

## **Smolt Tracking on the Miramichi River 2014**

*Prepared by:*  
Holly Labadie  
Biologist  
Miramichi Salmon Association

*In cooperation with:*  
Atlantic Salmon Federation

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## Introduction

Juvenile Atlantic salmon which have undergone physiological changes to transition from freshwater to saltwater are referred to as smolt. These salmon have begun a process known as smoltification where they exhibit negative rheotaxis (consistent downstream movement), silvering of the body, and a decrease in body condition due to increased growth in length. Smolts migrate from natal tributaries and rivers or from pre-smolt overwintering staging areas to estuaries as freshwater temperatures start to rise in the spring. On the Miramichi River smolt movements typically start between late April and early May and conclude in late May or early June. During this time the majority of the total smolts from a river or tributary will migrate within a short window of five to six days. This peak movement is often observed during times of high water discharge following a rain event and when water temperatures are near 10°C. Upon entering brackish water, these fish may be required to stall downstream movements to allow for physiological acclimation to the salt water.

Striped bass (*Morone saxatilis*) are a large generalist fish species native to the Northumberland Strait and Gulf of St. Lawrence. Over the past 5 years their population numbers have increased in the Miramichi Estuary. The only known location of successful spawning for the entire GOSL population occurs between May and June in the upper portion of the tidally influenced water of the Northwest Miramichi River. During this time a large number of mature, breeding striped bass from various locations throughout the Northumberland Strait and Gulf region will move into this area for several weeks.

The timing of the striped bass migration closely coincides with the salmon smolt migration. This spatial and temporal overlap raise concerns regarding the survival of Northwest Miramichi salmon smolts. Striped bass are opportunistic feeders and cases of smolt predation on both Atlantic and Pacific salmon species (*Oncorhynchus spp.*) have been documented to varying degrees throughout North America in both native and non-native ranges of the species. With the recent decline in adult salmon returns to the Northwest Miramichi River, there is potential that increased levels of predation may greatly impact the survival rates of the smolts, therefore reducing the number of smolts leaving the Miramichi system to a level that also reduces the number of adults returning in subsequent years.

The use of acoustic technology is an effective way to estimate the survival of a fish population in a river or estuary. Fish implanted with acoustic transmitters are identified as they move through the detection field of an acoustic receiver. For Atlantic salmon smolt, the placement of multiple receivers throughout a river system allows for the detection of tagged fish as they move downstream to the marine environment. Changes in the percentage of tagged fish detected moving downstream through a river can indicate the level of survival through the system. The placement of receivers between barrier islands in an estuary allow for estimates on the percentage of tagged fish which survived to the ocean.

As a compliment to the Atlantic Salmon Federation's smolt tracking program to estimate the survival of smolts from the Southwest branch of the Miramichi River, an acoustic tagging study was carried out on the Northwest branch during the 2014 smolt migration to determine survival rates throughout the river and estuary.

## **Methods**

### ***Study Area***

The Northwest Miramichi watershed drainage area of 3,950km<sup>2</sup> makes up approximately one third of the total watershed of the Miramichi River. The Northwest Miramichi basin includes two major river systems: the Little Southwest River (1,342km<sup>2</sup>) and the Northwest Miramichi River (2,078km<sup>2</sup>) which merge in a delta at the head of tide. The Northwest Miramichi River includes a large tributary, the Sevogle River, which has a drainage area of 799km<sup>2</sup>.

### ***Tagging***

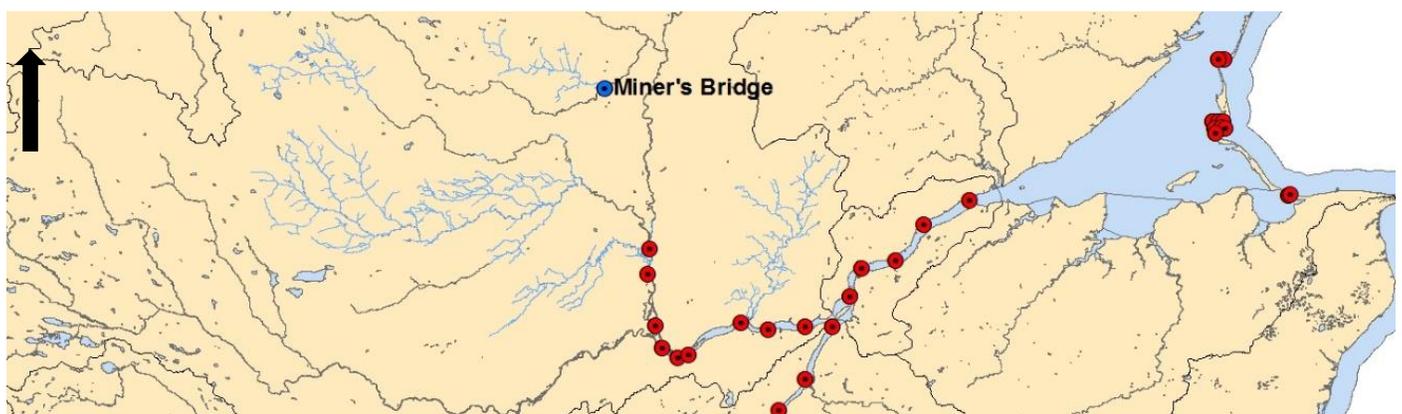
Atlantic salmon smolt were captured by a rotary screw trap (RST) on the Northwest Miramichi River immediately upstream of the mouth of Trout Brook. Only fish greater than 13cm were held for tagging (to allow for room in the body cavity for the transmitter). The fish were held in live boxes off the shore until the following morning (to allow for digestion and therefore easier tag insertion) when they were transported to the tagging location in an x-actic

tank on a truck. The smolts were tagged at Miner's Bridge, approximately 27km upstream of the RST.

Prior to surgery the fish was placed in a clove oil bath for several minutes until equilibrium was lost and movement was minimal. Both Vemco V8 and V9 acoustic tags were used during surgery, at a 2:1 ratio, respectively. The tag was inserted by making a small incision on the ventral surface on the fish, off-center, between the pectoral and pelvic fins. The incision was closed with two sutures and the fish placed into a recovery box (live well) for observation. Time out of the water for this procedure was 2 – 3 minutes per fish, with water passed through the gills during surgery. The smolts regained equilibrium within one hour after the surgery and were then released.

### ***Receiver Placement***

A total of 14 Vemco VR2w acoustic receivers were placed throughout the tidally influenced portions of the Northwest and Southwest Miramichi River and five receivers were placed on the main stem of the Miramichi River to detect in-river movements and survival rates. Additional receivers were placed to form detection gates between openings at barrier islands near the mouth of Miramichi Bay at Neguac Beach, Portage Island, and Huckleberry Gully (Figure 3).



**10km**

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Figure 3. Acoustic receiver locations (red dots) in the Miramichi River and Bay in 2014. Smolt tagging and release locations are represented by a blue dot – Miner’s Bridge on the Northwest branch and Rocky Brook on the Southwest branch.

## **Results**

### *Northwest River*

On May 28<sup>th</sup> and 31<sup>st</sup>, 50 smolts captured at the Northwest smolt wheel were transported upstream to the tagging site located at Miner’s Bridge. Of the initial 50 fish tagged, 28 of them (56%) were detected on the first receiver at Big Hole Pool (BHP), however at the head of tide (HOT) in Cassilis 40 of the 50 fish (80%) were detected, indicating a 20% mortality rate from the tagging location to HOT, and poor tag reception at the BHP receiver (as the missing tags were detected downstream). Another 20% of the fish were lost between Cassilis and Nelson. Survival in the main channel of the river from Nelson to Loggieville was 80% of the remaining fish, and 48% from the tagging location. Only 14% (7/50) of the smolts tagged at Miner’s Bridge survived out of the estuary (past the barrier receiver lines), and 10% to the Strait of Belle Isle (SOBI) (Figure 4a).

### *Southwest River*

On May 27<sup>th</sup>, 29<sup>th</sup>, and 30<sup>th</sup>, 80 smolts captured at the Rocky Brook smolt wheel were tagged and released. Of the initial 80 fish tagged, 40 (50%) of them were detected at the first receiver in Quarryville, and 50 (63%) at HOT in Millerton (this is because of poor receiver reception in Quarryville, as the 10 missing fish were detected downstream). From Millerton to Nelson, 6 fish were lost (12% mortality of the 50 remaining fish). In the main river, a further 6 fish were lost up to Loggieville – a mortality rate of 12% again. Survival from the tagging location to the estuary was 31%, and 9% to the SOBI (Figure 4b).

In total, 25% of the smolts leaving the entire Miramichi River survived to exit the estuary, and 9% survived to the SOBI.

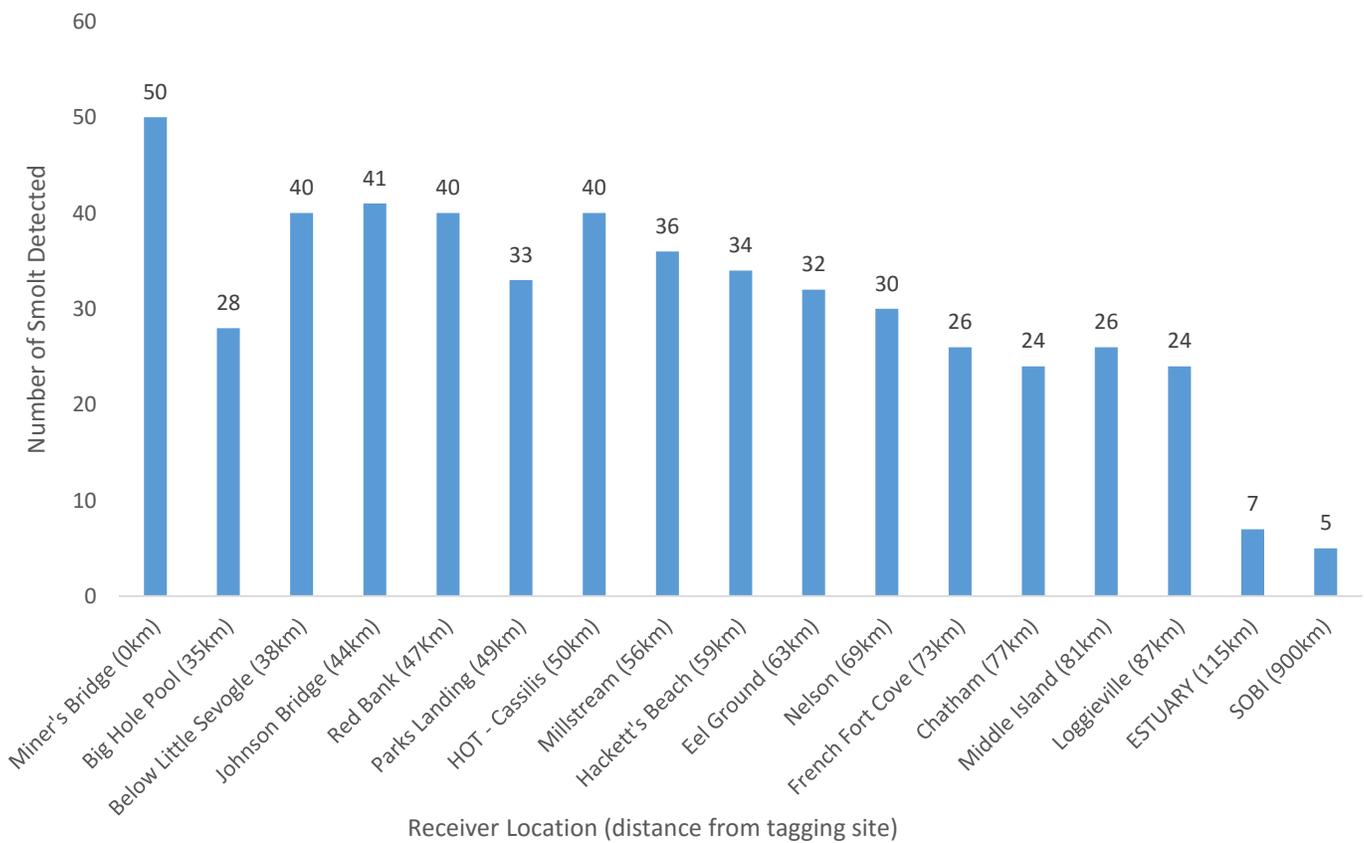


Figure 4a. Survival numbers of acoustic tagged smolts from the Northwest River at each receiver deployed in the Miramichi River, Bay, and the SOBI in 2014. The low detection numbers at Big Hole Pool and Parks Landing are the result of poor receiver detection, as these fish showed up on receivers further downstream.

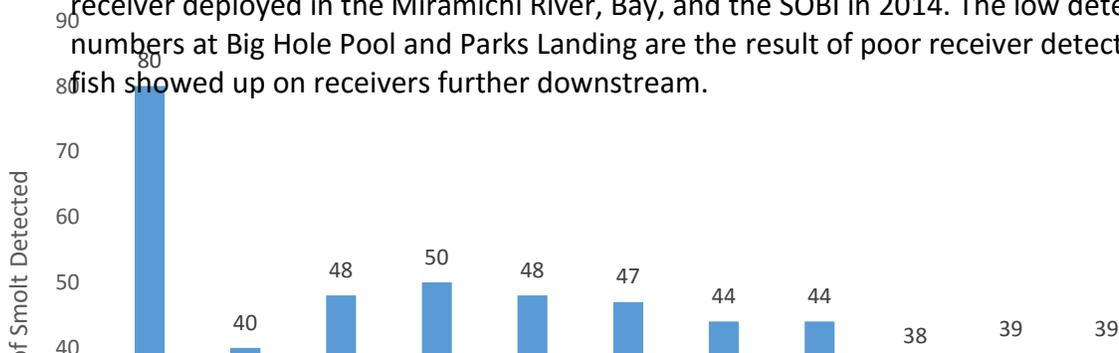


Figure 4b. Survival numbers of acoustic tagged smolts from the Southwest River at each receiver deployed in the Miramichi River, Bay, and the SOBI in 2014. The low detection numbers at Quarryville and Doyle's are the result of poor receiver detection, as these fish showed up on receivers further downstream.

## **Discussion**

Survival numbers from the 2014 tagging study are less than desirable for the Miramichi River. The fish that successfully survived tagging (a 10% mortality rate is assumed for tagging studies) and were detected exiting Miramichi Bay was less than 15% from the Northwest branch. Only 50 smolts were tagged on the Northwest branch due to the minimum size required for tagging; the other smolts caught were too small. The highest areas of loss on the Northwest were from the tagging site at Miner's Bridge to the first receiver at Big Hole Pole (9 fish went missing (adjusted for the poor receiver reception), or 18%) and from Loggieville to the estuary receivers (17 fish missing, or 34%). From Big Hole Pool to Cassilis (15km stretch) the mortality rate was very low (2%). From Cassilis to Nelson (19km), the area where the striped

bass are most prevalent, a further 10 fish (20%) were lost, which is a loss of 1.05 smolts/km. For the Northwest River in total, 0.37 smolt/km were lost.

On the Southwest branch, 38% of the fish (30/80) were not detected at the first receiver in Quarryville (adjusted for poor receiver reception). From Quarryville to Loggieville (44km stretch), 11 smolts (22%) were lost. From Loggieville to the estuary receivers, 14 fish (18%) were unaccounted for. The smolt loss per km on the entire Southwest River was 0.30.

It is important to note that there are multiple sources of smolt predation within the tidally influenced waters of the Northwest Miramichi River, and that at this time it is not possible to quantify the level of tagged smolt mortality that can be attributed to striped bass. Avian predation from mergansers, gulls, and cormorants, as well as fish predation by trout, tomcod, or reconditioning kelt could all contribute to natural smolt mortality in the river. In order to narrow the sources of predation, detailed study of individual tag data is required. For 2014 data, further analysis will be carried out by the Atlantic Salmon Federation to look at the behaviour of the fish which did not reach Miramichi Bay, specifically whether fish exhibited atypical movements likely attributed to another animal (i.e.: consumption).

In past years, the smolts tagged were all released on the same day, which left us unable to determine if changes in survival occur over the duration of the juvenile migration. On the Northwest River, striped bass are known to stage in distinct areas before, during, and after spawning. The changing position of the bass over the course of the smolt run may influence their spatial overlap with juvenile salmon, changing the likelihood of predation. The feeding behaviour of striped bass while they occupy these areas is also not fully understood. In 2014, the hope was to stagger the tagging efforts on the Northwest River over multiple days to allow for detection of movement and survival changes over time. This information would then be available for comparison to striped bass tracking research, conducted by DFO, to determine the times of greatest overlap between the species. Research of striped bass stomach contents, which is carried out over several weeks by DFO, could be used to determine if changes in the occurrence of smolts on the stomach contents matches with peaks in the smolt migration. This combined research should allow for a more precise understanding of the interaction between the species. The timing of the smolt run and number of smolts available in 2014, along with the

scheduling of the small tagging crew, did not allow for tagging to occur over multiple days on the Northwest River. Tagging at Rocky Brook began on May 27<sup>th</sup>, after which the crew moved to the Northwest to tag 48 fish on May 28<sup>th</sup>. A large run of fish then traveled through the wheel at Rocky Brook and the crew traveled back there to ensure all 80 fish would be tagged for the season (tagging continued on May 29<sup>th</sup> and 30<sup>th</sup>). On May 31<sup>st</sup>, the crew returned to the Northwest to hopefully tag the remainder of the 80 fish, but only two fish were available for tagging, as the others were too small. The catches at the Northwest wheel were decreasing, as this was nearing the end of the smolt run, and the tagging efforts ceased after the 50 fish were tagged. Efforts will be made again in 2015 to spread the tagging out over multiple days to try and determine temporal overlap between smolts and striped bass.