Abegweit
Conservation Society

ATLANTIC SALMON MANAGEMENT PLAN for Midgell River PEI

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INTRODUCTION

For thousands of years First Nation peoples sustained themselves and maintained a livelihood from the natural resources provided by the water, soil and air that make up Abegweit’s (Prince Edward Island) natural environment.

“Before Contact, the Mi'kmaq people based their lives on where different foods were available at different times of the year, returning again and again each season to the same area. They lived in wigwams (wigoun), which could accommodate one to several families. In spring, there were large gatherings along lower rivers; summer, smaller gatherings, along the bays and coasts. Fall brought large gatherings of Mi'kmaq families along upper rivers and, in winter, small family- type groups went inland to hunt large game. This cyclical round of land and resource use is still carried out today, as shown by the extensive PEI Mi'kmaq interviews and mapped evidence compiled by the MCPEI Traditional (“living memory”) Land Use program. If a map were generated illustrating the entire inventory of this gathered information, it would cover the land and waterways of Prince Edward Island, as well as along its coastlines and out into the Northumberland Strait and the Gulf of St. Lawrence.

Contact with Europeans brought about many changes to the Mi'kmaq people of the Island. Life became one of feast and famine. Besides the radical and rapid decline of population due to diseases, the majority of the Mi'kmaq now oriented their lives towards the collection and exchanging of furs for an ever-expanding assortment of European goods, some of which made the Mi'kmaq lives easier – copper pots instead of tree stumps and heated rocks, iron knives instead of flaked stone; some of which made life harder – liquor. “

Tammy MacDonald, Research Director, MCPEI

http://www.mcpei.ca/files/u1/Mi_kmaq_history_on_PEI_1.pdf

Management plans are not static, but dynamic and need to be assessed every year or so then updated to new developments as projects and programs progress.

BACKGROUND

The development of an Atlantic salmon management plan for Midgell River cannot be complete with the consideration of historical references, both Traditional Indigenous Knowledge, and more modern times

The Abegweit Conservation Society has been consistently working in the Midgell River Watershed since 2015. In the late 1980s, early 1990s the PEI Native Council carried out some stream habitat improvement projects in partnership with the Province of PEI that consisted of instream flow structures and manning a fish trap approximately 1 km upstream of the head of tide. During the time period between 1994 and 2012 the watershed had not received much attention until the Morell River Management Cooperative initiated some explorative work starting with an assessment paddle from the Elm Road to Pius MacDonald's Pond in mid-July of that year. On that trip was Rosanne MacFarlane (PEI Freshwater Recreational Fisheries Biologist) and Daryl Guignion (author of the two Atlantic Salmon Strategies for Prince Edward Island 2009 & 2019) the watershed coordinator for the MRMC Rebecca Hersom-Petersen and Forests, Fish & Wildlife staff Danielle Horne. The first task, which is very important and ongoing to this day, is the management of beaver activity (dam building) along the main branch right from the head of tide to the headwaters, 15 km of channel length. The reason why this is such an important job for the ACS every year is that migrating adult salmon need access to spawning habitat that at one time existed all the way to the headwaters approximately 2 km upstream of the Elm Road.

In 2014, both the MRMC and the Abegweit stream crew worked on barriers and brushmats to control excessive sediment in the main channel. These activities have greatly improved the quality and quantity of spawning and juvenile habitat for resident Atlantic salmon. Although the Provincial Watershed Management Program considers the Midgell River as under management of the Morell River Cooperative, since 2014 the Abegweit Conservation Society has been responsible for most of the work in Midgell and has added native tree planting in riparian zones to the stream habitat enhancement repertoire. In 2017 the ACS added the task of installing and manning a fish trap at Pius MacDonald's Pond with the goal of establishing a baseline data base of aquatic species in the river that would lead to the development of specific fish species management plans. In season of 2018 was a very busy fieldwork year similar to 2017-2018 with three major projects running simultaneously in 3 different watersheds. Another new activity was added to the field work in 2018 and that was PIT tagging salmon caught in the trap at Pius MacDonald's Pond. The goal of this activity was to gather knowledge about salmon use of the different habitats in the river and to gather timing of their movements.

When Abegweit first began working in Midgell it was not difficult to identify the single most limiting factor to water quality within the watershed as being the extensive impoundment of the stream channels, throughout the entire watershed, that limited flows from natural spring feeds which would normally maintain cooler water temperatures and thereby impacting dissolved oxygen levels. Since Midgell has less natural large spring inputs stream channels than other PEI systems, especially downstream of Pius MacDonald's Pond, water temperature and solar irradiation from impounded water, man-made or natural, has been a target of habitat and water quality efforts for Abegweit.

Another limiting factor in the Midgell River system is the degradation of areas where spawning likely occurred pre-European settlement mostly caused by unnatural beaver population increase due to deforestation for agriculture advancement. Once connectivity within the main channel was addressed and

2014/2019 SUMMARY

2014 - 2019 WATER QUALITY/BEAVER MANAGEMENT

The beaver/impoundment management strategy presently being applied to the Midgell River Watershed includes:

- Monitoring of beaver activity by walking or canoeing;
- Recording active and inactive beaver dams and colonies;
- Removing inactive dams;
- Contracting a trapper to target identified colonies;
- Follow up after trapping is completed by the Abegweit Fieldwork crew to notch recently trapped dams allowing fish passage to spawning habitat

In the following spring and summer dams that are still inactive are further opened and monitored periodically throughout the summer and fall months for new beaver activity or jams created by natural debris movement downstream. For the past four years this method of beaver management has mainly taken place on the main branch of the river from the Elm Road to the head of tide. Since 2016 this management method has also been applied to a tributary in the headwaters that flows from McCarrick's Pond into the main branch. The original beaver-free management zone was assigned according to a strategy written by Daryl Guignion (2009) that was written as a conservation strategy for Atlantic salmon on PEI. A revised strategy was renewed in 2019 and recommendations in the revised version are being addressed in 2019.

A section 1.5 km long of the main branch upstream (south) of the Elm Road was added to the beaver free management zone in 2018. It is located between a tributary entering the main branch from the east (in back of Grover/Cecil MacKay's Farm Strathcona), and the Elm Road. The Abegweit Fieldwork crew removed inactive dams in this reach in August and September and rerecorded active colonies for the trapper. The rationale for extending the management zone is based on observations made in relation to the use of habitat by Atlantic salmon once it is accessible. It appears that if physically possible adult salmon will enter and utilize habitat even in smaller stream located in the headwaters.

The methods applied over the past three years of monitoring, removing inactive dams and hiring a trapper to manage beaver populations were applied again in 2018. The McCarricks tributary was also monitored and trapped with follow up dam notching in the fall. In total 5 active colonies were trapped, and a dozen beavers removed. As in previous years all trapping was done in season.

MANAGEMENT PLAN GUIDING PRINCIPLES

In 2019 the "Moving Toward Ecosystem-Based Management in the Midgell Watershed" Project focused on applying ecosystem-based management concepts by attempting to link past and existing monitoring and rehabilitation activities in the Midgell watershed on PEI to the principles outlined in "Principles For Ensuring Healthy and Productive Freshwater Ecosystems" (Laponte et al 2013). The Midgell Atlantic Slamon Management plan will make efforts to continually these concepts and principles.

Prescribed management strategies three of them are: (see paper by Jack Imhof)
Protect and restore **habitat as the foundation for fisheries**,
Protect **biodiversity**
Implement **ecosystem-based management**

Atlantic salmon management activities outlined for the next three years are based on addressing specific threats identified by the COSEWIC Species status report 2010 and the Renewed Conservation Strategy for Atlantic Salmon in Prince Edward Island, 2019. Appendix

Threats addressed by the planned activities are habitat related; obstructions/barriers to migration/connectivity, substrates/cover for both adults and juvenile life stages, water quality/temperatures, biodiversity, land management/sedimentation/headwaters/riparian zones, ecosystem-based management approach.

Barriers resulting from beaver activity are addressed in the Midgell Beaver Management Plan.

Water levels and process in the development of a Management for Pius MacDonald's Pond are addressed in the draft plan.

Reference data sets are contained in separate Excel files.

YEAR 1 – 2020

1. Maintain the main branch of the river barrier free from the tributary draining from McCarricks Pond to it confluence of the main branch and from the confluence downstream to the estuary by:
    a. Actively monitoring for barriers and recording locations with GPS to be communicated to the contracted trapper.
    b. Removing large barriers with seasonal crew staff
2. Install 3 low profile instream flow structures KM upstream from the head of tide to … reference 1993 draft mtg plan
3. Continue monitoring water temperatures at 12 established sites within the watershed that include the main branch and two larger tributaries (McCarricks & Church Road)
4. Install a real-time remote temperature logging station on the main branch below Pius MacDonald's Pond.
5. Continue monitoring the Atlantic salmon population trough a number of techniques already in use; Redd surveys, electrofishing, PIT tagging.
6. Continue to work with other partners to establish agreement on a management plan for the water level in Pius MacDonald's Pond.
7. Work with the Province in establishing a co-management agreement in relation to Provincially owned lands along the river.
8. Continue to work on multi-species management plans with the goal of merging as components of a larger ecosystem-based plan.

YEAR 2 - 2021

1. Maintain the main branch of the river barrier free from the tributary draining from McCarricks Pond to it confluence of the main branch and from the confluence downstream to the estuary by:
    a. Actively monitoring for barriers and recording locations with GPS to be communicated to the contracted trapper.
    b. Removing large barriers with seasonal crew staff
2. Install 3 more low profile instream flow structures KM upstream from the head of tide
3. Continue monitoring water temperatures at 12 established sites within the watershed that include the main branch and two larger tributaries (McCarricks & Church Road)
4. Maintain real-time remote temperature logging station on the main branch below Pius MacDonald's Pond.
5. Continue monitoring the Atlantic salmon population trough a number of techniques already in use; Redd surveys, electrofishing, PIT tagging. Includes:
    a. Maintain trap at Pius MacDonald's Pond for the purpose of collecting data on multi-species
6. Continue to work with other partners to establish agreement on a management plan for the water level in Pius MacDonald's Pond.
7. Work with the Province in establishing a co-management agreement that include the Provincially owned lands along the river
8. Continue to work on multi-species management plans with the goal of merging as components of a larger ecosystem-based plan.

YEAR 3 - 2022

1. Maintain the main branch of the river barrier free from the tributary draining from McCarricks Pond to it confluence of the main branch and from the confluence downstream to the estuary by:
    a. Actively monitoring for barriers and recording locations with GPS to be communicated to the contracted trapper.
    b. Removing large barriers with seasonal crew staff
2. Install 3 more low profile instream flow structures KM upstream from the head of tide
3. Continue monitoring water temperatures at 12 established sites within the watershed that include the main branch and two larger tributaries (McCarricks & Church Road)
4. Maintain real-time remote temperature logging station on the main branch below Pius MacDonald's Pond.
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6. Continue to work with other partners to establish agreement on a management plan for the water level in Pius MacDonald's Pond.
7. Work with the Province in establishing a co-management agreement that include the Provincially owned lands along the river
8. Continue to work on multi-species management plans with the goal of merging as components of a larger ecosystem-based plan.

LONG TERM MANAGEMENT GOALS

In general, the long-term management plan for Midgell is to continue increasing connectivity and access to a variety of habitat types for multiple freshwater species. In 2019 the beaver dam free zone was extended on the main branch all the way to the confluence with the tributary from McCarrick's Pond and including the tributary and work was started on the tributary entering form the Church Road are west of HWY 315.

More specific management strategies will be developed from data being collected as a result of the fish trap and PIT tagging efforts over the past two years.

APPENDIX

THREATS TO SOUTHERN GULF OF ST LAWRENCE ATLANTIC SALMON POPULATION IDENTIFIED BY COSEWIC STATUS REPORT 2010

Threats to Atlantic salmon identified as being within the capacity and scope of the Midgell Watershed Management Plan

Obstructions can severely reduce the productive habitat and production of salmon (DFO and MRNF 2008). Low head and surmountable dams delay, at the very least, upstream migration until such time as water discharges are adequate for salmon to leap the obstruction. Higher dams equipped with fish passages have varying passage efficiencies, 100% being very uncommon (Fay et al. 2006). Even when upstream passage is available, the impoundments behind these dams can delay and/or prevent smolt emigration, increase the energetic costs of smolt movements and, dependent on discharge conditions, can result in increased predation (NRC 2004).

In addition to **direct loss of productive habitat** from **flooding**, dams also **alter natural river hydrology and geomorphology, interrupt natural sediment and debris transport processes, and alter natural temperature regimes** (Ruggles and Watt 1975, Wheaton et al. 2004). These impacts can adversely change aquatic community composition and affect the entire aquatic ecosystem structure and function.

Ruggles (1980) identified the following **unnatural conditions created by dams** that can threaten anadromous salmonid populations: passage over spillways, passage through turbines, passage through impoundments, exposure to atmospheric gas saturation, pollutants, predators, unnatural temperatures, disease organisms and increased vulnerability to exploitation from angling. Smolts are vulnerable to the impacts of dams and may become impinged on screens, entrained in forebays, accrue lethal abrasions or be killed in turbines during downstream migration. Dams can also alter flow patterns of rivers, increase water temperature, and concentrate pollutants, all of which are factors that can adversely affect resident parr and migrating smolts (Foerster 1934, Saunders 1960). Entrainment mortality for salmonids can range between 10-30% at hydroelectric dams (Fay et al. 2006). Passage through turbines can also lead to indirect mortality from increased predation and disease (Odea 1999). Where multiple dams exist, the losses of downstream migrating smolts from turbine entrainment are often cumulative and biologically significant (Gibson et al. 2009). Because of their larger size, turbine mortality of kelts is expected to be significantly greater than 10 to 30% (FERC 1997). Mortality of salmon in hydropower generation plants, although potentially mitigated with fish passage facilities and water management, can pose a significant threat to the persistence of Atlantic Salmon.

Juvenile Atlantic Salmon can use extensive areas of freshwater habitat (e.g. Robertson et al. 2003) **and must be able to access feeding and refuge habitat**. **Lack of habitat connectivity affects the abundance and distribution of Atlantic Salmon populations but may also reduce access to habitats, which improve growth** (e.g. Hutchings 1986) **and survival** (Breau et al. 2007).

Land management activities, particularly land clearing for development, has the potential to negatively affect freshwater habitat of salmon and food sources. Habitat alteration resulting from sedimentation, run-off pollution, channelization and changes to hydrological regimes are all associated with development (Trombulak and Frissell 2000, Wheeler et al. 2005, Fay et al. 2006).

Juvenile salmon can be adversely affected by **contaminants in fresh water**. Pesticide effects on salmonids may range from acute (e.g. fish kills in PEI; Cairns et al. 2009) to chronic (leading to increased cumulative mortality; DFO and MRNF 2009).

Sub-lethal concentrations of contaminants, such as endocrine-disrupting chemicals, may compromise survival of salmon at sea (Fairchild et al. 2002, Moore et al. 2003, Waring and Moore 2004). Sources of these compounds may include agriculture, sewage, pesticide spraying (e.g. forest spraying; Fairchild et al. 1999) and industrial effluents (e.g. pulp and paper mills; McMaster 2001). A caging study in the Miramichi River showed a general trend of better feeding and growth in Atlantic Salmon smolts caged at sites with fewer known anthropogenic inputs, of which pulp and paper mill effluent was a major contributor (Jardine et al. 2005). In addition, chemical pollution from chlorinated organic compounds, which are widely distributed in the North Atlantic Ocean, has been proposed as a complementary factor affecting the sea survival of Atlantic Salmon (Scott 2001). The limited studies to date have only examined a minute number of the vast variety of chemicals currently being used and introduced.

Infiltration of sediment into stream bottoms has been suggested as a cause for significant decrease in the survival, emergence and over-wintering success of Atlantic Salmon juveniles (Chapman 1988). Sediment size and movement in a stream (bedload) is a natural process; however, a multitude of impacts can greatly increase the input and accumulation of sediments to streams (Meehan 1991, Wheeler et al. 2005). The result is the loss of habitat as interstitial spaces become filled with sediment. All but the oldest of juvenile salmon occupy interstitial spaces at some stage and therefore exceeding the equilibrium input of sediments into streams can have devastating effects. As little as 0.02% silt has been shown to decrease the survival of eggs to the pre-eyed stage by 10% (Julien and Bergeron 2006). As stated above, sedimentation is often a by-product of road construction, urban development, agriculture and some industries.

THREATS/PRESSURES IDENTIFIED BY A RENEWED CONSERVATION STRATEGY FOR ATLANTIC SALMON IN PRINCE EDWARD ISLAND 2019

Threats/Pressures identified as relevant to the Province of Prince Edward Island

A RENEWED CONSERVATION STRATEGY FOR ATLANTIC SALMON IN PRINCE EDWARD ISLAND, 2019

SECTION 2. EXISTING AND EMERGING PRESSURES

All watersheds in Prince Edward Island are facing challenges related to land use; challenges that are **becoming greater with climate change**. Unless these issues are addressed, watersheds will be under increasing stress and will have difficulty maintaining populations of Atlantic salmon. If steps are taken to reverse the damage of current land use practices, watersheds may have the resiliency required to withstand the impacts of climate change.

2.1. Soil Erosion

The most significant surface water quality issue across PEI is the movement of water-borne sediment from agricultural lands, primarily lands under intensive row crop cultivation. This is not a new issue. The 1987 Conservation Strategy for Prince Edward Island (Stewardship and Sustainability) concluded that soil erosion, particularly row-crop production, is the most serious environmental problem facing the province. The urgency of the issue on PEI was underscored over the following decades in the Report of the Round Table on Resource Land Use and Stewardship in 1996 and the Report of the Action Committee on Agricultural Runoff Control in 1999.

The problem of soil loss is inextricably tied to the loss of soil organic matter (Science Council of Canada 1986). The loss of soil organic matter has reached critical levels on PEI. A long-term monitoring study of soil organic matter (SOM) in agricultural fields across PEI found significant overall declines in SOM between 1998 and 2015, concluding that under current low residue cropping systems with intensive tillage, loss of SOM is expected to continue (Nyiraneza et al. 2017). Loss of organic matter creates a downward spiral of environmental degradation. Soil low in organic matter is less resilient to wind and water erosion, high precipitation events, flooding and droughts. In turn, crops require more fertilizer and irrigation, increasing the input of sediment and nutrients to the aquatic environment, and possibly reducing stream flow at critical times of the year.

2.1.1. Impacts of Sedimentation on Atlantic Salmon Habitat

The ongoing issue of sediment input into a river is the major reason for channel and habitat degradation on PEI and is considered an important limiting factor for Atlantic salmon (e.g., Cairns 1999; Cairns et al. 2012). Newcombe (2003) discusses the profound impact of suspended sediment on fish and their habitat as *…triggering a cascade of impacts, from one trophic level to the next, involving phytoplankton, zooplankton, insects, freshwater mollusks and fish …(with) direct effects (mortality, reduced physiological function, and habitat alienation) and indirect effects (decreased rates of growth, reproduction and recruitment) linked to reduced food supply.* But perhaps the more serious long-term impact arising from sedimentation in PEI streams is the effect on bottom substrates.

Infiltration of sediment into stream bottoms can result in a significant decrease in the survival, emergence and over-wintering success of Atlantic salmon eggs and juveniles. The first and most sensitive stage affected by sediment is eggs in redds, a particularly important issue on PEI as spring runoff often coincides with sensitive stages of egg development. Even relatively small increases in sediment levels in streams have been shown to reduce egg survival (Julien and Bergeron 2006, Levasseur et al. 2006). An unpublished field study in the Morell River (Guignion et al. 1996, Appendix III) found there was no survival of emerging fry in high sediment situations, presumably due to fine sediments reducing the required oxygen during egg development. Embedding of gravel and cobble substrate can also prevent the escape of alevins from the gravel pockets and reduce the spawning success of salmon by "cementing" the substrate making it difficult for spawning salmonids to move substrate and create an effective redd. (e.g., Everest et al. 1987).

The impact on juvenile salmon is also considerable. Sediment fills the interstitial spaces in gravel and cobble that are critical habitat for all but the oldest of juveniles (DFO 2008). Juveniles use these interstitial spaces for cover from predation and to stabilize in swift currents. In general, greater habitat heterogeneity exists when large sediment fractions such as gravel, cobble, and boulders dominate the substrate (rather than silt, sand and clay), which can be important to meeting cover and dietary needs of juvenile salmon (e.g., DFO 2008).

2.1.2 Economic Impacts

Economic impacts of sedimentation are also significant. In 2016, national studies suggested the recreational fishery is worth $6 million to $7 million a year to PEI., and in a study by ASE Consulting and UPEI (1997) it was estimated that this value would be ten times higher without sedimentation. The costs of dealing with instream sedimentation and its effects are also very high, requiring a major effort and expenditures across virtually all watersheds. While outdated, and therefore likely an underestimate of costs in today's dollars, information on economic impacts of off-farm effects of soil degradation for the Great Lakes region of southern Ontario serves to illustrate the scope of costs (*in* Science Council of Canada 1986). It was estimated that sedimentation due to agricultural production caused $91 million in damage annually including sediment damage to inland lakes and waterways, the cost of dredging ditches and harbors, and recreational fishing losses.

2.1.3. Agricultural Practices and Sedimentation Risk

Prince Edward Island continues to have the largest land area devoted to potato production in Canada (Statistics Canada 2016). Although the 2016 census showed that acreage actually decreased slightly between 2011 and 2016 (from 86,560 to 83,326), there is a trend towards more intensive, large scale agriculture. Our observations identified several factors that could increase the impact on our streams and salmon habitat as a result.

Field consolidation - In November 2018 Cavendish Farms warned a legislative committee about "significant threats to the long-term sustainability of potato farming on Prince Edward Island," while asking government to double land ownership limits imposed on Island potato farmers. The move towards larger and larger fields is causing greater stress on streams. Depending on topography, consolidation of fields can increase slope length, resulting in significant increase in runoff and soil loss. Generally, if the slope length is doubled, the soil loss is increased 1.5 times. Current regulations and incentives (e.g., for the retiring of sensitive agricultural land) address slope (9%) but not slope length. It would be beneficial to incorporate slope length into assessments and regulations.

Hedgerow removal - Hedgerow removal often goes hand in hand with field consolidation and can expose fields to increased wind and water erosion. This is particularly important for spring runoff. With less snow held on fields, infiltration to soil is reduced and surface runoff is increased. In the Hillsborough River watershed, there was an estimated loss of 78 ha or 16.2% of hedgerow cover between 2000 and 2012 and it appears that this rate of loss is not diminishing (Hillsborough River Association 2018).

Exposed Fields - Late harvested potato fields and fields ploughed in the fall can experience major soil erosion during spring runoff. During the winter, cycles of freezing and thawing have a major effect on exposed soil, with the frozen top layer of soil thawing while bottom layers are frozen, making it more susceptible to accelerated runoff through sheet erosion. This is likely to intensify with the increasing frequency of winter rainfall events due to climate change. Exposed winter soil is also subject to sublimation and increased wind erosion. On PEI, there have been several notable “red snow” events – most recently in February 2019 - due to massive topsoil loss in winter as a result of high winds blowing over exposed fields with minimal snow or crop cover. Minimizing the practice of fall ploughing and use of crop residue management techniques would help to reduce soil erosion from exposed fields.

Crop Rotation – The authors of a 2017 report on changes in soil organic matter (SOM) levels in Prince Edward Island concluded that “the current rotation systems in PEI are not sufficient to maintain soil organic matter and further efforts are needed to reverse this trend toward declining soil organic matter” (Nyiraneza et al. 2017). Since 2008, a 3-yr potato crop rotation has been mandatory under the *Agricultural Crop Rotation Act*, however producers can have a 2-yr crop rotation provided that they have filed an environmental farm management plan. In the 1999 *Report of the Action Committee on Agricultural Runoff*, a minimum of a 3-yr crop rotation for potatoes was recommended, although longer rotations were considered preferable. Given ongoing issues with soil loss, a 2-yr crop rotation should not be considered, and even three years will not be sustainable without enhanced soil conservation and enhancement practices.

Grassed Waterways - Grassed waterways are constructed channels designed to drain water off fields without causing soil erosion. However, many of these areas were once small, first order streams which now carry water and chemicals directly to streams. Some are properly constructed and well maintained but others serve more as trenches, carrying massive amounts of sediment to the stream and eroding stream banks.

Grassed Headlands - With the narrow 15-metre buffer zone requirements in areas of intensive agriculture, grassed headlands can play an essential role in reducing agricultural impacts as a complement to buffer zones. Although grassed headlands are currently part of the buffer zone regulations on PEI, they are sometimes lacking or highly disturbed. The potential is there to use these more effectively, and current requirements for grass headlands should be strengthened, especially in areas where fall plowing is practiced. It has also been suggested that where fall tillage is practiced, an extended grass headland is needed to mitigate impact on streams (Bedeque Bay Environmental Management Association (BBEMA) pers. comm.). Even a well-maintained grassed headland cannot compensate for poor farming practices on the adjacent field.

The use of heavy machinery in the headland and into the buffer zone may accelerate sedimentation. On the northwest branch of the Mill River, for example, trees and shrubs from field expansion were being pushed directly into a stream.

There was an urgency in the recommendation from the 1987 *Conservation Strategy for Prince Edward Island*: "We recommend a series of actions designed to alleviate the erosion problem … with a commitment to fund soil conservation at whatever level is necessary in order to get significant improvement". Sadly, this recommendation remains as relevant and urgent today as it was three decades ago. Although several soil conservation and stewardship programs and incentives exist, this problem is far from solved. A renewed focus on proactive and precautionary regulation, policy, partnerships and incentives to address this problem is urgently needed.

While some watersheds are impacted by runoff from multiple agricultural sources, other rivers may have one or two problematic areas that are contributing most of the sediment to a river system. Pinpointing these sources and working cooperatively to address them, as well as increased vigilance on new activities such as field expansion and land clearing, are required.

2.1.4. Highway Erosion

It was noted by some watershed groups that unpaved roads continue to be a significant source of sediment to aquatic systems. There are also areas where the highway ditch serves to direct sediment and pesticides from agricultural fields to a nearby stream. An enhanced program is needed to install sediment catchment basins in the ditches along unpaved roads, including a maintenance component to clean them as required. The addition of gravel or millings in sensitive areas can reduce the amount of erosion from road surfaces.

The Department of Transportation, Infrastructure and Energy (DTIE) has improved its road construction practices in recent years. During the construction of the new highway alignment in Cornwall, DTIE sought input from the Central Queens Wildlife Federation (CQWF) and incorporated their suggestions into the bridge construction project on the Clyde River. The result was a greatly improved section of river for anadromous fish and the likelihood of better cooperation in future endeavors. There remains a need to strengthen communication between DTIE and watershed groups regarding road maintenance and construction.

2.2. Nutrients and Pesticides

2.2.1. Nutrients

Excess nutrients alter the productivity of freshwater systems in fundamental ways; increasing algal growth, reducing dissolved oxygen, and limiting biological diversity. The provincial government assessment of long-term (1960 to 2016) nitrate trends on PEI shows that nitrate concentrations have increased in each stream sampled and that overall, the streams which have a higher percentage of agriculture and land in potato production have the highest nitrate levels. The rate of increase was highest after the rapid expansion in potato production which occurred in the early 1990s. Results from the last 3-4 years indicate that seven out of the ten streams in this monitoring network are showing increasing nitrate trends while the other three streams have a recent trend that is not changing over time. The release of nutrients to the environment is an issue which extends outside of Prince Edward Island. A group of scientists and graduate students working on the Northumberland Strait

(Northumberland Strait- Environmental Monitoring Partnership under the Canadian Water Network) estimated that ninety-five percent of the nitrates that are emptying into the Northumberland Strait are coming from this province, and of these, ninety-one percent are coming from the Island's agriculture industry (as reported in *The Guardian,* March 4, 2016).

One of the most serious consequences of nutrient loading for Atlantic salmon and other fish is the frequent anoxic events in Island estuaries. North Shore estuaries are more prone to water quality problems because of their low tidal amplitude and limited flushing capacity. Even an estuary with little nutrient input, such as on the Midgell River, can have an anoxic event when low tidal flushing is combined with warm water temperatures. By contrast, there is rarely an anoxic event in the Wilmot River, in spite of 700 kilograms of nutrients going into it daily because the system has a high flush rate and low water temperatures (BBEMA pers. comm.).

2.2.2. Pesticide Related Fish Kills

There have been 29 recorded pesticide-related fish kills in PEI rivers since 2000. While fish kills are devastating for all aquatic life, they are particularly damaging to Atlantic salmon populations. The dead salmon collected in the 2000 fish kill on the Souris River, for example, were the last salmon observed in that river. The factors leading to these pesticide related fish kills are consistent: heavy rainfall, turbidity, and evidence of severe agricultural runoff. The agricultural community has been slow to adjust to the changing weather patterns and intensive rainfall events that are becoming more frequent with climate change.

Many of the pesticides linked to fish kills enter the river attached to soil particles. Improving soil health and reducing erosion are key to preventing future fish kills, along with use of lower toxicity products. It will require major changes in current agriculture practices for significant improvements to be realized. In the interim, immediate action must be taken to identify and protect sensitive areas. In Trout River (Coleman) for example, an action committee made up of farmers, watershed representatives, and government was established after three concurrent fish kills (2011-2013). Some of the actions taken to reduce the likelihood of future fish kills included the purchase of high-risk land and use of subsidized lower toxicity fungicides during high risk periods.

2.3. Forest Cover and Riparian Zone Management

Loss of riparian habitat along streams, rivers, and estuaries is one of the most significant impacts on wild salmon survival. A good riparian zone can moderate water temperature, reduce sedimentation, enhance nutrient cycling, productivity and biodiversity of a stream, serve as a source of woody debris for cover, and stabilize banks.

There appears to be a relationship between the amount of forested land in a watershed and the current status of Atlantic salmon. Heavily forested watersheds, especially in northeastern PEI, tend to have more robust salmon populations than those with less woodland. The 2000 Forest Inventory for PEI found that the total forested area had fallen from 48% in 1990 to 45% in 2000, and the 2010 State of the Forest Report found that the decline was continuing, with forest covering only 43.9 percent of the province. Our forests are also very different from the original Acadian forest, and are now heavily fragmented with small stands composed of young, small diameter trees, and softwood monocultures. Riparian zones with deciduous-dominated versus coniferous- dominated cover will function very differently in terms of water retention, temperature modulation, run-off and flashiness, and biodiversity.

The current 15 metre buffer has not been effective in reducing sedimentation, fish kills and anoxic events. In some cases, the buffer does not even extend to the top of the bank, for example in hilly regions of Prince Edward Island. To protect salmon bearing streams, a continuous riparian buffer of 60 metres is recommended as a long-term goal. Immediate focus for riparian restoration should be planting of appropriate deciduous trees (yellow birch, red maple, sugar maple, red oak) rather than white spruce and fir as is currently a common practice (likely due to availability). This will require a shift in production of seedlings at the J. Frank Gaudet Tree Nursery. Planting should focus on quality, not quantity, of trees. Appropriate planting distances, protection from rodents and beaver, and ongoing maintenance are important to ensuring success of deciduous species. Training and updated guidance on planting may be needed.

Grasses, sedges and native shrubs in the floodplain are important for sediment control, juvenile cover, and nutrient flow. A deciduous canopy will allow these species to grow, while a dense coniferous canopy will not. In some cases, opening patches in the existing canopy may be needed to encourage a well-functioning floodplain.

Consider multiple values in managing and restoring riparian zones. Bonshaw Park is an excellent example of the multiple uses and value of a forested watershed. Mill River could be similarly developed and could provide a key recreational draw for that area.

2.4. Inadequate Protection of Headwaters and Source Water

Headwater streams play a fundamental role in maintaining the health and productivity of river systems (e.g., Freeman et al. 2007; Meyer et al. 2003) such as mitigating flooding, maintaining water quality and quantity, recycling nutrients, and providing critical habitat for a variety of plants and animals. The Genomics Laboratory at the Department of Fisheries and Oceans in Moncton are conducting research on salmon fry foraging and preliminary results indicate that headwater streams may be providing ideal food items for salmon fry. Smaller tributaries may also provide important refugia from extreme events in the main channel. Springs are essential to the quality and quantity of water in streams, and in maintaining the cold-water temperatures on PEI that are preferred by salmonids.

Protection of first and second order tributaries in headwater streams is often overlooked and buffer zones in these areas may be narrow or non- existent. In some cases, it appears that headwaters and source waters may have been “channelized” as drainage ditches or grass waterways. It is recommended that buffer zone legislation and other protective measures are applied to headwaters, and that riparian restoration extend to these areas.

Emerging Areas: Potential Limiting Factors Requiring Further Study

2.5. Seal Predation

The importance of predation was highlighted in the 2015 report of the Minister’s Advisory Committee on Atlantic salmon (Fisheries and Oceans Canada 2015*)*, especially in areas where salmon are concentrated at certain times in their life cycle in rivers and estuaries (for example during smolt migration or salmon spawning runs). While the 2015 report noted that seals, striped bass, sea birds and small mouth bass are all important predators of salmon, seals are of particular and increasing concern on Prince Edward Island. Harbour seals are known to congregate in estuaries and move well upstream into salmon rivers during salmon runs. Their potential impact on salmon is exacerbated by the decline in the abundance of other prey species such as gaspereau (*Alosa pseudoharengus)*, smelt (*Osmerus mordax)* and blueback herring (*Alosa aestivalis)* that were traditionally in rivers in large numbers and provided "prey cover" that reduced predation on salmon smolts in rivers and estuaries.

Further research is needed to address the impact of seal predation on PEI, for example, dietary analysis of seals in estuaries during critical spawning and smolt migration periods. It is also important to co-manage "prey cover" species by restoring and maintaining habitat and access for anadromous species like smelt and gaspereau.

2.6. Survival of Atlantic Salmon Fry

On Prince Edward Island, Atlantic salmon redd counts have been used to estimate salmon population levels by converting numbers of redds to numbers of female spawners and using an estimate of eggs deposited to determine whether or not a river has met its conservation requirements (Cairns and MacFarlane 2015). However, this calculation does not account for the success or failure of the redds. Electrofishing surveys completed in an area of spawning in the following year can provide an indication of success, as young-of- the-year (YOY) salmon do not move far from where they have hatched out. In 2018, no YOY salmon were counted at four sampling locations on Priest Pond Creek despite there being 150 salmon redds counted in the spawning survey the previous fall. Additional stream areas were spot checked in an attempt to find these first-year salmon, with no success. This absence of YOYs in survey locations, despite strong redd counts the previous autumn, has been documented on at least two other occasions in this river.

Loss of an entire age class, especially the critical 0+ age class, could be catastrophic to the viability of a local salmon population and further study is needed to pinpoint the possible causes of such a failure. Cunjak et al. (1998) emphasized the importance of winter conditions on over- wintering success of juvenile salmon. An additional factor may involve the relationship between water temperature and initiation of feeding in this vulnerable life stage. In hatchery environments it has been shown that salmon fry require a temperature of at least 12°C to initiate viable feeding. **Timing** is critical because salmon fry have a limited amount of time after absorption of the yolk sac to forage successfully on their own. Certain watershed characteristics in the area of spawning could contribute to reduced water temperatures at this critical time. The presence of second year salmon in Priest Pond Creek, following a year with no YOYs observed, would suggest that there are pockets of stream where fry are successfully produced. Cow Creek, Bear River and Hay River have also had fewer juveniles than would be expected from the redds present and the lack of notable sediment inputs. A thorough discussion of this phenomenon, its implications, and suggested recommendations are included in Appendix I. **Research is needed to pinpoint the cause of fluctuating fry success in particular rivers and its impacts on the salmon populations**.

2.7. Climate Change

Changes in timing and intensity of precipitation, increased flooding, water temperature shifts, increased coastal and stream bank erosion, sedimentation, and changes in vegetation are all attributable to climate change and create new challenges for Atlantic salmon recovery. This is a broad area and cannot be addressed in any detail in this report, although it is woven throughout many sections of the report.

The characteristics of a river are important in building the resilience needed to absorb impacts. For example, flooding will result in increased sedimentation in a stream, but diverse and well-connected floodplains can help remove sediment from watercourses. Natural, unobstructed watercourses are more resistant to bank erosion that will occur during flood events.

Agricultural impacts are also likely to intensify as a result of climate change. In two recent fish kills, extreme runoff events were blamed on climate change, although the inability of the agricultural sector to adapt to climate change – using current farming practices - may be the bigger issue. It is also expected that there will be increased winter rain events with significant consequences for accelerated runoff over exposed soil and consequent sedimentation of watercourses.

Extreme weather events and coastal erosion could also impact access to sea in vulnerable coastal areas. The November 2018 storm surge is an example of the intensity of storm surges. Coastal access points for salmon may have highly exposed access channels, or near-shore berms or dams that may be particularly at risk.

Extreme weather events may become more frequent and will necessitate an integrated strategy addressing vulnerable points in the system e.g., areas sensitive to increased runoff from agriculture and roads, resilience of the river to flooding or temperature extremes (e.g. functional floodplains and riparian zones); and an assessment of the adequacy of fish passages, roads, culverts and bridges to withstand the expected increases in storm events and flooding. The task is daunting, and will first require awareness, followed by sustained effort involving government, ENGOs and experts to find solutions.

SECTION 3. KEY HABITAT FACTORS FOR ATLANTIC SALMON

To be successful, strategies for Atlantic salmon habitat restoration must consider habitat requirements for all life stages in each season. The following section addresses key habitat variables that are considered crucial in restoring salmon runs to Prince Edward Island. The significance of each factor will vary among rivers; however, all should be included in any Atlantic salmon management plan. This section identifies key habitat factors for Atlantic salmon and makes general recommendations; we refer groups to the Technical Manual for Watershed Management on Prince Edward Island for specific habitat restoration techniques (Harris et al.2012).

3.1. Habitat Quality

3.1.1. Adult Atlantic salmon

Salmon entering a river require holding areas as they move upstream and select a spawning location. While deep pools are preferred, salmon also find shelter under undercut banks and large woody material. It is important to have a good mix of cover suitable for these large fish. The highest concentration of redds tend to be associated with pools, with spawning taking place at the head and tail of a pool. The wooden cribs installed in North Lake in the mid-1990s, for example, provided excellent spawning habitat and salmon redds are counted in the same locations each year. It should be noted that sections of river downstream from a dam tend to have high densities of juvenile salmon (e.g., Leards Pond on Morell River and Quigleys Pond on St. Peters River), possibly because of the reduced sediment below the dam. Once spawning is completed, salmon spend the winter in pools and ponds.

The nature of the substrate is a major determining factor in whether the redd is successful in producing salmon fry. Atlantic salmon select for a good mixture of gravel and cobble and it needs to be of suitable depth to allow the redd to be thoroughly excavated and eggs covered. Salmon will spawn in substrate that is flat and angular, but the flow of water through the red may not be as suitable as in rock that is more rounded. Also, if hard pan is close to the surface, sufficient depth may not be obtained. In some rivers, the streambed is so embedded, it resembles cement. Salmon have difficulty excavating this material and the success of the redd would be reduced. Some watershed groups have experienced success in raking existing gravel and cobble beds in known salmon spawning locations, as well as adding granite cobble. This was shown to be effective in the West River in resisting washout under extreme flood conditions. An increase in juvenile salmon density was observed after adding heavier granite cobble in spawning locations.

Recommendations

- The transition area for salmon entering freshwater should be assessed and any blockages or impediments in this zone should be addressed.
- If a river is lacking pools, they can be added using proven pool restoration techniques (refer to Technical Manual for Watershed Management on PEI).
- Raking of gravel-cobble beds is labour intensive but can prove effective if used in specific salmon spawning locations. Addition of granite gravel and cobble can also be used to improve spawning success.

3.1.2. Juvenile Atlantic salmon

While adult salmon use freshwater habitat for a short period of time - entering the river in autumn and leaving in early spring - juvenile salmon in Prince Edward Island rivers spend two years in freshwater. Their habitat requirements change dramatically as they progress through various life stages but the principle habitat factor for juvenile Atlantic salmon is substrate.

3.1.2.1. Substrate

Atlantic salmon on PEI are generally associated with cobble substrate (e.g., Roloson et al. 2018). As well, salmon redd quality is determined by the type of substrate located in spawning locations, with coarse, non-embedded substrate directly related to density of young salmon. During the early stages of life, juvenile Atlantic salmon are territorial and are closely associated with the substratum, holding position against the current in the rocks and cobble (aided by their large pectoral fins). The size of the substrate preferred by juvenile salmon differs with life stage. Salmon fry were seen "burrowed" into smaller gravel during the 2018 electrofishing survey. Two salmon fry were inadvertently crushed while walking in the survey site. Second year salmon are found in river reaches where larger cobble provides cover in interstitial spaces. Juvenile salmon may also move into the substrate when water temperatures are at winter lows, most likely to come in contact with warmer groundwater (Heggenes 1990, Wimmer et al. 1984); however, winter survival may be affected by a number of environmental factors that affect habitat availability (e.g., Cunjak et al. 1998). Salmon fry are found in close in proximity to the redds in which they hatched, but second year parr can move considerable distances to find suitable habitat.

Field assessments in 2018 found that the highest density of juvenile salmon, especially for salmon fry, was in well sorted, unembedded, rounded gravel- cobble substrate with adequate interstitial spaces to provide cover. These characteristics are evident in the sample taken from North Lake Creek (right). At this site, high densities of juveniles were found in very shallow water that barely covered the substrate, occupying the interstitial spaces in the gravel. Flatter stones may not provide interstitial spaces for juvenile salmon unless manually manipulated. Several watershed groups have raked existing embedded gravel-cobble substrate or have added cobble to streams to improve salmon habitat.

Recommendations

- Where suitable gravel-cobble substrate is embedded, raking the stream bottom in late summer can improve juvenile salmon habitat until sedimentation issues are resolved.
- Addition of a mixture of granite gravel and cobble in suitable locations can improve juvenile salmon habitat in rivers with poor quality substrate.
- Crews accessing a site on a regular basis should walk along trails rather than through the stream itself. Many feet walking over gravel beds has potential to kill a large number of juvenile salmon, particularly in sensitive areas where salmon are known to spawn.

3.1.2.2. Other cover

While rocky substrate is of primary importance for juvenile Atlantic salmon, they also use several other types of cover such as medium to large woody debris (LWD) and submergent and emergent vegetation. Floodplain vegetation, such as dense sedges and grasses, could potentially also provide important cover in high water or flood conditions. Predator avoidance is a major function of cover for juvenile salmon. On PEI, all rivers with Atlantic salmon also have trout populations that can be found in similar stream reaches. During their first year, Atlantic salmon can become prey for larger brook and rainbow trout, and they seek shelter in shallow water and vegetation along stream edges or within rooted instream vegetation. Larger parr tend to be in cobble and under banks and woody material.

When smolts leave the river and swim toward the ocean, they encounter a wide variety of predators. Fortunately, there are a variety of fish species in the estuary for predators like seals and cormorants to eat. “Prey cover” refers to the “safety in numbers” effect of the salmon smolts migrating to saltwater at the same time as large numbers of blueback herring, gaspereau and smelts are in the estuary. Recent smolt tagging studies in North Lake Creek (see text box) indicate that smolts are quite successful in traveling through the estuary. The abundance of smelts in the North Lake Creek estuary at the time of the smolt exodus may have been a factor in the high survival rate.

Recommendations

- Co-manage “prey cover” species by restoring and maintaining habitat and access for these species. A key part of this management is the removal of blockages affecting prey cover species on all watercourses, big and small, which drain into an estuary used by Atlantic salmon.

3.2. Habitat Connectivity

For a species that migrates between fresh and saltwater during its life cycle, maintaining access to and between critical habitats is a fundamental determinant of success. When salmon are transitioning from salt to fresh water, it is beneficial to have a long estuary with deep holding pools. Examples of holding areas at or near the head of tide include estuarine pools in the Naufrage River, the TransCanada Highway pool and Crosbys Pond on the West River, and constructed pools in the former Getsons mill pond in Trout River. Other rivers, such as Cow River and Bear River, have an abrupt exit at the shore. With storm events and coastal erosion, such rivers may fan out over a wide swath of beach and Atlantic salmon may have to wait for a very high tide to readily ascend and could experience difficulty attempting passage.

Once in fresh water, salmon encounter natural and man-made obstacles that may prevent them from reaching spawning habitat. The 2017 redd survey found that the first major beaver dam often marked the upper limit of spawning. Connectivity has spatial, seasonal, and life stage dimensions. Put simply, salmon will use different parts of the river at different ages and at different times of the year. For example, delays caused by blockages to downstream passage would impact the successful recruitment of smolts to the marine environment in the spring, while limiting upstream passage for spawning adults later in the year; pointing to the need to check for blockages prior to both the smolt migration and the adult spawning period. The impact also depends greatly on location. Head of tide dams that block the connection between estuary and freshwater and/or access from open sea to coastal ponds are considered a major barrier to successful salmonid runs (ASE Consulting and UPEI 1997).

Removing blockages to salmon access on PEI rivers was a major focus of the 2009 Atlantic Salmon Conservation Strategy and more background on the issue can be found in that report. Since then, a great deal of progress has been made by local watershed groups in clearing beaver dams and other instream blockages, installing fish ladders, and repairing or improving the design of culverts. However, significant issues with connectivity remain.

While many kinds of blockages can occur, beaver dams continue to be one of the most important impediments to Atlantic salmon in many Island streams. Under ideal conditions, salmon can jump as high as 4 metres but a beaver dam, with its lack of defined waterfall and pool, does not provide the right hydraulic lift necessary for salmon to jump. Salmon can negotiate around some dams or work their way through others, but some dams are impassible, especially under low water conditions. This is particularly serious if the dam is located at the head of tide, as was the case in Bear River in 2018. While most people associated dams with blocking the spawning run, a beaver dam can also block downstream movement of smolts, depending upon stream flow conditions in spring. Kelts and smolts were observed holding within a beaver impoundment on the west branch of the Morell River in the mid-1990s (Guignion pers. comm.).

In some rivers, where beaver numbers and dams are carefully managed, salmonids and beavers can co-exist. It is when multiple beaver dams lead to long term changes to riparian zones, stream flow and substrate, and water temperature that serious impacts occur on cold water fishes like Atlantic salmon. The Marie River, for example, has lost its run of Atlantic salmon due to the combination of man-made and beaver impoundments, and a large percentage of the Midgell River is currently unsuitable for salmon.

Recommendations

- To effectively assess and manage blockages, a connectivity assessment and completion of a beaver management strategy should be part of a salmon habitat management plan for all salmon bearing streams. The assessment should look at the impact of blockages throughout the salmon's lifecycle, and from headwaters to the sea.
- Ongoing management of beaver populations is needed to maintain salmon habitat. Beaver dams should be assessed seasonally and especially prior to critical migration and spawning periods. Despite the enormous effort involved, ongoing persistence is needed to ensure that annual or seasonal loss of connectivity does not negate years of hard work. Beavers can rebuild or move into an area quickly, even after dams were cleared a few weeks prior.
- In some streams, leaving a "sill" at a beaver dam site may assist in warming water temperatures in spring and could provide benefits to salmon fry (see Section 2.6).

3.3. Water Temperature

Water temperature is a key factor controlling vital activities of Atlantic salmon at all life stages. In general, salmonids thrive in the relatively cold, spring-fed waters of PEI. It is when a low gradient river becomes impounded that water temperatures can warm to levels that are inhospitable to cold water fish like Atlantic salmon and brook trout. For example, ASE Consulting and UPEI (1997) found that water temperature in low relief streams with multiple beaver or man-made impoundments often exceeds optimum water levels for salmonids. Although Atlantic salmon are known to tolerate higher temperatures than brook trout (juvenile salmon may tolerate temperatures of 27.8°C), the optimal temperature range for Atlantic salmon productivity would be well below this (e.g., DFO 2012). However, in a river with cold water temperatures, such as the West River that rarely exceeds 13˚C in summer, warmer water may be beneficial for salmon.

The importance of colder temperatures as a limiting factor Atlantic salmon is not well understood for PEI rivers. Cold water temperatures in spring that could limit survival of emerging salmon fry is a potential limiting factor that requires additional study (Section 2.6).

Recommendations

- Research is needed to assess the impact of cold-water temperatures on salmon fry
- Water temperature monitoring should be done on warm rivers and a management strategy developed to identify options available to improve conditions.

3.4. Food Availability

The quality and quantity of preferred dietary items has obvious consequences for Atlantic salmon juveniles. It is generally thought that preferred dietary items for juvenile Atlantic salmon are microbenthic invertebrates, e.g., stonefly or mayfly larvae, and these are often considered an indicator of ideal water and habitat quality. Salmon fry, once their yolk sacs are depleted, are likely to feed on smaller organisms such as zooplankton. The Department of Fisheries and Oceans Genomics Laboratory in Moncton NB have been using sequencing analyses of DNA from Atlantic salmon parr feces to assess their diet (Appendix II). Early results indicate that headwater streams like the upper reaches of the Brookvale branch in West River seem to produce a perfect match of food items for juvenile salmon, likely resulting in better survival.

Recommendations

- Research on the diet of juvenile Atlantic salmon will be important to understanding food availability in various river reaches and should assist in planning restoration activities in the future.

3.5 Habitat Availability

For many rivers, salmon population growth is limited by habitat availability, either due to a barrier to access or the need to enhance habitat for various life stages. For example, the Morell and Midgell Rivers are maintaining runs of Atlantic salmon but at a level lower than one would expect for such large systems. It may be assumed that salmon spawning is occurring in certain areas because these sites present ideal habitat. However, a blockage upriver could be the reason why salmon are currently spawning in a location, and not because it is ideal habitat. Ideally, salmon spawning areas should be distributed throughout the watershed. Salmon populations will suffer if they are restricted to spawning in poor quality habitat or in a limited amount of good quality habitat. Even the highest quality section of river can only support a certain number of juveniles.

Habitat availability in nearby rivers is also important and a key reason why we treat our assessment as “clusters” of rivers rather than isolated rivers. Rivers adjacent to salmon streams can serve as alternate sites for salmon when conditions in nearby rivers are unfavorable, for example a blockage near the head of tide.

Recommendations

- In many of PEI's salmon rivers, salmon are restricted to a short distance of stream and additional upstream habitat would need to be made accessible and restored if the population is to increase.
- Management plans for salmon rivers should include an identification of areas which would historically have been used by salmon and could be restored to productive salmon habitat.
- Salmon rivers should be managed as "clusters" and suitable habitat maintained in adjacent rivers, even where salmon are not currently present.

3.6. Competition

Some of the salmon rivers on PEI have brook trout and rainbow trout, as well as Atlantic salmon. While brook trout and salmon both spawn in late autumn, rainbow trout spawn in April. On the West River, rainbow trout have been observed to excavate their redds on top of Atlantic salmon spawning sites from the previous fall. Rainbow trout were once only found in south side rivers of the Island but are now established in three northside rivers, and it appears as though the range of rainbow trout is moving eastward. Rainbow trout are known to be aggressive and fast growing and their impacts on salmon in PEI streams is not fully understood. Recent studies in PEI suggest that because of habitat separation between the three salmonid species, the impacts of rainbow trout may not be the most significant threat to native salmonid populations (Roloson et al. 2018). A fourth salmonid, brown trout, is now more frequently caught by anglers in PEI and may also be expanding its range.

3.7. Impoundments

While dams block access for salmon, the impoundments they create can have far reaching effects (ASE Consulting and UPEI 1997). One of the most significant impacts for salmonids is the warming effect on downstream waters. This is especially important in watersheds such as the Morell where numerous impoundments flood low relief land, changing the temperature regime for the river. The impact is particularly noticeable for brook trout. Normally, good numbers of brook trout are found during electrofishing surveys. In those sites prone to excessively warm summer water temperatures, very few trout (and in one site, zero trout) were found, even though surveys were carried out long after water temperatures had reduced to acceptable levels.

There are many different ways to manage an impoundment for fish and wildlife, depending on the river and the management objectives. Options may include, but are not limited to: seasonal or regular draw downs, bottom draw to improve water temperatures, operating at a lower level, altering the fish passage structure, maintaining the status quo, or decommissioning.

Recommendations

- River management plans for Atlantic salmon should include an impoundment management strategy.

MAPS

WATER TEMPERATURE DATA

Excel files

HABITAT ASSESSMENT DATA

Excel files

TRAP DATA

Excel files

PIT TAGGING DATA

Excel files

MACROINVERTEBRATE DATA

Excel files and Environment Climate Change Canada web data base

ELECTROFISHING DATA

Excel files