Assessment of the 2008 West River, Sheet Harbour Atlantic salmon smolt migration

Photo: E.A. Halfyard

Nova Scotia Salmon Association

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EXECUTIVE SUMMARY

In response to the issue of acid precipitation, the Nova Scotia Salmon Association initiated an acid rain mitigation program on the West River, Sheet Harbour. This program uses an automated lime doser to buffer the acid waters of this once prolific salmon river. In addition to the mitigation activities on this system, the NSSA also began a monitoring program to assess the rivers salmon smolt production and indirectly the effects of the liming program. This report summarizes the activities from the 2008 salmon smolt monitoring programs.

Salmon were sampled from April 26th to May 30th, at two sites, the main branch West River Sheet Harbour and the Little River, a tributary of the West. A rotary screw trap (smolt wheel) was used to sample the main branch and fyke nets were used to sample the Little River. A total of 362 salmon smolts were captured in the smolt wheel and an additional 39 smolts were captured in the fyke nets. The mean length of smolts was 18.4 cm for both sites. Mean smolt weight was 68 g for fish sampled in the smolt wheel and 64 g for fish sampled in the fyke nets.

Using a stratified mark recapture, the total emigration of salmon smolts from the area above the smolt wheel was estimated at 2796 smolts with 95% confidence intervals of (1389, 4204). This is slightly above the 2007 estimate of 2441 smolts. The number of smolts that emigrated from the Little River could not be estimated as a result of high water inhibiting catches.

In addition to the smolt monitoring program, collection of smolts for a Live Gene Banking enhancement strategy was conducted and 300 wild smolts were transported to the Coldbrook biodiversity facility to be reared to adult.

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INTRODUCTION

The West River, Sheet Harbour (WRSH), a once prolific salmon river, has been acidified by acid precipitation. In 2005, a lime doser was installed by the Nova Scotia Salmon Association to increase the river waters pH. Since start-up, the lime d buffered the acidity of the water to the target pH of 5.5, deemed sufficiently hig prevent acid-related hindrance of salmon production. While electrofishing survey activity has remained relatively constant on this river in recent history, adult abundance estimates via catch data has been lost since the closure of the sport fishery in 1999.

As changes in the river's production capacity are expected to coincide with the acid mitigation project, some estimate of smolt abundance is crucial to assessing the impact of the lime doser.

The WRSH can be divided into three main areas:

Main West River, Sheet Harbour

The Main WRSH red solid oval – Figure 1) is a tannic-stained water, highly deforested, flash-flood prone river. A natural barrier is located some 30000m above the head of tide. The lime doser was installed some 600m above this barrier. There are two, large lake-like pools on the system, the uppermost being River Lake at roughly 0.5 km^3 and the lower, Sheet Harbour lake, at roughly 1.2 km^3. Figure 1 shows the Main West River, Sheet Harbour sampling sites. The solid red oval in figure 1 shows the approximate area of the main river from which smolts were collected by rotary screw trap (smolt wheel), as denoted by SW.

The Killag River

The Killag River (blue solid oval – Figure 1) is the major tributary to WRSH. According to local knowledge, the majority of salmon spawned in this part of the system. The Killag has a rather long and narrow drainage basin, with a main channel length of approximately 27000m. This system is also organic-acid stained. The area in figure 1 surrounded by the solid blue line approximately denotes the section of the Killag river from which the smolt wheel collects smolts.

Little River

The Little River is the second largest tributary of WRSH, also traditionally supporting a large portion of the salmon spawning and rearing habitat. The Little River has a main channel of approximately 16500m. This system is anchored at the headwaters by Lake Alma, a large, shallow impounded lake. This system is relatively clear and historically has been only episodically acidic. Figure 1 shows Little River sampling sites. The dashed blue line in figure 1 shows the approximate area of the Little River from which smolts were collected by fyke nets (location denoted by FN).

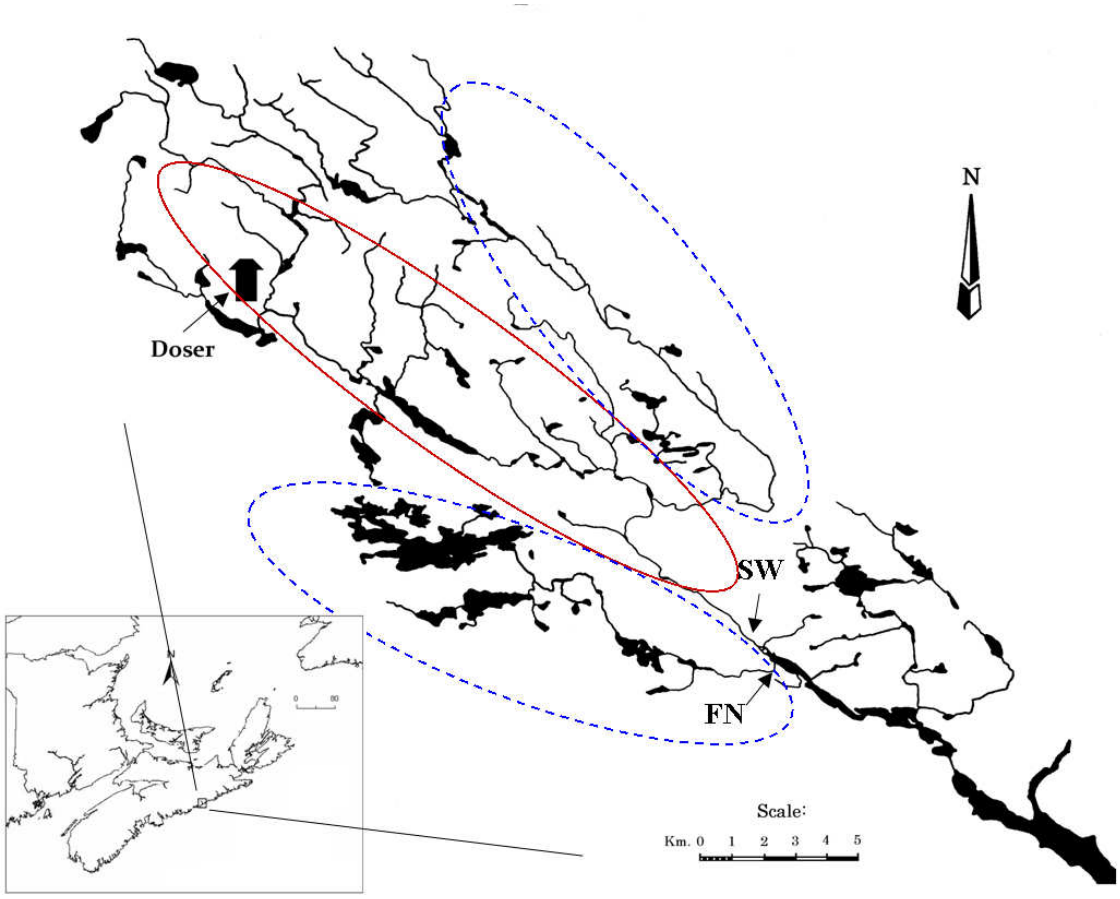

Figure 1 – Map of West River, Sheet Harbour and Nova Scotia indicating the positions of the smolt wheel (SW), fyke nets (FN) and lime doser (Doser). The river section in the solid (red) oval is a treated section of the main branch, WRSH and the two dotted (blue) ovals represent the Killag River (Northern-most oval) and the Little River (Southern-most oval). The smolt wheel samples the main branch WRSH and the Killag River while the fyke nets sample only the Little River.

METHODS

Rotary Screw Trap Installation and Operation

The rotary screw trap (smolt wheel) was installed and operational April 26th, 2008 in Iron Bridge pool, main branch West River, Sheet Harbour. Deflectors of 1.22m by 2.43m by 1.3 cm plywood were installed and anchored with 2.5cm steel rebar to form a north and south wall.

Initially flood water from April 28th to May 5th washed out all in-stream defectors. When reinstalled, the north side of the cone had 2 sections of plywood preceded by a 5m length of coniferous trees lashed together to act as a fish defector in high water conditions when plywood could not be used. One piece of plywood was

installed on the south side of the cone. The deflectors remained as described orientation for the remaining duration of the assessment.

Fyke Net Installation/ Operation

Two Fyke nets were installed in Little River April 26th, 2008. The fyke nets had been modified from 2007 to include a catch box which was attached to the bag of the fyke net to collect and hold fish. Their main purpose was to provide a reduced flow environment for the captured fish thus reducing stress and the possibility of injury. The catch box had a flat plywood front with a 15.24cm pipe where the fyke net attached and the fish entered through. Three rectangular water escape holes (approx. 30cm by 25cm) were cut in the remaining sides and covered with galvanized wire mesh (1.25 cm) allowing for the flow through of water at a controlled rate. The boxes were weighed down with four (30.5cmx30.5cm) cement patio blocks placed on the inside and excess space was packed tight with gravel. The boxes were anchored in place with steel rebar and large rocks around the outside edges.

The fyke net bag was attached to the catch box with a stainless steel hose clamp and two plastic pull-ties. One of the pull-tie was used to pull back and secure any excess net around the entrance of the pipe that would cause the net to budge out and collect debris potentially blocking the pipe entrance. The second pull-tie was used to close off fyke net bag at the pipe entrance preventing fish from swimming out of the catch box back into fyke net bag.

The most efficient method for cleaning the wings of the fyke net while keeping it attached to the catch box was to remove one arm at a time from the rebar, clean it off and then replace. Only in high flows when a large amount of debris was captured in the fyke nets did the bag have to be removed from the catch box.

Catch Monitoring, Sampling and Marking

Each morning and evening, fish were emptied from the holding bin/nets, identified to species and counted. For salmonid fishes, lengths and weights were taken from Monday to Friday of each week, thus representing a sample of the total run. Also, salmon smolts were examined for marks used in the efficiency tests, generally either an anal fin clip or a pelvic fin clip. Scale samples were taken on a random sample of fish, and ages were back-calculated via the Fraser-Lee equation (Murphy and Willis 1996).

Hydrological / Physical Monitoring

Two Hobo – Onset pendant temperature loggers were deployed at the start of the project at each of the two capture sites. Temperature was recorded every hour. A staff gauge located at the lime doser was read at the end of the day (2000h) and the water level recorded. This staff gauge is used as a proxy for hydrologic conditions across the system.

Salmon Smolt Yield Estimates

The statistical design adopted for this study was that of simple stratified design, implementing a Chapman-modified Petersen (Ricker 1975, Carlson et al. 1998, Volkhardt et al. 2007).

Using the smolt mark recapture data, information can be arranged so that;

h = Stratum index
L = Number of strata
U_h = Smolt population estimate for strata h
Mh = Number of smolts marked and released in strata h
mh = Number of marked smolts recaptured in strata h
uh = Number of unmarked smolts captured in strata h
N = Smolt estimate for entire study period

These variables are then plugged into the following equations;

Equation 1 - Single strata estimator

$$\tilde{U}_h = \tilde{N}_h — M_h = \frac{u_h (M_h+1)}{m_h+1}$$

Equation 2 – Single strata variance

$$\tilde{V}(\tilde{U}_h) = \frac{(M_h+1)(u_h+m_h+1)(M_h-m_h)u_h}{(m_h+1)^2 (m_h+2)}$$

Equation 3 – Overall estimator

$$N = \sum_{h=1}^{L} \tilde{U}_h$$

Equation 4 – Overall variance

$$v(N) = \sum_{h=1}^{L} v(\tilde{U}_h)$$

Equation 5 – 95% Confidence intervals for overall estimator

$$95\%\ CI = \tilde{U} \pm 1.96\sqrt{v(N)}$$

Live Gene Bank Collection and Holding

Smolt were collected for the Live Gene Bank (LGB) Program, administered by the Department of Fisheries and Oceans Biodiversity facility in Coldbrook, NS. Smolts were collected from the rotary screw trap and fyke nets and transported to a streamside flow through tank (1.5m dia.) and held for a maximum of 5 days. The flow through tank was supplied with water from the treated main branch by an electric pond pump through a 1.27cm garden hose. A plywood cover was secured to the top of the tank to prevent possible predation and provide shade. When being held, smolts were checked, at minimum, daily.

RESULTS

Hydrological / Physical Monitoring and Trap / Net Operation

Water height, as measured by the staff gauge at the lime doser (main branch, WRSH) was at its lowest on April 28th and reached its maximum height on May 1st. Two obvious flood events occurred, the first and largest of which was the flood of late April / early May and the second commenced on approximately May 10th (Figure 2). Median water height was 1.45m (S.E. = 0.02)

While the smolt wheel drum operated at acceptable RPM across most of the sampling period (Median= 6.9, S.E.= 0.5)(Figure 2), the largest flood ceased trap operation for a period of 4 days. Similarly, the fyke nets did not fish during the largest flood.

Mean daily temperature exhibited a moderately steady increase over the sampling period with anticipated diel fluctuations. Only the flood waters mentioned above interrupted this trend. The first recorded hourly temperature in exceedance of 10ºC was on April 27th and April 28th at the Main branch and Little River sites, respectively. The first daily mean temperature to exceed 10ºC was on May 6th and April 29th for the Main branch and Little River sites, respectively (Figures 3 and 4).

Smolt Catch

In total, 362 unique smolts were captured in the smolt wheel and an additional 39 smolts were captured in the Little River fyke nets. In the smolt wheel, few smolts were captured prior to May 6th (N=3). Of the 362 total captures, 304 or 84 % were captured

between May 8th and May 19th (Figure 3). In the Little River fyke nets, no smolts were captured after May 10th (Figure 4).

Salmon Smolt Yield Estimates

The 2008 estimate of smolts from the Main Branch WRSH + Killag River (i.e.. everything above the smolt wheel) was 2796 with 95% confidence intervals of (1389, 4204). This estimate is thought to be conservative as a result of the smolt wheel remaining inactive during the period from May 1st to May 5th (inclusive). Very few smolts were captured prior to the flood however and the number of smolts that emigrated with the floodwater is unknown. For the purposes of the estimate, we interpolated the smolt catch over the four day interval the wheel was not fishing as the mean of the catches from 2 days before and 2 days after the event. Therefore we are likely slightly underestimating the actual number of smolts in the migration. The 2007 estimate was 2441 (1452, 3431).

Unfortunately, we were not able to estimate the number of smolts leaving the Little River this year. Catches were low on either side of the flood, and the four days the nets were not fishing is likely when the vast majority of the smolts ran down the system. Last year, the Little River estimate was 1035 smolts (948, 1122), which was 42% of the Main + Killag estimate.

Smolt Length and Weight

Of the smolts captured in the smolt wheel, 189 were measured and weighed. The mean length was 18.4 cm (S.E.=0.09) (Figure 5). This compares to last years mean of 17.1 cm (N=97). A subsample of 101 smolts from 2008 had a mean weight of 68 g (S.E.=1.5).

Similarly, of the few smolts captured in the Little River, 25 were measured with a mean length of 18.4 cm (S.E.=0.33) (Figure 5). This again is larger than last years mean length of 17.2 cm (N=138).The 25 smolts of 2008 had a mean weight of 64 g (S.E.=3.5). Due to the small and temporally restricted sampling, these values for Little River smolts may be inaccurate.

The smallest smolt captured was 15.0 cm and weighed 30 g and the largest was 22.1 cm and weighed 120 g. Both were taken in the smolt wheel (Figure 5).

Smolt length across the entire period did not significantly shift (Regression A, R^2=0.13, P=0.21) however there were two obvious periods in the migration (Figure 6). The first period, as denoted from smolt lengths before May 17th exhibited a significant increase over time (Regression B - R^2=0.76, P=0.00) while the second half showed no trend (Regression C – R^2=0.01, P=0.86).

Live Gene Bank Collection and Holding

A total of 300 wild smolts from WRSH were sent to the Coldbrook biodiversity facility for use in the live gene banking program, from which adult broodstock and potentially 1st generation progeny will be released back into the WRSH. To augment smolts taken in the smolt wheel and Little River fyke nets when catches were low, 3 additional fyke nets were set 1.8 km above the smolt wheel. The temporal spread of

collection was as even as possible though during times of high rates of migration, more smolts were retained.

Other Fish Species

In the smolt wheel, a total of 73 brook trout, 369 white suckers, 85 yellow perch, 14 American eel and 73 lake chub were captured. In the Little River fyke nets, a total of 111 brook trout, 426 white suckers, 2226 yellow perch, 40 American eels, 7 Lake chub and 43 brown bullhead were captured (Table 1). For most species, the number captured in 2008 was substantially lower than those captured in 2007. The one exception was in Little River where the number of yellow perch almost doubled. Again, as in 2007, the average size of the yellow perch captured was estimated to be in the 10-12 cm range. Many of the brook trout appeared to be anadromous fish on their downstream migration to the estuary.

DISCUSSION/RECOMMENDATIONS

Smolt catch

The lack of success capturing smolts in the Little River was likely due to a late start of sampling and the flood of early May that prevented fishing during the period when presumably the majority of the smolts emigrated. While an earlier start to sampling next year may improve the opportunity to catch smolts, the issue of flooding may be inevitable. In 2007, sampling took place over a similar time scale and capture was highly successful.

Salmon smolt yield estimate

Because of the relationship between trap efficiency and relative error (as summarized in figure 1 of Carlson et al 1998), the sample size required to give a reasonable alpha of 0.05 is rather large. Given that the entire smolt emigration is rather small, the error around our estimate is rather large and thus our confidence is accordingly low. This is an unfortunate effect of small population size and will be a reality of the project in the future.

Future Initiatives - Recommendations

In an effort to facilitate research on the enhancement efforts of the Live Gene Banking program, smolts collected in the future must be separated and identified based on collection area. This may aid in broodstock / progeny release as well as genetic mapping. Additionally, as the smolts captured in 2007 return to the river in the autumn of 2008, careful planning is required when selecting release locations and strategies. I|t is unknown whether the broodstock will attempt to return to their native stream reach, however without evidence supporting otherwise, we should assume that they will and thus these fish should be placed no further up the system than the point of capture to facilitate natural spawning site selection.

Smolt used in the efficiency trials for the smolt wheel should be released in fast moving water, well downstream from the pool associated with the old counting fence. This may encourage rapid downstream movement and thus additional efficiency trials. Smolt released in the counting fence pool in 2008 often remained there for several days.

A staff gauge should be attached to both the iron bridge at the smolt wheel site and at some point on the lower Little River to provide increased resolution in the monitoring of water height.

The smolt holding boxes used in association with the fyke nets have openings with metal mesh. This mesh should be replaced with Vexar plastic coated mesh to reduce abrasion of smolts as was experienced in 2008.

Finally, the wings currently used for deflection of water flow and smolts are costly, require substantial maintenance and are easily destroyed by high flows. The construction of wings attached to the smolt wheel itself would alleviate these problems.

In all, the 2008 smolt estimation project was a success despite the inclement weather and high water. With each successive year that the project is run, the methods used to estimate the smolt population becomes refined and the hope is that in the future, the project will produce a reliable estimate with a minimum amount of resources and work. These data should aid resource managers in assessing the status of the river and the contributions of the acid rain mitigation program.

REFERENCES

Carlson, S.R., L.G. Coggins Jr., and C.O. Swanton. 1998. A Simple Stratified Design for Mark-Recapture Estimation of Salmon Smolt Abundance. Alaska Fishery Research Bulletin.5(2): 88-102

Craig, J.D.C. and D. McCubbing. 2002. Assessment of 2002 steelhead smolt yield from the Englishman River, Vancouver Island. Prepared for Community Fisheries Development Centre, Nanaimo, B.C. 11 p.

Murphy, B.R., and Willis, D.W. 1996. Fisheries Techniques 2nd ed. American Fisheries Society, Bethesda, Maryland. 17

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Brd. Can. 191: 382 p.

Schwarz, C.J. and C.G. Taylor. 1998. Use of the stratified-Petersen estimator in fisheries management: estimating the number of pink salmon (Oncorhynchus gorbuscha) spawners in the Fraser River. Can. J. Fish. Aquat. Sci. 55:281-296

Volkhardt, G.C., S.L. Johnson, B.A. Miller, T.E. Nickelson and D.E. Seiler.2007. Rotary

Screw Traps and Inclined Plane Screen Traps. Pages235-266 in D.H. Johnson, B.M.

Shrier, J.S. O' Neal, J.A. Knutsen, X. Augerot, T.A. O' Neal, and T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

APPENDIX

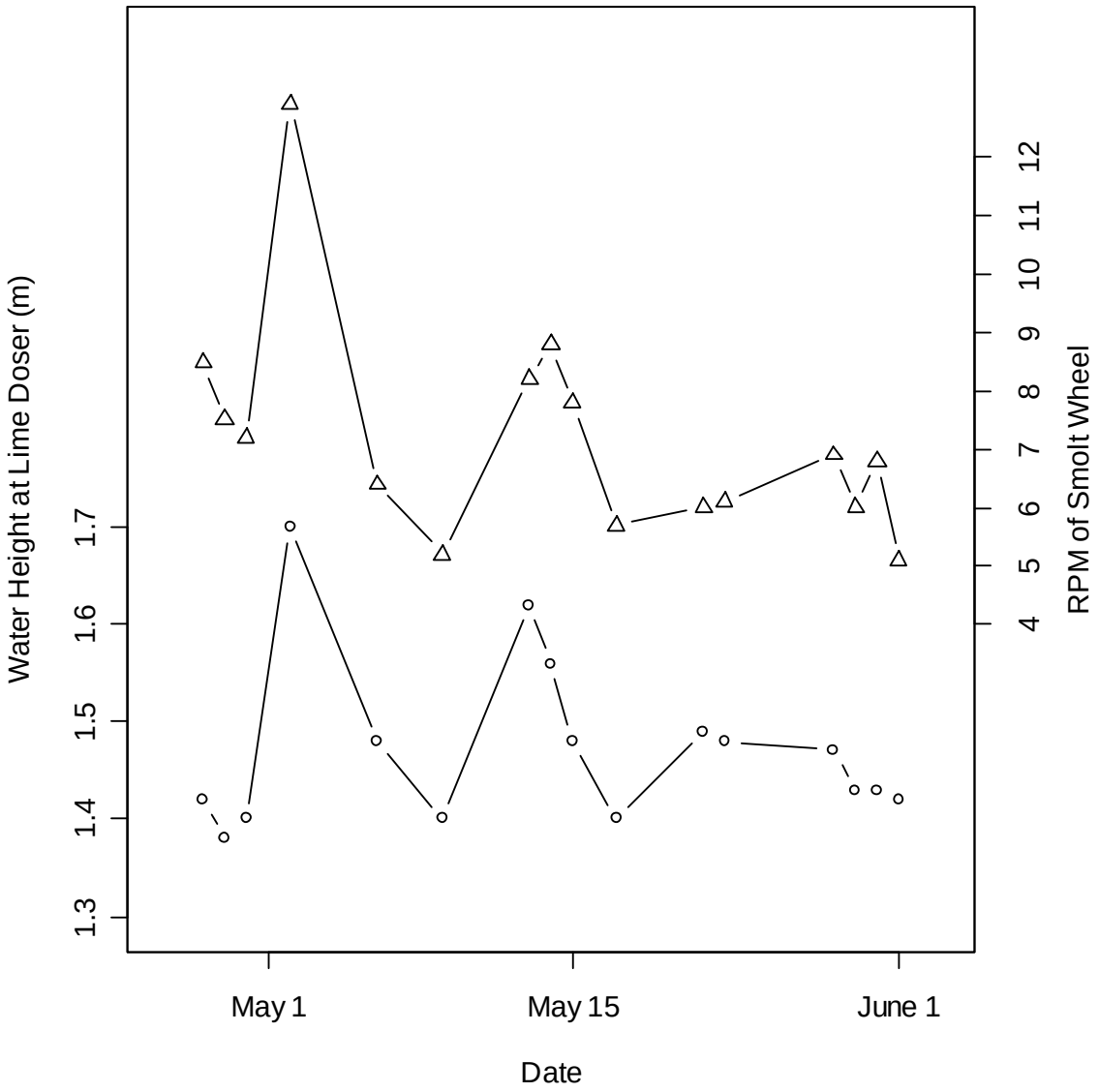

Figure 2 – Water height (m) at lime doser staff gauge (round points) and the associated RPM of the smolt wheel drum (triangle points). The heavy rainfall event of April 28th to May 5th resulted in few measurements during that period.

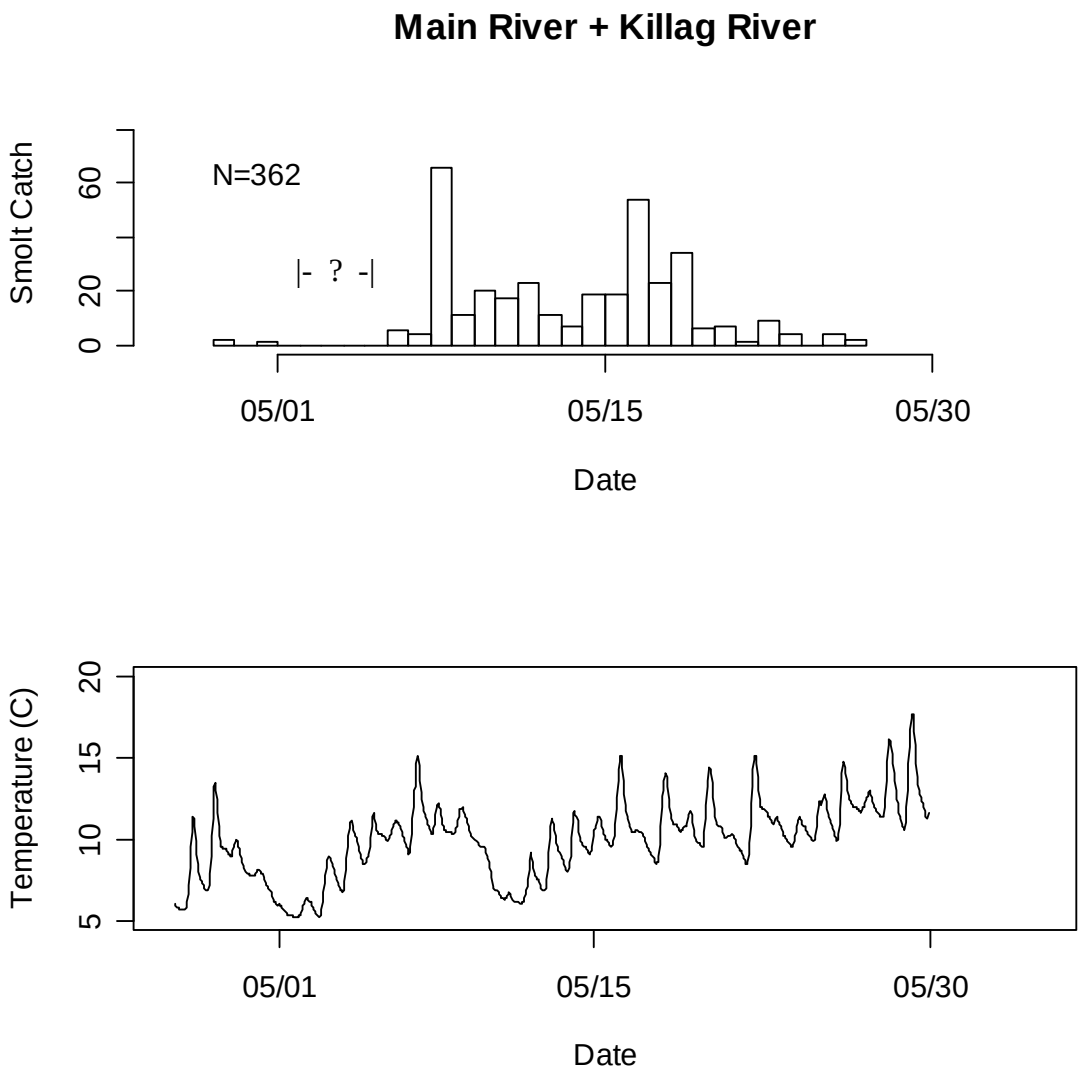

Figure 3 - Smolt catch (# of smolts) and water temperature (ºC) for the rotary screw trap set on the main branch, West River, Sheet Harbour. The trap was not fishes from May 1st to May 4th 2008.

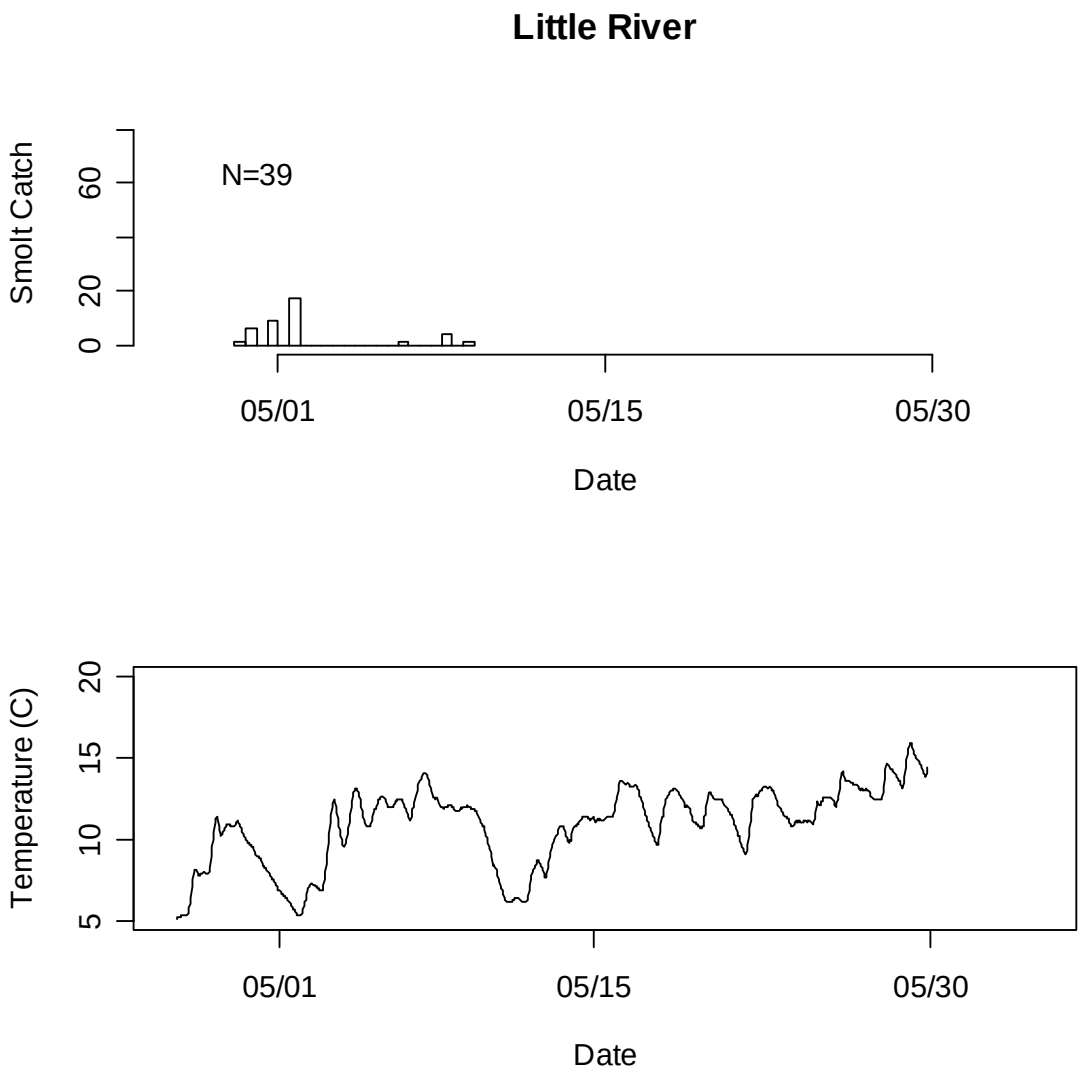

Figure 4 – Smolt catch (# of smolts) and water temperature (ºC) for the fyke nets set on the Little River.

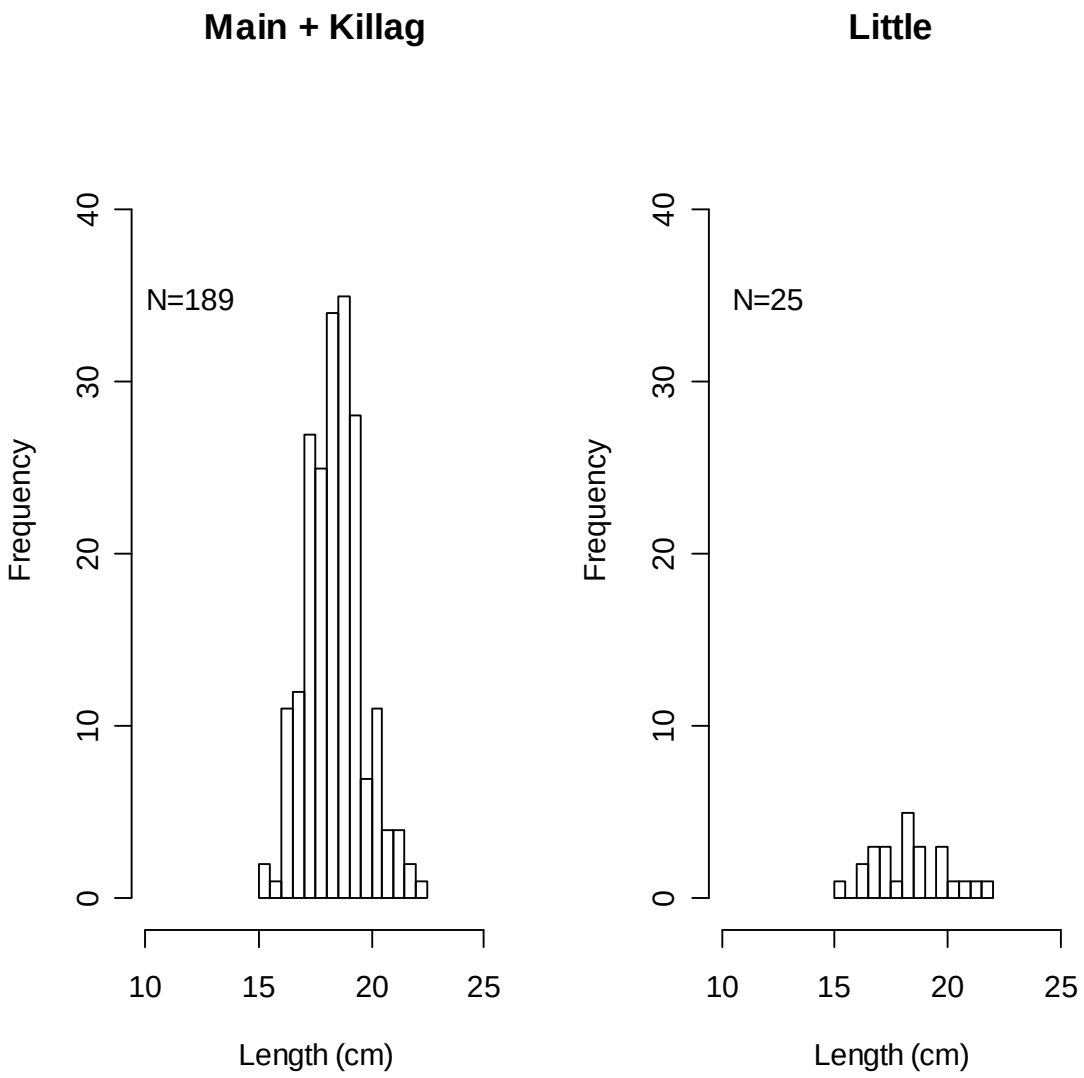

Figure 5 – Fork length histograms for smolts captured in the smolt wheel (Main River + Killag River) and the fyke nets (Little River). Length categories represent 0.5 cm intervals.

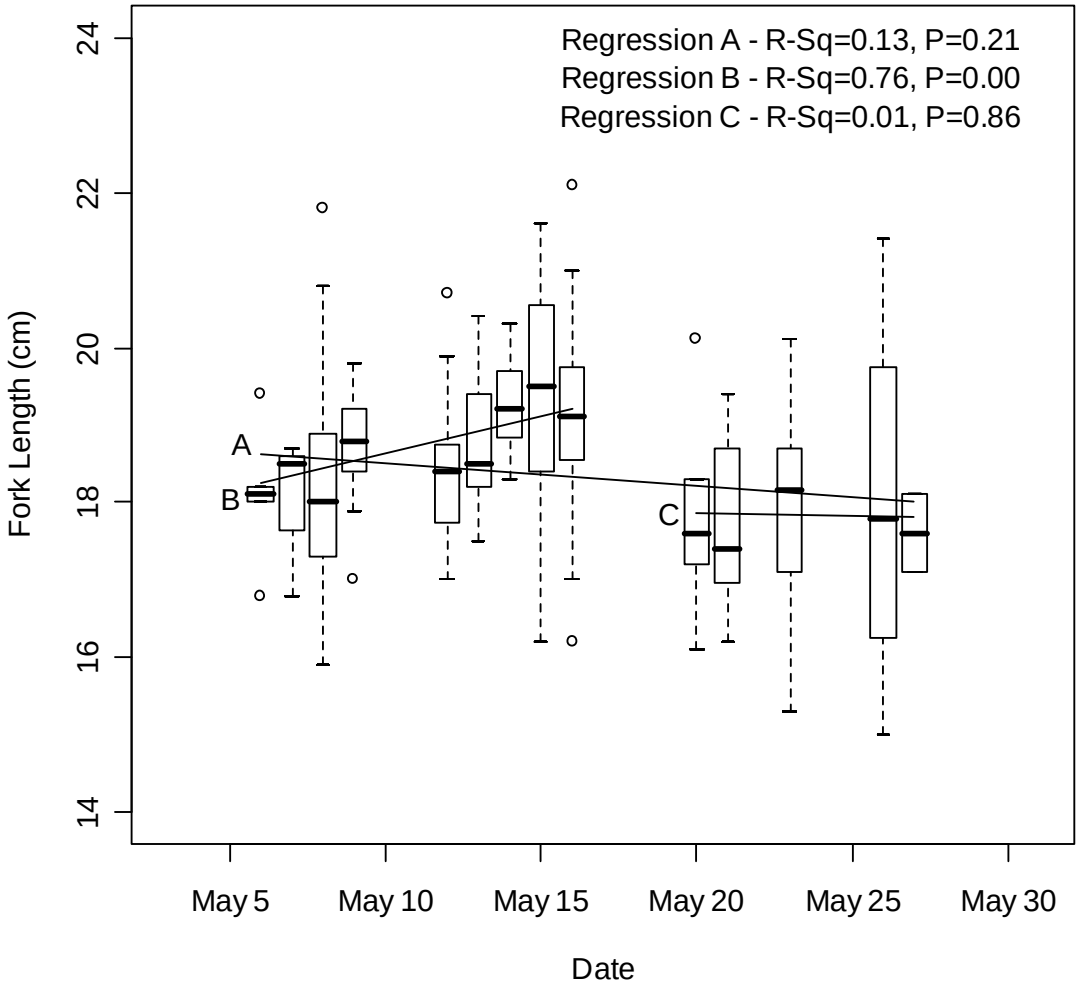

Figure 6 – Box plots of smolt fork length over the sampling period. Each box represents the daily median length, the lower and upper quantiles and the whiskers represent the minimum and maximum lengths. Represents only salmon captured at the smolt wheel site.

Species	Smolt Wheel (Main WRSH + Killag River)	Fyke Nets (Little River)
Atlantic Salmon Smolts	350	39
Atlantic Salmon Parr	4	3
Brook Trout	73	111
White Sucker	369	446
Yellow Perch	85	2226
American Eel	14	40
Lake Chub	73	7
Brown Bullhead	0	43

Table 1 – Total captures of all species at both sites from April 27th to May 30th 2008.

Figure 7 - Smolt wheel in operation prior to the flood of late April / early May.
Photo: J.P. Hastey

Figure 8 - A large Atlantic salmon smolt captured in the smolt wheel. This fish was later used in a pilot study to track smolt movements through the WRSH estuary using ultrasonic acoustic transmitters. Photo: A. Spares