The Re-Establishment of Diadromous Fish Passage to the Petitcodiac River

Origin of Fish Passage Problem

The Petitcodiac River Causeway was built in 1968. It included tidal gates to protect the inundation of farmland by tidal inflow. These lands had been protected previously by individual dykes. Slowed by the presence of the causeway suspended solids at the 10K ppm level deposited in the estuary.

MUD DEPOSITION IN THE PETITCODIAC ESTUARY

Up to 8 m of mud would deposit annually in the summer within a short reach downstream of the causeway. The deposited sediment contributed to fish passage problems, delaying and reducing the size of the tidal bore.

MUD FLUSHING

DIADROMOUS FISHES OF THE PETITCODIAC SYSTEM

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Atlantic salmon
Atlantic sturgeon
American shad
American eel
Blueback herring
Alewife
Rainbow smelt
Atlantic tomcod
Sea lamprey
Striped bass
Brook trout

Vertical Slot Fishway

GULLS AND CORMORANTS AT BOTTLENECK OF CAUSEWAY

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Solution Implemented

A 2003 EIA determined that the only practical solution for providing fish passage upstream and downstream for all of these species was to re-establish as close to uninhibited flow as practical to the estuary. Presently we are in an extended so-called Stage 2, which involves keeping the gates open. Stage 3 will be implemented through the construction of a 250 m long bridge.

DIADROMOUS FISH MONITORING STAGE 2, YEAR 5 (2014)

- The primary reason for permanently raising the gates of the causeway was to provide uninhibited upstream and downstream passage for diadromous fish between the ocean and the Petitcodiac River.
- The diadromous fish monitoring program is intended to allow evaluation of how successful the initiative has been. It also includes an Atlantic salmon re-introduction component.
- The monitoring program has been conducted in association with a semi-formal partnership between First Nations, environmental groups, a Village within the watershed and fish & game groups.
- This partnership is called the Petitcodiac Fish Recovery Coalition, and is comprised of Fort Folly First Nation, the Petitcodiac Watershed Alliance, Moncton Fish & Game, the Petitcodiac Sportsman's Club, the Village of Petitcodiac, The Petitcodiac Riverkeeper, the Big Salmon River Salmon Association, Shepody Fish & Game, the Dieppe Fly Tying Club, the NB Salmon Council and the Atlantic Salmon Federation.
- The Department of Fisheries and Oceans provides advice to the Coalition.

FISH TRAP AND FYKE NETS

- The live trapping operation, with its location depicted on the right top slide, originally employed only the picket trap - lower left.
- With huge mud accumulations, smaller, easily moved fyke nets (lower right) were used after July 1 starting in 2013.

FISH TRAP

SUMMARY OF TRAP AND FYKE NET RESULTS TO-DATE

Year	Soak Time (hrs)	Rainbow Smelt	Gaspereau	Brook Trout	American Shad	Striped Bass	Atlantic Salmon	American Eel	White Sucker	Other	Grand Total
2010	1,348	0	138,273	2	0	0	1	124	5,434	Sea Lamprey 2 Smallmouth Bass 59 Brown Bullhead 4 White Perch 249 Tomcod 1	144,149
2011	1,864	0	55,195	2	1	158	0	118	1,716	Smallmouth Bass 48 Brown Bullhead 7 White Perch 463 Tomcod 1,316 Creek Chub 3 Common Shiner 2 Mummichog 1	60,870
2012	1,779	1	59,754	4	0	706	5	388	923	Smallmouth Bass 15 Brown Bullhead 14 White Perch 335 Tomcod 774 Creek Chub 18 Common Shiner 2 Mummichog 1	62, 940
2013* *picket trap & fyke nets combined	1,692	1	22,487	7	2	456	11	242	707	Sea Lamprey 5 Smallmouth Bass 0 Brown Bullhead 10 White Perch 600 Tomcod 3,155 Creek Chub 39 Common Shiner 14 Mummichog 6 3 spine stickleback 1	27,744
2014* *picket trap & fyke nets combined	1,774	0	8.198	19	2	2,813	7	592	795	Sea Lamprey 2 Smallmouth Bass 0 Brown Bullhead 8 White Perch 353 Tomcod 2,518 Creek Chub 27 Common Shiner 43 Mummichog 4 3 spine stickleback 12 Banded Killifish 1 Blacknose Dace 15 Atlantic Silverside 1	15, 410

RAINBOW SMELT

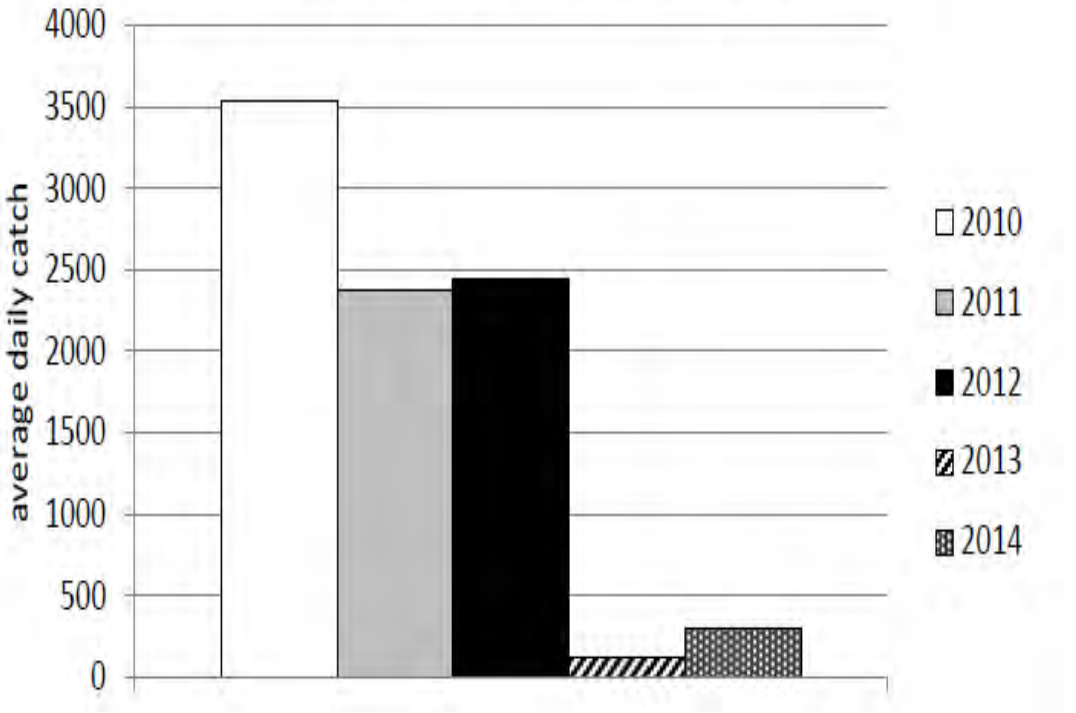
This fish species was negatively affected by a lack of upstream passage at the causeway. This small fish is bite-sized forage for many larger fish including Atlantic salmon that overwinters in its home river after spawning. We cannot stress enough that this is vitally important for Inner Bay of Fundy salmon that require successful repeat spawning for persistence of the species.

We do not have the picket trap in place in time to intercept the smelt spawning run and therefore have no capture numbers. Smelt recovery was documented through the discovery of egg masses in past years, and in 2014, we captured pre-spawning smelt like this one by dip netting them from the shore at the trap site.

GASPEREAU – ALEWIFE AND BLUEBACK HERRING

Because of a later spring and to avoid early-season wash-outs, trap installation has been later in recent years. This means that the total number of gaspereau captured has been down. My co-author, Edmund Redfield of Fort Folly and the PFRC uses an index of daily capture rates from May 30 to July 4, and this is down too. This could be the result of the loss of gaspereau nursery area in the headpond. It may be cyclical fluctuation. No matter the reason, there are still hundreds of thousands of gaspereau returning to the system each year.

Figure 5: Average daily catch of Gaspereau between May 30th and July 4th during 5 years of monitoring at PFRC fish trap



BROOK TROUT

Brook trout capture numbers are increasing, but mainly from late in the year. This has been attributed to the use of the fyke nets at that time. The picket trap does not seem to be able to catch early-run "sea trout" like these, which were harvested by an angler not far upstream of the trap on Little River.

AMERICAN SHAD

Two shad were captured at the trap site in 2014, but late in the year as opposed to pre-spawning fish such as that captured in 2013 and pictured here. The 2014 captured shad were strays from among the hundreds of thousands if not millions of eastern seaboard migrants that move through the upper Bay of Fundy in the summer. At the northern edge of the range of American shad, there is very high home river fidelity, and a recolonization program is probably needed to restore the species.

Shad are thought to be an important intermediate host for the extirpated dwarf wedge mussel.

STRIPED BASS

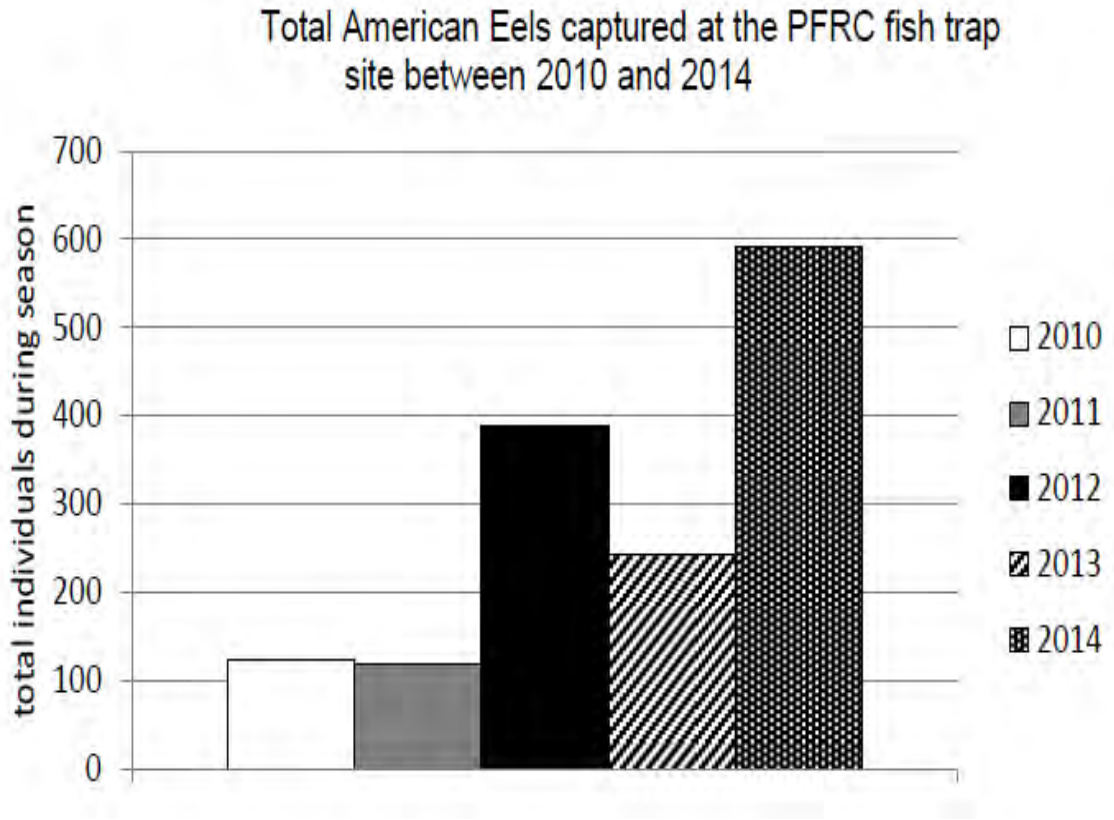
The colonization of the upper Petitcodiac River estuary and lower river by striped bass has been amazing, and incidentally it has carried through to this year. In 2014, > 2,800 striped bass were captured (with more this year) after none were captured in the first year of monitoring in 2010.

The river appears to be primarily a nursery area for young bass and a rearing area for small adults that probably originate in the Stewiacke / Shubenacadie system. Young-of-the year striped bass show up at the site like clockwork around August 15 each year.

Bass are being tagged at the site, and are the subject of DNA analysis by DFO to confirm their origin.

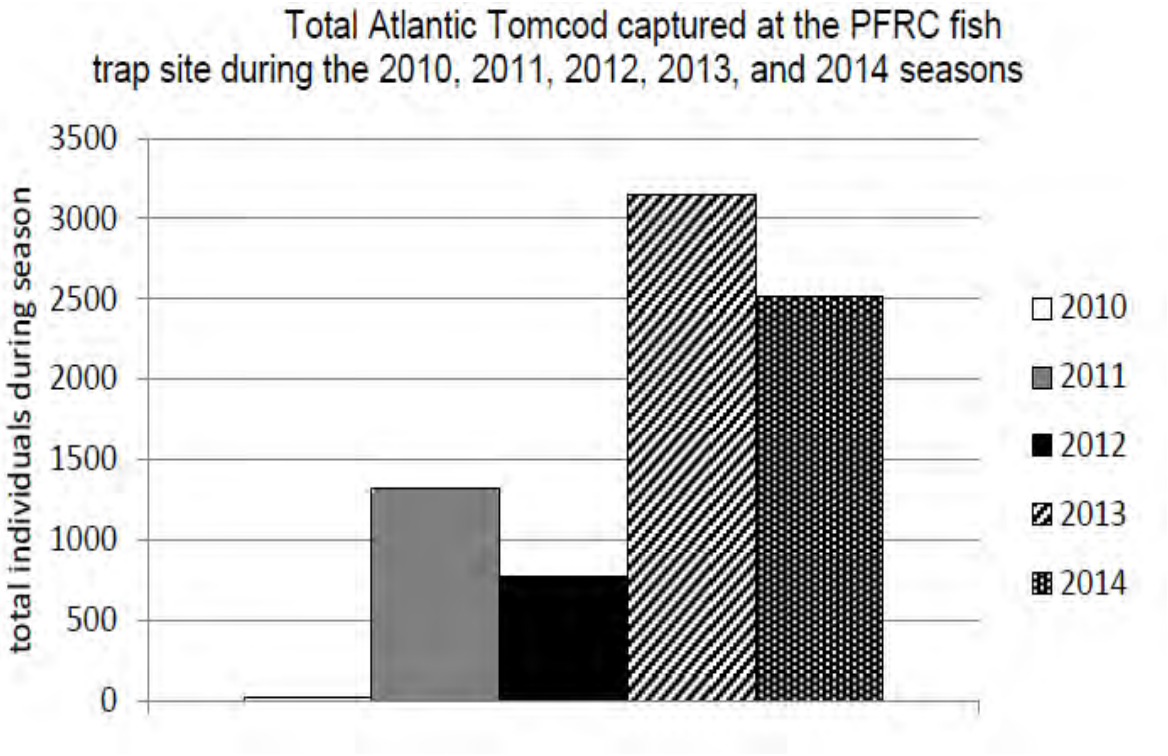
AMERICAN EEL

The American eel density in the vicinity of the trap has also appeared to have increased. Eels may have learned that the trap is a good foraging area for small fish like young-of-the year gaspereau and striped bass.



ATLANTIC TOMCOD

Another important forage fish, and a winter spawner, the tomcod was virtually eliminated from the Petitcodiac River by the presence of the causeway. The accompanying figure demonstrates that the opening of the gates has produced rapid recolonization by tomcod.

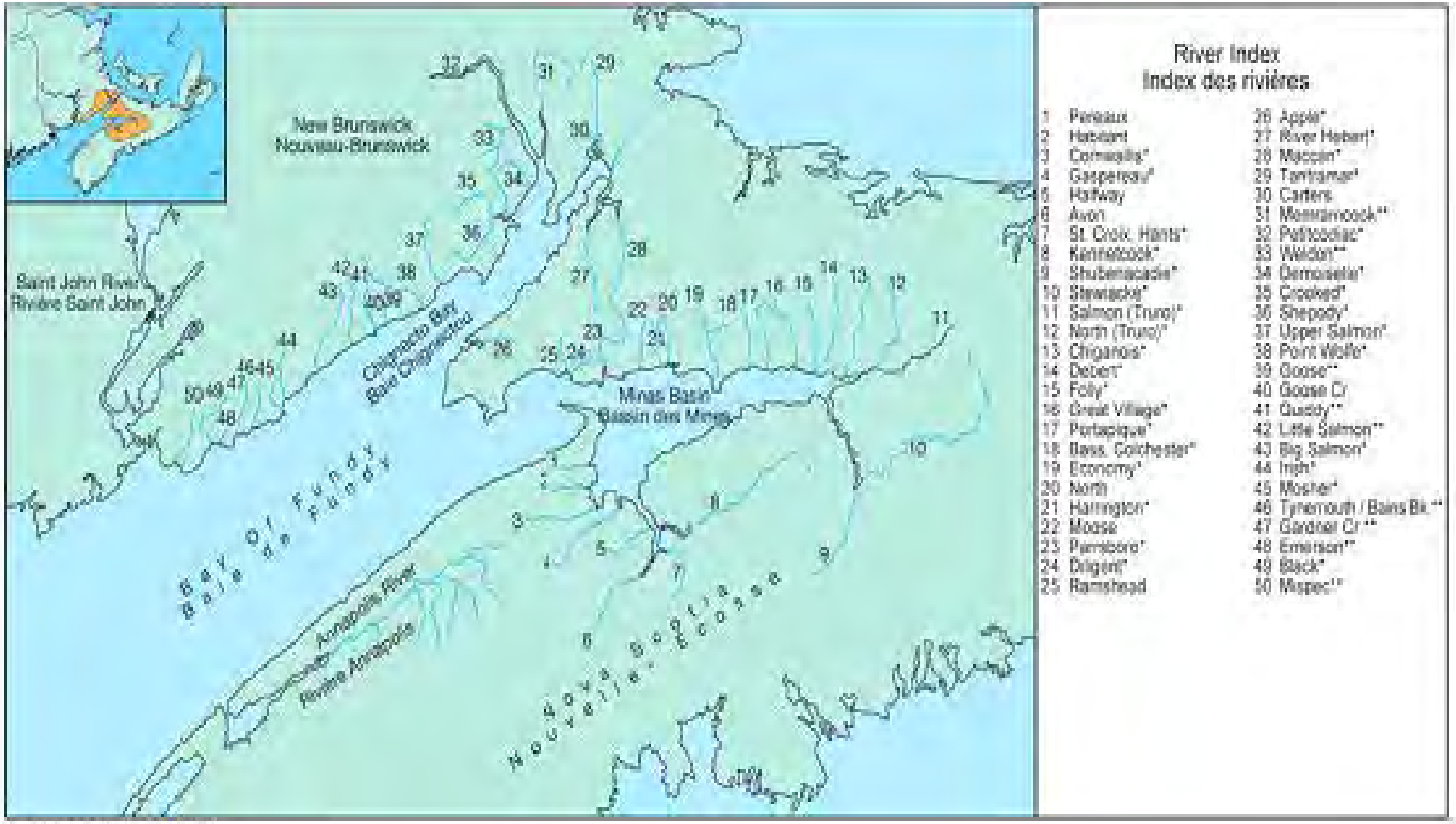


OTHER SPECIES

The top photo is of an Atlantic sturgeon. It was taken at a point just downstream of the trap by a resident of Salisbury. Sturgeon are not thought to spawn in the river, but use it occasionally as a foraging ground. The lower photo is of a smallmouth bass caught this year. Until this one, none were caught since 2012, their disappearance another indication of the re-establishment of the Petitcodiac River estuary. The invasive chain pickerel have been captured for the first time this year as well.

Other species caught in significant quantities include various minnows and the salinity-tolerant white perch.

Atlantic Salmon - Inner Bay of Fundy Salmon Rivers



Source: DFO, 2008

DECLINE OF THE PETITCODIAC RIVER'S SALMON

Until the construction of the causeway, the Petitcodiac River had an annual salmon run of approximately 2,000 to 10,000 pre-spawning salmon. These numbers show the decline subsequent to construction, this despite the juvenile introductions indicated. Most juvenile production comes from the Little and Pollett rivers, two tributaries that drain Albert County's Caledonia Highlands. This provides ideal gradient for juvenile production.

Year	Adult Returns	Smolts Stocked	Parr Stocked	Fry Stocked
1968	101			
1969	131			
1970	345			
1971	895			
1980				151956
1982		28299		
1983	1211	18045	31080	224883
1984	390	8728	9320	307459
1985	150		20514	300473
1986	110			291071
1987	130	8693	20501	407555
1988	50	9876	20338	349483
1989	150	5000		230135
1990	7	6879		229735
1991	7	2942		

Petitcodiac River Salmon Habitat

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ATLANTIC SALMON

Atlantic salmon have been re-introduced through a program to stock unfed fry and pre-spawning adults from the Mactaquac Biodiversity Facility. To date, no wild pre-spawning Atlantic salmon have been captured at the trap site, although one was seen in a swim-through by Fort Folly in a pool on the Pollett River in September-2014, and two have been seen during swim-throughs this year. This one is a ripe female that was released to the Little River upstream of the trap in 2012.

In 2014, all seven of the salmon captured at the trap were smolts that were of Big Salmon River origin produced at the Mactaquac Biodiversity Facility. These fish were released as unfed fry to the Pollett River in 2011 and 2012. The release was part of an experiment by DFO to determine which best Inner Bay of Fundy salmon population to use to recolonize the Petitcodiac River system.

ATLANTIC SALMON SMOLT MONITORING

Smolts are the juvenile salmon that travel to ocean foraging grounds. Fort Folly First Nation, our partner in the Petitcodiac Fish Recovery Coalition, has monitored the smolt run with a rotary screw trap just upstream from the mouth of the Pollett River as part of the previously-mentioned DFO-led study. The 2014 smolt count on the Pollett was estimated by mark-recapture to be 1,598.

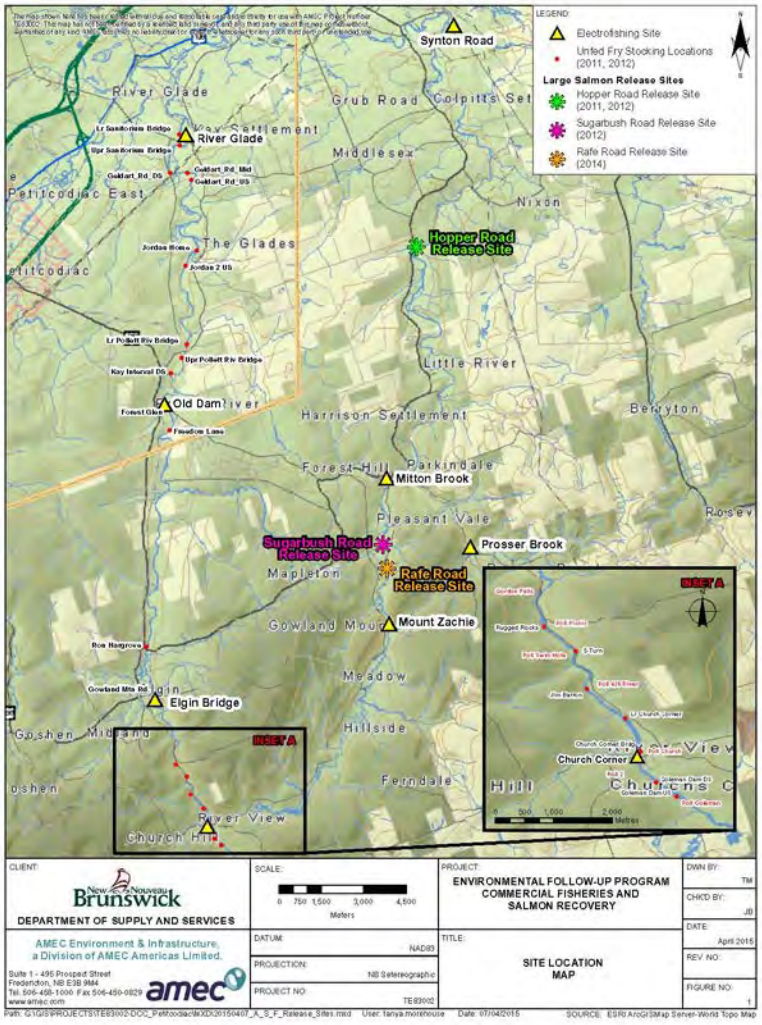
In 2014, 328 smolts were captured and retained, grown out in Cooke Aquaculture sea cages to produce adult spawners for the river. These fish were recently stocked in the Pollett.

SALMON STOCKING SITES

The attempts at recolonizing the Petitcodiac system with salmon has involved the stocking of unfed fry in the Pollett River and maturing adults in the Little River. These are the locations where the various introductions have taken place.

Fry introductions have not occurred since 2012, and the smolts from these introductions have largely already gone to sea and many have had the opportunity to return.

The first smolts from the adult releases emigrated in 2015. In 2014, the juvenile densities were assessed using electrofishing.



ELECTROFISHING

In November - 2012, 484 mature salmon of which 340 were females were introduced to the Little River. In 2013, only 24 mature female salmon. These 2014 electrofishing results reflect the difference in egg deposition with parr found at all four Little River sites as a result of the adult introductions, and fry at only one site. No salmon were caught at the Pollett River sites.

In general, these salmon density numbers are disappointing and are being addressed by Fort Folly's attempt to raise smolts from the two rivers in sea cages for their eventual release as mature adults.

Site Name	Date	Wet Area (m^2)	Species	Total Captures	Mean Fish Weight (g)	Zippin Estimate of Fish Numbers	Extrapolated Weight (g)	Wet Area Standing Crop (g/m^2)	Salmon / $100m^2$	Proportion of salmonids in Standing Crop
Little River @ Synton Road	Sept. 3/'14	684.3	Atlantic salmon	4	12.42	5	62.1	0.091	0.7	
			American eel	15	24.39	28	682.8	0.998		
			Brook trout	2	103.45	2	206.9	0.302		
			Non-salmonid, non-eel	58	14.54	103	1497.2	2.188		
			Totals	79		138	2449.0	3.58		11.0%
Little River @ Mitton Brook	Sept. 11/'14	299.0	Atlantic salmon	14	29.93	14	419.0	1.401	4.7	
			American eel	2	28.45	2	56.9	0.190		
			Brook trout	2	4.00	2	8.0	0.03		
			Non-salmonid, non-eel	29	5.37	32	171.8	0.57		
				47		50	655.7	2.19		65.1%
Pollett River @ Elgin Bridge	Sept. 9/'14	571.2	Blacknose dace + 1							
			Com. Shiner	55	1.95	436	849.2	1.485		
			American eel	1	40.80	1	40.8	0.07		
				-		-	-	1.56		0.0%
Pollett River, Church's Corner	Sept. 10/'14	309.0	Atlantic salmon	0	0.00	0	0.0	0.000	0.0	
			American eel	0	0.00	0	0.0	0.00		
			Brook trout	2	51.75	2	103.5	0.33		
			Non-salmonid, non-eel	52	2.91	77	223.7	0.72		
				54		79	327.2	1.06		31.6%
Little River, Prosser Brook	Sept. 9/'14	313.5	Atlantic salmon	3	35.13	3	105.4	0.336	1.0	
			American eel	0	0.00	0	0.0	0.00		
			Brook trout	27	12.14	31	376.2	1.20		
			Non-salmonid, non-eel	184	2.60	230	598.0	1.91		
				214		264	1079.6	3.44		44.6%
Little River Mount Zackie	Sept. 4/'14	481.5	Atlantic salmon	6	32.12	6	192.7	0.400	1.2	
			American eel	7	14.64	24	351.4	0.730		
			Brook trout	3	9.57	3	28.7	0.060		
			Non-salmonid, non-eel	67	1.88	75	140.8	0.29		
				83		108	713.6	1.48		31.0%
Pollett River Old Dam	Sept. 3/'14	198.9	Atlantic salmon	0	0.00	0	0.0	0.00	0.0	
			American eel	12	26.61	12	319.3	1.605		
			Brook trout	2	29.45	2	58.9	0.296		
			Non-salmonid, non-eel	46	3.50	69	241.5	1.21		
				60		83	619.7	3.12		9.5%
Pollett River @ the Glades	Sept. 3/'14	345.0	Atlantic salmon	0	0.00	0	0.0	0.000	0.0	
			American eel	9	17.40	9	156.6	0.454		
			Brook trout	0	0.00	0	0.0	0.000		
			Non-salmonid, non-eel	78	1.67	110	183.6	0.53		
				87		119	340.2	0.99		0.0%

ATLANTIC SALMON REDD (SPAWNING NEST) SEARCHES

In November of each year, PFRC members and AMEC canoe the Little and Pollett rivers to search for evidence of salmon spawning. As mentioned, in 2014, 203 mature females and 192 mature males were introduced to the Little River. Because of high water, the upper river sites that are normally surveyed by Fort Folly were not surveyed. The lower river AMEC sites were surveyed. Four "redds" were discovered in each reach, which is interesting in that the Pollett River spawners were probably of wild origin.

Redds have been seen at the site on the Pollett since 2010, and because of this, spot check electrofishing at the site was conducted in 2014. One salmon fry was captured. A population-level exercise was conducted there in 2015, but no juvenile salmon were captured.

Final Points

1. **Beneficial effects on rainbow smelt, tomcod, and striped bass**
2. **May have also benefitted American eels**
3. **No effect observed to-date on sea run brook trout, American shad and Atlantic salmon, and sea lamprey**
4. **Effects on gaspereau (blueback herring and alewives) may be negative due to the loss of the "headpond"**
5. **Shad recovery could and probably should be accelerated through a re-introduction program.**
6. **Salmon recovery might be aided by the construction of the bridge (250 m wide opening instead of the current 50), so less of a predatory bottleneck.**
7. **DFO IBoF salmon RPA (DFO, 2008) – salmon decline is related to low at-sea survival, and interactions with farmed and hatchery salmon, ecological community shifts, environmental shifts, fisheries, and depressed population phenomena**
8. **Better salmon farming practices to diminish interactions with wild salmon, maintaining effective juvenile population densities in the river, and a natural return to cooler summer water temperatures in the rearing area of the outer Bay as the result from a shift to a negative phase of the Atlantic Multi-decadal Oscillation would cause IBoF salmon populations including that of the Petitcodiac River to rapidly rebound.**

► DFO. 2008. Recovery Potential Assessment for Inner Bay of Fundy Atlantic Salmon. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/050.