Miramichi Salmon Association
Conservation Field Program Report
2011

Prepared by:
Jenny Reid
Biologist
Miramichi Salmon Association
South Esk, New Brunswick

In Cooperation with:
Department of Fisheries and Oceans
Northumberland Salmon Protection Association
Rocky Brook Camp – International Paper
Atlantic Salmon Federation
Miramichi Watershed Management Committee

Funding Provided in Part By:
New Brunswick Wildlife Trust Fund
Canada Summer Jobs
Student Employment Experience Development (SEED)
JD Irving Ltd.

Table of Contents

List of Tables

List of Figures

1. OVERVIEW

This report is a review of the 2011 Miramichi Salmon Association (MSA) field and research programs for rivers and streams in the Miramichi Watershed. A large focus of the field programs for the MSA is on the Cains and Dungarvon Rivers looking at juvenile (fry and parr) and smolt production, as well as focusing on headwater areas that can be used to enhance juvenile salmon production due to habitat quality, less competition and typically fewer predators than lower reaches.

The MSA was started in 1953 as a non-profit conservation group dedicated to protecting the Miramichi River system. The MSA has acted as a conservation advocate on behalf of anglers, outfitters, guides, and all others with economic, environmental and recreational interests in the river. Managed by volunteers from Canada, the USA and abroad, as officers and directors, the MSA remains cooperative with, but independent of, government or special interests influence. It responds in the end only to its growing conservation membership. The MSA employs four full-time staff as well as one seasonal field technician.

The MSA has evolved since 1953 from primarily a conservation advocate group to non-profit conservation group whose work focuses on research and field programs. Through partnerships with government organizations and other non-profit groups, the MSA has been crucial in increasing the amount that is known about Atlantic salmon on this river and assessing the current status of many life stages of Atlantic salmon on the Miramichi, and providing funding to other important programs that would not be able to take place.

In addition the MSA also oversees the Miramichi Salmon Conservation Centre, located in South Esk, NB, which is used to produce Atlantic salmon and brook trout fry for enhancement activities.

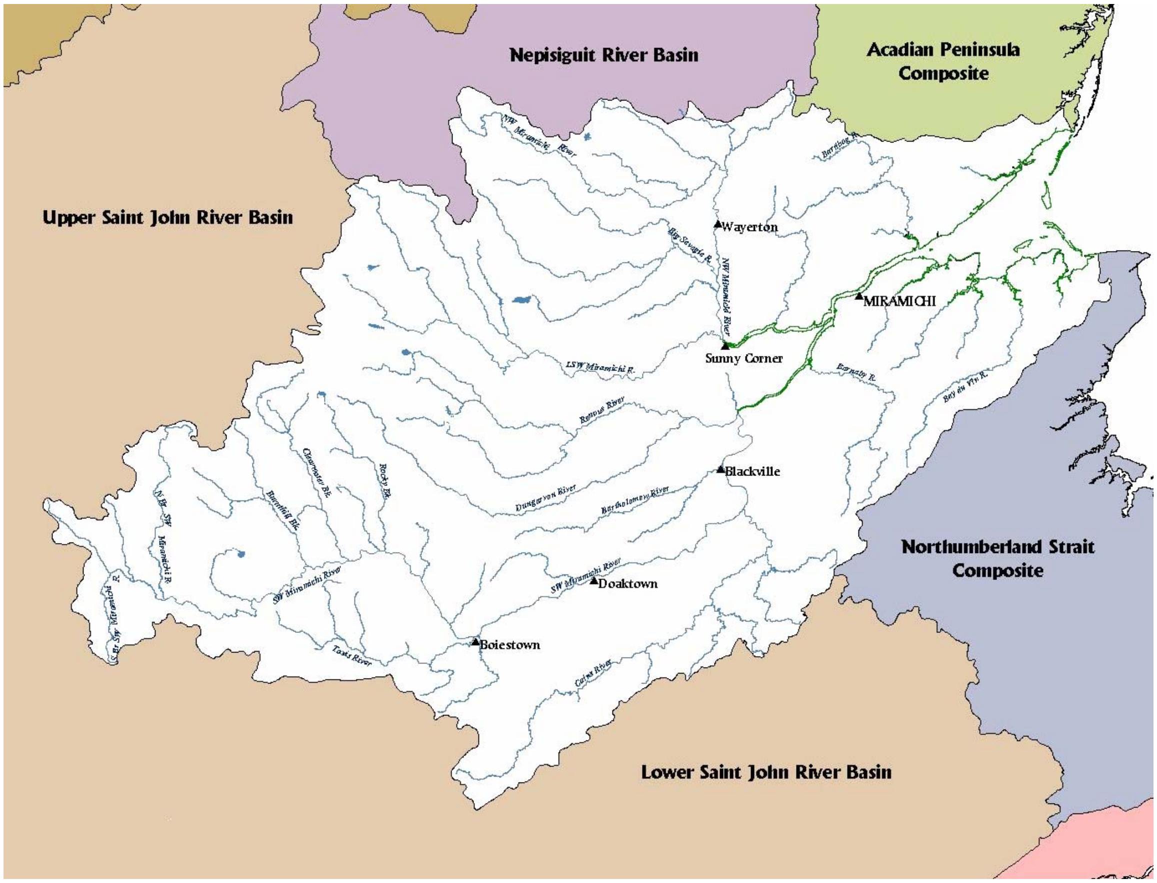


Figure 1. A map showing the Miramichi River basin.

2. KELT TRACKING THROUGH THE MIRAMICHI RIVER AND ESTUARY

Introduction

Kelts are salmon that have spawned the previous fall and are migrating out of the river towards the ocean in spring to feed and recondition. Kelt survival on the Miramichi River is currently estimated between 15-20%, based on the life history characteristics of the fish captured in the DFO index trap nets. Fish that return to spawn in subsequent years are termed repeat spawners and they make up an increasing amount of the spawning run each year. Since they are older, these fish tend to be larger and produce larger eggs and more eggs than maiden fish (grilse and 2 sea-winter maiden salmon). It is estimated that they produce between 25-40% of the eggs laid each year in the river. Repeat spawning salmon can either come back the subsequent year they left the river or the same year they left the river. Kelts that leave the river in spring and come back that same year are termed consecutive spawners. Kelts that leave the river in spring and come back the next year to spawn are termed alternate spawners. Approximately half of the repeat spawning salmon come back as alternate spawners and half as consecutive spawners, depending on the year. There is a large loss of Atlantic salmon at sea and this project will give insight into where the losses of some of these adults may be occurring.

The purpose of this project is to determine the migrations paths and timing of kelts movements through the Miramichi River, estuary and Gulf of Saint Lawrence. It will give us information on the temperature and depths kelts prefer to migrate through and how long individual kelts spend in the ocean before returning to spawn. This project will also give us the locations and possible sources of mortality for some of the kelts.

Methods

Vemco VR2 receivers were deployed at the head of tide, Cassilis and Millerton, NB, at Loggieville at the river mouth and between the barrier islands in Miramichi Bay near Neguac, Portage Channel and Huckleberry Gully. Receivers were also deployed in the Strait of Belle Isle between Newfoundland and Labrador and in the Cabot Strait between Newfoundland and Cape Breton. This is the first year that Cabot Strait had receivers in it which were put in place through the Ocean Tracking Network.

The spring salmon, or kelts were captured by angling on the Miramichi River below the head of tide. Fish were anesthsitized using MS-222 in an oxygenated holding box. The fish was held upside down by another holding box with a wet sponge over the fishes' head to keep the gills moist. A transmitter was surgically inserted into the abdominal cavity by making a small incision in the abdominal wall and sliding the transmitter into the cavity. The incision was then closed with 2-3 sutures depending on the size of the incision. The surgery took between 1-3 minutes. After surgery the fish was placed in a wooden holding box with river water flowing through it to recover. Each transmitter (tag) gave each fish an individual code, which was be used to identify it when it passed by receivers located at the head of tide, at the mouth of the river, at the barrier islands at Miramichi Bay or through the Strait of Belle Isle. After the fish had fully recovered the fish was released back into the river.

Receivers recorded the tag number, date and time of kelts each time the fish and tag passed the receiver.

Results

Overall 50 kelts were angled and tagged over a two day period, on May 3rd and 4th, 2011 on the Northwest and Southwest Miramichi. Twenty seven kelts were tagged on the Northwest Miramichi, at Red Bank, and twenty three kelts were tagged on the Southwest Miramichi at Quarryville. The surgery typically took around two minutes and all fish recovered fully. Each fish was implanted with an acoustic tag which records the date and time as a fish passes a receiver. A range of fish sizes were tagged, with the smallest being 22.8 inches and the largest being 38.8 inches. Two were female grilse, nine were male grilse, twenty seven were female salmon and twelve were male salmon.

Kelt survival out of the river and estuary was very high, 94% of the tagged kelts through inner Miramichi Bay. The kelts moved through Miramichi Bay between May 7 and June 2nd, 2011. Two kelts went through the Neguac exit, 43 went through receivers in Portage Channel, the main river channel exiting Miramichi Bay and two kelts were not picked up by the receivers in Miramichi Bay. No fish exited near Huckleberry Gully near Bay du Vin, NB. Of the 46 kelts that made it through the outer array, fifteen kelts passed through the Strait of Belle Isle on their way to Greenland. Based on the data we have collected to date it appears that the kelts that went through the Strait of Belle Isle are making their way to Greenland and are alternate spawners These kelts will recondition in the ocean in 2011 and may return to spawn in 2012.

The kelts that exited the estuary but were not picked up by the receivers at the Strait of Belle Isle may have exited through the part of Cabot Strait not covered by receivers, may be reconditioning the Gulf of Saint Lawrence or may have died at sea.

Five kelts returned back to the Miramichi River, to spawn in 2011. The kelts that returned back to the Miramichi in 2011 are consecutive spawners, which recondition in the ocean for part of the summer and return in the summer or fall of 2011 to spawn again. Most of the kelts that came back to the river moved through the bottom section of the river within two to three days of entering. All of the kelts that returned to the Miramichi River went up the respective branches where they were tagged this spring. Of the kelts that returned two were tagged as female salmon and three were tagged as male salmon. All of the kelts returned to the river between July 9 and July 26th, 2011.

We will not know entirely how many kelts successfully returned until 2011 when the kelts that went to feed off the coast of Greenland return.

Table 1. Numbers of kelts of each size and sex picked up on receivers in the Miramichi River and bay, Strait of Belle Isle and returning to the river in 2011.

Sex	Size	Tagged	Miramichi Bay	Strait of Belle Isle	Returned
Female	Salmon	27	27	7	2
Female	Grilse	2	1	1	0
Male	Salmon	12	10	4	3
Male	Grilse	9	9	3	0

b)

a)

Figure 2. a) Biologist Jenny Reid implants a kelt with an acoustic tag for tracking its movements through the Miramichi River and Gulf of Saint Lawrence. b) President Mark Hambrook releases a kelt that has undergone surgery.

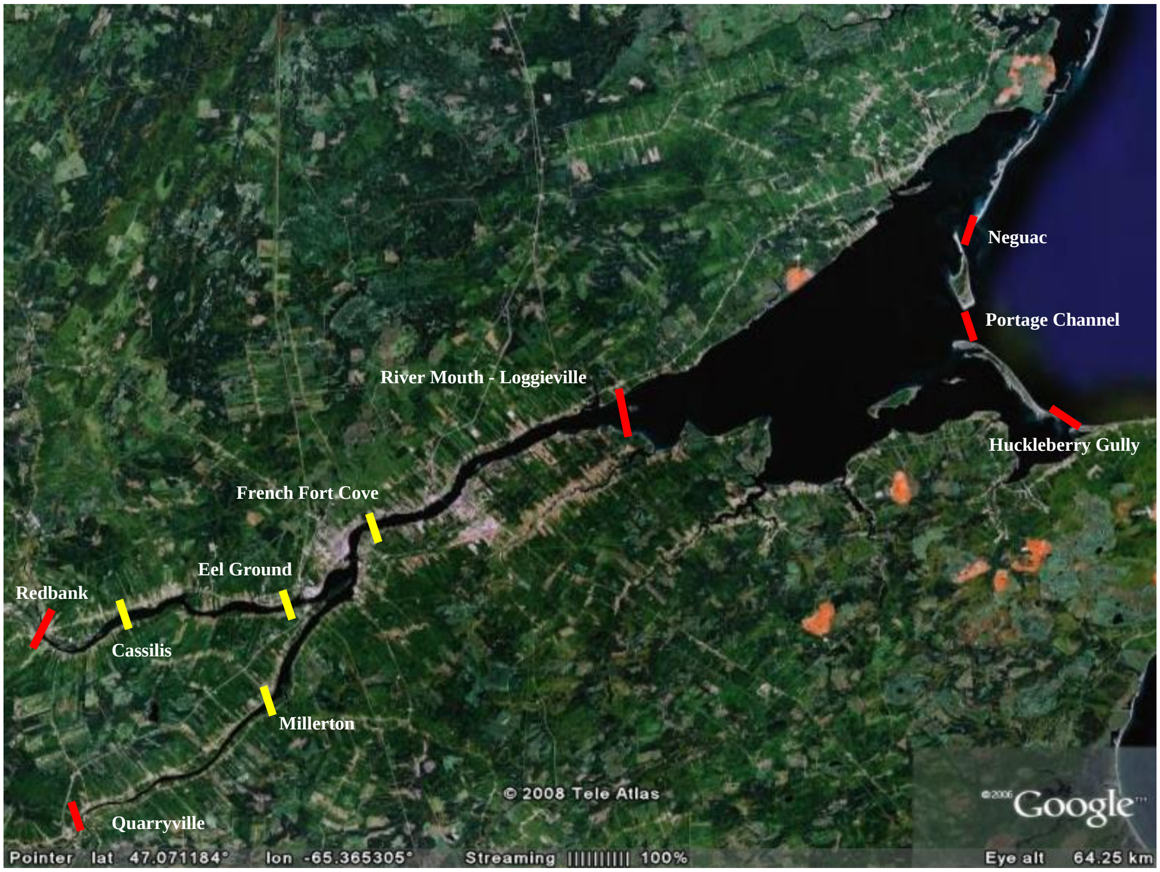


Figure 3. Location of receivers in Miramichi River and Miramichi Bay. Red lines are receivers located at head of tide, river mouth and exits of barrier islands, yellow lines are additional receivers which may have extra information about a kelt's movements.

Figure 4. Location of receivers in the Gulf of Saint Lawrence. Red lines are receivers arrays.

Acknowledgements
The Miramichi Salmon Association acknowledges the financial contributions of the Atlantic Salmon Federation, New Brunswick Wildlife Trust Fund, MSA kelt sponsors and volunteers, and in kind-help provided by the Department of Fisheries and Oceans for this project in 2011.

3. JUVENILE PRODUCTION – FRY AND PARR

Introduction

The Miramichi Salmon Association (MSA) continued its electro-fishing program in 2011 to assess juvenile Atlantic salmon populations in the headwater areas Miramichi River watershed. The MSA worked co-operatively with the Department of Fisheries and Oceans (DFO) Science Branch on another survey to target sites being monitored on a yearly basis to assess Atlantic salmon on the Miramichi watershed.

The electro-fishing survey targets Atlantic salmon fry and parr in the river. All other fish species captured are recorded and fork lengths are taken. Wild fry (0+) are typically less than 60mm in length in late summer and wild parr (1+, 2+) vary in size by site but are grouped together in length by year class and generally don't exceed 120mm. Fish that are reared at the Miramichi Salmon Conservation Centre and in the MSA Satellite Rearing tanks are marked by the removal of the adipose fin (adipose clipped – AC). In many cases these fish have experienced accelerated growth due to feeding and being reared in optimal water temperatures that are conducive to growth. Generally the fish are larger than wild fish of the same age class.

There is typically a higher abundance of 0+ fish than 1+ or 2+ salmon, with fewer salmon being present in the next subsequent age class due to mortality and predation from year to year. If this trend is not observed, it could be viewed as an indication that fry survival is low and should be investigated. In this report, juveniles are listed as fry and parr, with the parr consisting of 1+ and 2+ age classes.

Sites

MSA/DFO electro-fishing sites are generally 3rd or 4th order streams which are tributaries to major rivers where salmon are historically present and spawn but also include some main river sites. Generally, swift moving water less than 60cm in depth with gravel, rocky substrate characterize juvenile salmon habitat. It is important to note that juveniles do not remain in one place. While adult salmon migrate upstream as far as possible to spawn, juveniles in their first, second or third year do move around quite extensively in search of food, avoiding predation and searching for suitable over-wintering habitat. During the warm summer months, juveniles will generally seek colder water refuge.

The tributary streams are of major focus to the MSA electrofishing as they are considered feeder streams to the major rivers. The selection of a specific stream is made to:

1. Estimate the number of juvenile salmon in the river. Work is currently being conducted collaboratively through the MSA/DFO to estimate the numbers of smolts that are produced from the Southwest Miramichi and the Cains and Dungarvon tributaries. The estimate developed for parr through electrofishing can give us an indication of the number of smolts that could be expected for the subsequent year.

Additionally the fry to parr survival, and parr to smolt survival, can be calculated to aid in determining where bottlenecks to salmon production may be.

2. Assess proper distribution of fall fingerlings. Broodstock are collected from specific rivers and their progeny must return to their native river system. Determining densities allows us to avoid overstocking and target naturally under-stocked streams in each individual river system. In terms of stocking, any site containing more than 100 fry / 100m^2 is not considered for stocking as it appears to reflect a healthy natural population. Sites with less than 50 fry / 100m^2 are first considered candidates for fall stocking.

3. Identify problem areas. Evidence of fry indicates evidence of adult salmon present last fall. No fry present could mean that adults were unable to access the spawning grounds. That is, the river or stream may be barricaded in some way (beaver dams) as to limit upstream migration of adults. Not only will these areas be targeted to stock but efforts may be made to identify and remove any impediments to natural spawning.

4. Evaluate the success or failure of past stocking activities by identifying and recording any adipose clipped parr found at the site. In many cases areas which have been stocked in the past couple years will show a presence of adipose clipped parr identifying that area as a successful stocking site.

Methods

Electrofishing is the use of electricity for the capture and control of fish. Electricity is generated by a battery located on the back-pack of the electrofisher. An anode wand (positive) and the cathode tail are placed in the water. The current moving between them produces an electric field that is used to stun and capture fish. When a site has been identified, a crew of three people wearing leak proof waders and rubber gloves enter the site facing upstream. The other crew members collect the fish with dip-nets and a small seine net as they are drawn up to the water surface by the electrical current. The fish are placed in a bucket of water and held until the site is completed.

There are two methods for measuring density in a given area: Catch Per Unit Effort (CPUE) and Removal. The MSA survey for assessing headwater areas for stocking uses the CPUE method exclusively. This process is continued back and forth along the stream from bank to bank, until 500 seconds has elapsed on the electro-fisher. The crew then samples the captured fish on shore for length by species. All salmon are checked for the presence of the adipose clip. The fish are then released back into the stream.

The removal method, which is done on the juvenile assessment survey done in collaboration with DFO is done by capturing all fish from a given section of stream rather than a timed sample as in the CPUE method. A 200 square meter section of stream is measured off and barricaded with fine nets at the upper and lower ends of the site. This ‘closed site’ is then swept three to four times removing all fish or until an acceptable reduction in fish occurs (usually four sweeps). This produces an actual density for an area and is used to calibrate the formula for the timed CPUE method. All fish are identified to species and lengths and weights are recorded. Substrate type (rocky, gravel, etc.), stream type (riffle, run, etc.), water and air temperature, and site dimensions are all recorded along with a diagram of the site.

Assessment of Stocking First Feeding Fry

Since 2010 the Miramichi Salmon Association has shifted the focus from stocking young of the year Atlantic salmon fingerlings in fall to stocking first feeding young of the year salmon in early spring when they would normally being feeding for the first time in the wild. Stocking sites were selected based on the previous years electrofishing results as well as some additional headwater sites that were thought to likely have low levels of fry. Twenty stocking sites were selected and electrofished later in the summer to determine if the first feeding fry stocking was successful. These sites were all headwater tributary sites with moderate to high Atlantic salmon habitat qualities. We compared the average density of the sites stocked with first feeding fry to those not stocked with first feeding fry as well as compared the fry numbers in 2010 when first feeding fry were stocked with the fry numbers in 2006-2009 when those sites were not stocked with first feeding fry.

Figure 5. Technician Tyler Storey captures juvenile salmon by electrofishing with Pius Marshall on the dip net and Matt Ward on the seine.

Results

Juvenile population assessment survey (MSA/DFO)

Of the sites that were sampled, similar numbers of fry and parr were found in 2011 as compared to 2010. On average in 2011, moderate fry levels were found on the Southwest Miramichi tributaries and Taxis River. High fry levels were found on the Cains, Dungarvon, Renous and very high fry levels were found on the South Branch of the

Southwest Miramichi (Figure 1). High parr densities were found in the Dungarvon, Renous, Taxis and Southwest Miramichi tributaries, except for the Cains and South Branch of the SW Miramichi which generally had low parr densities (Figure 2). On average the Northwest Miramichi had very high fry densities on the upper reaches of the Northwest Miramichi, and moderate fry densities on the main stem of the Northwest, Sevogle and Little Southwest (Figure 3). The Northwest Miramichi had high parr densities on the upper reaches of the Northwest Miramichi, Sevogle and moderate densities the Little Southwest (Figure 4).

Electrofishing assessment of stocking first feeding salmon fry in spring
Twenty two sites were stocked with first feeding fry from the Miramichi Salmon Conservation Centre in June of 2011 on the Miramichi River. We compared the average density of the sites stocked with first feeding fry to those not stocked with first feeding fry (Figure 5). The average fry density at the sites that were not stocked with first feeding fry was 11 fry per $100m^2$ which is considered a low fry density, while the sites that were stocked with first feeding fry had average densities of 113 fry per $100m^2$, which is considered above the optimum fry density. Of the 14 sites that were not stocked, eight had no fry at the sites and the additional six sites had between (6-69 fry per $100m^2$). All of the sites that were stocked, had fry present, ranging from 3 to 422 fry per $100m^2$. Over half of the stocked sites had fry densities higher than the optimal number. The survival of first feeding fry is good and can help to increase the overall juvenile salmon production in the river. Therefore the MSCC will continue its stocking of first feeding fry in the future.

Table 2. Predicted abundance of Atlantic salmon fry and parr/100m^2, calculated by CPUE method, from headwater sites located on the Miramichi River.

Major River	Site	Fry	Parr	Stocked 2011
Cains	10 Mile Brook	0.0	7.8	No
Cains	Sling Dung	0.0	3.6	No
Cains	Cains River	0.0	3.6	No
Cains	McKinley Brook	0.0	6.1	No
Cains	Muzroll brook	6.3	17.3	No
Little Southwest	North Pole Stream	8.8	1.2	No
Little Southwest	West Branch Little Southwest	32.3	1.4	yes
Little Southwest	Devils Brook	54.8	0.0	Yes
Little Southwest	Squaw Barren Brook	56.3	24.7	Yes
Little Southwest	Lower North Branch Little Southwest	70.7	0.0	Yes
Little Southwest	North Pole Stream	113.3	0.0	Yes
Little Southwest	Libbies Brook	117.4	43.5	Yes
Little Southwest	Fish Brook	130.2	0.0	Yes
Little Southwest	Upper Saddlers Brook	143.9	0.0	Yes
Northwest	South Branch Northwest Miramichi	3.5	27.9	Yes
Northwest	East Branch of the South Branch Northwest	40.5	0.0	Yes
Northwest	Gill brook	135.2	1.2	Yes
Northwest	Tomogonops	174.1	0.0	Yes
Northwest	Mountain Brook	196.2	35.0	Yes
Northwest	South Branch Northwest Miramichi	281.0	0.0	Yes
Northwest	Tomogonops	422.4	13.1	Yes
Sevogle	Travis Brook	0.0	1.2	No
Sevogle	Clearwater	78.0	26.3	Yes
Sevogle	North Branch Sevogle	195.4	0.0	Yes
South Branch Southwest Miramichi	Little Teague	20.7	14.3	No
South Branch Southwest Miramichi	Juniper Brook	21.7	0.0	No
South Branch Southwest Miramichi	Simpson Brook	29.8	10.9	No
Southwest Miramichi	Betts Mills Brook	0.0	9.3	No
Southwest Miramichi	Big Hole Brook	0.0	1.4	No
Southwest Miramichi	Porter Brook	0.0	9.5	No
Southwest Miramichi	Doak Brook	10.7	12.3	Yes
Southwest Miramichi	Moores Donnelly Brook	40.4	0.0	Yes
Southwest Miramichi	Bartholomew	48.4	24.1	Yes
Southwest Miramichi	Crooked Bridge Brook	62.6	11.7	Yes
Southwest Miramichi	Big Hole Brook	69.1	9.5	No
Southwest Miramichi	Morse Brook	81.3	0.0	Yes

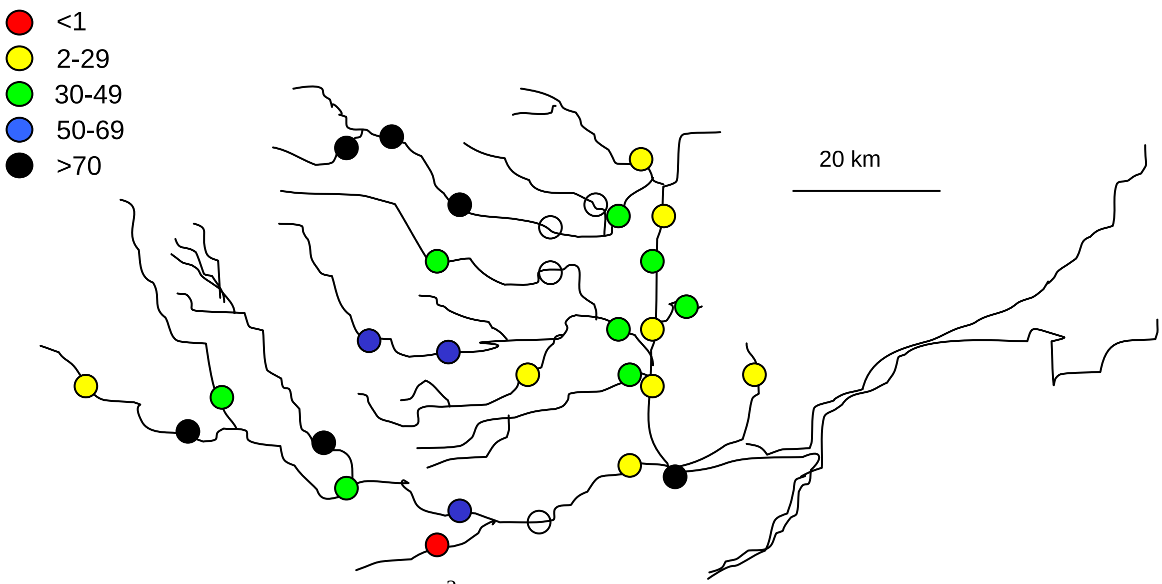


Figure 6. Density of fry per 100m^2 on the Northwest Miramichi based on the juvenile abundance survey. Clear circles indicate sites that are normally part of the assessment but were not surveyed due to issues with high water.

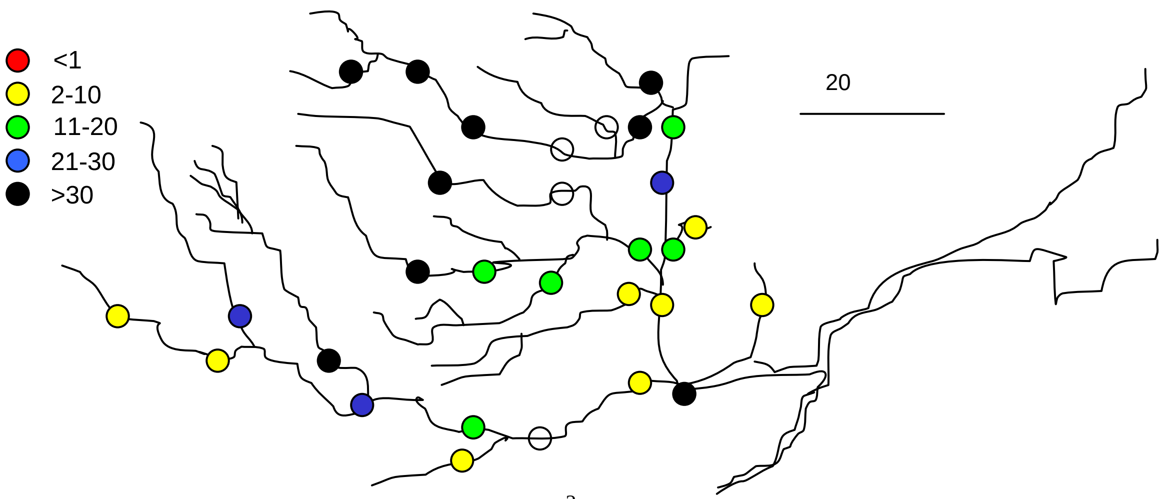


Figure 7. Density of parr (1+ 2+) per 100m^2 on the Northwest Miramichi based on the juvenile abundance survey. Clear circles indicate sites that are normally part of the assessment but were not surveyed due to issues with high water.

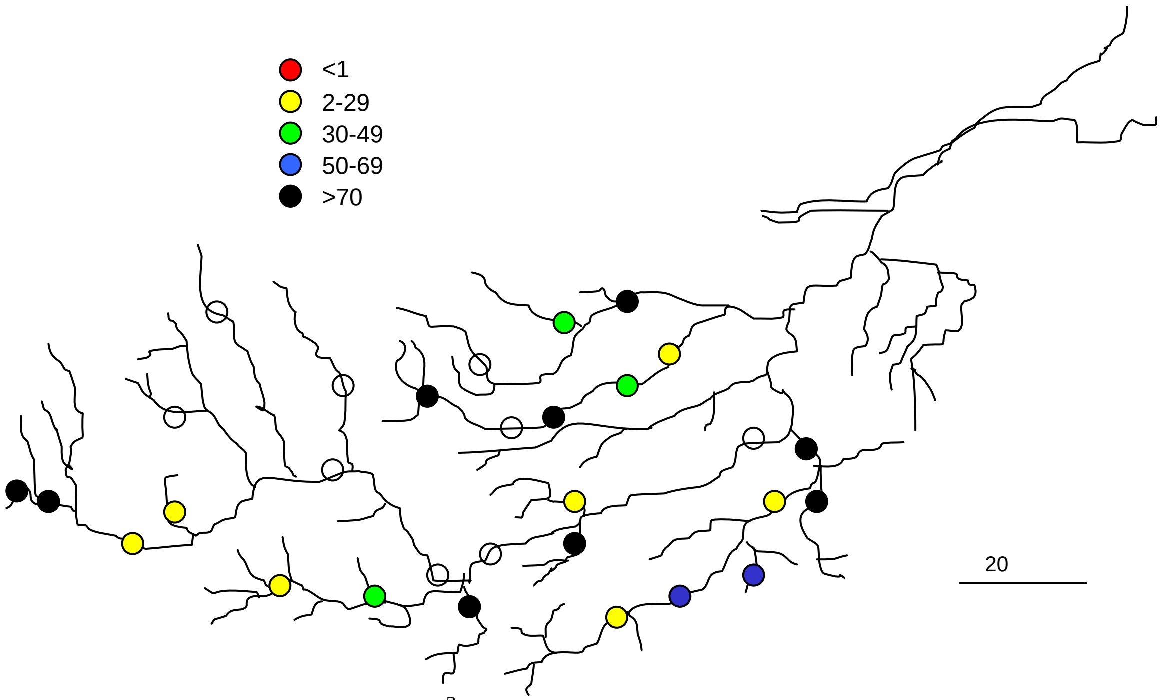


Figure 8. Density of fry per 100m^2 on the Southwest Miramichi based on the juvenile abundance survey. Clear circles indicate sites that are normally part of the assessment but were not surveyed due to issues with high water.

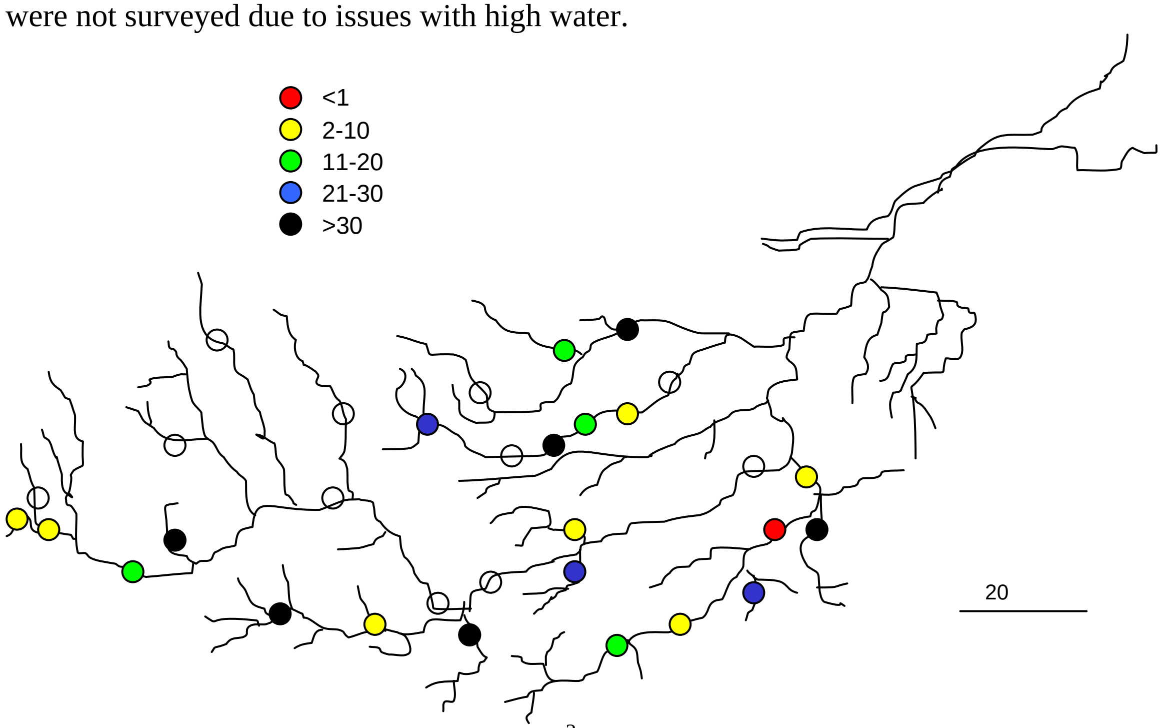


Figure 9. Density of parr (1+ 2+) per 100m^2 on the Southwest Miramichi based on the juvenile abundance survey. Clear circles indicate sites that are normally part of the assessment but were not surveyed due to issues with high water.

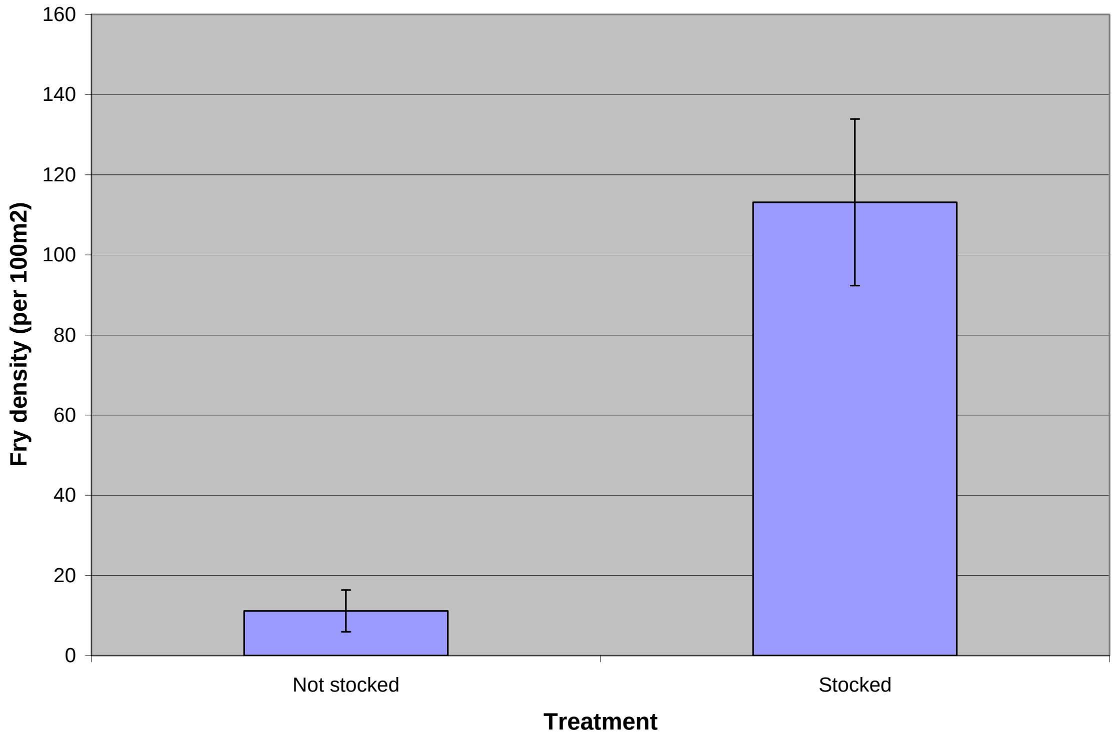


Figure 10. Average density of electrofishing sites in 2011 stocked with first feeding fry compared to sites that were not stocked with first feeding fry in 2011.

4. SMOLT PRODUCTION

Smolt Production Study on the Southwest Miramichi River

Introduction

Over the past three decades there has been a continuing need for conservation efforts to sustain Atlantic salmon stocks in the Miramichi River. While the adult stock assessment has indicated that Southwest Miramichi has averaged 103% (range 77% to 119%) of the conservation requirement (for sustainability) in the years 1998 – 2009, the Northwest Miramichi typically reaches less than 50% (range 26% to 111%) of spawning escapement in a given year.

Although electrofishing studies on the Northwest Miramichi have consistently indicated an abundance of fry and parr in the river, the adult returns have been much lower than should logically be expected. It has been assumed that smolt production would be consistent with the levels of juveniles, however adult returns to the Northwest Miramichi do not seem to reflect this trend. Hence, an accurate estimation of the total smolt population migrating from the Northwest Miramichi River and it’s tributaries is an essential component to understanding and managing Atlantic salmon in this watershed and a way to measure at-sea survival of smolts returning as grilse and salmon. This information will also allow us to determine which tributaries contribute the most to smolt production on the Northwest Miramichi since the juvenile densities (fry and parr) vary between tributaries, with the Little Southwest being the lowest, Sevogle moderate and Northwest Miramichi being highest.

The Northwest Miramichi system likely experiences an increased harvest compared to the Southwest Miramichi of grilse and salmon due to the abundance of public pools, crown reserve stretches and First Nation Fisheries Allocations which could reduce the number of salmon available for spawning each year. Additionally the Northwest Miramichi has an increasing striped bass population which contributes to increased mortality of smolts exiting this system on their way to the ocean.

The purpose of this project is to assess smolt production on the Northwest Miramichi system, and it's three major tributaries; the Big Sevogle River, the Northwest Miramichi tributary and the Little Southwest Miramichi (smolt estimate conducted by the Northumberland Salmon Protection Association (NSPA)) to determine if adequate juvenile production is occurring in the Northwest Miramichi River System. The data will be used to allow science based management decisions to be made for the Northwest Miramichi system since the conservation targets of adult salmon have rarely been met. Finally, to determine the at sea-survival from smolt to adult salmon on the Northwest, since it may be higher due to predation by striped bass, as smolts move through the primary spawning area for striped bass in the Gulf of St. Lawrence.

Methods

The method used to obtain the smolt estimates was a mark and recapture experiment. On the Sevogle, Northwest and Little Southwest Rivers (NSPA), rotary screw traps (RST) or smolt wheels were used to capture smolts for tagging. The smolt wheel was strung across the river by an overhead cable and floated on the top of the water by two large pontoons. The current forced the partially submerged wheel to rotate. Any fish that entered the trap were guided into the trap's holding box which is located at the back of the smolt wheel. The rotating wheel prevented the fish from swimming out of the trap. All the fish in the live-box were collected and sorted. Each species caught was identified, counted and released, except for salmon smolts, which were measured for fork length and then tagged with streamer research tags. Scale samples were also taken from up to five smolts per day for age analysis. After the smolts were tagged they were moved upstream of the smolt wheel. The percent of tagged smolts that are recaptured at the smolt wheel allow us to estimate the number of smolts moving out of that particular tributary.

A single large trapnet was installed in the estuary of the Northwest Miramichi at Cassilis to capture smolts moving from freshwater into the estuary. Tagged smolts captured at the Cassilis trap net allow us to get an estimate of the smolts moving out of the entire Northwest Miramichi. The Cassilis trapnet efficiency is calculated by the total catch of smolts at Cassilis divided by the population estimate. The total smolt run from the Northwest Miramichi is determined by a ratio of the number smolts that are tagged upstream at the Sevogle, Northwest and Little Southwest smolt wheels, the number of tagged smolts that are recaptured at the Cassilis trap and the number of untagged smolts captured at the Cassilis trap. This latter facility was fished daily, generally at low tide, and the smolts were sorted from the rest of the species captured. Each day, sub-samples of up to 100 smolts were measured and 20 were sampled in detail for length, weight, sex and age. All smolts captured were counted and checked for missing adipose fin clips and streamer tags.

Permits
The Navigable Waters Permit from the Department of Transportation, Instream Data Collection Devices Permit from the local Department of Environment and the Scientific Collection Permit from the Department of Fisheries and Oceans were all obtained prior to starting this project.

Results
The Sevogle smolt wheel operated from May 3 to June 2, however was not operating on May 5-9th due to high water conditions and a tree that destroyed the trap of the smolt wheel. The Northwest smolt wheel operated from May 3 to June 4, however did not operate from May 5-8 due to high water conditions. The Little Southwest smolt wheel operated from May 3-June 5, however also did not operate from May 5-9 due to high water conditions. The estuary trap net at Cassilis operated from May 18 to June 10, 2011, was late being put in due to high water conditions.

The peak of the smolt run for the Sevogle River was May 21 and 182 smolts were captured that day. The peak of the smolt run on the Northwest River was May 22 with 307 smolts being captured that day. The peak of the smolt run on the Little Southwest River was May 30 with 250 smolts being captured that day. This year we tagged 812 smolts on the Sevogle and 1055 smolts on the Northwest Miramichi, and 1036 on the Little Southwest Miramichi. We were able to capture 909 smolts in the Sevogle smolt wheel and 1153 smolts on the Northwest smolt wheel, and 1898 smolts on the Little Southwest smolt wheel over the entire season. The capture efficiency of the Sevogle smolt wheel was the lowest at 1.6%, however the Northwest Miramichi (3.0%) and Little Southwest Miramichi (2.8%) smolt wheels had good capture efficiencies.

At the Cassilis estuary trap, we captured 9,958 smolts, 42,000 smelts, 861 striped bass and 250 gaspereau as well as many other species throughout the season. We were able to recapture 34 smolts with streamer tags at the Cassilis trap net which were tagged at the Sevogle, Northwest or Little Southwest smolt wheels upstream. Smolt production on the Northwest Miramichi in 2011 was estimated at 765,000 smolts (4.6 smolts per $100m^2$) assuming a 10% mortality of tagged smolts due to handling and predation.

The smolt estimate for the Sevogle River in 2011 was 56,800 (CI 37,000 to 114,000), which worked out to be 2.0 smolts per $100m^2$. The smolt estimate for the Northwest River in 2011 was 38,000 (CI 28,000 to 57,000), which worked out to be 1.0 smolts per $100m^2$. The smolt estimate for the Little Southwest River in 2011 was 70,000 (CI 50,000 to 104,000), which worked out to be 1.8 smolts per $100m^2$. Therefore according to our smolt estimates none of the major tributaries of the Northwest Miramichi met the target of 3.0 smolts per $100m^2$.

Our objective to reach the 3.0 smolts per $100m^2$ smolt production target for the Miramichi was exceeded on the Northwest Miramichi River as a whole, however smolt production on the Sevogle, Northwest and Little Southwest Miramichi was were much lower than expected in 2011 with none of the rivers seemingly meeting the production target of 3.0 smolts per $100m^2$.

Discussion

The Northwest Miramichi River as a whole, exceeded the smolt production target for the Miramichi River in 2011. We were surprised by this result as the numbers of adults returning to the river each year has generally been below the conservation requirements for the river.

We were very surprised that the smolt production on the Sevogle, Northwest and Little Southwest Miramichi was low in 2011 with none of the rivers seemingly meeting the production targets, particularly since there were very high parr numbers on the Northwest and Sevogle Rivers, especially in the headwater areas. The largest problem we encountered was with the analysis of the smolt estimates. When the branch estimates were added, (Little Southwest, Sevogle, Northwest combined produce an estimated 164,000 smolts), however they do not add to near the estimates produced from the Northwest Miramichi system (trap at Cassilis 765,000 smolts), even assuming a 20% mortality due to predation.

One problem that we had with this project was that the water was extremely high on the Miramichi early in spring and all of the smolt wheels had to be tied up for 5 days so they would not be lost by the high water. Even so, the trap box of the Sevogle smolt wheel was destroyed when a tree hit the raised wheel. The wheel was replaced and the study continued.

We feel that the Northwest system estuary trap net estimate best represents the number of smolts produced by the Northwest Miramichi System. There are two reasons for this, firstly because the capture efficiencies for the fish tagged in each tributary are very similar which indicates that adequate mixing of marked individuals is occurring (Table 1), and secondly if we use only the number of tags put on at each smolt wheel and the recaptures at the trap from the different wheels, for the mark-recapture experiment, they give similar estimates to the Northwest System estuary trap (Table 1).

It is possible that high discharge in spring flushed smolts from the tributaries or some smolts were moving during the time when the wheels were up due to high water and therefore underestimated. However it is unlikely that hundred of thousands of smolts were moving when the wheels were up due to high water because the water temperature was still low (<8°C).

It was very surprising that the Northwest Miramichi tributary and Sevogle had such low smolt production. Especially considering the very high numbers of parr (1-2+) found in the Northwest Miramichi tributary by electrofishing the previous year (6 out of 9 sites had greater than 30 parr per $100m^2$) and Sevogle (3 out of 6 sites had greater than 30 parr per $100m^2$).

Alternately, smolt production may be lower than expected due to the movement of presmolts from the Northwest Miramichi tributary and possibly the Sevogle. It is speculated that Rocky Brook on the Southwest Miramichi does not contain enough over-winter habitat for the high numbers of parr that live there. On average, a minimum of 72% of a smolts produced by Rocky Brook leave as presmolts in fall. These large numbers of parr destined to become smolts exit the brook in late fall to seek suitable over-wintering habitat downstream. We speculate that the low smolt estimate on the Northwest Miramichi may result from pre-smolt movements since there are very high numbers of parr in the headwaters of the Northwest tributary. If this is the case it is surprising that the presmolts seemed to move much lower than the Northwest smolt wheel at Trout Brook to overwinter, since they were not picked up at the smolt wheel which is approximately 14 km upstream from the head of tide.

Another explanation for such low smolt numbers from the tributaries (smolt wheels) is due to gear bias. Assuming that 765,000 smolts were produced from the Northwest Miramichi system the number of smolts captured in the smolt wheels should be much higher (Table 2). It may be that the method of recycling smolts in the smolt wheels over-inflates the trap efficiency, resulting in lower than expected smolt estimates.

Based on one year of data, it appears as though the current management actions on the Northwest Miramichi may be capable of sustaining salmon on the Northwest Miramichi system as a whole. However more years are required to determine if this is a one year event or if the Northwest Miramichi meets smolt production targets regularly. It is unclear as to which tributaries contribute the most to juvenile production as the target of 3.0 smolts per $100m^2$ was not met in any of the tributaries and the tributaries with the highest juvenile densities did not produce the highest number of smolts. Due to this it is also difficult to determine which tributaries may be over-exploited or under-seeded.

The recommendations we have for future work is to continue counting smolts on the Northwest system and its tributaries to determine if smolt production is being met in more than one year. Other projects that would give insight into the smolt dynamics on the Northwest Miramichi would be to install a smolt wheel in the fall to determine if presmolts are moving out of the Northwest Miramichi and the Sevogle, which is resulting in underestimated smolt counts in spring. Install acoustic tags to determine where these presmolts may be over-wintering and if they are over-wintering below the smolt trap at Trout Brook and capture smolts with a different method at the smolt wheels (ie. fyke net, counting fence) to determine if the recycling method isn't over estimating the wheel efficiencies and resulting in lower than expected estimates on our river.

Acknowledgements

The Miramichi Salmon Association acknowledges the financial contributions of the New Brunswick Wildlife Trust Fund, Canada Summer Jobs (CSJ), the Student Employment Experience Development (SEED), MSA members, and in kind-help provided by the Department of Fisheries and Oceans for this project.

Figure 11. Two MSA staff count smolts and other fish species that are captured in the smolt wheel daily.

Figure 12. Andrew Haddad and Sean Losier tag smolts that are captured in the smolt wheels and release them upstream.

Figure 13. The estuary smolt trap used to capture smolts from the Northwest Miramichi system.

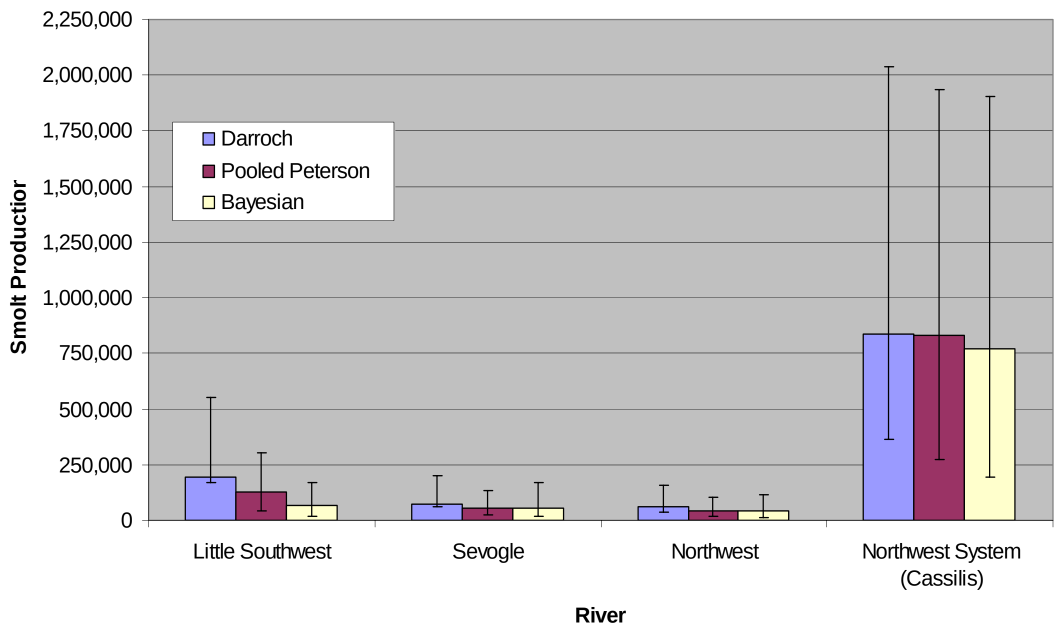


Figure 14. Smolt production for the major rivers on the Northwest Miramichi in 2011.

5. STOCKING OF JUVENILE ATLANTIC SALMON AND SEA-RUN BROOK TROUT

Introduction

Stocking Atlantic salmon juveniles can improve the production capacity of a river by targeting areas that are under seeded or not accessible to spawning adults. An electrofishing survey is carried out each year by the MSA to assess areas of the river that are lacking adequate numbers of fry or parr. If lots of fry are found it indicates that adult salmon were able to spawn in that area the previous fall. If no fry were present it could mean that adults were unable to access that spawning area. In most cases the river or stream may be barricaded in some way (eg. beaver dams) as to limit upstream migration of adults. Not only will these areas be targeted to stock but efforts may be made to identify and remove any impediments to natural spawning. The majority of these areas are located in headwater areas or small tributaries of the main stem. These brooks often have good quality habitat and lower numbers of predators compared to lower stream sites however are often inaccessible to adult salmon due to blockages by beaver dams or due to the small size of the brook, especially in years with low flow conditions.

The Miramichi Salmon Association uses information from the wild juvenile abundance survey and smolt information to aid in determining specific tributaries that may need additional stocking. In the past both the Little Southwest and the Cains River have had low to moderate fry and parr densities as well as low smolt production. Therefore additional stocking areas have been identified on these tributaries by electrofishing. This is important because if fish are stocked into an area with an already high density of fry or parr then there will be increased competition and will likely not result in an increase in production for that area. Determining juvenile densities allows us to avoid overstocking and target naturally under-stocked streams in each individual river system. In terms of stocking, any site containing more than 100 fry / 100m^2 is not considered for stocking as it appears to reflect a healthy natural population. Sites with less than 50 fry / 100m^2 are considered candidates for fall stocking.

Stocking efforts should also be evaluated so that we can determine how good the stocking site is for increasing salmon production. If stocked fry are not present at stocking sites it may indicate that the site does not contain the appropriate habitat or it may have too many predators. Prior to 2010, fall fingerlings were stocked and were identified by an adipose clip (removal of the adipose fin). In 2010 the Miramichi Salmon Association shifted the focus from stocking young of the year Atlantic salmon fingerlings in fall to stocking first feeding young of the year salmon in late spring when they would normally being feeding for the first time in the wild. These fry are stocked in late May or June, instead of October. However due to the size of the fish it is not possible to mark them in any way. Additional fall fingerlings were raised by the satellite rearing program run through the MSA, NSPA, JD Irving Ltd and MHSF.

The objectives of this program were to improve Atlantic salmon production in the headwater areas of the Miramichi River and to assess the practice of stocking first feeding salmon fry in headwater sites.

Methods

Adult salmon were collected in September and early October in 2010 for broodstock. When female salmon were ready to spawn, they were stripped of their eggs and the eggs were fertilized by the milt of a male salmon. Eggs were incubated on brook water until the eyed stage, when dead eggs were removed weekly. Prior to hatch eggs were transferred to incubation boxes for hatching. After hatching fry were fed a formulated salmonid diet (EWOS #1) for approximately 2 weeks until stocking. All salmon fry were stocked in their river of origin (river specific stocking).

Stocking sites were identified based on the juvenile densities found at the headwater sites by electrofishing and tributaries that typically have low juvenile production (ie. Cains and Little Southwest). Additional salmon fry were taken to satellite rearing sites for rearing at the camps during the last week in June.

Twenty stocking sites were selected and then electrofished later in the summer to determine if the first feeding fry stocking was successful. These sites were all headwater tributary sites with moderate to high Atlantic salmon habitat qualities. We compared the average density of the sites stocked with first feeding fry to those not stocked with first feeding fry to determine if the first feeding fry stocking was effective.

Results

In 2011 260,521 first feeding salmon fry (Table 1) and 20,000 sea-run brook trout were released into the Miramichi River in the spring of the year (Table 2). In 2011 44,098 salmon fry were distributed to the satellite rearing sites in late-June (Table 3). In total seventy five sites on the Miramichi River were stocked with approximately 5,000 (60 to 10,000) first feeding salmon fry in June and four sites with 5000 sea-run trout fry from the Miramichi Salmon Conservation Centre in July of 2011. In total 113,000 Southwest Miramichi strain and 148,000 Northwest Miramichi strain Atlantic salmon were stocked in 2011.

Twenty two sites that were stocked with first feeding fry from the Miramichi Salmon Conservation Centre in June of 2011 were electrofished in August the same year. We compared the average density of the sites stocked with first feeding fry to those not stocked with first feeding fry (Figure 1). The average fry density at the sites that were not stocked with first feeding fry was 11 fry per $100m^2$ which is considered a low fry density, while the sites that were stocked with first feeding fry had average densities of 113 fry per $100m^2$, which is considered above the optimum fry density. Of the 14 electrofishing sites that were not stocked, eight had no fry at the sites and the additional six sites had between (6-69 fry per $100m^2$). All of the sites that were stocked, had fry present, ranging from 3 to 422 fry per $100m^2$. Over half of the stocked sites had fry densities higher than the optimal number. The survival of first feeding fry is good and can help to increase the overall juvenile salmon production in the river. Therefore the MSCC will continue its stocking of first feeding fry in the future.

Table 3. Distribution of Atlantic salmon first feeding fry (0.2 to 0.3 grams) from the Miramichi Salmon Conservation Centre.

Date	Stock Origin	Number Released	Site	Latitude	Longitude
28-Jun-11	Clearwater	2500	Clearwater	46.7590	66.8606
28-Jun-11	Clearwater	2500	Clearwater	46.7574	66.8782
28-Jun-11	Clearwater	500	Clearwater	46.7758	66.8826
28-Jun-11	Clearwater	4500	Clearwater	46.7692	66.8613
23-Jun-11	Juniper	6474	Simpson Brook	46.5420	67.2891
23-Jun-11	Juniper	6474	South Branch Southwest	46.5449	67.2283
23-Jun-11	Juniper	6474	South Branch Southwest	46.5386	67.1839
23-Jun-11	Juniper	6474	Little Teague	46.5842	67.2606
23-Jun-11	Juniper	6474	Big Teague	46.5578	67.2340
21-Jun-11	Rocky Brook Dom	5000	North Br Bartholomew	46.6263	66.3382
21-Jun-11	Rocky Brook Dom	5000	Bartholomew	46.6208	66.3219
21-Jun-11	Rocky Brook Dom	5000	Morse Brook	46.6687	65.8502
21-Jun-11	Rocky Brook Dom	5000	Moores Donnolly Brook	46.5579	65.9501
21-Jun-11	Rocky Brook Dom	5000	Otter Brook	46.6470	65.9556
21-Jun-11	Rocky Brook Dom	5000	Doak Brook	46.5511	66.1244
21-Jun-11	Rocky Brook Dom	5000	S Br Betts Mills Brook	46.4600	66.2651
21-Jun-11	Rocky Brook Dom	5000	N Br Betts Mills Brook	46.4782	66.2735
21-Jun-11	Rocky Brook Dom	5000	Crooked Bridge Brook	46.5573	66.2724
21-Jun-11	Rocky Brook Dom	2375	Big Hole Brook	46.5880	66.3181
21-Jun-11	Rocky Brook Dom	5000	Big Hole Brook	46.5796	66.2444
23-Jun-11	Rocky Brook Dom	200	Lake Brook	46.8600	65.7950
23-Jun-11	Rocky Brook Dom	300	West Br Indiantown Brook	46.8370	65.8000
23-Jun-11	Rocky Brook Dom	100	N Br White Rapids Brook	46.7650	65.8890
23-Jun-11	Rocky Brook Dom	60	Big Spring Brook	46.7660	65.8820
23-Jun-11	Rocky Brook Dom	500	White Rapids Brook	46.7740	65.8500
23-Jun-11	Rocky Brook Dom	200	Brandy/Mersereau Brook	46.7040	65.8100
23-Jun-11	Rocky Brook Dom	500	White Rapid Brook	46.7690	65.8580
23-Jun-11	Rocky Brook Dom	200	N Br Hudson Brook	46.7580	65.8460
23-Jun-11	Rocky Brook Dom	200	Main Hudson Brook	46.7580	65.8450
23-Jun-11	Rocky Brook Dom	200	S Br Hudson Brook	46.7570	65.8440

23-Jun-11	Rocky Brook Dom	1000	Black Brook	46.6790	65.7010
23-Jun-11	Rocky Brook Dom	200	Watson Brook	46.7230	65.8710
23-Jun-11	Rocky Brook Dom	100	Hallihan Brook	46.7120	65.8190
23-Jun-11	Rocky Brook Dom	100	Brandy/Mersereau Brook	46.6900	65.8400
23-Jun-11	Rocky Brook Dom	140	Zack's Brook	46.6740	64.8470
24-Jun-11	Rocky Brook Dom	550	4 mile brook (Bartholomew)	46.6090	66.0790
24-Jun-11	Rocky Brook Dom	550	Fowler middle brook (Bartholomew)	46.6190	66.1080
24-Jun-11	Rocky Brook Dom	650	Leadbetters Brook (Bartholomew)	46.6190	66.1120
24-Jun-11	Rocky Brook Dom	600	Davis Landing Brook (Bartholomew)	46.6000	66.2090
24-Jun-11	Rocky Brook Dom	100	Big Hole Brook below lake	46.6100	66.3200
24-Jun-11	Rocky Brook Dom	550	South Br Big Hole Brook	46.5720	66.3580
24-Jun-11	Rocky Brook Dom	1000	South Br Bartholomew	46.5860	66.4550
28-Jun-11	Rocky Brook Wild	10000	LL Bridge on Rocky Brook	46.7797	66.7255
17-Jun-11	Little Southwest	5000	Little North Pole Stream	47.0250	66.5984
17-Jun-11	Little Southwest	5000	North Pole Stream	47.1425	66.6163
17-Jun-11	Little Southwest	2900	Fish Brook	47.1617	66.6068
17-Jun-11	Little Southwest	5000	Fish Brook	47.1236	66.5326
17-Jun-11	Little Southwest	5000	Br of Lower N Br Little Southwest	47.1579	66.5306
17-Jun-11	Little Southwest	5000	Saddlers Brook	47.1536	66.5531
17-Jun-11	Little Southwest	5000	Upper Saddlers Brook	47.1650	66.5690
17-Jun-11	Little Southwest	3750	Upper West Branch Little Southwest	47.0423	66.7645
17-Jun-11	Little Southwest	3750	Squaw Barron Brook	46.9731	66.7003
20-Jun-11	Little Southwest	5000	Crooked Brook Tuadook	46.9149	66.7759
20-Jun-11	Little Southwest	5000	Devils Brook	46.8739	66.2273
20-Jun-11	Little Southwest	1667	Libbys Brook	46.8748	66.6625
20-Jun-11	Little Southwest	1667	Libbys Brook	46.8813	66.3719
20-Jun-11	Little Southwest	1667	Libbys Brook	46.8937	66.3922
20-Jun-11	Little Southwest	5000	Little South West @ Foot Bridge	46.9505	65.8724
29-Jun-11	Northwest	5000	Mountain Brook	47.7020	66.0724
29-Jun-11	Northwest	5000	Gill Brook	47.2273	66.2300
29-Jun-11	Northwest	5000	East Br North Br Northwest	47.2338	66.3432
29-Jun-11	Northwest	5000	South Br Northwest	47.2367	66.3560
29-Jun-11	Northwest	5000	South Br Northwest	47.2491	66.3925

29-Jun-11	Northwest	5000	South Br Northwest	47.2498	66.4022
29-Jun-11	Northwest	5000	N Br Northwest	47.2768	66.4034
29-Jun-11	Northwest	5000	N Br Northwest	47.2669	66.4178
29-Jun-11	Northwest	5000	N Br Tomogonops	47.3266	66.0541
29-Jun-11	Northwest	5000	N Br Tomogonops	47.3053	66.0135
29-Jun-11	Northwest	5000	North Little River	47.2631	66.1331
22-Jun-11	Sevogle	5000	Clearwater Brook	47.1093	66.2356
22-Jun-11	Sevogle	5000	N Branch Big Sevogle	47.2034	66.3204
22-Jun-11	Sevogle	5000	N Branch Big Sevogle	47.2056	66.3456
22-Jun-11	Sevogle	7375	N Branch Big Sevogle	47.2077	66.3547
22-Jun-11	Sevogle	5000	N Branch Big Sevogle	47.2178	66.3864
22-Jun-11	Sevogle	5000	N Branch Big Sevogle	47.2092	66.3635

Table 4. Distribution of sea-run brook trout first feeding fry from the Miramichi Salmon Conservation Centre.

Release date	Stock Origin	# released	Length (mm)	Weight (g)	Release Location	Latitude	Longitude
July 15, 2011	Beadle Brook	5000	75	4	McKiel Brook	46.55037	67.04405
July 15, 2011	Beadle Brook	5000	75	4	McKiel Brook	46.56176	67.04705
July 15, 2011	Beadle Brook	5000	75	4	McKiel Brook	46.57769	67.04166
July 15, 2011	Beadle Brook	5000	75	4	Deadman Brook	46.59462	67.03016

Table 5. Distribution of Atlantic salmon fry to the satellite rearing tanks.

Delivery Date	**Site**	**Strain**	**Number**
29-Jun	Rocky Brook	Rocky Brook	10000
29-Jun	Miramichi Fish and Game	Northwest	5000
29-Jun	Rocky Brook	Rocky Brook	6000
21-Jun	Salmon Brook	Rocky Brook Dom	5000
22-Jun	Clearwater	Clearwater	5000
23-Jun	Miramichi Headwaters Salmon Federation	Juniper	4238
30-Jun	Friends of the Kouchibouguacis	Kouchibouguacis	8860

6. BEAVER DAM BREACHING AND MANAGEMENT

Introduction

Beavers can block off access to spawning areas by building large dams or building dams in culverts or fish ladders. The effect of beaver dam blockages can be pronounced during a fall season with little rainfall and low flows, which do not afford Atlantic salmon enough water to jump over the dams. Salmon will congregate below the dams and if they cannot access the additional habitat in time, they will dig nests on top of each other which can kill the eggs in the underlying nests. This reduces the number of juvenile salmon that will hatch the following year. Areas that fish cannot access for spawning, become devoid of juveniles, do not contribute to the production of salmon on the river, or provide food for wildlife (ie. eagles, otters). Beavers typically build dams on smaller streams, which are excellent rearing areas for juvenile salmon due to the habitat quality, fewer numbers of large predators and cooler stream temperatures.

Beaver numbers have likely increased due to the decrease in people trapping beaver which has resulted in more beaver dams and more blockages for migrating fish. Most people trap to supplement their income with few people relying on it for their sole income. Over the past three years beaver pelt prices have been at the lowest point since the 1993/1994 season, and beaver harvests have declined over the past 5 years.

Prior to 2006, few salmon fry were found on Bett's Mills Brook despite the building of a new fish ladder near its mouth. In 2006, the beaver dam blocking the fish ladder, as well as 21 additional beaver dams were notched/removed on Betts Mills Brook which resulted access to more than 50,000m^2 of spawning habitat and resulted in fry being found in the brook the following year. Porter Brook and Big Hole brook have high quality salmon habitat and high densities of salmon fry have been counted in years that salmon were able to access spawning habitat upstream of these beaver dams.

Maintaining and increasing the number of adult Atlantic salmon that return to the river each year will ensure a strong and stable outfitting and guiding industry in NB, and provide the highest quality Atlantic salmon fishing experience in the province. One of the ways that we can do this is to increase juvenile salmon production by allowing adult fish access to spawning habitat above beaver dams.

The focus of this project was on the lower section of the Cains River, from Rte 123 downstream. This section was focused on because the lower sections of the river are warmer in summer than the upper reaches, there are large tributaries with good habitat that are blocked by beaver and the Cains has lower juvenile production than should be expected.

Methods

In the fall of 2011, the Miramichi Salmon Association staff surveyed brooks on the lower section of the Cains River from Rte 123 downstream to the mouth to locate active beaver dams and have the beavers and dams removed. MSA crews were made up of Tyler Storey (MSA technician), Matt Ward, Tyler Coughlan and Colby Donovan. The rivers and brooks that were surveyed included Blue Rock Brook, Ten Mile Brook, McKenzie Brook, Mahoney Brook, Trout Hole Brook, Six Mile Brook, Muzroll Brook, Sabbies River, Little Otter Brook, an unnamed brook, Porter Brook and Bett's Mills Brook.

Active beaver dam locations were given to a "nuisance wildlife trapper", and he removed the beavers. A nuisance trapper possesses a special permit to remove beavers out of season, since the furbearer season is from October 30 to January 1st, after the majority of salmon have spawned. On the brooks where the beavers were removed by the nuisance trapper, all of the beaver dams were removed. On the brooks where beavers were not removed, all of the active dams (dams with beavers) were notched so that salmon could pass through and abandoned dams were removed from the brook so that salmon could swim upstream in time to spawn. The dams on these brooks were notched at least one time with some being notched twice.

Tyler Coughlan marks the location of an active beaver dam for the trapper

Broodstock were gathered from Island pool at Camp Admiral on September 13, 2010 using a seine net. Five female salmon and five male salmon were gathered for spawning at the MSCC in mid-October.

Surrounding Island Pool on the Cains River at Camp Admiral (Photo Credit Tom Doyle)

Results

The beaver dam surveys took place in September and continued into October and removing and notching of dams took place in October. The main stem of the Cains from Rte 123 to Shinnickburn was canoed in order to survey small brooks that were not accessible by road. Salmon Brook was not surveyed due to issues with accessibility. Some of the streams were difficult to canoe, due to the water depth. In some cases the canoes were dragged downstream over 1 km before there was enough water to paddle downstream. Many of the upper stretches of brooks, such as McKenzie Brook, were full of alders which made walking or "paddling" through them very difficult. Weather conditions were favorable as there was no early snow in October; however the rain was both a blessing and a curse. It provided more water so brooks could be canoed easier however made for unpleasant working conditions while tearing out dams. In total 88 beaver dams on the Cains were removed/notched and 15 beavers were trapped. Six dams were notched on Bett's Mill's Brook and six on Porter Brook. It was hoped that more beavers would be trapped on the Cains River, but due to time constraints of the trapper and the inaccessibility of the beavers and dams, not as many beavers were removed.

Atlantic salmon were observed below beaver dams on the West branch of the Sabbies River this fall. The dams were notched by Tyler and Colby, and the salmon immediately continued swimming upstream to available spawning habitat.

Tyler Coughlan notches a beaver dam on the Cains

Table 6. The approximate number of kilometers (km) of brook surveyed, number of active and abandoned beaver dams found on each stretch and the numbers of beavers removed from each stretch of the Cains River.

Tributary	**Km of brook surveyed**	**Active Dam**	**Abandoned Dam**	**Total Dams**	**Beavers Removed**
Blue Rock Brook	4.3	3	5	8	0
Little Otter Brook	0.8	5	5	10	2
Mahoney Brook	2.0	0	0	0	0
McKenzie Brook	7.1	10	1	11	5
Muzroll Brook	34.0	10	3	13	0
Sabbies River	18.2	5		5	0
Six Mile Brook	21.6	10	1	11	5
Ten Mile Brook	3.5	9	9	18	3
Trout Hole Brook	0.5	0	0	0	0
unnamed Brook	0.3	0	0	0	0
Grand Total	**92.3**	**60**	**28**	**88**	**15**

Acknowledgements

We would like to acknowledge the donations made by the MSA members for this project, without the donations this project would not have been possible.

h

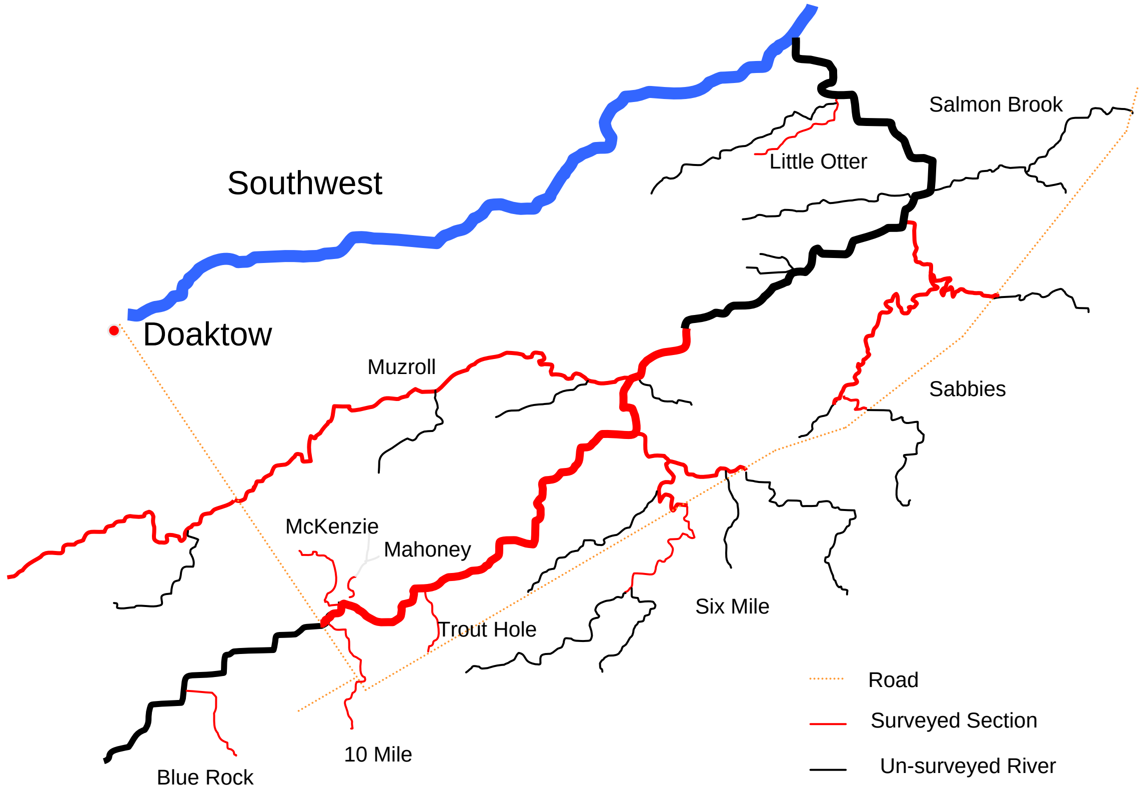
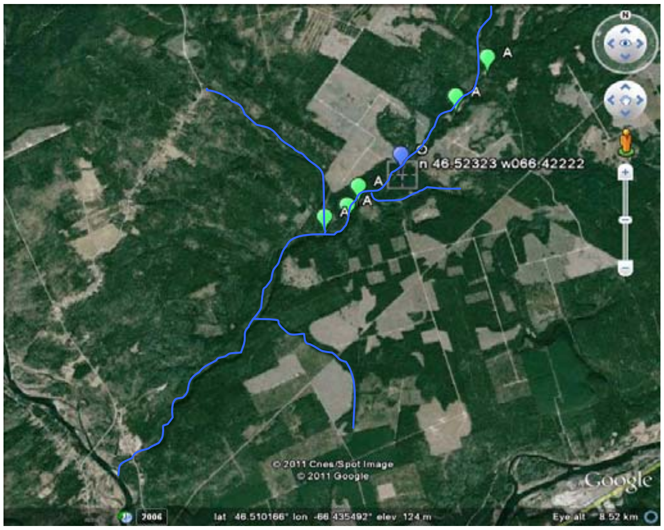
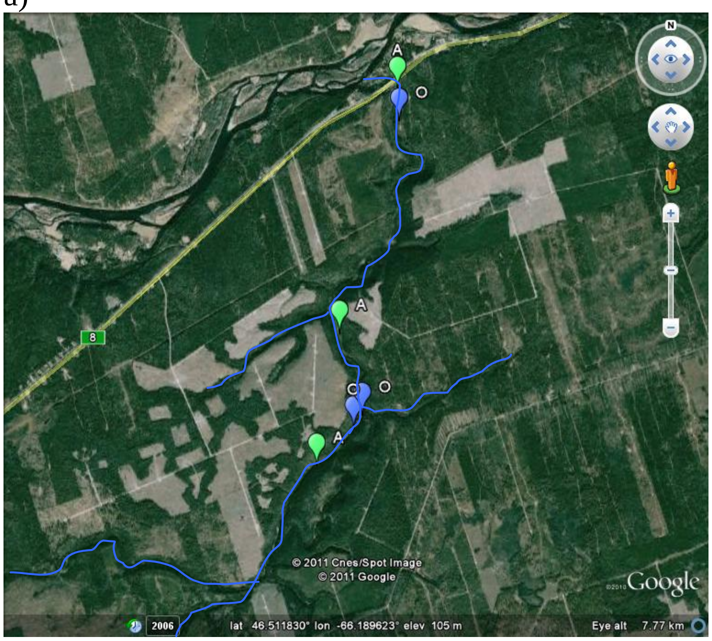


Figure 15. Areas of the Cains River that were surveyed for beaver dams.



a)



b)

Figure 16. Location of beaver dams removed from a) Porter Brook and b) Betts Mills Brook.

7. BROAD-SCALE THERMAL CHARACTERISTICS OF THE MIRAMICHI RIVER

Introduction

As climate change increases air temperatures, river temperatures also increase. Therefore in the future we can expect larger numbers of warm-water temperature events to occur in the Miramichi watershed which has negative consequences for the fisheries resource, particularly Atlantic salmon and brook trout. We need to develop warm water protocols for the fishery resources that can help prevent declines in the abundance of fish numbers from these environmental changes. Some water temperature data has been collected on the Miramichi River, however there are many voids in the data, particularly on the main stem of the Southwest Miramichi where water temperatures are typically warmer than the tributaries. Therefore, it is difficult to develop a warm water management plan for the fisheries resource unless we know the full temperature regime of the watershed.

The collection of the temperature data from the different tributaries will allow the river to be divided into thermal zones and provide a science-based approach to manage the river system during periods of warm water that may be lethal to fish species, particularly salmon and trout that are a cool-water species. Using air-temperature/weather data that has already been collected by Environment Canada we can further improve this protocol by developing a relationship between the air-temperature/weather data to predict the water temperature at that location.

Methods

Thermal Map of the Miramichi River

Thirty-three temperature loggers (VEMCO) were installed in the major rivers of the Miramichi River system by MSA and DFO as part of their long-term temperature monitoring. The loggers were installed in late June or early July below the lower water mark, in the main channel of the river and away from any coldwater sources, as to be representative of the thermal regime of that particular river and logged at one hour intervals. Loggers were recovered from the different sites and downloaded in the fall of 2011. A thermal map of the Miramichi River system was developed by relating the water temperatures at the different sites to the water temperature at the real-time Environment Canada water temperature monitoring station in Doaktown to develop a broad-scale thermal map of the Miramichi. The regression equation was then used to determine the water temperature at that location based on a water temperature of 23°C at Doaktown for standardization. Twenty-three degrees was picked because it is the threshold temperature for Atlantic salmon (they congregate in cool-water sources to cool their bodies). The relationship at Doaktown and the other sites, allows a real-time picture of the water temperatures across the major tributaries of the Miramichi without having to have real-time monitoring stations at every location. In cases where sufficient data was not available data from 2010 was used.

Air-Water Temperature Model at Doaktown

An air-water temperature model was developed using water average daily temperature data between 2006 to 2011, excluding 2008, from the Environment Canada station at Doaktown. Eight variables, consisting of julien day, water temperature, humidity, daily precipitation, daily low water temperature, daily high water temperature, minimum daily air temperature and maximum daily air temperature were run through a multiple linear regression.

Results

Thermal Map of the Miramichi River

Thermal data was downloaded at thirty-three sites, however at three sites data was unable to be downloaded from the loggers due to unknown reasons (Figure 1). The sites on the river showed a good relationship with the water temperatures at Doaktown (Table 1). Therefore Doaktown could be used to determine the water temperature in other major rivers on the Miramichi River based on the real-time data available. The majority of the river system was within ±2°C of Doaktown, particularly the Southwest Miramichi, Little Southwest Miramichi and the main stem of the Northwest Miramichi (Figure 2). The areas within ±2°C were designated to be within Zone 1, the warm water zone (Figure 4). The coolest areas of the Miramichi River system were the headwaters of the Northwest Miramichi (upstream of Miner's Bridge), the Sevogle, Rocky Brook, Clearwater Brook and Burnthill Brook and these areas were designated as zone 2 (Figure 4). Mapping the locations relative to temperatures in excess of 23°C did not change the majority of the relative temperature of the sites or the temperature zone.

Model Equation:

The regression analysis indicated that water temperature tomorrow (WT_2) could be predicted from water temperature today (WT_1) and air temperature tomorrow (AT_2) (Figure 5).

Predicted water temp tomorrow = 0.0360 + (0.189 * Forecasted air temp tomorrow) + (0.829 * Actual water temp today) (Table 2).

WT_2 =0.0360 + (0.189 *AT_2) + (0.829 * WT_1) R_2=0.896

The model can then be extrapolated to predict the WT_2 (water temperature tomorrow) for the subsequent days based on the forecasted average air temperature through the Environment Canada Site and the output from the previous days model. The model is only as accurate as the forecasted weather and is less accurate as more days are forecasted, as the forecasted weather is less accurate.

WT_3 =0.0360 + (0.189 *AT_3) + (0.829 * WT_2)

WT_4 =0.0360 + (0.189 *AT_4) + (0.829 * WT_3)

WT_5 =0.0360 + (0.189 *AT_5) + (0.829 * WT_4)

Project Summary

This project will allow us to predict water temperatures in the near future to determine when water temperatures may get to critical levels for the fisheries resource. Using this model management can use a proactive approach to regulation changes which may benefit the fisheries resource. The water temperature relationships with Doaktown will allow us to determine where the critical water temperatures for the fisheries resource are occurring without having to manually measure water temperatures on each river or require expensive real-time stations. All of the objectives of this project were obtained and the data from this project has been very useful in the warm water protocol being developed for the Miramichi River system.

Table 1. Water temperature relationship between thermal sites and Doaktown real-time temperature monitoring station. * indicates data was insufficient from 2011 so 2010 data was used. R^2 is a measure of the closeness of fit of the data, where $R^2=1$ is a perfect fit.

Southwest River System	**Location**	**Slope**	**Intercept**	**R^2**
Burnthill	Burnthill	0.7359	1.7495	0.9116
Clearwater	Clearwater	0.8572	-0.0622	0.914
Rocky Brook	Rocky Brook	0.67	3.7658	0.8921
Taxis River	Taxis River	1.0776	-2.2118	0.9334
Burntland Brook	Burntland Bk	0.9196	-0.7287	0.847
Renous River	North Branch Renous	0.87	2.0962	0.9303
Renous River	Renous	0.9173	1.9551	0.9305
Dungarvon	Mouth of Dungarvon	0.8848	2.4148	0.9401
Dungarvon	Russell and Swim Bridge	0.9209	0.1066	0.911
Bartholomew	Bartholomew	0.8534	1.1245	0.9062
Cains	Route 123	0.8818	1.1634	0.8367
Cains	Camp Admiral (mouth)	0.8354	2.8847	0.8727
Southwest Miramichi	Boiestown	1.0278	-0.8463	0.9788
Southwest Miramichi	Wades Camp	0.7837	3.422	0.8513
Southwest Miramichi	Millerton	0.9381	2.2898	0.8825
Southwest Miramichi	Nelson Hollow	1.0327	-0.1608	0.9986
Southwest Miramichi	Quarryville	0.9168	2.343	0.8809
Northwest River System	**Location**	**Slope**	**Intercept**	**R2**
Little Southwest	Below North Pole	0.8211	3.0224	0.8171
Little Southwest	Moose Landing	0.6335	7.7485	0.6961
Little Southwest	Sillikers	0.9213	1.7306	0.8604
Little Southwest	Catamaran	0.9068	1.0963	0.7212
Northwest	Main stem below Sevogle	0.9563	0.504	0.8292
Northwest	Tomogonops	0.791	2.7674	0.8898
Northwest	Miners Brdg	0.9166	-0.1204	0.9313
Northwest	Cassilis	0.949	1.7368	0.8373
Northwest*	Bridge Pool	0.8175	-0.0502	0.7809
Northwest*	Wayerton Bridge	0.7753	4.7068	0.768
Sevogle	South Branch Sevogle	0.5879	2.3224	0.6883
Sevogle*	North Branch Sevogle	0.5964	6.758	0.5278

Table 2. Example of the predicted water temperature from the model based on the water temperature on the current day and forecasted air temperature tomorrow.

		Predictive Model
Water Temperature Today	Air Temperature Tomorrow	Water Temperature Tomorrow
23	20	22.9
23	21	23.1
23	22	23.3
23	23	23.5
23	24	23.6
23	25	23.8
23	26	24.0
23	27	24.2
23	28	24.4
23	29	24.6
23	30	24.8

Figure 17. Retrieving a temperature logger from a site on the Little Southwest.

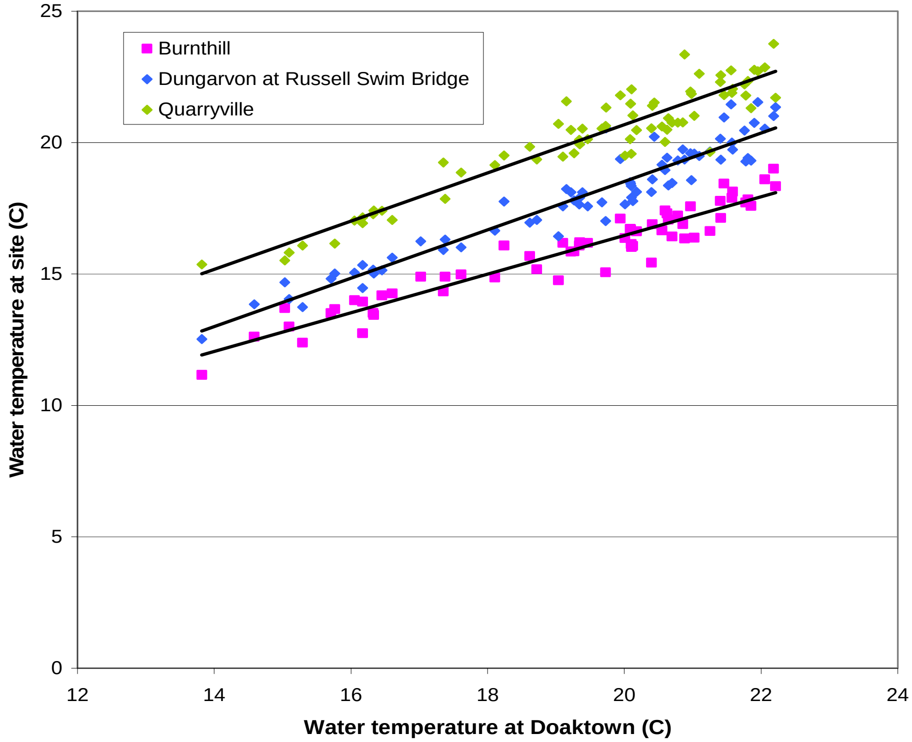


Figure 18. Water temperature relationships between Burnthill Brook, Dungarvon River at the Russell and Swim Bridge and on the Southwest Miramichi at Quarryville, and the water temperature in the river at Doaktown.

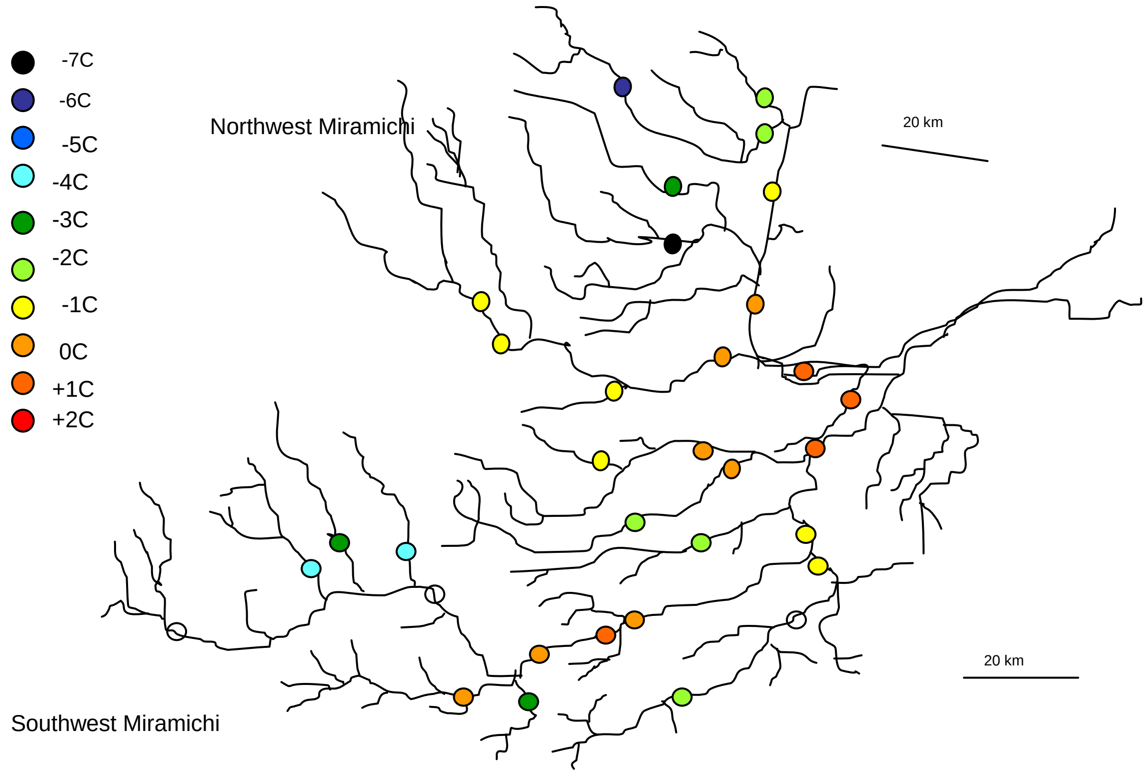


Figure 19. Relative water temperature of rivers on the Miramichi River in relation to a water temperature of 23°C at Doaktown.

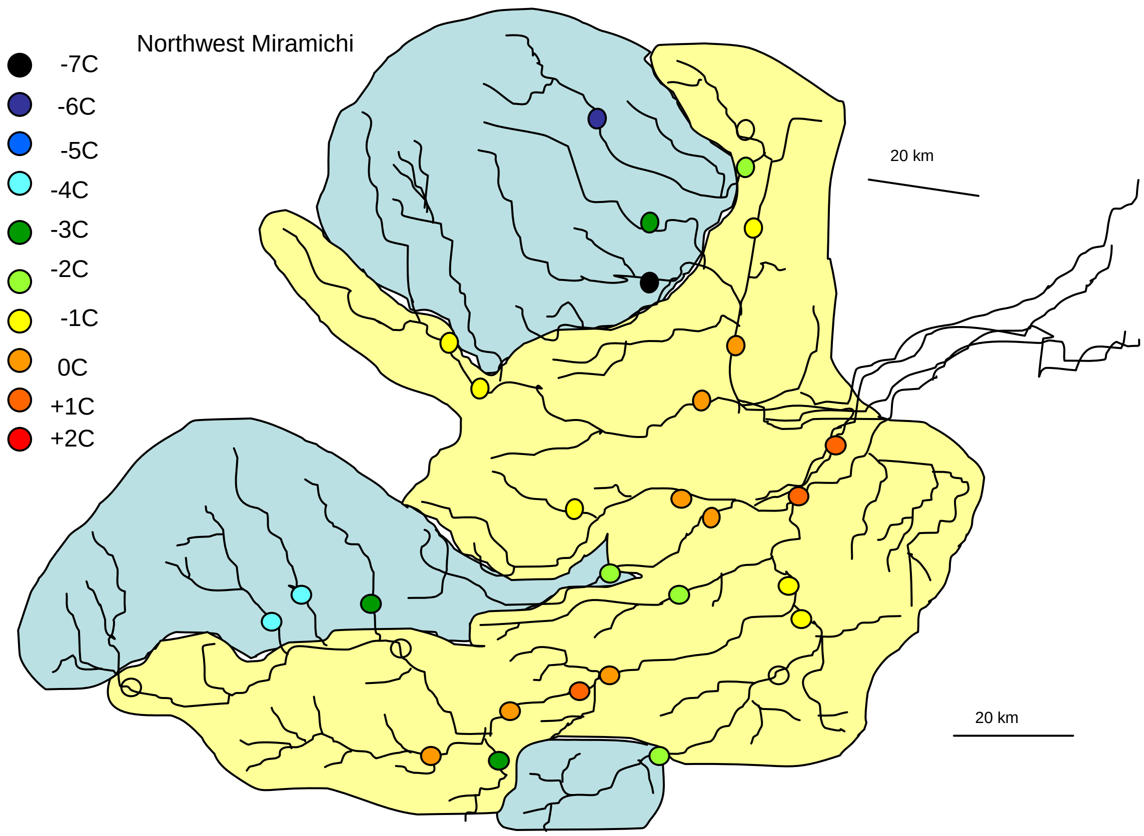


Figure 20. Two major water temperature zones on the Miramichi River based on water temperatures relative to the water temperature of 23°C at Doaktown. Yellow indicates Zone 1, warm water zone and blue indicates Zone 2, a cool water zone.

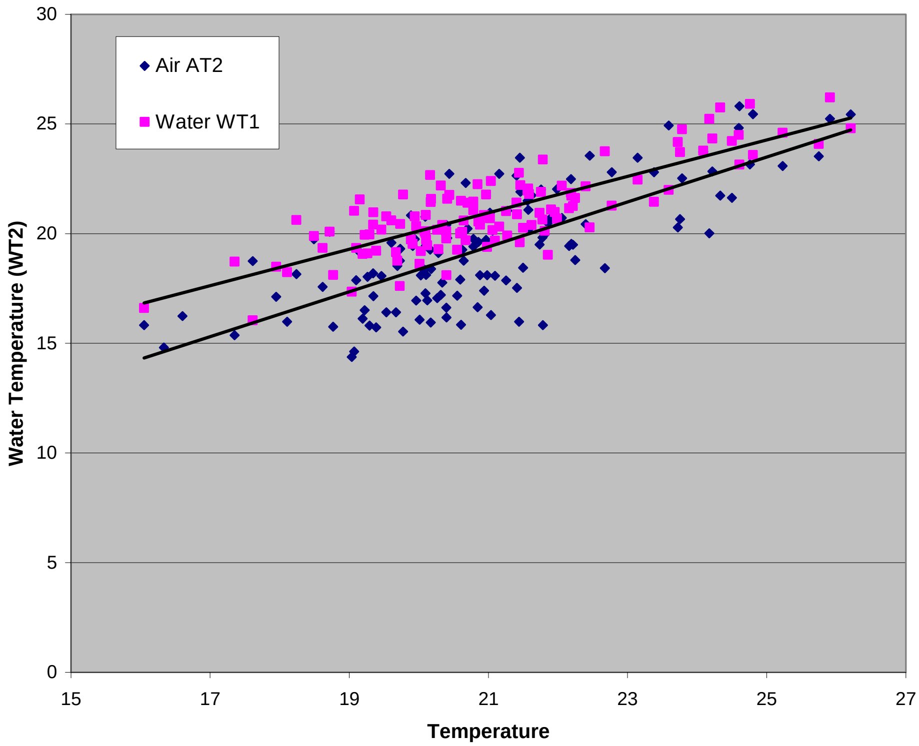


Figure 21. Relationship between water and air temperatures at Doaktown.