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Information on Atlantic Salmon (*Salmo salar*) from Salmon Fishing Area 18 (Gulf Nova Scotia) of relevance to the development of a 2nd COSEWIC status report

Abby Daigle

Fisheries and Oceans Canada
Gulf Region, Science Branch
343 University Avenue
Moncton (NB) E1C 9B6

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

This document presents information on Atlantic Salmon (*Salmo salar*) for rivers in Salmon Fishing Area 18 (SFA 18; Northumberland Strait Nova Scotia and Western Cape Breton) of relevance to the development of the status report by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). There are 55 potential Atlantic Salmon rivers in SFA 18. Of these, the Gulf Nova Scotia (GNS) program focuses its monitoring efforts on four index rivers within SFA 18: The Margaree River, West River Antigonish, East River Pictou, and River Philip. For the Margaree River in 2019, the estimated eggs in the returns of small Salmon and large Salmon combined were 3.9 times greater than the lower reference point (LRP) value. The Salmon population has remained above the LRP for the duration of the Margaree monitoring program (1987 to present). However, returns to all rivers in SFA 18 remain below the long-term return average. The principal threats in SFA 18 are: habitat shifting and alteration, extreme temperatures, and droughts, all of which are related to global climate change.

INTRODUCTION

Atlantic Salmon begin their life cycle as eggs deposited in nests (redds). These eggs hatch and become young-of-year (YOY), also known as fry. Fry mature into parr and will remain in fresh water for up to eight years. Between two and eight years parr will undergo physiological change (smoltification) and will transition to living in the ocean environment. Atlantic Salmon commonly spend one to three years at sea before returning to their natal rivers to spawn. After spawning, Atlantic Salmon will remain in rivers until the following spring, at which point they will migrate back to the ocean environment.

Salmon Fishing Area 18 (SFA 18) is located in Nova Scotia (NS) and incorporates all NS catchment areas that drain into the Gulf of St. Lawrence (Figure 1). Within SFA 18 there are 55 potential Salmon rivers (Figure 2). Of these, the Margaree River on Cape Breton Island is a large and well known Salmon fishing river, and serves as a Salmon index river for the Department of Fisheries and Oceans (DFO). Annual stock assessment activities have occurred on the Margaree River since 1984. On SFA 18 mainland, West River (Antigonish), East River (Pictou), and River Philip serve as index rivers, with annual electrofishing surveys occurring at historical sites throughout their catchments.

There is no commercial fishery for Atlantic Salmon. The two sanctioned user groups are First Nations groups and recreational anglers. First access belongs to First Nations groups, after conservation, and is used for food, social, and ceremonial (FSC) purposes. The recreational fishery is catch and release only.

This document provides information regarding the Atlantic Salmon populations residing in SFA 18. It provides updated information on trends in population indicators, estimates of population size, lists areas of occupancy, and outlines threats to the species within the SFA. The intent of this report is to provide the most up-to-date scientific information to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) regarding SFA 18 Atlantic Salmon.

LIFE HISTORY CHARACTERISTICS

In order to understand the biological characteristics of wild Atlantic Salmon, an understanding of terminology is required:

- **Large Salmon** – Salmon with a fork length equal to, or greater than 63 cm.
- **Small Salmon** – Salmon with a fork length less than 63 cm.
- **Maiden Salmon** – The first time a Salmon returns to a river to spawn
- **Repeat Spawner** – A non-maidan Salmon that returns to spawn after reconditioning at sea. Can be consecutive or alternate.
- **Consecutive Spawner** – A Salmon that spawns each year over two (or more) consecutive years.
- **Alternate Spawner** – Salmon that spend an entire year at sea between spawning events.
- **1SW** – One sea winter (1SW) Salmon are adult Salmon that have spent one year at sea.
- **2SW** – Two sea winter (2SW) Salmon are adult Salmon that have spent two years at sea without spawning.
- **3SW** – Three sea winter (3SW) Salmon are adult Salmon that have spent three years at sea without spawning.

- **Smoltification** – The process that allows young Salmon to transition from living in fresh water to salt water.

Biological characteristics of wild Atlantic Salmon can differ between populations and are often associated with differences in geographic location, particularly along the latitudinal scale. Chaput et al. (2006) illustrated that wild Atlantic Salmon populations located in SFA 18 are commonly associated with having a high proportion of large Salmon (relative to small) in total river returns, with small Salmon returns being predominantly male and large Salmon returns being predominantly female. Minimal repeat spawners are observed in the small Salmon category. Males (in general) comprise a greater proportion of 1SW maiden Salmon, while females comprise a greater proportion of 2SW and 3SW Salmon. Both small and large Salmon tend to be long in length. The smoltification process has been observed to commonly occur at ages two and three for SFA 18 rivers. All of these biological characteristics are not necessarily unique to SFA 18, but are instead shared with other populations located in the Gulf of St. Lawrence.

Generation time, as defined by the International Union for Conservation of Nature (IUCN) and adopted by the COSEWIC, is the average age of parents in a cohort. It reflects the turnover rate of breeding individuals in a population (IUCN 2019). Generation time can be determined by averaging the smolt age, averaging the years in the marine phase, and adding those numbers together, plus one more year to account for the egg deposition year. For SFA 18, generation time was determined using data from the Margaree River because it is the most extensive dataset available for the SFA. Catch data from (LeBlanc et al. 2005) was used to calculate generation time and was determined to be 5.14 years (Appendix 1). The COSEWIC requests that trends be examined over three generations (COSEWIC 2010). Thus, for this report three generations will be 16 years (rounded up).

Run timing, the period of time when Salmon ascend rivers to spawn, can vary between populations. In general for SFA 18, Atlantic Salmon tend to ascend in the fall, starting in September (Claytor 1996). However, three rivers are known to have had early runs of Salmon in addition to their fall run; Chéticamp River, Margaree River, and River Philip (Claytor 1996; Landry et al. 2005; Chaput et al. 2006b). The recent extent of these early runs are unknown.

The Margaree river is a large, historic, and well-studied Salmon river located in SFA 18 on Cape Breton Island. Specific information on biological characteristics for the Margaree river Salmon population is available by LeBlanc et al. (2005). More general biological characteristics for all rivers in SFA 18 became available during the application of the precautionary approach for Atlantic Salmon in the Gulf Region (DFO 2018).

OVERVIEW OF DESIGNATABLE UNITS (DUS)

Wild Atlantic Salmon populations located in SFA 18 all belong to DU 12 because no significant evidence illustrating genetic or life history divergence from other Gulf of St. Lawrence wild Salmon populations could be determined (COSEWIC 2010).

In a previous pre-COSEWIC report by Breau et al. (2009), detailed information regarding wild Atlantic Salmon populations located in SFA 18 is provided for years up to 2009. No new information has been published.

TRENDS IN POPULATION INDICATORS (COSEWIC CRITERION A)

The Gulf Nova Scotia (GNS) program, as part of the DFO Gulf Region, focuses its efforts on four index rivers within SFA 18. The Margaree River, located on Cape Breton Island is a large river system, and a well-known historical Salmon river. West River Antigonish, East River Pictou, and River Philip are the three biggest rivers draining into the Gulf of St. Lawrence that are located on mainland Nova Scotia. Indictors of abundance for adult and juvenile Atlantic Salmon life stages are calculated annually for these index rivers. To provide a perspective on recent trends (up to and including 2019), the changes (exponential regression of change) in the indicators over the recent 16-years (approximately three Salmon generations) are presented.

Indices of abundance for the four index rivers in SFA 18 are derived from recreational fishery catch and effort data coming from the NS Salmon license stub return database. Catch and effort data from the returned license stubs are raised by total license sales to estimate total catch and effort.

Over the recent 16-year period, the trend for catch rates of large and small Salmon declined 36% and 67% for West River (Antigonish), inclined 4% and declined 59% for East River (Pictou), and increased by 141% and declined 25% for River Philip (Figure 3). The Margaree river shows a decrease of 22% in large Salmon over the same period, as well as a decrease of 46% in small Salmon (Figure 4).

Of the four index rivers located within SFA 18, only the Margaree River has had a Salmon stock assessment completed annually by DFO, since 1987. Adult Salmon abundance is derived with a model that estimates exploitation rates in the recreational fishery based on mark and recapture experiments conducted between 1988 and 1996 applied to the corresponding recreational fishery catch and effort data recorded in volunteer angler logbooks, and license stub returns (Breau and Chaput 2012).

The estimated returns of large Salmon to the Margaree River in 2019 were 2,584 fish (median; 5th to 95th percentile range of 1,949 to 3,189; Table 1), which is below the long term average of 2,768 fish (1988 to 2018; Figure 5). The estimated returns of small Salmon to the Margaree River in 2019 were 619 fish (median; 5th to 95th percentile range of 410 to 827; Table 1), which is below the long term average of 844 fish (Figure 5). For the Margaree River, trends in estimated returns over the recent 16-year period show a decline of 25% and 49% for large and small Salmon, respectively.

The eggs in the returns and spawners of small Salmon and large Salmon combined are estimated using average biological characteristics of Salmon in the Margaree River (DFO 2018, 2019a). In 2019 the estimated eggs in the returns of small Salmon and large Salmon combined were 593 eggs per 100 m² (median; 5th to 95th percentile range of 468 to 743 eggs per 100 m²; Figure 6), 3.9 times the lower reference point (LRP) value of 152 eggs per 100 m². The Salmon population has remained above the LRP for the duration of the Margaree monitoring program (DFO 2019a). Under the Precautionary Approach (DFO 2006) this indicates that the population is not in the critical zone. However, until an upper stock reference (USR) is determined, we cannot know if the population resides in the cautionary zone or the healthy zone.

Juvenile Salmon surveys have been regularly conducted in the tributaries and main stems of the four index rivers by means of electrofishing (Figures 7 to 11; Tables 2 and 3). Results are presented for years with at least three sites sampled per river. The recent 16-year fry abundance trend shows a decrease of 6% in West River (Antigonish), a decrease of 24% in East River (Pictou), a decrease of 62% in River Philip, and a decrease of 32% in the Margaree River (Figure 11). The parr abundance trend shows a decrease of 56% in West River (Antigonish), an increase of 10% in East River (Pictou), a decrease of 67% in River Philip, and a decrease of 68% in the Margaree River (Figure 11).

TRENDS IN DISTRIBUTION AND DECLINE OR FLUCTUATION (COSEWIC CRITERION B)

In 2009, 55 rivers located in SFA 18 were listed with corresponding presence/absence data for Atlantic Salmon (Breau et al. 2009). Juvenile and adult presence/absence data for a fraction of these rivers have been updated for every year between 2010 and 2019 (Table 4 and Table 5, respectively). Juvenile data were collected during annual DFO electrofishing surveys. Juvenile Atlantic Salmon were observed each year a river was surveyed (Table 4). However, only a small subset (nine) of the 55 rivers were able to be surveyed by DFO between 2010 and 2019.

Adult data come from the NS Salmon license database where licenses sold and angled Salmon catches are reported. A larger subset (18) of the 55 rivers have adult Atlantic Salmon data recorded between 2010 and 2019. Adult Salmon were present almost every year for most rivers that had angler presence (Table 5). However, Wrights River and Pomquet River both had years absent of Salmon, but that could be a result of low angling presence (Table 6).

Estimates of fluvial area, drainage area, and egg requirements for 30 rivers were published in 2006 (Chaput et al. 2006a), and then updated to include 25 additional rivers in 2009 (Breau et al. 2009). This information was further updated in 2018 to provide the river specific lower reference point (LRP) egg requirements as determined under the precautionary approach (DFO 2018).

ESTIMATES OF TOTAL POPULATION SIZE (COSEWIC CRITERION C)

Estimates of total returns of large and small Salmon have been developed for SFA 18 based on estimates from monitored rivers (DFO 2014). Specifically, returns to SFA 18 are derived from estimates of returns to the Margaree River, adjusted for the ratio of the SFA 18 angling catch to the Margaree River catch (Figure 12). Although this method for estimating total returns of small and large Salmon to all of SFA 18 utilizes the available angling information from monitored rivers, it is important to remember that not all Salmon rivers in SFA 18 are monitored. In 2019, only 24 of the 55 GNS rivers were monitored, and only 15 of the 24 rivers monitored had angling information that was reported. It is unknown if the reported angling information from monitored rivers accurately reflects the angling information that would be collected from the unmonitored rivers. Our estimation method assumes that it would be.

Returns of large Salmon to SFA 18 in 2019 were estimated at 5,701 fish (5th to 95th percentile range of 2,134 to 9,268 fish; Table 7) which is below the long term average of 5,797 fish (Figure 13). Small Salmon returns to SFA 18 in 2019 were estimated at 2,019 fish (5th to 95th percentile range of 472 to 3,599 fish; Table 7) which is below the long term average of 2,130 fish (Figure 13). Over the recent 16-years, the estimated abundances of large Salmon has decreased in SFA 18 by 23%, while small Salmon have decreased by 46% (Figure 13).

DESCRIBE THE CHARACTERISTICS OR ELEMENTS OF THE SPECIES HABITAT TO THE EXTENT POSSIBLE, AND THREATS TO THAT HABITAT

Breau et al. (2009) provided a list of 55 rivers located in SFA 18. Coordinates are provided for all 55 rivers. Egg requirement, drainage area, and fluvial area were provided when known. No specific habitat characteristics were described. The list was further updated in 2018 to include information relevant to the application of the precautionary approach to Atlantic Salmon in the gulf region (DFO 2018; Table 8). From this information it is observed that SFA 18 is comprised of many (55) small (fluvial areas less than one million m^2) rivers, with the exception of the Margaree River (approximate fluvial area of 2.8 million m^2).

THREATS

In the context of the identification and management for species at risk, a threat, is 'an activity or process (both natural and anthropogenic) that has caused, is causing, or may cause harm, death, or behavioral changes to a species at risk or the destruction, degradation, and/or impairment of its habitat to the extent that population-level effects occur' (Environment Canada 2007). In essence, it is an activity that imposes a stress on a species at risk population which contributes to or perpetuates its decline, or limits its recovery. In the case of Atlantic Salmon, the elevated marine mortality and declining returns in recent years are stress caused by unknown (but hypothesized) threats (DFO and MNRF 2009).

An assessment of the impact of all threats to Atlantic Salmon in SFA 18 is summarized in Table 9. A subset of these threats will be expanded upon here, as more detailed information is available.

BIOLOGICAL RESOURCE USE

Logging and Wood Harvest

Within SFA 18, percentage of streams within forestry land ranges from 31.1% to 89.9% (GOSLIM unpublished document[1]). Forestry can lead to nutrient regime alterations which can result in adverse water conditions such as eutrophication, hypoxia, and anoxia (GOSLIM unpublished document[1]). The percentage of forestry occurring on slopes (>3%) within SFA 18 watersheds ranges from 21.9% to 72.5% (GOSLIM unpublished document[1]). These forested areas have the ability to cause sediment regime alteration, potentially leading to an increase in water turbidity, a smothering of benthic habitats, and changes to channel morphology and water depths (GOSLIM unpublished document[1]).

Fishing and Harvesting Aquatic Resources

There is no domestic commercial fishery for wild Atlantic Salmon. Rivers in SFA 18 are open to recreational angling, but only catch and release is allowed. For the recreational fishery, retention of large Salmon has been prohibited since 1984, while retention of small Salmon (grilse) has been prohibited since 2015 (DFO 2016). The assumed mortality rate from the recreational fishery for SFA 18 is 5%. Returned license stubs from the recreational fishery provide catch and effort data that are raised by total license sales to determine indices of abundance for SFA 18 rivers. Unfortunately, the annual reporting from the recreational fishery is often incomplete. Furthermore, the incompleteness of this reporting has been increasing, as indicated by the downward trend in the number of license stubs returned annually (Figure 14). The result is that these indices of abundance are being determined based on a decreasing number of data points.

Under the 1992 Aboriginal Fisheries Strategy, First Nations communities are allocated Atlantic Salmon retention permits for food, social, and ceremonial (FSC) purposes. The details of the FSC fishery are included in the Integrated Fisheries Management Plan (IFMP) 2008 to 2012 (DFO 2008). Atlantic Salmon harvest allocations to aboriginal communities in SFA 18 rivers for 2012 and 2013 are available in Biron and Breau (2015). Similar to the recreational fishery stub returns, annual reporting of FSC retention is often incomplete.

[1] Gulf of St. Lawrence Integrated Management (GOSLIM). 2009. Gulf of St. Lawrence Regional Vulnerability Profile. PowerPoint presentation 77 slides, unpublished.

NATURAL SYSTEMS MODIFICATIONS

Dam and Waterfall Management/Use

The extent of dam construction in SFA 18 has not been quantified. Two historical dams of issue exist on mainland NS. Middle and West River Pictou have causeway dams that were constructed in 1966 and 1967 (respectively) to provide water for the Scott Maritime Pulp Mill (now known as Northern Pulp). Although the dams were constructed with fishways to aid in fish passage, these fishways became inadequate during low water conditions directly affected by the water demand for the pulp mill. A study by McLeod (1971) concluded that the Middle River causeway dam eliminated the river's spawning habitat for Atlantic Salmon and that poor management of the reservoir's water level often resulted in the fishway being inoperable during the fall Salmon run. In recent years, the gates for the West River dam have remained open, eliminating fish passage issues. Regardless, the long term impact of these causeway dams on the Atlantic Salmon populations belonging to Middle and West River Pictou is unknown.

Concern has been raised regarding water control and diversion from the damming of Cheticamp River for the Wreck Cove Hydroelectric project in the late 1970s. Since 1978, water levels in the Cheticamp River have been controlled by releases from the Cheticamp Flowage Reservoir. These releases are regulated to deliver a minimum flow of 41 cubic feet per second (cfs) at the Barrier Falls, 12.5 km below the dam, as called for by the Environmental Assessment Panel (FEARO 1977) to maintain the Cheticamp Salmon. Over time, there has been some discussion whether the release schedule adequately replicates natural flows, especially freshets responsible for maintaining the distribution of bedload and juvenile habitat, and whether heating of the impounded headwaters warms the river below the dam to temperatures threatening to Salmon.

Other Ecosystem Modifications

During a preliminary assessment of stream crossings in SFA 18, impediments to fish passage were noted in 47% of 669 studied sites from SFA 18 rivers (Breau 2012). Sites were based on an inventory of stream crossings within the first kilometer inland, above the head of tide.

INVASIVE AND OTHER PROBLEMATIC SPECIES AND GENES

Invasive Non-native/Alien Species

Smallmouth bass (*Micropterus dolomieu*) are not endemic to SFA 18. They are considered predators of fish, and are potential predators of Atlantic Salmon, particularly Salmon juveniles. This non-native, invasive species is documented to now occur in the Pugwash River system (Big Lake), the Middle River system (Middle River Reservoir and Lansdowne Lake), and in the Margaree River system (Lake Ainslie; Leblanc 2010). The confirmed presence of smallmouth bass in Lake Ainslie in 2003 represents the first documented introduction of the species on Cape Breton Island (Leblanc 2010). It is important to note that Lake Ainslie empties into the Southwest Margaree River. To date, smallmouth bass have not been documented during any DFO lead electrofishing surveys (1957 to 2020), nor during the smolt wheel operation on the main branch of the Margaree river (2001 to 2009, and 2018).

Brown trout (*Salmo trutta*) are not endemic to North America. However, Nova Scotia stocking practices from the early 1900s have led to the successful establishment of populations throughout the province. Brown trout and Atlantic Salmon are considered competitors, competing for similar habitat and resources at various stages of their life cycles. The degree to which this competition impacts Atlantic Salmon populations within SFA 18 is unknown. Brown trout juveniles have been documented in all four SFA 18 index rivers (Figures 15 and 16). Brown trout juveniles have further been documented in Barneys River and Wallace River.

Introduced Genetic Material

Known stocking of the Margaree River began in 1882. Initial stocking occurred by the Maritimes hatchery programs (1882 to 1897), but then by the Margaree Fish Culture Station (now known as the Margaree Hatchery; 1902 to present day; Marshall 1982). Margaree river stock has, over various historical stocking events, likely been placed in nearly all Cape Breton Salmon rivers, as well as various rivers in mainland NS. Introductions from Miramichi (New Brunswick) stock was completed in order to enhance the returns of the summer run for recreational angling (Marshall 1982).

As of 2020, stocking continues to occur in the Margaree River, as well as various other rivers within SFA 18. The extent of these stocking events is not readily accessible. The province of NS does provide stocking records as an open access resource. However, this data appears to be incomplete, as no records on the well-known Margaree hatchery stocking program could be accessed. It is known that the Margaree hatchery collect 50 Salmon (25 males and 25 females) annually from the Margaree River for their stocking program. If the extent of stocking is to be quantified, a good resource is the DFO's Introductions and Transfers Committee (ITC) for NS. All organizations must apply to the ITC if they wish to introduce or transfer aquatic species. These organizations must provide specific information regarding species, life stage, proposed number of individuals to transfer, stock origin, and final destination. Alternatively, a request can be placed to the province of NS for their stocking records. Such a request was placed for this pre-COSEWIC report. The information received is present in Table 10.

CLIMATE CHANGE

Temperature Extremes

In summer 2018, a warm water protocol was required for the Margaree River due to increasingly warm air temperatures lasting extended periods, combined with dry weather, which was resulting in warm water temperatures known to be unfavorable for Salmon. A protocol was developed to temporarily shut down recreational Salmon fishing during periods of unusually warm water temperatures (DFO 2019b). The aim is to reduce overall stress being placed on the Salmon, until water temperatures drop, and responsible angling can resume. To date, the warm water protocol has been used twice; once in 2018 from August 4th to 21st (18 days), and once in 2020 from August 7th to 27th (21 days).

Storms and Flooding

High water events have the potential to wash out eggs or smother redds, which can decimate a whole year class. A major flood in the Margaree River during March 2003 resulted in low fry abundance during the juvenile electrofishing survey for that year (Breau 2012). Another major flood event occurred December 2010 and resulted in changes to the streambed and river morphology. These changes are thought to have been detrimental to incubating eggs in redds, as evidenced by the absence of Salmon fry from many electrofishing sites in 2011 (Breau 2012).

A flashflood occurred in August of 2015 on the Cheticamp River. This resulted in the movement of substrate altering the channel morphology (Cheticamp River Salmon Association 2015, Cheticamp River Salmon Association 2015b). The impact of this flood on Salmon habitat has not been quantified.

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TABLES

Table 1. Median estimates of total returns and spawners for small and large Salmon for the Margaree River, 1987 to 2019. Estimates of returns for 1987 to 2019 are based on the 95% confidence interval of Bayesian catch rate model (Breau and Chaput 2012).

Year	Small Salmon		Large Salmon	
	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)
1987	1,665 (1,339 - 1,991)	693 (367 - 1,019)	3,482 (2,946 - 4,017)	3,389 (2,854 - 3,925)
1988	1,416 (1,127 - 1,705)	515 (226 - 804)	3,372 (2,848 - 3,896)	3,273 (2,749 - 3,797)
1989	924 (725 - 1,123)	350 (151 - 549)	2,825 (2,372 - 3,278)	2,745 (2,292 - 3,198)
1990	1,019 (800 - 1,237)	364 (145 - 582)	2,548 (2,141 - 2,955)	2,472 (2,065 - 2,879)
1991	1,200 (946 - 1,453)	427 (173 - 680)	3,149 (2,626 - 3,671)	3,058 (2,536 - 3,581)
1992	1,025 (813 - 1,237)	326 (114 - 538)	3,184 (2,684 - 3,684)	3,084 (2,584 - 3,584)
1993	1,156 (943 - 1,368)	387 (174 - 599)	1,789 (1,524 - 2,054)	1,735 (1,470 - 2,000)
1994	694 (544 - 844)	267 (117 - 417)	2,688 (2,247 - 3,128)	2,614 (2,173 - 3,054)
1995	570 (442 - 697)	227 (99 - 354)	2,019 (1,680 - 2,357)	1,964 (1,625 - 2,302)
1996	2,531 (1,947 - 3,115)	1,292 (708 - 1,876)	4,267 (3,529 - 5,004)	4,170 (3,432 - 4,907)
1997	594 (450 - 738)	283 (139 - 427)	4,650 (3,822 - 5,477)	4,544 (3,717 - 5,372)
1998	677 (511 - 842)	325 (159 - 490)	2,817 (2,313 - 3,321)	2,750 (2,246 - 3,254)
1999	747 (564 - 930)	436 (253 - 619)	2,147 (1,754 - 2,540)	2,107 (1,714 - 2,500)
2000	650 (483 - 817)	388 (221 - 555)	1,995 (1,609 - 2,380)	1,960 (1,574 - 2,345)
2001	854 (639 - 1,069)	490 (275 - 705)	2,309 (1,876 - 2,742)	2,266 (1,833 - 2,699)
2002	888 (658 - 1,118)	525 (295 - 755)	1,699 (1,365 - 2,032)	1,668 (1,334 - 2,001)
2003	827 (611 - 1,043)	500 (284 - 716)	3,284 (2,653 - 3,915)	3,227 (2,596 - 3,858)
2004	1,164 (858 - 1,470)	646 (340 - 952)	3,649 (2,939 - 4,358)	3,578 (2,869 - 4,288)
2005	833 (628 - 1,037)	415 (210 - 619)	3,006 (2,456 - 3,555)	2,939 (2,389 - 3,488)
2006	922 (683 - 1,160)	479 (240 - 717)	2,904 (2,354 - 3,454)	2,841 (2,291 - 3,391)
2007	761 (565 - 956)	422 (226 - 617)	2,006 (1,620 - 2,391)	1,966 (1,581 - 2,352)
2008	1,348 (979 - 1,716)	606 (237 - 974)	3,061 (2,446 - 3,676)	2,986 (2,371 - 3,601)
2009	347 (232 - 462)	175 (60 - 290)	2,331 (1,833 - 2,829)	2,280 (1,782 - 2,778)
2010	958 (680 - 1,236)	445 (167 - 723)	3,116 (2,470 - 3,762)	3,042 (2,396 - 3,688)
2011	1,270 (925 - 1,615)	662 (317 - 1,007)	5,217 (4,189 - 6,244)	5,106 (4,078 - 6,133)

Year	Small Salmon		Large Salmon	
	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)
2012	254 (160 - 348)	174 (80 - 268)	1,310 (1,005 - 1,615)	1,291 (986 - 1,596)
2013	489 (342 - 636)	279 (132 - 426)	2,793 (2,225 - 3,361)	2,739 (2,171 - 3,307)
2014	332 (220 - 444)	233 (121 - 345)	1,924 (1,505 - 2,343)	1,898 (1,479 - 2,317)
2015	847 (597 - 1,097)	615 (365 - 865)	2,687 (2,110 - 3,263)	2,656 (2,079 - 3,232)
2016	443 (296 - 590)	437 (290 - 584)	2,535 (1,975 - 3,094)	2,504 (1,945 - 3,064)
2017	663 (463 - 863)	652 (452 - 852)	1,864 (1,425 - 2,302)	1,838 (1,399 - 2,276)
2018	562 (381 - 743)	552 (371 - 733)	3,120 (2,419 - 3,821)	3,071 (2,370 - 3,772)
2019	619 (410 - 827)	605 (397 - 814)	2,584 (1,979 - 3,189)	2,539 (1,934 - 3,144)

Table 2. Margaree electrofishing site coordinates. Coordinates listed are most recent coordinates on file. However, sites can shift upstream or downstream year-to-year due to the dynamic nature of river systems. Coordinates are given in decimal degrees. Data collected from closed (depletion) sites are used to calibrate data from catch per unit effort (CPUE) sites. A visual representation of site locations is present in Figure 7.

Site Code	Latitude	Longitude	Type
2	46.3835	-61.0373	CPUE
15	46.29048	-61.0317	closed
22L	46.33087	-61.0008	CPUE
34C	46.38432	-60.9469	CPUE
40	46.47994	-60.9278	CPUE
45	46.46802	-60.9191	closed
51	46.42682	-60.9443	CPUE
56B	46.40565	-60.9639	CPUE
91B	46.24199	-61.1221	CPUE
95	46.23532	-61.124	closed
96	46.20604	-61.1455	closed
98	46.09677	-61.1341	CPUE
103C	46.29197	-61.1424	CPUE

Table 3. Mainland Gulf Nova Scotia electrofishing site coordinates. Coordinates listed are most recent coordinates on file. However, sites can shift upstream or downstream year-to-year due to the dynamic nature of river systems. Coordinates are given in decimal degrees. No closed sites exist on mainland, only catch per unit effort (CPUE) sites. A visual representation of site locations is present in Figures 8 to 10.

Site Code	Latitude	Longitude	Type
West River Antigonish			
1	45.5726	-62.0461	CPUE
2	45.5809	-62.1058	CPUE
3	45.5045	-62.0652	CPUE
4	45.5408	-62.1332	CPUE
6B	45.5601	-62.0766	CPUE
7	45.5994	-62.0840	CPUE
East River Pictou			
3	45.4644	-62.6525	CPUE
4	45.4253	-62.6736	CPUE
5	45.4175	-62.5752	CPUE
7	45.4603	-62.6893	CPUE
8B	45.4151	-62.5522	CPUE
9A	45.4045	-62.5419	CPUE
River Philip			
1	45.5968	-63.8177	CPUE
3	45.6277	-63.9275	CPUE
4	45.6581	-63.9098	CPUE
5	45.5948	-63.9396	CPUE
6	45.5717	-63.9460	CPUE
8A	45.5900	-63.8191	CPUE

Table 4. Juvenile Salmon presence and absence data for GNS rivers. The blue column indicates the presence and absence data that was reported in 2009 (Breau et al. 2009). For the 2010 to 2019 columns information came from our annual electrofishing database. '.' indicates no information was available, 'A' indicates absence of Salmon, and 'P' indicates presence of Salmon.

Map #	River	Longitude (W)	Latitude (N)	Juveniles										
				2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CAPE BRETON														
1	Salmon River	-60.4936	47.0003	P	.	.	.	.	.	.	.	.	.	.
2	Blair River	-60.6992	46.9167	.	.	.	.	.	.	.	.	.	.	.
3	Red River	-60.7658	46.8500	P	.	.	.	.	.	.	.	.	.	.
4	Grande Anse River	-60.7992	46.8333	P	.	.	.	.	.	.	.	.	.	.
5	Mackenzies River	-60.8325	46.8167	P	.	.	.	.	.	.	.	.	.	.
6	Fishing Cove River	-60.8825	46.8000		.	.	.	.	.	.	.	.	.	.
7	Corneys Brook	-60.9254	46.7237	A	.	.	.	.	.	.	.	.	.	.
8	Anthony Aucoin's Brook	-60.9528	46.6734	A	.	.	.	.	.	.	.	.	.	.
9	Rigwash Brook	-60.9528	46.6734	A	.	.	.	.	.	.	.	.	.	.
10	Chéticamp River	-60.9492	46.6667	P	.	.	.	.	.	.	.	.	.	.
11	Aucoin Brook	-60.9809	46.6068	P	.	.	.	.	.	.	.	.	.	.
12	Fiset Brook	-61.0053	46.6028	P	.	.	.	.	.	.	.	.	.	.
13	Farm Brook	-61.0154	46.5821	P	.	.	.	.	.	.	.	.	.	.
14	Margaree River	-61.0992	46.4333	P	P	P	P	P	P	P	P	P	P	P
15	Smiths Brook	-61.2684	46.2639	A	.	.	.	.	.	.	.	.	.	.
16	Broad Cove River	-61.3029	46.1654	P	.	.	.	.	.	.	.	.	.	.
17	Mill Brook	-61.4488	46.1431	A	.	.	.	.	.	.	.	.	.	.
18	Northeast Mabou River	-61.4158	46.0833	P	.	.	.	.	.	.	.	.	.	.
19	Southwest Mabou River	-61.4325	46.0667	P	.	.	.	.	.	.	.	.	.	.
20	Mabou River	-61.3825	46.0667	P	P	.	.	.	.	.	.	.	.	.
21	Captains Brook	-61.5041	45.9757	A	.	.	.	.	.	.	.	.	.	.
22	Judique Intervale Brook	-61.4742	45.9000	P	.	.	.	.	.	.	.	.	.	.
23	Graham River	-61.4912	45.8611	P	.	.	.	.	.	.	.	.	.	.
24	Campbells Brook	-61.4843	45.8491	P	.	.	.	.	.	.	.	.	.	.
25	Chisholm Brook	-61.4825	45.8167	P	.	.	.	.	.	.	.	.	.	.
26	Mill Brook (Strait of Canso)	-61.4219	45.6695	P	.	.	.	.	.	.	.	.	.	.
MAINLAND NOVA SCOTIA														
27	Wrights River	-61.5175	45.6671	P	.	.	.	.	.	.	.	.	.	.
28	Tracadie River	-61.6158	45.6167	.	.	.	.	.	.	.	.	.	.	.
29	Afton River	-61.7325	45.6333	P	.	.	.	.	.	.	.	.	.	.
30	Pomquet River	-61.7992	45.6000	P	.	.	.	.	.	.	.	.	.	.
31	South River	-61.9158	45.6000	P	.	.	.	.	.	.	.	.	.	.
32	West River (Antigonish)	-61.9658	45.6167	P	P	P	P	P	P	P	P	P	P	P
33	North River	-61.9391	45.6661	P	.	.	.	.	.	.	.	.	.	.

Map #	River	Longitude (W)	Latitude (N)	Juveniles										
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
34	MacInnis Brook	-61.9169	45.8086	A	.	.	.	.	.	.	.	.	.	.
35	Doctors Brook	-62.1200	45.7777	A	.	.	.	.	.	.	.	.	.	.
36	Vameys Brook	-62.2685	45.7012	P	.	.	.	.	.	.	.	.	.	.
37	Baileys Brook	-62.2698	45.6921	P	.	.	.	.	.	.	.	.	.	.
38	Barneys River	-62.3492	45.6667	P	P	P	.	.	.	.	.	.	.	.
39	French River (Merigomish)	-62.4492	45.6333	P	.	.	.	.	.	.	.	.	.	.
40	Russell Brook	-62.4882	45.5803	P	.	.	.	.	.	.	.	.	.	.
41	Sutherlands River	-62.4992	45.5833	P	.	.	.	.	.	.	.	.	.	.
42	Pine Tree Brook	-62.5448	45.6011	A	.	.	.	.	.	.	.	.	.	.
43	East River (Pictou)	-62.6992	45.6500	P	P	P	P	P	P	P	P	P	P	P
44	Middle River (Pictou)	-62.7325	45.6500	P	.	.	.	.	.	.	.	.	.	.
45	West River (Pictou)	-62.7658	45.6667	P	P	P	P	P	P	P	P	P	P	P
46	Haliburton Brook	-62.7592	45.6980	A	.	.	.	.	.	.	.	.	.	.
47	Big Caribou River	-62.8430	45.7379	A	.	.	.	.	.	.	.	.	.	.
48	Toney River	-62.9025	45.7555	A	.	.	.	.	.	.	.	.	.	.
49	River John	-63.0658	45.7500	P	P	P	.	.	.	.	.	.	.	.
50	Waughs River	-63.2992	45.7333	P	.	.	.	.	.	.	.	.	.	.
51	French River	-63.3262	45.7037	P	.	.	.	.	.	.	.	.	.	.
52	Wallace River	-63.5158	45.8167	P	P	P	.	.	.	.	.	.	.	P
53	Pugwash River	-63.6658	45.8500	P	.	.	.	.	.	.	.	.	.	.
54	River Philip	-63.7325	45.8500	P	P	P	P	P	P	P	P	P	P	P
55	Shinimicas River	-63.9094	45.8664	P	.	.	.	.	.	.	.	.	.	.

Table 5. Adult Salmon presence and absence data for GNS rivers. The blue column indicates the presence and absence data that was reported in 2009 (Breau et al. 2009). For the 2010 to 2019 columns information was pulled from Salmo NS (online angling license database). '.' indicates no information was available, 'X' indicates no fishing presence was recorded on that river for the given year, 'A' indicates there was fishing presence but no Salmon were hooked. A number indicates presence and number of Salmon hooked.

Map #	River	Longitude (W)	Latitude (N)	Adults										
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CAPE BRETON														
1	Salmon River	-60.4936	47.0003	.	.	.	.	.	.	.	.	.	.	.
2	Blair River	-60.6992	46.9167	P	.	.	.	.	.	.	.	.	.	.
3	Red River	-60.7658	46.8500	.	.	.	.	.	.	.	.	.	.	.
4	Grande Anse River	-60.7992	46.8333	P	.	.	.	.	.	.	.	.	.	.
5	Mackenzies River	-60.8325	46.8167	P	.	.	.	.	.	.	.	.	.	.
6	Fishing Cove River	-60.8825	46.8000	P	.	.	.	.	.	.	.	.	.	.
7	Corneys Brook	-60.9254	46.7237	.	.	.	.	.	.	.	.	.	.	.
8	Anthony Aucoin's Brook	-60.9528	46.6734	.	.	.	.	.	.	.	.	.	.	.
9	Rigwash Brook	-60.9528	46.6734	.	.	.	.	.	.	.	.	.	.	.
10	Chéticamp River	-60.9492	46.6667	P	28	32	6	93	6	28	10	34	7	A
11	Aucoin Brook	-60.9809	46.6068	.	.	.	.	.	.	.	.	.	.	.
12	Fiset Brook	-61.0053	46.6028	.	.	.	.	.	.	.	.	.	.	.
13	Farm Brook	-61.0154	46.5821	.	.	.	.	.	.	.	.	.	.	.
14	Margaree River	-61.0992	46.4333	P	1996	2820	453	1282	619	846	713	737	1185	1305
15	Smiths Brook	-61.2684	46.2639	.	.	.	.	.	.	.	.	.	.	.
16	Broad Cove River	-61.3029	46.1654	.	.	.	.	.	.	.	.	.	.	.
17	Mill Brook	-61.4488	46.1431	.	.	.	.	.	.	.	.	.	.	.
18	Northeast Mabou River	-61.4158	46.0833	P	.	.	.	.	.	.	.	.	.	.
19	Southwest Mabou River	-61.4325	46.0667	P	.	.	.	.	.	.	.	.	.	.
20	Mabou River	-61.3825	46.0667	P	37	43	24	25	4	2	19	8	7	27
21	Captains Brook	-61.5041	45.9757	.	.	.	.	.	.	.	.	.	.	.
22	Judique Intervale Brook	-61.4742	45.9000	P	.	.	.	.	.	.	.	.	.	.
23	Graham River	-61.4912	45.8611	.	.	.	.	.	.	.	.	.	.	.
24	Campbells Brook	-61.4843	45.8491	.	X	X	X	X	X	X	X	X	X	X
25	Chisholm Brook	-61.4825	45.8167	P	.	.	.	.	.	.	.	.	.	.
26	Mill Brook (Strait of Canso)	-61.4219	45.6695	.	.	.	.	.	.	.	.	.	.	.
MAINLAND NOVA SCOTIA														
27	Wrights River	-61.5175	45.6671	P	A	A	13	4	A	A	A	A	4	X
28	Tracadie River	-61.6158	45.6167	P	X	A	X	X	X	X	X	X	X	X
29	Afton River	-61.7325	45.6333	P	X	X	X	X	X	X	X	X	X	X
30	Pomquet River	-61.7992	45.6000	P	X	31	14	17	A	6	14	A	A	A
31	South River	-61.9158	45.6000	P	34	71	7	79	12	25	17	5	34	38
32	West River (Antigonish)	-61.9658	45.6167	P	395	405	207	434	128	189	166	23	138	102
33	North River	-61.9391	45.6661	.	.	.	.	.	.	.	.	.	.	.
34	MacInnis Brook	-61.9169	45.8086	.	.	.	.	.	.	.	.	.	.	.

Map #	River	Longitude (W)	Latitude (N)	Adults										
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
35	Doctors Brook	-62.1200	45.7777	.	.	.	.	.	.	.	.	.	.	.
36	Vameys Brook	-62.2685	45.7012	.	.	.	.	.	.	.	.	.	.	.
37	Baileys Brook	-62.2698	45.6921	.	.	.	.	.	.	.	.	.	.	.
38	Barneys River	-62.3492	45.6667	P	14	61	28	37	22	40	43	A	15	54
39	French River (Merigomish)	-62.4492	45.6333	P	X	X	X	X	A	X	X	X	X	X
40	Russell Brook	-62.4882	45.5803	.	.	.	.	.	.	.	.	.	.	.
41	Sutherlands River	-62.4992	45.5833	P	8	9	6	4	2	7	A	2	A	A
42	Pine Tree Brook	-62.5448	45.6011	.	.	.	.	.	.	.	.	.	.	.
43	East River (Pictou)	-62.6992	45.6500	P	254	344	118	189	39	113	112	64	167	75
44	Middle River (Pictou)	-62.7325	45.6500	P	X	3	2	X	A	X	X	X	4	0
45	West River (Pictou)	-62.7658	45.6667	P	166	134	83	83	29	34	148	24	89	64
46	Haliburton Brook	-62.7592	45.6980	.	.	.	.	.	.	.	.	.	.	.
47	Big Caribou River	-62.8430	45.7379	.	.	.	.	.	.	.	.	.	.	.
48	Toney River	-62.9025	45.7555	.	.	.	.	.	.	.	.	.	.	.
49	River John	-63.0658	45.7500	P	45	115	29	37	34	10	54	6	33	27
50	Waughs River	-63.2992	45.7333	P	37	143	11	1	14	9	34	A	27	43
51	French River	-63.3262	45.7037	.	.	.	.	.	.	.	.	.	.	.
52	Wallace River	-63.5158	45.8167	P	166	252	59	164	84	63	175	28	47	193
53	Pugwash River	-63.6658	45.8500	P	X	X	X	X	X	X	X	X	X	X
54	River Philip	-63.7325	45.8500	P	234	609	371	301	209	317	224	98	381	613
55	Shinimicas River	-63.9094	45.8664	.	X	X	X	X	X	X	X	X	X	X

Table 6. Observed number of anglers per fishing season (year), for rivers in GNS where Salmon were caught. The blue column indicates the presence and absence data that was reported in 2009 (Breau et al. 2009). 'P' indicates Salmon presence. For the 2010 to 2019 columns, information was pulled from Salmo NS (online angling license database). '0' indicates no anglers were observed. Numbers greater than '0' indicate the number of anglers observed.

Map #	River	Longitude (W)	Latitude (N)	Observed Number of Anglers										
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CAPE BRETON														
10	Chéticamp River	-60.9492	46.6667	P	6	5	3	9	4	7	6	9	8	2
14	Margaree River	-61.0992	46.4333	P	372	548	458	591	473	389	389	467	452	321
20	Mabou River	-61.3825	46.0667	P	7	13	10	10	6	2	6	4	2	3
MAINLAND NOVA SCOTIA														
27	Wrights River	-61.5175	45.6671	P	1	2	4	4	3	1	1	1	2	0
28	Tracadie River	-61.6158	45.6167	P	0	2	0	0	0	0	0	0	0	0
30	Pomquet River	-61.7992	45.6000	P	0	9	6	12	4	2	4	3	4	5
31	South River	-61.9158	45.6000	P	11	21	27	26	12	15	16	13	15	11
32	West River (Antigonish)	-61.9658	45.6167	P	77	86	97	123	85	83	74	40	66	42
38	Barneys River	-62.3492	45.6667	P	8	15	16	15	14	12	10	9	11	6
39	French River (Merigomish)	-62.4492	45.6333	P	0	0	0	0	1	0	0	0	0	0
41	Sutherlands River	-62.4992	45.5833	P	3	3	2	3	5	4	4	2	4	2
43	East River (Pictou)	-62.6992	45.6500	P	51	69	91	98	55	71	52	36	65	28
44	Middle River (Pictou)	-62.7325	45.6500	P	0	1	3	0	2	0	0	0	1	0
45	West River (Pictou)	-62.7658	45.6667	P	52	68	72	86	62	53	49	28	58	34
49	River John	-63.0658	45.7500	P	16	21	26	24	21	10	14	13	15	2
50	Waughs River	-63.2992	45.7333	P	19	34	41	28	32	16	16	18	24	8
52	Wallace River	-63.5158	45.8167	P	57	71	68	91	92	65	64	52	75	43
54	River Philip	-63.7325	45.8500	P	81	111	145	150	109	107	92	80	121	67

Table 7. Median estimates of total returns and spawners for small and large Salmon for all of SFA 18, 1970 to 2019. Estimates of returns for 1987 to 2019 are based on the 95% confidence interval of Bayesian catch rate model (Breau and Chaput 2012).

Year	Small Salmon		Large Salmon	
	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)
1970	669 (264 - 1,073)	504 (167 - 842)	7,009 (6,161 - 7,858)	1,109 (395 - 1,824)
1971	165 (65 - 265)	125 (41 - 208)	2,827 (2,456 - 3,198)	485 (173 - 797)
1972	330 (131 - 530)	249 (82 - 416)	6,509 (6,095 - 6,924)	542 (193 - 891)
1973	1,306 (516 - 2,095)	985 (325 - 1,645)	5,838 (5,376 - 6,299)	604 (215 - 992)
1974	472 (187 - 757)	356 (118 - 595)	7,541 (7,119 - 7,963)	552 (196 - 908)
1975	283 (112 - 454)	214 (71 - 357)	4,736 (4,483 - 4,989)	331 (118 - 544)
1976	755 (299 - 1,212)	570 (188 - 951)	3,901 (3,578 - 4,223)	423 (151 - 694)
1977	543 (215 - 871)	409 (135 - 684)	5,727 (5,175 - 6,280)	722 (257 - 1,187)
1978	197 (78 - 316)	148 (49 - 248)	6,578 (5,954 - 7,201)	815 (290 - 1,340)
1979	4,696 (1,857 - 7,536)	3,543 (1,170 - 5,915)	1,995 (1,676 - 2,315)	418 (149 - 688)
1980	1,314 (520 - 2,108)	991 (327 - 1,655)	5,399 (4,846 - 5,951)	722 (257 - 1,187)
1981	7,072 (2,797 - 11,348)	5,335 (1,762 - 8,908)	3,783 (3,234 - 4,332)	718 (255 - 1,181)
1982	5,436 (2,150 - 8,722)	4,101 (1,354 - 6,847)	6,077 (5,370 - 6,783)	924 (329 - 1,519)
1983	535 (212 - 858)	404 (133 - 674)	5,436 (4,848 - 6,024)	769 (273 - 1,264)
1984	1,164 (460 - 1,867)	688 (177 - 1,200)	3,606 (3,105 - 4,107)	828 (337 - 1,320)
1985	1,948 (730 - 3,167)	967 (145 - 1,788)	3,173 (1,196 - 5,150)	3,071 (1,131 - 5,010)
1986	2,409 (965 - 3,854)	896 (63 - 1,729)	8,074 (2,953 - 13,195)	7,850 (2,811 - 12,889)
1987	5,064 (1,541 - 8,586)	2,408 (422 - 4,394)	7,426 (3,177 - 11,674)	7,242 (3,078 - 11,406)
1988	4,325 (1,297 - 7,353)	1,864 (260 - 3,467)	7,197 (3,071 - 11,322)	7,000 (2,965 - 11,035)
1989	2,839 (835 - 4,843)	1,271 (174 - 2,368)	6,042 (2,558 - 9,526)	5,882 (2,471 - 9,293)
1990	3,128 (921 - 5,335)	1,338 (167 - 2,510)	5,448 (2,309 - 8,588)	5,297 (2,227 - 8,367)
1991	3,678 (1,089 - 6,266)	1,566 (199 - 2,933)	6,750 (2,832 - 10,669)	6,570 (2,735 - 10,406)
1992	3,135 (936 - 5,335)	1,226 (131 - 2,320)	6,800 (2,895 - 10,706)	6,601 (2,787 - 10,416)
1993	3,492 (1,085 - 5,900)	1,392 (200 - 2,583)	3,806 (1,644 - 5,969)	3,698 (1,585 - 5,811)
1994	2,133 (626 - 3,640)	966 (135 - 1,798)	5,757 (2,423 - 9,090)	5,610 (2,344 - 8,876)

Year	Small Salmon		Large Salmon	
	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)	Estimated returns (Avg; 5th and 95th percentiles)	Estimated spawners (Avg; 5th and 95th percentiles)
1995	1,757 (509 - 3,006)	820 (114 - 1,527)	4,331 (1,812 - 6,850)	4,222 (1,753 - 6,691)
1996	7,837 (2,241 - 13,433)	4,453 (815 - 8,090)	9,174 (3,806 - 14,542)	8,981 (3,701 - 14,261)
1997	1,850 (518 - 3,183)	1,001 (160 - 1,841)	10,019 (4,122 - 15,917)	9,810 (4,008 - 15,611)
1998	2,110 (588 - 3,631)	1,148 (183 - 2,113)	6,073 (2,494 - 9,651)	5,939 (2,422 - 9,457)
1999	2,330 (649 - 4,011)	1,480 (291 - 2,669)	4,637 (1,892 - 7,382)	4,556 (1,848 - 7,264)
2000	2,040 (556 - 3,523)	1,324 (254 - 2,393)	4,326 (1,735 - 6,917)	4,257 (1,698 - 6,816)
2001	2,673 (736 - 4,610)	1,678 (317 - 3,040)	4,996 (2,023 - 7,969)	4,911 (1,977 - 7,845)
2002	2,789 (757 - 4,821)	1,798 (340 - 3,256)	3,689 (1,472 - 5,905)	3,628 (1,439 - 5,817)
2003	2,601 (703 - 4,498)	1,707 (327 - 3,088)	7,119 (2,861 - 11,378)	7,006 (2,800 - 11,212)
2004	3,664 (988 - 6,339)	2,248 (391 - 4,106)	7,917 (3,170 - 12,665)	7,777 (3,094 - 12,460)
2005	2,597 (723 - 4,472)	1,456 (242 - 2,669)	6,490 (2,649 - 10,331)	6,357 (2,576 - 10,137)
2006	2,894 (786 - 5,003)	1,684 (276 - 3,092)	6,288 (2,539 - 10,038)	6,163 (2,471 - 9,855)
2007	2,387 (650 - 4,123)	1,460 (260 - 2,661)	4,348 (1,747 - 6,949)	4,269 (1,705 - 6,834)
2008	4,264 (1,127 - 7,400)	2,237 (273 - 4,200)	6,660 (2,638 - 10,683)	6,511 (2,557 - 10,465)
2009	1,130 (267 - 1,992)	660 (69 - 1,251)	5,099 (1,977 - 8,222)	4,998 (1,922 - 8,074)
2010	3,056 (783 - 5,330)	1,655 (192 - 3,118)	6,798 (2,664 - 10,933)	6,651 (2,584 - 10,718)
2011	4,015 (1,065 - 6,965)	2,354 (365 - 4,343)	11,332 (4,518 - 18,146)	11,111 (4,398 - 17,825)
2012	842 (184 - 1,501)	624 (92 - 1,156)	2,889 (1,084 - 4,693)	2,851 (1,064 - 4,639)
2013	1,568 (394 - 2,743)	995 (152 - 1,837)	6,084 (2,400 - 9,768)	5,977 (2,342 - 9,612)
2014	1,084 (253 - 1,915)	814 (139 - 1,488)	4,216 (1,623 - 6,809)	4,164 (1,595 - 6,734)
2015	2,709 (687 - 4,731)	2,075 (420 - 3,730)	5,879 (2,276 - 9,483)	5,818 (2,242 - 9,394)
2016	1,443 (341 - 2,544)	1,427 (334 - 2,520)	5,561 (2,130 - 8,992)	5,501 (2,097 - 8,904)
2017	2,127 (533 - 3,722)	2,097 (520 - 3,674)	4,113 (1,537 - 6,690)	4,062 (1,509 - 6,615)
2018	1,821 (439 - 3,204)	1,793 (427 - 3,160)	6,857 (2,609 - 11,104)	6,759 (2,556 - 10,962)
2019	2,019 (472 - 3,566)	1,983 (457 - 3,509)	5,701 (2,134 - 9,268)	5,611 (2,085 - 9,136)

Table 8. Area of occupancy of Atlantic Salmon for rivers of Salmon Fishing Area 18 flowing into the Northumberland Strait. Rivers are listed from East to West (see Figure 2 for map). Table modified from DFO 2018. The conservation egg requirement column is the value used prior to implementing the precautionary approach to Atlantic Salmon management. It was estimated as the product of 2.4 eggs per m² and fluvial area. Under the precautionary approach, the lower reference point (LRP) egg requirement is estimated as the product of 1.52 eggs per m² and fluvial area. Dashes indicate information was not available.

Map number	River	Longitude (W)	Latitude (N)	Conservation Egg requirement (million)	LRP Egg Requirement (million)	Drainage area (km²)	Fluvial area (million m²)
Cape Breton							
1	Salmon River	-60.4936	47.0003	-	-	-	-
2	Blair River	-60.6992	46.9167	0.230	0.148	58	0.0974
3	Red River	-60.7658	46.8500	0.140	0.089	35	0.0588
4	Grande Anse River	-60.7992	46.8333	0.200	0.130	51	0.0852
5	Mackenzies River	-60.8325	46.8167	0.300	0.189	75	0.1244
6	Fishing Cove River	-60.8825	46.8000	0.130	0.079	31	0.0521
7	Corneys Brook	-60.9254	46.7237	-	-	-	-
8	Anthony Aucoin's Brook	-60.9528	46.6734	-	-	-	-
9	Rigwash Brook	-60.9528	46.6734	-	-	-	-
10	Chéticamp River	-60.9492	46.6667	0.770	0.489	298	0.3220
11	Aucoin Brook	-60.9809	46.6068	-	-	-	-
12	Fiset Brook	-61.0053	46.6028	-	-	-	-
13	Farm Brook	-61.0154	46.5821	-	-	-	-
14	Margaree River	-61.0992	46.4333	6.710	4.252	1,100	2.7976
15	Smiths Brook	-61.2684	46.2639	-	-	-	-
16	Broad Cove River	-61.3029	46.1654	-	-	-	-
17	Mill Brook	-61.4488	46.1431	-	-	-	-
18	Northeast Mabou River	-61.4158	46.0833	1.020	0.645	254	0.4242
19	Southwest Mabou River	-61.4325	46.0667	0.370	0.234	123	0.1540
20	Mabou River	-61.3825	46.0667	0.560	0.357	188	0.2351
21	Captains Brook	-61.5041	45.9757	-	0.086	-	-
22	Judique Intervale Brook	-61.4742	45.9000	0.180	0.112	44	0.0738
23	Graham River	-61.4912	45.8611	-	-	-	-
24	Campbells Brook	-61.4843	45.8491	-	-	-	-
25	Chisholm Brook	-61.4825	45.8167	0.070	0.042	17	0.0279
26	Mill Brook (Strait of Canso)	-61.4219	45.6695	-	-	-	-
Mainland Nova Scotia							
27	Wrights River	-61.5175	45.6671	-	-	-	-
28	Tracadie River	-61.6158	45.6167	0.130	0.080	120	0.0525
29	Afton River	-61.7325	45.6333	0.050	0.029	43	0.0189
30	Pomquet River	-61.7992	45.6000	0.190	0.117	176	0.0769

Map number	River	Longitude (W)	Latitude (N)	Conservation Egg requirement (million)	LRP Egg Requirement (million)	Drainage area (km²)	Fluvial area (million m²)
31	South River	-61.9158	45.6000	0.230	0.144	217	0.0950
32	West River (Antigonish)	-61.9658	45.6167	1.150	0.730	353	0.4803
33	North River	-61.9391	45.6661	-	-	-	-
34	MacInnis Brook	-61.9169	45.8086	-	-	-	-
35	Doctors Brook	-62.1200	45.7777	-	-	-	-
36	Vameys Brook	-62.2685	45.7012	-	-	-	-
37	Baileys Brook	-62.2698	45.6921	-	-	-	-
38	Barneys River	-62.3492	45.6667	0.510	0.323	156	0.2128
39	French River (Merigomish)	-62.4492	45.6333	0.420	0.264	128	0.1740
40	Russell Brook	-62.4882	45.5803	-	-	-	-
41	Sutherlands River	-62.4992	45.5833	0.160	0.101	-	0.0666
42	Pine Tree Brook	-62.5448	45.6011				
43	East River (Pictou)	-62.6992	45.6500	1.750	1.108	536	0.7291
44	Middle River (Pictou)	-62.7325	45.6500	0.710	0.449	217	0.2953
45	West River (Pictou)	-62.7658	45.6667	0.800	0.506	245	0.3326
46	Haliburton Brook	-62.7592	45.6980	-	-	-	-
47	Big Caribou River	-62.8430	45.7379	-	-	-	-
48	Toney River	-62.9025	45.7555	-	-	-	-
49	River John	-63.0658	45.7500	0.950	0.604	292	0.3973
50	Waughs River	-63.2992	45.7333	0.750	0.476	230	0.3132
51	French River	-63.3262	45.7037	-	0.426	-	-
52	Wallace River	-63.5158	45.8167	1.500	0.947	458	0.6229
53	Pugwash River	-63.6658	45.8500	0.590	0.375	182	0.2470
54	River Philip	-63.7325	45.8500	2.310	1.462	726	0.9621
55	Shinimicas River	-63.9094	45.8664	-	-	-	-

Table 9. Summary of threats to, and rating of effects on recovery and/or persistence of Atlantic Salmon in SFA 18 (modified from DFO and MNRF 2009). Threat scope (% of population affected) categories are as follows: PERVASIVE 71% - 100%; LARGE 31% - 70%; RESTRICTED 11% - 30%; SMALL 1% - 10%; NEGLIGIBLE < 1%; UNKNOWN. Threat timing categories are as follows: High – Continuing threat; Moderate – Short-term future; Low – Long-term future; Insignificant/Negligible – in past and unlikely to return. Threat severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %) categories are as follows: EXTREME 71% - 100%; SERIOUS 31% – 70%; MODERATE 11% - 30%; SLIGHT 1% - 10%; NEGLIGIBLE < 1%; NEUTRAL or BENEFIT POTENTIAL – Not a threat; UNKNOWN . NA means the data is not available.

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %)	Comments
Residential and Commercial Development	Housing and Urban Areas	Small	low	Slight	Some inadequate facilities and occasional system failures.
	Commercial and Industrial Areas	NA	NA	NA	None apparent.
	Ecotourism and Recreation	Small	High	Negligible	Construction of docks and clearing of land in the riparian zone; of greater relevance if existing mitigations measures are not followed.
	CUMULATIVE EFFECT	Small	High	Slight	-
Agriculture and Aquaculture	Annual and perennial non-timber crops	Negligible	Insignificant	Negligible	Enforcement/monitoring of existing regulations; compensations when required.
	Livestock farming and ranching	Negligible	Insignificant	Negligible	Potential impacts from direct stream contact by farm animals/vehicles.
	Marine and freshwater aquaculture	Unknown	Insignificant	Unknown	Although not directly relevant in this SFA, there exists potential for interaction at sea with populations that may be affected by aquaculture (escapes from finfish facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression).
	CUMULATIVE EFFECT	Unknown	NA	NA	-

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %)	Comments
Energy Production and Mining	Oil and Gas Drilling and Renewable Energy	Negligible	Unknown	Negligible	None apparent.
	Mining and Quarrying	Negligible	Low	Negligible	Historical impacts.
	CUMULATIVE EFFECT	Negligible	Low	Negligible	Potential impacts from future energy or resource extraction projects.
Transportation and Service Corridors	Roads and railroads	Pervasive	High	Moderate	A high number of roads and stream crossings exist in most watersheds throughout the SFA. The threat severity would need to take into account the cumulative impact these roads and stream crossings have on hydrology, water quality, habitat, and fish passage.
	Utility and service lines	Negligible	Insignificant	Negligible	Pipelines and cleared power transmission exist throughout the SFA.
	Shipping lanes	Negligible	Insignificant	Negligible	None apparent.
	CUMULATIVE EFFECT	Pervasive	High	Moderate	-
Biological Resource Use	Logging and wood harvest	Pervasive	High	Moderate	Where forestry occurs in SFA 18, the land is intensively managed (clear-cutting, planting, pesticide spraying) for timber resource extraction. The activities are conducted with measures in place to mitigate effects on watercourses and fish habitat, but the landscape across all major watersheds is altered from its natural state as a result of clear-cutting and road construction.

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %)	Comments
	First Nations food, social and ceremonial fisheries	Small	High	Slight	Control harvest through agreements between DFO and First Nations.
	Recreational	Restricted	High	Slight	Retention of large Salmon in SFA 18 has not been allowed since 1984. In 2015, all retention was prohibited and the Salmon fishery became catch and release (C&R) only (DFO 2016). Minimal mortality is associated with C&R angling. The model for the Margaree River stock assessment assumes 5% mortality from C&R (Breau and Chaput 2012).
	Poaching	Small	High	Slight	Poaching does occur within the SFA; enforcement actively targets areas of known non-compliance.
	Commercial	NA	Insignificant	NA	Targeted commercial fisheries closed.
	Greenland / St Pierre – Miquelon mixed stock harvests	Small	High	Slight	Agreements are in place to reduce harvest in Greenland. Direct impact on this SFA may vary annually due to mixed stock fishery.
	Bycatch in other recreational fisheries	Negligible	High	Negligible	All bycatch is mandatory release.
	Bycatch in commercial fisheries near shore	Small	High	Slight	All bycatch is mandatory release.
	Bycatch in commercial fisheries offshore	Unknown	High	Unknown	All bycatch is mandatory release.
	CUMULATIVE EFFECT	Pervasive	High	Moderate	-
Human Intrusions and Disturbance	Recreational activities	Negligible	High	Unknown	ATV and other vehicles crossing watercourse.

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %)	Comments
	CUMULATIVE EFFECT	Negligible	High	Unknown	-
Natural Systems Modifications	Fire and fire suppression	Negligible	Insignificant	Negligible	-
	Dam and water management/use	Unknown	High	Unknown	Middle and West River Pictou both have causeway dams that act as migration barriers under low water conditions (McLeod 1971). West River dam is no longer a barrier due to gates remaining open in recent years. Other dams likely present throughout SFA 18.
	Other ecosystem modifications	Negligible	Insignificant	Negligible	-
	CUMULATIVE EFFECT	Unknown	High	Unknown	-
Invasive and Other Problematic Species	Invasive non-native /alien species	Pervasive	High	Unknown	Smallmouth bass have been documented in the Pugwash River system (Big Lake), the Middle River system (Middle River Reservoir and Lansdowne Lake), and in the Margaree River system (Lake Ainslie; Leblanc 2010). Brown trout juveniles have been documented in the Margaree River, West River Antigonish, East River Pictou, River Philip, Barneys River, and Wallace River.
	Problematic native species	NA	NA	NA	None apparent.
	Introduced genetic material	Unknown	Moderate	Unknown	Hatchery programs release hatchery Salmon juveniles into various rivers within SFA 18.
	CUMULATIVE EFFECT	Pervasive	High	Unknown	-

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by "x" %)	Comments
Pollution and Contaminants	Household sewage and urban wastewater	Negligible	Insignificant	Negligible	Threat level assumes adequate and properly functioning systems.
	Industrial and military effluents	Negligible	Insignificant	Negligible	Threat level assumes adequate and properly functioning systems.
	Agricultural and forestry effluents	Negligible	Insignificant	Negligible	Threat level assumes adequate and properly functioning systems.
	Garbage and solid waste	Negligible	Insignificant	Negligible	Threat level assumes adequate and properly functioning systems.
	Air-borne pollution	Negligible	Insignificant	Negligible	Threat level assumes adequate and properly functioning systems.
	Excess Energy	NA	Insignificant	NA	-
	CUMULATIVE EFFECTS	Negligible	Insignificant	Negligible	-
Geological Events	Volcanoes	NA	Insignificant	NA	-
	Earthquakes and Tsunamis	Negligible	Insignificant	Negligible	Rare occurrence.
	Avalanches and Landslides	Negligible	Insignificant	Negligible	Rare occurrence.
	CUMULATIVE EFFORT	Negligible	Insignificant	Negligible	-
Climate Change	Habitat shifting and alteration	Pervasive	High	Extreme	Extreme weather events can impact hydrology and/or habitat, changing climate may have effect on short and long term conditions in freshwater and marine habitats.
	Droughts	Pervasive	High	Extreme	Extreme low flow and high water temperatures.
	Temperature extremes	Pervasive	High	Extreme	Summer temperatures are increasing and contributing to higher water temperatures.
	Storms and flooding	Restricted	High	Moderate	Storms may lead to increase in erosion and sedimentation (washouts, improper sized culverts, bridges).

Threat category	Specific threat (with examples)	Threat Scope (% of population affected)	Threat Timing	Threat Severity (likelihood to destroy/reduce/degrade occurrences or habitat by “x” %)	Comments
	CUMULATIVE EFFECT	Pervasive	High	Extreme	-

Table 60. Stocking information for SFA 18 provided by the province of NS.

River	Year	Life Stage Stocked					Total
		Eggs	Fingerling	Fry	Parr	Smolt	
Graham's	2018	-	-	-	5,700	-	5,700
Mabou	2007	-	-	10,000	-	-	10,000
Mabou	2008	-	-	9,100	-	-	9,100
Mabou	2009	-	-	10,000	11,700	-	21,700
Mabou	2016	-	-	-	12,000	-	12,000
Mabou	2017	-	-	-	16,500	-	16,500
Mabou	2018	-	-	-	29,000	-	29,000
Mabou	2020	-	-	-	6,400	-	6,400
Margaree	2008	-	-	-	121,200	42,900	164,100
Margaree	2009	-	-	-	111,700	44,700	156,400
Margaree	2010	-	-	-	118,100	37,300	155,400
Margaree	2011	-	-	-	110,200	32,400	142,600
Margaree	2012	-	-	-	100,000	31,000	131,000
Margaree	2013	-	-	-	-	35,000	35,000
Margaree	2014	-	-	-	100,000	40,000	140,000
Margaree	2015	-	-	-	83,000	72,000	155,000
Margaree	2016	-	-	-	14,200	33,000	47,200
Margaree	2017	-	-	-	190,000	94,800	284,800
Margaree	2018	-	-	-	-	84,600	84,600
Margaree	2019	-	-	-	111,000	59,500	170,500
Margaree	2020		-	-	113,300	62,000	175,300
Philip	2007	-	-	9,500	24,000	-	33,500
Philip	2008	-	-	-	19,500	13,000	32,500
Philip	2009	-	-	-	25,000	12,100	37,100
Waugh's	2010	15000	-	-	16,300	-	31,300
Waugh's	2011	-	-	9,700	3,000	-	12,700
Waugh's	2012	-	-	16,000	27,000	-	43,000
Waugh's	2013	-	-	-	24,000	-	24,000
Waugh's	2014	-	-	10,000	35,500	-	45,500
West (Antigonish)	2016	-	-	5,400	9,000	-	14,400
West (Antigonish)	2017	-	-	-	8,300	-	8,300
West (Antigonish)	2018	-	-	3,300	17,500	-	20,800
West (Antigonish)	2020	-	-	-	12,100	-	12,100
West (Pictou)	2007	-	12700	15,000	-	-	27,700
West (Pictou)	2008	-	-	34,500	8,100	-	42,600
West (Pictou)	2009	-	-	28,000	2,300	-	30,300
West (Pictou)	2018	-	-	2,000	-	-	2,000
West (Pictou)	2019	-	-	2,000	-	-	2,000
West (Pictou)	2020	-	-	10,000	-	-	10,000

FIGURES

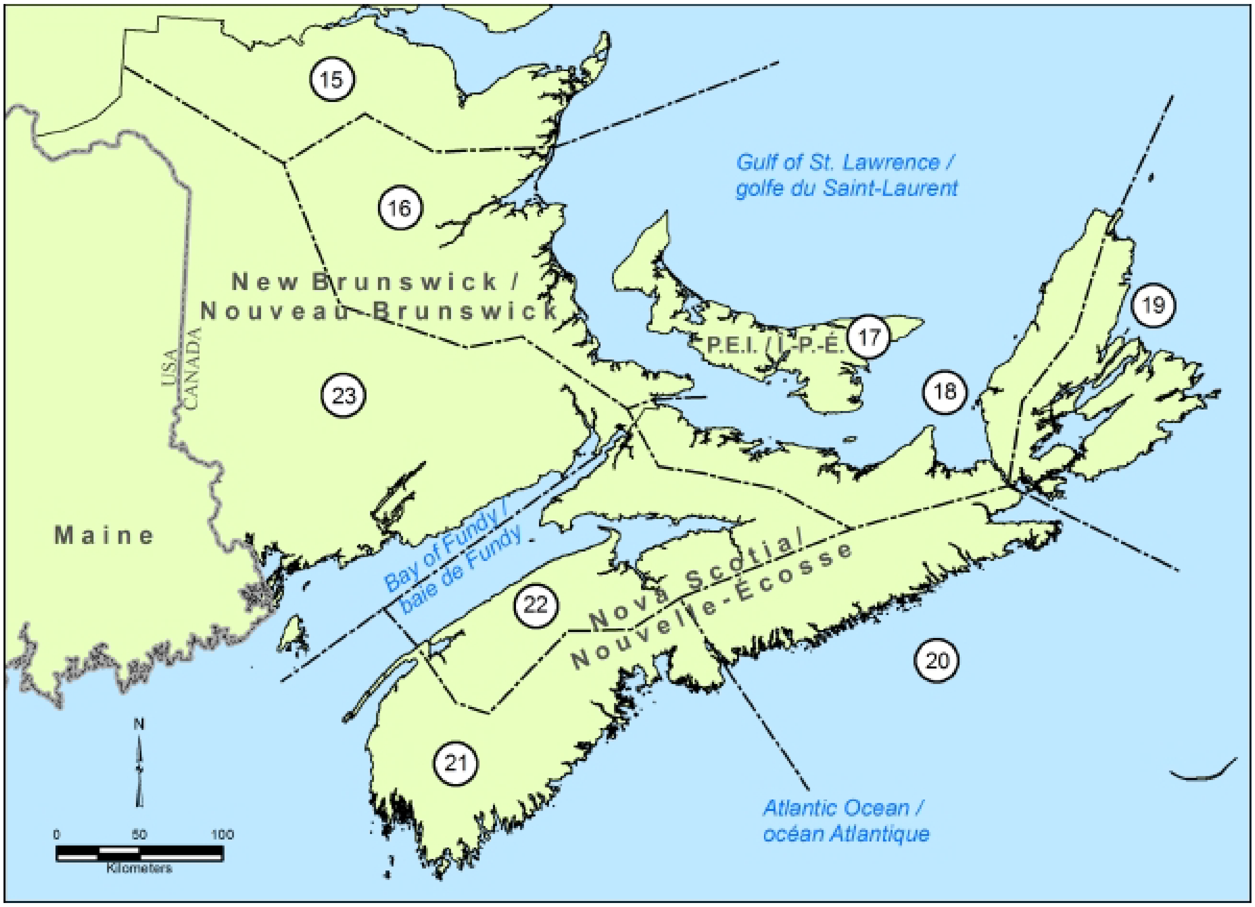

Figure 1. Salmon Fishing Areas in eastern Canada.

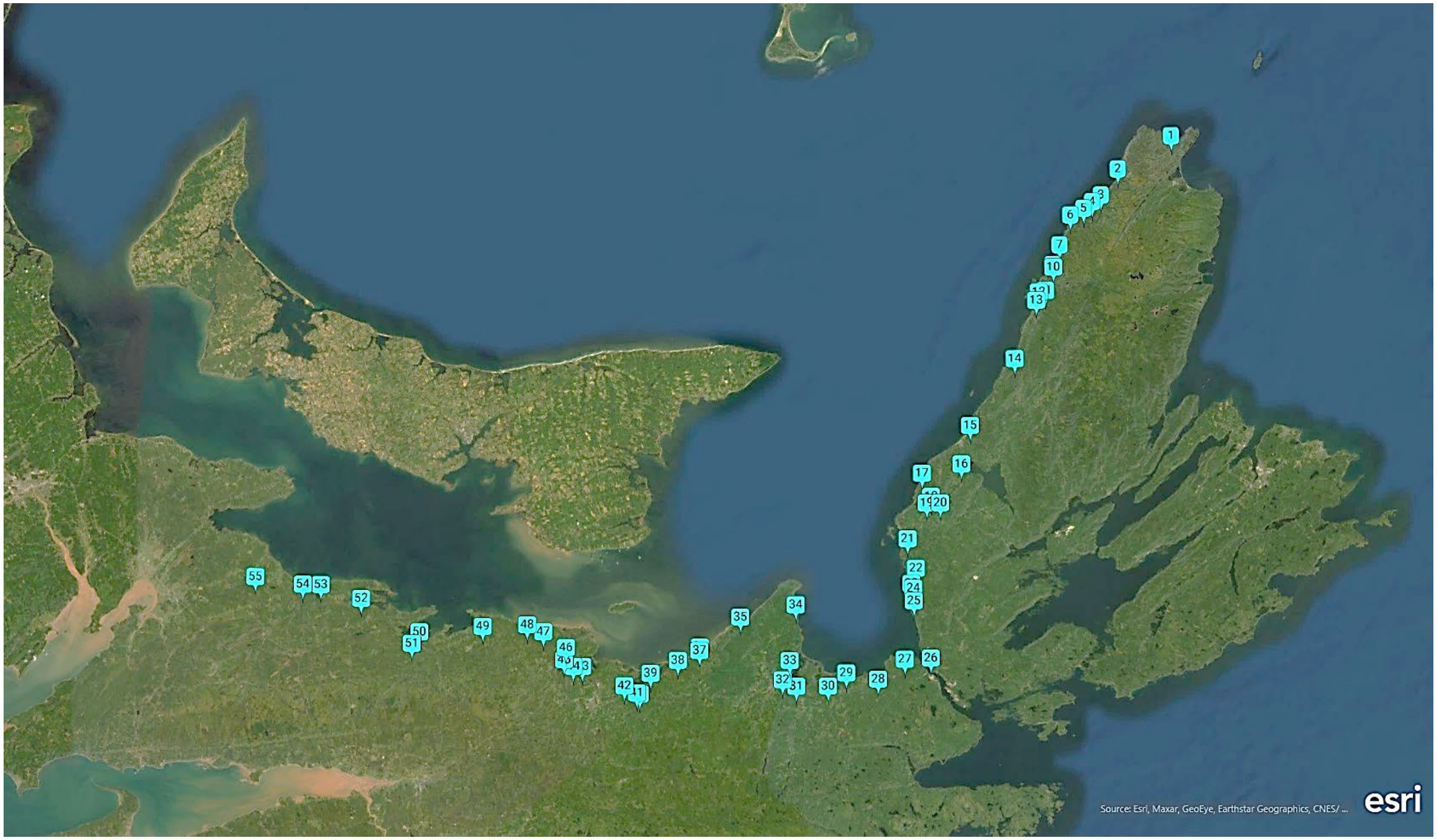

Figure 2. Potential Atlantic Salmon rivers in Gulf Nova Scotia (SFA 18). Numbers refer to numbered rivers in Table 4. Numbering is sequential from East to West.

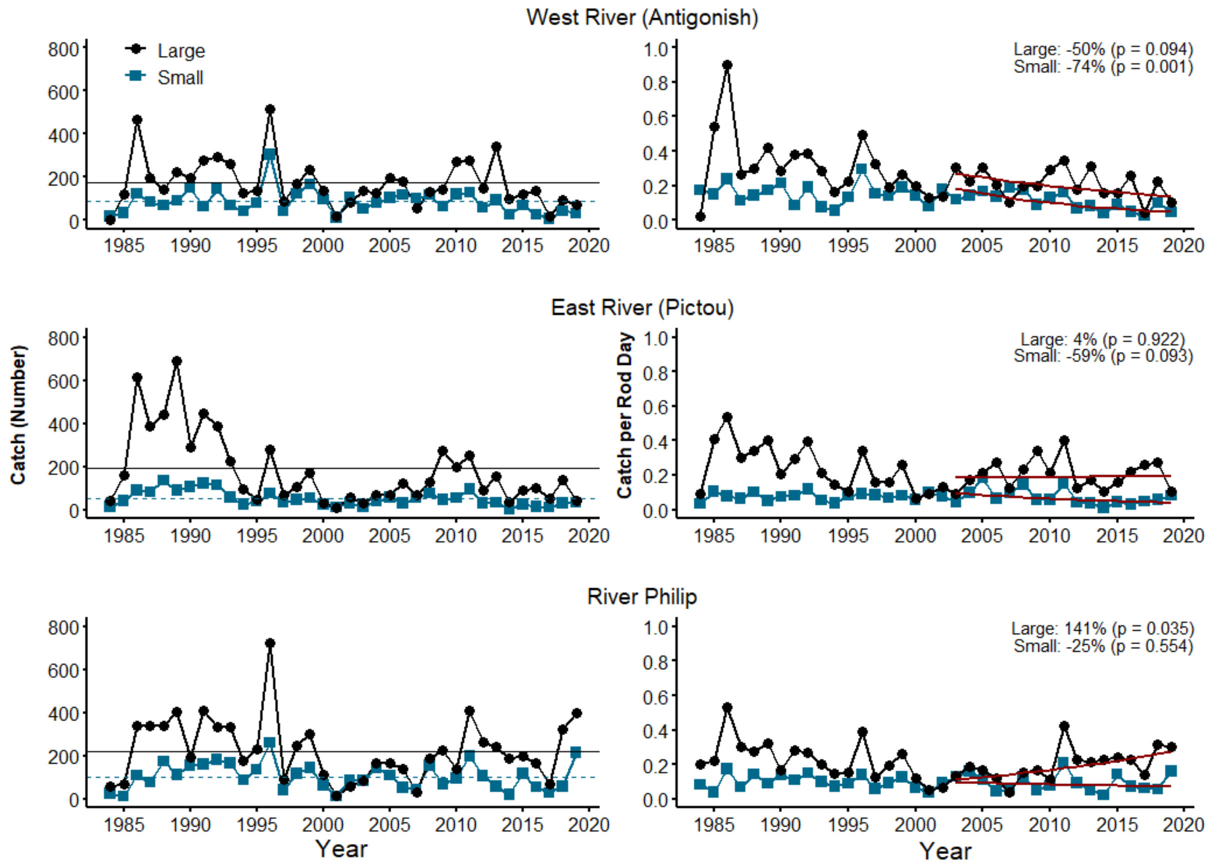

Figure 3. Estimated catches (left panels) and catch rates (catch per rod day; right panels) of large Salmon and small Salmon from the recreational fishery in the three largest rivers of SFA 18A, 1984 to 2019. In the left panels, the horizontal lines are the average catch for large Salmon (solid) and for small Salmon (dashed line) for the time series (1984 to 2018). The trend line (exponential regression, red line) in the median of the estimated catch rates over the previous 16-year time period (2003 to 2019). The corresponding percent change over that period are shown in each panel on the right with associated p-values in parenthesis (p < 0.05 is considered significant).

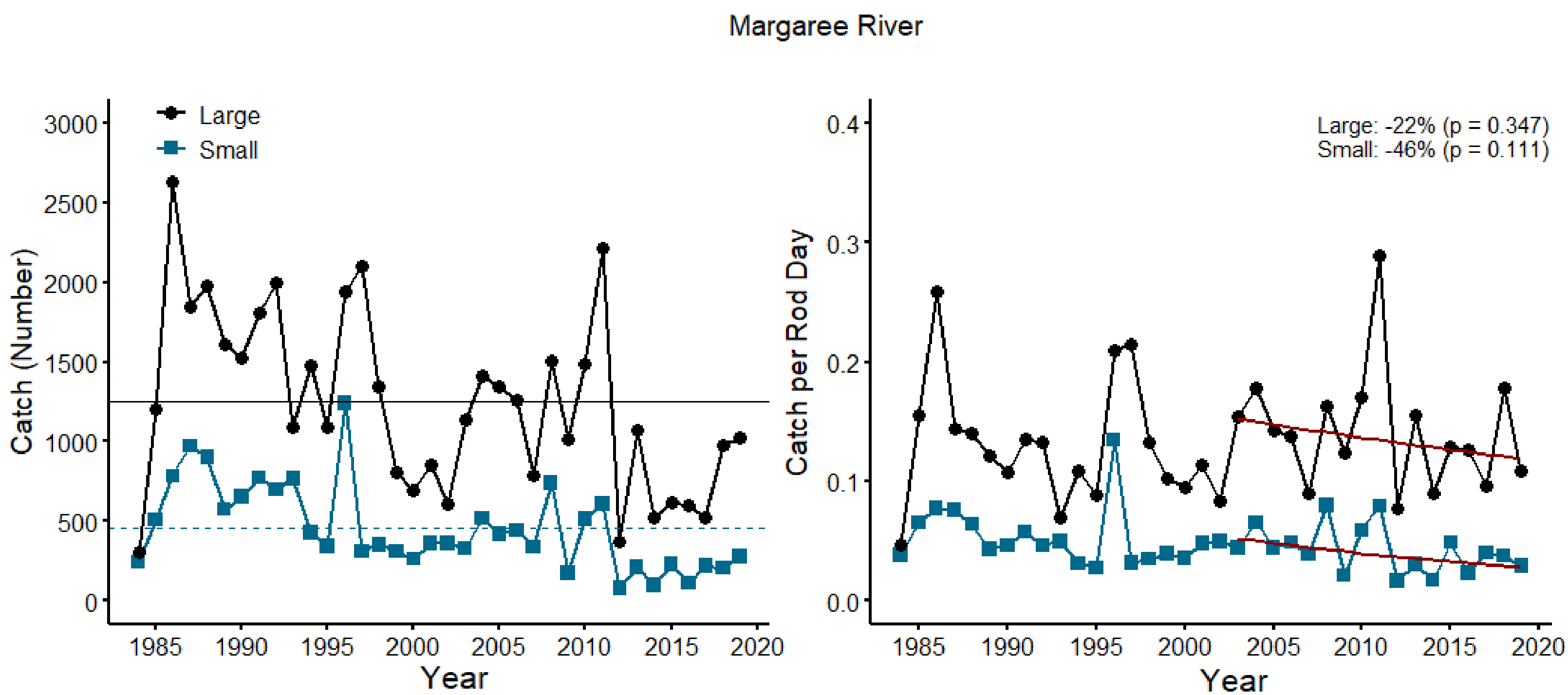

Figure 4. Estimated catch (left) and catch rates (catch per rod day; right) of large Salmon and small Salmon from the Margaree River recreational fishery, 1984 to 2019. The horizontal lines are the average catch for large Salmon (solid) and for small Salmon (dashed line) for the time series (1984 to 2018). The trend line (exponential regression, red line) in the median of the estimated catch rates over the previous 16-year time period (2003 to 2019) and the corresponding percent change over that period are shown in each panel on the right

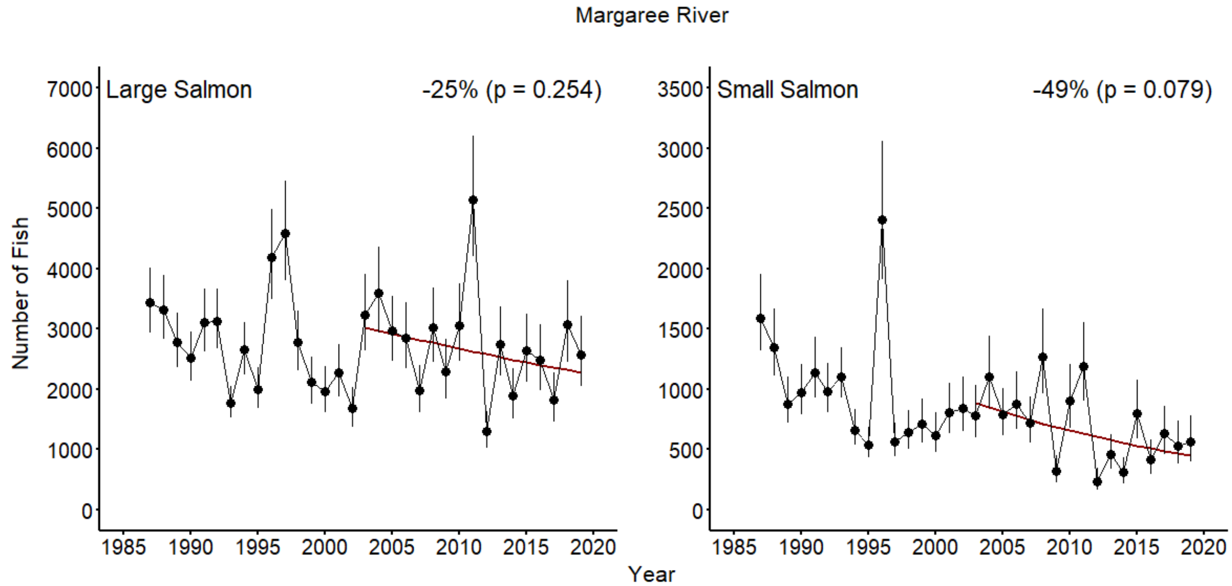

Figure 5. Posterior distributions (medians; 5th to 95th percentile range) of estimated returns of large Salmon (left panel) and small Salmon (right panel) to the Margaree River, 1987 to 2019. The trend line (exponential regression, red line) in the median estimated returns over the previous 16-year time period (2003 to 2019). The percent change over that period is shown for each size group in each pane, along with the corresponding p-value (p<0.05 is considered significant).

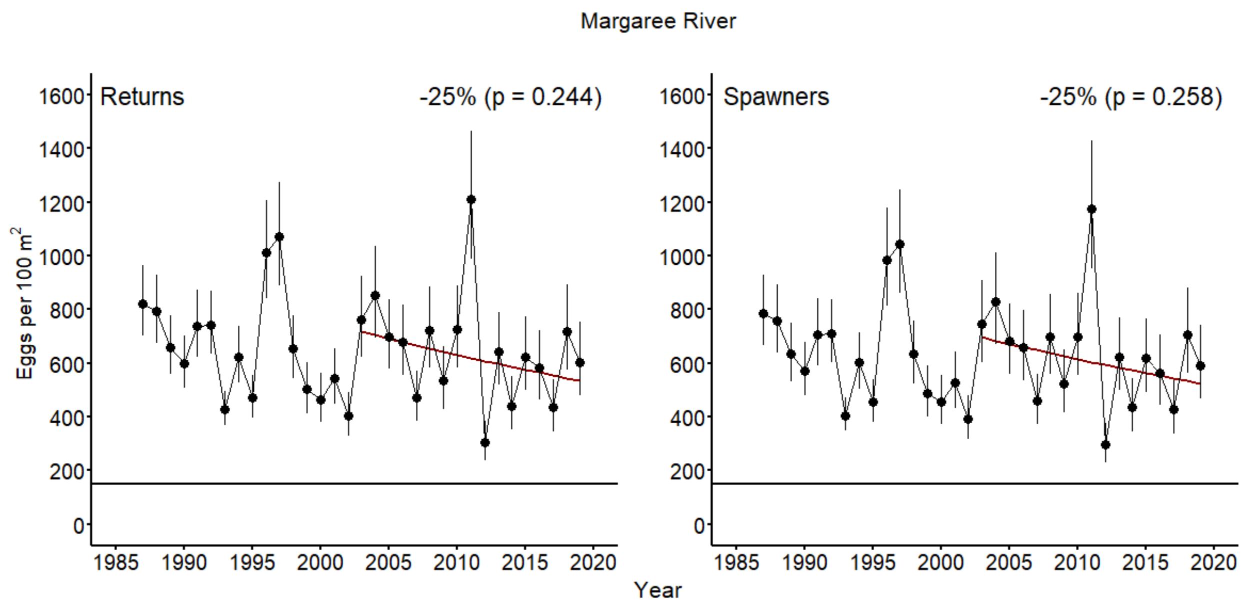

Figure 6. Median and 5th to 95th percentile range of the estimated number of eggs (expressed per 100 m² of habitat) in the returns (left panel) and spawners (right panel) of small and large Salmon combined to the Margaree River, 1987 to 2019. The LRP value (152 eggs per 100 m²) is shown as the solid horizontal line. The trend line (exponential regression, red line) in the median of the estimated eggs for large Salmon and small Salmon combined over the previous 16-year time period (2003 to 2019). The percent change over that period is shown in each panel, along with the corresponding p-value in parenthesis (p<0.05 is considered significant).

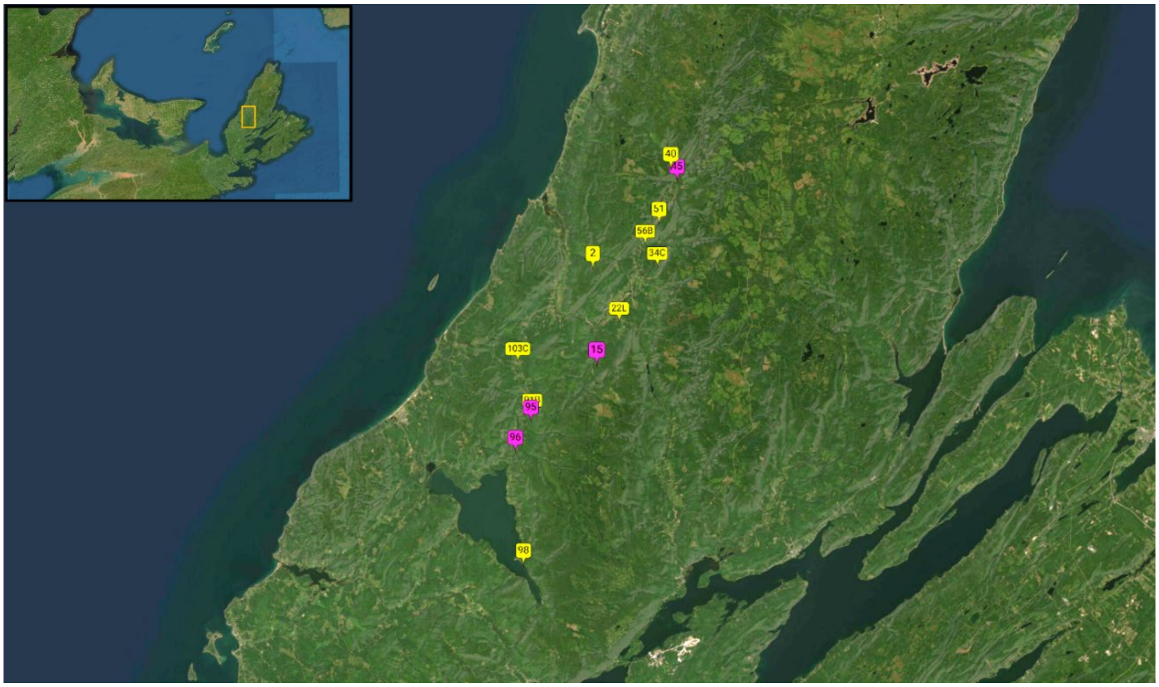

Figure 7. Map illustrating the locations of the Margaree River electrofishing sites. Yellow icons represent catch per unit effort (CPUE) sites, while pink icons represent closed sites used to calibrate the CPUE sites. The number within the icon indicates the site number and corresponds to the coordinates in Table 2.

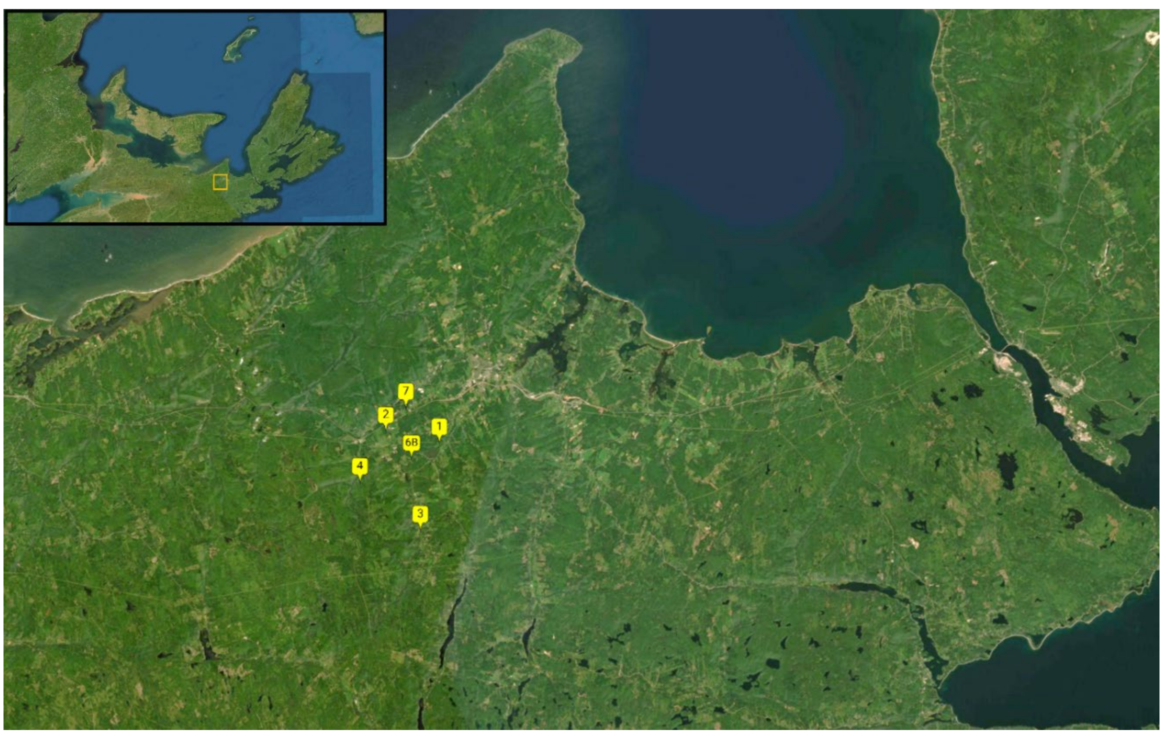

Figure 8. Map illustrating the locations of the West River Antigonish electrofishing sites. Yellow icons represent catch per unit effort (CPUE) sites. The number within the icon indicates the site number and corresponds to the coordinates in Table 3.

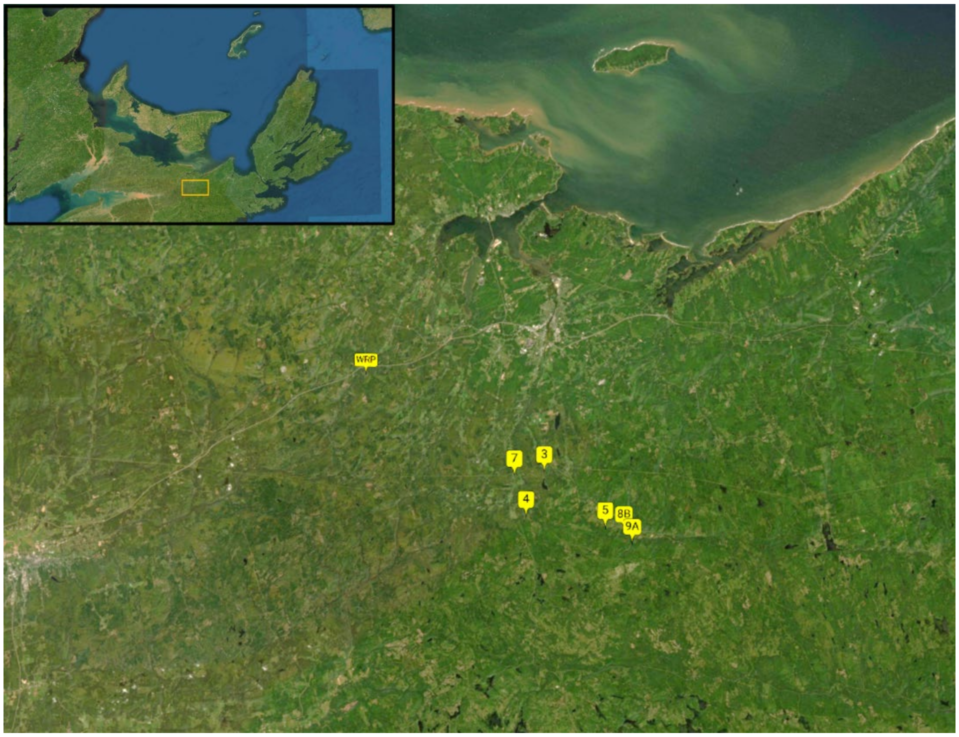

Figure 9. Map illustrating the locations of the East River Pictou electrofishing sites, plus one site on West River Pictou. Yellow icons represent catch per unit effort (CPUE) sites. The number within the icon indicates the site number and corresponds to the coordinates in Table 3.

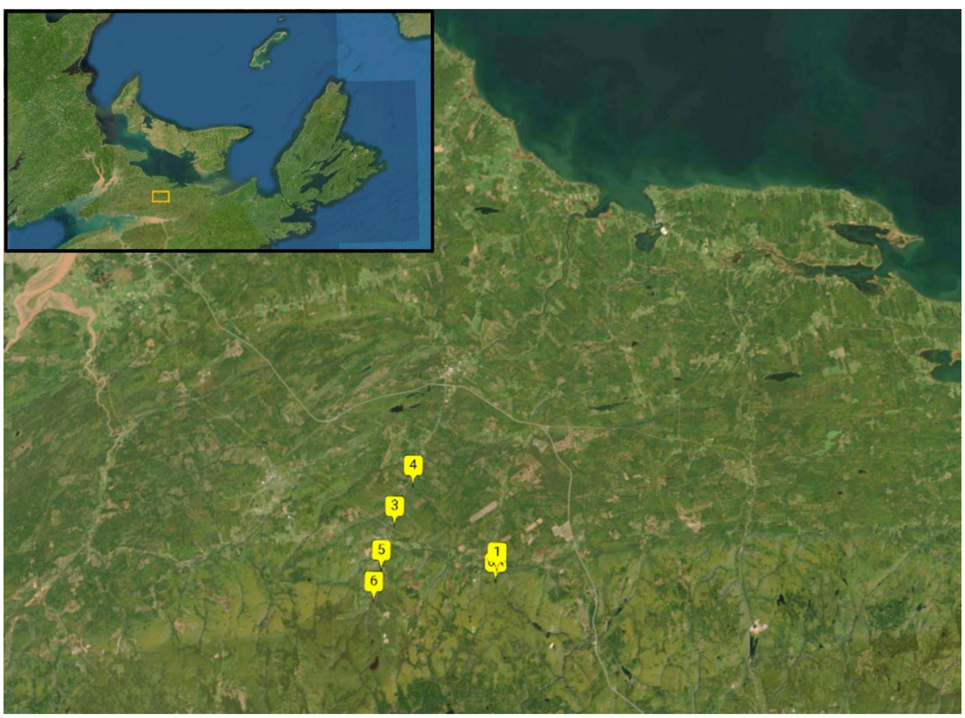

Figure 10. Map illustrating the locations of the River Philip electrofishing sites. Yellow icons represent catch per unit effort (CPUE) sites. The number within the icon indicates the site number and corresponds to the coordinates in Table 3.

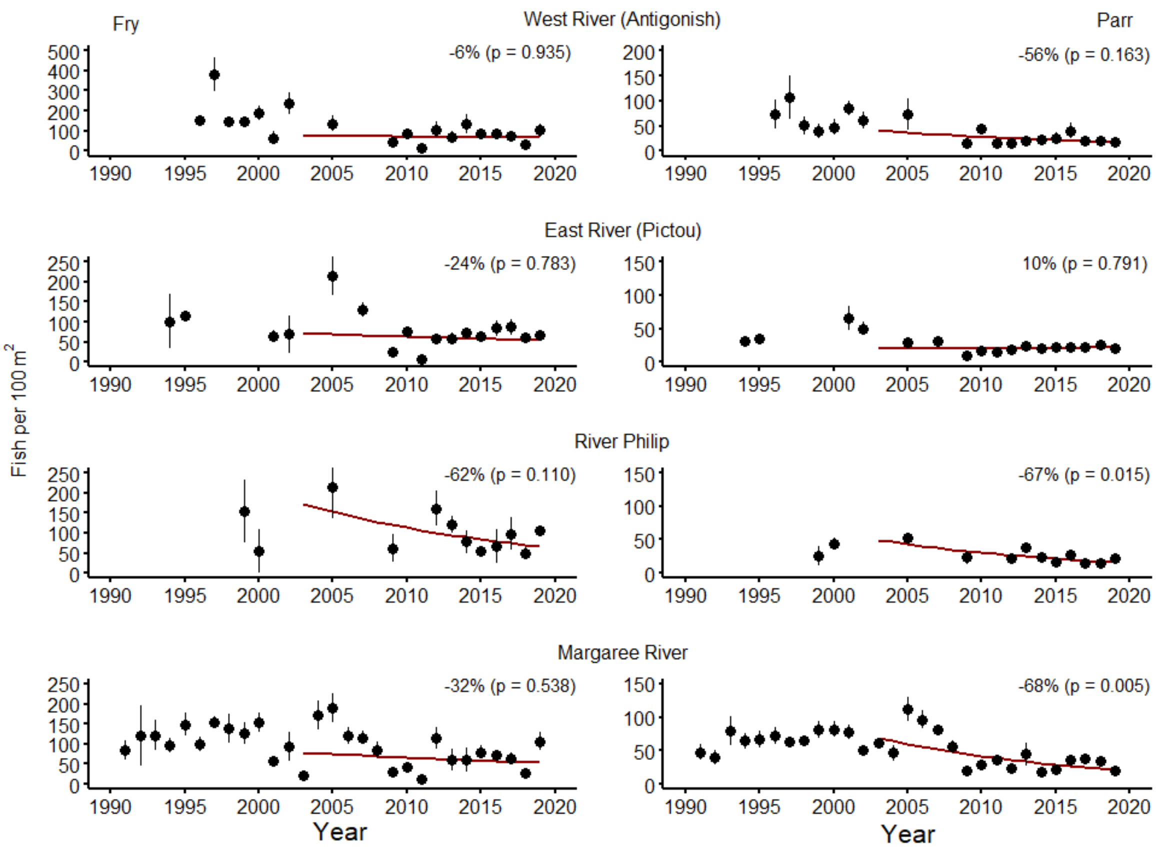

Figure 11. Mean juvenile Atlantic Salmon densities (fish per 100 m²) for fry (left panels) and parr (right panels; small and large size groups combined) for sites sampled in the West River (Antigonish; top row), East River (Pictou; second row), River Philip (third row) and Margaree River (bottom row). Only years for which at least three sites per river were sampled are presented. Vertical bars are ± one standard error. The trend line (exponential regression, red line) in the median of the estimated densities over the previous 16-year time period (2003 to 2019). The percent change over that period are shown in each panel along with the corresponding percent change in parenthesis (p<0.05 is considered significant). Note different range in y-axes for fry and parr, as well as the difference in axes range for West River (Antigonish).

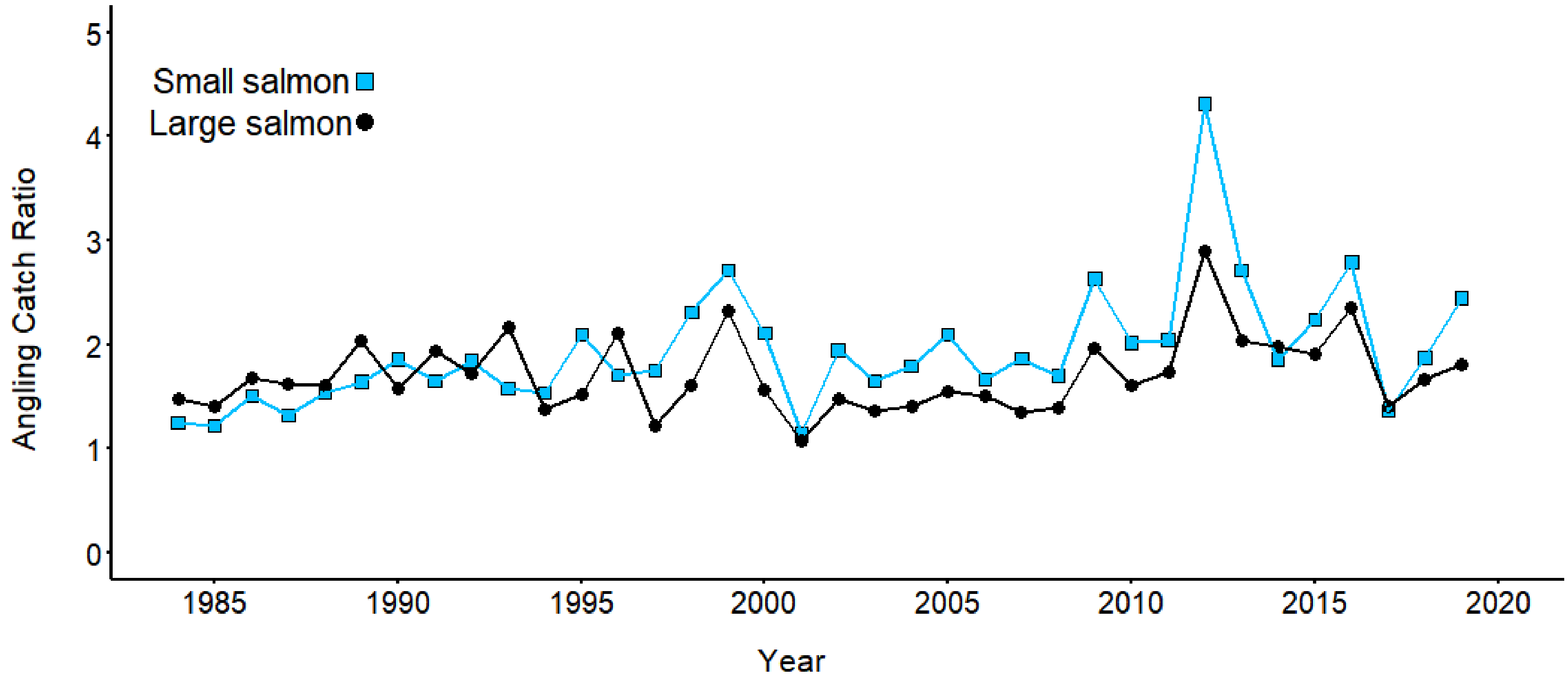

Figure 12. Angling catch ratio for small and large Atlantic Salmon in SFA 18, 1984 to 2019. The catch ratio is determined by dividing catches from all monitored rivers in gulf Nova Scotia by catches from the Margaree River. The blue line and squares represent the catch ratio for small Salmon, while the black line and circles represents the catch ratio for large Salmon.

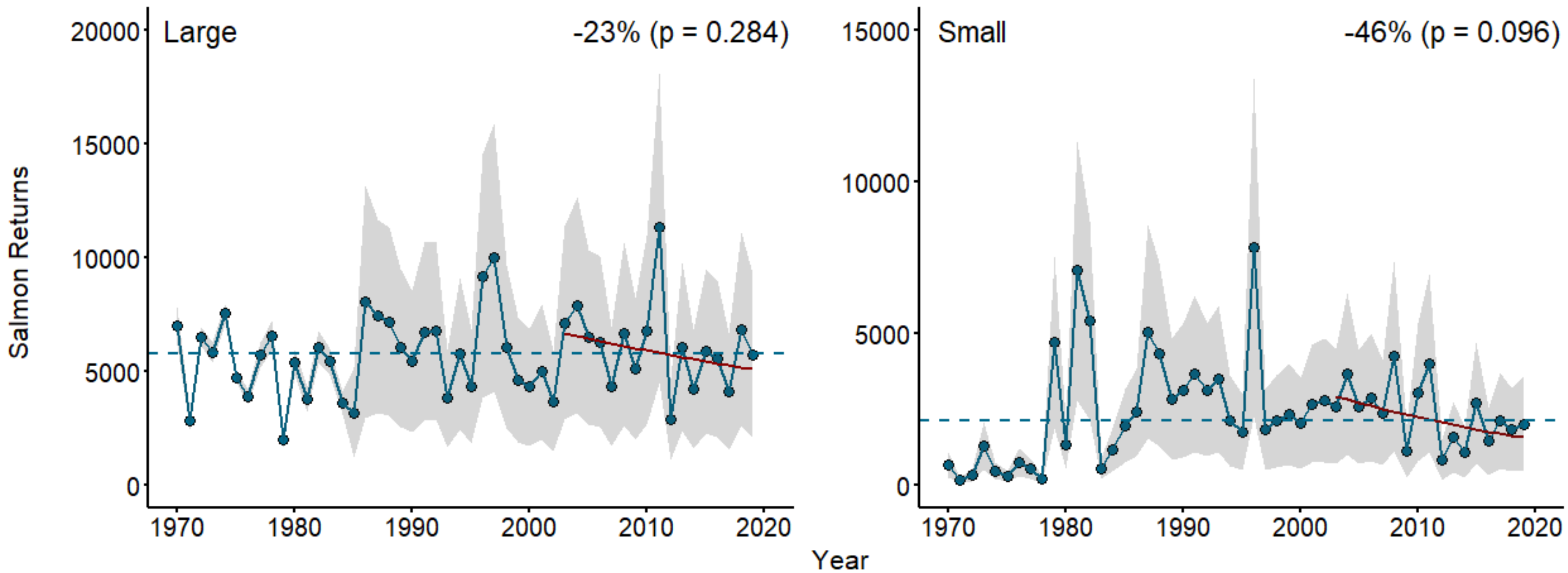

Figure 13. SFA 18 estimates (medians are coloured symbols, shaded contours are the 5th to 95th percentile ranges) of total returns of large Salmon (left) and small Salmon (right), 1970 to 2019. The trend line (exponential regression, red line) in the median of the estimated returns over the previous 16-year time period (2003 to 2019). The corresponding percent change over that period are shown in each panel, along with the p-value in parenthesis (p<0.05 is considered significant). The blue horizontal dashed line is the median abundance for the time series 1970 to 2019.

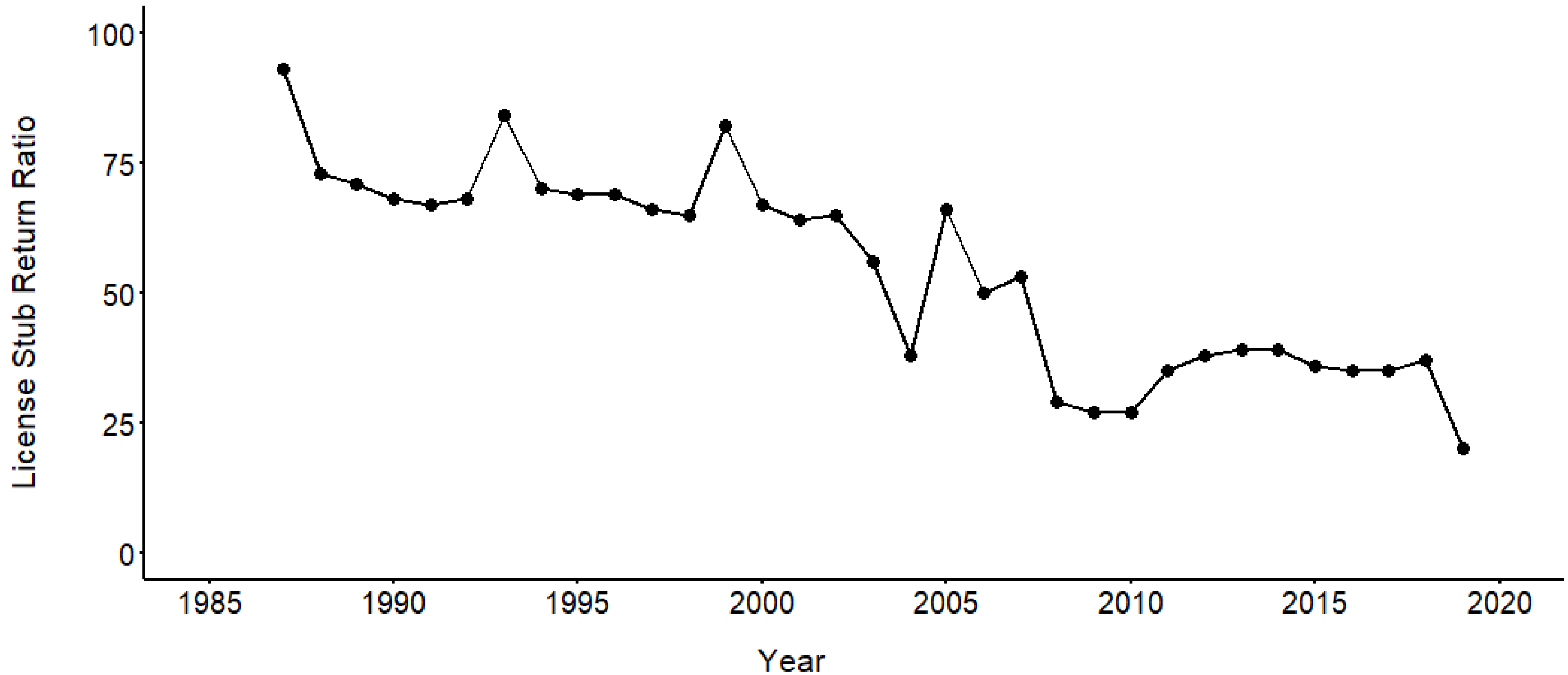

Figure 14. Recreational fishery license stub return ratio, 1987 to 2019. Each point on the graph indicates the ratio of number of licenses sold to number of license stubs returned.

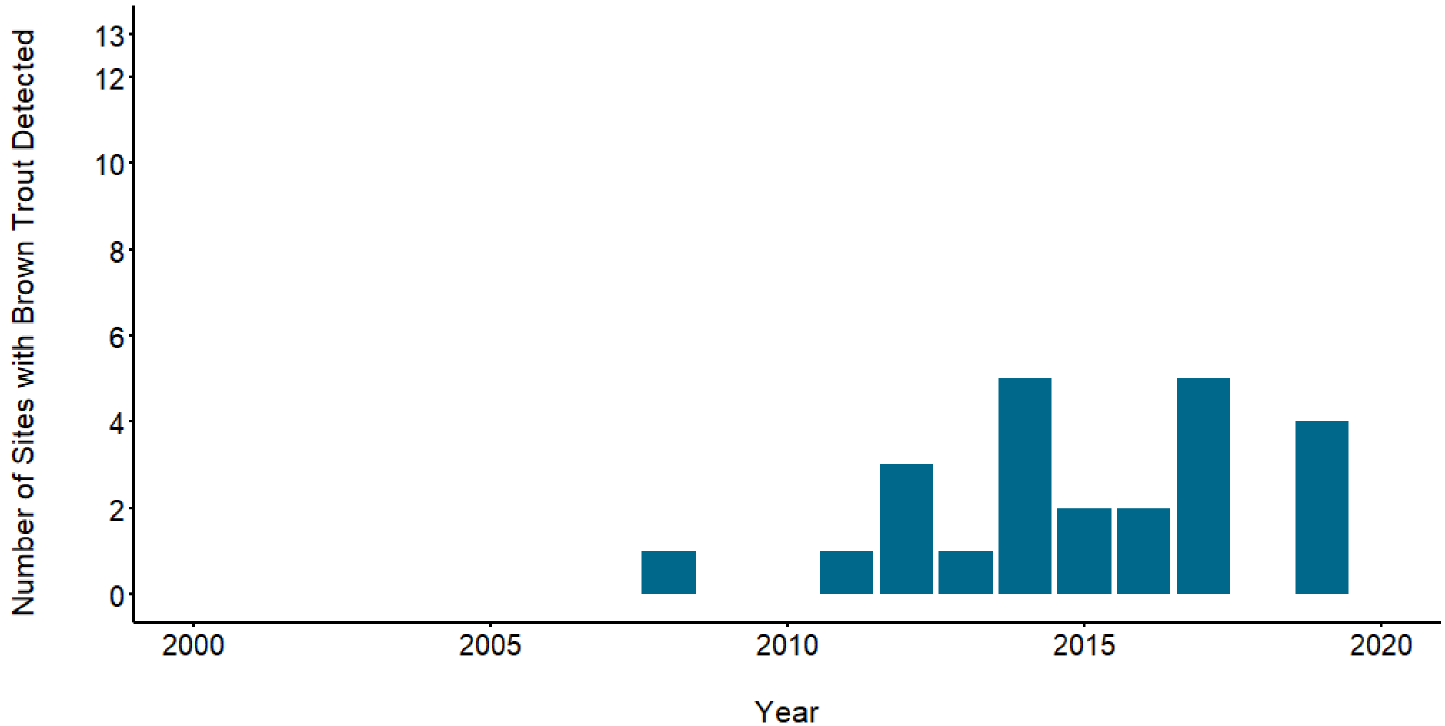

Figure 15. Number of electrofishing sites in the Margaree river system (13 sites max) from 2001-2019 that had juvenile brown trout present. The y-axis displays the number of sites. The x-axis displays time (years) from 2001 to 2019. Bars indicate the number of sites with brown trout present for a given year. Absence of a bar indicates no brown trout juveniles were detected in that year at any of the electrofishing sites. 2020 data were not added.

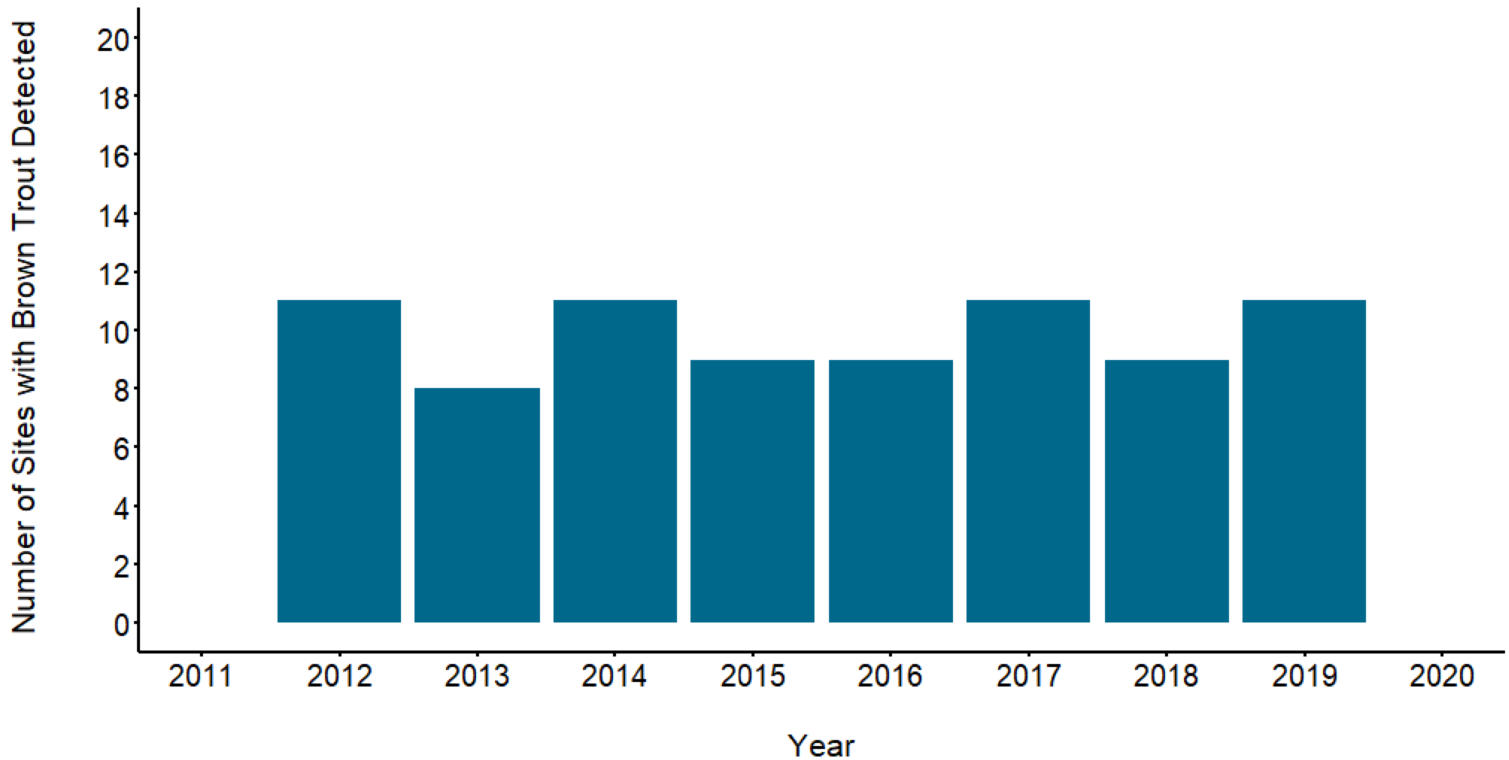

Figure 16. Number of electrofishing sites for mainland GNS (20 sites max) from 2012-2019 that had juvenile brown trout present. Prior electrofishing years were excluded due to a low number of sites being surveyed. The y-axis displays the number of sites. The x-axis displays time (years). Bars indicate the number of sites with brown trout present for a given year. 2020 data were not added.

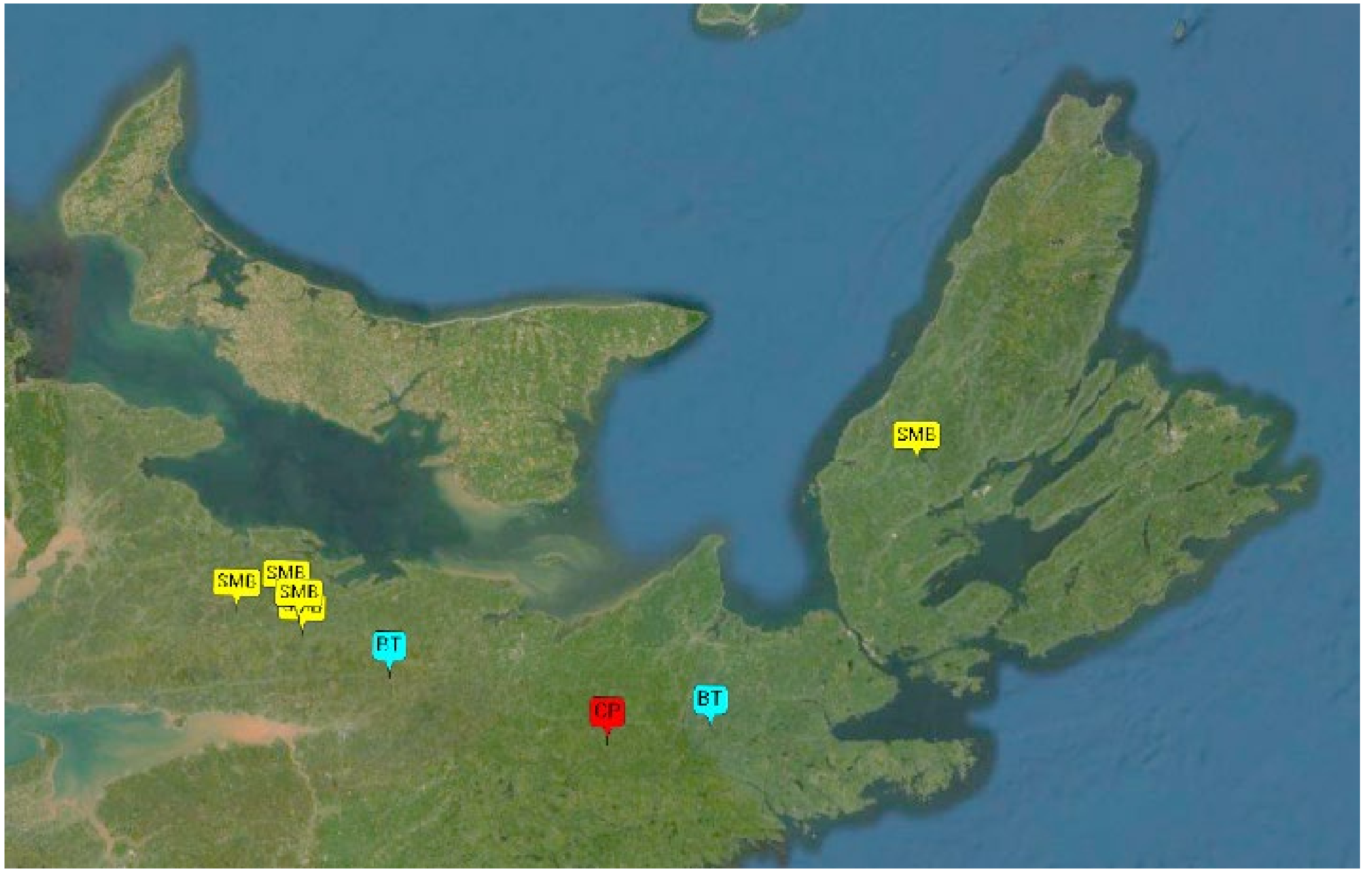

Figure 17. Distribution of non-native and invasive species present in SFA 18, as documented by the province of Nova Scotia. Detection dates range from 1977 to 2017. Detection methods varied. SMB (yellow) indicates presence of smallmouth bass. BT (blue) indicates presence of brown trout. CP (red) indicates presence of chain pickerel. It is assumed that the provincial data provided does not represent the full distribution of these species.

APPENDIX

APPENDIX 1. CALCULATING GENERATION TIME

Table A1. Smolt age and sea age from historical Margaree River catch data. Data come from Table 8 in LeBlanc et al. (2005).

		Sea Age			Total per Smolt Age
		1	**2**	**3**	
Smolt Age	**2**	611	1476	106	**2193**
	3	377	872	31	**1280**
	4	30	23	1	**54**
Total per SW		**1018**	**2371**	**138**	**3527**

Formula to calculate mean age of spawners. Note that a constant of one is added to represent the egg deposition year.

(Equation 1) $Mean\ Age\ of\ Spawners\ (in\ years) = 1\ + Mean\ Smolt\ Age + Mean\ Sea\ Age$

Calculating mean smolt age.

(Equation 2) $Mean\ Sea\ Age = \left(\frac{1018}{3527}\ x\ 1\right) + \left(\frac{2371}{3527}\ x\ 2\right) + \left(\frac{138}{3527}\ x\ 3\right) = 1.75$

Calculating mean sea age.

(Equation 3) $Mean\ Smolt\ Age = \left(\frac{2193}{3527}\ x\ 1\right) + \left(\frac{1280}{3527}\ x\ 2\right) + \left(\frac{54}{3527}\ x\ 3\right) = 2.39$

Populating Equation 4.

(Equation 4) $Mean\ Age\ of\ Spawners = 1\ + 2.39 + 1.75 = 5.14$