

Smolt Tracking on the Miramichi River 2015

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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 (GOSL). 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 2015 smolt migration to determine survival rates throughout the river and estuary.

Methods

Study Area

The Northwest Miramichi watershed drainage area of 3,950km² 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 (1,342km²) and the Northwest Miramichi River (2,078km²) 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 799km².

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 were placed in a clove oil bath for several minutes until equilibrium was lost and movement was minimal. Vemco V8 acoustic tags were used during surgery. 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. An additional three receivers were placed on the main stem of both the Northwest and Southwest (new in 2015) rivers to detect in-river movements and survival rates. Receivers were also placed to form detection gates between openings at barrier islands near the mouth of Miramichi Bay at Neguac Beach, Portage Island, and Huckleberry Gully. An additional receiver line in the Strait of Belle Isle (SOBI) was deployed in 2015, 3.5km north of the original line so that two lines of detection were present to increase the chances of tag detections in this area (Figure 1a&b).

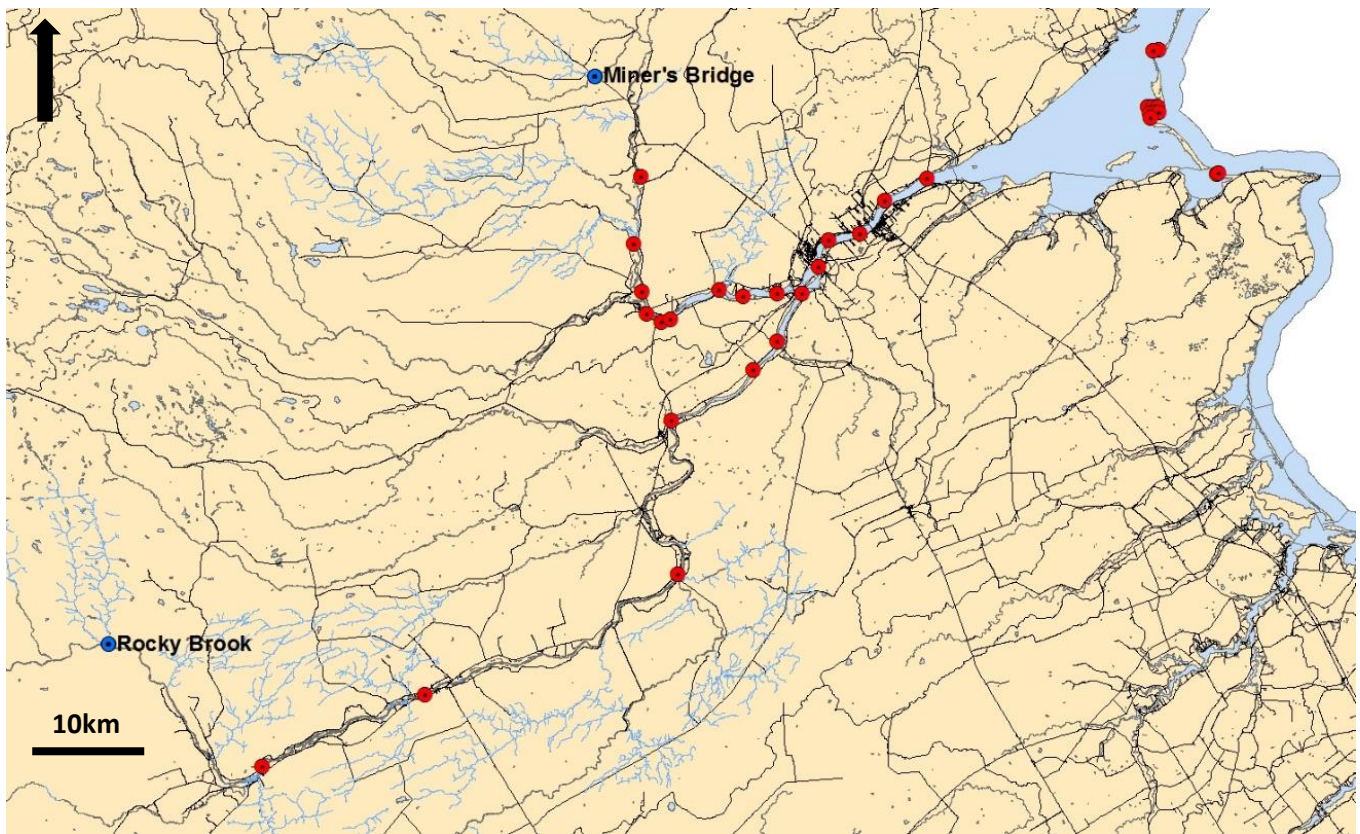


Figure 1a. Acoustic receiver locations (red dots) in the Miramichi River and Bay in 2015. Smolt tagging and release locations are represented by a blue dot – Miner's Bridge on the Northwest branch and Rocky Brook on the Southwest branch.

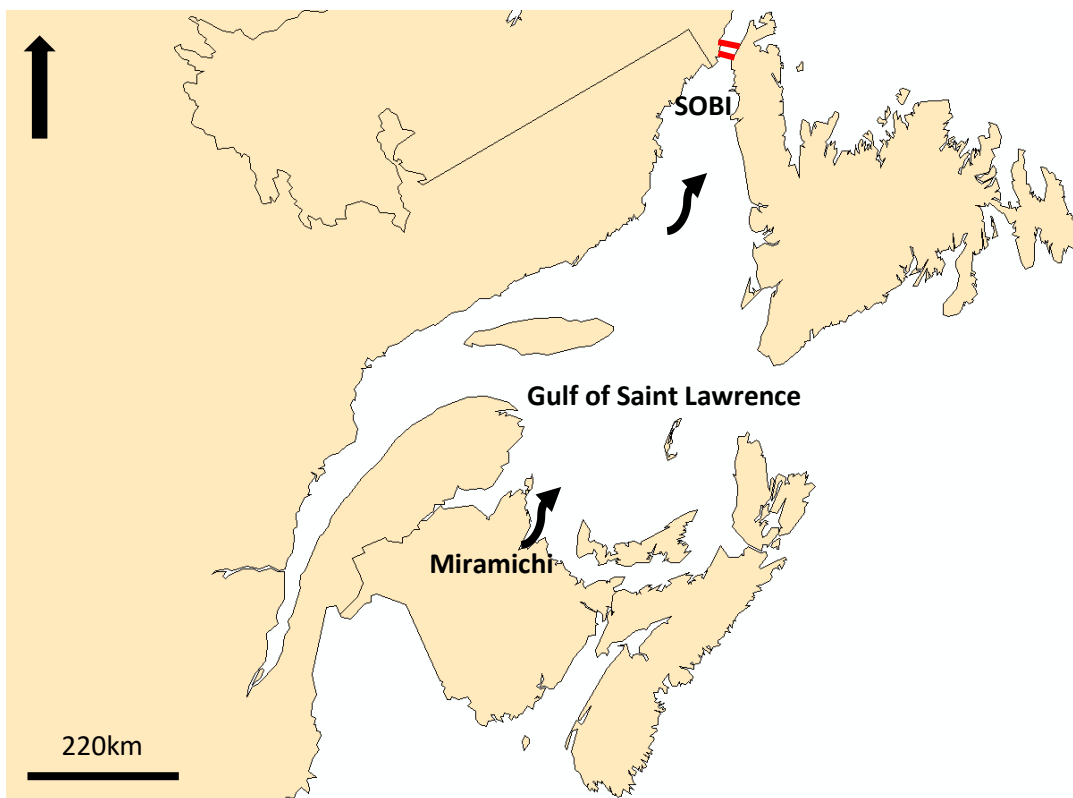


Figure 1b. Acoustic receiver locations (red lines) across the Strait of Belle Isle in 2015. A second line was added north of the original line in 2015. The lines are 3.5km apart. Suspected fish movement paths are indicated with a black arrow.

Results

Northwest River

From May 20th – 26th, a total of 80 smolts were captured at the Northwest smolt wheel and transported upstream to the tagging site located at Miner's Bridge. Of the initial 80 fish tagged, 71 of them (89%) were detected on the first receiver at Kingston Lane, however at the head of tide (HOT) in Cassilis, only 63 of the 80 fish (79%) were detected, indicating a 21% mortality rate from the tagging location to HOT. Another 23% of the fish were lost between Cassilis and Nelson. Survival in the main channel of the river from Nelson to Loggieville was 69% of the remaining fish, and 39% from the tagging location. Only 29 fish (36%) of the smolts tagged at Miner's Bridge survived out of the estuary (past the barrier receiver lines), and 21% to the SOBI (Figure 2a).

Southwest River

On May 20th & 21st, 80 smolts captured at the Rocky Brook smolt wheel were tagged and released. Of the initial 80 fish tagged, 59 (74%) of them were detected at the first receiver in Boiestown and the same number at the HOT in Millerton. At the second receiver in Doaktown however, 64 tags (80%) were detected indicating poor receiver reception in Boiestown. The mortality rate from the tagging location to the HOT was 26%. Another 29% of the fish were lost between Millerton and Nelson. Survival in the main channel of the river from Nelson to Loggieville was 94% of the remaining fish, and 43% from the tagging location. Only 32 fish (40%) of the smolts tagged at Rocky Brook survived out of the estuary (past the barrier receiver lines), and 14% to the SOBI (Figure 2b).

In total, 38% of the smolts leaving the entire Miramichi River survived to exit the estuary, and 18% survived to the SOBI.

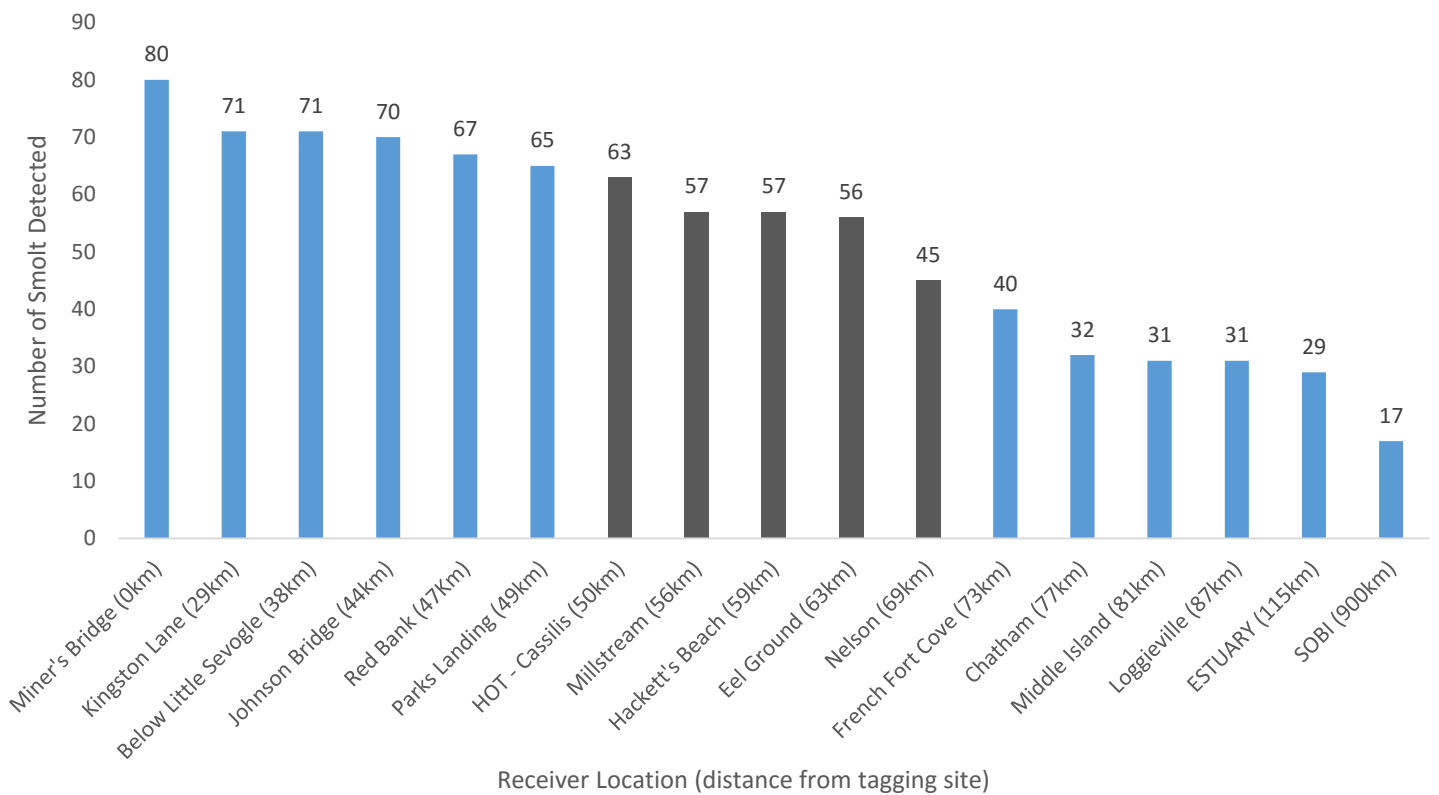


Figure 2a. Survival numbers of acoustic tagged smolts from the Northwest River at each receiver deployed in the Miramichi River, Bay, and the SOBI in 2015. The highest percentage of mortality occurred between Cassilis and Nelson (18 fish/23%), marked in grey.

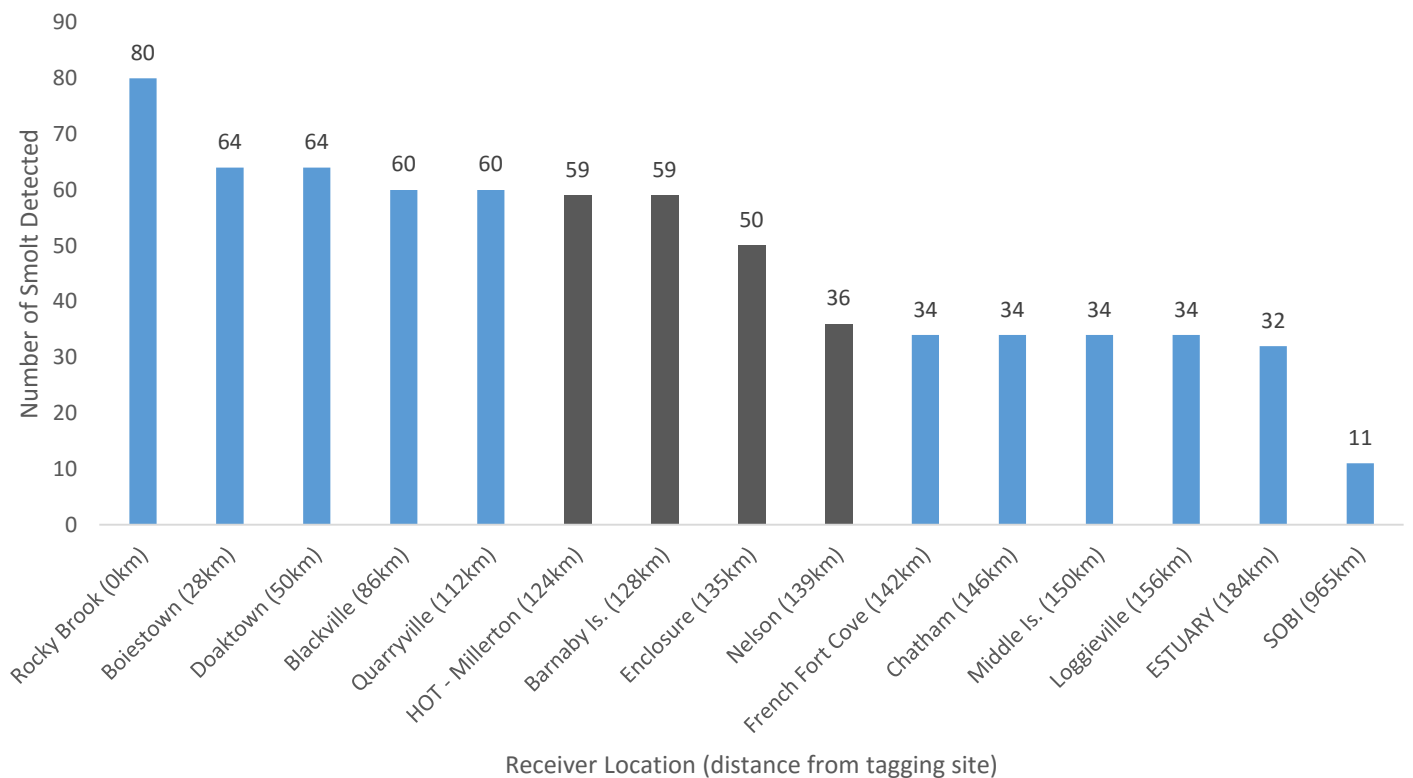


Figure 2b. Survival numbers of acoustic tagged smolts from the Southwest River at each receiver deployed in the Miramichi River, Bay, and the SOBI in 2015. The highest percentage of mortality occurred between Millerton and Nelson (21 fish/29%), marked in grey.

Discussion

Survival numbers from the 2015 tagging study are less than desirable for the Miramichi River, however they were better than numbers recorded in 2014. The fish that successfully survived tagging (a 10% mortality rate is assumed for tagging studies) and were detected exiting Miramichi Bay was only 36%.

The highest areas of loss on the Northwest were between the head of tide at Cassilis and Nelson (18 fish/23%) where striped bass are most prevalent, and from the tagging location at Miner's bridge to Cassilis (17 fish/21%) (Figure 2a). The highest survival rate was observed between Loggieville and the estuary receivers, as only 2 fish (3%) were lost. For the Northwest River in total, 0.44 smolt/km were lost.

On the Southwest branch the highest areas of loss were between the head of tide at Millerton and Nelson (23 fish/29%) and from the tagging location at Rocky Brook to Millerton and the estuary to the SOBI, both at 21 fish lost and 26% mortality (Figure 2b). The highest survival rate was observed between Nelson and Loggieville, and between Loggieville and the estuary, with each section only losing 2 fish each (2.5%). For the Southwest River in total, 0.26 smolt/km were lost.

The second receiver line placed in the SOBI in 2015 has shown that the first line did not always pick up all the fish moving through the Strait. Of the 17 smolts that survived to the SOBI from the Northwest River, three fish were picked up by the first line, six on the second line, and eight on both lines. Of the 11 fish that survived to the SOBI from the Southwest River, four were picked up on the first line, one on the second line, and six on both lines. This error percentage can be modeled and applied to smolt tracking data from previous years to produce a more accurate estimate than originally thought.

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

2015 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 2016 a new Vemco acoustic predator tag will be used in this study, along with regular acoustic tags. The predator tags change their signal code ID if a fish is consumed, but will still be picked up by the same receivers used in previous years. With this information we will be able to monitor if, when, and where a fish is predated upon.

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 2015, tagging efforts were staggered 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. Efforts will be made again in 2016 to spread the tagging out over multiple days to try and determine temporal overlap between smolts and striped bass.