Smolt Production on the Northwest Miramichi River

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Introduction

The decline in the number of adult Atlantic salmon returning to the Northwest Miramichi has been cause for serious concern. Despite multiple management actions, including the closure of commercial fisheries and implementation of catch and release on portions of the Northwest Miramichi, annual returns of adult salmon remain poor. The level of adult returns directly impacts egg deposition within a river system, and therefore is a major factor in a watersheds ability to produce age-0 juvenile salmon. On the Miramichi River an egg deposition of 2.4 eggs/m^2 is considered the density required to maintain a healthy adult population, and is referred to as a conservation requirement. Over recent years the Northwest River has been out performed by the Southwest with regards to conservation requirements. From 1998 to 2012 the Northwest system reached or exceeded conservation requirements two separate years, compared to seven years over the same period on the Southwest system. Even during exceptionally high adult returns in 2011, the Northwest Miramichi only reached a conservation requirement of 132%, compared to 220% for the Southwest Miramichi. Furthermore, whereas the Southwest Miramichi averaged a conservation requirement of 103% (range 77% to 119%) in the years 1998 – 2009, the Northwest Miramichi averaged less than 50% (range 26% to 111%) of spawning escapement over the same period.

Despite recording poor conservation requirement levels, electrofishing results from the Northwest Miramichi have typically shown healthy densities of Atlantic salmon fry and parr. It seems reasonable to assume that smolt production should be positively correlated with juvenile densities, and should therefore follow that a river system with high juvenile densities should have high smolt productivity. However, this progression implies that high smolt production should result in sustaining spawning returns to the Northwest Miramichi, and this has not been observed. Therefore, an accurate estimation of the total smolt population emigrating from the Northwest Miramichi River to the marine environment is an essential component to understanding and managing Atlantic salmon in this watershed and a way to determine the ocean survival rate of smolts returning as grilse and salmon.

One of the most well used methods of establishing an accurate estimate of riverine smolt production is through the use of mark-recapture study. Two-sample mark-recapture studies include the tagging of smolts at a mark-release trap, and the recapturing of marked fish at a

second recapture trap. The percentage of marked fish recaptured at the second trap is used to establish recapture trap efficiency over different time strati, which is then applied to the total number of smolt captured at the trap to give an estimate of the population.

In response to low adult returns to the Northwest Miramichi angling regulations were modified in 2011 to a catch and release fishery to reduce human caused harvesting mortality. Although this management policy has likely reduced the rate of angling based mortality in comparison to the Southwest Miramichi, Northwest salmon are still subjected to significantly higher sources of non-angling mortality from First Nations Fisheries Allocations. Furthermore, the Northwest system is the site of large congregations of pre-spawning and spawning striped bass during the same time as Atlantic salmon smolts are migrating into the estuary. Although the scientific correlation between striped bass predation and smolt survival is not well understood at this time, it is possible that adult bass are having an additive mortality impact on seaward moving juvenile salmon. The study of smolt production in the Northwest system, in combination with movement tracking of tagged smolt and the timing, number, and feeding habits of striped bass spawners has the potential to shed further light onto the relationship between these two species, to allow for the development of an adaptive ecosystem based fisheries management approach to the Miramichi Watershed.

The 2013 smolt population estimates from this study represent the third year of the multi-year Northwest Miramichi River smolt production project. The purpose of this project is to assess smolt production on the Northwest Miramichi system, to determine if adequate juvenile production is occurring in the Northwest Miramichi River System. This project is run in joint partnership between the Miramichi Salmon Assocation (MSA) and the Northumberland Salmon Protection Assocation (NSPA). Data resulting from this project 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, and to facilitate further research into the ecological influences of striped bass on salmon smolts.

Methods

Study Area

The Northwest Miramichi watershed drainage area of 3,950 km^2 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 Miramichi River (1,342 km^2) and the Northwest Miramichi (2,078 km^2) River which flow merge in a delta at the head of tide. The Northwest Miramichi River includes a large tributary, the Big Sevogle River, with a drainage area of 799 sq. km^2.

Design

The smolt production estimate for the Northwest Miramichi system used a two-sample mark-recapture study design, using three rotary screw traps (RST's) installed on the system's largest tributaries as mark-release locations. RST's, commonly referred to as smolt wheels, were installed in early May on the Little Southwest, Northwest, and Sevogle rivers. Smolt wheels were held in place by large overhead cables spanning the width of the river acting as a support line for the entire structure. From this support line a second cable hung down and attached to the RST, centering the trap over a desired location with a depth that would facilitate full rotation of the wheel without contacting bottom. The buoyancy of smolt wheel pontoons floated the trap, while the flow of water spun the submerged wheel and prevented the trap from swaying within the river. Smolts migrating downstream had the potential to enter into the RST, where the rotating action of the wheel funneled fish into to the trap box located at the rear of the smolt wheel and prevented fish from escaping. During each day of operation field crews used boats to access the traps and collect captured fish. Once retrieved, 25 smolts were measured to fork length, 20 of which received clear, individually numbered streamer tags while the remaining 5 were used for scale samples. Remaining unmeasured smolts were tagged with clear, individually numbered streamer tags and released along shore adjacent to the wheel, with the exception of days with high catches in which it became unfeasible to tag all individuals. Other fish species and smaller juvenile salmon were counted and released. For the purpose of the study all Atlantic juvenile salmon > 100mm FL were considered smolts to be used in the mark recapture experiment.

A single large trapnet was installed in the estuary of the Northwest Miramichi at Cassilis to function as the recapture trap. Tagged smolt captured at the Cassilis trap net allow us to get an

estimate of the smolt moving out of the entire Northwest Miramichi. The total smolt run from the Northwest Miramichi is determined by a ratio of the number smolt that are tagged upstream at the Sevogle, Northwest and Little Southwest smolt wheels, the number of tagged smolt that are recaptured at the Cassilis trap, and the number of untagged smolt captured at the Cassilis trap. This latter facility was fished daily, generally at low tide, and the smolt were sorted from the rest of the species captured. Each day, sub-samples of up to 100 smolts were measured, 20 of which were lethal sampled for detailed information on length, weight, sex and age. All smolt captured were counted and checked for streamer tags.

Stream course distance from rotary screw trap to the Cassilis trapnet were 7.9 km on the Little Southwest, 15.7 km on the Sevogle, and 22.4 km on the Northwest River.

Results

The Sevogle and Northwest smolt wheels operated from May 4 to May 31 excluding the May 25 to 29 due to high water levels. The Little Southwest smolt wheel operated from May 9 to May 24 excluding May 13 to May 16 due to damage from woody debris. The estuary trap net at Cassilis operated from May 10 to May 31 but the trapnet leader was raised from May 25 to 29 to avoiding washing out from the debris moving from high water levels.

The peak of the smolt run for the Sevogle River occurred May 12 with 638 smolt. The peak of the smolt run on the Northwest River was on May 11 with 460 smolt. The peak of the smolt run on the Little Southwest River was on May 11, 2012 with 126 smolt. In 2013, we tagged 1482 smolt on the Sevogle, 1560 smolt on the Northwest Miramichi, and 422 smolt on the Little Southwest Miramichi. We were able to capture 1733 smolt in the Sevogle smolt wheel, 1727 smolt in the Northwest River smolt wheel, and 652 smolt in the Little Southwest smolt wheel over the entire season

At the Cassilis estuary trap a total of 12776 smolts were captured smolt, 39 of which had been tagged at the upstream smolt wheels. After accounting for a combined 10% mortality and tag loss of marked fish, the recapture efficiency at Cassilis was 1.25%. Smolt production on the entire Northwest Miramichi River system, after assuming mortality and tag loss was estimated at 982,669 smolt (95% CI 684,294 to 1,281,044) using the Pooled Peterson estimate from SPAS software, and 1,050,000 using the median value from a Bayesian population estimate (95% CI

775,000 to 1,475,000). These two estimates produced smolt production values of 5.85 and 6.25 smolt/m^2, respectively.

Movement of fish following tagging varied across tributaries. The minimum and maximum time of recapture after of smolt was 2 and 7 days on the Northwest, 1 and 5 days on the Sevogle, and 1 and 3 days on the Little Southwest. Excluding movements of smolt tagged before being available for recapture within 1 day (May 4 to 8), the mean and mode of time of recapture was 4 and 2 days for Northwest (n=7), and 3 and 2 days for Sevogle (n=19). From May 4 to 8 for the Northwest River, the mode for time of recapture after tagging was 5 days (n=5), with a mean of 4 days. Two of these fish were tagged May 8 with movements of 2 days and 3 days before recapture. No smolt tagged on the Sevogle from May 4 to 8 was recaptured.

Discussion

During the three year study of smolt on the Northwest Miramichi, estimates of juvenile production have varied considerably, with unexpected and sometimes confounding results. In 2011 and 2013 smolt production significantly exceeded 3.0 smolt/100m^2, considered the production target in to meet conservation requirements, by 50 and 100%, respectively. These values are surprising, as the years in which these fish were first produced had fewer adults than required to meet spawning requirement, which one might expect to to correlate to production below 3.0 smolt/100m^2. Furthermore, smolt production estimates from one-way mark recapture studies conducted in 2011 and 2012 on the tributaries used for tagging in the current study did not match well. The combined estimates of the Little Southwest, Sevogle and Northwest Rivers in 2011 was 164,800 smolt, compared to an estimate of 765,000 smolt for the entire system at the Cassilis trapnet from the two-way mark recapture study, a nearly 5 fold difference in estimates.

Smolt production on the Northwest Miramichi has used a two-sample mark recapture design to determine a total estimate of migrating smolts. This study design requires one or more capture-marking stations in upstream locations, and one downstream recapture station. In 2013 due to logistical issues, the Cassilis trapnet used for recapture was not installed until May 10th, six days after the start of tagging on the Sevogle and Northwest. Fish tagged during this time may have moved through the river system before the trapnet was operational, leaving them unavailable for capture. Based on mean and mode values of smolt movement time, it is probable that a reasonable percentage of fish tagged during this time were not available for recapture.

Similar issues with delayed trapnet installation occurred in 2011 where, after the exclusion of days in which RST's did not operate due to high water events, there was a total of 10 tagging days in which the downstream trapnet was not operational. For this past year's study it is difficult to make corrections for tag availability due to small sample sizes from each tributary in 2013. Analysis is currently underway to compare movement of smolt from each tributary from all years of the study, to determine movement patterns and their correlation to water temperature and stream discharge.

The recapture site during this study, located shortly downstream of the convergence of the Little Southwest and Northwest rivers, has been highly susceptible to spring freshets. During each of the past three years the trap has been washed out or forced to be lifted during high water events following precipitation. Multiple studies have shown that smolt migration rates increase during moderate high water events, which likely means that our smolt estimates have been skewed as the study has been unable to account for smolt numbers during peak runs. Further analysis of movement patterns may allow for increased refinement of smolt estimates by attempting to conservatively quantify the number of tags which moved past Cassilis while the trapnet was inactive.

The disparity between tributary specific and system wide estimates in past years may be the result of pre-smolt movements the previous fall. In other tributary systems on Miramichi River high numbers of large juvenile salmon have been observed to move downstream during the fall, possibly to stage in lower positions of the river system before migrating to sea the following spring. Smolt which moved downstream of the rotary screw trap locations would not be available for capture as untagged fish. Although the recapture efficiency of tagged smolts would not be affected by the absence of these fish, the number of untagged fish available for capture would be reduced. This reduction would cause the smolt estimate for these systems to be artificially low. The three year smolt production study on the Northwest Miramichi was not designed to address the impact of pre-smolt movement on these systems, but may warrant future research.

In order to address these confounding issues the MSA has chosen to re-focus the intent of the study from a smolt estimate on the Northwest system to an estimate of the entire Miramichi watershed. During the 2014 field season three marking sites will be operated throughout the entire watershed; the Sevogle and Northwest Rivers on the Northwest system, and the Dungarvon River on the Southwest system. Furthermore, smolts tagged by Rocky Brook Camp

during their annual fall pre-smolt population estimate on Rocky Brook will be available for recapture in the recapture trap net. In order to determine a river wide estimate of smolt migration the recapture trap net will be relocated downstream of the convergence of the Northwest and Southwest Miramichi, in a location between Bushville and Chatham. Moving the trap net to a more downstream location will reduce the intensity of freshets, increasing our ability to continue sampling during high water events. Adjusting our study specifically to a watershed level estimate of smolts will no longer require the recycling of smolts on individual tributaries, and as such we will not be developing tributary specific estimates which have possibly been biased by the effect of pre-smolt movement in the fall. Smolt wheel locations for this study have been chosen for tributaries, which in past studies, have been shown to have high catch of smolts in order to optimize our ability to add tagged individuals to the study. The Little Southwest Miramichi will not be used as a tagging location as it has generally been out performed by the Sevogle and Northwest wheels.

Repositioning the trap net below the confluence of the branches of the Miramichi will also allow for further research opportunities. In 2014 the MSA will participate with DFO in a tagging study of bright salmon returning to the Miramichi. Salmon captured at the downstream site will be tagged and released for re-capture at DFO trap nets on the SW and NW branches as part of a mark-recapture survey to improve the DFO adult return estimates. This improved adult estimate will provide valuable information for future salmon management policies.

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Promotion

The New Brunswick Wildlife Trust Fund was promoted through the Northwest Smolt Production Study by the use of the pencils and stickers, and on the gear used at the smolt wheels. Through the MSA website under Programs, the NB WTF will be acknowledged, as well as in the report

from this project to be circulated at the Miramichi Watershed Management Committee Science Committee meetings and at MSA board meetings in Boston, MA and Freeport, ME as well as acknowledged at the joint MWMC/MSA Science Workshop.