as needed. In 2009, a large instream sediment trap should be excavated below the Emerald beaver flowages to provide better spawning and nursery habitat upstream from Scales Pond.
4. Remove beavers and their dams from the main stem downstream from Route 227 and Route 225 (Shamrock, Stanchel and Glen Valley). Particular care must be taken in the Emerald area to find ways to remove or stabilize the enormous silt load behind current beaver dams before they are breached.
5. In future, this river might be considered for semi-natural rearing and a put-and-take fishery of early run Atlantic salmon.
6. Manipulation of the hardpan substrate and addition of gravel and cobble, as was done to provide spawning sites in the West River, might be beneficial downstream from Scales Pond.

Figure 58. Greenans Bridge - electrofishing site on the Dunk River.

Figure 59. Dunk River downstream from Scales Pond where a few salmon redds were located.

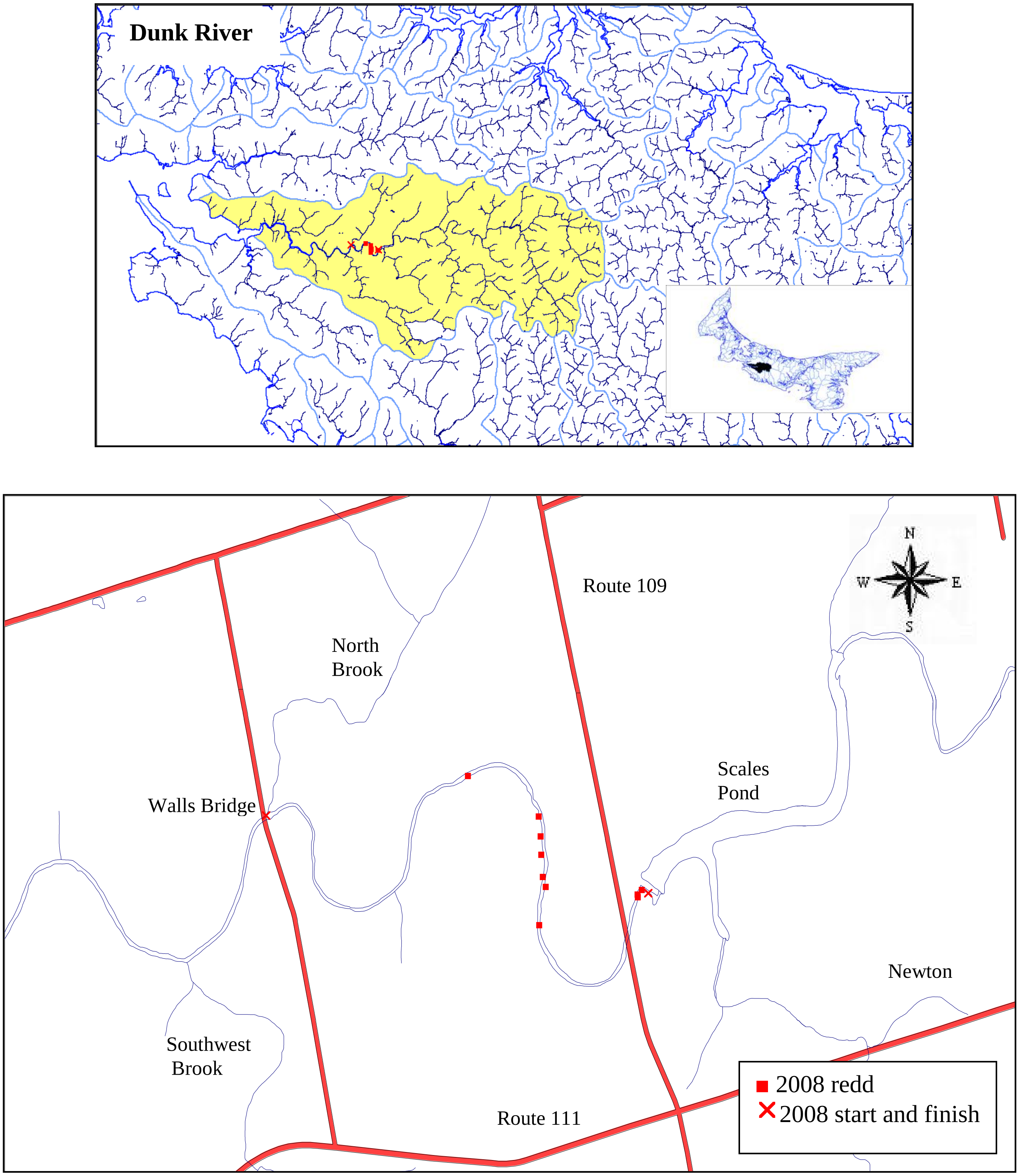


Figure 60. Location of salmon spawning sites on the Dunk River in 2008. The survey was only completed from Scales Pond to the Steel Bridge (Route 110).

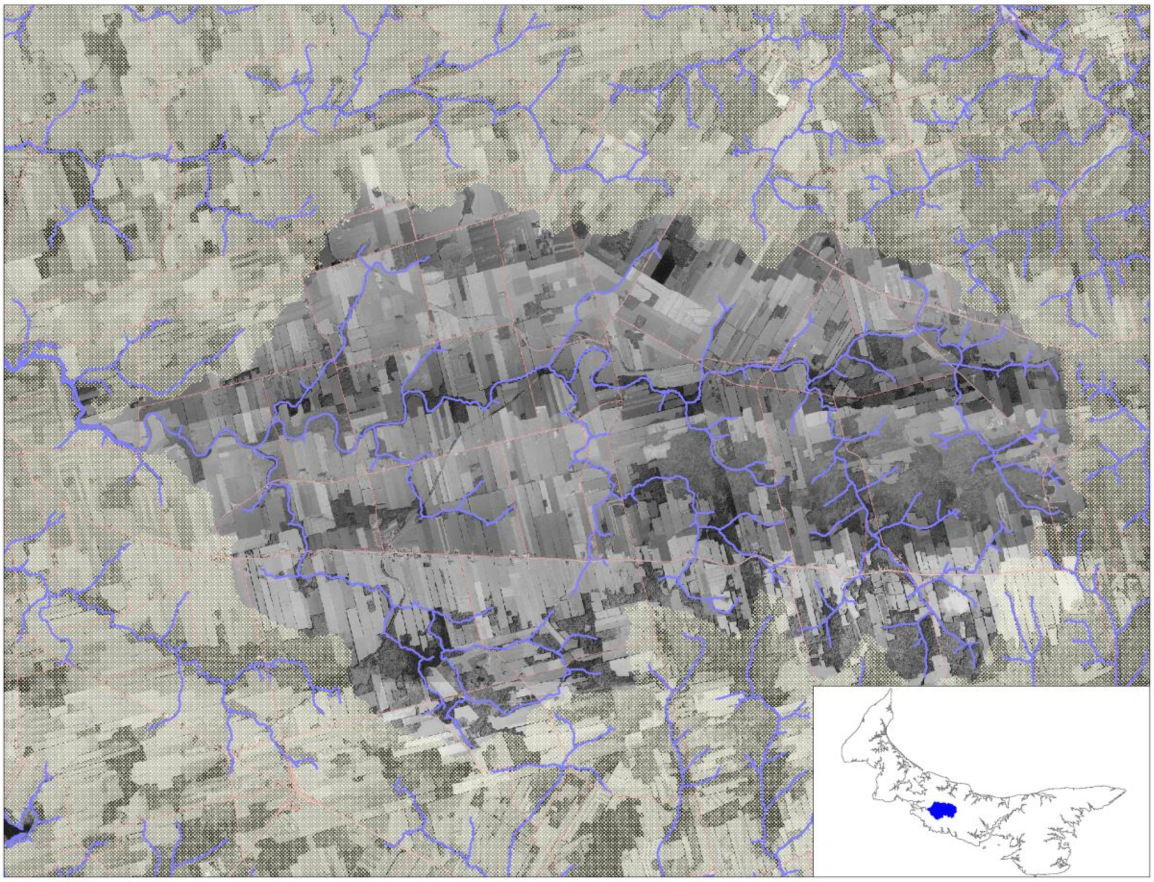


Figure 61. Dunk River drainage basin.

5.2.3 MIDGELL RIVER

The Midgell River (Figure 69) was once considered so important for salmon that it was declared a sanctuary river (Dupuis 2008). The Native Council of P.E.I. worked on the river in the 1990s and maintained the section from Pius MacDonalds Pond to the head of tide free from beaver blockages. With no active watershed group now working on the river, beavers frequently set up dams in this reach and reduce or occasionally eliminate movements of anadromous fish. In autumn of 2008, salmon could not reach prime spawning and nursery habitat downstream from Pius MacDonald's Pond because of a large beaver dam.

Water entering Pius MacDonalds Pond in summer can be very warm and have oxygen levels too low for salmonids (MaFarlane 1999). At times, stream water temperatures downstream from Pius MacDonalds Pond also exceed the upper threshold for trout and on one occasion, I have witnessed trout dying in the river when water temperatures approached 25˚C. Other fish species are also under stress and management strategies need to be changed. Pius MacDonalds Pond is used for canoeing, angling, trapping and hunting and provides an excellent location for gaspereau spawning. Thus, the pond should be maintained because of its many uses but de-watered once every six years during spring run-off to channelize the original stream channel and promote better water movement. Inflow water will be dramatically improved if beaver dams are removed upstream and from adjacent upland springs around the pond.

5.2.3.1 Recommendations

1. The main river from the Elm Road to the head of tide should be declared a year round beaver free zone.
2. Upstream from the Elm Road, inactive beaver dams should be breached regularly so natural riparian buffer zone vegetation can gradually re-establish.
3. The addition of many carefully located digger logs and other instream devices are needed to create more pools and better spawning sites downstream from Pius MacDonalds Pond.
4. Spring leads that drain into Pius MacDonalds Pond should have new and inactive beaver dams removed.

Figure 62. Good spawning and nursery habitat 100 metres downstream from Rte 313.

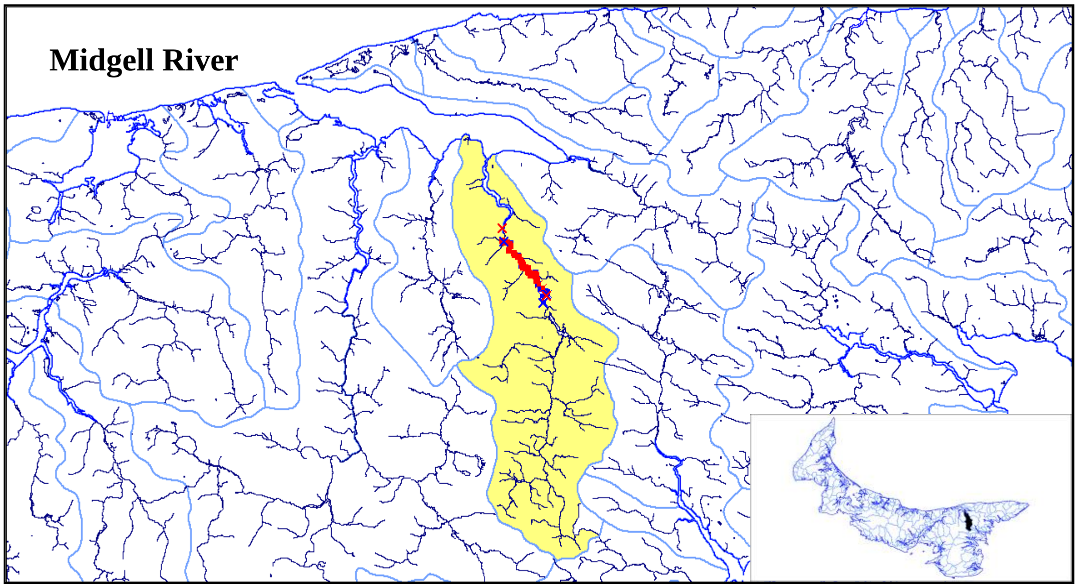
Figure 63. Good Atlantic salmon parr habitat on the Midgell River.

Figure 64. Old beaver dam on the Midgell River being rebuilt in June 2008.

Figure 65. Dead gaspereau are a frequent sight in beaver dams, such as this breached dam in theMidgell River.

Figure 66. A breached beaver dam on the Midgell River, causing erosion of the stream bank.

Figure 67. A beaver dam established in the Midgell River during the summer of 2008. This dam blocked all upstream movement of salmon in autumn.



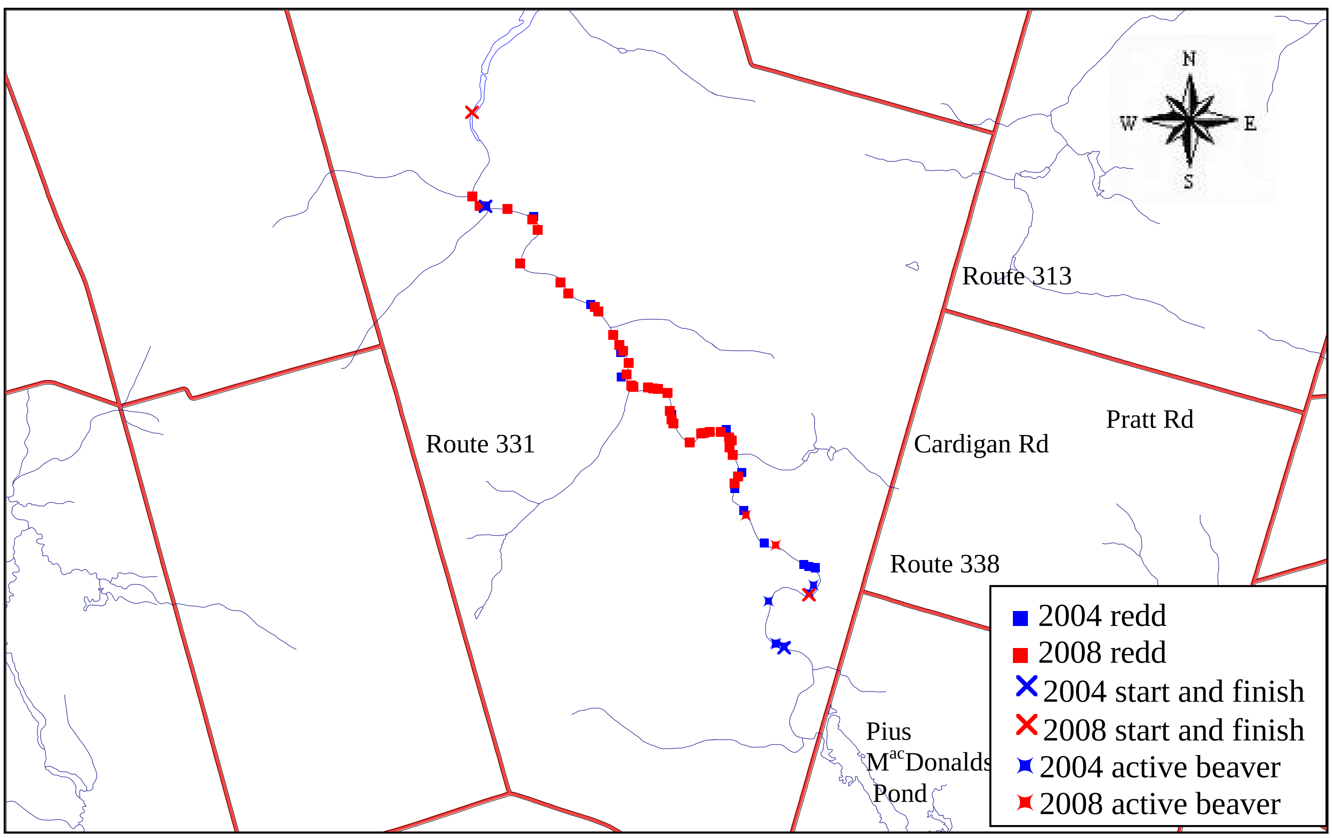


Figure 68. Location of salmon spawning sites in the Midgell River in 2004 and 2008. The survey included the main river from Pius MacDonalds Pond to the head of tide.

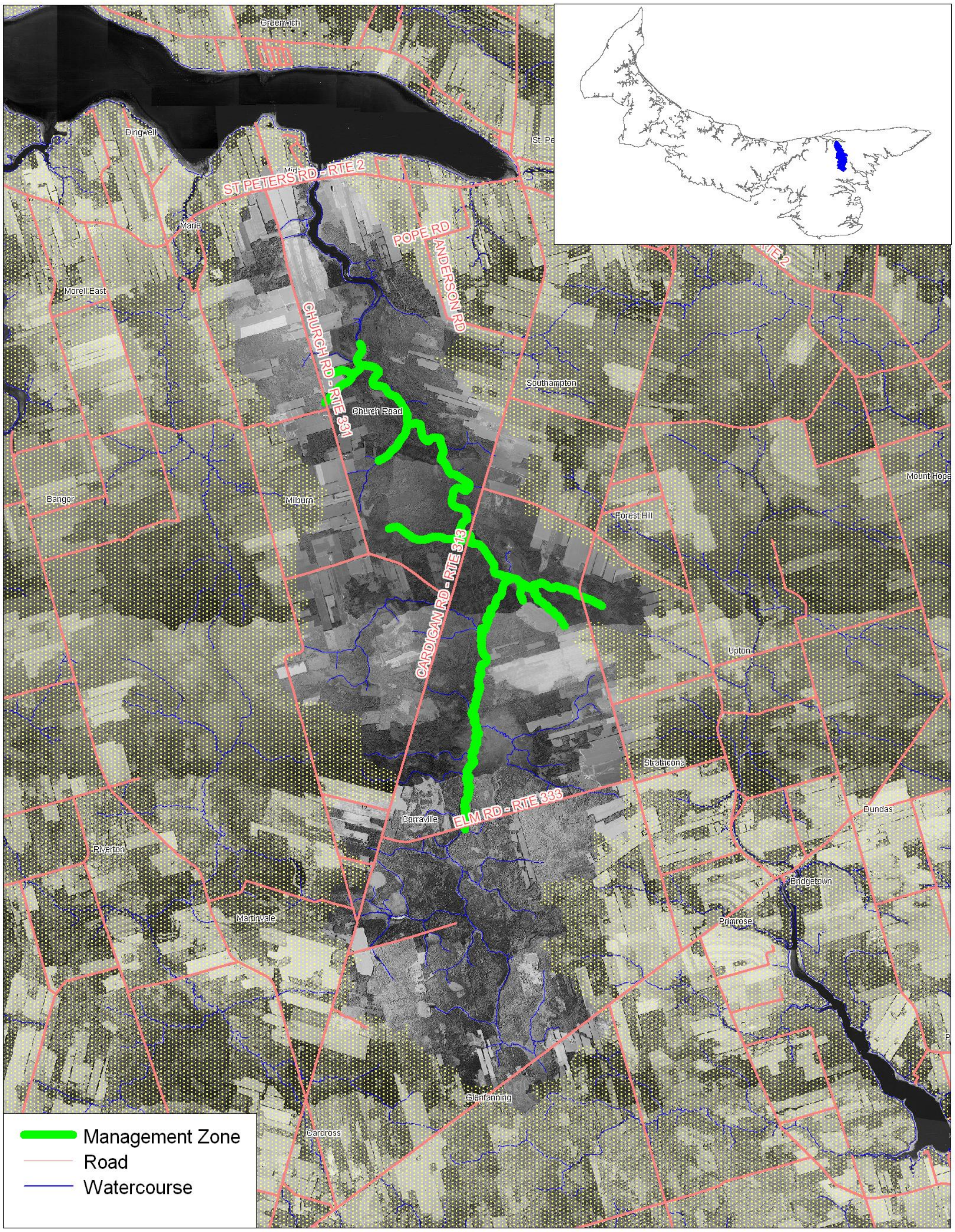


Figure 69. Beaver-free (management) zone in the Midgell River.

5.2.4 MORELL RIVER

The Morell River (Figure 84) remains the most popular site for salmon angling in Prince Edward Island. It may be the only river on Prince Edward Island that retained a small, early run salmon population, but by 1970, even that run had disappeared. The Morell has a long history of supplying broodstock for the Kelly (Stratford) Hatchery where salmon were raised through much of the first half of the 20th century. Salmon migrating up river were captured and retained in net pens at a site now known as the Hatchery Road, about 3 kilometres downstream from Indian Bridge. Juveniles were released in rivers on Prince Edward Island and elsewhere (Dupuis 2008 and Cairns et al. 2009).

For a couple of years in the early 1980s, hatchery smolts were released into the Morell River, with limited return rates from sea. Then, in the mid 1980s, under the guidance of Ron Gray from the Department of Fisheries and Oceans and in conjunction with the Morell and Area Land Use Steering Committee, semi-natural rearing was started on the Morell River using Rocky Brook stock from the Miramichi River in New Brunswick. The stocking of semi-naturally reared salmon smolts proved extremely successful and return rates from sea of the stocked fish were comparable to that of wild fish. A peak in return rates occurred in 1992 when based on the number of redds dug that autumn (about 1,000), sex ratio of salmon (about 75% male), and recorded and unrecorded catch (provided from an angler survey), I estimated a salmon run of about 4,000 fish.

For the past two decades, the Morell River Management Co-op was primarily responsible for management of river habitat and populations of anadromous fish on the Morell River drainage basin. The organization was provided with clear guidelines that needed to be followed to ensure successful return from sea of goodly numbers of salmon so recreational angling could continue. In recent years, with the addition of board members with limited experience in watershed management, the Morell River Management Co-op began to make management decisions that were contrary to the advice originally provided. Within a decade, all three tributaries of the river was blocked with beaver dams, salmon smolts could not always make it to sea because of blockages and the rearing strategy was in shambles. By the autumn of 2008, salmon redds were not observed in traditional sites below Mooneys Pond and only three salmon were able to be captured in “Anderson’s Pool” for broodstock. There are now limited numbers of Rocky Brook origin juveniles available to “jump start” future populations in other rivers. However, the overall number of redds counted in the Morell River in 2008 is comparable to other years with good salmon runs (Table 2).

In 2008, an experienced field biologist was hired by the Morell River Management Co-op and many of the blockages that were impeding anadromous fish movements have been removed. There are still water quality issues, especially on the east branch due to the flooding of the former Everglades impoundment by beavers. Water quality, especially summer oxygen and water temperatures, has been a concern for the Morell River because of the size of the eight ponds and the many beaver impoundments on the drainage basin.

5.2.4.1 Recommendations

1. At the very least, keep the "beaver-free" zone that was agreed to years ago free of any beaver dams in every season (see Figure 84). It is futile to keep breaching such dams; the beavers must be killed or anadromous fish species will suffer the consequences.
2. Revisit the habitat needs on river reaches, bearing in mind that the Morell is arguably the best river on Prince Edward Island for trout fishing and trout requirements are of paramount importance.
3. Sediment inputs remain a serious concern, especially on the south branch and the causes of sedimentation need to be addressed.
4. In 2009, the current group of 1+ parr in the hatchery should probably be raised in Mooney's Pond in appropriate cages.
5. It would be desirable to trap early-run salmon broodstock at Leards Pond bypass if funding is secured for the salmonid enhancement program.

Figure 70. MacAulays Pond on the south branch of the Morell River is largely infilled with sediment.

Figure 71. Beaver impoundment in the beaver-free zone downstream from MacAulays Pond.

Figure 72. Typical riffle habitat in the south branch of the Morell River.

Figure 73. Traditional salmon spawning area on the west branch downstream from Kennys Bridge.

Figure 7424. Beaver dam blocking the west branch of the Morell River one-half kilometre upstream from Leards Pond.

Figure 75. Traditional spawning site for late-run MSW fish downstream from Leards Pond.

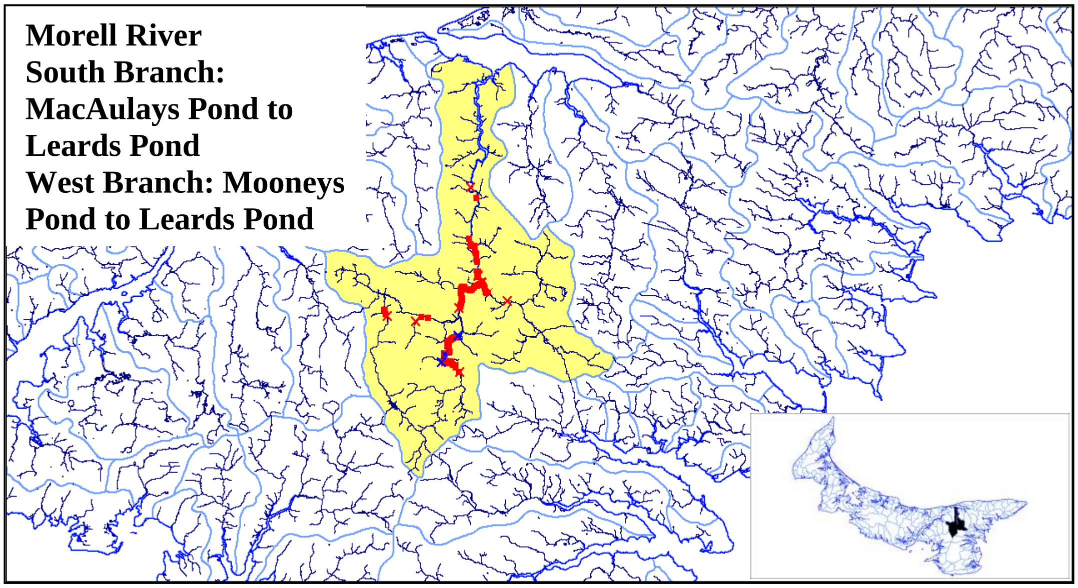
Figure 76. Morell River between Indian Bridge and Mooneys Pond.

Figure 77. One of the four active beaver impoundments in the beaver-free zone on the east branch downstream from the Martinvale Road.

Figure 78. Beaver meadow established after four decades of continuous flooding on the east branch (Martinvale).

Figure 79. Two decades of regular flooding by beavers in the beaver-free zone (Martinvale section) results in brush marshes and eventually a beaver meadow.

Figure 80. Semi-natural rearing site established at Mooneys Pond in 1988.



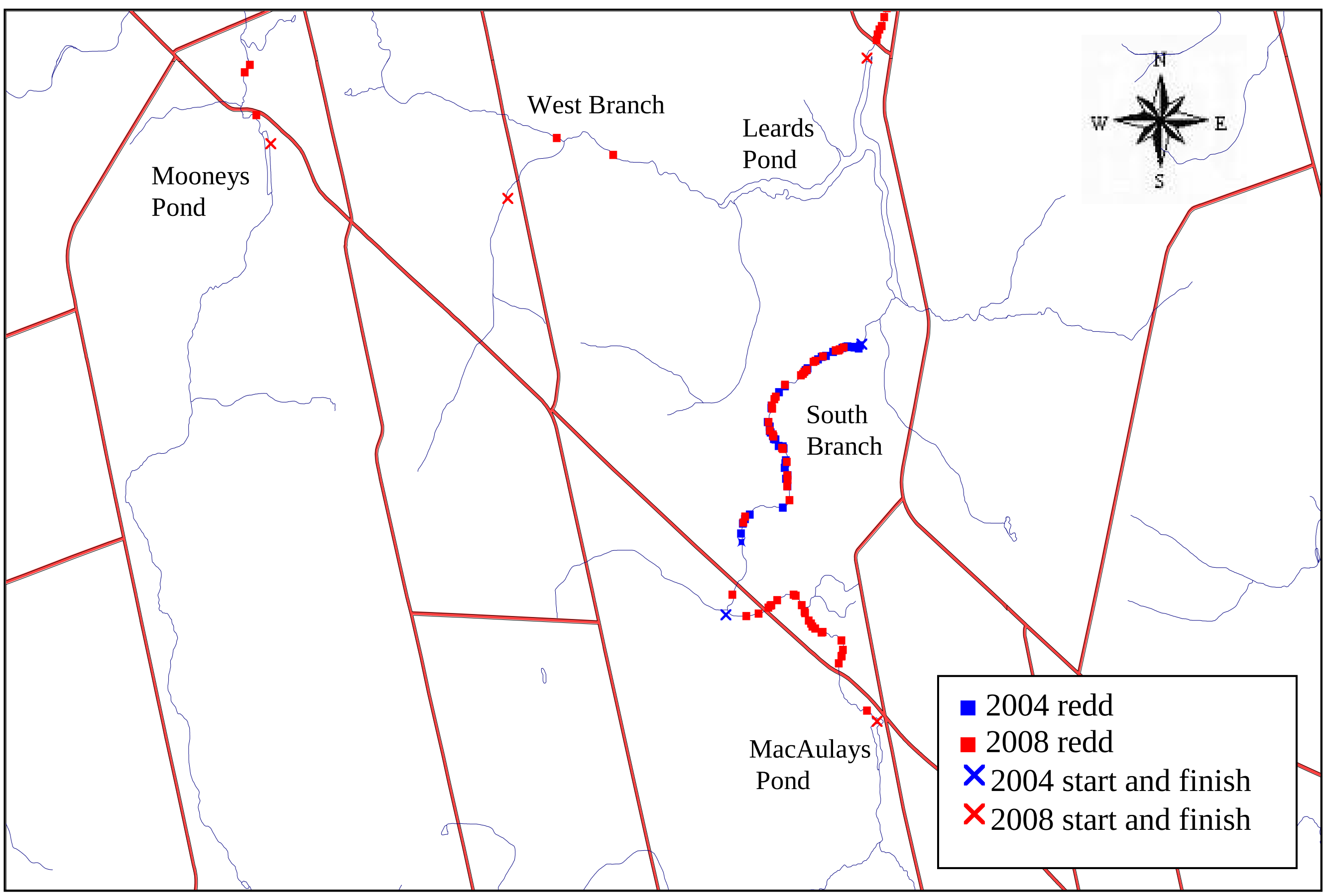
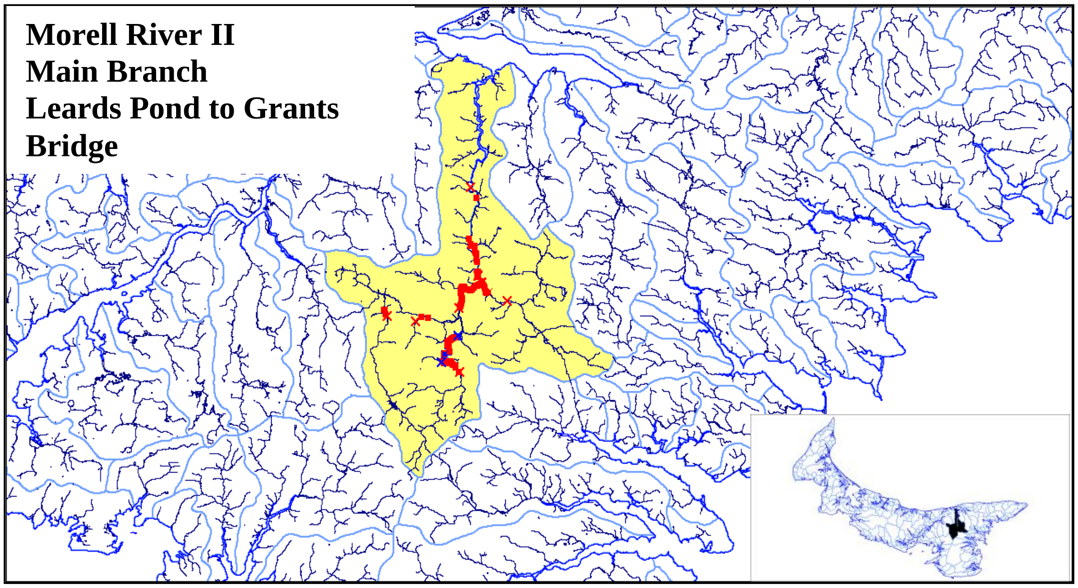


Figure 81. Location of salmon spawning sites in the Morell River – South Branch and West Branch – in 2004 and 2008.



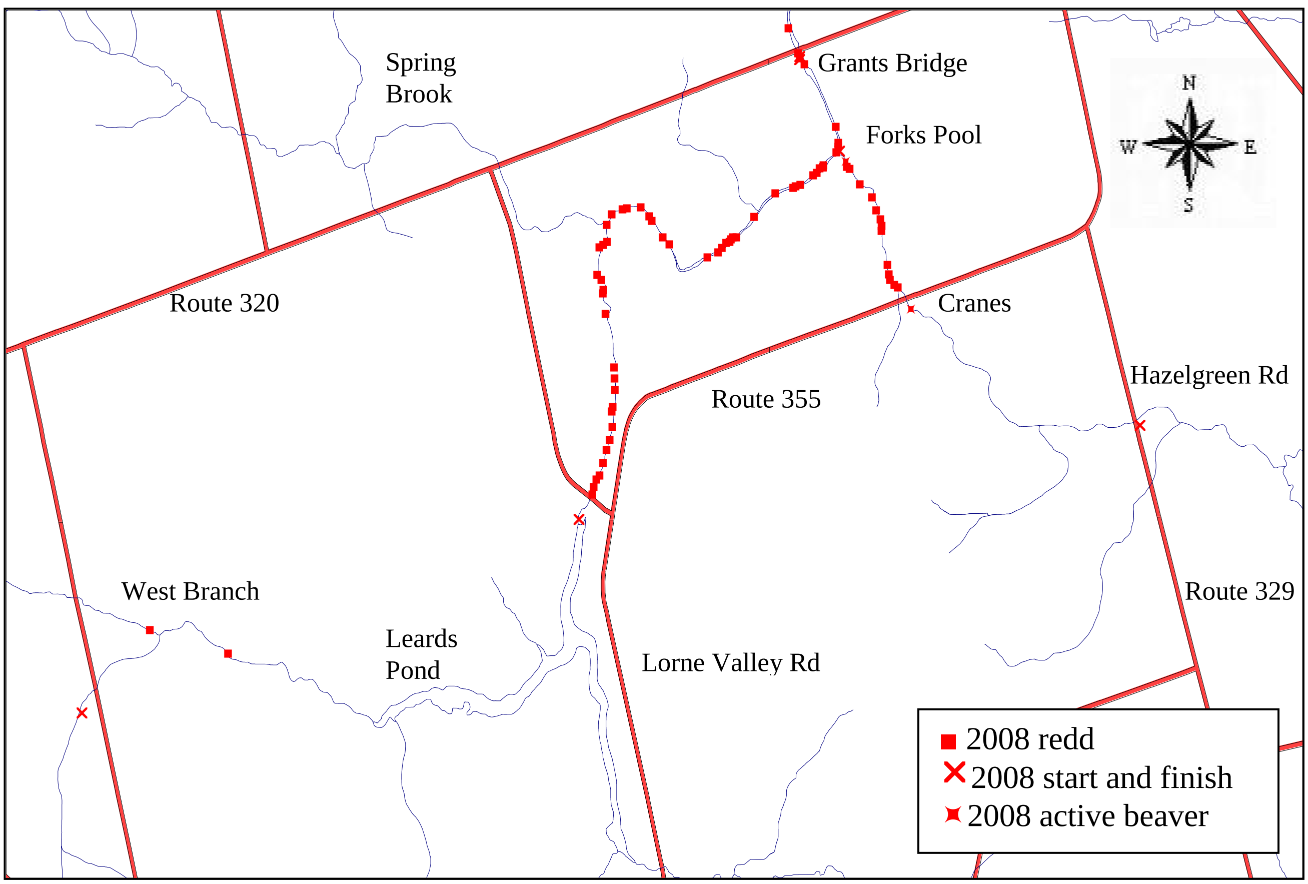
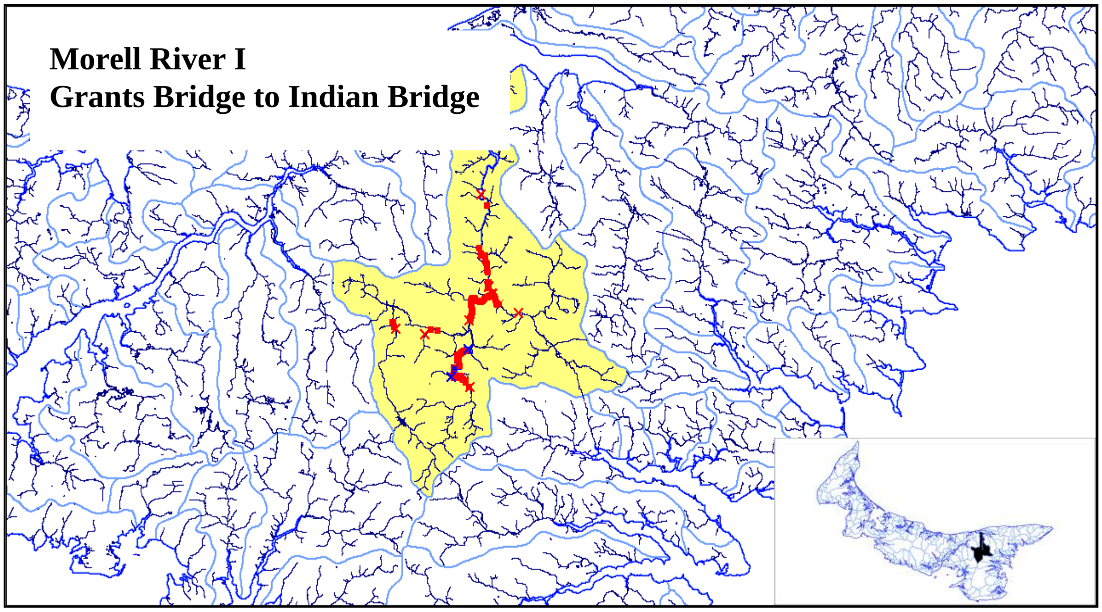


Figure 82. Location of salmon spawning sites in the Morell River – Main Branch from Leards Pond to Grants Bridge – in 2008.



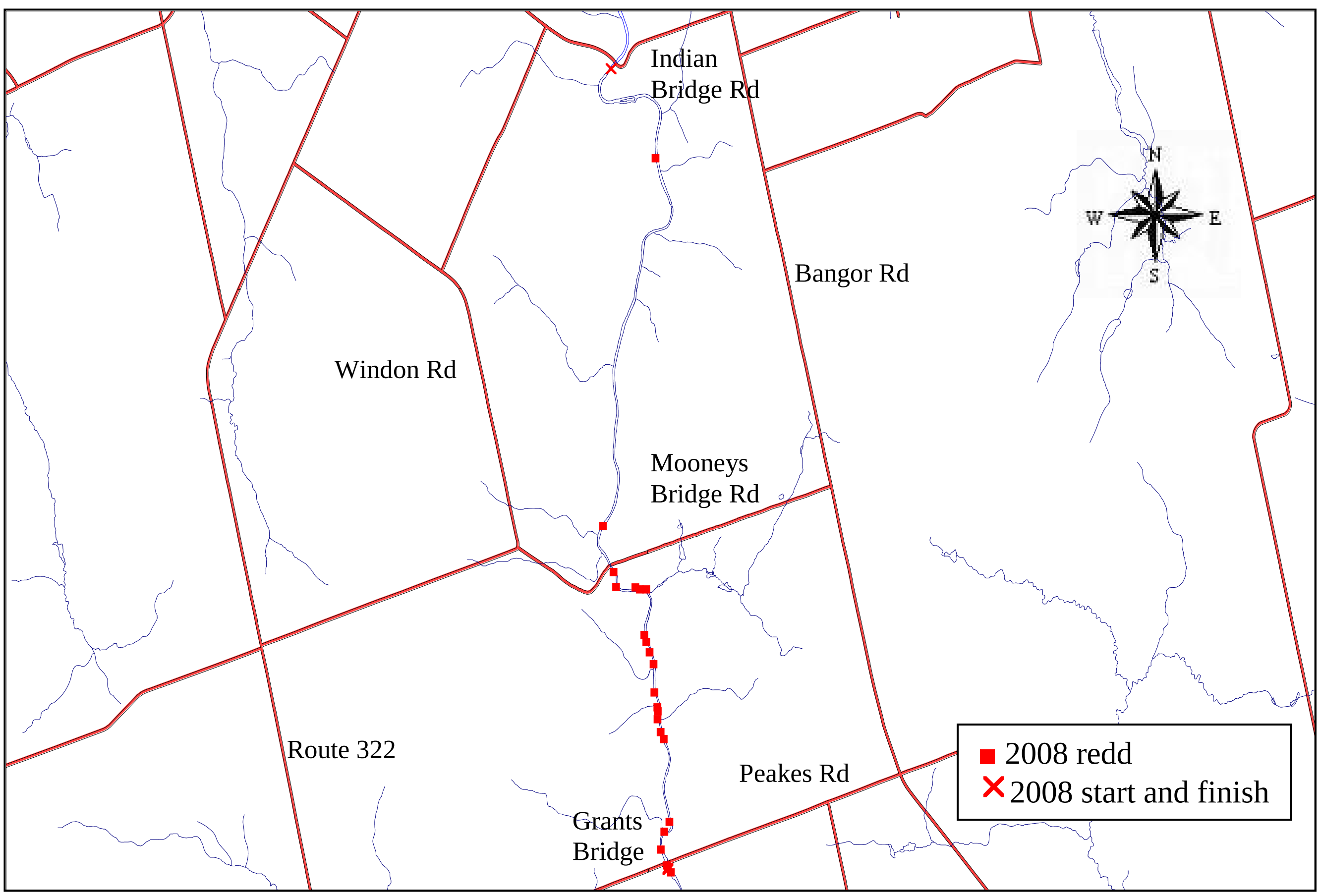


Figure 83. Location of salmon spawning sites in the Morell River – Grants Bridge to Indian Bridge – in 2008.

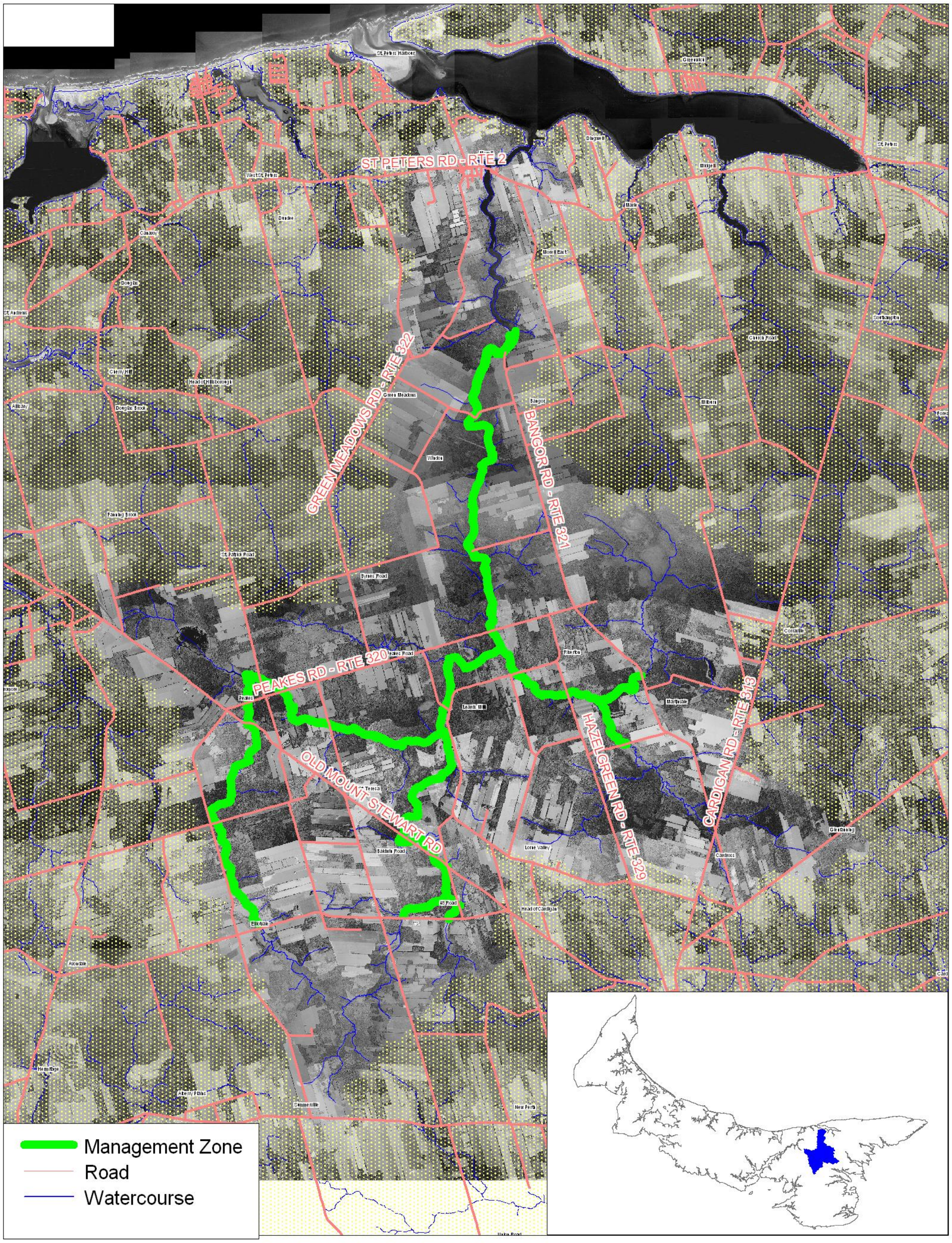


Figure 84. Beaver-free (management) zone in the Morell River.

5.2.5 VERNON RIVER

Vernon River (Figure 87) has long been considered an excellent system for production of brook trout but also has good Atlantic salmon and rainbow trout populations. The eastern tributary has many springs draining from agricultural land and is relatively cool in summer. There are numerous beaver dams upstream from the Glencoe Pond. Between the pond and the forks downstream from the Glencoe Road, the gradient and substrate is good for salmon parr. The northern tributary drains the rather flat, boggy land lying south of O'Keefes Lake. There are many beaver dams in small headwater streams which eventually join and flow into MacMillans Pond at the Route 3 highway. Downstream from Route 3 is a 4-5 kilometre reach of stream which can potentially be ideal for Atlantic salmon production. Old beaver flowages exist and probably can be navigated by adult Atlantic salmon but a beaver dam established at the headwaters of MacLeans Pond (near the head of tide) appeared impassable for upstream movements of anadromous fish in autumn 2008. Since there are no suitable spawning sites downstream from MacLeans Pond, no salmon redds were observed on Vernon River in the autumn of 2008.

<u>Note</u>: Rivers cannot have runs of fish prevented from reaching their spawning sites or those species such as Atlantic salmon will inevitably disappear. A watershed group has been working on this river for several years but as usual, salaries and effort stop by late summer. Beaver dams constructed after summer work programs are completed can prevent spawning and obstruct downstream movement of smolts the following spring.

5.2.5.1 Recommendations

1. Remove beavers from the east branch but do not completely breach the dams until sediment becomes stabilized with grasses and add brush mats as needed.
2. Keep the north branch completely free of beaver dams from Gauls Road to head of tide. This should improve water quality in MacMillans Pond which currently experiences high summer water temperatures in outlet waters.
3. Stabilize sediment in old beaver flowages downstream from MacMillans Pond and add digger logs where appropriate to improve spawning and nursery sites.
4. Try to get landowner agreement to expand the current 15 metre buffer zone along the river between MacMillans Pond to MacLeans Pond where tiny parcels of remnant old growth trees, especially hemlock, still survive.

Figure 85. Excellent habitat for Atlantic salmon in the reach between MacLeans Pond and MacMillans Pond.

Figure 86. Beaver dam immediately upstream from MacLeans Pond on Vernon River. It was established in early fall and no salmon redds were found upstream.

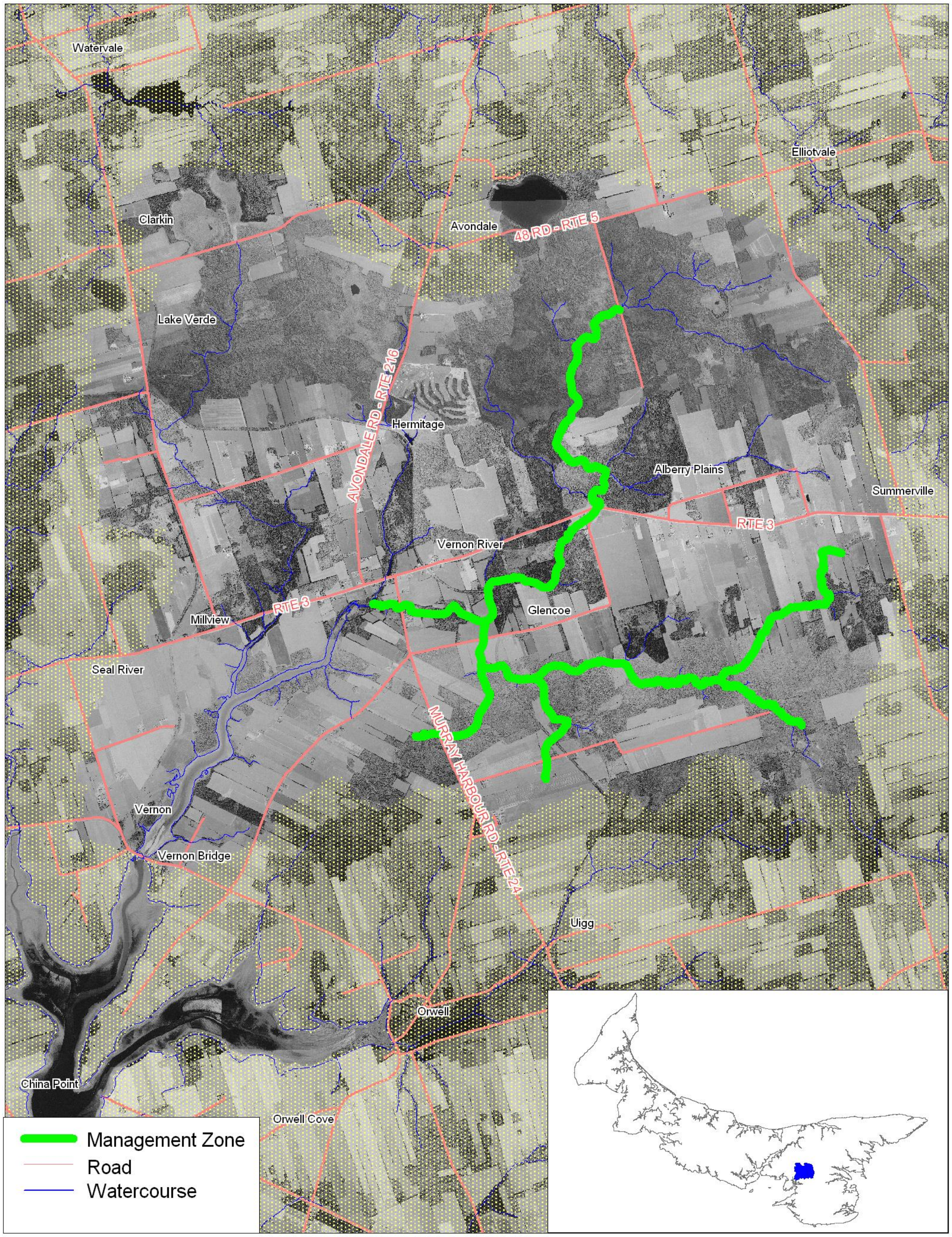


Figure 87. Beaver-free (management) zone on the Vernon River.

5.3 Class III Rivers – Atlantic Salmon on the Verge of Disappearing

Each of the rivers in Class III requires an active watershed group to oversee river management. Most of these rivers are relatively short and have serious problems with blockages and/or sediment. Salmon populations in each river are very low and are often missing year classes.

5.3.1 BRISTOL CREEK (BERRIGANS CREEK)

Bristol Creek flows from Morell Rear through MacKinnons Pond and St. Peters Lake to empty into the Gulf of St. Lawrence, close to the mouth of St. Peter's Bay (Figure 91). St. Peters Lake has long been a spring destination for sea trout anglers in May of each year. Many of these anglers are unaware that a substantial number of salmon traditionally spawned upstream and departed the pond and lake early in April. Good gradients occur upstream from Bristol Pond for about 3-4 kilometres, after which the stream becomes slow, deep and meandering before picking up velocity as it approaches the Cemetary Road (Route 352).

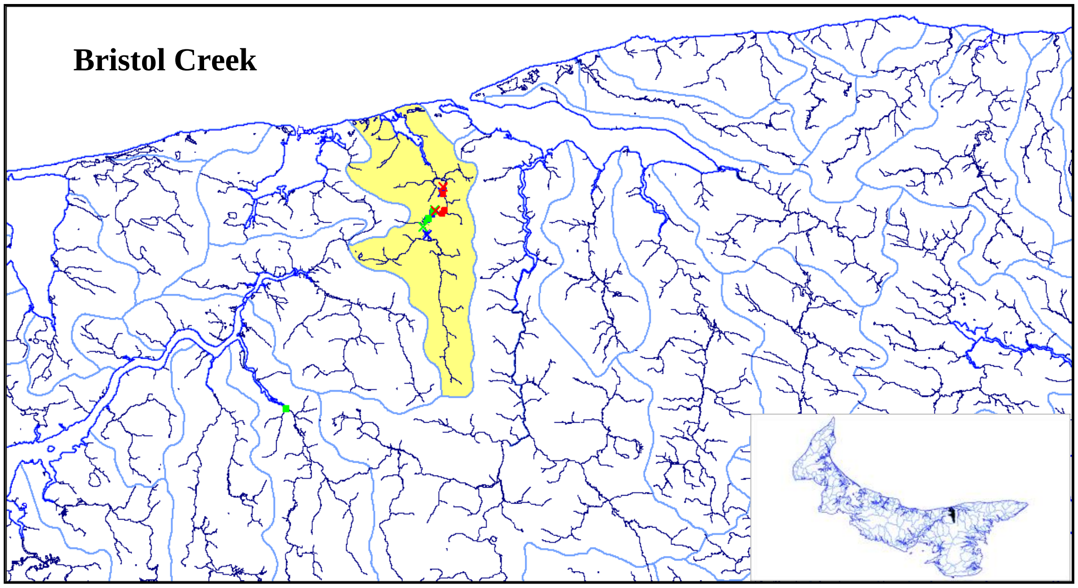
Beavers have repeatedly blocked the stream and prevented upstream movement of most salmonids in recent years, even though trappers annually caught beavers on this stream. Sea run trout have been restricted from reaching their prime spawning spring where huge numbers used to concentrate in late autumn. Only eight (8) salmon redds were detected on the stream in 2008 and although no juvenile salmon were caught when electrofishing in recent years, a spot check where a few salmon redds were seen in 2007 revealed some 1+ parr but no 0+ salmon in July 2008.

5.3.1.1 Recommendations

1. The establishment of a watershed management group should be encouraged so they could clear a trail along the stream and conduct necessary habitat enhancement work on the river. In the absence of a watershed group, some government agency has to take responsibility; if not, Atlantic salmon and most sea run brook trout in Bristol Creek will soon disappear.
2. Remove all beavers and their dams from the main tributary between the Green Meadows Road (Route 322) and St. Peters Lake. Their removal has to be permanent, as the salmon run is on the verge of disappearing and the trout fishery has undoubtedly been compromised.

Figure 88. Excellent salmon habitat one kilometre upstream from MacKinnons Pond in Bristol.

Figure 89. One of several beaver dams blocking fish movement in Bristol Creek.



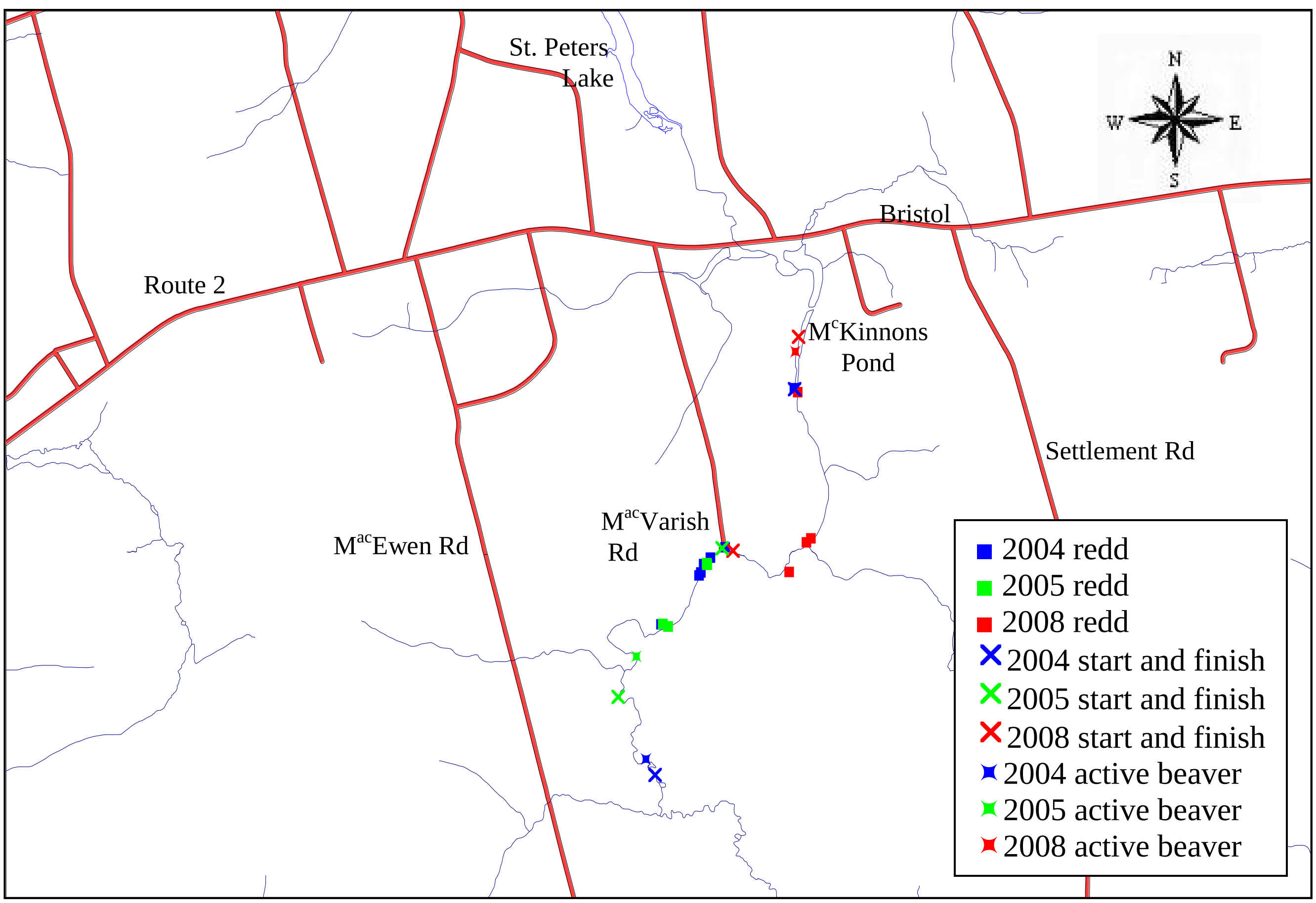


Figure 90. Location of salmon spawning sites in Bristol Creek in 2004, 2005 and 2008.

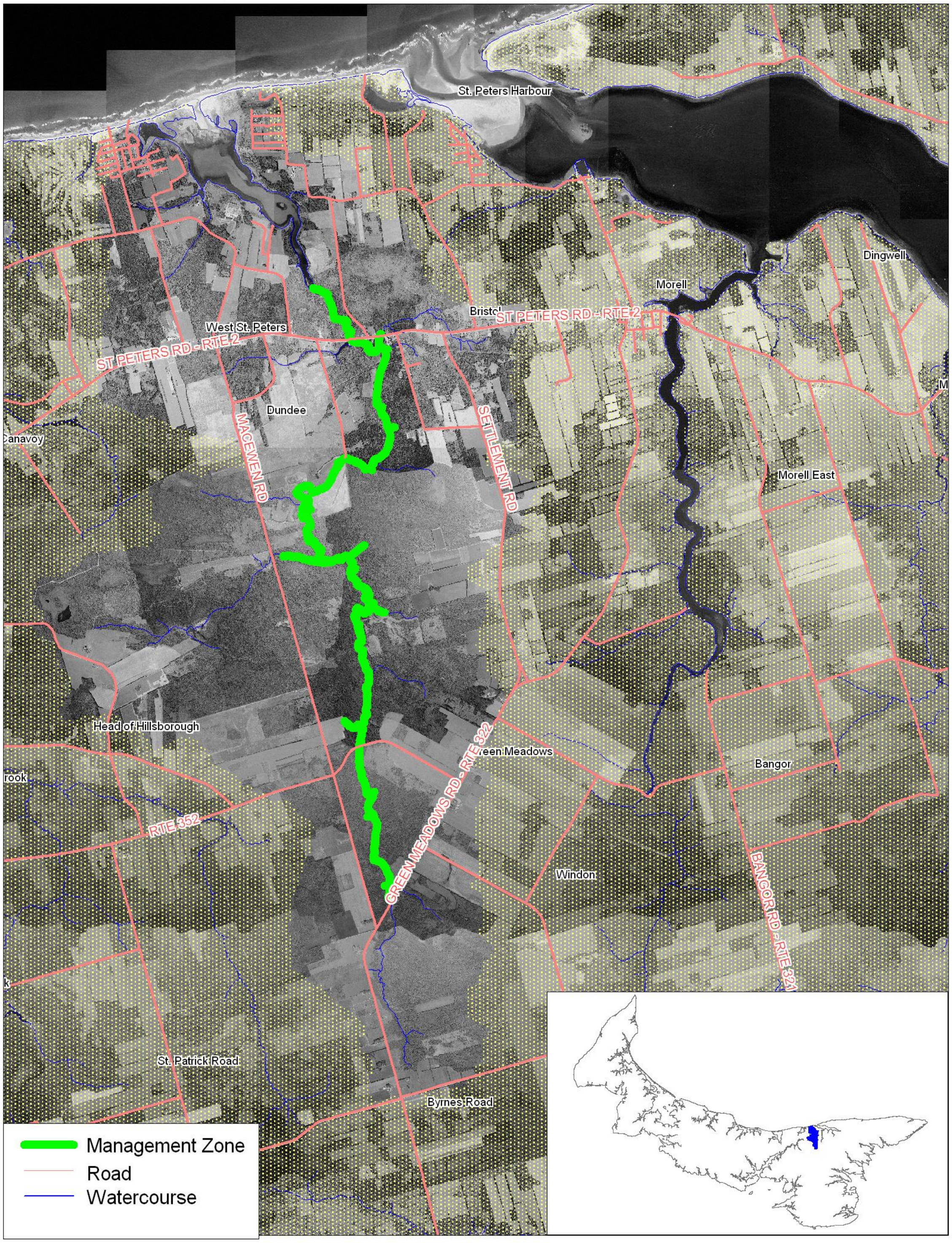


Figure 91. Beaver-free (management) zone in Bristol Creek.

5.3.2 CARDIGAN RIVER

The Cardigan River (Figure 94) is a small, cold water stream draining into Cardigan Bay. It was chosen as a site for a federal hatchery in 1937 and with more recent upgrades, provided trout and salmon for stocking of Prince Edward Island rivers. The hatchery was the backbone for a very successful semi-natural rearing project for Atlantic salmon on the Morell River. When the federal government divested itself of the hatchery, the University of Prince Edward Island acquired it for five years before eventually selling it to a private aquaculture operation. The owners continue to provide wild fish for the enhancement program with periodic funding from the federal and provincial governments and the Prince Edward Island Wildlife Conservation Fund but the future of this source of salmon for rejuvenating runs or providing “put-and-take” fishing seems bleak without assured long term funding.

In recent years, expansion of intensive row crop production within the drainage basin has compromised water quality in the Cardigan River. Massive quantities of sediment entering the river have begun to infill the head pond for the hatchery. The fish ladder at the head pond has not operated for years and it would take an acrobatic salmon to jump through the opening into the head pond. In 2008, there were no salmon redds counted in the river and it appears that the salmon run is doomed, even though good numbers of two year classes of juveniles were documented in the short stream reach between the hatchery and Route 4 in 2007.

5.3.2.1 Recommendations

1. A watershed group is needed to take on the land use challenges within the drainage basin.
2. Sediment input to the river must be limited and instream sediment removed or consolidated. A large sediment trap upstream from the Straghbohgie Road stream crossing would help protect the hatchery head pond from infilling.
3. The fish ladder at the head pond for the hatchery has to be rebuilt if salmon or sea run trout are ever going to use the bulk of the river again.
4. Close liaison with hatchery personnel is needed to ensure cooperation and support.
5. If the fish ladder at the Cardigan Fish Hatchery was rebuilt and sediment problems addressed, a watershed group could consider maintaining a beaver-free zone as indicated in Figure 94. Without a functioning fish ladder, it is unlikely that the salmon run will survive for very long.

Figure 92. Head pond dam at the Cardigan Fish Hatchery in the Cardigan River.

Figure 93. Short sections of good spawning and nursery habitat for Atlantic salmon remain on the Cardigan River downstream from the Fish Hatchery.

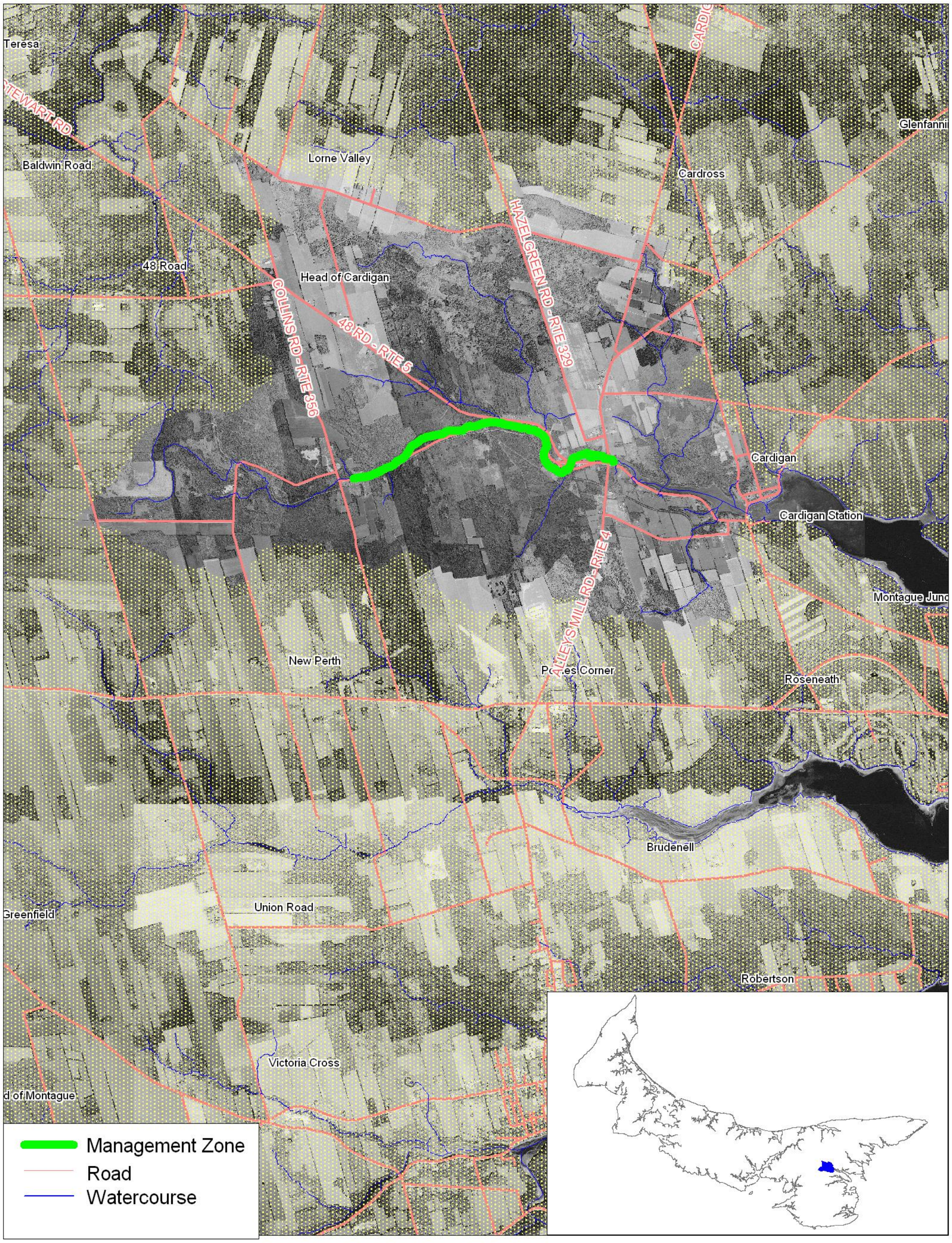


Figure 94. Beaver-free (management) zone in Cardigan River.

5.3.3 HEAD OF HILLSBOROUGH

This cold water stream has a good gradient for most of its length except for about 1 kilometre upstream from Warrens Pond (Figure 97). In the mid-1990s, a stream enhancement crew did tremendous work to restore instream habitat, excavate sediment traps, plant trees, and work with the Department of Transportation and Public Works to remedy sources of sediment from unpaved roads. However, beavers that remained in the upper reaches of the river and in Fanningbrook tributary made a dramatic comeback, in spite of regular trapping. The stream above Warren Pond has been flooded so extensively by beavers that a zone of dead and fallen trees spans almost 200 metres in width in places. The stream channel has been braided many times as it goes over beaver dams, causing considerable erosion and the tangle of vegetation and sediment has created an almost impenetrable mess. The upper reaches of the main tributary above Route 352 is currently blocked by beavers and has been for many years. Although the Head of Hillsborough has good water temperatures and some good quality spawning and nursery areas, the likelihood of a recovery of this system from beaver influence is minimal, since the stream is relatively small and impacted by beavers along its entire length. Parr numbers are very low and with few accessible habitat units remaining, salmon runs cannot survive for long. No salmon redds were seen in 2008 but if salmon did manage to spawn, the redds would likely have been obliterated with sediment within days.

5.3.3.1 Recommendations

1. A highly industrious watershed group would be able to clear the stream again. However, without regular removal of beavers and their dams in the headwaters, it seems like a futile venture. Even a modest increase in accessible stream habitat upstream from Warrens Dam would make several springs available for sea run trout spawning.
2. All anadromous fish would benefit from the removal of beavers from at least a portion of the drainage basin, and the river might then become a good candidate for restocking of salmon. If there is to be any hope of recovery in salmon populations, the complete southeast branch, from the head of tide to its source at the New Road, as well as the Fanningbrook tributary to the Revell Road, must be kept free of beaver blockages (Figure 97).
3. The Revell Road continues to be a serious source of sediment for the river which needs to be addressed.

Figure 95. Excellent juvenile salmon habitat still exists upstream from beaver blockages in Head of Hillsborough.

Figure 96. Upstream from the unpaved section of Route 323 on the Head of Hillsborough River, the stream is impounded and full of sediment and the riparian zone is virtually impenetrable.

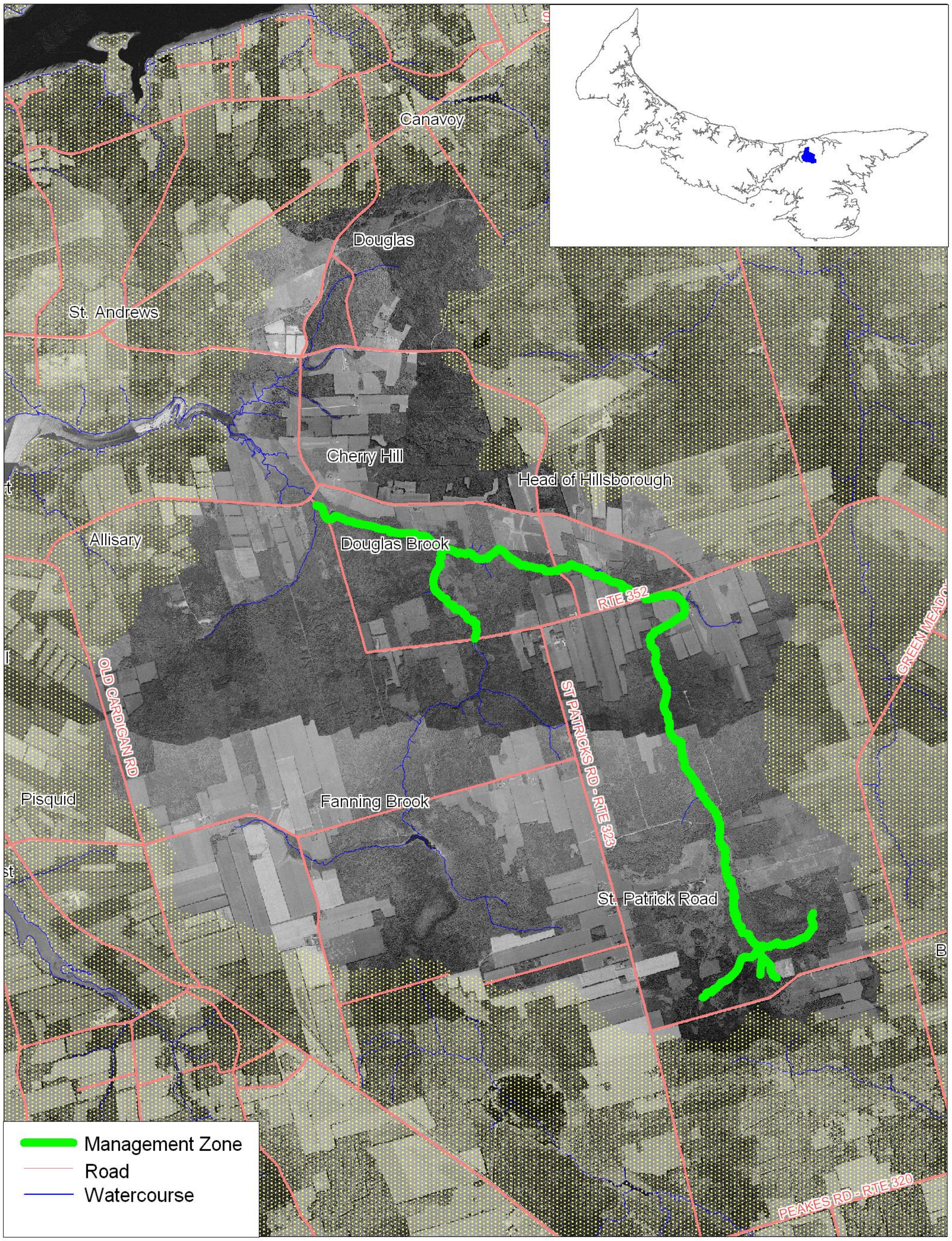


Figure 97. Beaver-free (management) zone in the Head of Hillsborough River.

5.3.4 LITTLE TROUT RIVER

This small river drains relatively flat land near the village of Richmond in Prince County (Figure 101). A decade ago, before beavers blocked most of the its tributaries, the density of various year classes of juvenile salmon in this stream was higher than one would expect from such a small stream. A local dedicated watershed group did superlative work trying to rid the streams of blockages and consolidate or extract sediment. Efforts may have come too late as no juveniles were detected in survey sites in 2006, 2007 and 2008. The good news is that a small run of salmon (including some MSW fish) spawned here in 2008. It remains to be seen whether or not the continual movement of sediment will prevent good survival of eggs to hatching in the eleven (11) redds counted by Cathy Gallant in 2008 (Figure 101).

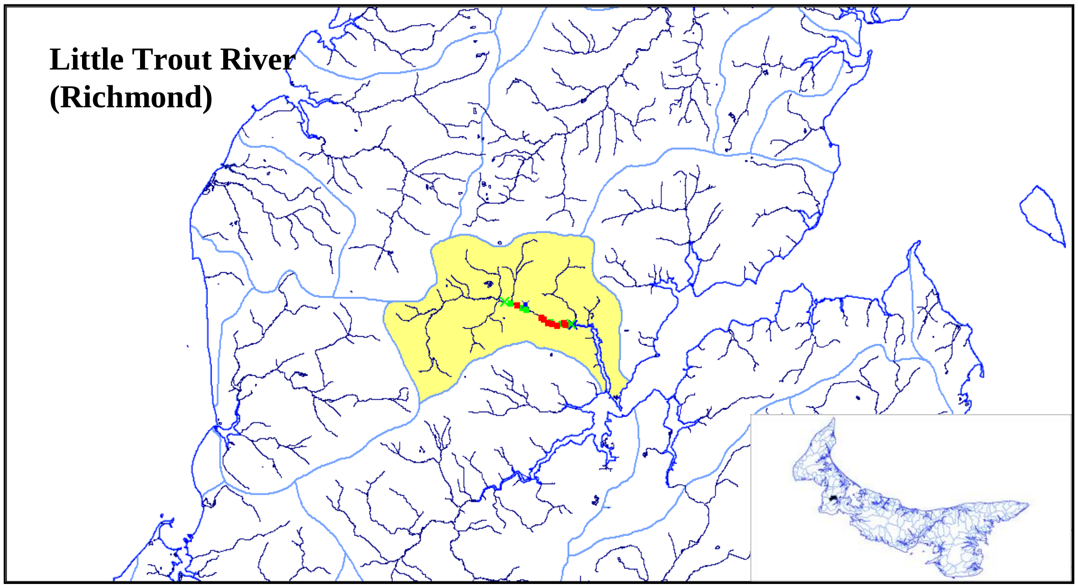
5.3.4.1 Recommendations

1. Add one more sediment trap about halfway between Richmond and the head of tide.
2. Continue to maintain the structures and sediment traps already in place.
3. Add brush mats or instream cover as needed on each stream reach.
4. Keep beaver dams and beavers out of the beaver-free zone or there will be no hope for Atlantic salmon survival.
5. Keep the delightful trail along the river open for visitors to enjoy.

Figure 98. Cathy Gallant in front of a beaver dam on Little Trout River. ***Photo by Shawn Hill***

Figure 99. Sediment bypass pond on Little Trout River in Richmond.

Figure 100. Brush mats downstream from Richmond on Little Trout River.



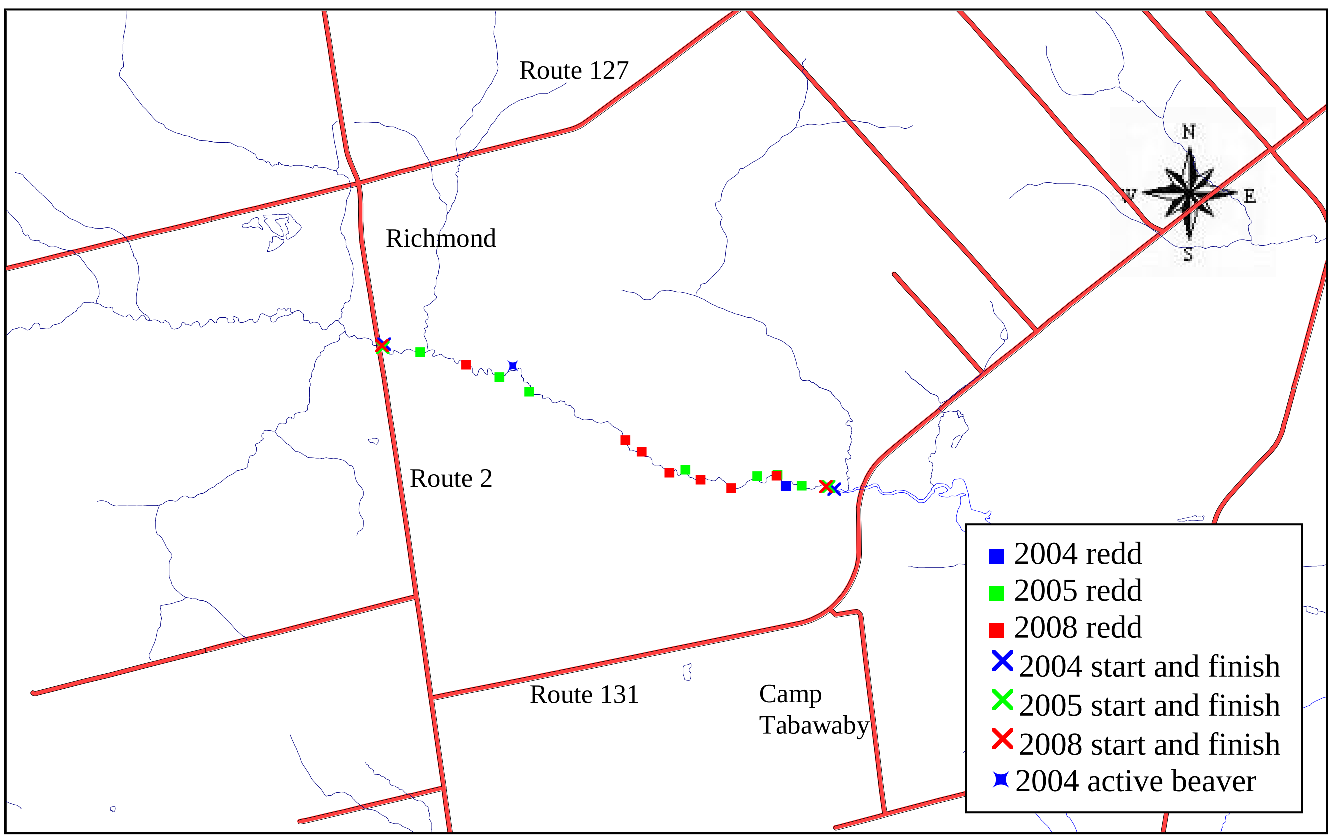


Figure 101. Location of salmon spawning sites in Little Trout River, Richmond, in 2004, 2005 and 2008.

5.3.5 NORTH RIVER

North River (Figure 104) is one of only two rivers on Prince Edward Island where Atlantic salmon populations are known to have expanded and increased in the past decade. It is not known why populations of salmon are slowly increasing in North River. There have been regular salmon runs in the West River which shares a common estuary with the East and North Rivers, so some straying could occur. The opening of the North River causeway undoubtedly improved water quality from Milton to the causeway and could also have contributed to the rebound in Atlantic salmon. In early November, 2008, four (4) MSW salmon were collected at the Milton Bridge in support of the salmon enhancement program. Later in November, a few salmon redds were found on each of the three main tributaries. The severe storm in August 2008 caused much movement of sediment into the river but especially on the Crabbe Road tributary (Figure 4) so hatching success of eggs in redds is problematic. With such a high proportion of the drainage basin deforested (Table 1), sediment input and flashy conditions will continue to present problems.

5.3.5.1 Recommendations

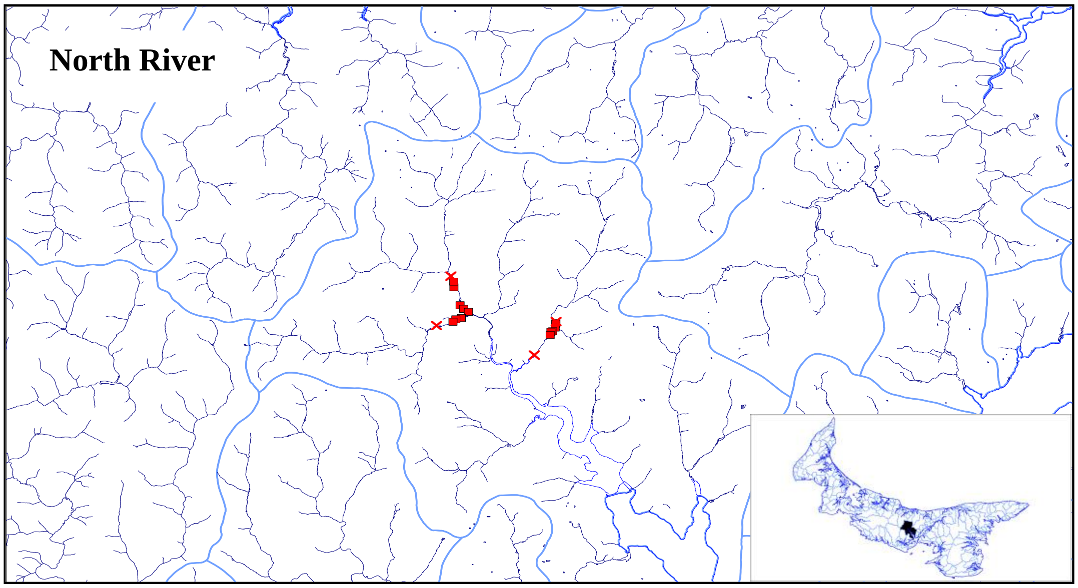
1. Reach by reach recommendations should be discussed with the local watershed group for the three major branches. This group's good work on Coles Brook should be encouraged and expanded to all tributaries.
2. Beavers and their dams should be removed from all tributaries and the river maintained beaver free (there are currently very few beavers on North River).
3. Stream restoration activities should include the installation of brush mats and digger logs in appropriate locations.
4. North River has a good population of rainbow trout and it could be a candidate for monitoring of potential interactions between rainbow trout and Atlantic salmon.
5. North River should not become the next Winter River for the City of Charlottetown. At least three times since the new millennium, the upper reaches of Winter River have been sucked dry by over-extraction of groundwater for Charlottetown. The city of Charlottetown should be required to develop a comprehensive water conservation plan and implement it before more wells are drilled in a different drainage basin.
6. Instream sediment traps should be excavated in the following locations: a) 200 metres west of the Loyalist Road (in the old mill pond basin); b) upstream from the Crabbe Road (Route 256); and c) in the site of the former pond basin (referred to by locals as the Art Bowness pond) downstream from Route 2.
7. It would be desirable to establish a few good "youth fishing" pools downstream from the Milton Bridge (Route 258).
8. Offspring from the MSW salmon collected in autumn 2008 should be released in the river in May 2010.

Recommendation

The City of Charlottetown should be required to develop and implement a comprehensive water conservation plan before a new well field is permitted in the North River drainage basin.

Figure 102. Garbage dumped in North River downstream from Route 2.

Figure 103. Juvenile Atlantic salmon were found on Coles Brook, a tributary of the North River.



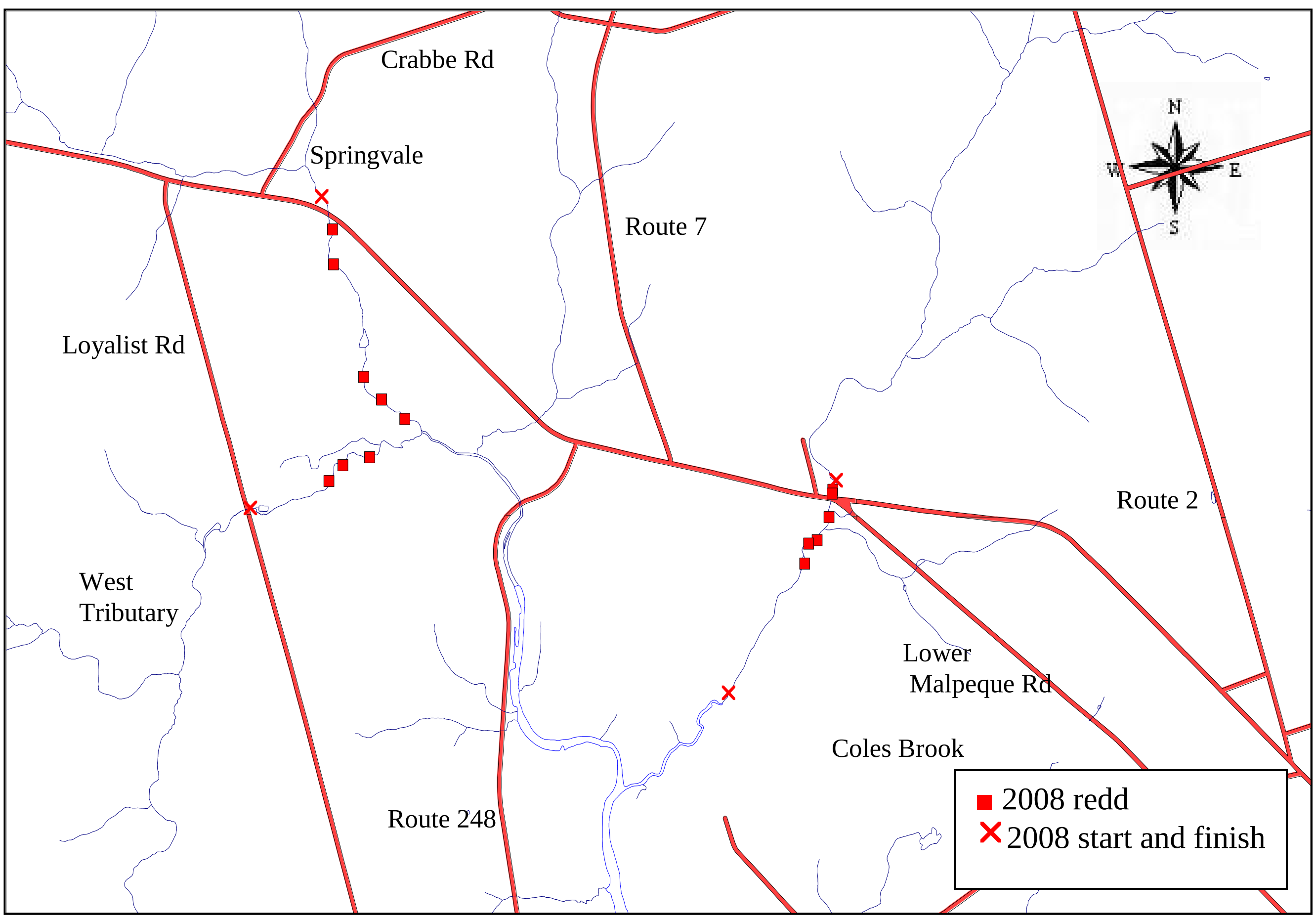


Figure 104. Location of salmon spawning sites in North River in 2008.

5.3.6 TROUT RIVER (TYNE VALLEY) AND BANK BROOK

The Trout River and Bank Brook (Figure 108) drain relatively flat terrain and at first glance, one would not expect to encounter salmon. However, both Trout River and Ellerslie River were important Atlantic salmon study sites for Smith and Saunders over a half century ago. At that time, excellent runs of salmon and sea run trout were reported in both Trout River and Bank Brook (MacLean, pers. comm.) which flows parallel to Trout River and enters the estuary at about the same location. In recent years, beavers have been damming both Trout River and Bank Brook and the salmon run is in jeopardy of disappearing. In autumn 2008, there were only eight (8) salmon redds counted in Trout River and six (6) redds observed in Bank Brook.

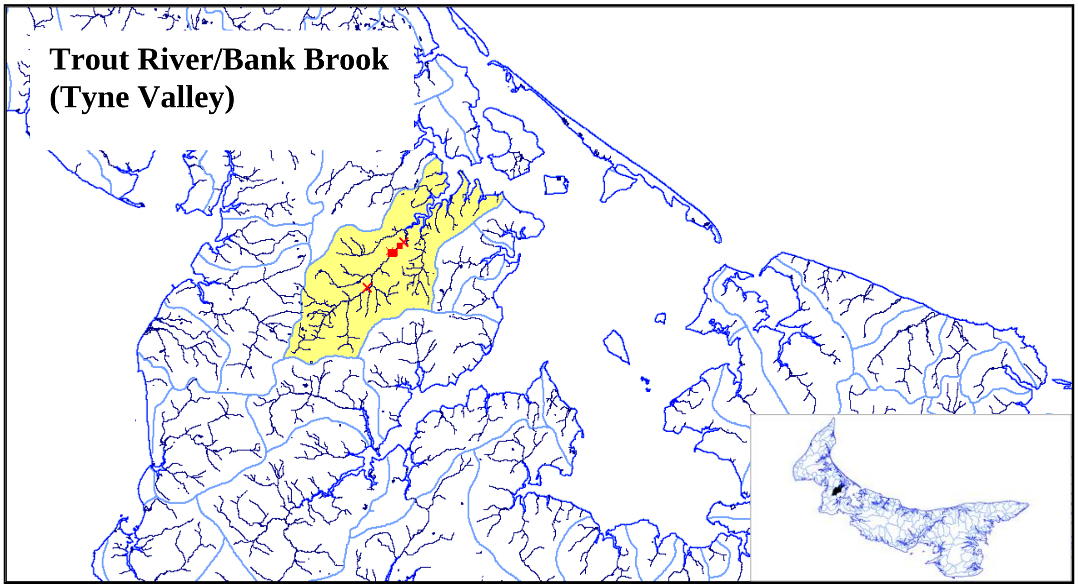
Fortunately, an extremely conscientious watershed group overseen by project manager Cathy Gallant has good landowner support and is doing excellent habitat work. The control of beaver populations and installation of more sediment traps and brush mats will likely determine whether or not salmon continue to exist in these productive streams.

5.3.6.1 Recommendations

1. It will be very difficult to salvage the Atlantic salmon run unless beavers are completely removed from both Trout River and Bank Brook. If this is not feasible, removal of beavers and their dams from all of Bank Brook and upstream on the Trout River to the Rails to Trails crossing (upstream from Route 132) might be enough to permit recovery of the salmon run.
2. Sediment traps should be cleaned and others installed as needed, including two upstream from Dan MacLean's farm.
3. The excellent reforestation work currently being carried out should be continued.
4. If the salmon run is lost and beavers are completely removed from the drainage basin, this stream should be considered for a jump-start early run salmon release.

Figure 105. Section of good gravel-cobble habitat in Trout River (Tyne Valley).

Figure 106. Active beaver dam in Bank Brook (Tyne Valley).



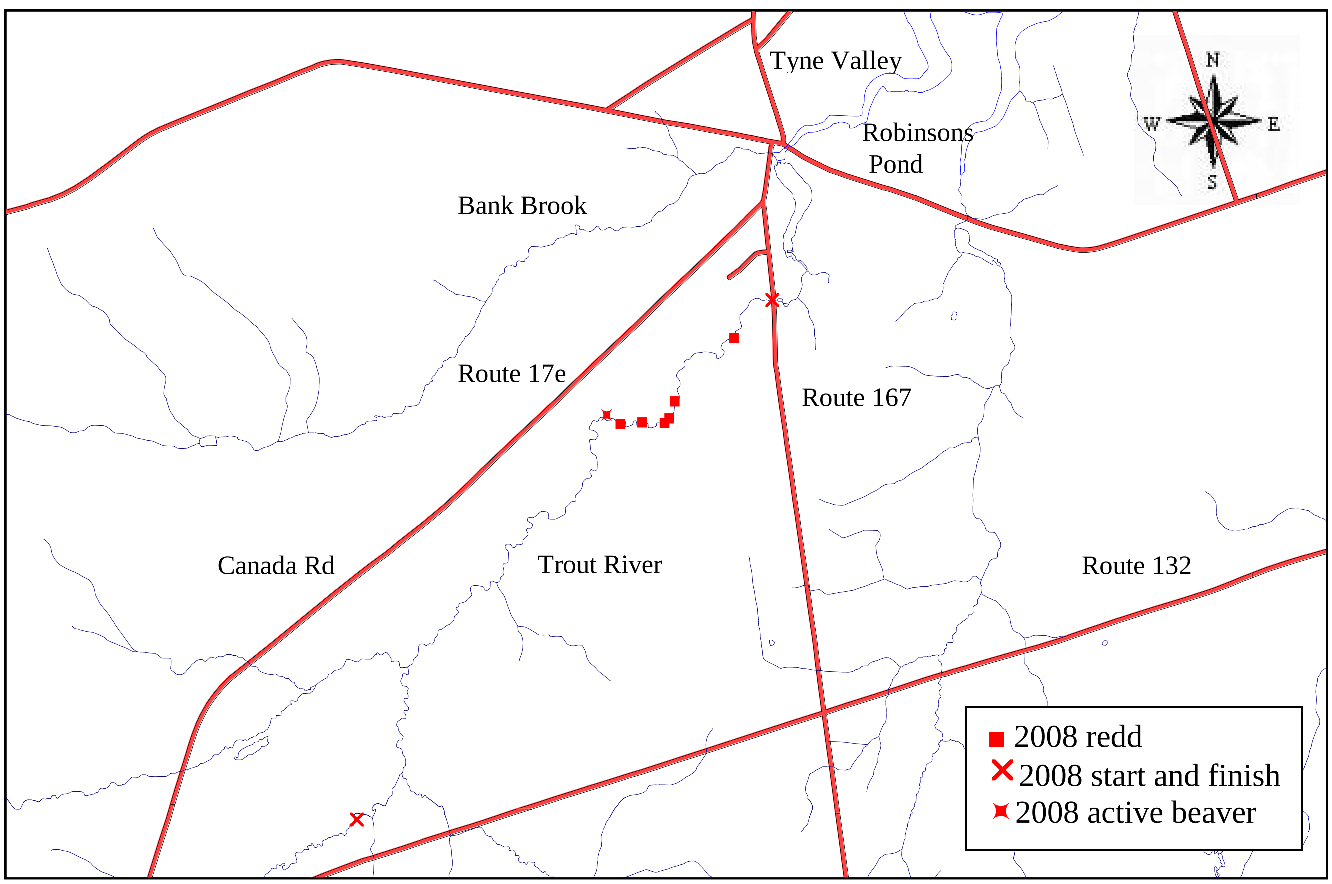


Figure 107. Location of salmon spawning sites in Trout River (Tyne Valley) in 2008. Bank Brook redds are not included on the map.

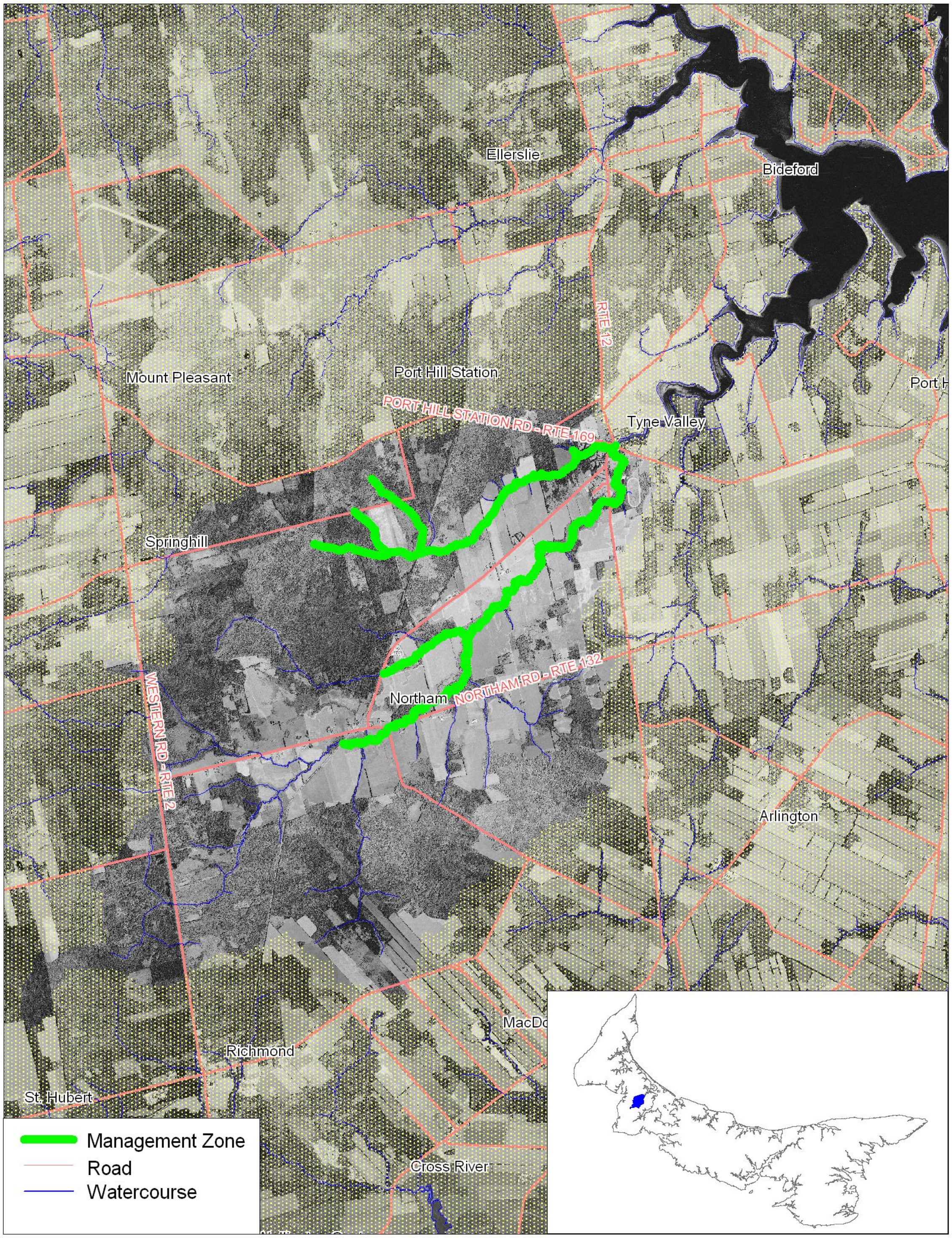


Figure 108. Beaver-free (management) zone on the Trout River (Tyne Valley) and Bank Brook.

5.3.7 WILMOT RIVER

It is truly amazing that any salmon remain in the Wilmot River (Figure 111). Frequent fish kills, extremely high sediment impact, the high proportion of cleared land in the watershed (89%), flashy streams and over-enriched water (nitrate levels almost three times as high as the maximum level recommended for fresh water streams), should have closed the book on Atlantic salmon presence in this system. Seldom have salmon parr been picked up in several electrofishing sites on the Wilmot but in 2007, a spot check yielded two salmon parr along with rainbow trout and brook trout. Of course, the Wilmot River shares the same estuary as the Dunk and even with 5% straying of returning adults, salmon may continue to show up occasionally on the Wilmot River.

5.3.7.1 Recommendations

1. Continue watershed work on the Wilmot River in spite of the land use challenges it faces. If salmon do not return in better numbers, habitat improvement within the drainage basin will surely help sea run trout populations, as well as other anadromous fish.
2. Keep the river free of blockages. In 2007, a huge beaver dam 1 kilometre upstream from Marchbanks Pond (near the head of tide) totally blocked the river for all anadromous fish. The dam was not discovered until late summer. Permission was subsequently granted to breach the dam after the beavers were trapped in autumn, but not before fish movements had been curtailed for months.
3. Agricultural run off and sediment input into the river is the principal problem facing the Wilmot River. If all best management practices for row crop production were strictly followed, this river could again become an angling destination, at least for brook trout.

Figure 109. A bridge near Marchbanks Pond on the Wilmot River after a high water event.

Figure 110. Beaver dam approximately one-half kilometre downstream from Route 110.

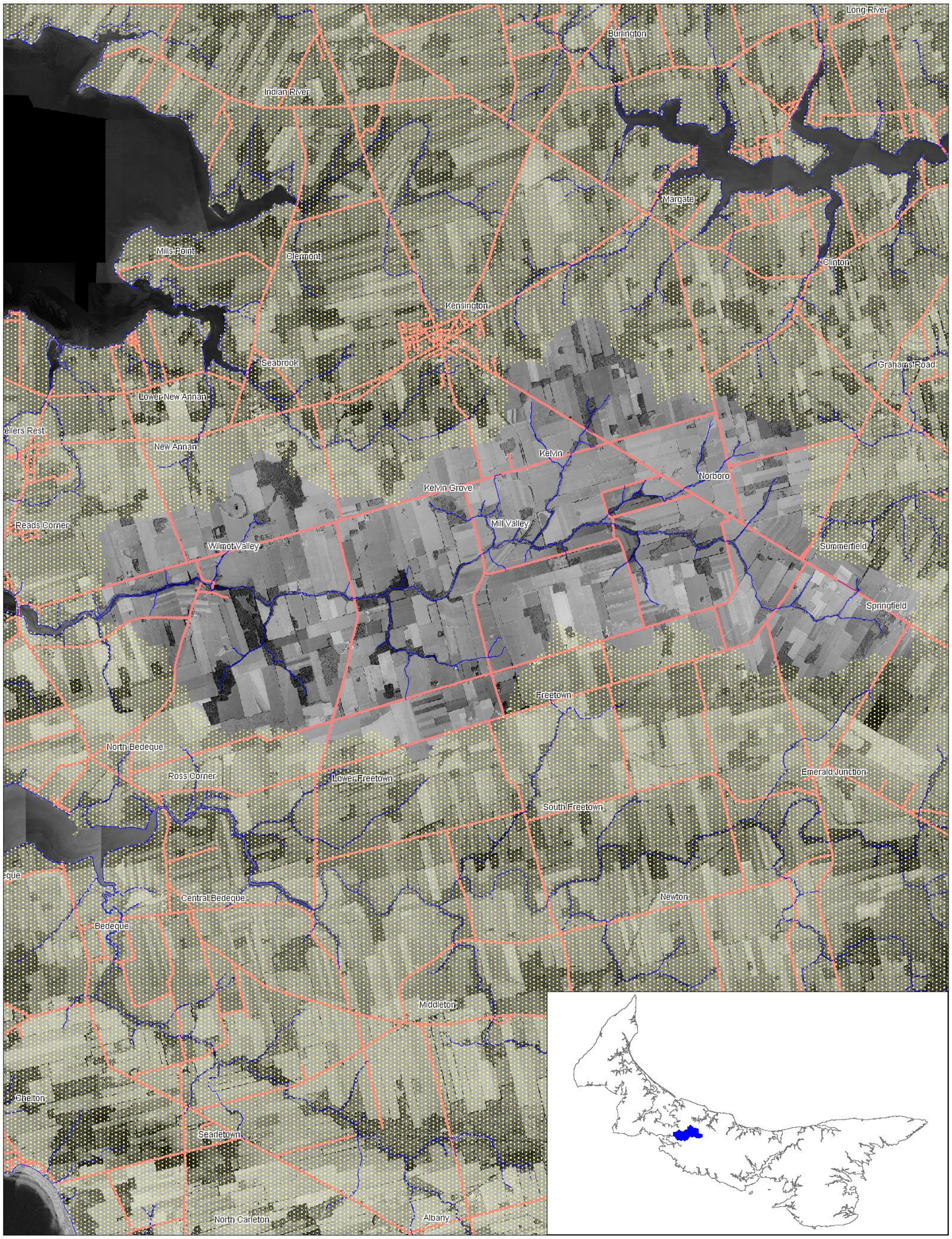


Figure 111. Wilmot River drainage basin.

5.4 Class IV Rivers – Salmon Populations have Disappeared since 2002.

A survey of the distribution and relative abundance of salmonids in Prince Edward Island streams was conducted in 2001-2002 (Guignion et al. 2002). Recent data from electrofishing and redd surveys have shown that eleven streams which had salmon in 2002 no longer have salmon present. Some possible reasons for the disappearance of salmon are discussed in Section 3.0 of this document. In Section 4.7, it is suggested that certain rivers may become good candidates for a restocking initiative if watershed management improvements. In some cases, it is possible that stray salmon from nearby rivers may provide enough broodstock to rekindle salmon production. Following is a discussion regarding the Souris River and a few candid remarks regarding why Brudenell River, Cow Creek, Hay River, Marie River and Valleyfield River may also merit future restocking of Atlantic salmon.

5.4.1 SOURIS RIVER

In most Prince Edward Island rivers which have lost salmon runs in recent years, the suspected root habitat causes contributing to the losses have not been totally remedied (sediment input, blockages, water quality etc.). The Souris River (Figure 113) is an example where great strides have been taken to restore quality habitat. A decade ago, land use issues were a major concern with large quantities of sediment entering the river during severe storm events. Beavers were common in both major tributaries and rainbow trout had arrived in the system, presumably as aquaculture escapees. To make matters worse, both tributaries were hit with kills from agricultural pesticide run-off.

Much has changed on the Souris River in the past few years. With the encouragement and hard work of the Souris Branch of the P.E.I. Wildlife Federation, and much technical and financial assistance from both the provincial and federal government (Ecological Goods and Services Program), many of the habitat related concerns have improved. For instance, many farmers leave wider riparian buffer strips and have moved away from autumn ploughing, thus improving water quality and alleviating wind and water erosion during the most vulnerable seasons. Public awareness has been heightened and the whole community appears to work cooperatively and takes pride in their successes. Beaver populations and their dams are under control and much habitat enhancement has occurred on both branches of the river, as well as the upper estuary. But, the salmon have disappeared. The last salmon I have seen in the Souris River were dead parr, picked up on the river after the pesticide run-off event in 1999. The situation is ripe to consider the following research/restoration project which could demonstrate whether or not it is possible to restore salmon in a river with habitat parameters improved and rainbow trout present.

5.4.1.1 Suggested Outline for a Potential Research Project:

a) An early season walk of all tributaries (March 15-April 15) to record potential sediment input sites during spring run-off. If problem sites occur, work with the landowner to find solutions and install brush mats and sediment traps as needed.

b) Install thirty digger logs similar to the work done on Briarly Brook, Nova Scotia (McInnis et al. 2008) to restore potential spawning sites on both branches of the river. Sites chosen for digger logs would require desired flow patterns and sufficient depth of gravel and cobble above any hardpan. Where necessary, gravel and cobble should be added to give 20-30 cm of movable substrate.

c) At the convergence of both branches, and in one other location near the “head of tide”, large deep pools should be established. Pincer gabions and digger logs may be sufficient to create the required holding areas. If necessary some additional pools should be excavated to provide autumn holding sites for returning adults every 300 metres along each branch.

d) For a period of five years, angling upstream from the estuary should be restricted to catch and release fishing with barbless hooks. Normal provincial regulations would apply in the estuary.

e) Determine the embeddedness of gravel and cobble substrate in both branches and if necessary, plan strategies for substrate improvement.

f) Continue with planting of native species of grasses, shrubs, and trees that should normally occur along such riparian buffer zones on Prince Edward Island.

g) If available, release at least 2000 1+ marked salmon parr (Morell River/Rocky Brook origin) along each branch in the spring of 2009. If these are not available, use North River stock (broodstock collected in 2008) and release the parr in the spring of 2010.

h) Monitoring:
   a. Expand electrofishing and redd counts for brook trout, rainbow trout, and Atlantic salmon;
   b. Conduct regular summer and autumn snorkeling surveys of established pools;
   c. Provide angler record books to those who regularly use the river;
   d. Install temperature data loggers to obtain the seasonal temperatures of stream water and in winter, the temperature within the substrate at 15 cm, 25cm and 40 cm depths in potential salmon redd sites. Incubation baskets similar to those used on the Morell River in 1996 could be used to determine hatching success.

i) A public relations program should be expanded to keep youth, anglers, local residents and landowners informed and involved.

Figure 112. Souris River - forks upstream from the head of tide.

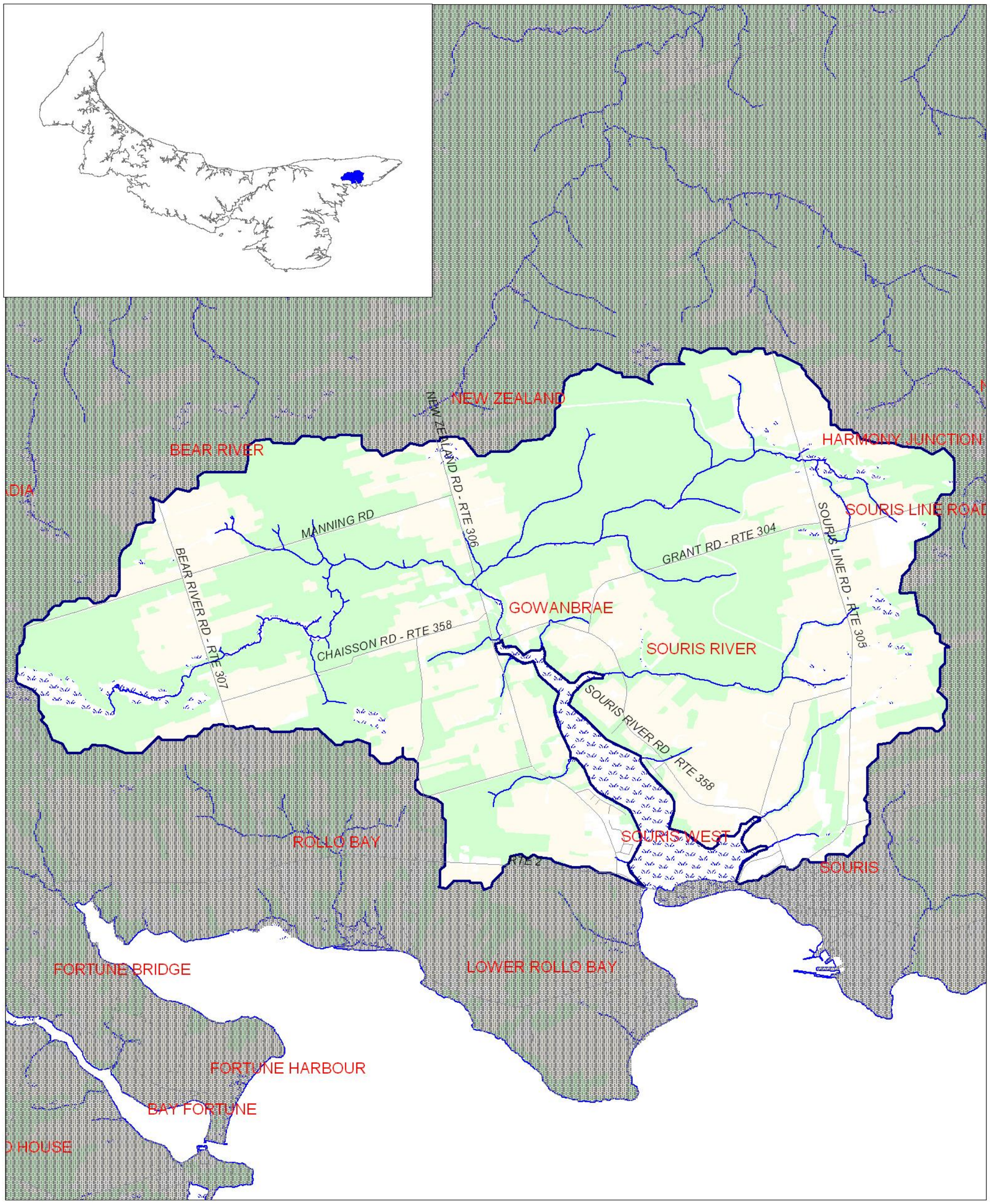


Figure 113. Souris River - a potential research/restocking river.

5.4.2 BRUDENELL RIVER

The Brudenell River (Figure 115) is a lovely little stream that flows eastward from Summerville and Greenfield to eventually drain into Cardigan Bay. From Mellishs Pond to the head of tide, the stream gradient appears ideal for salmon parr. The last report of young salmon in the Brudenell River was two years ago. Even after extensive electrofishing in 2008, no juvenile salmon were observed. Rainbow trout have a well established population and when we were electrofishing for brook trout broodstock in autumn 2008, many large fresh-run rainbow trout, some with sea lice still present, were seen. However, most of the 0+ and 1+ fish observed in the river at that time were brook trout.

River blockages by beavers are the most likely cause of the decline in Atlantic salmon populations in the Brudenell River. A beaver dam at Mellishs Pond bypass and several more upstream, would have greatly reduced the number of habitat units available for salmon to utilize. If an active watershed group becomes interested in pursuing a salmon restocking venture, a thorough assessment of habitat problems should be made and corrective habitat actions taken before such a venture is considered. Figure 115 outlines the section of river where beaver dams should not exist in order to maintain enough habitat units for a potentially viable Atlantic salmon run.

Figure 114. Brudenell River near the former Dewars Pond site.

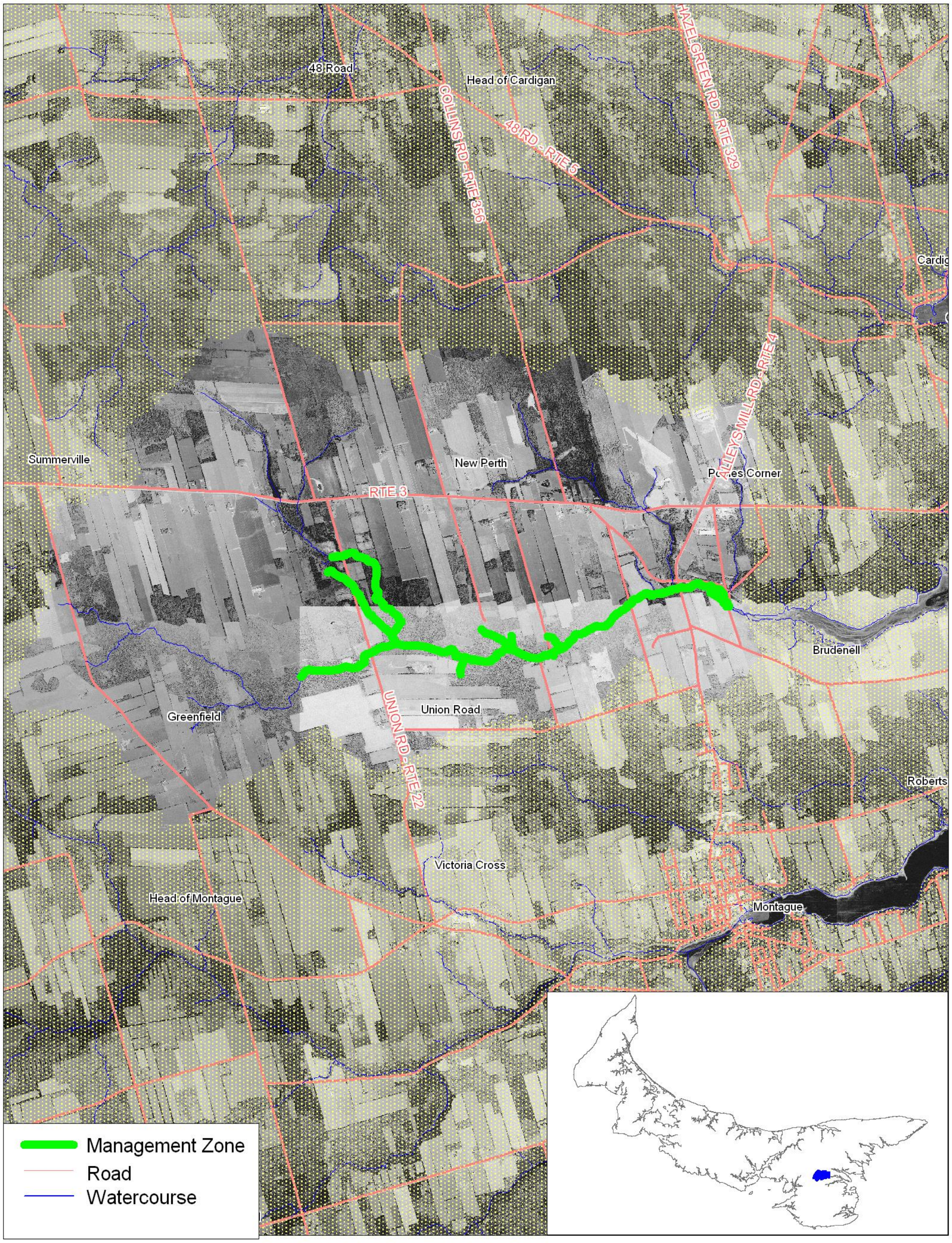


Figure 115. Beaver-free (management) zone in the Brudenell River.

5.4.3 COW CREEK

Cow Creek (Figure 116) drains through forested regions from its source to the Gulf of St. Lawrence. Minor sediment problems occur at road crossing sites. A new culvert was installed at Route 16 in 2007 and the bank slopes were not properly stabilized. At the Selkirk Road crossing (Route 309), a major beaver blockage was removed in summer 2007. Upstream, two clay roads (Goose River Road and Barry Road) cross Cow Creek but not on steep terrain. With practically no agriculture on the drainage basin, the only real problem is beavers and their dams. Cow Creek provides a good example of how beavers and their activities can totally destroy a salmon run. Initially, the beavers seemed to focus their dam construction on upper tributaries where gradients are lower. In recent years, however, their dams could be found downstream to the barrier beach pond where the stream empties into salt water. In the 1970s, I conducted waterfowl surveys on the barrier beach pond and regularly angled for sea trout on what I would consider as one of the finest little rivers on Prince Edward Island.

Since the upper reaches of Cow Creek are relatively flat and are inundated with beavers, the most practical management option would be the establishment of a beaver-free zone from the Goose River Road to salt water (Figure 116). Sections of Cow Creek have good stream gradient and in these areas, the beaver dams have not been in place for many years. Therefore, the recovery of the trees and shrubs should be relatively fast once dams are removed. There should be adequate habitat units within the managed zone to successfully restore both sea run trout and Atlantic salmon populations. Some salmon may stray into the river; if not, it may be possible to introduce fish from adjacent river systems.

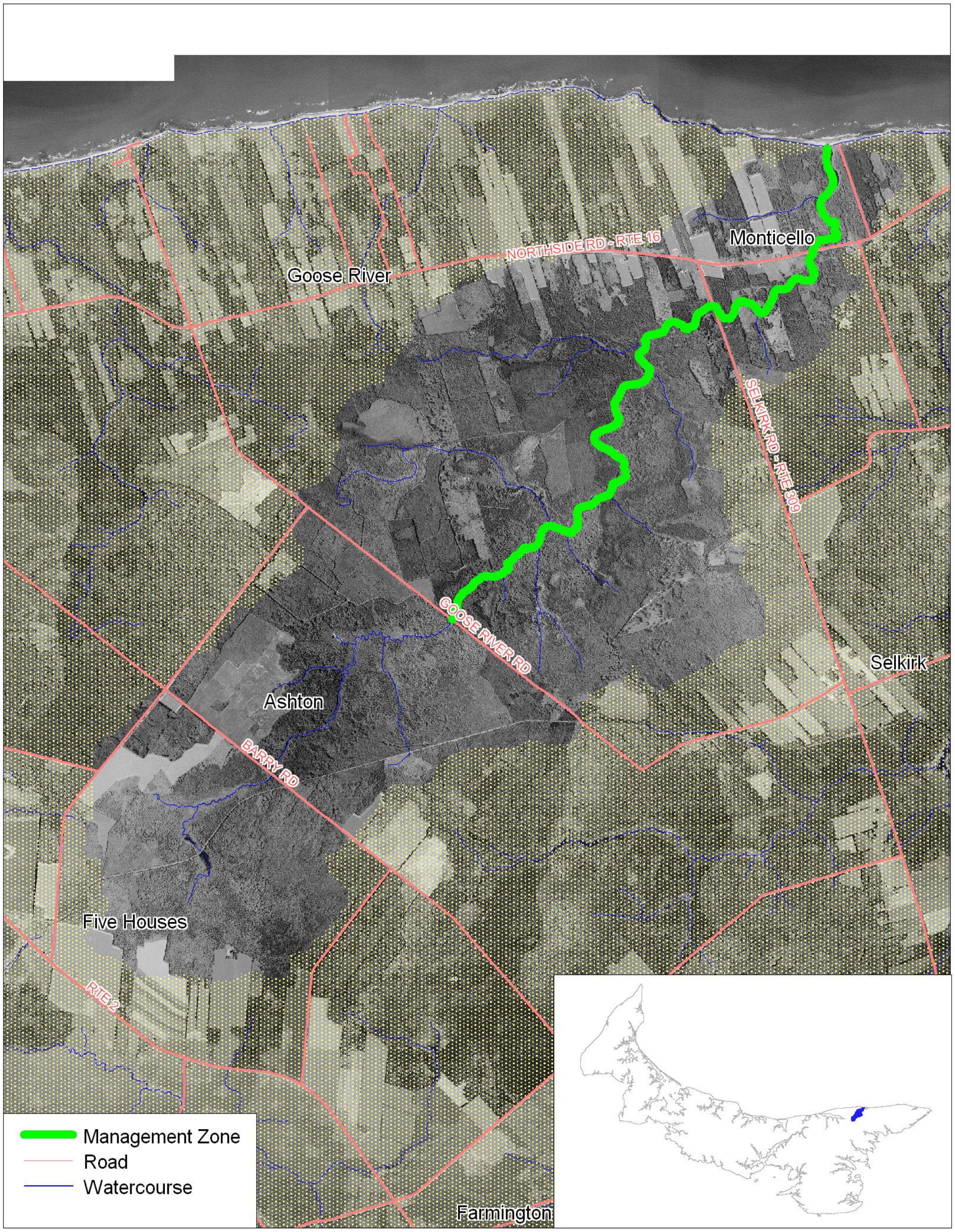


Figure 116. Beaver-free (management) zone in Cow Creek.

5.4.4 HAY RIVER

Hay River (Figure 118) still has excellent salmon habitat for Atlantic salmon, particularly in a steeper gradient section from Route 16 to Johnstons Pond. Upstream from Route 16, there are numerous old and new beaver impoundments. The fish ladder in Johnstons Pond could possibly pose a barrier to fish moving upstream and the large cobble that was washed in by storm surges near the culvert exit should be removed with heavy equipment. At the very least, stream reaches upstream from Route 16 to the highway crossing at Bear River North (Route 307) should be kept free of beavers and their dams to allow access for anadromous fish. This is another river which may have lost its salmon run because of beaver blockages. There appears to be little point in trying to restore salmon runs while beavers are so prevalent on the watercourse. If a dedicated group (with the aid of trappers) focuses long term attention on this river to keep the main tributary free of beavers and their dams, as indicated in Figure 118, salmon runs might be restored. If nothing else, the removal of blockages would certainly benefit the sea run trout population in the river.

Figure 117. Stream habitat on Hay River between Johnsons Pond and Route 16.

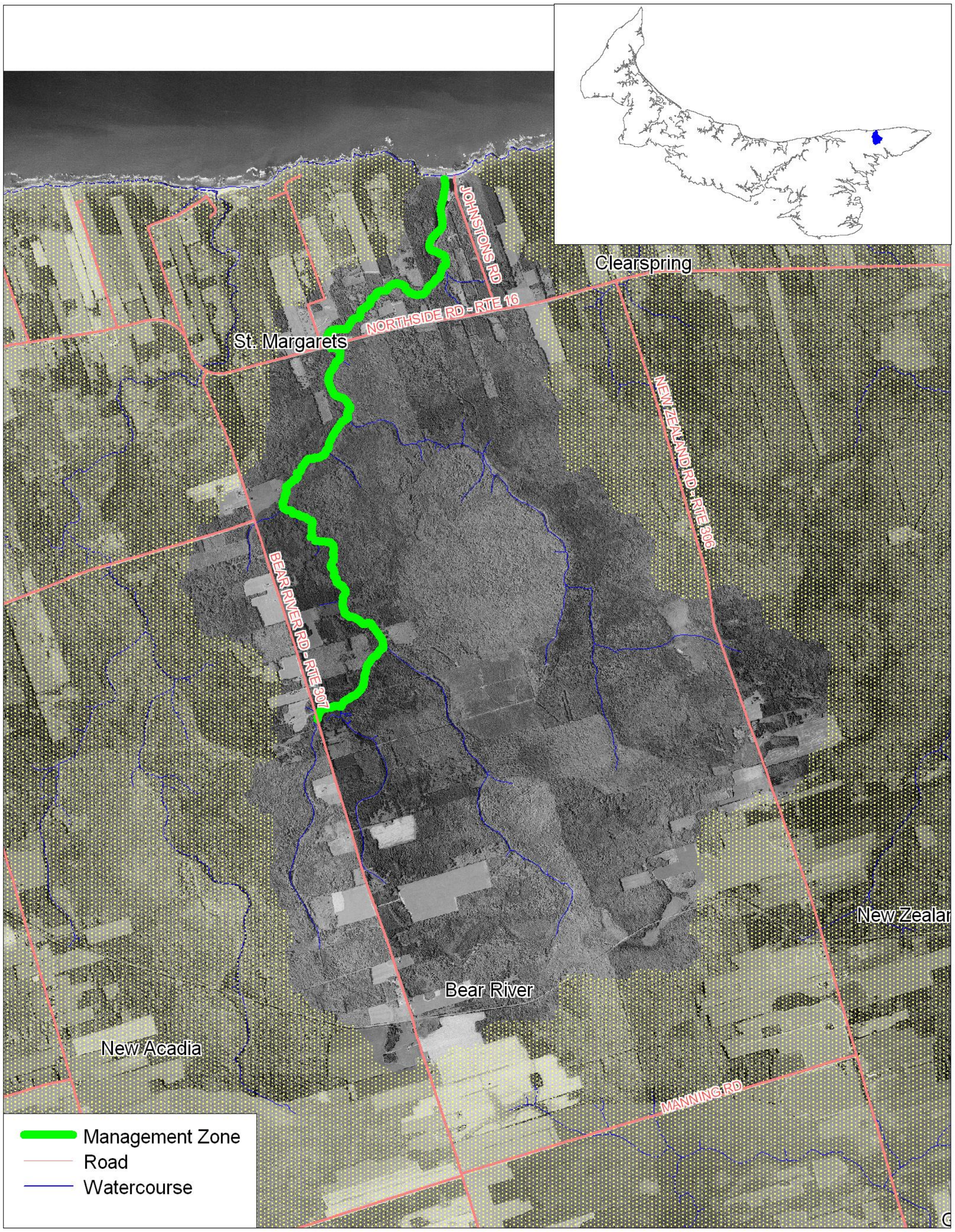


Figure 118. Beaver-free (management) zone in Hay River.

5.4.5 MARIE RIVER

The Marie River (Figure 120) used to have an excellent run of both sea trout and Atlantic salmon. Two decades ago, a large river restoration project focused on removing blockages, beaver and other, from the Sandy Cape Road to Websters Pond, near the head of tide. No follow-up work was ever done and beavers eventually had the whole river blocked, including dams at the head of tide downstream from Websters Pond. Two Ducks Unlimited impoundments upstream from the Sandy Cape Road, along with a proliferation of new and old beaver dams, make it difficult to even find running water. Huge swaths of former forest are now brush marsh and the water quality leaving the Sandy Cape Road Ducks Unlimited impoundment is severely compromised. However, there are springs and a reasonable gradient between the Sandy Cape Road and Websters Pond that could certainly become good habitat for sea run brook trout. It is possible that salmon from any of the other three nearby rivers – Morell, Midgell and St. Peters – could jump-start salmon production in the Marie River again, if habitat is available.

A watershed group needs to be established to oversee any restoration activities on the Marie River. If the river were cleared of beaver dams from the Sandy Cape Road to the head of tide, it might provide adequate habitat to sustain a small run of salmon and would certainly be very beneficial to sea run brook trout.

Figure 119. Marie River - Ducks Unlimited impoundment at the Sandy Cape Road.

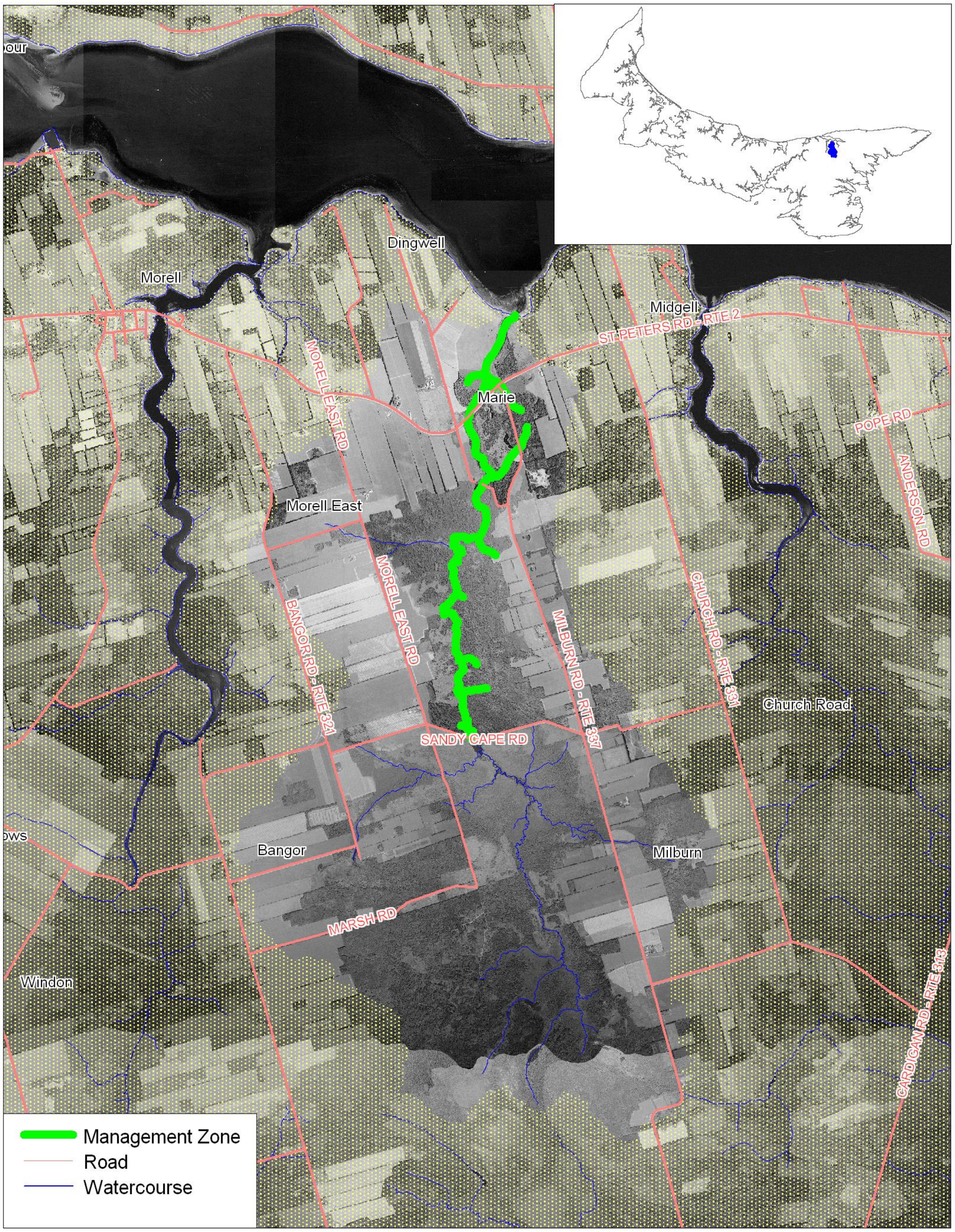


Figure 120. Beaver-free (management) zone in the Marie River.

5.4.6 VALLEYFIELD RIVER

Although various electrofishing surveys have been carried out in the Valleyfield River (Figure 123) in recent years, no juvenile salmon have been encountered. During the summer of 2008, Dr. David Cairns, Research Scientist at DFO Charlottetown, arranged to have a DFO electrofishing crew (headed by Paul LeBlanc) assess fish populations in Prince Edward Island rivers that had recently lost Atlantic salmon runs. No juvenile salmon were found in the Valleyfield River or any of the other rivers surveyed. However, all branches of the Valleyfield River have not been electrofished and it is quite possible that salmon parr remain in sections of some tributaries.

A burned-out baffle within the fishway at the Maritime Electric Pond has likely prevented all anadromous fish from ascending further upstream for at least a couple of years. The fishway was repaired in late summer, 2008. Brian Dempsey, a member of the Valleyfield Angling Association, told me that until recently, anglers would see a number of black salmon (kelts) each spring in Maritime Electric Pond. In 2008, none were seen but a MSW fish was reportedly caught downstream in a pool near salt water in early spring.

There could be numerous factors that have influenced the decline of salmon numbers in the Valleyfield River. Rainbow trout have been prominent in the river in recent years and would presumably compete with Atlantic salmon. However, for many years, large numbers of juvenile salmon were stocked into the river with modest return rates from sea (Cairns et al. 2009), even when rainbow trout were not as abundant. John MacMillan (1998) noted very high densities of brook trout in the river and larger trout could be preying on juvenile Atlantic salmon. The river has large quantities of excellent gravel (usually limited in most Island streams) which is very mobile, but often larger cobble/boulder is not abundant. In high water or even when one walks on the gravel in many stream reaches, it moves downstream so gravel mobility may impact salmon spawning success. Also, anglers speculate that double-crested cormorants and seals are so abundant that they now are major predators on both young and adult salmon. The Valleyfield River flows through rolling hills and with considerable row cropping of sandy soils, much sediment, and occasionally pesticides, pose problems for salmonids. Beavers do exist on various tributaries, but it is unlikely with almost 80 kilometres of good gradient stream (Figure 121) and regular trapping that they could have played a major role in salmon declines.

Figure 121. The Valleyfield River.

Figure 122. A burned-out cell in the fishway at Maritime Electric Pond on the Valleyfield River.

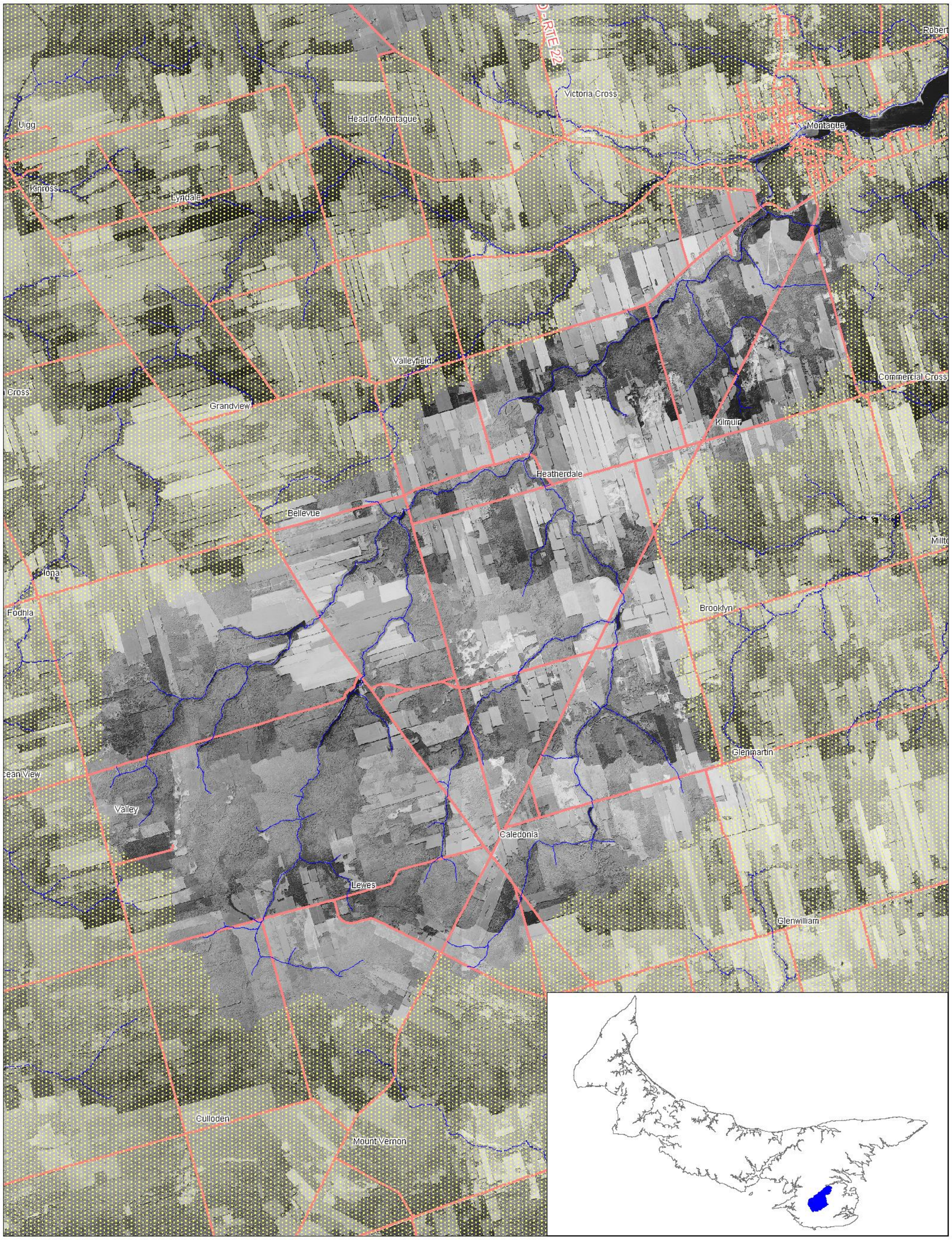


Figure 2523. Valleyfield River drainage basin.

5.4.7 LITTLE PIERRE JACQUES, BRADSHAW RIVER, WHEATLEY RIVER, BLACK RIVER AND BELLS CREEK

The remaining Class IV rivers would appear to be "long shots" for any recovery of Atlantic salmon populations. Stream length is minimal for adequate habitat units and many land use or river blockage problems still exist. However, all of these streams could have excellent runs of sea-run trout and watershed groups working on these watercourses should be encouraged to "soldier on" with habitat enhancement activities. A detailed habitat assessment for these and the other rivers in this group (Class IV) should be completed for anadromous fish other than Atlantic salmon which could act as a guide for watershed groups.

Figure 124. Cass's Pond on Bells Creek.

We owe it to current and future generations of Islanders to protect salmon and other wildlife populations in perpetuity.

6.0 ACKNOWLEDGEMENTS

This study was made possible by the Atlantic Salmon Conservation Foundation which granted monies to the P.E.I. Council of the Atlantic Salmon Federation for the development of a conservation strategy for salmon on Prince Edward Island. I was given the privilege of putting together the proposed conservation strategy and received an immense amount of help from numerous people. Kirk Roach was a great asset to have as my assistant. He helped organize and conduct electrofishing surveys, carried out literature searches, and helped with stream assessments. The delightful Christina Pater, a MSc student at U.P.E.I., spent many days counting salmon redds, often in inclement weather, and prepared maps for their locations. Ben Hoteling's entire class in Wildlife Conservation Technology at Holland College was enthusiastically involved in redd counts on the various branches of the Morell River. Students from Kevin Teather's fish biology course helped with electrofishing surveys in Coles Brook. Dr. David Cairns from the Department of Fisheries and Oceans has done an excellent job compiling historical and current data and was generous with his knowledge and data. Paul LeBlanc, also from DFO, assisted in electrofishing various rivers in 2008. The provincial Department of Environment, Energy and Forestry provided much assistance. Brad Potter was especially helpful, not only in the field, but also in consolidating watershed data and providing maps for use in the field and final report. The Department's Environment Futures program provided crews to assist in electrofishing. The Souris Branch of the P.E.I. Wildlife Federation provided advice and many assistants during work in the northeast drainage basins. I am particularly indebted to Fred Cheverie for the tireless hours he spent in the streams, at meetings, and on the phone helping me in innumerable ways. Cathy Gallant and her crews on Little Trout River and Trout River were always interested, enthusiastic, and dedicated. Volunteers and crew members of watershed groups and wildlife organizations across Prince Edward Island were quick to lend a hand. Many thanks to the Morell River Management Co-op, the Friends of Covehead and Brackley Bay, the Prince County Fly Fishers, the Central Queens Wildlife Federation, Wheatley River Environment Committee, Trout Unlimited Prince County Chapter, Trout Unlimited P.E.I., and the P.E.I. Trappers Association. It was indeed a pleasure to be able to work with such wonderful people. I met many landowners on my travels – all were concerned about various environmental issues. When landowners across Prince Edward Island, like Dan MacLean in Tyne Valley, encourage habitat restoration in their streams and riparian zones, the future becomes brighter for our fish and other wildlife species. I also want to thank members of the P.E.I. Trappers Association for voicing their concerns about proposed changes to beaver management. They care deeply about management of habitat for all wildlife. I extend a sincere thank you to Todd Dupuis for his encouragement and assistance. Most of all, I want to thank my family for their support and understanding of the long days in the field. Rosie, my soul mate, not only understands the challenges facing our Atlantic salmon but is always able to provide rational suggestions, enlightened ideas, and provoking approaches to their management.

7.0 REFERENCES

ASE Consultants Inc. and U.P.E.I. Biology Department. 1997. Impact of impoundments and their suitability for resident and anadromous fish species on Prince Edward Island. Final Report Volume 1, 152 pp and Volume 2, 142 pp. Department of Fisheries and Oceans Habitat Management Division, Moncton, NB.

Bley, P.W. 1987. Age, growth, and mortality of juvenile Atlantic salmon in streams: a review. Main Cooperative Fish and Wildlife Research Unit, Biological Report 87 (4).

Cairns, D. 2002. Substrate sedimentation and salmonid densities in Prince Edward Island streams. Pp. 35-81 *in* D.K. Cairns (Ed.). Effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2408.

Cairns, D.K., D.L. Guignion, T. Dupuis, and R.E. MacFarlane. Stocking history, biological characteristics, and status of Atlantic salmon on Prince Edward Island. Canadian Science Advisory Secretariat Research Document 2009/xxx

Caissie, D., and E. Arseneau. 2002. Substrate composition in the Morell River and other Maritime Province rivers: implications for Atlantic salmon fry emergence. Pp. 26-34 *in* D.K. Cairns (Ed.). Effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2408.

Cunjak, R.A. 1988. Behaviour and microhabitat of young Atlantic salmon (*Salmo salar*) during winter. Canadian Journal of Fisheries and Aquatic Sciences 45: 2156-2160.

Cunjak, R.A., and D. Caissie. 1993. Frazil ice accumulation in a large salmon pool in the Miramichi River, New Brunswick: ecological implications for overwintering fishes. *In* T.D. Prowse (Ed.) Proceedings of the workshop on environmental aspects of river ice.

DeGrace, J.R. 1999. In the story of the Earth, the page called Prince Edward Island. The Island Magazine, Number 46.

Elliot, J.M. 1989. The critical-period concept for juvenile survival and its relevance for population regulation in young sea trout, *Salmo trutta*. Journal of Fish Biology 35: 91-98.

Dupuis, T. 2008. The early history of Atlantic salmon on Prince Edward Island. The Island Magazine 64: 21-25.

Foster, L. 2005. A fish and fish habitat stewardship strategy for Prince Edward Island. Pilot project: Eastern Kings, P.E.I. Souris and Area Branch of the P.E.I. Wildlife Federation.

Gormley, K.L. 2003. Assessing the impacts of stream habitat and land use variables on population and community structure of salmonids of Prince Edward Island. M. Sc. Thesis, Department of Biology, University of Prince Edward Island, Charlottetown, PEI. 176 pp.

Gray, R.W., J.D. Cameron, and E.M.J. Jefferson. 1989. The LaHave River: Physiography and potential for Atlantic salmon production. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1701 iv. + 58 p.

Gries, G., and F. Juanes. 1998. Microhabitat use by juvenile Atlantic salmon (*Salmo salar*) sheltering during the day in summer. Canadian Journal of Zoology 76: 1441-1449.

Guignion, D., T. Dupuis, and K. Teather. 2002. Distribution and relative abundance of salmonids in streams and rivers on Prince Edward Island. Interim Report. Watershed Research Group, Department of Biology, University of Prince Edward Island, Charlottetown, PEI.

Kondolf, G.M., and M.G. Wolman. 1993. The sizes of salmonid spawning gravels. Water Resources Research 29, 2275-2285.

Ledgerwood, S. pers. comm.. Sean Ledgerwood, P.E.I. Department of Environment, Energy and Forestry. January 2009.

MacFarlane, R.E. 1999. An evaluation of the potential impact of some Prince Edawrd Island impoundments on salmonid habitat. M. Sc. Thesis. Acadia University, Wolfville, Nova Scotia.

MacFarlane, R., B. Potter, and D. Guignion. 2009. Density of juvenile salmonids in selected watersheds, 2008. Forests, Fish and Wildlife Division, P.E.I. Department of Environment, Energy and Forestry. January 2009.

MacLean, D. pers. comm. Dan MacLean, landowner, Tyne Valley, Prince Edward Island. October 2008.

MacMillan, J.L. 1998. Thermal ecology of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) in impounded streams: behavioural responses and populations impacts. MSc thesis, Acadia University, Wolfville, N.S.

Matheson, M. pers. comm. Miles Matheson, Morell, Prince Edward Island. February 2009.

McCleave, J.D. 1978. Rhythmic aspects of estuarine migration of hatchery-reared Atlantic salmon (*Salmo salar L.*) smolts. Journal of Fish Biology 12: 559-570.

McInnis, C., T.A. Floyd, and B.R. Taylor. 2008. Large woody debris structures and their influence on Atlantic salmon spawning in a stream in Nova Scotia, Canada. North American Journal of Fisheries Management 28: 781-791.

Moore, A., E.C.E. Potter, N.J. Milner, and S. Bamber. 1995. The migratory behavior of wild Atlantic salmon (*Salmo salar*) smolts in the estuary of the River Conwy, North Wales. Canadian Journal of Fisheries and Aquatic Sciences 52: 1923-1935.

Naiman, R.J., G. Pinay, C.A. Johnston, and J. Pastor. 1994. Beaver influences on the long-term biochemical characteristics of boreal forest drainage networks. Ecology 75 (4): 905-921.

O'Grady, M.F., J. O'Neill, and S. Molloy. 2000. Optimizing natural production. Pp. 139-151 in F.G. Whoriskey, JR. and K.E. Whelan (Eds.) Managing Wild Atlantic Salmon. New Challenges – New Techniques.

Peterson, R.H., H.L.E. Spinney, and A. Sreedharan. 1977. Development of Atlantic salmon (*Salmo salar*) eggs and alevins under varied temperature regimes. Journal of the Fisheries Research Board of Canada 34: 31-43.

Potter, B. pers. comm. Brad Potter, biologist, Forests, Fish and Wildlife Section, P.E.I. Department of Environment, Energy and Forestry. February 2009.

Report of Action Committee on Agricultural Runoff Control. 1999. Prince Edward Island Department of Agriculture and Forestry and Department of Technology and Environment. 12 pp.

Rimmer, D.M., U. Paim, and R.L. Saunders. 1984. Changes in the selection of microhabitat by juvenile Atlantic salmon (*Salmo salar*) at the summer-autumn transition in a small river. Canadian Journal of Fisheries and Aquatic Sciences 41: 469-475

Symons, P.E.I., and M. Heland. 1978. Stream habitats and behavioural interactions of underyearling and yearling Atlantic salmon (*Salmo salar*). Journal of the Fisheries Research Board of Canada 35, 175-183.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7. 251 pp.

Witzel, L., and H. MacCrimmon. 1983. Redd-site selection by brook trout and brown trout in southwestern Ontario streams. Transactions of the American Fisheries Society 112, 760-771.

Yongson, A.P., I.A. Malcolm, J.L. Thorley, P.J. Bacon, and C. Soulsby. 2004. Long-residence groundwater effects on incubating salmonid eggs: low hyporheic oxygen impairs embryo development. Canadian Journal of Fisheries and Aquatic Sciences 61: 2278-2287.

8.0 GLOSSARY

ALUS or Alternative Land Use Services Program: Provides government assistance to landowners by a) allowing trees to be established in buffer zones b) retiring sensitive land and c) conserving land using soil conservation structures.

Anadromous: Fish that reproduce in fresh water and also spend a part of their life in the marine environment.

Anchor ice: Frazil ice that has aggregated on woody debris and substrate, often filling the stream channel and causing flooding into the riparian zone, even during low flow conditions.

Anoxia: An absence of oxygen in some portion of the water column.

Aquaculture: The farming or culturing of aquatic organisms in marine and fresh water environments.

Atlantic salmon: The Atlantic salmon (*Salmo salar*) is the only species of the genus *Salmo* that is native to northeastern North America. It has both landlocked and anadromous forms but only populations of the anadromous form are found on Prince Edward Island.

Biodiversity or biological diversity: The variety and variability within and among living organisms and the ecological complexes in which they occur, the diversity they encompass at the ecosystem, community, species, and genetic levels, and the interaction of these components.

Barrier beach pond: A natural pond formed inside sand dunes that may have varying degrees of salinity throughout the year.

Base flow: The contribution of ground water discharge (springs and seeps) to total stream flow, excluding contributions of surface runoff.

Black salmon: A spent or spawned-out adult salmon, also referred to as a “kelt”.

Brush mat: brush material anchored on point bars to catch and stabilize sediment.

Clay road: A country road surfaced with clay or shale, without benefit of gravel or asphalt.

Cobble: Substrate material, sometimes referred to as rubble, that is roughly the size of a human head.

Conservation: Planned management of a natural resource to prevent its loss or degradation. For Atlantic salmon, success in achieving conservation refers to the number of adult spawners or fertilized eggs deposited in the substrate in relation to that required to achieve maximum sustained yield.

Drainage basin: All land and water surface area inside a watershed boundary. On Prince Edward Island, the terms "watershed" and "drainage basin" are sometimes used interchangeably.

Drowned river valleys: Deep channels that formed from glacial melt water which were submerged with rising seawater, a process which created many large estuaries around Prince Edward Island.

Electrofishing: Use of an electric current to temporarily stun fish so that they can be netted.

Ephemeral streams: Streams which flow for part of the year, particularly in spring, and are dry at other times of the year.

Estuary: A semi-enclosed body of water, connected to the ocean, where salt water is measurably diluted with fresh water from surface or ground water inputs.

First order stream: Stream that originates from a point source, such as a spring, before joining other first order streams to then become known as a second order stream.

Frazil ice: Ice crystals that form and grow in super-cooled water. Frazil ice is sometimes obvious downstream from riffles in very cold weather.

Grilse: A term used to refer to an adult salmon less than 63 cm in fork length and which generally has spent only one winter at sea.

Habitat Suitability Index: The manner in which habitat features, such as water temperature, water velocity or substrate roughness, affect particular life stages of fish species.

Hardpan: Smooth stream bottom composed of sandstone with little cover for fish.

Head of tide: The furthest region upstream where tidal push raises water height in the stream.

Head of water: Water which was stored behind dams to run various types of mills.

Habitat Unit: $100m^2$ of stream surface area.

High graded forests: Harvest of the best quality trees while leaving the poor quality ones to produce future forests.

Hymac: A large capacity excavator

Index population: Those populations of salmon or other fish that are biologically monitored and assumed to reflect the general health and stock status of their neighboring populations that are generally similar in terms of life history characteristics and the habitat type of the rivers in which they are produced.

Hypoxia: Low oxygen levels.

Impoundment: A pond or lake created by a dam.

Instream sediment trap: A deep hole excavated in a slow water section of a watercourse to trap fine sediment.

Kelt: A spent or spawned-out adult salmon, also referred to as a “black salmon”.

Land stewardship: The act of caring for the land through sustainable management practices.

Large woody debris: Trunks of trees or large branches that stabilize stream substrate material, provide cover for innumerable stream organisms and generally are very valuable components of stream habitat.

Lentic: Standing water, as in ponds and lakes.

Lotic: Running water, as in streams.

Mitigation: Actions taken during the planning, design, construction and operation of works and undertakings to alleviate potential adverse effects on the productive capacity of fish habitats.

Multi-Sea-Winter (MSW) or Salmon: A salmon for which two or more winters have elapsed since migrating from the river as a smolt and which is generally more than 63 cm in fork length.

Nursery habitat: Sections of stream habitat used by young-of-the-year and yearling (1+) parr.

Nutrient enrichment: A process which increases nutrient inputs into ground water or surface water, often resulting in excessive production of organic matter in the aquatic system.

Pool: A deep, slow moving section of stream often with cover such as boulders, large woody debris, overhanging bank vegetation or undercut banks.

Post-smolt: A juvenile salmon from the time that it departs the river as a smolt until it completes its first winter at sea, when it becomes a one-sea-winter salmon.

Precocial parr: Young salmon in fresh water that can mature prematurely and fertilize eggs from returning female salmon.

Protocol: Rules of any procedure, such as electrofishing.

Riffle: Shallow, fast flowing broken surface water (over 20 cm/sec velocity; 10-40 cm depth).

Riparian Zone: The ecologically sensitive, vegetated zone along the borders of any watercourse from upland springs to the ocean.

River reach: A term used to describe a section of stream which has similar physical characteristics, such as gradient and substrate.

Row crop: Any farm crop that is spaced to allow cultivation between rows such as potatoes, carrots, cole crops and corn.

Run: Deep, fast flowing unbroken surface water (over 60 cm/sec velocity; over 40 cm depth).

Run-around bypass pond: Water diversion around a pond site which carries a portion of outflowing water from the impoundment.

Salmon parr: A term used to identify young salmon in fresh water after their first year of life and before their transformation to smolts.

Salmon berth (stand): Commercial netting site in salt water for capture of salmon.

Second order stream: A term used to describe a stream formed from the joining of two first order streams. When two second order streams unite, the result is a third order stream.

Self-sustainability: Used to refer to a population that is able to maintain itself over an extended period of time.

Semi-natural rearing: Refers to an enhancement technique in which salmon parr are kept for their second year in a natural pond before being released as smolts. The return rate of these smolts from sea exceeds that of smolts stocked directly from a hatchery.

Shade-intolerant trees: Refers to trees that grow well in open sunlight, for example aspen and pincherry.

Smolt: Fully silvered juvenile salmon during its seaward migration and with physiological capability to survive transition from fresh water to salt water.

Soil conservation structures: Physical structures in fields that reduce soil losses, such as diversion terraces and grassed waterways.

Spawning: The reproductive ritual involving egg fertilization and in the case of salmon in natural streams and rivers, the deposition of those eggs in the gravel riverbed.

Stock (or biological stock): Any group of interbreeding organisms that is reproductively isolated from other groups of the same species.

Two-Sea-Winter (2SW) Salmon: A salmon for which two winters have elapsed since migrating from the river as a smolt and which is generally equal to or more than 63 cm in fork length.

Watershed: The land base bounded peripherally by the water draining into a particular watercourse, which in this instance includes a river system and all its tributaries or the collection of river systems and all their tributaries. In Prince Edward Island, the term “drainage basin” is often used interchangeably with the term “watershed”.

Watershed management: The sustainable management of forests, fields, watercourses, natural areas, sensitive habitat and the wildlife that depend upon them.

Wild salmon: The progeny of salmon that have spawned naturally.

Winter ice roads: Ice roads used for winter transport across frozen water bodies; often flagged with small conifer trees as a guide during inclement weather.

Young-of-the-year (YOY) salmon: Juveniles, sometimes referred to as 0+, during their first summer after hatching.

APPENDIX I – Outline for a simple watershed management strategy

Project Management Strategies for Salmon Rivers Where Watershed Groups are Involved[1]

1. Obtain community and landowner support.

2. Develop a simple, long term work plan with appropriate timing for each activity.

3. Obtain required permits in a timely fashion.

4. Secure training for at least one project leader and develop close ties with knowledgeable regional coordinators and others for expert advice. Coordinators must be appropriately trained and should be given more responsibility. This may require additional personnel.

5. Obtain landowner permission for all access, explain projects to landowners and keep them updated.

6. Develop a walking trail and remove (with permission) all old barbed wire along the stream.

7. Identify all fish blockages and develop a beaver management program (if applicable). This will include the removal of all inactive and/or active dams and in some cases, beavers, in identified areas.

8. Identify all sources of sediment input to the system (e.g. agricultural fields, roads, culverts, development, instream). Walk all tributaries during the month of April for best information. Begin work with landowners and appropriate government agencies as soon as possible.

9. Construct sediment traps (instream or bypass ponds and brush mats) before other work is undertaken (with exception of beaver dam removal).

10. With the help of government agencies, expand buffers and work to change land use in sites that cause regular input of sediment into the watercourse.

11. Only after the above steps are taken should instream work begin (other than fish passage and sediment work already undertaken). This requires careful prescriptions from knowledgeable field personnel.

12. Monitor progress and quality of work completed. Do not continue to fund "huff and puff" projects.

[1]Not all rivers with salmon runs have active watershed groups. Where effective watershed groups do not exist, some government agency should be mandated to manage the river for anadromous fish.

APPENDIX II – Habitat Suitability Indices for Atlantic salmon and other anadromous fish

Source: Department of Fisheries and Oceans

Rating and Score for Habitat Variables

Rating	Score
no use	0
some use	1
good	2
very good	3

Habitat Suitability Index for Rainbow Smelt.

Habitat Variable	Criteria	Ratings for Life Stages Egg	Larval	Juvenile/Adult
Average Water Temperature (°C)	0-2	0	0	0
	2-4	0	0	0
	4-6	1.5	1	1
	6-8	3	2.5	2.5
	8-10	3	3	3
	10-12	1	3	3
	12-14	0	2.5	2.5
	14-16	0	1.5	1.5
	16-18	0	0.5	0.5

Other Habitat Characteristics and their Suitability for Rainbow Smelt

Alewife spawn at water temperatures between 4-18 °C; the peak is 6-9 °C
Pelagic fish dwell in midwaters of lakes, onshore coastal waters, and rivers. Water depth is used for overhead cover
Slow moving water is generally acceptable. Swift current is good for spawning
Optimum level of dissolved oxygen is > 5 mg/l; less than 3.5 mg/l may be lethal
High total dissolved solids affect spawning; < 1.5 ppt preferred

Habitat Suitability Index for Alewife.

Habitat Variable	Criteria	Ratings for Life Stages: Egg	Ratings for Life Stages: Juvenile/Adult
Average Water Temperature (°C)	8	0	0
	8-10	0	1
	10-12	1	1.5
	12-14	2.5	2
	14-16	3	3
	16-18	2	3
	18-20	1	3
	20-22	0	2.5
	22-24	0	1
	24	0	0
Average Water Velocity (cm/sec)	0-4	1.5	1.5
	4-6	3	3
	6-20	3	2
	20-25	2	1.5
	25-30	2	1
	30-45	1	1
	45	0	0
Substrate (Dominant)	silt	1	1
	sand	3	3
	gravel	3	3
	rubble/rock	2	2
	boulder	1	1
	bedrock	1	1
	mud	0	0

Other Habitat Characteristics and their Suitability for Alewife

Depth is not important
Eggs are most common at shallow depths of 15-30 cm
Juveniles and adults move from shallow to moderately deep water depending on the time of day and weather conditions e.g. found in shallow waters during overcast days or at night, and in deeper waters during the daylight hours
Sea-run alewife spawn in slow moving waters of streams [or ponds] above the head of tide

often far up river

Habitat Suitability Index for Brook Trout and Rainbow Trout.

Habitat Variable	Criteria	Ratings for Life Stages		
		Egg	Juvenile	Adult
Average Water Temperature (°C)	0	0	0	0
	0-3	1	0.5	0.5
	3-6	2	1	1
	6-9	3	1.5	1.5
	9-12	3	2.5	2.5
	12-15	2.5	3	3
	15-18	1.5	2	2
	18-21	1	1	1
	21-24	-	0.5	0.5
	24	0	0	0
Average Water Depth (cm)	10	-	-	0
	10-15	-	-	1
	15-30	-	-	2
	30-60	-	-	3
	60	-	-	2
* juvenile and adult readings during the warmest part of the year * egg readings during time of incubation				
Average Water Velocity (cm/sec)	0-15	1	-	-
	15-30	2	-	-
	30-60	3	-	-
	60-75	2	-	-
	75-90	1	-	-
	90	0	-	-
	upwelling	3	-	-
Substrate (dominant type)	clay	0	1	1
	silt	0	1	1
	sand	1	1	1
	gravel	3	2	2
	rubble/rock	2	3	3
	boulder	1	2	2
	fractured bedrock	0	1	1
	solid bedrock	0	0.5	0.5
	mud, detritus	0	1	1
* silt and vegetation will lower values - estimate 10% silt equals a zero value for spawning * for spawning to receive a value of 3, up to 20% cobble and up to 15% sand are allowed, if there is at least 40% gravel				
Percentage of Instream Cover	0-6	-	1	1
	6-12	-	2	1
	12-14	-	2	2
	14-22	-	3	2
	22	-	3	3

Habitat Suitability Index for Brook Trout and Rainbow Trout...Continued

Habitat Variable	Criteria	Ratings for Life Stages: Egg	Juvenile	Adult
Percentage of Pools	0-15	0	1	1
	15-35	-	2	2
	35-65	-	3	3
	65-85	-	2	2
	85-100	-	1	1
* during late summer or low water conditions				
Percentage Bank Stabilization	0-50	1	1	1
	50-75	2	2	2
	75-100	3	3	3
* by rooted vegetation and up to 30% boulder				
Percentage of Pool Type (estimate as a percentage of total wetted area of stream)	10% 1st class and 50% 2nd class	-	1	1
1st Class Pool - large and deep (1.5 m), more than 30% pool bottom obscured by depth, surface turbulence or structure, can hold several adult trout	10-30% 1st class	-	2	2
2nd Class Pool - moderate size and depth, between 5-30% bottom obscured by depth, surface turbulence or structure, can hold several adult trout	> 50% 2nd class	-	3	2
	> 30% 1st class	-	2	3
3rd Class Pool - small, shallow, or both. Cover if present, is surface turbulence or very limited. Structure, e.g. wide, shallow pool areas of streams, small eddies behind rocks. Holding area for 1 or 2 adult trout	> 65% 1st class	-	1.5	2
	> 85% 1st class	-	1	1.5

Other Habitat Characteristics and their Suitability for Trout

Brook Trout
Redds found in areas of ground water upwelling in streams and ponds
Temperature range for incubation is 0-20 °C, optimum of 4-14 °C
Temperature range for adults is 0-24 °C, optimum at 9-16 °C
Velocity range of 0-90 cm/sec, optimum is 30-60 cm/sec
Dissolved oxygen required >5 mg/l
pH tolerance of 4.0-9.5
Minimum water depth of 15 cm

Rainbow Trout
Spawn exclusively in streams
Redds located at head of a riffle or downstream edge of a pool
Temperature range for incubation is 0-20 °C, optimum 7-10 °C
Temperature range for adult is 5.5-20 °C, optimum 11-14 °C
Velocity range of 10-90 cm/sec, optimum 30-70 cm/sec
Dissolved oxygen required >3 mg/l
pH tolerance range 5.5-9.0
Maximum water depth 15 cm

Habitat Suitability Index for Atlantic Salmon.

Habitat Variable	Criteria	Ratings for Life Stages: Egg	Fry	Parr
Average Water Temperature (°C)	0	0	0	0
	0-3	1	0.5	0.5
	3-6	2	1	1
	6-9	3	1.5	1.5
	9-12	3	2.5	2.5
	12-15	2.5	3	3
	15-18	1.5	2	2
	18-21	1	1	1
	21-24	0	0.5	0.5
	24	0	0	0
Average Water Depth (cm)	5	0	0	0
	5-10	0	1	0
	10-15	0	1	1
	15-20	0	2	1
	20-25	0	2	2
	25-30	0	3	2
	30-35	0	3	3
	35-40	0	2	3
	40-50	0	2	3
	50-60	0	2	3
	60-65	0	1	2
	65-80	0	0	2
	80-115	0	0	1
	115	0	0	0
Average Water Velocity (cm/sec)	0-20	0	-	-
	20-50	1	-	-
	50-60	3	-	-
	60-70	2	-	-
	70-80	1	-	-
	80	0	-	-
Substrate (dominant type)	sand	0	1	0
	sand/gravel	0	2	0
	gravel/sand	1	2.5	1.5
	gravel	2	3	3
	rubble	3	3	3
	rock/boulder	1	2	3
	boulder	0	1.5	3
	fractured bedrock	0	1	2
	solid bedrock	0	0.5	1

Habitat Suitability Index for Atlantic Salmon... Continued

Habitat Variable	Criteria	Ratings for Life Stages Egg	Fry	Parr
Overwintering Substrate	silt	-	0	0
	sand (no silt)	-	1	0
	sand/gravel	-	1.5	0.5
	gravel	-	2	1
	gravel/rubble	-	2.5	1.5
	rubble/gravel	-	3	2
	rubble/rock	-	2.5	2.5
	rock/boulder	-	2	3
	boulder/rock	-	1	2.5
	boulder	-	1	2
	fractured bedrock	-	0.5	1
	solid bedrock	-	0	0.5