

A summary of Atlantic Salmon (*Salmo salar*) and other aquatic species captured during electrofishing surveys on rivers within the Outer Bay of Fundy region in 2009

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ABSTRACT

Jones, R.A., Cyr, Y.C., and Anderson, L.A. 2023. A summary of Atlantic Salmon (*Salmo salar*) and other aquatic species captured during electrofishing surveys on rivers within the Outer Bay of Fundy region in 2009. Can. Tech. Rep. Fish. Aquat. Sci. 3526: vii + 56 p.

An expanded electrofishing survey was conducted in 2009 on the rivers within Outer Bay of Fundy (OBoF) region in Salmon Fishing Area (SFA) 23 to assist a review of Atlantic Salmon (*Salmo salar*) populations in Eastern Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The survey was designed to sample the smaller, less studied, tributaries in order to examine the distribution and densities of various freshwater fish species, particularly Atlantic Salmon. Results from these new sites (n=84) were compared to the regularly sampled index sites (n=51) from the more 40 tributaries or rivers sampled within the outer region of SFA23. Although Atlantic Salmon juveniles of at least one age class were captured at more than half these sites surveyed, the overall densities were well below those of healthy self sustaining populations. The highest mean densities of juvenile salmon were observed on two index rivers; the Keswick (17.8 fish per 100 m²) and Shikatehawk (25.3 fish per 100 m²) rivers. The distribution and densities of other species varied amongst the different geographic areas. American eel catches were larger and more prevalent in the sites located downriver of the Mactaquac Hydroelectric Dam than the sites sampled upriver of the dam. Non-native species, such as Smallmouth Bass and Rainbow Trout were captured more frequently at the sites upriver of Mactaquac Dam.

RÉSUMÉ

Jones, R.A., Cyr, Y.C., and Anderson, L.A. 2023. A summary of Atlantic Salmon (*Salmo salar*) and other aquatic species captured during electrofishing surveys on rivers within the Outer Bay of Fundy region in 2009. Can. Tech. Rep. Fish. Aquat. Sci. 3526: vii + 56 p.

Afin d'aider le Comité sur la situation des espèces en péril au Canada (COSEPAC) à examiner les populations de saumon atlantique (*Salmo salar*) dans l'Est du Canada, un relevé élargi de la pêche électrique a été mené sur les rivières de la région de la baie extérieure de Fundy dans la zone de pêche au saumon (ZPC) 23. Le relevé a été conçu pour échantillonner les affluents plus petits et moins intensément étudiés afin d'examiner la répartition et la densité des diverses espèces de poissons, mais en accordant une attention particulière au saumon de l'Atlantique. Les résultats de ces nouveaux sites (n = 84) ont été comparés aux sites index échantillonnés régulièrement (n = 51) de plus de 40 affluents ou rivières échantillonnés dans la région extérieure de la ZPC 23 en 2009. Bien que des juvéniles de saumon atlantique d'au moins une classe d'âge aient été capturés dans plus de la moitié des sites étudiés, les densités globales étaient bien inférieures à celles des populations autosuffisantes en santé. Les densités moyennes les plus élevées de saumons juvéniles ont été observées dans deux rivières indices; les rivières Keswick (17,8 poissons par 100 m²) et Shikatehawk (25,3 poissons par 100 m²). La répartition et la densité des autres espèces variaient selon les différentes régions géographiques. Les captures d'anguille d'Amérique étaient plus importantes et plus répandues dans les sites situés en aval du barrage hydroélectrique de Mactaquac comparativement aux sites échantillonnés en amont du barrage. Des espèces non indigènes, dont l'achigan à petite bouche et la truite arc-en-ciel, ont été capturées plus fréquemment dans les sites situés en amont du barrage de Mactaquac.

1.0 INTRODUCTION

The purpose of this report is to provide detailed results of an expanded electrofishing survey conducted in the Outer Bay of Fundy (OBoF) region of Salmon Fishing Area (SFA) 23 by the Department of Fisheries and Oceans Canada (DFO) and its collaborators in 2009. The Population Ecology Division (PED) within Science Branch of DFO received additional funding, from the DFO Species at Risk Office, to increase the coverage of the regular electrofishing survey¹. The results of the survey would assist the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in reviewing Atlantic Salmon (*Salmo salar*) populations in Eastern Canada. Specifically, the survey was designed to address the 'area of occupancy' terms of reference (DFO and MRNF 2008) for Atlantic Salmon in the OBoF region of SFA 23. The 'area of occupancy' could be defined as any habitat area within the OBoF region in which juvenile or adult Atlantic Salmon were found (captured). The survey would also allow a comparison of the current status of Atlantic Salmon populations within the smaller, less intensely surveyed, tributaries or rivers within the SFA to larger tributaries or rivers with historical abundance data. The COSEWIC review led to an 'endangered' designation which triggered a Recovery Potential Assessment (RPA) in 2013. The juvenile salmon densities from this expanded electrofishing survey were summarized as component of the assessment and trends document for the RPA (Jones et al. 2014). With a pending Species at Risk Act (SARA) listing decision, potentially triggering another RPA, and discussion of another broadscale survey in the region in the coming years, the detailed site information from the 2009 survey would be an invaluable resource at this time.

The largest salmon producing river within the OBoF region is the Wolastoq (Saint John) River (Jones et al. 2014), New Brunswick's longest river at 673 km. The main stem of the Saint John River is transected by 3 major dams: Mactaquac Dam (672 MW with six units), Beechwood Dam (113 MW with three units) and Grand Falls Dam (66 MW with 4 units) (Carr 2001, Marshall et al. 2014). The Grand Falls Dam was constructed at the head of a 23 meter falls, a natural barrier to diadromous fish species and therefore does not require upstream passage. The Beechwood Dam is fitted with a fish trap and hoist that captures and transports upstream migrating fish species to the Beechwood head pond (Smith 1979, Ingram 1981, Beaumaster et al. 2022). The Mactaquac Dam, constructed in 1967, is fitted with a collection facility designed to trap and truck anadromous fish species (e.g. Atlantic Salmon, Alewife, and Blueback Herring) to release locations upriver of the Mactaquac Dam (Smith 1979, Ingram 1980). Neither of these two hydroelectric dams have downstream fish passage facilities so juveniles or post-spawning adults are required to move downstream either via the turbines or spill gates (if open) (Carr 2001, Marshall et al. 2014). Additionally, the largest tributary of the Saint John River, the Tobique River, has the greatest amount of available salmon habitat but is also transected by a hydroelectric facility (Tobique Narrows Dam) at its confluence (Marshall et al. 2014). The Tobique Narrows Dam is fitted with a pool and weir fish ladder for upstream passage (Smith 1979, Francis 1984, Beaumaster et al. 2022). In 2017, a surface bypass was installed and made operational to improve downstream fish passage (J. Perly per comm.). Another large tributary of the Saint John River, the Aroostock River, also has a hydroelectric dam near it confluence but has been faced with a multitude of fish passage programs (Carr 2001) and has an ongoing international multi-agency restoration program in place (J. Adesola, pers. comm.). Beyond the Saint John River basin, rivers within the Outer Bay of Fundy region of SFA 23 with accessible spawning and rearing habitat include: Magaguadavic, Skudik (St. Croix), New, Pocologan, Digdeguash, Waweig, Bocabec and Dennis Stream (Jones et al. 2014).

This survey provided an opportunity to examine the distribution, relative catches and biological characteristics of various diadromous (i.e. Sea Lamprey and American Eel), native freshwater (i.e. Brook Trout, Slimy Sculpin, and Blacknose Dace) and non-native (i.e. Rainbow Trout, Brown Trout,

¹ Regular electrofishing survey: includes the index sites located on index rivers that are annually surveyed as part of the regular Atlantic Salmon assessment and monitoring activities within the OBoF region in SFA 23.

Smallmouth Bass and Chain Pickerel) fish species found in traditional salmon habitat both upriver and downriver of the Mactaquac Dam as well as other rivers draining to the Bay of Fundy.

2.0 MATERIALS & METHODS

The electrofishing sites completed in 2009 are divided into two categories within three geographical areas of Outer Bay of Fundy region. 1) Sampling stations referred to as index sites are primarily those sites done semi-regularly since the early 1990's. Assessments on some index sites have occurred since the 1960's (Francis 1980) (Fig. 1a). 2) Sampling stations categorized as new sites were selectively chosen on tributaries not normally surveyed as part of the annual assessment and monitoring activities of Atlantic Salmon within the OBoF region of SFA 23 (Fig. 1b). A reference table with the estimated productive and accessible habitat area for juvenile salmon within the Saint John River, NB was used to identify important tributaries for the selection of new sites (Marshall et al. 1997). These productive and accessible habitat areas were calculated using measurements from aerial photographs and orthophotographic maps (Amiro 1993). The habitat area estimates are based on accessible rearing and productive habitat. Accessible habitat excludes any riverine habitat above impassable obstructions including dams and water falls. Productive habitat is considered to have stream gradients between 0.12% and 5% (Amiro 1993). Some of the new sites selected for this survey were chosen on tributaries not identified in the productive and accessible habitat table (Marshall et al. 1997). These tributaries were likely not identified because of the small productive area in relation to the larger watersheds. The selection of new sites in the Outer Fundy rivers (i.e., not draining to the Saint John River) within the OBoF region was done with the assistance of Atlantic Salmon Federation staff and incorporation of a portion of their regular sampling sites. The productive and accessible habitat area estimates for the OBoF region have been updated since this survey (Marshall et al. 2014).

For comparing population status and the diversity of the various fish species within the OBoF region of SFA 23, the sampling areas were divided into three geographical areas: 1) Saint John River above Mactaquac Dam, 2) Saint John River below Mactaquac Dam and 3) Outer Fundy rivers within OBoF region in SFA 23.

1a) Tributaries of the Saint John River with index sites upriver of Mactaquac Dam (Fig. 2a, 2b) are:

- Tobique
- Salmon (Vic. Co.)
- Shikatehawk
- Becaguimec
- Meduxnekeag

1b) Tributaries of the Saint John River with new sites upriver of Mactaquac Dam (Fig. 3a, 3b, 3c) are:

- Muniac
- River de Chute
- Monquart
- Big Presque Isle
- Little Presque Isle
- Gibson Creek
- Eel
- Bulls Creek
- Shogomoc
- Pokiok
- Nackawic
- Longs Creek
- Mill Stream
- Mactaquac Stream
- Stickney Brook

2a) Tributaries of the Saint John River with index sites downriver of Mactaquac Dam (Fig. 4) are:

- Keswick
- Nashwaak
- Kennebecasis

2b) Tributaries of the Saint John River with new sites downriver of Mactaquac Dam (Fig. 5a, 5b) are:

- Nashwaaksis
- Oromocto (inc. Rusagonis)
- Noonan
- Burpee Millstream
- Little (Sunbury Co.)
- Newcastle Creek

- Cumberland Bay
- Coal Creek
- Salmon (inc. Gaspereau)
- Youngs Creek
- Nerepis
- Belleisle Creek

3a) Tributaries with new sites considered as Outer Fundy rivers in OBoF region in SFA 23 (Fig. 6) are:

- New
- Pocologan
- Digdeguash
- Waweig
- Dennis Stream

Tributaries considered but sites with suitable salmon habitat could not be found in time for this study were:

- Lower Guisguait
- Bull Creek
- Baker Brook
- Bocabec
- Otnabog
- Rathburn Brook

Tributaries not surveyed because of ongoing electrofishing programs or adult assessment work by local conservation groups or US federal or state agencies are:

- Aroostock – Atlantic salmon for Northern Maine.
- Hammond – Hammond River Angling Association.
- Canaan – Canaan River Fish and Game Association.
- Magaguadavic – Atlantic Salmon Federation.
- St. Croix – St. Croix International Waterway Commission.

The sampling of the various diadromous, freshwater fish species and other aquatic species within the rivers of the OBoF region was done by electrofishing and took place between July 13 and September 17, 2009. The most frequently used electrofishing unit was a battery powered Smith-Root (12B) while a backpack gasoline powered generator Smith-Root unit was used to complete the sites on the OBoF Fundy rivers.

At each new site, up to 25 salmon fry and all salmon parr (age-1 or older) captured were measured to the nearest millimetre (fork length) and weighed. A scale and tissue (caudal fin) sample was taken from all captured parr for aging and genetic profiling purposes, respectively. In all cases for the new sites a single pass per site was performed targeting an area of approximately 750 m² without the use of barrier nets (i.e. open site). Densities (number of fish per 100 m² of habitat) of fry and age-1 and older parr at open sites were derived using a mean probability of capture derived in Jones et al. (2004).

American Eel measuring greater than 10 cm in length were randomly selected and collected as specimens (up to 35 per site) for a Master's project to document the distribution, prevalence and intensity of an infection of an invasive swim bladder parasite found in other Maritime rivers. American Eels collected for this project were frozen and later sampled in the laboratory. In most cases, all other fish captured were identified to species (Appendix 1) and a random sub-sample of ten fish per species were measured (fork length when possible, or total length if not) to the nearest millimetre and weighed to the nearest decigram. For the following species, counts were grouped into taxa; 1) Fallfish, Creek Chub & Lake Chub were grouped together as "Chub", 2) White Suckers and Longnose Suckers were grouped together as "Suckers", 3) Common Shiner and Golden Shiner were grouped as "Shiners", 4) Sticklebacks were not identified to species but were mostly Three Spine Sticklebacks.

To evaluate the historical status of juvenile salmon on the Saint John River, densities of fry and parr were analyzed using the annual mean of index sites completed since 1992. Upriver of Mactaquac Dam, the Tobique, Salmon (Vic. Co.), Becaguimec, Shikatehawk and Meduxnekeag rivers were surveyed while downriver of Mactaquac Dam, index sites were completed on the Kennebecasis, Keswick and Nashwaak rivers. In 2009, 15 of the 16 historical index sites located on the Tobique River were completed as well as 17 of the 17 index sites on the Salmon (Vic. Co.), Becaguimec, Shikatehawk, and Meduxnekeag rivers. Nineteen of the 19 index sites were completed on the three rivers (Kennebecasis, Keswick and Nashwaak) located downriver of Mactaquac Dam. If resources and time permitted additional sites were surveyed on the index rivers. An additional two sites were completed on each of the Tobique, Salmon (Vic. Co.) and Becaguimec rivers and one additional site was completed on the Nashwaak River in 2009.

At these index sites, if more than ten parr were captured during the single pass, the parr were marked and released and second pass was completed generally two days later. Densities (number of fish per 100 m² of habitat) of age-1 and older parr at open sites were either derived using 1) mark-recapture techniques using the adjusted Petersen method (Ricker 1975) or 2) a mean probability of capture derived in Jones et al. (2004). For the mark-recapture index sites, the number of age-0 parr or fry for the site was determined by applying the capture efficiency for age-1 and older parr to the number of fry captured during the marking pass. For sites in which only a single pass was completed, the number of fry for the site was derived using the mean probability of capture. Similar to previous years, a mean probability of capture was applied to sites completed in 2009 in which zero parr were recaptured during a second pass (Jones et al. 2004). Age composition of parr was determined from stratified sampling of large parr in 0.5 cm length intervals and generally one parr was scale sampled for each interval. At each index site, all salmon fry (up to 25) were measured to the nearest millimetre (fork length) and weighed. In most cases, all other fish captured were identified to species and total counts were either estimated or recorded but not included in this report as no biological data was collected on these fish.

The densities presented for both new and index sites are for wild (or adipose fin present) Atlantic Salmon juveniles only. Since 2004, wild parr could be progeny from either sea-run or captive-reared adults, but

the captive-reared adult were primarily released to the Tobique River. For the most part, prior to 1998 all fall fingerling parr and unfed fry were released unmarked (Jones et al. 2010). Consequently, suspected hatchery origin parr, captured during electrofishing surveys, were determined by observations of fin erosion or condition made by field staff. Since 1998, most of the released fall fingerling parr received an adipose clip (with exception of 2004 and 2008) and very few unfed fry (with exception of 2000) were released (Jones et al. 2010). These program alterations made the identification of wild parr more precise for most tributaries (exception Tobique).

Water and air temperature readings were taken using a handheld digital thermometer just prior to the start of the electrofishing.

3.0 RESULTS

Analysis of the historical mark-recapture data (which included Saint John River data) using the empirical Bayes method determined that the mean probability of capture during the first pass was 34.7% (Jones et al. 2004). This mean probability of capture was used to calculate site densities for 42 of the 52 index sites completed on the index rivers while mark-recapture data was used for the remainder of sites in 2009. The mean probability of capture was used to calculate site densities for all the new sites completed in 2009.

3.1 Salmon catches and densities at sites upriver of Mactaquac Dam

3.1.1 Index sites:

The mean density of wild fry (age-0 parr) at 15 index sites (excluding site TR16 which was not completed due to time constraints at the end of the sampling season) (Fig. 2a, 2b) on the Tobique River in 2009 was 2.2 fish per 100 m² (Table 1). This value was the third lowest density observed since 1992 (Fig. 7). From 1990 to 2009, mean juvenile salmon densities at the index sites were well below the 'Elson norm' of 29 fry per 100 m² (excluding 1995; Elson 1967) and trending downward. Twelve of these 16 sites were also periodically done in the 1970s and 1980s and the mean fry densities were quite variable but on average higher than those observed since 1990 (Jones et al. 2014). Wild fry were captured at 40% (n = 6) of the 15 electrofishing index sites completed within the Tobique River (Table 1). The mean density of wild fry in 2009 at index sites on tributaries upriver of Mactaquac Dam (excluding the Tobique River); Salmon (Vic. Co.), Shikatehawk, Becaguimec, and Meduxnekeag rivers was 7.2 fish per 100 m² (Table 1). This mean density was about three times higher than the mean density observed on the Tobique River in 2009 (Fig. 8), however was the fifth lowest for the years surveyed since 1992 (no data from 2004 to 2006). Wild fry were captured at 65% (n = 11) of the 17 index sites sampled in 2009. Three of the five index sites on the Shikatehawk River had densities above the 'Elson norm' (Table 1).

Mean density of age-1 and older wild parr at the 15 index sites on the Tobique River was 2.1 parr per 100 m² in 2009 (Table 1). This value is well below Elson's (1967) 'normal index' of 38 small and large parr per 100 m² (Fig. 7) and is the lowest mean density observed since 1992. Jones et al. 2014 reported that age-1 and older wild parr densities have continued to decline since the 1970s when summarizing data from twelve of the 16 index sites. Despite the low densities, parr appear to be well distributed throughout the Tobique watershed as only one index site (TR9) was devoid of wild parr. The mean density of age-1 and older wild parr at 17 sites on the Salmon (Vic. Co.), Shikatehawk, Becaguimec, and Meduxnekeag rivers in 2009 was 1.8 fish per 100 m² (Table 1), an average similar to the mean density observed on the Tobique River. The mean density from the 17 sites on these four rivers is also the lowest mean density observed since 1992, and 5% of the Elson norm (Fig. 8). Unlike the parr distribution on the Tobique River, more than half the index sites on these rivers were devoid of age-1 or older wild parr (Table 1). No wild parr were captured at 19% (n = 6) of 32 index sites, completed upriver of Mactaquac Dam, including all three sites in the Salmon River (Vic. Co.) (Table 1, Fig. 9).

3.1.2 New sites:

A total of 34 new sites among 15 smaller tributaries located upriver of Mactaquac Dam were selected for the electrofishing assessment, and the total habitat area surveyed was 28,026 square meters (Table 2, Fig. 1b, Fig. 3a, 3b, 3c).

The mean density of wild fry for the 34 new sites was 1.6 fish per 100 m² which is well below the 'Elson norm' of 29 fry per 100m² (Elson 1967) and slightly lower than the mean observed on the Tobique River (Table 2). Wild fry were captured at 13 or 38% of the 34 new sites surveyed upriver of the Mactaquac Dam. This value is lower than the 53% found when combining the results from the five upriver index rivers (Table 1). None of the new sites within the non-index tributaries sampled had fry densities at or above the 'Elson norm'. The highest site densities were observed on the Monquart (11.6), Little Presque Isle (13.3, 8.8) and Big Presque Isle (5.3) tributaries (Table 2).

The mean density of wild parr (age-1 and older) for the same new sites upriver of Mactaquac Dam was 0.5 fish per 100 m² (Table 2) which is also well below the "Elson norm" of 38 fry per 100m² (Elson 1967). Unlike the index rivers (in particular the Tobique River) wild parr were captured at only 13 or 38% of the 34 new sites (Table 2). None of the non-index tributaries had high densities of wild parr and no parr were captured in Mill Stream (1,021 m²), Eel (3,605 m²), Little Presque Isle (1,863 m²), Mactaquac Stream (813 m²), Shogomoc (1,561 m²), River de Chute (2,258 m²) or Bulls Creek (689 m²) (Table 2). No juvenile salmon of any age class were captured on four (27%) of the 15 tributaries surveyed (Fig. 10).

3.2 Salmon catches and densities at sites downriver of Mactaquac Dam

3.2.1 Index sites:

In 2009, the mean density of wild fry at the 19 index sites (Fig. 4) downriver of Mactaquac Dam (Keswick, Nashwaak and Kennebecasis rivers) was 7.0 fry per 100 m². Densities ranged from 0.0 to 17.9 fry per 100 m² in these tributaries (Table 3). Annual mean densities at these index sites were below the "Elson norm" between 1993 through 2002, ranging from ten to 25 fry per 100 m². In the following seven years (2003 through 2009), the mean densities were assessed as less than ten fry per 100 m² (Fig. 11). Additionally, in 2009, wild fry were present at 16 of the 19 index sites on the three index tributaries surveyed, with the highest mean densities observed on the Keswick River (Table 3).

Mean density of wild parr at the downriver index sites was 2.8 fish per 100 m². Densities ranged from 0.0 to 10.5 in these tributaries (Table 3). Densities were the lowest observed in the time-series since 1992 (Fig. 11). Since 1992, the observed mean densities are < 30% of Elson's (1967) 'normal index' of 38 small and large parr per 100 m² (Note: no data for the Keswick and Kennebecasis rivers from 2004 to 2008; Fig. 11). Wild parr, were widely distributed throughout these three tributaries and observed at 16 of the 19 index sites surveyed (84%) in 2009 (Table 3). Only one (KS4; Kennebecasis) of the 19 index sites completed on the Saint John River downriver of Mactaquac Dam was devoid of juvenile salmon of any age class (Table 3, Fig. 9).

3.2.2 New sites:

A total of 38 previously unsampled electrofishing sites, distributed amongst 12 tributaries of the lower Saint John River (downriver of the Mactaquac Dam), were assessed in 2009 (Fig. 1b, 5a, 5b). The total habitat area of these sites was estimated to be 31,214 m² (Table 4). The mean density of wild fry at the new sites was 0.7 fish per 100 m², a value below both the "Elson norm" of 29 fry per 100 m² (Elson 1967) and ten percent of that of the mean density value calculated for the index sites downriver of Mactaquac Dam (7.0 fry per 100 m²). In 2009, wild fry were captured at 45% (n = 17) of these 38 new sites. Sixty-

seven percent ($n = 8$) of twelve tributaries surveyed downriver of the Mactaquac Dam had presence of fry (Table 4). The highest fry density observed among the new sites downriver of the Mactaquac Dam was 5.8 fish per 100 m² of habitat (NS2; Nerepis), which was much lower (33%) of the highest density observed at one of the index sites below the Mactaquac Dam (17.9 fish per 100 m²; KW2; Keswick River).

The mean density of wild parr at the 38 new sites located below the Mactaquac Dam was 0.5 fish per 100 m², a density < 2% of the “Elson norm” of 38 small and large parr per 100 m² (Elson 1967). Wild parr were captured at 39% ($n = 15$) of 38 new sites and in 67% ($n = 8$) of 12 non-index tributaries (Table 4). The highest wild parr density (8.7 fish per 100 m²) was observed on the Nashwaaksis River at the site closest to its confluence with the Saint John, the geographically closest site, in a non-index downriver tributary, to the Mactaquac Dam (Fig. 5a). Fifty-three percent of the new sites ($n = 20$) contained neither parr nor fry (Table 4, Fig. 10).

3.3 Salmon catches and densities at sites in other outer Bay of Fundy rivers

3.3.1 New sites:

Twelve new electrofishing sites were selected amongst five rivers outside of the Saint John River, draining to the Bay of Fundy within SFA 23. The total habitat area sampled in 2009 was estimated to be 5,443 m² (Table 5).

The mean density of wild fry observed at the 12 sites was 1.3 fish per 100 m², a density < 5% of the “Elson norm” of 29 fry per 100 m² (Elson 1967). Fry were captured in 80% ($n = 4$) of the five rivers and at 50% ($n = 6$) of the 12 sites assessed (Table 5). The highest fry density (6.5 per 100 m² of habitat), was observed on the upper site of Dennis Stream, whereas fry densities at the Digdeguash sites were < 3.0 per 100 m² of habitat. Salmon fry were present at all three sites sampled on the Digdeguash (Fig. 6).

The mean density of wild parr was 0.9 fish per 100 m², a density below the “Elson norm” of 38 fry per 100 m² (Elson 1967). Wild parr were captured at 42% ($n = 5$) of 12 sites sampled in 80% ($n = 4$) of the five rivers surveyed. The middle site (DS2) on the Dennis Stream had the highest wild parr density among the other outer Bay of Fundy rivers with a density of 5.0 fish per 100 m². Of the other oBoF rivers, the Waweig was the only one devoid of salmon juveniles in the 1,326 m² of its habitat surveyed (Table 5, Fig. 10).

3.4 Non-Salmon catches

3.4.1 At new sites upriver of Mactaquac Dam

A very diverse group of freshwater and diadromous fish species were captured at the new sites upriver of Mactaquac Dam (Table 6). The two most abundant species observed were Blacknose Dace and Slimy Sculpin with total catches of both species greater than 1,200 fish. The next most abundant taxa captured (100-300 captured) were Rainbow Trout (287), “Chub” (264), Brook Trout (250), and “Sucker” species (155) (Table 6). Less frequent taxa (less than 100 captured) were the Smallmouth Bass (42), “Shiner” (8), “Stickleback” species (6), Brown Bullhead (5), Yellow Perch (4), American Eel (3), Pumpkinseed Sunfish (3), Burbot (1) and Chain Pickerel (1). Eleven Crayfish (freshwater invertebrate species) were captured during the electrofishing survey. Rainbow Trout were the third most numerically abundant but geographically found in only two tributaries (Muniac and Stickney Stream) and 95% were captured at the one site near the mouth of Stickney Stream (Table 6, Fig. 3a). Slimy Sculpin were also abundant and geographically located to only seven tributaries. The less abundant Brook Trout, “Sucker”, and “Chub” were more widely distributed and captured in more than ten tributaries. Smallmouth Bass were captured in nearly one third of the sites sampled but in relatively low numbers with the exception of one site on the Big Presque Isle River where numbers ($n=25$) were high (Table 6). Three American

Eels were captured among the 34 sites completed upriver of the Mactaquac Dam. Single individuals were captured in each of the Mactaquac, Nackawic and Pokiok systems. It was also noted that no Sea Lamprey were captured at any of the sites upriver of Mactaquac Dam.

3.4.2 At new sites downriver of Mactaquac Dam

The non-salmon fish species captured at the new sites downriver of Mactaquac Dam on the Saint John River, were similar to those captured at new sites upriver of Mactaquac Dam, with some notable exceptions. No Rainbow Trout, Yellow Perch, Pumpkinseed Sunfish or Smallmouth Bass were captured while Sea Lamprey and American Eel were commonly observed (Table 7). The two most abundant fish species, Blacknose Dace (2,540) and American Eel (547) were observed at more than 94% of the sites surveyed downriver of Mactaquac Dam. The next two most abundant fish taxa captured were “Chub” (252) and Brook Trout (173). These taxa were captured at more than half the sites surveyed (Table 7). Other fish taxa present in lower abundance were Slimy Sculpin (98), “Suckers” (57), Burbot (23), Sea Lamprey (22), along with less than ten individuals of each of the following taxa; Brown Bullhead, “Stickleback” and Chain Pickerel. Nine Crayfish were also captured at three sites (Table 7).

3.4.3 At new sites in other outer Bay of Fundy rivers

Combining the catches from the five other outer Bay of Fundy rivers surveyed, the most abundant and widely distributed species was the Blacknose Dace ($n = 523$), present at 92% ($n = 11$) of twelve sites sampled (Table 8). Similarly widely distributed but less abundant were American Eel (69) and “Suckers” (63). Furthermore, in descending order of abundance, were “Shiners” (40), “Chub” (22) and Brook Trout (17). Finally, three Sea Lamprey and one Smallmouth Bass were captured during the surveys (Table 8). The aquatic taxa observed in our surveys of the Saint John watershed but not captured at any of the sites in these five outer Bay of Fundy rivers in SFA23 were; Brown Bullhead, Burbot, Crayfish, Chain Pickerel, Slimy Sculpin, “Stickleback”, Pumpkinseed Sunfish, Yellow Perch and Rainbow Trout.

3.5 Biological characteristics – New sites

Four age classes of juvenile Atlantic Salmon were sampled at the new sites upriver of Mactaquac Dam in 2009 (Table 9). The majority were fry or age-0 parr with a mean length and weight of 6.9 cm and 4.5 g, respectively. The mean length and weight of the age-1 parr sampled was 13.6 cm and 29.8 g while the age-2 parr were on average 2.4 cm longer and 22.2 g heavier (Table 9). Only one age-3 parr (17.3 cm and 64.8 g) was sampled at the sites located upriver of Mactaquac Dam. Comparatively, the mean length and weight of the juvenile salmon sampled at the new sites downriver of the Mactaquac Dam for the three age classes were smaller than those sampled upriver of Mactaquac Dam. The mean length for age-0, age-1 and age-2 parr was 5.7 cm, 11.7 cm and 14.6 cm and the mean weights were 2.5 g, 20.0 g and 40.9 g, respectively (Table 9). The juvenile salmon captured and sampled on the outer Fundy rivers sites in SFA 23 were similar in mean length and weight to those juvenile salmon sampled upriver of the Mactaquac Dam (Table 9). The time of year in which the sampling took place needs to be considered when comparing size among the geographic areas. The timing of sampling (i.e., months) at sites up and downriver from Mactaquac was similar, whereas sampling for the outer Fundy rivers occurred in September only (Table 10).

Length and weight data was also collected for the other fish taxa captured during the expanded electrofishing surveys (Table 11, Table 12). The larger bodied (length and weight) fish taxa with medium to high abundance and wide distributions were identified as Sucker sp., American Eel (downriver only) and Brook Trout.

4.0 DISCUSSION

The primary goal of this expanded electrofishing survey was to investigate the presence and absence of juvenile salmon in some of the smaller, less intensely surveyed tributaries or rivers within the OBoF region of SFA 23. Of the thirty-one new non-index tributaries or rivers surveyed in 2009, no juvenile salmon were captured from Bulls Creek, Mactaquac Stream, Mill Stream, River de Chute, Burpee, Cumberland Bay, Noonan, Youngs Creek or Waweig. In six of those nine tributaries or rivers, only one site was surveyed, therefore further electrofishing surveys are required to validate the results from these tributaries. Approximately, one half of the new sites surveyed upriver (20 of 34 sites) and downriver (18 of 38 sites) of Mactaquac Dam and in other OBoF rivers (eight of 12 sites) had juvenile salmon of at least one age class present. When considering or combining all age-classes, the overall the mean densities were similar for the three geographical areas surveyed when considering the non-index sites – upriver of Mactaquac Dam (2.1 salmon per 100 m²; Table 2), downriver of Mactaquac Dam (1.2 salmon per 100 m²; Table 4) and other OBoF rivers (2.2 salmon per 100 m²; Table 5). None of the new or index sites surveyed in 2009 had densities that were at or above the 'Elsion norm'. Three sites (SK1, SK2 and SK3) on Shikatehawk River had fry densities just above the 'Elsion norm' of 29 fry per 100 m² (Table 1). In general, densities observed in the non-index tributaries or rivers were lower compared to those observed in the index tributaries or rivers; upriver of Mactaquac Dam (2.1 vs 9.0 salmon per 100 m²) and downriver of Mactaquac Dam (1.2 vs 9.9 salmon per 100 m²). Only three new sites had salmon densities (age classes combined) greater than 10 fish per 100 m². 'Elsion norm' values for a healthy salmon population is approximately 58 fish / 100 m². The highest mean densities of juvenile salmon in the index tributaries were as follows; Shikatehawk, Keswick, and Nashwaak, ranging from 15 to 44% of the 'Elsion norm'. Mean densities below 10% of the 'Elsion norm' were observed from the remaining index tributaries: Kennebecasis, Tobique, Becaguimec, Meduxnekeag and Salmon (Vic. Co.) but overall the mean densities were similar when considering the index sites within the Saint John River – upriver of Mactaquac Dam (9.0 salmon per 100 m²; Table) and downriver of Mactaquac Dam (9.9 salmon per 100 m²; Table 3). The highest mean densities observed from non-index tributaries were on the Monquart, Little Presque Isle, Nashwaaksis, Dennis Stream, Pocologan, Big Presque Isle and Nerepis (less than 24% of 'Elsion norm'). Less than 13% of the 136 sites surveyed in 2009 had juvenile salmon densities greater than 10 fish per 100 m² of habitat. These low densities of all age classes of juvenile salmon were expected given low adult returns and estimated egg depositions from 2006 to 2008 in relation to conservation egg requirements for OBoF rivers monitored in the region (Jones et al. 2010).

The abundance and distribution of the other diadromous fish species captured during the electrofishing survey varied among sites upriver and downriver of Mactaquac Dam. Of the diadromous fish species, a low number of American Eel and no Sea Lamprey were captured in the new sites located upriver of Mactaquac Dam. Comparatively, more than five hundred American Eel and 22 Sea Lamprey were captured in the new sites located downriver of the Mactaquac Dam. These results are to be expected as there has been limited upstream fish passage for juvenile American Eel (elvers). Furthermore, since the construction of the Mactaquac Dam in 1967, Sea Lampreys are, as of this writing, yet to be targeted for capture and transport to spawning areas upstream from the dam (Smith 1979).

The distribution and prevalence of non-native fish species captured at new sites also varied between tributaries upriver and downriver of the Mactaquac Dam. Only three Chain Pickerel were captured in new sites located in tributaries downriver of Mactaquac Dam. Furthermore, no Rainbow Trout or Smallmouth Bass were captured at these same sites. Smallmouth Bass were widely distributed throughout the Saint John River, but were in low numbers in the new sites sampled upriver of Mactaquac Dam. Additionally in Muniac, Monquart and Stickney Brook, all located upstream of the Mactaquac dam, one Chain Pickerel and 300 Rainbow Trout were captured at four sites.

Given the low densities of Atlantic Salmon throughout the OBoF region, high densities of other species, co-habiting with salmon, are unlikely to be limiting salmon production. This occurrence may be one explanation for the size differences observed between juvenile salmon sampled upriver and downriver of Mactaquac Dam. Generally salmon sampled in tributaries below Mactaquac were slightly smaller than

those sampled in at the sites upriver of Mactaquac Dam (Table 9) despite being sampled at approximately the same time of year (Table 10). American Eel were practically devoid of the upriver sites and were almost always present in the downriver sites (Tables 6 and 7). American Eel have been shown to be predators and competitors (have similar diet) of age-0 and older parr (Elson 1941). Mean length of American eels sampled in these sites was greater than 25 cm in length. The presence and body mass of the American eel could possibly be reducing the growth rate of the salmon in the sites below Mactaquac Dam.

5.0 RECOMMENDATIONS FOR FUTURE STUDIES

Access to a detailed inventory or database of obstructions to Atlantic Salmon passage, including dams and falls, would have been very helpful in selecting the new sites for this study. After the field work was completed, it was determined that a couple new selected sites (GC2, PK3) were likely upstream of barriers or impassable falls but that could not be confirmed so they were included in the results of the study.

Further studies should be done to determine if the Rainbow Trout present in the Muniac, Monquart and Stickney Brook are progeny of self-sustaining populations or fish escapes from a local aquaculture facility. Using traditional (electrofishing) and new technologies (eDNA) may be a way to better understand invasive species distributions throughout the watershed as eDNA can be used to detect species that are in low density or those restricted to (or in highest abundance in) habitats that are not easily sampled via electrofishing (i.e., deep pools).

Tissue samples from all parr captured were collected preserved in ethanol and sent to DFO ABL lab at Bedford Institute of Oceanography (BIO), Dartmouth, NS for storage and are available for genetic analysis and development of eDNA primers.

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7.0 REFERENCES

- Amiro, P.G. 1993. Habitat measurement and population estimation of juvenile Atlantic salmon (*Salmo salar*). p. 81 - 97. In R.J. Gibson and R.E. Cutting [ed.]. Production of juvenile Atlantic salmon, *Salmo salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118.
- Beaumaster, R., Chateauvert, A., Anderson, L., Linnansaari, T., and Jones, R.A. 2020. Counts of fish captured from upstream fish passage facilities at Beechwood and Tobique dams, New Brunswick, 1990-2019. Can. Data Rep. Fish. Aquat. Sci. 1328: iii + 23 p.
- DFO and MRNF. 2008. Conservation Status Report, Atlantic Salmon in Atlantic Canada and Quebec: PART I – Species information. Can. Man. Rep. Fish. Aquat. Sci. 2861: viii + 208 p.
- Elson, Paul F. 1941. Eels as a limiting factor in smolt production. Atlantic Salmon and Trout Investigations. Report No. XVI. 17 p.
- Elson, P. 1967. Effects on wild young salmon of spraying DDT over New Brunswick forests. J. Fish. Res. Board Can. 24(4): 731 – 767.
- Francis, A.A. 1980. Densities of juvenile Atlantic salmon and other species, and related data from electroseining studies in the Saint John River system, 1968-78. Can. Data Rep. Fish. Aquat. Sci. 178: 102 p.
- Francis, A.A. 1984. Numbers of Atlantic salmon ascending the Tobique Narrows fishway, Saint John River System, N.B., 1978-83. Can. Data Rep. Fish. Aquat. Sci. 475: vii + 15p.
- Gibson, A.J.F., R.A. Jones and H.D. Bowlby. 2009. Equilibrium analyses of a population's response to recovery activities: a case study with Atlantic Salmon. North Amer. J. Fish. Man. 29: 959-974.
- Ingram, J.H. 1980. Capture and distribution of Atlantic salmon and other species at Mactaquac Dam and Hatchery, Saint John River, N.B., 1972-76. Can. Data Rep. Fish. Aquat. Sci. 181.
- Ingram, J.H. 1981. Fish-count data at Beechwood Dam fish-collection facilities, 1972-76. Freshwater and Anadromous Division, Resource Branch, Department of Fisheries and Oceans, Halifax, Nova Scotia. Can. Data Rep. Fish. Aquat. Sci. 254: 41 p.
- Jones, R.A., L. Anderson, and T. Goff. 2004. [Assessments of Atlantic Salmon stocks in southwest New Brunswick, an update to 2003](#). Can. Sci. Advis. Sec. Res. Doc. 2004/019: ii + 70 p.
- Jones, R.A., L. Anderson, J.J. Flanagan and T. Goff. 2006. [Assessments of Atlantic Salmon stocks in southern and western New Brunswick \(SFA 23\), an update to 2005](#). Can. Sci. Advis. Sec. Res. Doc. 2006/025: ii + 82 p.
- Jones, R.A., L. Anderson, A.J.F. Gibson, and T. Goff. 2010. [Assessments of Atlantic Salmon stocks in South Western New Brunswick \(outer portion of SFA 23\): An update to 2008](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/118: vi + 77 p.
- Jones, R.A., Anderson, L., and Clarke, C.N. 2014. [Assessment of the Recovery Potential for the Outer Bay of Fundy Population of Atlantic Salmon \(*Salmo salar*\): Status, Trends, Distribution, Life History Characteristics and Recovery Targets](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2014/008: vi + 94 p.
- Marshall, T.L., R. Jones and T. Pettigrew. 1997. [Status of Atlantic salmon stocks of southwest New Brunswick, 1996](#). DFO CSAS Res. Doc. 97/27: iii + 67p.
- Marshall, T. L., C. N. Clarke, R. A. Jones, and S. M. Ratelle. 2014. [Assessment of the recovery potential for the Outer Bay of Fundy population of Atlantic Salmon \(*Salmo salar*\): habitat considerations](#). Can. Sci. Advis. Sec. Res. Doc. 2014/007: vi + 82 p.

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

Smith, K.E.H. 1979. Capture and distribution of all fish species at Saint John River power dams, New Brunswick, from construction years to 1971. Can. Data Rep. Fish. Aquat. Sci. 171: viii + 55 p.

TABLES

Table 1: Wild Atlantic salmon catches and densities by age from electrofishing surveys at index and non-index sites located in Tobique, Becaguimec, Meduxnekeag, Salmon (Vic. Co.) and Shikatehawk tributaries upriver of Mactaquac Dam, sampled in 2009.

River	Site number	Site area (m ²)	Atlantic salmon catches	Density (Fish /100 m ²)				Total
				Age - 0	Age - 1	Age - 2	Age - 3	
Tobique	TR1	729	1	0.0	0.4	0.0	0.0	0.4
	TR2	1,160	1	0.0	0.3	0.0	0.0	0.3
	TR3	2,146	2	0.0	0.0	0.3	0.0	0.3
	TR4	1,393	5	0.2	0.9	0.0	0.0	1.1
	TR5	1,303	1	0.0	0.2	0.0	0.0	0.2
	TR6	1,215	3	0.0	0.7	0.0	0.0	0.7
	TR7	933	35	0.0	5.7	0.7	0.0	6.4
	TR8	1,083	13	0.6	2.4	0.5	0.0	3.5
	TR9	1,056	0	0.0	0.0	0.0	0.0	0.0
	TR10	950	14	0.0	2.1	2.1	0.0	4.2
	TR11	1,595	242	8.1	1.9	0.5	0.0	10.5
	TR12	1,012	9	0.6	1.8	0.3	0.0	2.7
	TR13	974	135	18.7	4.5	1.4	0.0	24.7
	TR14	736	11	0.0	3.6	0.8	0.0	4.4
	TR15	563	11	5.2	0.5	0.0	0.0	5.7
		TR16			Not done in 2009			
Totals, Mean Densities		16,848	483	2.2	1.7	0.4	0.0	4.3
Becaguimec	BC1	1,392	28	5.6	0.2	0.0	0.0	5.8
	BC2	977	3	0.3	0.3	0.3	0.0	0.9
	BC4	911	17	5.4	0.0	0.0	0.0	5.4
	BC5	1,505	15	0.8	2.1	0.0	0.0	2.9
	BC7	774	12	0.0	3.8	0.8	0.0	4.6
Meduxnekeag	MG1	675	13	3.4	2.1	0.0	0.0	5.5
	MG2	498	0	0.0	0.0	0.0	0.0	0.0
	MG3	600	0	0.0	0.0	0.0	0.0	0.0
	MG4	1,285	4	0.9	0.0	0.0	0.0	0.9
Salmon (Vic. Co.)	SV3	315	0	0.0	0.0	0.0	0.0	0.0
	SV4	1,220	0	0.0	0.0	0.0	0.0	0.0
	SV5	855	0	0.0	0.0	0.0	0.0	0.0
Shikatehawk	SK1	1,297	400	32.8	5.5	3.9	0.0	42.2
	SK2	1,256	355	33.3	4.2	2.9	0.0	40.4
	SK3	1,715	588	36.4	3.2	1.3	0.0	40.9
	SK4	1,661	14	2.4	0.0	0.0	0.0	2.4
	SK5	1,250	3	0.7	0.0	0.0	0.0	0.7
Totals, Mean Densities		18,184	1452	7.2	1.3	0.5	0.0	9.0
Additional non-index sites completed on index rivers in 2009.								
Salmon	SV1	660	4	1.4	0.0	0.5	0.0	1.9
	SV2	817	0.0	0.0	0.0	0.0	0.0	0.0
Becaguimec	BC3	608	0.0	0.0	0.0	0.0	0.0	0.0
	BC6	1,051	7	0.0	1.4	0.5	0.0	1.9
Tobique	TR17	702	18	2.4	4.5	0.4	0.0	7.3
	TR18	717	14	2.0	3.2	0.4	0.0	5.6

Table 2: Wild Atlantic salmon catches and densities by age from electrofishing surveys at new sites located in non-index tributaries upriver of Mactaquac Dam, sampled in 2009.

River	Site number	Site area (m ²)	Atlantic salmon catches	Density (Fish /100 m ²)				
				Age - 0	Age - 1	Age - 2	Age - 3	Total
Big Presque Isle	BP1	856	1	0.4	0.0	0.0	0.0	0.4
Big Presque Isle	BP2	657	14	5.3	0.5	0.5	0.0	6.2
Big Presque Isle	BP3	1,130	15	3.8	0.0	0.0	0.0	3.8
Bulls Creek	BS1	689	0	0.0	0.0	0.0	0.0	0.0
Eel	EL1	1,160	3	0.8	0.0	0.0	0.0	0.8
Eel	EL2	660	3	1.4	0.0	0.0	0.0	1.4
Eel	EL3	760	0	0.0	0.0	0.0	0.0	0.0
Eel	EL4	1,025	0	0.0	0.0	0.0	0.0	0.0
Gibson Creek	GC1	774	7	1.6	1.2	0.0	0.0	2.8
Gibson Creek	GC2	876	0	0.0	0.0	0.0	0.0	0.0
Little Presque Isle	LE1	980	45	13.3	0.0	0.0	0.0	13.3
Little Presque Isle	LE2	883	27	8.8	0.0	0.0	0.0	8.8
Longs Creek	LC1	808	1	0.0	0.4	0.0	0.0	0.4
Longs Creek	LC2	660	0	0.0	0.0	0.0	0.0	0.0
Mactaquac Stream	MC1	813	0	0.0	0.0	0.0	0.0	0.0
Mill Stream	MM1	1,021	0	0.0	0.0	0.0	0.0	0.0
Monquart	MT1	900	44	11.6	2.6	0.0	0.0	14.2
Muniac	MU1	798	7	0.0	2.1	0.4	0.0	2.5
Muniac	MU2	986	14	3.2	0.6	0.3	0.0	4.1
Muniac	MU3	560	0	0.0	0.0	0.0	0.0	0.0
Nackawic	NC1	692	1	0.0	0.0	0.4	0.0	0.4
Nackawic	NC2	781	3	0.4	0.0	0.8	0.0	1.2
Nackawic	NC3	878	1	0.0	0.0	0.3	0.0	0.3
Nackawic	NC4	796	2	0.0	0.0	0.4	0.4	0.8
Nackawic	NC5	907	5	0.3	1.0	0.3	0.0	1.6
Pokiok	PK1	908	0	0.0	0.0	0.0	0.0	0.0
Pokiok	PK2	836	3	0.0	0.4	0.7	0.0	1.1
Pokiok	PK3	698	0	0.0	0.0	0.0	0.0	0.0
River de Chute	RE1	621	0	0.0	0.0	0.0	0.0	0.0
River de Chute	RE2	833	0	0.0	0.0	0.0	0.0	0.0
River de Chute	RE3	804	0	0.0	0.0	0.0	0.0	0.0
Shogomoc	SC1	785	10	3.7	0.0	0.0	0.0	3.7
Shogomoc	SC2	776	0	0.0	0.0	0.0	0.0	0.0
Stickney Brook	SY1	716	5	0.0	0.0	2.0	0.0	2.0
Totals, Mean Densities		28,026	211	1.6	0.3	0.2	0.0	2.1

Table 3: Wild Atlantic salmon catches and densities by age from electrofishing surveys at index and non-index sites located in Nashwaak, Keswick and Kennebecasis tributaries downriver of Mactaquac Dam, sampled in 2009.

River	Site number	Site area (m ²)	Atlantic salmon catches	Density (Fish /100 m ²)				Total
				Age - 0	Age - 1	Age - 2	Age - 3	
Kennebecasis	KS1	1,326	42	5.2	3.7	0.2	0.0	9.1
Kennebecasis	KS2	912	2	0.0	0.0	0.7	0.0	0.7
Kennebecasis	KS3	900	43	11.9	1.0	1.0	0.0	13.8
Kennebecasis	KS4	1,380	0	0.0	0.0	0.0	0.0	0.0
Kennebecasis	KS5	1,285	18	1.1	1.6	1.3	0.0	4.0
Keswick	KW1	1,000	50	9.5	2.9	2.0	0.0	14.4
Keswick	KW2	1,030	68	17.9	0.6	0.6	0.0	19.1
Keswick	KW3	1,155	88	17.0	2.3	2.8	0.0	22.0
Keswick	KW4	1,140	63	14.6	0.5	0.5	0.2	15.8
Nashwaak	NK1	1,277	32	0.9	2.8	0.3	0.0	3.9
Nashwaak	NK2	1,510	5	0.9	0.0	0.0	0.0	0.9
Nashwaak	NK4	1,254	84	14.5	4.9	0.0	0.0	19.4
Nashwaak	NK5	1,014	4	0.0	0.3	0.9	0.0	1.2
Nashwaak	NK6	1,124	3	0.8	0.0	0.0	0.0	0.8
Nashwaak	NK7	1,363	102	17.8	3.8	0.0	0.0	21.6
Nashwaak	NK8	1,214	11	1.6	0.0	1.0	0.0	2.6
Nashwaak	NK9	1,140	20	2.3	1.0	1.8	0.0	5.1
Nashwaak	NK10	1,272	106	6.4	4.6	0.9	0.0	11.9
Nashwaak	NK11	1,659	149	10.8	8.6	1.9	0.0	21.3
Totals, Mean Densities		22,955	890	7.0	2.0	0.8	0.0	9.9

Additional non-index sites completed on index rivers in 2009.

Nashwaak	NK3	804	27	0.0	9.7	0.0	0.0	9.7
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Table 4: Wild Atlantic salmon catches and densities by age from electrofishing surveys at new sites located in non-index tributaries downriver of Mactaquac Dam, sampled in 2009.

River	Site number	Site area (m ²)	Atlantic salmon catches	Density (Fish /100 m ²)				
				Age - 0	Age - 1	Age - 2	Age - 3	Total
Burpee	BE1	825	0	0.0	0.0	0.0	0.0	0.0
Burpee	BE2	735	0	0.0	0.0	0.0	0.0	0.0
Burpee	BE3	837	0	0.0	0.0	0.0	0.0	0.0
Belleisle Creek	BL1	1,020	3	0.3	0.0	0.6	0.0	0.9
Belleisle Creek	BL2	707	6	1.7	0.0	0.8	0.0	2.5
Cumberland Bay	CB1	845	0	0.0	0.0	0.0	0.0	0.0
Cumberland Bay	CB2	900	0	0.0	0.0	0.0	0.0	0.0
Coal Creek	CC1	969	5	0.6	0.6	0.3	0.0	1.5
Coal Creek	CC2	905	2	0.3	0.0	0.3	0.0	0.6
Coal Creek	CC3	743	8	1.6	0.8	0.8	0.0	3.2
Little River (Sunbury Co.)	LR1	774	0	0.0	0.0	0.0	0.0	0.0
Little River (Sunbury Co.)	LR2	771	3	1.2	0.0	0.0	0.0	1.2
Little River (Sunbury Co.)	LR3	767	1	0.0	0.0	0.4	0.0	0.4
Nashwaaksis	NA1	858	31	1.6	5.7	3.0	0.0	10.3
Nashwaaksis	NA2	679	0	0.0	0.0	0.0	0.0	0.0
Newcastle Creek	NE1	826	3	0.7	0.4	0.0	0.0	1.1
Newcastle Creek	NE2	1,008	0	0.0	0.0	0.0	0.0	0.0
Noonan	NN1	759	0	0.0	0.0	0.0	0.0	0.0
Nerepis	NS1	799	0	0.0	0.0	0.0	0.0	0.0
Nerepis	NS2	790	17	5.8	0.4	0.0	0.0	6.2
Nerepis	NS3	734	10	3.5	0.0	0.4	0.0	3.9
Oromocto	OO1	735	0	0.0	0.0	0.0	0.0	0.0
Oromocto	OO2	804	0	0.0	0.0	0.0	0.0	0.0
Oromocto	OO3	835	6	1.7	0.4	0.0	0.0	2.1
Oromocto	OO4	801	2	0.4	0.4	0.0	0.0	0.8
Oromocto	OO5	876	0	0.0	0.0	0.0	0.0	0.0
Oromocto	OO6	723	0	0.0	0.0	0.0	0.0	0.0
Oromocto	OO7	891	3	1.0	0.0	0.0	0.0	1.0
Oromocto	OO8	761	6	1.6	0.0	0.8	0.0	2.4
Oromocto	OO9	763	0	0.0	0.0	0.0	0.0	0.0
Salmon River (Queens Co.)	SN1	793	0	0.0	0.0	0.0	0.0	0.0
Salmon River (Queens Co.)	SN2	769	1	0.4	0.0	0.0	0.0	0.4
Salmon River (Queens Co.)	SN3	758	0	0.0	0.0	0.0	0.0	0.0
Salmon River (Queens Co.)	SN4	955	0	0.0	0.0	0.0	0.0	0.0
Salmon River (Queens Co.)	SN5	790	15	2.9	1.4	1.1	0.0	5.4
Salmon River (Queens Co.)	SN6	980	10	1.7	1.2	0.0	0.0	2.9
Salmon River (Queens Co.)	SN7	855	0	0.0	0.0	0.0	0.0	0.0
Youngs Creek	YK1	879	0	0.0	0.0	0.0	0.0	0.0
Totals, Mean Densities		31,214	132	0.7	0.3	0.2	0.0	1.2

Table 5: Wild Atlantic salmon catches and densities by age from electrofishing surveys at new sites located in non-index tributaries of other outer Bay of Fundy rivers, sampled in 2009.

River	Site number	Site area (m ²)	Atlantic salmon catches	Density (Fish /100 m ²)				
				Age - 0	Age - 1	Age - 2	Age - 3	Total
Digdeguash	DH1	567	5	2.1	0.5	0.0	0.0	2.6
Digdeguash	DH2	461	4	2.6	0.0	0.0	0.0	2.6
Digdeguash	DH3	442	1	0.7	0.0	0.0	0.0	0.7
Dennis Stream	DS1	407	0	0.0	0.0	0.0	0.0	0.0
Dennis Stream	DS2	179	3	0.0	5.0	0.0	0.0	5.0
Dennis Stream	DS3	541	16	6.5	2.2	0.0	0.0	8.7
New River	NR1	713	3	1.3	0.0	0.0	0.0	1.3
New River	NR2	384	1	0.0	0.0	0.8	0.0	0.8
Pocologan	PN1	425	6	2.8	1.4	0.0	0.0	4.2
Waweig	WG1	338	0	0.0	0.0	0.0	0.0	0.0
Waweig	WG2	572	0	0.0	0.0	0.0	0.0	0.0
Waweig	WG3	416	0	0.0	0.0	0.0	0.0	0.0
Totals, Mean Densities		5,443	39	1.3	0.8	0.1	0.0	2.2

Table 6: Catches of all non-salmon species from electrofishing surveys at new sites located in non-index tributaries upriver of Mactaquac Dam, sampled in 2009.

Site	American eel	Blacknose dace	Brook trout	Brown bullhead	Chain pickerel	Chubb	Crayfish	Pumpkinseed sunfish	Rainbow trout	Sea lamprey	Shiner	Slimy sculpin	Smallmouth bass	Stickleback sp.	Sucker sp.	Yellow perch	Grand Total
BP1		30	2									1	1				36
BP2		200	3			1						1	25		1		231
BP3		130															138
BS1		9	23									10			3	5	42
EL1		101	5	1													114
EL2							6						1				8
EL3							4						3			1	8
EL4					1		28						1				8
GC1		39					34										148
GC2		41											2			1	76
LC1		211	1				3	1									126
LC2		83	14				5	4									85
LE1		225					15				2						115
LE2		60					4				4						3
MC1	1	9	7				10	3									18
MM1		59	5														2
MT1		2	2				1		1		2						1
MU1			29						3								1
MU2			25						10								2
MU3		1	37														68
NC1	1			1													185
NC2		9					1										1
NC3		41					8										2
NC4		32		3													4
NC5		10				1											8
PK1		38	1				1										2
PK2		7					8										1
PK3	1	44					1	3									3
RE1			42														175
RE2			13														235
RE3			35														375
SC1							1										1
SC2		10					10	3						2			2
SY1		3	6				117		273								77
Totals	3	1513	250	5	1	1	264	11	3	287	0	8	1223	42	6	155	4

Table 7: Catches of all non-salmon species from electrofishing surveys at new sites located in non-index tributaries downriver of Mactaquac Dam, sampled in 2009.

Site	American eel	Blacknose dace	Brook trout	Brown bullhead	Burbot	Chain pickerel	Chubb	Crayfish	Pumpkinseed sunfish	Rainbow trout	Sea lamprey	Shiner	Slimy sculpin	Smallmouth bass	Stickleback sp.	Sucker sp.	Yellow perch	Grand Total
BE1	10	22			1		2											35
BE2	7	67	3	2	1		1											81
BE3	7	32	3				5	1									2	50
BL1	77	200									2	4			1		2	286
BL2	5	359	68								1		87					520
CB1	36	9				2	18				1						4	70
CB2	29	71			2		13										2	117
CC1	17	117					5											139
CC2	4	14	2															20
CC3	1	79	4				8								1		8	101
LR1	16	27					2				1	5						51
LR2	4	10	1		5		1				1							22
LR3	20	10			2							6						38
NA1	40	98	3		1													142
NA2	24	65	24				8	1			1		3				1	127
NE1	15	39																54
NE2	3	85			1		1										2	92
NN1	5	63	7					7										82
NS1	9		7															16
NS2	8	27	21															56
NS3	2	10					8											20
OO1	33	67			4		10										1	115
OO2	2	130	11				10				3						1	157
OO3	28	123			2		13										1	167
OO4	18	115	2				10										5	150
OO5	8	92					12				6						5	123
OO6	4	30					5										1	40
OO7		44		1			8											53
OO8	8	119	2		4		8										5	146
OO9	8	81	8				6										4	107
SN1	11	113	3				4				2						2	135
SN2	10	17		1														28
SN3		10		1			2										3	16
SN4	8	36	2				1											47
SN5	21	10	2								1	1	3					38
SN6	2	29											4					35
SN7	8	23					1				1		1					34
YK1	39	97		3		1	90				2						8	240
Totals	547	2540	173	8	23	3	252	9	0	0	22	16	98	0	2	57	0	3750

Table 8: Catches of all non-salmon species from electrofishing surveys at new sites located in non-index tributaries of other outer Bay of Fundy rivers, sampled in 2009.

Site	American eel	Blacknose dace	Brook trout	Brown bullhead	Burbot	Chain pickerel	Chubb	Crayfish	Pumpkinseed sunfish	Rainbow trout	Sea lamprey	Shiner	Slimy sculpin	Smallmouth bass	Stickleback sp.	Sucker sp.	Yellow perch	Grand Total
DH1	1	17										11						18
DH2	1	18					3										2	22
DH3	2	47										9					7	49
DS1	15	91					4				2						3	110
DS2	3	19	1									9					2	23
DS3	5	120					2				1	11		1			9	127
NR1	2	18	1														1	21
NR2	1																	1
PN1	3	5	6				1											15
WG1	12	85	5				5										3	107
WG2	15	40	3				3										10	61
WG3	9	63	1				4										25	77
Totals	69	523	17	0	0	0	22	0	0	0	3	40	0	1	0	63	0	738

Table 9: Mean length (cm) and weight (g) + standard deviation of wild juvenile Atlantic salmon sampled in the new electrofishing sites by age and geographical area in 2009.

Geographic Area	Wild				
	Age-0	Age-1	Age-2	Age-3	Overall
Length (cm)					
Upriver of Mactaquac Dam	6.9 ± 1.0 (140)	13.6 ± 1.6 (25)	16.0 ± 1.2 (16)	17.3 (1)	8.7 ± 3.5 (182)
Downriver of Mactaquac Dam	5.7 ± 1.2 (75)	11.7 ± 1.1 (33)	14.6 ± 2.1 (24)	n/a	8.8 ± 4.0 (132)
Other selected rivers	7.2 ± 0.8 (28)	13.7 ± 1.8 (10)	14.4 (1)	n/a	9.0 ± 3.2 (39)
Overall	6.6 ± 1.2 (243)	12.7 ± 1.7 (68)	15.1 ± 1.9 (41)	17.3 (1)	8.8 ± 3.6 (353)
Weight (grams)					
Upriver of Mactaquac Dam	4.5 ± 1.7 (140)	29.8 ± 12.1 (25)	52.0 ± 15.5 (16)	64.8 (1)	12.6 ± 17.0 (182)
Downriver of Mactaquac Dam	2.5 ± 1.5 (75)	20.0 ± 5.7 (33)	40.9 ± 19.8 (24)	n/a	13.9 ± 17.2 (132)
Other selected rivers	4.7 ± 1.8 (28)	39.3 ± 10.2 (10)	31.7 (1)	n/a	13.9 ± 16.1 (39)
Overall	3.9 ± 1.9 (243)	26.1 ± 11.2 (68)	45.0 ± 18.7 (41)	64.8 (1)	13.2 ± 16.9 (353)

Table 10: Monthly summary of the new electrofishing sites completed, mean water and air temperatures by geographical area in 2009.

Location	July			August			September		
	Site done	Temperature (°C)		Site done	Temperature (°C)		Site done	Temperature (°C)	
		Water	Air		Water	Air		Water	Air
Upriver of Mactaquac Dam	51.51%	17.6 ± 3.1	21.4 ± 3.3	42.42%	19.4 ± 2.5	23.1 ± 2.6	6.06%	13.0 ± 2.0	11.7 ± 3.2
Downriver of Mactaquac Dam	47.37%	16.3 ± 1.5	19.5 ± 3.5	36.84%	19.2 ± 2.0	24.0 ± 3.9	15.79%	12.9 ± 2.3	15.5 ± 3.0
Other select rivers	0%	n/a	n/a	0%	n/a	n/a	100%	11.8 ± 4.6	13.8 ± 3.2

Table 11: Mean length (cm) ± standard deviation of non-salmon species sampled in the new electrofishing sites by geographical area in 2009.

Species	Mean length (cm) ± standard deviation (n)		
	Upriver	Downriver	Other rivers
American eel	35.1 ± 15.1 (3)	25.6 ± 8.6 (241)	12.3 ± 6.2 (27)
Brook trout	12.5 ± 5.2 (122)	13.0 ± 6.0 (108)	16.1 ± 6.7 (17)
Brown bullhead	11.0 ± 5.5 (5)	8.0 ± 1.6 (8)	-
Burbot	21.8 (1)	19.7 ± 5.1 (23)	-
Chubb	7.2 ± 3.0 (114)	7.4 ± 3.1 (162)	7.2 ± 1.9 (22)
Cray fish	2.5 ± 0.6 (11)	2.6 ± 0.7 (9)	-
Dace	6.2 ± 1.4 (236)	5.6 ± 1.1 (402)	5.5 ± 1.2 (116)
Sea lamprey	-	12.5 ± 2.0 (22)	13.4 ± 1.2 (3)
Chain pickerel	9.0 (1)	7.1 ± 0.6 (3)	-
Rainbow trout	14.0 ± 4.1 (25)	-	-
Slimy sculpin	6.5 ± 1.3 (113)	7.0 ± 1.8 (22)	-
Shiner	5.1 ± 0.8 (8)	5.0 ± 1.4 (16)	4.5 ± 1.4 (40)
Smallmouth bass	7.7 ± 5.0 (28)	-	9.1 (1)
Stickleback	4.1 ± 0.7 (6)	3.6 ± 0.4 (2)	-
Sucker	10.3 ± 5.3 (74)	11.6 ± 4.5 (57)	11.5 ± 4.5 (50)
Pumpkinseed sunfish	10.2 ± 0.7 (3)	-	-
Tadpole	8 (1)	9.8 (1)	-
Yellow perch	10.6 ± 0.8 (4)	-	-

Table 12: Mean weight (g) \pm standard deviation of non-salmon species sampled in the new electrofishing sites by geographical area in 2009.

Species	Mean weight (g) \pm standard deviation (n)		
	Upriver	Downriver	Other rivers
American eel	90.4 \pm 86.9 (3)	39.4 \pm 43.6 (241)	7.1 \pm 17.4 (29)
Brook trout	37.0 \pm 42.6 (121)	38.4 \pm 46.9 (108)	63.4 \pm 44.1 (17)
Brown bullhead	10.7 \pm 8.2 (5)	5.9 \pm 3.6 (8)	-
Burbot	59.6 (1)	53.2 \pm 37.0 (23)	-
Chain pickerel	4.3 (1)	2.1 \pm 1.2 (3)	-
Chubb	6.8 \pm 8.3 (114)	8.4 \pm 15.1 (162)	5.0 \pm 3.7 (22)
Cray fish	3.6 \pm 2.2 (11)	3.5 \pm 1.5 (9)	-
Dace	3.4 \pm 3.3 (236)	2.4 \pm 1.3 (402)	2.2 \pm 1.8 (116)
Pumpkinseed sunfish	22.6 \pm 5.8 (3)	-	-
Rainbow trout	37.5 \pm 25.2 (25)	-	-
Sea lamprey	-	4.2 \pm 3.0 (22)	3.9 \pm 0.7 (3)
Shiner	1.7 \pm 0.8 (8)	2.0 \pm 1.9 (16)	1.3 \pm 1.1 (40)
Slimy sculpin	3.9 \pm 2.3 (112)	5.7 \pm 4.0 (22)	-
Smallmouth bass	18.8 \pm 52.2 (27)	-	11.4 (1)
Stickleback	0.9 \pm 0.5 (6)	0.6 \pm 0.2 (2)	-
Sucker	25.6 \pm 39.6 (74)	27.5 \pm 35.5 (57)	27.8 \pm 34.4 (50)
Tadpole	5.9 (1)	15.7 (1)	-
Yellow perch	14.1 \pm 3.5 (4)	-	-

FIGURES

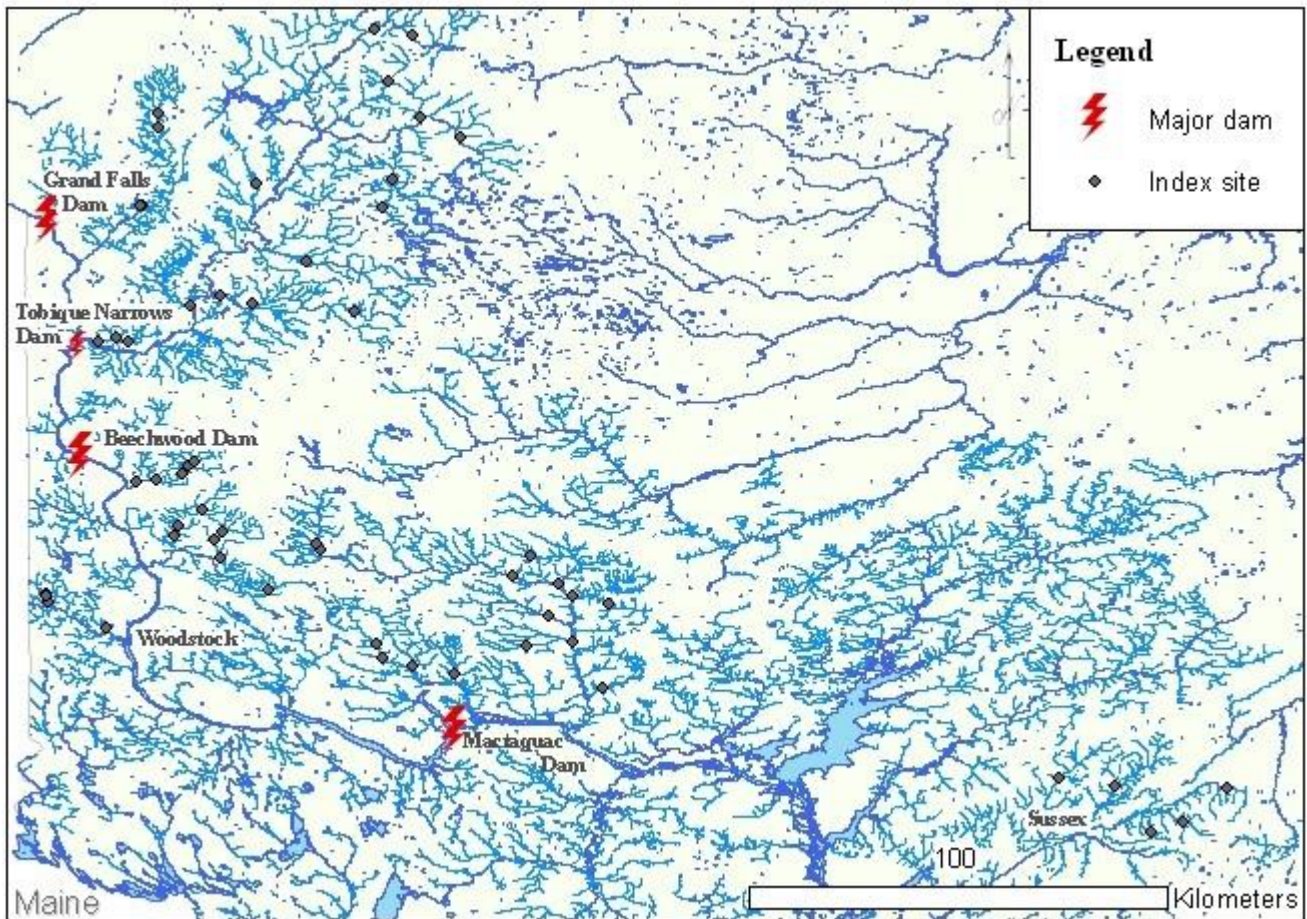


Figure 1a: Map of the Saint John River showing the locations of the index electrofishing sites in relation to the barriers or dams within the watershed.

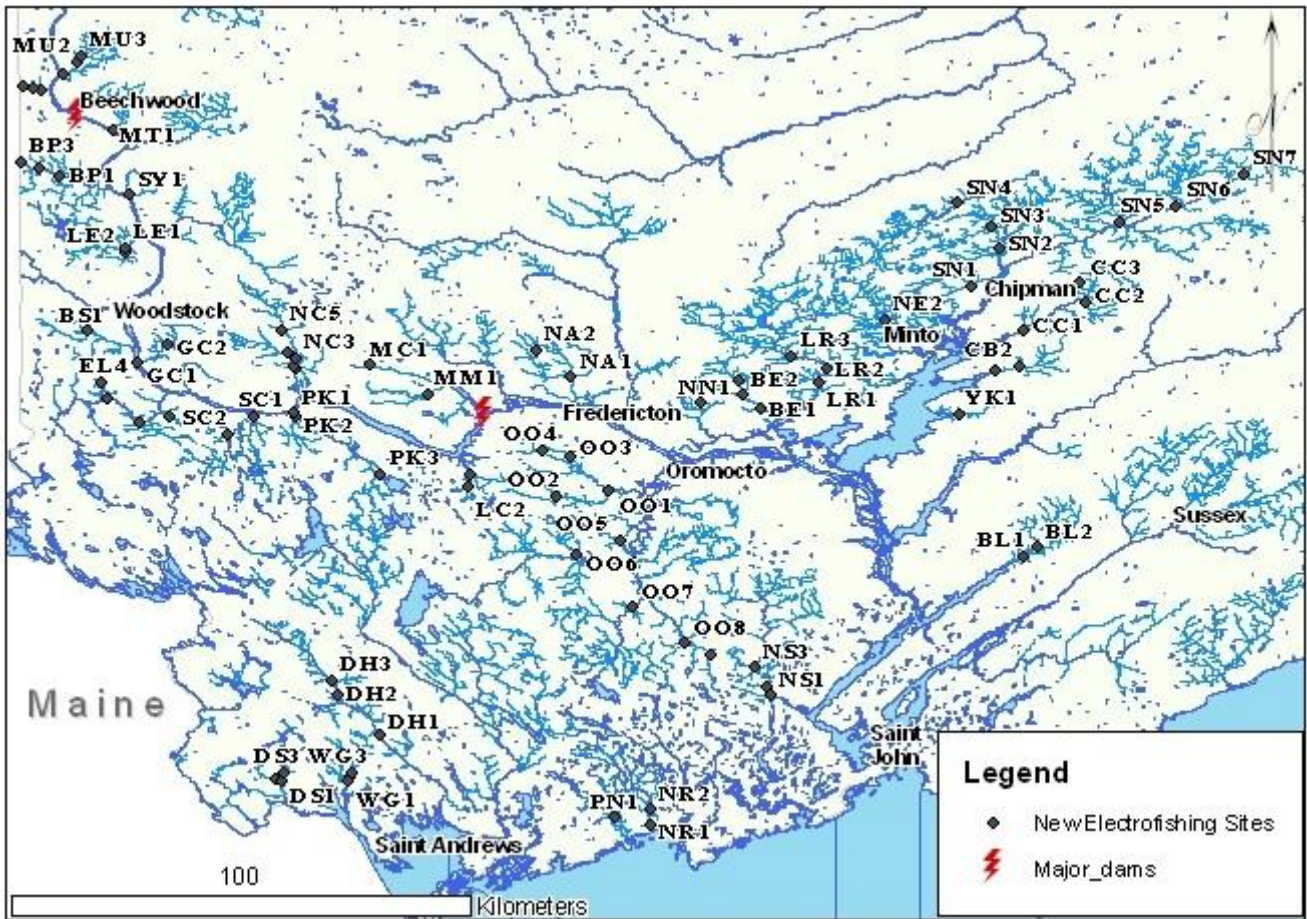
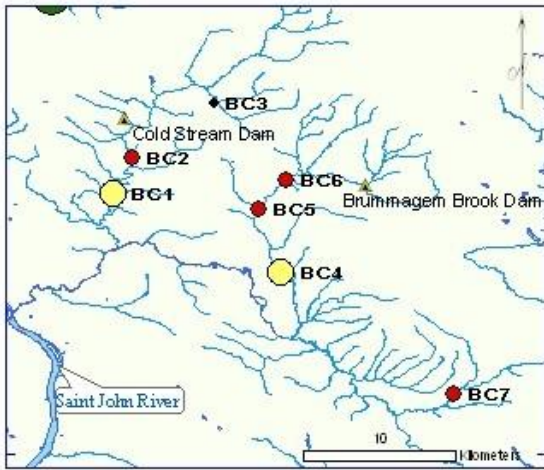


Figure 1b: Map of the Saint John River showing the locations of the new electrofishing sites in relation to the barriers or dams within the watershed.

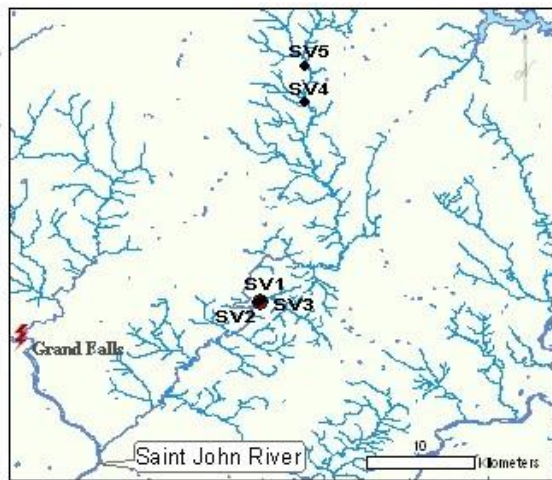
Becaguimec (BC)



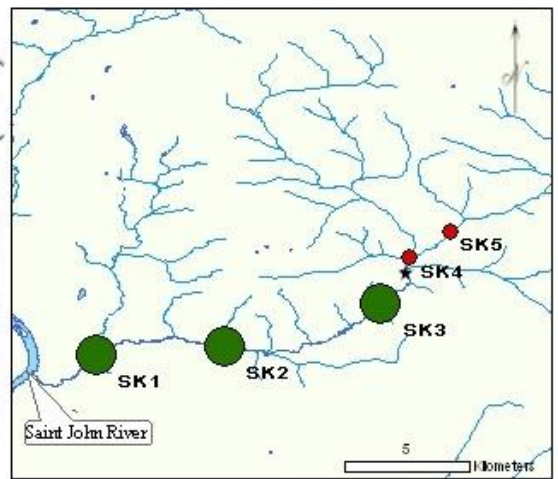
Meduxnekeag (MG)



Salmon River (SV)



Shikatehawk (SK)



Salmon Density ♦ 0.0 ● 0.1 - 5.0 ● 5.1 - 10.0 ● 10.1 - 15.0 ● 15.1 - 42.2

Figure 2a: Location of the index electrofishing sites and 2009 densities of juvenile salmon in the index tributaries (Becaguimec, Meduxnekeag, Salmon and Shikatehawk) upriver of Mactaquac Dam on the Saint John River, SFA 23.

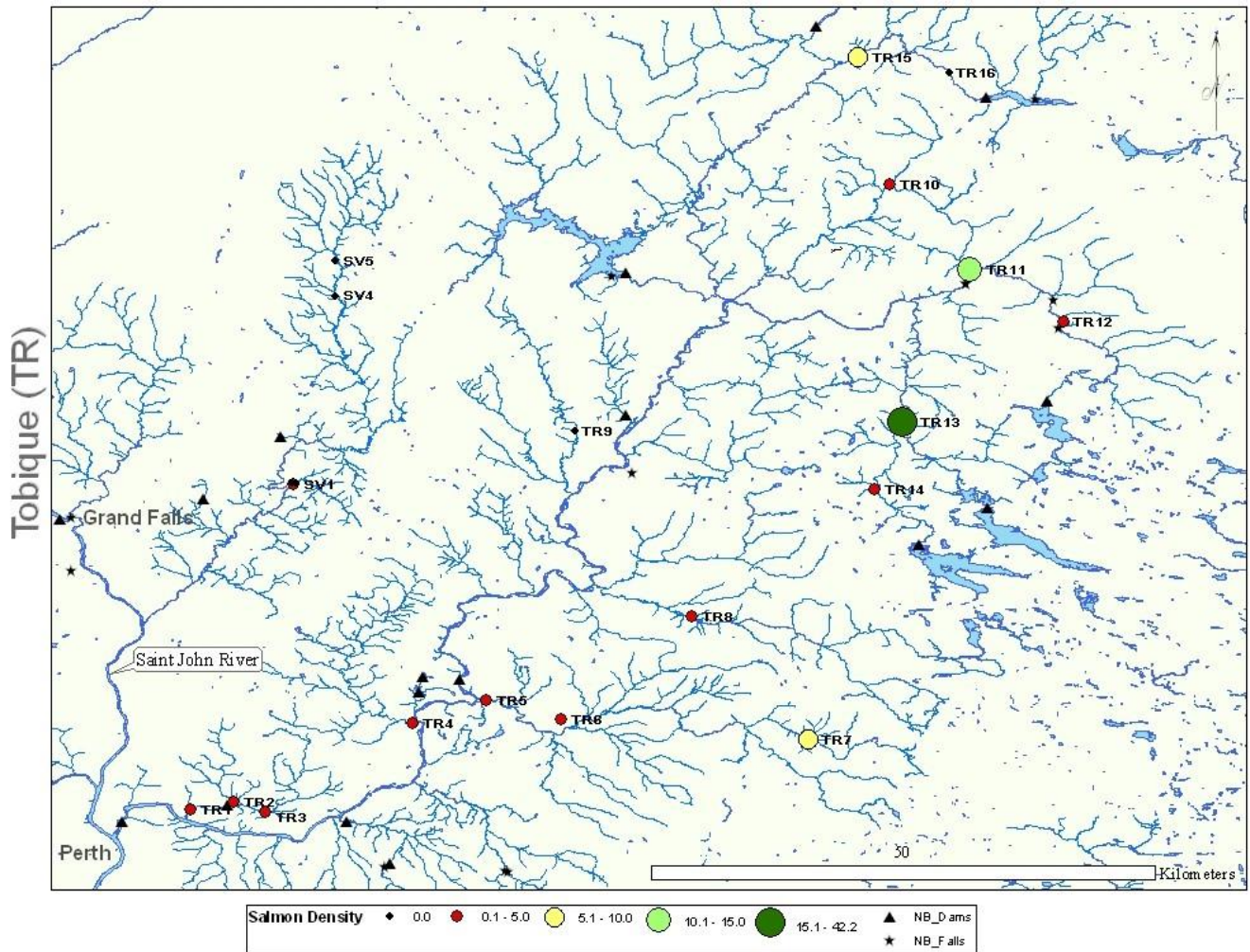


Figure 2b: Location of the index electrofishing sites and 2009 densities of juvenile salmon in the Tobique River (index tributary) upriver of Mactaquac Dam on the Saint John River, SFA 23.

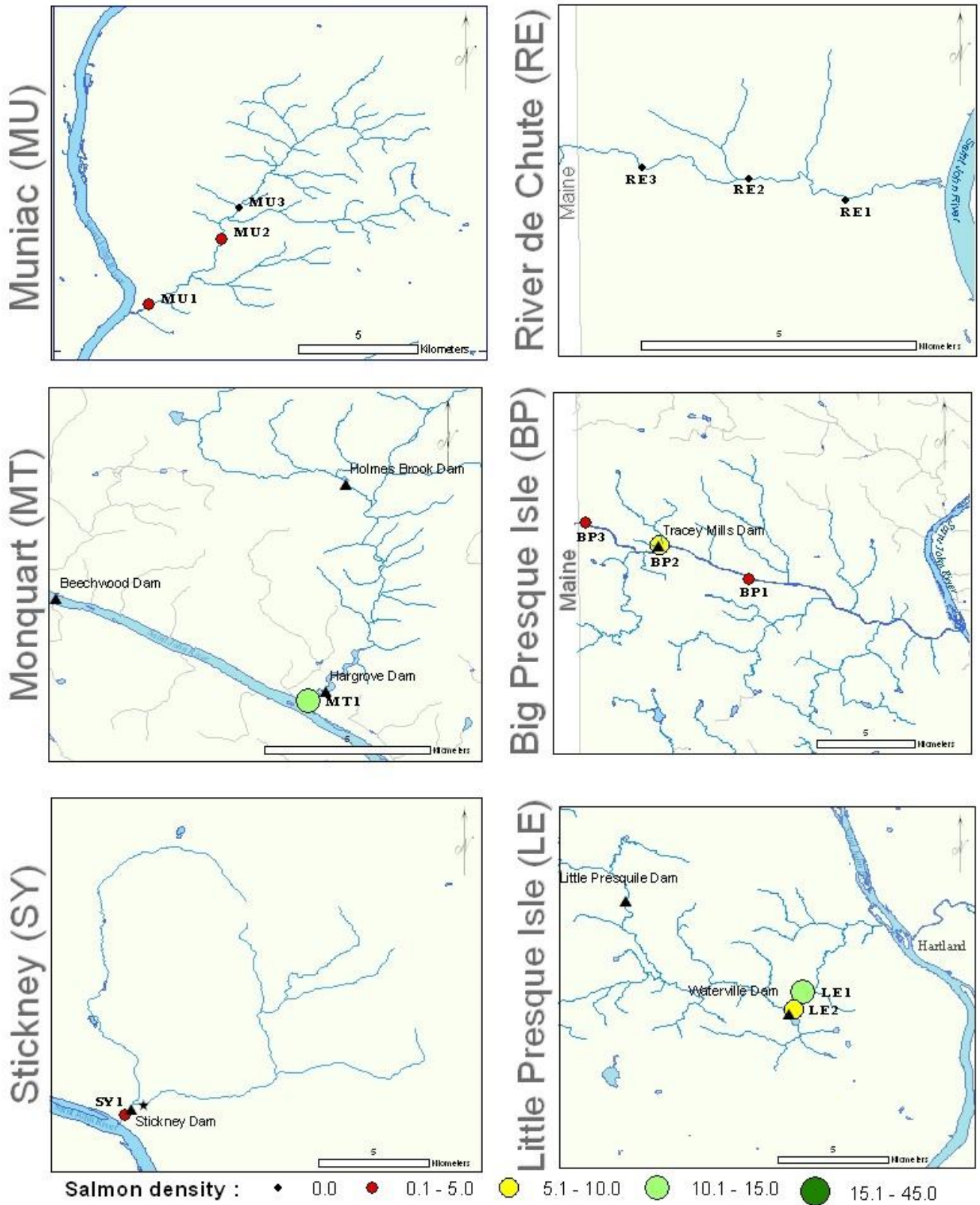


Figure 3a: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the tributaries (Muniac, River de Chute, Monquart, Big Presque Isle, Stickney and Little Presque Isle) upriver of Mactaquac Dam on the Saint John River, SFA 23.

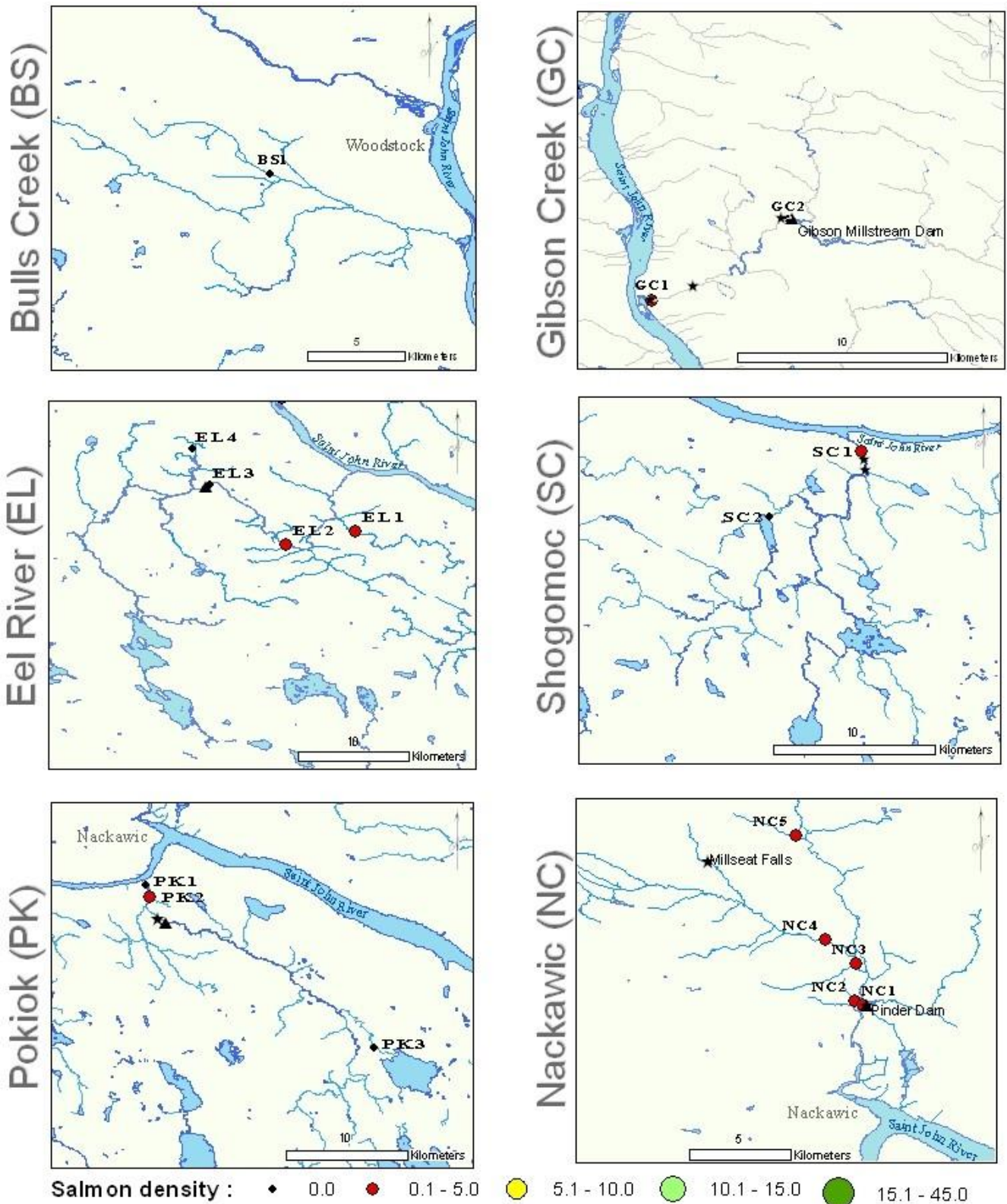


Figure 3b: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the tributaries (Bulls Creek, Gibson Creek, Eel, Shogomoc, Pokiok and Nackawic) upriver of Mactaquac Dam on the Saint John River, SFA 23.

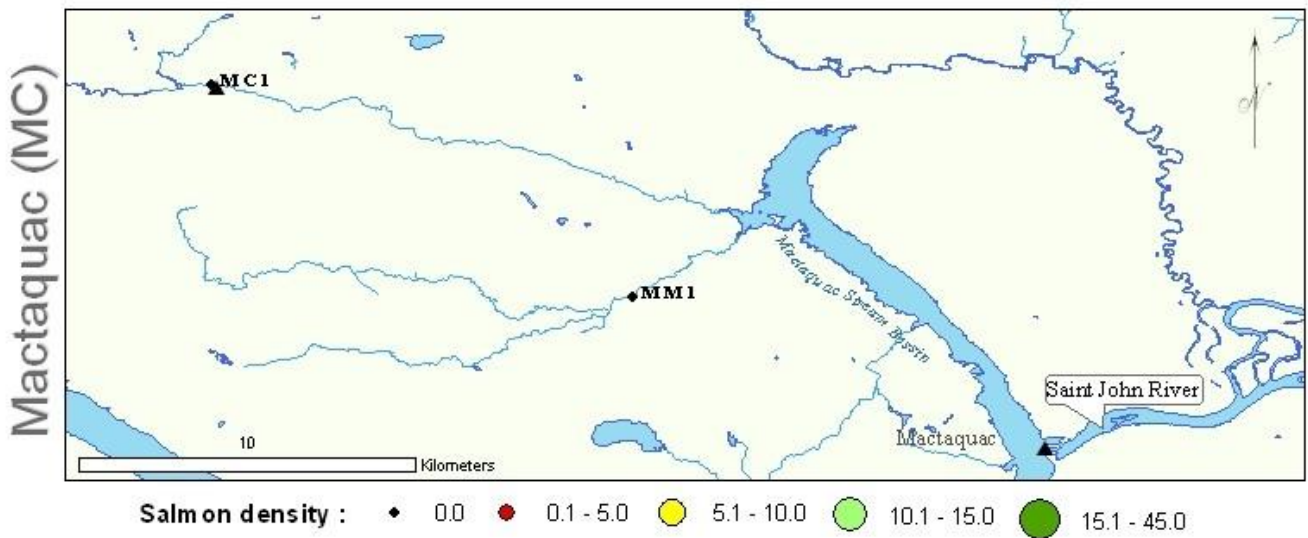
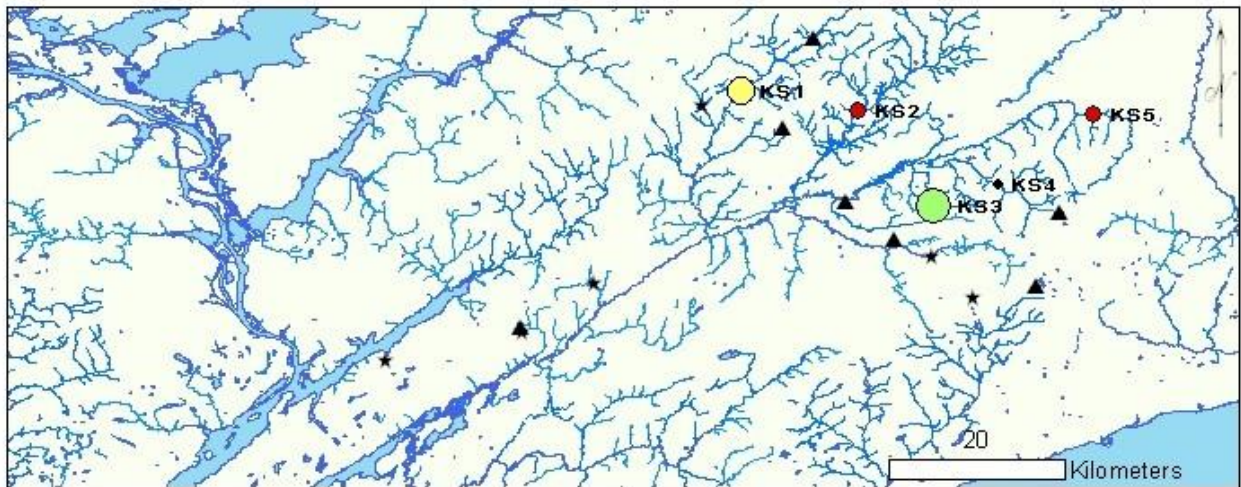
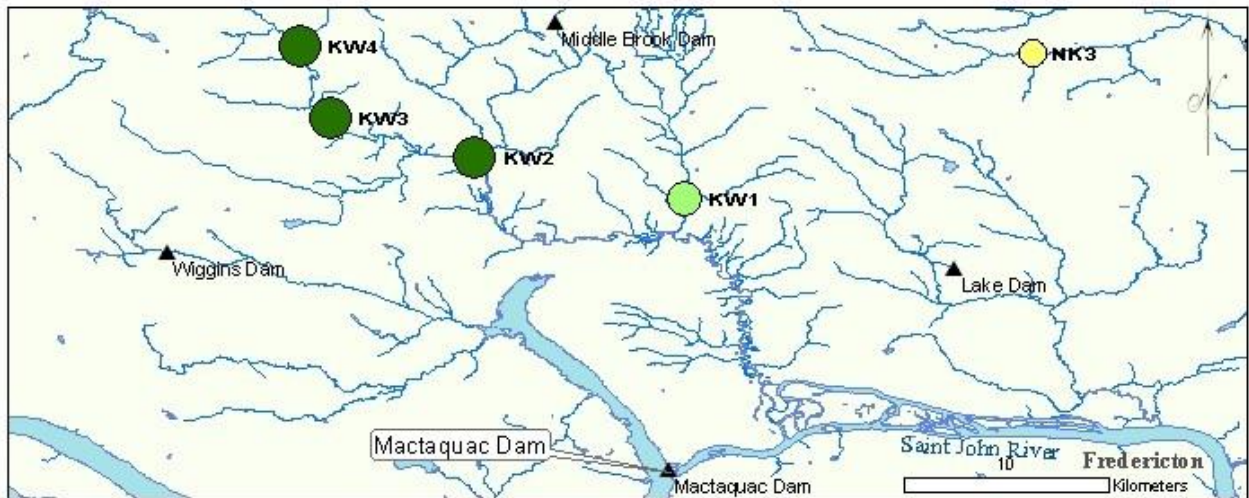


Figure 3c: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the tributaries (Longs Creek, Mill Stream and MacTaqvac) upriver of MacTaqvac Dam on the Saint John River, SFA 23.

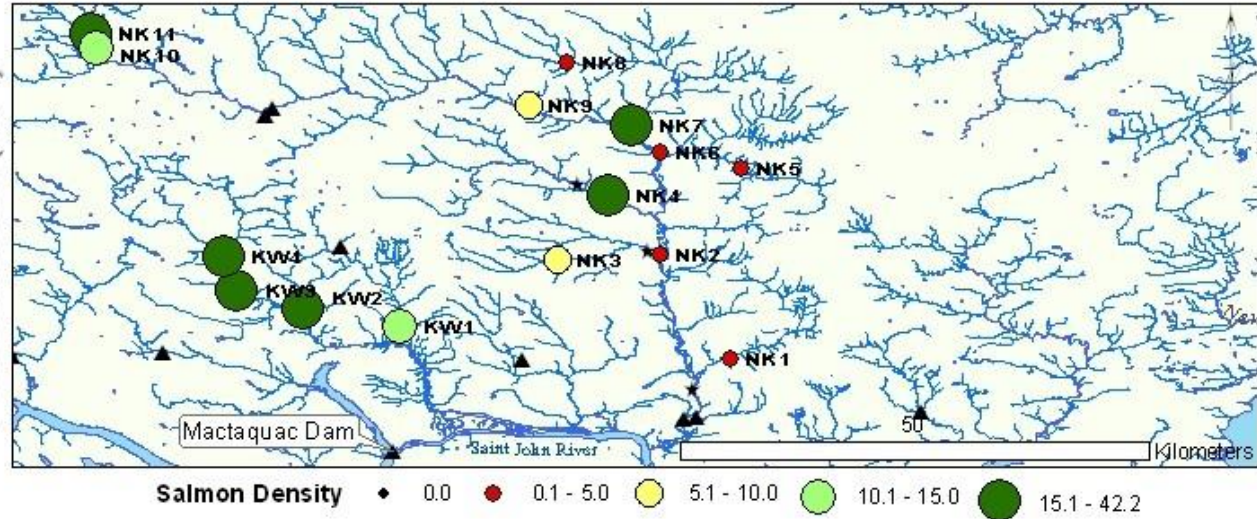
Kennebecasis (KS)



Keswick (KW)



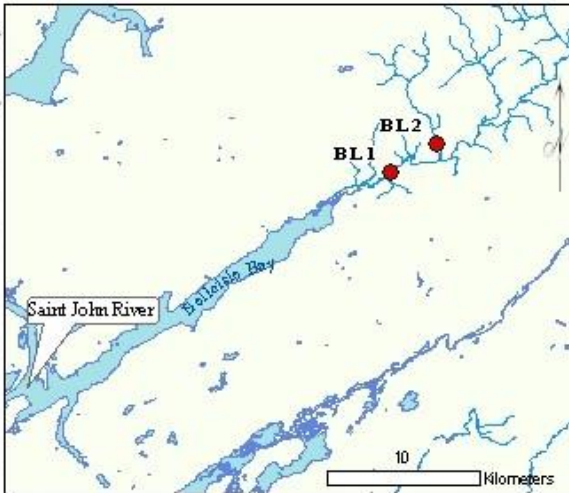
Nashwaak (NK)



Salmon Density ♦ 0.0 ● 0.1 - 5.0 ● 5.1 - 10.0 ● 10.1 - 15.0 ● 15.1 - 42.2

Figure 4: Location of the index electrofishing sites and 2009 densities of juvenile salmon in the index tributaries (Kennebecasis, Keswick and Nashwaak) downriver of Mactaquac Dam on the Saint John River, SFA 23.

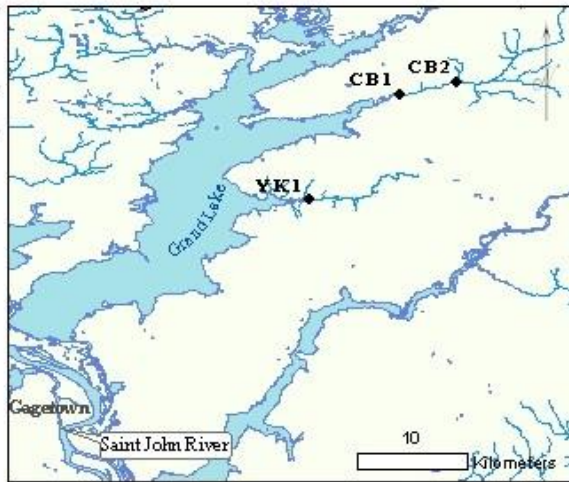
Belleisle Creek (BL)



Burpee Millstream (BE)



Cumberland Bay (CB)



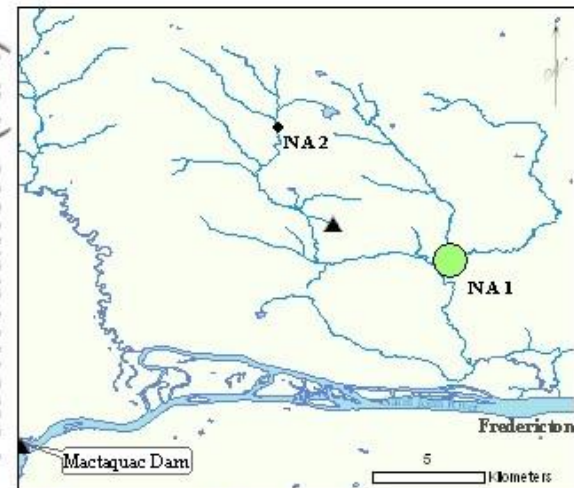
Coal Creek (CC)



Little River (LR)

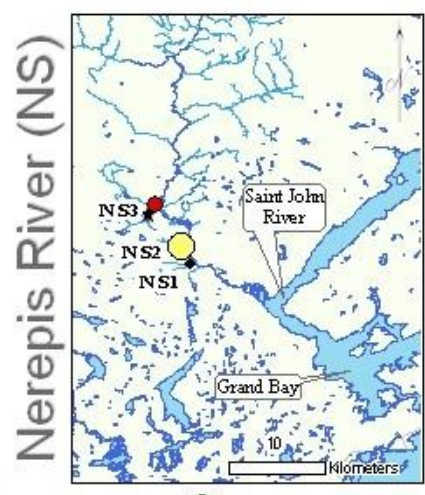
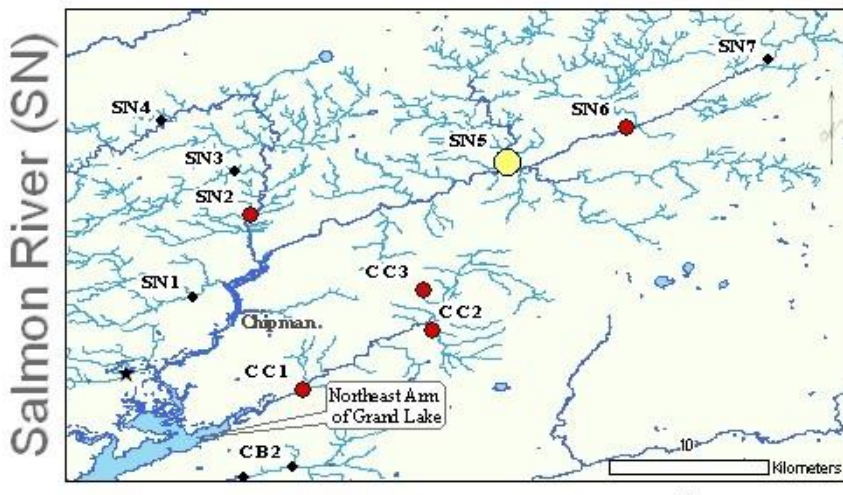
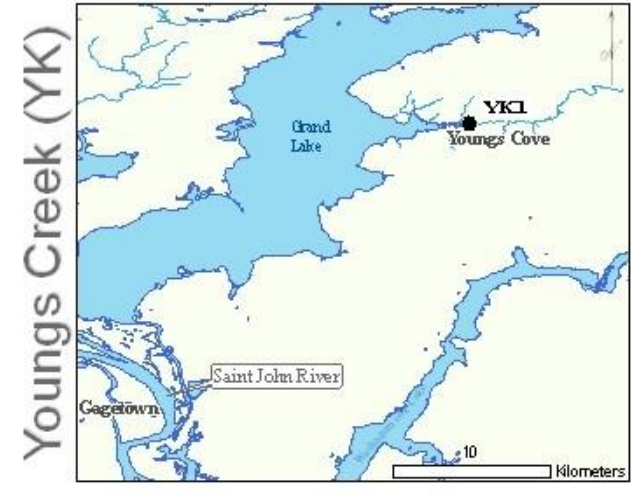
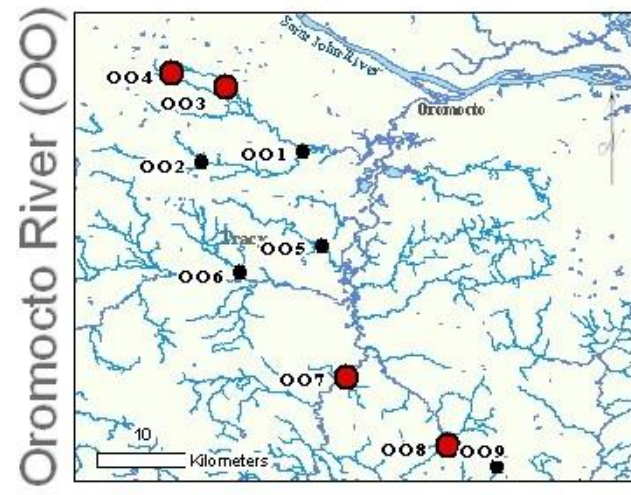
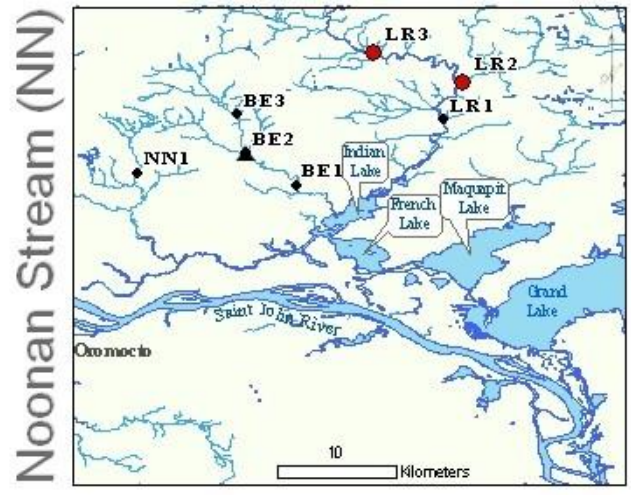
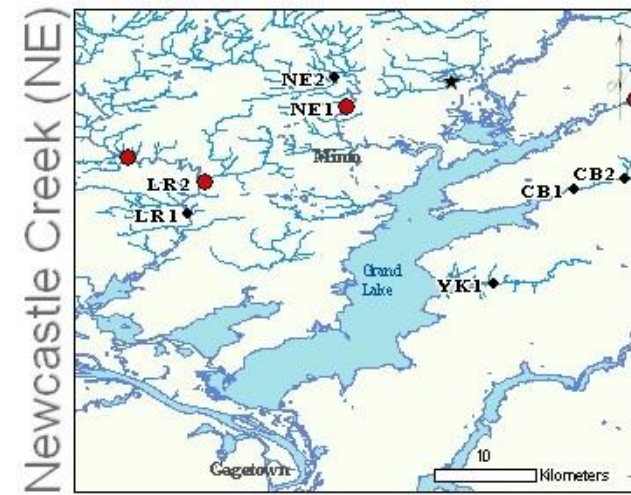


Nashwaaksis (NA)



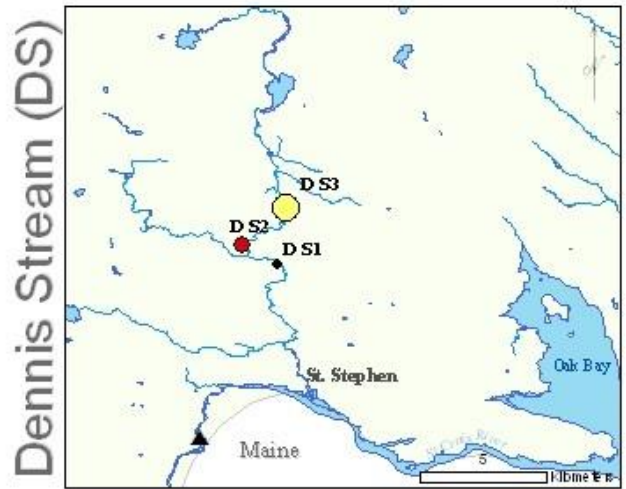
Salmon Density ◆ 0.0 ● 0.1 - 5.0 ● 5.1 - 10.0 ● 10.1 - 15.0 ● 15.1 - 45.0

Figure 5a: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the tributaries (Belleisle Creek, Burpee, Cumberland Bay, Coal Creek, Little and Nashwaaksis) downriver of Mactaquac Dam on the Saint John River, SFA 23.



Salmon Density ♦ 0.0 ● 0.1 - 5.0 ● 5.1 - 10. ● 10.1 - 15.0 ● 15.1 - 45.0

Figure 5b: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the tributaries (Newcastle Creek, Noonan Stream, Oromocto, Youngs Creek, Salmon and Nerepis) downriver of Mactaquac Dam on the Saint John River, SFA 23.



New Electrofishing Sites

Salmon Density

- 0.0
- 0.1 - 5.0
- 5.1 - 10.
- 10.1 - 15.0
- 15.1 - 45.0
- ★ NB_Falls
- ▲ NB_Dams

Figure 6: Location of the new electrofishing sites and 2009 densities of juvenile salmon in the 'other' outer Bay of Fundy rivers (Digdeguash, Dennis Stream, New, Pocologan and Waweig) of SFA 23.

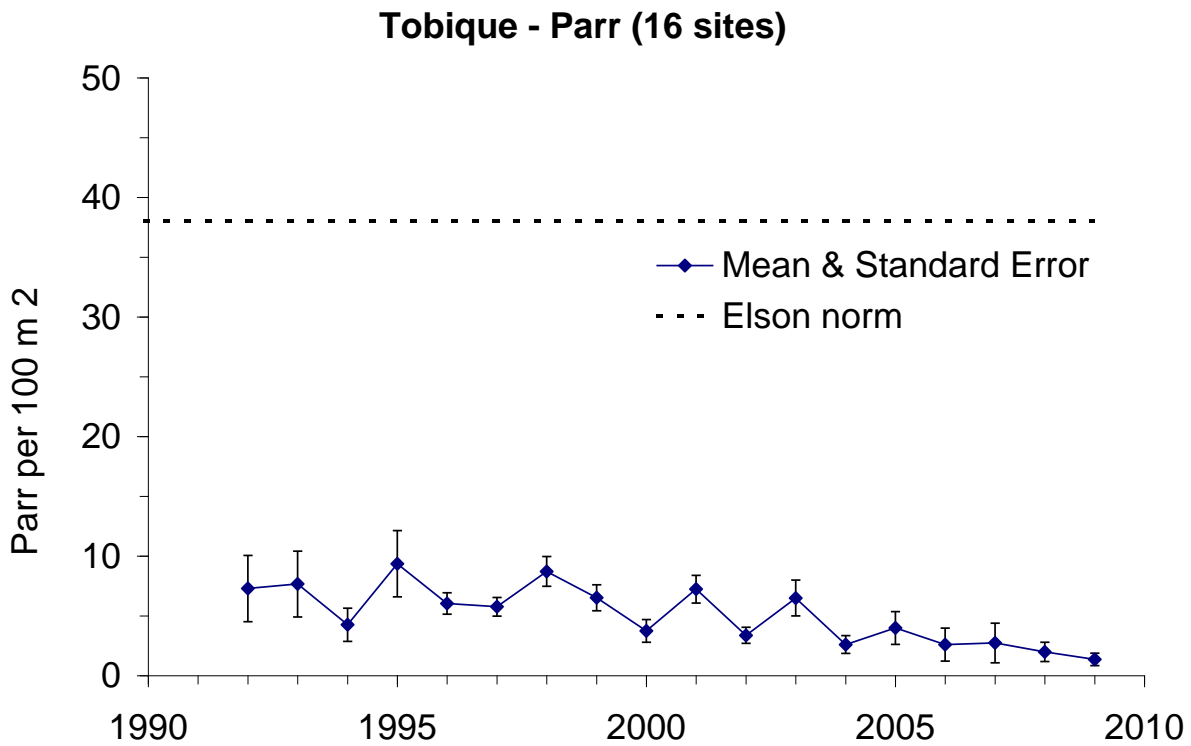
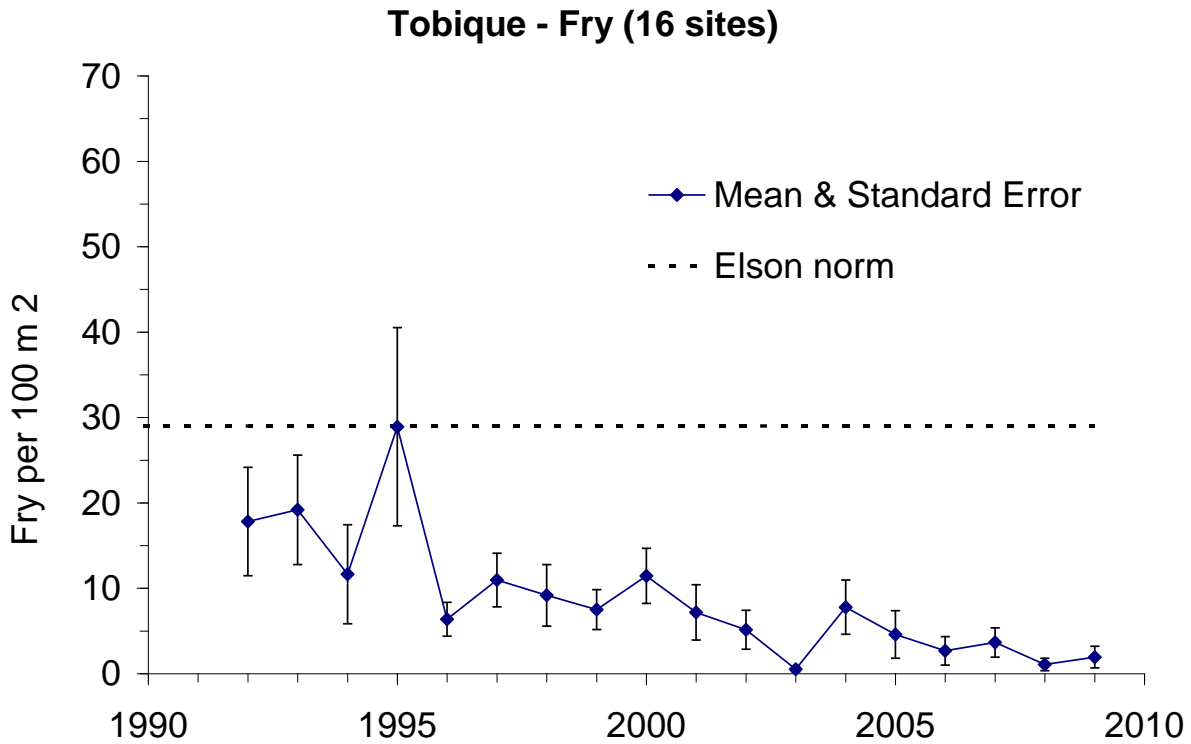


Figure 7: Mean densities of age-0 (fry) (upper panel) and age-1 and older parr (lower panel) from electrofishing index sites on the Tobique River in relation to the "Elson Norm" from 1992 to 2009.

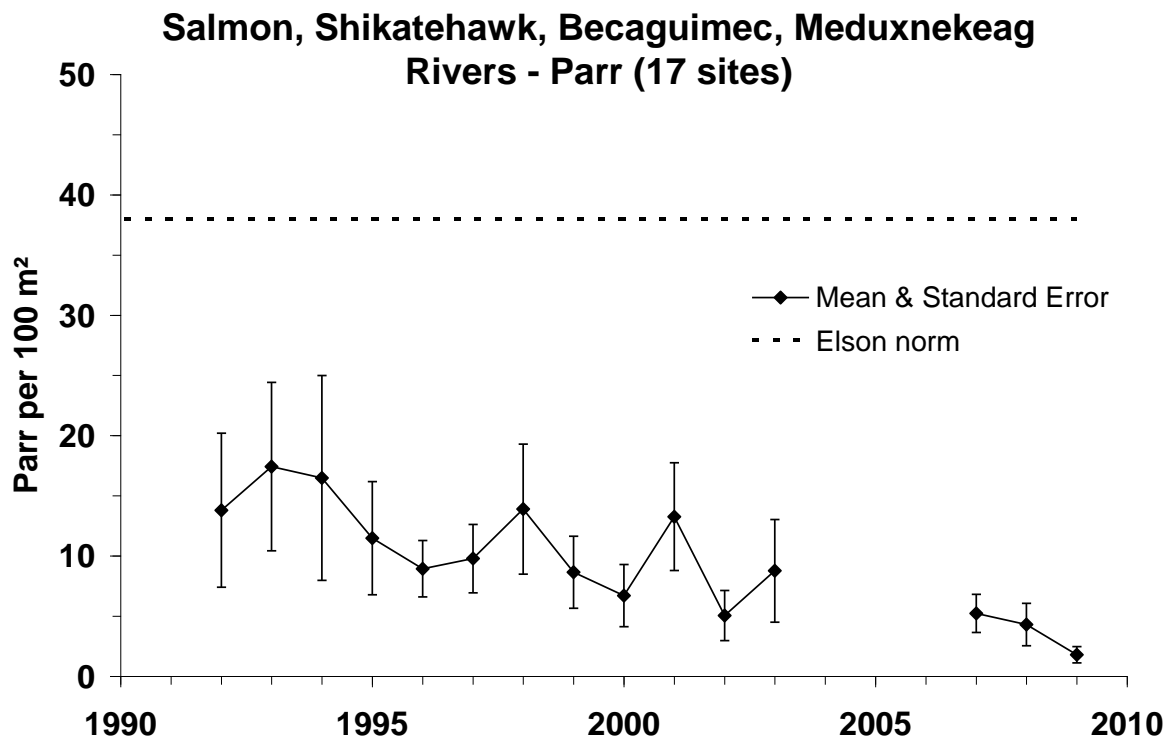
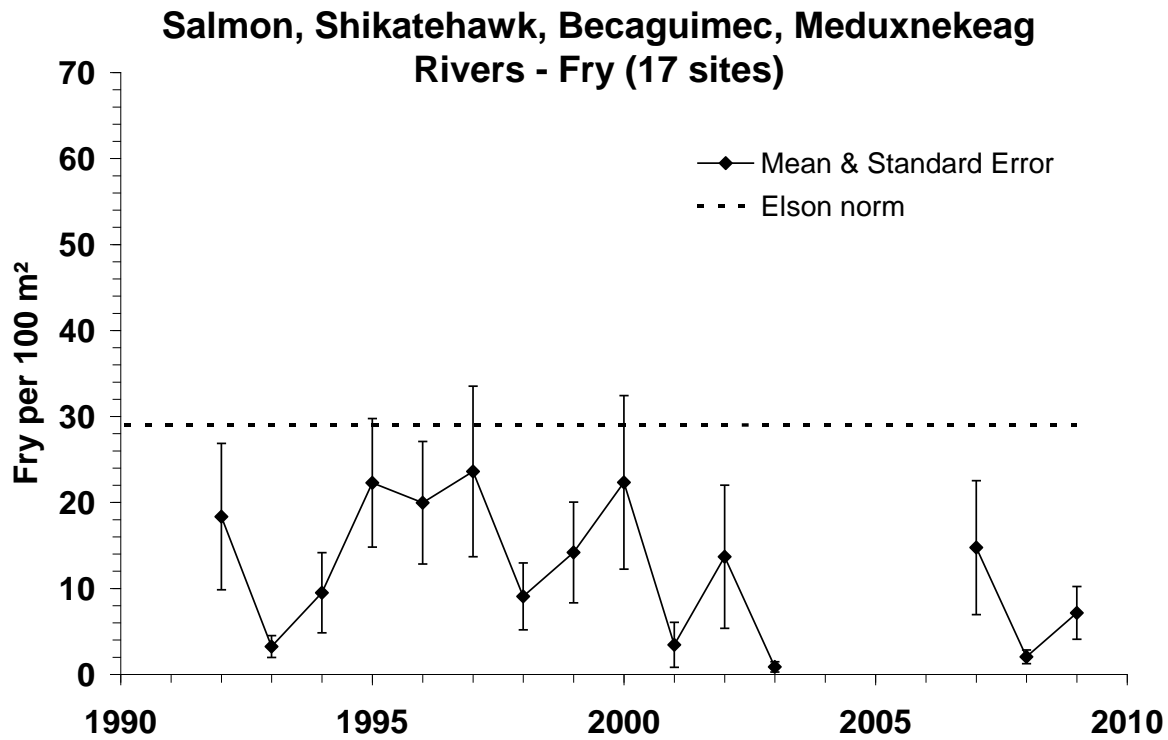


Figure 8: Mean densities of age-0 (fry) (upper panel) and age-1 and older parr (lower panel) from electrofishing index sites on the Salmon (Vic. Co.), Shikatehawk, Becaguimec, Meduxnekeag, rivers in relation to the "Elson Norm" from 1992 to 2009.

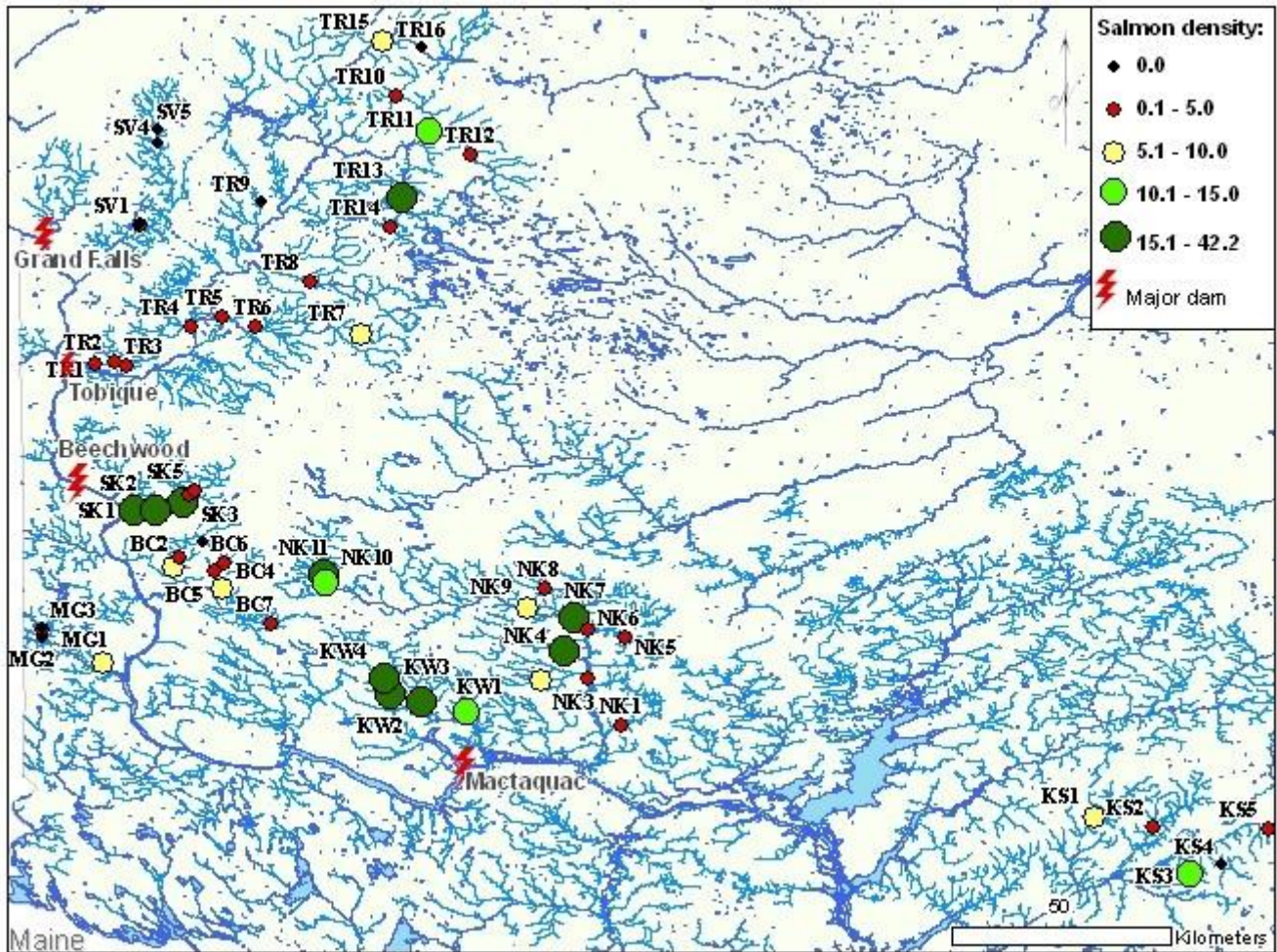


Figure 9: Densities of juvenile salmon at each of the index electrofishing sites in the Saint John River system downriver of the Grand Falls Hydroelectric Dam.

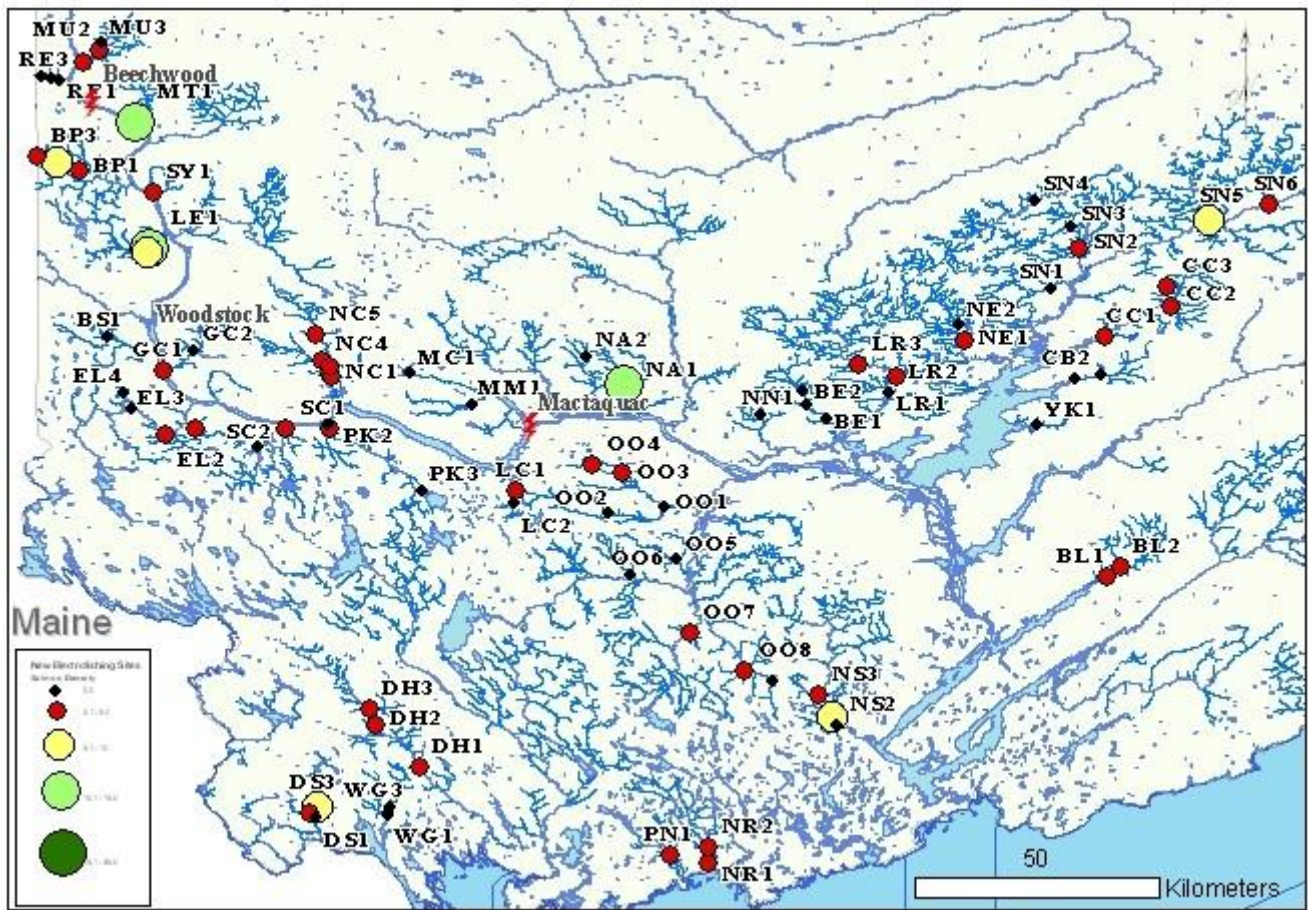


Figure 10: Densities of juvenile salmon at each of the new electrofishing sites in the Saint John River.

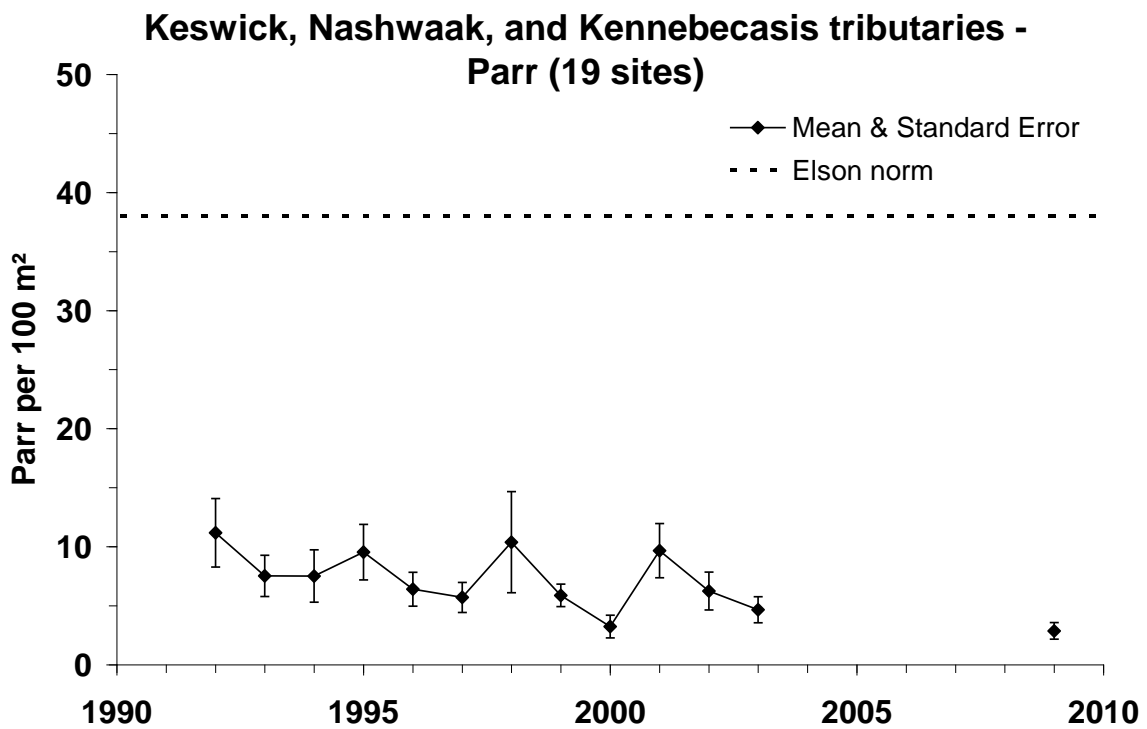
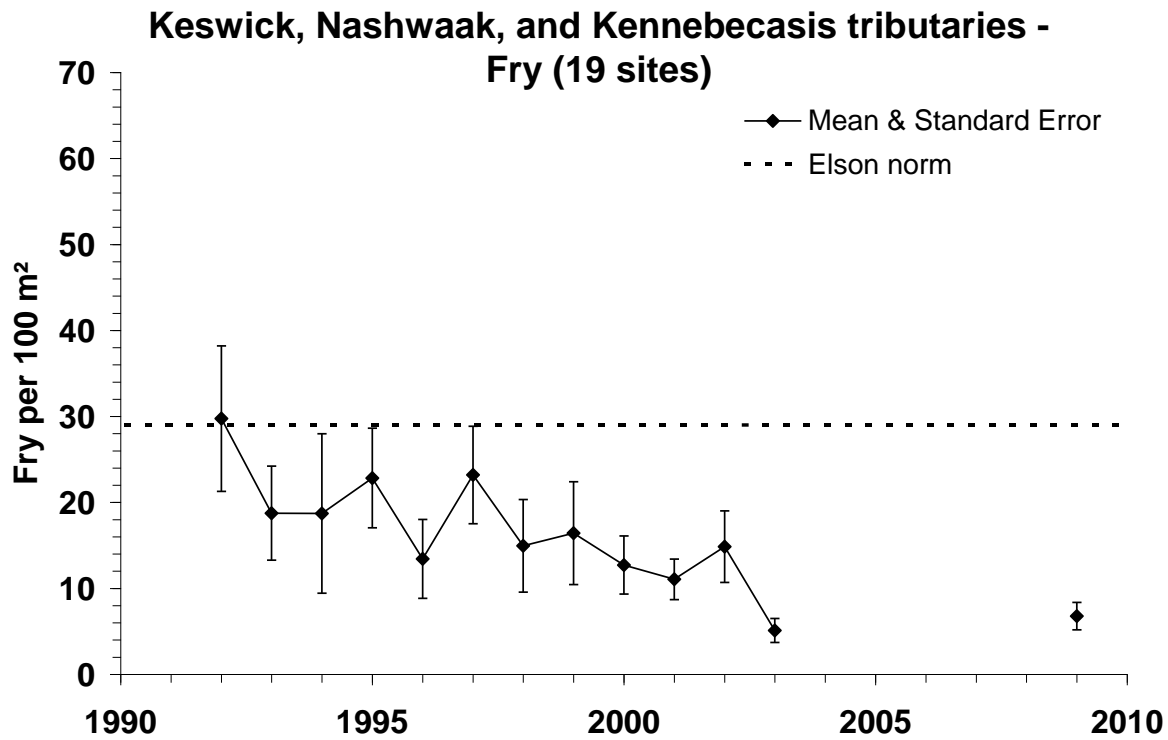


Figure 11: Mean densities of age-0 (fry) (upper panel) and age-1 and older parr (lower panel) from electrofishing index sites on the Keswick, Nashwaak, and Kennebecasis rivers in relation to the “Elson Norm” from 1992 to 2009.

APPENDIX I

List of various fish with common name and (Scientific name) captured during the electrofishing surveys within the OBoF region in 2009

Atlantic Salmon (*Salmo salar*).

American Eel (*Anguilla rostrata*)

Blacknose Dace (*Rhinichthys atratulus*)

Brook Trout (*Salvelinus fontinalis*)

Brown Bullhead (*Ameiurus nebulosus*)

Burbot (*Lota lota*)

Chain Pickerel (*Esox niger*)

Chub includes Creek chub (*Semotilus atromaculatus*), Fallfish (*Semotilus corporalis*) and Lake chub (*Couesius plumbeus*)

Pumkinseed Sunfish (*Lepomis gibbosus*)

Rainbow Trout (*Oncorhynchus mykiss*)

Shiner includes Common Shiner (*Notropis conutus*) and Golden Shiner (*Notemigonus crysoleucas*)

Slimy Sculpin (*Cottus cognatus*)

Smallmouth Bass (*Micropterus dolomieu*)

Sticklebacks were not identified to species but mainly Threespine stickleback (*Gasterosteus aculeatus*)

Suckers includes both species of White Sucker (*Catostomus commersonii*) and Longnose Sucker (*Catostomus catostomus*)

Yellow Perch (*Perca flavescens*)

APPENDIX II

Description and location of the new electrofishing sites surveyed in 2009 within the OBoF region

UPRIVER OF MACTAQUAC DAM

Tributary: Big Presque Isle **Name of site:** Big Presque Isle 1

Site Number: BP1

Latitude/Longitude: N46.42361 / W067.70418

Direction and description of location: The site is located on the main stem of the Big Presque Isle River and flows into the Saint John River 5 km south of Florenceville. To get to the site from the old Trans-Canada Highway, take route 110 into Centerville. Turn south onto route 560. After the first bridge, turn on to Charleston Road. Drive 0.4 km. Site is opposite of house #40, below the park bench overlooking the river.

Tributary: Big Presque Isle **Name of site:** Big Presque Isle 2

Site Number: BP2

Latitude/Longitude: N46.43912 / W067.74533

Direction and description of location: The site is located on the main stem of the Big Presque Isle River and flows into the Saint John River 5 km south of Florenceville. To get to the site, by route 110, go through Centerville towards Tracey Mills for 6.4 km after Home Hardware intersection. Turn left and site will be below DOT bridge P850.

Tributary: Big Presque Isle **Name of site:** Big Presque Isle 3

Site Number: BP3

Latitude/Longitude: N46.44916 / W067.77993

Direction and description of location: The site is located on the main stem of the Big Presque Isle River and flows into the Saint John River 5 km south of Florenceville. To get to the site, from site *Big Presque Isle 2*, go back on route 110 west. Drive 3.5 km towards United States border. Walk down trail opposite of house # 1420. Lower barrier is flagged.

Tributary: Bulls Creek **Name of site:** Bulls Creek 1

Site Number: BS1

Latitude/Longitude: N46.11720 / W067.65097

Direction and description of location: The site is located on the main stem of the Bulls Creek that flows into the Saint John River approximately 5 km south of Woodstock. To get to the site from new Trans-Canada Highway, take exit 191. Go pass Murray's Irving on Beardsley Road. Turn left at stop sign. Continue on Beardsley for 3.1 km to DOT bridge L315. The upper barrier is the downstream side of the bridge.

Tributary: Eel River **Name of site:** Eel River 1
Site Number: EL1
Latitude/Longitude: N45.94741 / W067.48966

Direction and description of location: The site is located on a tributary of the main stem that flows into the Saint John River approximately 15 km south of Woodstock. To get to the site, from the new Trans-Canada Highway, take exit 212 for Canterbury/Meductic. Turn for Canterbury on route 122 west. Proceed for 3.1 km and turn left onto Creek Road. After 1.2 km, stop at bridge. Site is downstream.

Tributary: Eel River **Name of site:** Eel River 2
Site Number: EL2
Latitude/Longitude: N45.93735 / W067.54682

Direction and description of location: The site is located on the main stem of Eel River that flows into the Saint John River approximately 15 km south of Woodstock. To get to the site, drive 6.8 km past Creek Road on route 122 west to turn onto Mill Street. Drive 2.3 km on Mill and turn left at the big yellow sign. Keep going for 0.3 km and turn right on Scott Siding Road. Drive 6.2 km to turn right, and drive another 0.5 km. Turn right at Dickinson Road (civic address #5). Go 1 km to camp #89 on Porter Road. A trail goes down to river. Rocks painted for lower barrier.

Tributary: Eel River **Name of site:** Eel River 3
Site Number: EL3
Latitude/Longitude: N45.98624 / W067.60937

Direction and description of location: The site is located on the main stem of Eel River, that flows into the Saint John River approximately 15 km south of Woodstock. To get to the site, leaving site *Eel River 2*, drive towards Benton. After 1.3 km turn right towards Benton. After 10.1 km you should be near the Benton Bridge. After the bridge turn right down to house #837 or next one. Site is across property out from 2 wooden chairs on shore from white house. In 2009 high water level and current was a concern, so this site is not recommended for electrofishing.

Tributary: Eel River **Name of site:** Eel River 4
Site Number: EL4
Latitude/Longitude: N46.01553 / W067.62281

Direction and description of location: The site is located on a tributary of the main stem above a passable dam. The Eel River flows into the Saint John River approximately 15 km south of Woodstock. To get to the site, follow down Benton Road north-east and turn left onto Caldwell Road (Paradise Hunting Lodge sign). Continue for 3 km to DOT bridge P240. Lower barrier is at bridge.

Tributary: Gibson Creek **Name of site:** Lower
Site Number: GC1
Latitude/Longitude: N46.05671 / W067.55002

Direction and description of location: The site is located on the main stem of the Gibson Creek that flows into the Saint John River approximately 10 km south of Woodstock. To get to the site, from route 105 south in Grafton, drive 15.5 km to Gibson Creek bridge #G200. The upper limit of site is 13.8 m above bridge abutment.

Tributary: Gibson Creek **Name of site:** Upper
Site Number: GC2
Latitude/Longitude: N46.09180 / W067.49167

Direction and description of location: The site is located above the Cub Camp Falls and the Gibson falls (both are impassable falls) on the main stem of the Gibson Creek. The Gibson Creek flows into the Saint John River approximately 10 km south of Woodstock. The site is accessible on route 105, 1.9 km south from Woodstock bridge, by turning left onto Kilmarnock Road. Continue on for 9.4 km to DOT bridge G205. Lower barrier of the site is 5 m below bridge.

Tributary: Little Presque Isle **Name of site:** Little Presque Isle 1
Site Number: LE1
Latitude/Longitude: N46.28017 / W067.57357

Direction and description of location: The site is located on the main stem of the Little Presque Isle and flows into the Saint John River approximately 2 km north of Hartland. To get to the site, from route 103 (old Trans-Canada Highway) in Waterville, take Raymond Road. Drive to gated road behind new hospital.

Tributary: Little Presque Isle **Name of site:** Little Presque Isle 2
Site Number: LE2
Latitude/Longitude: N46.27263 / W067.57715

Direction and description of location: The site is located on the main stem of the Little Presque Isle below an old passable dam and flows into the Saint John River approximately 2 km north of Hartland. To get to the site, from route 103 (old Trans-Canada Highway) in Waterville, take Waterville Road (loop) onto Stockford Road. Near house #55 stop at first DOT bridge L500. An old dam should be on the left. The upper barrier of site is below bridge.

Tributary: Longs Creek **Name of site:** Longs Creek 1
Site Number: LC1
Latitude/Longitude: N45.83472 / W066.89838

Direction and description of location: The site is located on the South Branch Longs Creek that flows into the Mactaquac Lake of the Saint John River, approximately 3 km upstream of Kingsclear. To get to the site, from the new Trans-Canada Highway, take route 5 at weigh scales. From overpass, drive 4.3 km and turn left onto Mountain Road. Continue for 2.2 km, past farm with red buildings and stop at DOT bridge L805. Site is downstream of bridge.

Tributary: Longs Creek **Name of site:** Longs Creek 2
Site Number: LC2
Latitude/Longitude: N45.80987 / W066.90254

Direction and description of location: The site is located on the South Branch Longs Creek that flows into the Mactaquac Lake of the Saint John River, approximately 3 km upriver of Kingsclear. To get to the site, drive 5.7 km on route 3 from Trans-Canada Highway overpass (or 1.3 km past Mountain Road). Then, turn left onto Pig Road and drive for 0.4 km to DOT bridge L810. Site is downstream of bridge.

Tributary: Mactaquac **Name of site:** Mactaquac 2
Site Number: MC1
Latitude/Longitude: N46.04996 / W067.09381

Direction and description of location: The site is located on the main stem of the Mactaquac Stream that flows into the Mactaquac Stream Basin and joins to the Saint John River near the village of Mactaquac. To get to the site, get on route 615. After 9.2 km past Mill Stream 1 site (MM1), turn left onto Wiggins Mill Road and drive 1.6 km. It will bring you to DOT bridge M036. The upper barrier is flagged 10 m upstream.

Tributary: Mill Stream **Name of site:** Mill Stream
Site Number: MM1
Latitude/Longitude: N45.99327 / W066.98142

Direction and description of location: The site is located on the main stem of the Mill Stream that flows into the Mactaquac Stream Basin and joins to the Saint John River near the village of Mactaquac. To get to the site, get on route 105 towards Mactaquac Park. Turn onto route 615 beside gas/convenience store past the marina. Continue to DOT bridge S575. Site is 15 m upstream of bridge. Lower barrier is flagged.

Tributary: Monquart **Name of site:** Monquart
Site Number: MT1
Latitude/Longitude: N46.51417 / W067.60068

Direction and description of location: The site is located on the main stem of Monquart Stream, almost at the confluence with the Saint John River, downstream of an impassable private hydroelectric dam. The Monquart stream flows into the Saint John River approximately 5 km downstream of the Beechwood Dam. To get to the site, get on route 105 and drive to DOT bridge M578 in Bath. Site is upstream of bridge.

Tributary: Muniac **Name of site:** Muniac 1
Site Number: MU1
Latitude/Longitude: N46.62299 / W067.69606

Direction and description of location: The site is located on the main stem of the Muniac Stream that flows into the Saint John River approximately 10 km upstream of the Beechwood Dam. To get to the site, from route 105 in Muniac, take Muniac Road. Site is 0.6 km from intersection with route 105. Orange flagging tape is along road side under a power line. Lower barrier is flagged.

Tributary: Muniac **Name of site:** Muniac 2
Site Number: MU2
Latitude/Longitude: N46.64791 / W067.66883

Direction and description of location: The site is located on the main stem of the Muniac Stream that flows into the Saint John River approximately 10 km upstream of the Beechwood Dam. To get to the site, from route 105 in Muniac take Muniac Road. Site is 4.5 km from intersection with route 105. Follow road direction for Kintore. Flagging tape is beside the road. The lower barrier is also flagged.

Tributary: Muniac **Name of site:** Muniac 3
Site Number: MU3
Latitude/Longitude: N46.65926 / W067.66212

Direction and description of location: The site is located on the main stem of the Muniac Stream that flows into the Saint John River approximately 10 km upstream of the Beechwood Dam. To get to the site, from route 105 in Muniac, take Muniac Road. Follow road for Kintore. Turn onto gravel road 1.4 km further of site MU2 or 0.3 km past house #1931. Site is downstream of bridge. Upper barrier is flagged.

Tributary: Nackawic **Name of site:** East 1
Site Number: NC1
Latitude/Longitude: N46.04498 / W067.23901

Direction and description of location: The site is located on the East Branch Nackawic Stream downstream of railway bridge and decommissioned impassable concrete dam (Pinder Dam). The Nackawic Stream flows into the Saint John River, near Nackawic. The site can be found near Pinder, on route 605, 15 m downstream of a bridge built in 2005. The upper barrier is flagged.

Tributary: Nackawic **Name of site:** Main 1
Site Number: NC2
Latitude/Longitude: N46.04668 / W067.24290

Direction and description of location: The site is located on the main stem of the Nackawic Stream that flows into the Saint John River, near Nackawic. The site is accessible from route 605 in Nackawic, by turning onto route 595 in Pinder. Cross DOT bridge N010. Site is below bridge and is not flagged. Site was kept on true right bank where riffle begins.

Tributary: Nackawic **Name of site:** Cross road
Site Number: NC3
Latitude/Longitude: N46.06302 / W067.24193

Direction and description of location: The site is located on the main stem of the Nackawic Stream that flows into the Saint John River, near Nackawic. The site is accessible from route 605 in Nackawic by turning left on Cross Road. Drive up to DOT bridge N015. Site is downstream of bridge approximately 85 m. Access is possible on east side of bridge by following mowed lane in field to orange flagging tape. Upper barrier is flagged.

Tributary: Nackawic **Name of site:** West 2
Site Number: NC4
Latitude/Longitude: N46.07371 / W067.25589

Direction and description of location: The site is located on the West Branch Nackawic Stream that flows into the Saint John River, near Nackawic. The site is accessible by route 595-west and driving 3.1 km past *Nackawic- Main 1* to DOT bridge N690. Site is upstream of bridge. The lower barrier is marked.

Tributary: Nackawic **Name of site:** Main 2
Site Number: NC5
Latitude/Longitude: N46.12005 / W067.26888

Direction and description of location: The site is located on the main stem of the Nackawic Stream that flows into the Saint John River, near Nackawic. The site is accessible by driving 9.2 km past Nackawic-west 2 (NC4) on Northdale Road which lead to route 585 DOT bridge N020. Take access road after bridge on right. Drive down to end of road. Lower barrier is out from rock wall.

Tributary: Pokiok **Name of site:** Pokiok 1
Site Number: PK1
Latitude/Longitude: N45.95586 / W067.24409

Direction and description of location: The site is located on the main stem of the Pokiok Stream and flows into the Saint John River approximately 5 km upstream of Nackawic. The site is accessible by the new Trans-Canada Highway taking exit 231. Down the exit ramp, cross over to the Pokiok Stream. The site is above bridge. In 2009, water flow in proposed site was swift.

Tributary: Pokiok **Name of site:** Pokiok 1A (2)
Site Number: PK2
Latitude/Longitude: N45.94781 / W067.24082

Direction and description of location: The site is located on the main stem of the Pokiok Stream and flows into the Saint John River, approximately 5 km upstream of Nackawic. The site is accessible by the new Trans-Canada Highway by taking exit 231. Down the exit ramp, you will cross over the Pokiok Stream. After bridge turn right onto Haul Road. Drive 1.1 km to stop under the new Trans-Canada Highway. Walk along deer fencing on right down to river. Site is below north bound of divided highway. Lower barrier is flagged.

Tributary: Pokiok **Name of site:** Pokiok 3
Site Number: PK3
Latitude/Longitude: N45.83476 / W067.07314

Direction and description of location: The site is located high on the main stem of the Pokiok Stream and flows into the Saint John River, approximately 5 km upstream of Nackawic. The site is accessible by taking exit 253 of the new Trans-Canada Highway at Kings Landing. Drive 6.4 km towards Lake George and stop at DOT bridge P620. The upper barrier is the bridge.

Tributary: River de Chute **Name of site:** 1
Site Number: RE1
Latitude/Longitude: N46.59222 / W067.74155

Direction and description of location: The site is located on the main stem of River de Chute that flows into the Saint John River approximately 8 km above the Beechwood Dam. The site is accessible from route 103 (old Trans-Canada Highway), by taking exit for route 560 for Upper Knoxford and drive for 1.4 km. Stop below highway north bridge (the first). Site is below bridge steep rocks.

Tributary: River de Chute **Name of site:** 2
Site Number: RE2
Latitude/Longitude: N46.59578 / W067.75718

Direction and description of location: The site is located on the River de Chute that flows into the Saint John River approximately 8 km above the Beechwood Dam. The site is accessible from route 103 (old Trans-Canada Highway), by taking exit for route 560 for Upper Knoxford and drive up to intersection of Upper Knoxford and Browning Road. Then, turn right onto Browning and drive for 100 m. Site is 50 m below DOT bridge R345 near house #385.

Tributary: River de Chute **Name of site:** 3
Site Number: RE3
Latitude/Longitude: N46.59754 / W067.77455

Direction and description of location: The site is located on the River de Chute that flows into the Saint John River approximately 8 km above the Beechwood Dam. The site is accessible from route 103 (old Trans-Canada Highway), by taking exit for route 560 for Upper Knoxford and drive 0.6 km past the intersection of Upper Knoxford and Browning Road and turn onto Smugglers Road. On Smugglers Road, drive 1.1 km to get to site on the left. The lower barrier is flagged.

Tributary: Shogomoc **Name of site:** 1
Site Number: SC1
Latitude/Longitude: N45.94884 / W067.32249

Direction and description of location: The site is located on the main Shogomoc Stream that flows into the Mactaquac Lake of the Saint John River approximately 8 km west (upriver) of Nackawic. The site is accessible by driving east on the new Trans-Canada Highway and stopping on the overpass of the Shogomoc Stream. The upper limit of the site is 18 m from the DOT bridge.

Tributary: Shogomoc **Name of site:** 2 (West branch)
Site Number: SC2
Latitude/Longitude: N45.91286 / W067.37375

Direction and description of location: The site is located on the West Branch of the Shogomoc Stream that flows into the Mactaquac Lake of the Saint John River approximately 8 km west (upriver) of Nackawic. The site is accessible by taking exit 223 of new Trans-Canada Highway and go west on Charlie Lake Road for 5.7 km. A lake will be visible but continue on private road past house #558 to a bridge. Site is downstream of bridge. The upper barrier is a boulder on left. Site starts below a deep hole.

Tributary: Stickney **Name of site:** Old mill
Site Number: SY1
Latitude/Longitude: N46.38454 / W067.56904

Direction and description of location: The site is located on the main stem of Stickney Brook that flows into the Saint John River approximately 10 km upstream of Hartland. The site is accessible by route 105 and is just upstream of the bridge crossing Stickney Brook. An impassable dam (Stickney Dam) is located upstream of the site.

DOWNRIVER OF MACTAQUAC DAM

Tributary: Burpee Millstream **Name of site:** Burpee 1
Site Number: BE1
Latitude/Longitude: N45.96552 / W066.32489

Direction and description of location: The site is located on the main stem of Burpee Millstream that flows into the Indian Lake, French Lake, Macquapit Lake and the Back Lake of Grand Lake to join the Saint John River, via the Jemseg River. The site is accessible from route 10 by turning onto Grub Road (on right from Fredericton). Drive 4.5 km and turn left. Drive 0.4 km on Fernmount Road. Stop at DOT bridge B852. Site is 30 m upstream of bridge. Lower Barrier is flagged.

Tributary: BurpeeMillstream **Name of site:** Burpee 2
Site Number: BE2
Latitude/Longitude: N45.99032 / W066.36256

Direction and description of location: The site is located on the main stem of Burpee Millstream that flows into the Indian Lake, French Lake, Macquapit Lake and the Back Lake of Grand Lake to join the Saint John River, via the Jemseg River. The site is accessible from route 10. Site is below DOT bridge B855 that goes over Burpee Millstream, near Acadia Research forest sign. Site is 25 m downstream of bridge using left channel. The upper barrier is flagged.

Tributary: BurpeeMillstream **Name of site:** Burpee 3
Site Number: BE3
Latitude/Longitude: N46.01958 / W066.36956

Tributary: Coal Creek **Name of site:** Dufferin
Site Number: CC1
Latitude/Longitude: N46.11877 / W065.81060

Direction and description of location: The site is located on the main stem of Coal Creek that flows into the Northeast Arm of Grand Lake. The Grand Lake reaches the Saint John River via the Jemseg River. To get to the site, using route 10, turn right in the town of Chipman on Riverfront Dr and turn left on Dufferin road for 8.2 km. Lower barrier of site starts 40 m above River Ford on true right bank.

Tributary: Coal Creek **Name of site:** South Branch
Site Number: CC2
Latitude/Longitude: N46.17491 / W065.68918

Direction and description of location: The site is located on the South Branch Coal Creek, a tributary of Coal Creek that flows into the Northeast Arm of the Grand Lake and into the Saint John River via the Jemseg River. To get to the site, by route 10 from town of Chipman T intersection, drive 10.1 km south. After crossing Coal Creek, turn left on Avon Road for 14.3 km through Wannamaker Ridge. Turn left at junction and proceed for 5.4 km (19.7 km in from route 10). On a four wheeler (preferably-not accessible with truck), drive 1.5 km into the right.

Tributary: Coal Creek **Name of site:** Bronson gravel pit
Site Number: CC3
Latitude/Longitude: N46.21197 / W065.69796

Direction and description of location: The site is located on a tributary of Coal Creek and flows to the Northeast Arm of the Grand Lake and into the Saint John River via the Jemseg River. To get to the site, from the town of Chipman, get on Bronson Siding Road (chip sealed). When road meets railway track, continue 5.6 km on dirt road straight ahead. Take the four-wheeler trail (not accessible with truck) to your right for 2 km. Take the path located to your left and go for 100 m. Site starts 8 m below lower edge of path.

Tributary: Little River **Name of site:** Little River 1
Site Number: LR1
Latitude/Longitude: N46.01598 / W066.21223

Direction and description of location: The site is located on the main stem of the Little River that flows into Indian Lake attached to the French Lake, Macquapit Lake and the Back Lake of Grand Lake and into the Saint John River, via the Jemseg River. To get to the site, get on Route 10 near Albrights Corner, stop at DOT bridge L555. Site is downstream of bridge below old abutment. The upper barrier is flagged at 3 m from head of Island LHS (true). Use the access road on the right when coming from Fredericton.

Tributary: Little River **Name of site:** Little River 2
Site Number: LR2
Latitude/Longitude: N46.04487 / W066.19722

Direction and description of location: The site is located on Eighteen Brook, a tributary of the main Little River that flows into Indian Lake attached to the French Lake, Macquapit Lake and the Back Lake of Grand Lake and into the Saint John River, via the Jemseg River. To get to the site, get on Route 10 near Albrights Corner. Turn north onto road 18 and drive for 2.5 km to DOT bridge E510. Site is approximately 60 m upstream of bridge.

Tributary: Little River **Name of site:** Little River 3
Site Number: LR3
Latitude/Longitude: N46.06709 / W066.26553

Direction and description of location: The site is located on the main stem of the Little River that flows into the Indian Lake attached to the French Lake, Macquapit Lake and the Back Lake of Grand Lake and to the Saint John River, via the Jemseg River. To get to the site, get on route 10 near Albrights Corner, turn north onto Route 18. Drive for 6.4 km and turn left. Drive for 4 km past Maston's Camps (down path wash out on road). Site is across from green camp with silver roof. There will be an unnamed brook on true left. Lower limit of site is lone maple tree on true right bank.

Tributary: Nashwaaksis **Name of site:** Estay Bridge
Site Number: NA1
Latitude/Longitude: N46.02730 / W066.69919

Direction and description of location: The site is located on the North Branch of the Nashwaaksis Stream that flows into the Saint John River in Fredericton. To get to the site from Fredericton, take Route 105 north and turn onto Route 620 (Royal Road). Drive 6.0 km to rock/cement bridge, immediately past Mcleod Hill. The site is upstream of bridge.

Tributary: Nashwaaksis **Name of site:** Kingsley road
Site Number: NA2
Latitude/Longitude: N46.08059 / W066.76832

Direction and description of location: The site is located on the West Branch of the Nashwaaksis Stream that flows into the Saint John River in Fredericton. To get to the site, from Fredericton take Route 105 north and turn onto Route 620 for Royal Road. Drive 6.0 km to rock/cement bridge immediately after bridge turn left on Kingsley Road and drive for 8.8 km until civic address 899 on private road Hoyt's Lane on left. Near mailboxes on right, take access trail down to stream until a bridge is crossed. The site is upstream/downstream of bridge.

Tributary: Newcastle Creek **Name of site:** Newcastle Creek 1
Site Number: NE1
Latitude/Longitude: N46.11205 / W064.06957

Direction and description of location: The site is located on the main stem of Newcastle Creek that flows into Grand Lake and reaches the Saint John River via the Jemseg River. To get to the site from

the village of Minto, take the North side drive Industrial Park going north toward upper Jemseg Bridge. Cross the DOT bridge N280 and find an access road upstream of bridge and a playground downstream. Follow walking trail. After the set of stairs turn left to river. Lower barrier is at end of trail.

Tributary: Newcastle Creek **Name of site:** Newcastle Creek 2

Site Number: NE2

Latitude/Longitude: N46.13853 / W065.08144

Direction and description of location: The site is located on the main stem of the Newcastle Creek that flows into Grand Lake and reaches the Saint John River via the Jemseg River. To get to the site from the village of Minto, follow the North side drive Industrial Park going north towards upper Jemseg Bridge. Turn left at bridge onto Tracy Road for 3.2 km until DOT bridge N285 is cross. Site is 25 m downstream of bridge.

Tributary: Noonan Stream **Name of site:** Noonan 1

Site Number: NN1

Latitude/Longitude: N45.97499 / W066.62411

Direction and description of location: The site is located on Noonan Stream, a tributary of the Portobello Stream. The Portobello Stream flows into the French Lake, Macquapit Lake and the Back Lake of Grand Lake to join the Saint John River, via the Jemseg River. The site is accessible by Route 10 near Noonan. Upper barrier is 5 m downstream of DOT bridge N345 on Route 10.

Tributary: Nerepis **Name of site:** Grand Bay

Site Number: NS1

Latitude/Longitude: N45.39925 / W066.30678

Direction and description of location: The site is located on an unnamed tributary of the Nerepis River. The Nerepis River flows into the Saint John River approximately 8 km upriver of Grand Bay (north of Westfield). To get to the site, from route 7, take exit 71 for Grand Bay / Westfield. Drive 0.3 km to bridge. Site is 10 m upstream of bridge.

Tributary: Nerepis **Name of site:** King County Line

Site Number: NS2

Latitude/Longitude: N45.41520 / W066.31556

Direction and description of location: The site is located on an unnamed tributary of the Nerepis River that flows into the Saint John River approximately 8 km upriver of Grand Bay (north of Westfield). To get to the site, from Route 7, drive 4.9 km south of the *Welsford Irving*. Near civic house 1149 and King County Line the road crosses over a bridge. The upper barrier of site is downstream of bridge.

Tributary: Nerepis **Name of site:** Welsford Irving
Site Number: NS3
Latitude/Longitude: N45.45482 / W066.34007

Direction and description of location: The site is located on Douglas Valley Brook, a tributary of the Nerepis River that flows into the Saint John River approximately 8 km upriver of Grand Bay (north of Westfield). The site is few meters after the brook confluence with the Nerepis River. To get to the site, from Route 7 get to the *Welsford Irving Gas Station*. The DOT bridge number P100 is on the right. The site is 50 m downstream of the bridge. There is an access trail on true left downstream of bridge.

Tributary: Oromocto **Name of site:** Rusagonis 1
Site Number: OO1
Latitude/Longitude: N45.80197 / W066.62411

Direction and description of location: The site is located on the main Rusagonis Stream, a tributary of the main Oromocto River that flows into the Saint John River near Oromocto. The site is accessible by Route 101 in New Maryland or by the Route 655 in Oromocto, going toward Rusagonis. At intersection of Whittaker and Rusagonis Road cross the DOT bridge S608 which is near the covered bridge. Site is 150 m downstream. Orange rock and flagging tape is the lower barrier.

Tributary: Oromocto **Name of site:** Rusagonis 4
Site Number: OO2
Latitude/Longitude: N45.79088 / W066.72697

Direction and description of location: The site is located on the Hazen Brook, a tributary of the South Branch Rusagonis Stream which is a tributary of the main Oromocto River that flows into the Saint John River near Oromocto. The site is accessible by the Regent Street in Fredericton, driving south on Route 101 from RCMP station, and turning right onto O'Leary Road. Drive 2.8 km to bridge. Site is 15 m upstream of bridge. Lower barrier is flagged.

Tributary: Oromocto **Name of site:** Rusagonis 2
Site Number: OO3
Latitude/Longitude: N45.86828 / W066.7012

Direction and description of location: The site is located on the North Branch Rusagonis Stream, a tributary of the main Oromocto River that flows into the Saint John River near Oromocto. The site is accessible by the Regent Street in Fredericton, driving 6.9 km south on Route 101 from RCMP station. Stay on Charters Settlement Road for 1 km to DOT bridge N565 near civic house #190. Lower barrier is 15 m below bridge.

Tributary: Oromocto **Name of site:** Rusagonis 3
Site Number: OO4
Latitude/Longitude: N45.88188 / W066.75626

Direction and description of location: The site is located on the North Branch Rusagonis Stream, a tributary of the main Oromocto River that flows into the Saint John River near Oromocto. The site is accessible by route 640 (Hanwell Road), 0.4 km past the *Scholten's Esso* (or 6.5 km from intersection

with Prospect Street in Fredericton), turn left onto Milkyway (in Starlite Subdivision) continue to Tucana drive, and follow Tucana to new road. Site is 20 m downstream of bridge. The upper barrier is flagged.

Tributary: Oromocto **Name of site:** 1- Wilsey Road

Site Number: OO5

Latitude/Longitude: N45.70632 / W066.60385

Direction and description of location: The site is located on Three Tree Creek, a tributary of the main Oromocto River that flows into the Saint John River, near Oromocto. The site is accessible by route 101 in Fredericton Junction and turning onto Wilsey Road. Drive for 5 km to DOT bridge T355. An access road is after the bridge on the right side. A trail is flagged. The site is 30 m downstream of bridge. The upper barrier is flagged.

Tributary: Oromocto **Name of site:** 2- Porcupine

Site Number: OO6

Latitude/Longitude: N45.67816 / W066.68847

Direction and description of location: The site is located on Spring Brook a tributary of the North Branch of the Oromocto River that flows into the Saint John River near Oromocto. The site can be reach by Route 101 toward Tracy. In Tracy take Route 645 "Rooth Road" at *Wilson Gas Station*. Drive 0.5 km to access path beside bridge. Site is 15 m upstream of bridge.

Tributary: Oromocto **Name of site:** 3- Mill road

Site Number: OO7

Latitude/Longitude: N45.57261 / W066.57872

Direction and description of location: The site is located on the South Branch of the Oromocto River that flows into the Saint John River near Oromocto. From the Horseman Road in Fredericton Junction, the site is accessible by driving 5.1 km on Route 101 south towards the village of Hoyt. At stop sign, turn right onto Mill Settlement Road and drive 2.3 km to cross covered bridge "Smyth 1912". There is an access road on right after the bridge.

Tributary: Oromocto **Name of site:** 4- Clarendon

Site Number: OO8

Latitude/Longitude: N45.50246 / W066.47630

Direction and description of location: The site is located on Clarendon Brook, a tributary of the Back Creek. Back Creek is a tributary of the South Branch of Oromocto River that flows into the Saint John River near Oromocto. The site is accessible on Route 101 at Wirral Station. A cement bridge crosses over the Clarendon Brook. Lower barrier is 51 m downstream of bridge.

Tributary: Oromocto **Name of site:** 5 - Ten

Site Number: OO9

Latitude/Longitude: N45.48081 / W066.42589

Direction and description of location: The site is located on a tributary of the Back Creek, upstream of Wirral Lake. Back Creek is a tributary of the South Branch of Oromocto River that flows into the Saint

John River near Oromocto. The site is accessible from the *Welsford Irving* on route 7, by turning onto Route 101. Keep going for 8 km to DOT bridge B027. Site is 2 m upstream of bridge.

Tributary: Salmon River **Name of site:** Salmon Creek

Site Number: SN1

Latitude/Longitude: N46.20628 / W065.91282

Direction and description of location: The site is located on Salmon Creek, a tributary of the Salmon River that flows into the Northeast Arm of the Grand Lake. The Grand Lake reaches the Saint John River via the Jemseg River near Gagetown. The site is accessible by driving 0.6 km from Chipman Bridge over the Salmon River and by turning right on Lillioet Drive. Then, drive 3.5 km and turn left on Route 116. Drive 1.4 km to bridge S051 on North Forks Road. Site starts 7 m above bridge.

Tributary: Salmon River **Name of site:** Gaspereau 1

Site Number: SN2

Latitude/Longitude: N46.28154 / W065.85908

Direction and description of location: The site is located on the Gaspereau River, a tributary of the Salmon River that flows into the Northeast Arm of the Grand Lake. The Grand Lake reaches the Saint John River via the Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10 through Chipman. In Chipman get onto Route 123 north. After Gaspereau Forks, cross the covered bridge “Burpee” and turn left. Site is upstream of bridge. Look for orange flagging tape.

Tributary: Salmon River **Name of site:** Gaspereau 2

Site Number: SN3

Latitude/Longitude: N46.32237 / W065.87326

Direction and description of location: The site is located on Pleasant stream, a tributary of the Gaspereau River that diverts in the Salmon River. The Salmon River flows in the Northeast Arm of the Grand Lake and reach the Saint John River via the Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10 through Chipman. In Chipman get onto Route 123 north. After bridge take the access road located after Girard road on right. Site starts on 3rd concrete check dam below and after culvert crossing. Below bridge flagging tape is the upper barrier.

Tributary: Salmon River **Name of site:** Gaspereau 3

Site Number: SN4

Latitude/Longitude: N46.36977 / W065.94202

Direction and description of location: The site is located on the Gaspereau River, a tributary of the Salmon River. The Salmon River flows in the Northeast Arm of the Grand Lake and reach the Saint John River via the Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10 through Chipman. In Chipman, turn onto Route 123 north, past Gaspereau Forks and drive 7.4 km above Pleasant Stream Site (SN3), past McKean Brook. The site is 90 m downstream of highway bridge. An access road can be found on the left before bridge.

Tributary: Salmon River **Name of site:** 1
Site Number: SN5
Latitude/Longitude: N46.33102 / W065.61921

Direction and description of location: The site is located on the Big Forks Stream, a tributary of the Salmon River that flows into the Northeast Arm of the Grand Lake and to the Saint John River, via the Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10 through Chipman. In Chipman, follow route 123 to get onto Route 116 east. Drive up to DOT bridge B444 located approximately 5 km after Kent county sign. Site is upstream of bridge.

Tributary: Salmon River **Name of site:** 2
Site Number: SN6
Latitude/Longitude: N46.36288 / W065.50879

Direction and description of location: The site is located on the Little Forks Stream, a tributary of the Salmon River that flows into the Northeast Arm of the Grand Lake and to the Saint John River via Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10. Past Chipman, turn onto Route 116 east beyond DOT bridge B444 for 9 km to DOT bridge L435. Site is downstream of bridge.

Tributary: Salmon River **Name of site:** 3
Site Number: SN7
Latitude/Longitude: N46.42654 / W065.37615

Direction and description of location: The site is located on the main stem of the Salmon River that flows into the Northeast Arm of the Grand Lake and to the Saint John River via the Jemseg River near Gagetown. Off Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Young Cove onto Route 10 through Chipman. Past Chipman, turn onto Route 116 east. Drive 11 km beyond DOT bridge L435 and turn right onto a four corner onto Bronson road (dirt road). Site is downstream of bridge.

Tributary: Youngs Creek **Name of site:** Youngs Creek
Site Number: YK1
Latitude/Longitude: N45.95361 / W065.93807

Direction and description of location: The site is located on the main stem of Youngs Creek that flows into the Youngs Cove of the Grand Lake and into the Saint John River via Jemseg River near Gagetown. Off the Trans-Canada Highway 2, between Fredericton and Moncton, the site is accessible by taking exit 365-Youngs Cove onto route 10. Youngs Creek is immediately the first bridge on route to Chipman. Site is downstream from bridge riffle.

OTHER RIVERS IN OUTER BAY OF FUNDY (SFA 23)

Tributary: Digdeguash **Name of site:** Rollingdam
Site Number: DH1
Latitude/Longitude: N45.32167 / W067.07617

Direction and description of location: The site is located on the main stem of the Digdeguash River that flows into the Passamaquoddy Bay approximately 10 km north-west of St-George, then into Bay of Fundy through several passages. To get to the site from the Atlantic Salmon Federation office, travel west on route 127 for 2.6 km to Ghost Road. Continue west on Ghost Road for 1 km. Travel north on route 127 for 12 km to Highway 1. Continue north on route 127 for 10.7 km to route 770. Travel east on route 770 for 3.7 km to Rollingdam Road. Continue east on 770 to covered bridge. Site ends at grassy area 89 m upstream.

Tributary: Digdeguash **Name of site:** Wyman Mills

Site Number: DH2

Latitude/Longitude: N45.40083 / W067.15931

Direction and description of location: The site is located on the main stem of the Digdeguash River that flows into the Passamaquoddy Bay approximately 10 km north-west of St-George, then into Bay of Fundy through several passages. To get to the site from the Atlantic Salmon Federation office, travel west on route 127 for 2.6 km to Ghost Road. Continue west on Ghost Road for 1 km to route 127. Travel north on Route 127 for 12 km to Highway 1. Continue north on Route 127 for 24 km to Wyman Mills Road. Travel west on Wyman Mills Road for 300 m to bridge across Digdeguash River. Site starts at tail of pool 40 m downstream from bridge. Site ends at ledge across river upstream from bridge.

Tributary: Digdeguash **Name of site:** Hwy 3

Site Number: DH3

Latitude/Longitude: N45.43722 / W067.17528

Direction and description of location: The site is located on the main stem of the Digdeguash River that flows into the Passamaquoddy Bay approximately 10 km north-west of St-George, then into Bay of Fundy through several passages. To get to the site, from the Atlantic Salmon Federation office, travel west on Route 127 for 2.6 km to Ghost Road. Continue west on Ghost Road for 1 km to Route 127. Travel north on Route 127 for 12 km to Highway 1. Travel north on Route 127 to highway 3. Travel north on highway 3 for 800 m to bridge across Digdeguash River. Site starts 125 m downstream from bridge. Site ends 56 m downstream of bridge.

Tributary: Dennis Stream **Name of site:** Valley Road

Site Number: DS1

Latitude/Longitude: N45.23958 / W067.26908

Direction and description of location: The site is located on the main stem of the Dennis Stream that flows into the St. Croix River at St. Stephen, then into the Western Channel of the Passamaquoddy Bay and reach the Bay of Fundy through passages. To get to the site from intersection with Highway 1 and Route 750, travel north on Route 750 (Valley Road) for 2.6 km to civic address #257. Travel west for 350 m to gravel pit. Stay to left and continue on woods road around south side of gravel pile for 375 m to Dennis Stream. Continue upstream for 50 m to end of road. Site is area below ford across stream.

Tributary: Dennis Stream **Name of site:** McGibbons
pit

Site Number: DS2

Latitude/Longitude: N45.23883 / W067.28725

Direction and description of location: The site is located on the main stem of the Dennis Stream that flows into the St. Croix River in St. Stephen, then into the Western Channel of the Passamaquoddy Bay and reach the Bay of Fundy through passages. To get to the site from intersection with highway 1 (St. Stephen traffic circle), travel north on Highway 3 for 3.7 km to civic address #9037. Travel east on dirt road (true gate) 350 m to bridge across Dennis Stream. Site starts under bridge and continues upstream to base of cascades.

Tributary: Dennis Stream **Name of site:** Upper site

Site Number: DS3

Latitude/Longitude: N45.25758 / W067.27500

Direction and description of location: The site is located on the main stem of the Dennis Stream that flows into the St. Croix River in St. Stephen, then into the Western Channel of the Passamaquoddy Bay and reach the Bay of Fundy through passages. To get to the site from Highway 1, travel 4.5 km north on Route 750 for 4.5 km to civic address 446. Or, from civic address 257, continue north on Valley Road for 1.9 km to civic address 446. Walk on trail on west side of road (across from 2nd driveway) approximately 10 m to Dennis Stream. Site starts at bottom of riffle / islands and ends at path.

Tributary: New River **Name of site:** Hwy 1

Site Number: NR1

Latitude/Longitude: N45.14558 / W066.54769

Direction and description of location: The site is located on the main stem of the New River and flows to Bay of Fundy in the Maces Bay area. The site is accessible by travelling east on Highway 1 to New River. You have to walk upstream approximately 400 m to riffle area to reach the site.

Tributary: New River **Name of site:** @ 780

Site Number: NR2

Latitude/Longitude: N45.18239 / W066.54739

Direction and description of location: The site is located on the main stem of the New River and flows to Bay of Fundy in the Maces Bay area. To get to the site from the ASF office, travel east on Route 127 to Highway 1. Travel east on Highway 1 to route 795. Travel east on route 795 for 0.8 km to Route 780. Travel west on Route 780 for 5.9 km to bridge across New River. Site is downstream of bridge.

Tributary: Pocologan **Name of site:** Pocologan

Site Number: PN1

Latitude/Longitude: N45.15647 / W066.61503

Direction and description of location: The site is located on the main stem of Pocologan River that flows into the Bay of Fundy in Maces Bay area. To get to the site from the ASF office, travel east on Route 127 to Highway 1. Then, travel east on Highway 1 to Route 795. Travel east on Route 795 for 0.8 km to Route 780. Travel west on Route 780 for 11.2 km to blueberry field on south side of road. Then, travel south through blueberry field for 3.2 km, before bridge across Pocologan and travel west for 1.35 km to Pocologan River.

Tributary: Waweig **Name of site:** Route 127

Site Number: WG1

Latitude/Longitude: N45.24317 / W067.13789

Direction and description of location: The site is located on the main stem of the Waweig River that flows into the Western Channel of the Passamaquoddy Bay and into the Bay of Fundy through passages. To get to the site from the ASF office, travel west on Route 127 for 2.6 km to Ghost Road. Travel west on Ghost Road for 1 km to route 127. Then, travel north on Route 127 for 12 km to Highway 1. Continue north on Route 127 for 2.7 km to driveway on west side of road (just before bridge across Waweig River). Walk approximately 50 m to stream. Site starts at bottom of riffle area approximately 20 m upstream from mouth of Pout Brook and ends 75 m upstream at top of riffle (big boulder and spruce tree on west bank).

Tributary: Waweig

Name of site: Hatchery

Site Number: WG2

Latitude/Longitude: N45.23989 / W067.13508

Direction and description of location: The site is located on the main stem of the Waweig River that flows into the Western Channel of the Passamaquoddy Bay and into the Bay of Fundy through passages. To get to the site from the ASF office, travel west on Route 127 for 2.6 km to Ghost Road. Travel west on Ghost Road for 1 km to Route 127. Then, travel north on Route 127 for 12 km to Highway 1. Continue north on Route 127 for 3.2 km to second bridge across Waweig River. Site starts at boulder on west bank 70 m downstream from bridge and ends at downstream side of bridge.

Tributary: Waweig

Name of site: Route 760

Site Number: WG3

Latitude/Longitude: N45.26081 / W067.14261

Direction and description of location: The site is located on the main stem of the Waweig River that flows into the Western Channel of the Passamaquoddy Bay and into the Bay of Fundy through passages. To get to the site from the ASF office, travel west on Route 127 for 2.6 km to Ghost Road. Travel west on Ghost Road for 1 km to route 127. Then, travel north on Route 127 for 12 km to Highway 1. Continue north on Route 127 for 5.3 km to Route 760. Travel west on Route 760 for 600 m to bridge across Waweig River. Site starts 55 m downstream from bridge and ends at downstream side of bride.