UPDATE OF STOCK STATUS INDICATORS OF ATLANTIC SALMON (*SALMO SALAR*) IN DFO GULF REGION SALMON FISHING AREAS 15 – 18 FOR 2022

Context

This Science Response Report results from the regional peer review of March 1, 2023 on Update of Atlantic salmon SFA 15-18 stock indicators.

The last Science Advisory Report detailing the assessment of Atlantic Salmon (*Salmo salar*) stock status in Fisheries and Oceans Canada (DFO) Gulf Region was published after the 2013 return year (DFO 2014). Updates on Atlantic Salmon stock status for the Region have been published either annually or biennially since 2014 (DFO 2022a).

Indicators of abundance for adult and juvenile Atlantic Salmon in Salmon Fishing Areas (SFAs) 15 to 18 for 2022 are provided in this report in response to a request by the Fisheries and Harbour Management Sector (FHM).

Background

All rivers flowing into the southern Gulf of St. Lawrence are included in DFO Gulf Region. Atlantic Salmon management areas in DFO Gulf Region are defined by four Salmon Fishing Areas (SFAs 15 to 18) that encompass portions of three Maritime provinces (New Brunswick (NB), Nova Scotia (NS), and Prince Edward Island (PEI); Figure 1).

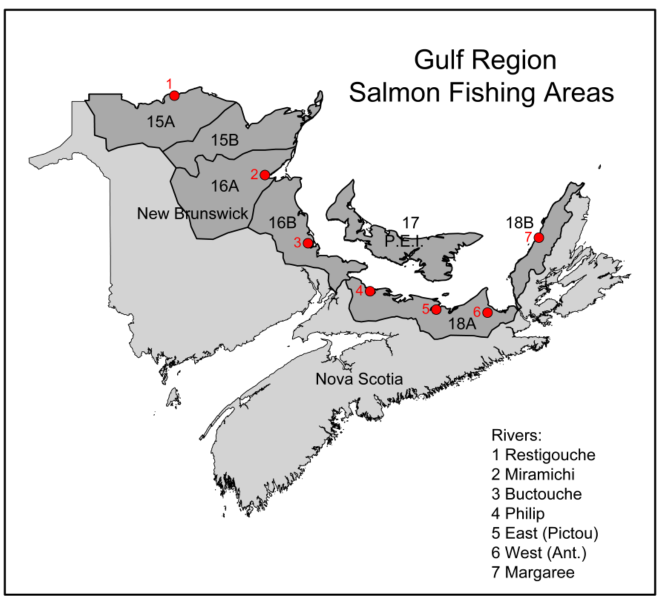

Figure 1: Salmon Fishing Areas in DFO Gulf Region and locations of rivers where indices of salmon abundance are presented for 2022. Note the Buctouche point represents the following southeastern New Brunswick rivers: Buctouche, Cocagne, Richibucto/Coal Branch, Kouchibouguacis and Kouchibouguac.

For management purposes, Atlantic Salmon are categorized as small salmon (grilse; fish with a fork length less than 63 cm) and large salmon (fish with a fork length equal to or greater than 63 cm).

There has not been an Atlantic Salmon commercial fishery in Gulf Region since 1984 due to concerns about the stock's conservation. Food, Social and Ceremonial (FSC) fisheries for Atlantic Salmon occur in several rivers in Gulf Region.

DFO manages a directed Atlantic Salmon recreational fishery in Gulf Region. Mandatory catch and release measures for the recreational fishery started in 1984 for large salmon and have been extended to small salmon since 2015 in all SFAs where recreational fisheries were authorized. Prior to 2015, retention of small salmon had been permitted in SFAs 15, 16A, and 18. Since 1998, rivers in SFA 16B have been closed to all directed salmon fishing. In SFA 17, mandatory catch and release has been in effect since 2009 (DFO 2012) and a recreational fishery is allowed on only two rivers (Mill and Morell).

This report presents indicators of abundance for adult and juvenile salmon life stages. To provide a perspective on recent trends, the changes (exponential regression of change) in the indicators over the recent 12 years, approximately two generations for Atlantic Salmon, are presented. The trend is calculated for the most recent 12 years or since the last year the data were available.

Environmental conditions, including water temperature and flow, for some Atlantic Salmon rivers in DFO Gulf Region, are summarized for 2022 in Appendix I.

Analysis and Response

Stock status in 2022

In DFO Gulf Region, the stock status of Atlantic Salmon under the Precautionary Approach (PA) framework is determined for rivers where data are available. A Limit Reference Point (LRP) was defined for all rivers in DFO Gulf Region in 2018 (DFO 2018) and values for the Upper Stock Reference (USR) points for all rivers were proposed in 2022 (DFO 2022b). In 2022, based on the available indicators, the Restigouche River (SFA 15A) and the Miramichi River (SFA 16A) were in the critical zone of the PA, while the Margaree River (SFA 18B) was in the healthy zone. In SFA 17 only two of 13 watersheds surveyed were above the LRP, in the cautious zone.

Indicators of the stock status of adult Atlantic Salmon

In SFAs 15, 16, and 18, models estimating returns and spawners of Atlantic Salmon include assumptions about mortality rates from catch and release as well as recreational fishery exploitation rates which were estimated individually for each river (DFO 2014). Additionally, the potential egg deposition rate is calculated from estimated returns of large and small Atlantic Salmon based on biological characteristics (mean fork length, proportion female, eggs per fish derived from a fecundity curve) that are specific to the populations in each assessed river. In the aforementioned three SFAs, estimated egg deposition rates from spawners are calculated by subtracting mortalities (estimated using catch and release and available food, social, and ceremonial (FSC) harvest data) from estimates of returns. Eggs in spawners are used to compare the current status of the population relative to PA reference points, whereas eggs in returns can be used to assess what the status of the population would have been without removals.

SFA 15A Restigouche River (NB)

The Restigouche River is the largest river in SFA 15. Information on adult salmon abundance is primarily derived from recreational catch data in the Restigouche mainstem and its tributaries, excluding the Matapedia River which is entirely within the province of Quebec. The data are extracted from private lodge and Crown Reserve catch reports. Catches from public waters are not available. An additional indicator of adult salmon abundance is the end of season visual spawner counts.

Returns of small salmon and large salmon to the Restigouche River are estimated with an assumed angling exploitation rate of 40% and the addition of the assumed Indigenous FSC fishery harvests (DFO 2014).

In 2022, returns to the Restigouche River (NB) were estimated at 5,800 large salmon (median; min to max estimates range 4,700 to 7,700; rounded to nearest 100) and 4,100 small salmon (median; min to max estimates range 3,200 to 5,400; rounded to the nearest 100). Over the last 12 years, small salmon returns decreased by 56% while large salmon returns decreased by 61% (Appendix II, Figure AII-1).

The estimated returns for large and small salmon combined are converted to an egg deposition rate that can be used to assess the status of the population compared to reference points defined under the PA framework. The LRP for the Restigouche River is defined as an egg deposition rate of 152 eggs per 100 m^2 (DFO 2018; Figure 2). In 2022, the potential egg deposition in returns was 126 eggs per 100 m^2, but, after accounting for in-river fishery losses (i.e., the assumed Indigenous FSC fishery harvests and a 6% catch and release mortality from the recreational fishery) the potential egg depositions in spawners represented 77% of the LRP or 117 eggs per 100 m^2 (Figure 2).

The potential egg depositions in the Restigouche River (NB) from spawners have been below the LRP (in the critical zone) in nine of the last 12 years (no estimate in 2020). The estimated eggs in the spawners have declined by 63% over the same time period (Figure 2). The USR, defined as an egg deposition rate of 578 eggs per 100 m^2 for the Restigouche River, (DFO 2022b) was never reached throughout the available time series, therefore the stock has been either in the critical or cautious zone since 1970.

The assessment of adult Atlantic Salmon in the Restigouche River is also informed by fishery-independent visual spawner counts conducted at the end of the season, after all fisheries and in-river losses are assumed to be complete. In 2022, the counts were conducted between September 12th and October 14 in the main stem of the Restigouche and four of its major tributaries (Kedgwick, Little Main Restigouche, Upsalquitch, and Patapedia), and about 8,100 large salmon and 2,300 small salmon were counted (Appendix II, Figure AII-2).

Visual spawner counts of large and small salmon are also converted into a potential egg deposition rate (Figure 2). These visual counts are subject to over and/or under-counting and these biases have not yet been quantified so caution should be used when interpreting these numbers. Additionally, the time-series comprises several years where only part of the tributaries were sampled, and, as such, these incomplete counts should only be considered as a lower bound for the actual number of spawners. Visual spawner counts are currently not used to determine the status of the population in reference to the LRP or USR.

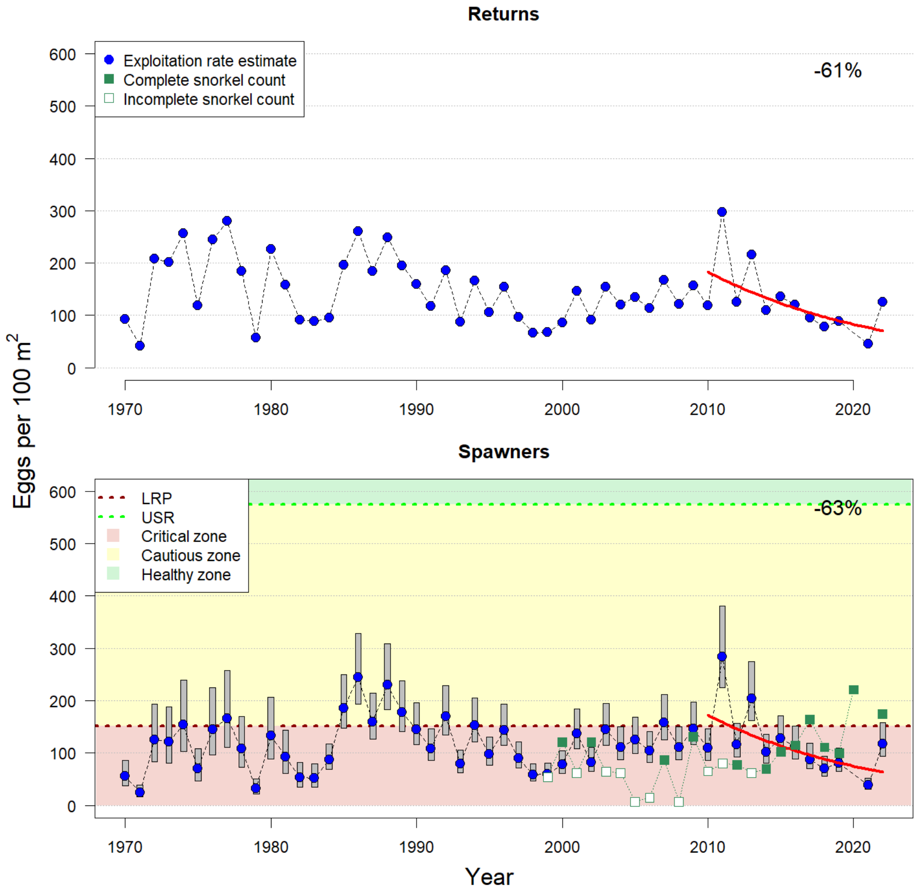

Figure 2: The potential eggs (expressed as eggs per 100 m² of wetted habitat area) of the combined small and large salmon returns (top panel) and spawners (bottom panel) in the Restigouche River (NB), 1970 to 2022. The LRP and USR are represented by a horizontal dashed dark red and dashed green line, respectively. The critical, cautious, and healthy zones are indicated by red, yellow, and green areas, respectively. In both panels, blue circles are estimates based on an assumed catch rate of 40% and the box encompasses the range for catch rates from 30% to 50%. In the spawners panel, the eggs based on the visual spawner counts are shown as green squares, the symbols are filled for the years with complete coverage, and empty for years with incomplete coverage. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the estimated egg densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 16A Miramichi River

The Miramichi River is the largest watershed in SFA 16 and DFO Gulf Region. Catches and counts of adult Atlantic Salmon, by size group, are available from trapnets operated in the estuary and from headwater barrier counting fences and provide fishery-independent indices of abundance. The annual catches at these monitoring locations are not adjusted for periods when the counting facilities were not operating due to maintenance, high water conditions, or suspension of activities due to high water temperatures.

Catches of small and large salmon have been available from DFO index trapnets located in the Southwest Miramichi at Millerton since 1994 and in the Northwest Miramichi at Cassilis since

1998. In 2022, the trapnet at Millerton operated between 25 May and 26 October while the trapnet at Cassilis operated between 11 May and 25 October.

The catches of large salmon at the Millerton (n = 383) and Cassilis (n = 186) trapnets in 2022 remained below the long-term average for this size group at both facilities. Similarly, small salmon catches at the Millerton (n = 532) and Cassilis (n = 195) trapnets in 2022 remained below the long-term average for this size group at both facilities (Atlantic Salmon Index Rivers).

Annual counts of small and large salmon have been available from two headwater protection barriers operated by the NB Department of Natural Resources and Energy Development, and more recently on their behalf by the Miramichi Salmon Association and Miramichi Fisheries Management Inc. One protection barrier has operated on the Dungarvon River, tributary of the Renous and Southwest Miramichi rivers since 1984, and the other, on the Northwest Miramichi River since 1988. In 2022, the Dungarvon River barrier operated between 6 June and 14 October, while the Northwest Miramichi River barrier operated between 3 June and 12 October.

The count of large salmon (n = 95) and small salmon (n = 66) at the protection barrier on the Dungarvon River remained below the long-term average counts for both size groups at this facility. The count of large salmon (n = 100) and small salmon (n = 121) at the Northwest Miramichi barrier in 2022 also remained below the long-term average for both size groups at this facility (Atlantic Salmon Index Rivers).

Returns of small and large salmon are estimated using mark and recapture experiments based on catches at various monitoring facilities throughout the watershed (DFO 2014). The estimated median return of large salmon to the Miramichi River in 2022 was 10,000 fish (median; 5th to 95th percentile range 7,000 to 14,000; rounded to nearest 100), while small salmon returns were estimated at 8,000 fish (median; 5th to 95th percentile range 6,000 to 11,200; rounded to nearest 100; Appendix II, Figure AII-3). Return estimates of both large and small salmon to the Miramichi River in 2022 were below the long-term average for both size groups for the 1971 to 2022 time series (Appendix II, Figure AII-3).

Estimated returns for the two main branches of the Miramichi River are available since 1992 (Appendix II, Figure AII-4). The return of large salmon to the Southwest Miramichi River in 2022 was estimated at 7,400 fish (median; 5th to 95th percentile range 5,000 to 11,300; rounded to nearest 100). Small salmon returns to the Southwest Miramichi in 2022 were estimated at 6,000 fish (median; 5th to 95th percentile range 4,100 to 9,100; rounded to nearest 100). Return estimates of both large and small salmon to the Southwest Miramichi River in 2022 were below the long-term average for both size groups for the 1992 to 2022 time series (Appendix II, Figure AII-4).

The return of large salmon to the Northwest Miramichi River in 2022 was estimated at 2,400 fish (median; 5th to 95th percentile range 1,500 to 4,100; rounded to nearest 100). Small salmon returns to the Northwest Miramichi in 2022 were estimated at 1,900 fish (median; 5th to 95th percentile range 1,300 to 2,900; rounded to nearest 100). Return estimates of both large and small salmon to the Northwest Miramichi River in 2022 were below the long-term average for both size groups for the 1992 to 2022 time series (Appendix II, Figure AII-4).

Over the recent 12-year period, the estimated returns of large salmon have declined 52% in the Miramichi River, 52% in the Southwest Miramichi River, and 56% in the Northwest Miramichi River (Appendix II, Figures AII-3 and AII-4). Similarly, the estimated returns of small salmon over the last 12 years have declined in the Miramichi River (69%), the Southwest Miramichi River (64%) and Northwest Miramichi River (78%) (Appendix II, Figures AII-3 and AII-4).

The estimated returns and spawners for large and small salmon are converted to an egg deposition rate using the 2022 biological characteristics. The egg deposition rate is used to assess the status of the population compared to reference points defined under the PA framework (DFO 2018 and DFO 2022b). In 2022, the median potential egg deposition rates for returning small and large salmon combined were 130 eggs per 100 m^2 for the Miramichi River, 142 eggs per 100 m^2 for the Southwest Miramichi River, and 98 eggs per 100 m^2 for the Northwest Miramichi River (Figures 3 and 4).

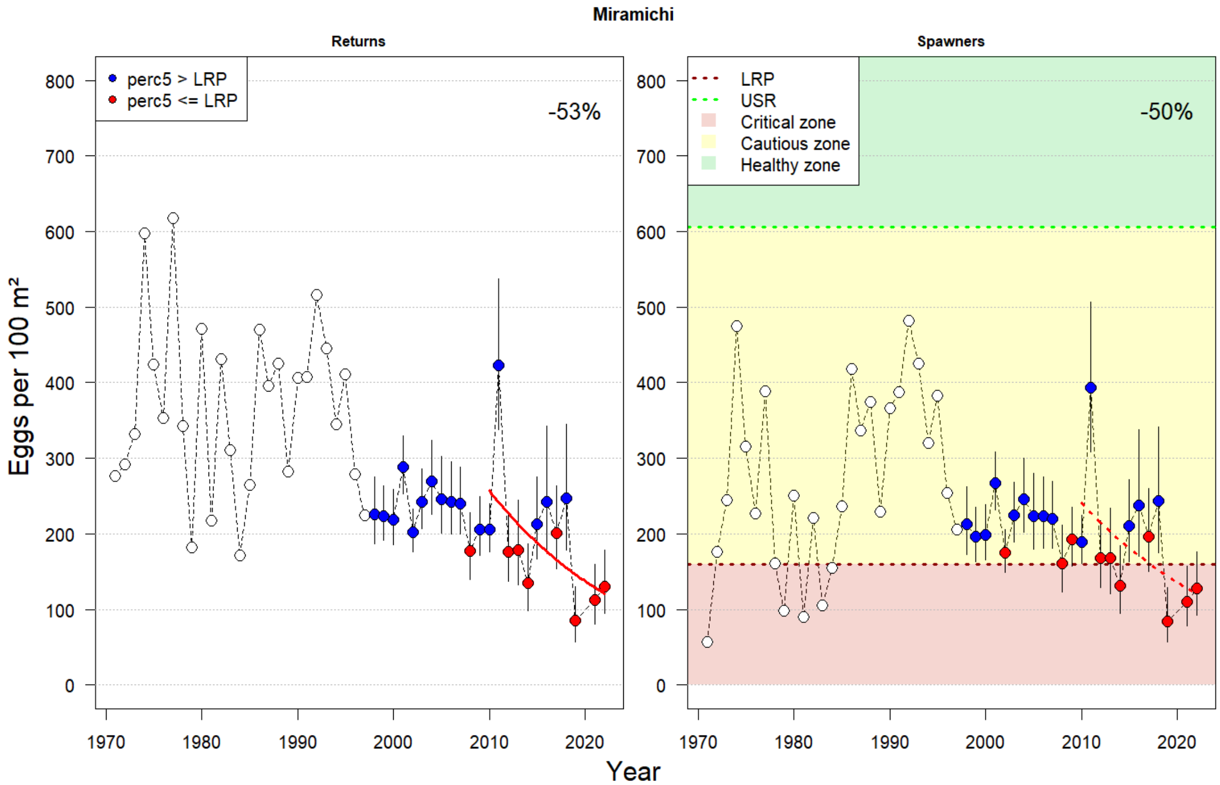

Figure 3: The estimated median (1971-2022) and 5th to 95th percentile range (1998-2022) of the number of eggs (expressed per 100 m² of habitat) from the returns (left panels) and spawners (right panels) of small and large salmon combined to the Miramichi River. The LRP and USR are represented by a horizontal dashed dark red and dashed green line, respectively. The critical, cautious, and healthy zones are indicated by red, yellow, and green areas, respectively (DFO 2018). Blue symbols indicate when the 5th percentile of the number of eggs was above the LRP, and red symbols indicate when the 5th percentile of the number of eggs was below the LRP. The white open circles are for years without estimates of uncertainties for egg depositions. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated egg densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

Spawners are calculated as returns minus losses from reported Indigenous FSC fisheries (based on data available to date) and from recreational fisheries. With the introduction of the mandatory release of small salmon in the recreational fishery, losses due to catch and release mortality were assumed to be 0.9% of the total returns (3% mortality of caught and released salmon, assuming 30% of the small salmon or large salmon return is caught and released; DFO 2014).

After accounting for removals and losses from fisheries, the median egg deposition rate for large and small salmon combined in 2022, was 128 eggs per 100 m^2 for the Miramichi River (LRP = 160 eggs per 100 m^2; USR = 608 eggs per 100 m^2), 140 eggs per 100 m^2 for the Southwest Miramichi River (LRP = 152 eggs per 100 m^2 ; USR = 578 eggs per 100 m^2), and 95 eggs per 100 m^2 for the Northwest Miramichi River (LRP = 176 eggs per 100 m^2; USR = 669 eggs per 100 m^2) (Figures 3 and 4).

In 2022, the reported and estimated fisheries related losses were low. The percentages of the LRP attained by estimated eggs in the combined spawners of small salmon and large salmon ranged from 54% (median value) for the Northwest Miramichi to 92% (median value) for the Southwest Miramichi, similar to the percentages of LRP attainment in the returns.

The trends in the number of eggs from large and small salmon spawners combined show decreases over the last 12 years in the Miramichi River (-50%), the Southwest Miramichi River (-48%), and the Northwest Miramichi River (-56%), although the trend is not statistically significant (Figures 3 and 4). Based on the posterior distribution of the spawner estimate, the probability of being below the LRP in 2022 was 87% for the Miramichi River, 63% for the Southwest Miramichi River, and 98% for the Northwest Miramichi River.

The Miramichi River, and the two main branches assessed individually are in the critical zone of the PA in 2022 (Figures 3 and 4). The Southwest Miramichi River has been in the critical zone in seven of the last 12 years, while the Northwest Miramichi River has been in the critical zone in ten of the last 12 years (there was no assessment in 2020).

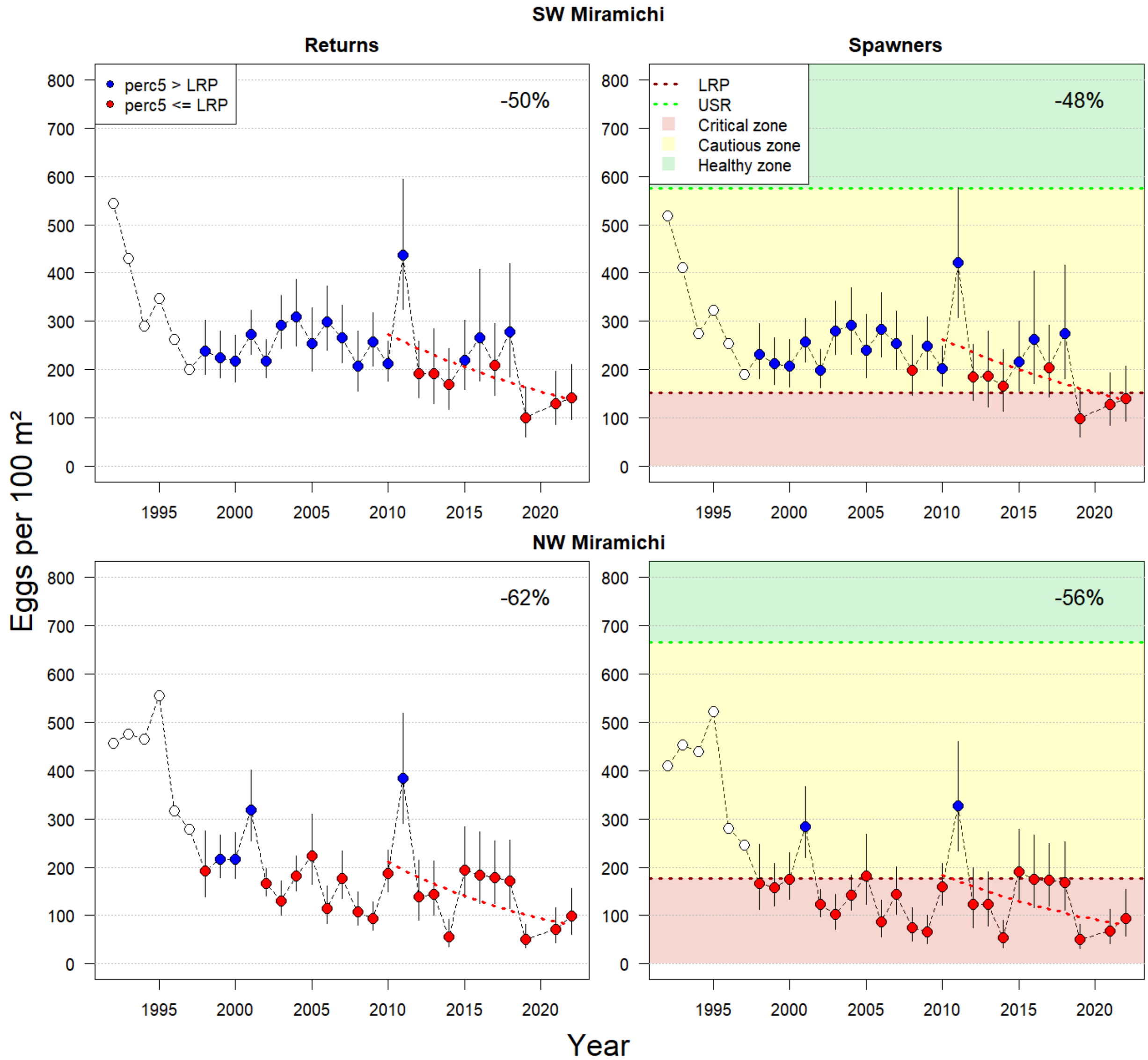

Figure 4: The estimated median (1992-2022) and 5th to 95th percentile range (1998-2022) of the number of eggs (expressed per 100 m² of habitat) from the returns (left panels) and spawners (right panels) of small and large salmon combined to the Southwest Miramichi River (top row) and the Northwest Miramichi River (bottom row). The LRP and USR are represented by a horizontal dashed dark red and dashed green line, respectively. The critical, cautious, and healthy zones are indicated by red, yellow, and green areas, respectively (DFO 2018). Blue symbols indicate when the 5th percentile of the number of eggs was above the LRP, and red symbols indicate when the 5th percentile of the number of eggs was below the LRP. The white open circles are for years without estimates of uncertainties for egg depositions. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated egg densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 17 PEI

Salmon stock assessment on PEI is currently based on redd counts which are conducted by local watershed groups. The method for converting redd counts to female salmon spawners is described in Cairns and MacFarlane (2015). The conversion of spawner abundance to egg number and their relation to the LRPs is river specific and described in DFO (2018).

There are 25 rivers in SFA 17 with current or recent Atlantic Salmon occupancy based on confirmed observations of redds or juveniles (Table 1). However, there are only 12 rivers where salmon have been detected in all monitored years between 2000 and 2022. Environmental conditions frequently limit the success of redd surveys for salmon stock assessment on PEI. In 2022, Hurricane Fiona caused widespread damage to riparian zones and access trails which resulted in incomplete redd surveys. A total of 13 rivers had redd surveys (10 partial and 3 complete). Of the rivers surveyed in 2022, only two, Cains Brook and Carruthers Brook (both in the Mill River Watershed), had counts that were above the LRP, and they achieved 215% and 320% of LRP respectively (Table 1). Part of the survey of Carruthers Brook was conducted prior to peak spawning, resulting in an incomplete count which should be considered a minimum number as more spawning likely occurred after the initial survey.

The assessment of Atlantic salmon relative to LRPs in PEI is reported in numbers of spawners and not eggs to reflect the low numbers of fish present in SFA 17 rivers. Atlantic salmon status for rivers in PEI with complete surveys is shaded relative to the LRP for each watershed (Figure 5). The map (Figure 5) includes Atlantic salmon status relative to LRPs based on surveys dating back to 2017 which may not fully reflect current conditions. Only six watersheds were above the LRP in the most recent complete survey including Mill River tributaries (Cains Brook 2022, Carruthers Brook 2021), Morell River (2020), Midgell River (2017), St. Peters River (2020), Cross Creek (2020), and North Lake Creek (2020).

Table 1: The percentage attainment of the Limit Reference Point (LRP) value for Atlantic Salmon monitored rivers in SFA 17, 2013 to 2022. A dash indicates no survey was performed. The spawner requirement is the estimated number of spawners, sexes and sea ages combined, corresponding to the LRP for the river (DFO 2018). Status of rivers for previous years is available in Cairns and MacFarlane (2015).

River	Spawner req.	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cains Brook (Mill R.)	15	161	-	161[a]	186	316	96	-	215	-	215
Carruthers Brook (Mill R.)	24	263[a]	-	277[a]	253	320	293	102[a]	247	358	320[a]
Trout River, Coleman/ Roxbury	94	41	25	25	31	29	22	17[a]	19	26	28
Trout River, Tyne Valley	26	0	0	-	-	7[a]	-	-	-	-	-
Little Trout River	11	0	0	7	-	77	-	-	-	-	-
Bristol (Berrigans) Creek	22	19	0	0[a]	-	16	-	-	49	10[a]	-
Morell River	160	132	157	58[a]	83	78	51	193[a]	174	21[a]	11[a]
Midgell River	34	46[a]	97	181	-	135	-	-	-	-	-
St. Peters River	24	80	79	122	37	35	-	-	184	-	-
Cow River	12	182	43	245	204	139	48[a]	29	11	2[a]	-
Naufrage River	23	845	405	288	201	166	80	138	71	0[a]	-
Bear River	9	74	14	60	164	33	5[a]	0	52	-	-
Hay River	14	140	49	117	133	49	13[a]	42	0	3	-
Cross Creek	24	496	357	440	315	355	109[a]	61	213	50[a]	37[a]
Priest Pond Creek	13	506	433	462	234	503	13	74	17	0[a]	-
North Lake Creek	26	568	311	447	428	364	68	95	133	19[a]	84[a]
Vernon River	37	12	0[a]	0	-	19	7[a]	11	14	21	18[a]
Clarks Creek	25	5	-	0[a]	-	7	-	4[a]	-	21	11[a]
Pisquid River	26	67	26[a]	81	49	47	28[a]	17	45	22	9[a]
Head of Hillsborough R.	29	4	-	0	-	0	-	-	17	9	3[a]
North River	53	18	-	-	-	7	-	-	0	12	6[a]
Clyde River	22	-[b]	-[b]	-[b]	-	0	-	-	-	-	-
West River	124	88	59	59	76	78	64[a]	59	53	20[a]	74
Dunk River	130	-	-	-	-	39	-	-	-	-	3[a]
Wilmot River	45	-	-	-[c]	-[c]	5	-	-	-	-	-

[a]Considered to be a minimum value due to poor counting conditions or incomplete survey coverage
[b]Juveniles were found by electrofishing in 2012, but not in 2013, 2014, and 2015
[c]Juveniles were found by electrofishing in 2014 and 2015

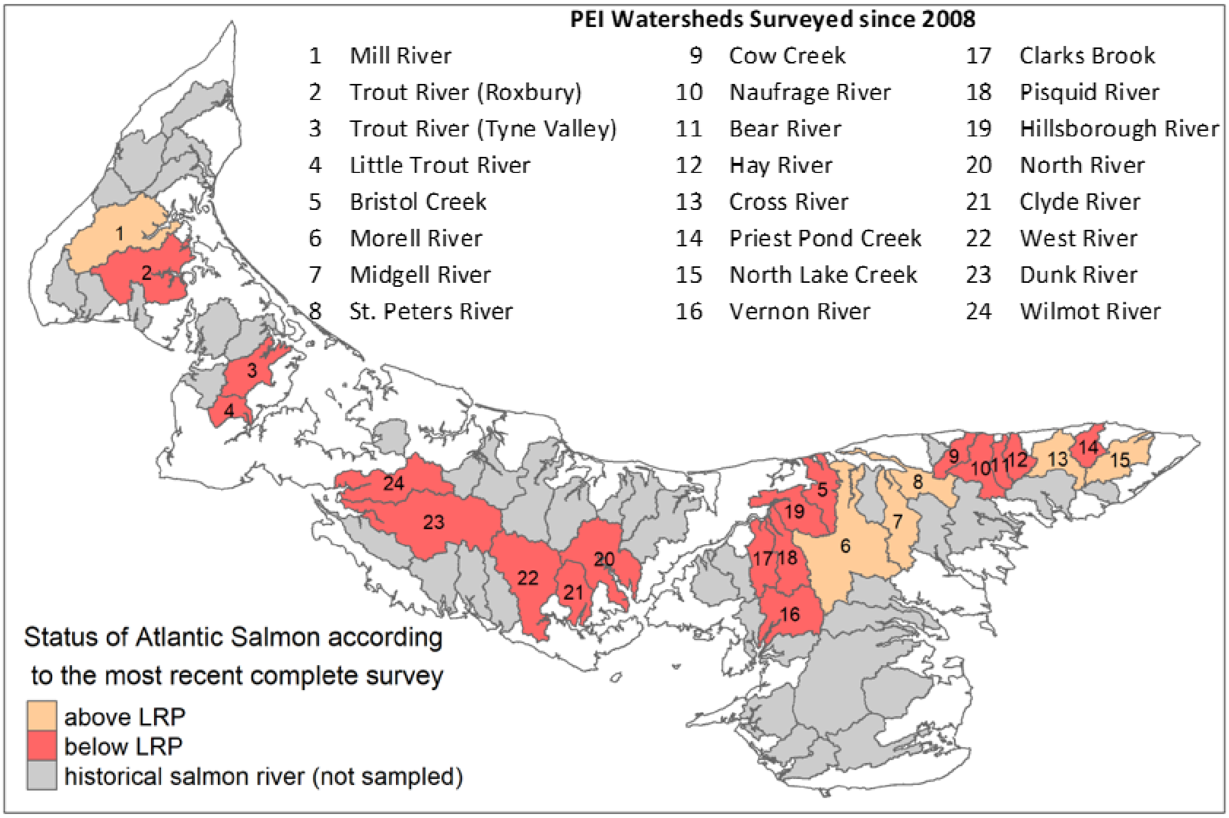

Figure 5: Status of Atlantic Salmon in relation to the LRP in PEI Watersheds that are part of the SFA 17 Atlantic Salmon redd survey (based on the most recent survey considered complete). Watersheds depicted are limited to those where salmon have been known to occur historically. Watersheds surveyed since 2008 are numbered, whereas those not sampled are grey and have no number. Six watersheds, denoted in orange (1, 6, 7, 8, 13, and 15), were above the LRP during the most recent completed survey, the others, in red, were all below the LRP.

SFA 18 Gulf Nova Scotia

Indices of adult salmon abundance for the rivers in SFA 18 are derived from recreational fishery catch and effort data. The recreational fishery data for 2022 are preliminary and are based on extracts from the licence stub return database from February 1st, 2023 (609 licence stubs returned out of 2,176 licences sold in 2022). Total license sales are used to estimate total catch and effort from catch and effort reported in the returned licence stubs. Indicators are provided for three mainland NS rivers (SFA 18A) and the Margaree River in Cape Breton, NS (SFA 18B).

SFA 18A Mainland Gulf Nova Scotia

Recreational angling catches are monitored in three rivers in SFA 18A: West River (Antigonish), East River (Pictou), and River Philip. Catch data are standardized by fishing effort. Over the recent 12-year period there is no significant change in the catch per rod day for large or small salmon in any of the three rivers (Figure 6). The effort, in rod days, over the time-series is not constant and has varied over time and with changes in the management of the recreational fishery.

This index of abundance does not allow for the calculation of a population estimate and therefore no comparison to PA reference points is possible.

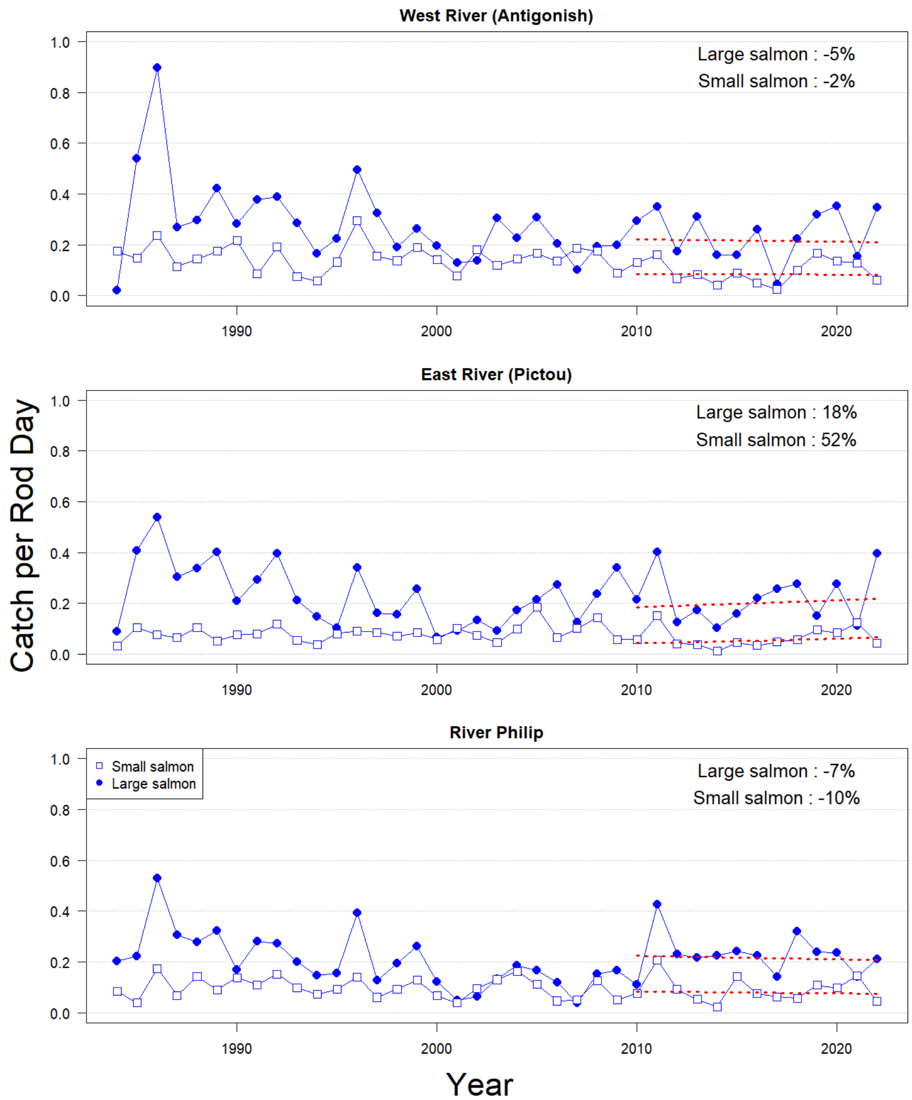

Figure 6: Estimated catch rates (catch per rod day) of large salmon and small salmon from the recreational fishery in the three largest rivers of SFA 18A, 1984 to 2022. Open squares represent small salmon and filled circles represent large salmon. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 18B Margaree River

Adult salmon abundances for the Margaree River are modeled by estimating exploitation rates in the recreational fishery based on mark and recapture experiments conducted between 1988 and 1996. These are then applied to the corresponding recreational fishery catch and effort data recorded in volunteer angler logbooks and licence stub returns (Breau and Chaput 2012). The estimate for 2022 is based on catch and effort data from volunteer angler logbook returns (n = 19) and licence stubs.

In 2022, the median estimated returns in the Margaree River were 3,300 large (median; 5th to 95th percentile range 2,800 to 4,000; rounded to nearest 100) and 1,000 small salmon (median;

5th to 95th percentile range 800 to 1,300; rounded to nearest 100). The changes in estimated returns over the recent 12-year period do not result in a statistically significant trend for either large or small salmon (Appendix II, Figure AII-5).

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 collected between 1988 and 1996 (DFO 2018, 2019). The eggs in spawners account for reported in-river fisheries losses (Indigenous FSC fisheries and an assumed 5% catch and release mortality rate for the recreational fishery; DFO 2014).

In 2022, the estimated eggs in the returns of small salmon and large salmon combined were 795 eggs per 100 m² (median; 5th to 95th percentile range of 677 to 934 eggs per 100 m²). The corresponding estimate for spawners was 784 eggs per 100 m² (median; 5th to 95th percentile range of 667 to 923 eggs per 100 m²).

Spawner estimates exceeded the LRP value of 152 eggs per 100 m² and USR value of 578 eggs per 100 m². The eggs in the combined spawners of small and large salmon have exceeded the LRP value every year since 1987 (Figure 7).

Caution should be taken when using abundance estimates for the Margaree River to inform on the status of the population because of the reduction in fishing effort that occurred since the model was calibrated with fisheries-independent data (see Sources of Uncertainties in the Conclusion for more detail).

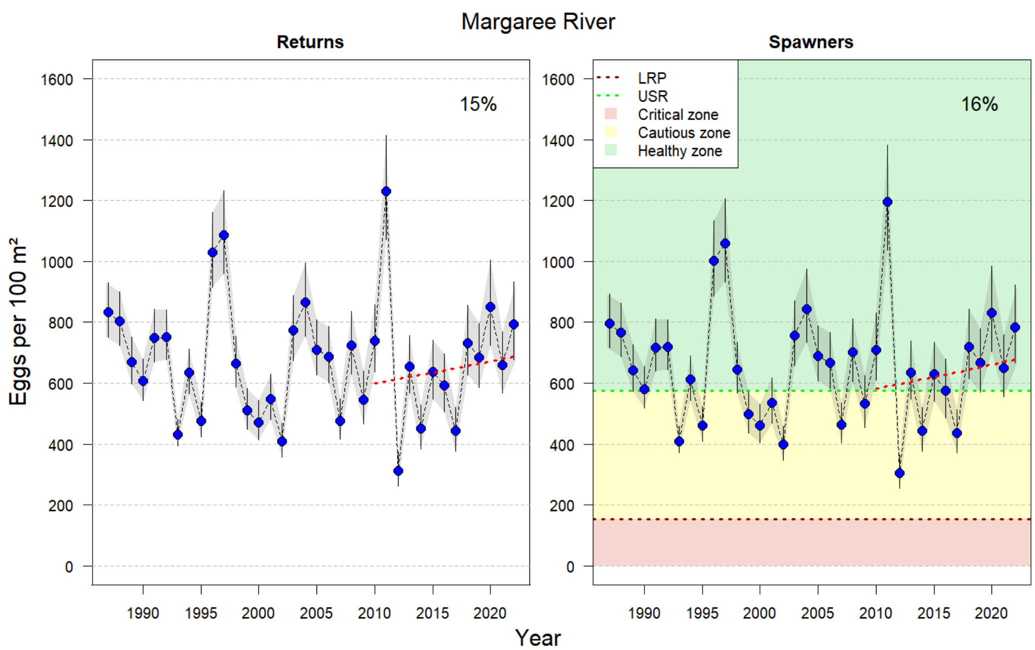

Figure 7: Median estimates of returns (left panel) and spawners (right panel) of small and large salmon combined to the Margaree River, 1987 to 2022, expressed in terms of eggs per 100 m². The grey shaded area represents the 5th to 95th percentile range. The LRP (152 eggs per 100 m²) and USR (578 eggs per 100 m²) values for the Margaree River are indicated by a horizontal dashed dark red and dashed green line, respectively. The critical, cautious, and healthy zones are indicated by red, yellow, and green areas, respectively. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated egg densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

Gulf Region adult estimates

Estimates of total returns of small salmon and large salmon are developed for each SFA and overall, for Gulf Region based on estimates from monitored rivers (DFO 2014).

As returns of large salmon to the Gulf Region were estimated at 34,300 fish (5^{th} to 95^{th} percentile range of 28,200 to 40,500 fish; rounded to nearest hundred). Small salmon returns to Gulf Region were estimated at 18,000 fish (5^{th} to 95^{th} percentile range of 14,000 to 22,000 fish; rounded to nearest 100) in 2022 (Figure 8).

Overall, for Gulf Region the estimated abundances had a declining trend for both large and small salmon over the period 2010 to 2022 (although the trend was not statistically significant), and in 2022 the abundance was below the long-term average for both large and small salmon (Figure 8). Over the recent 12 years, the estimated abundances of salmon have significantly decreased only in SFA 17: by 40% for large salmon and 20% for small salmon (Figure 8). The trend in the estimated abundances for both size categories was decreasing in all SFAs other than SFA 18 where it was increasing, however the change was not statistically significant.

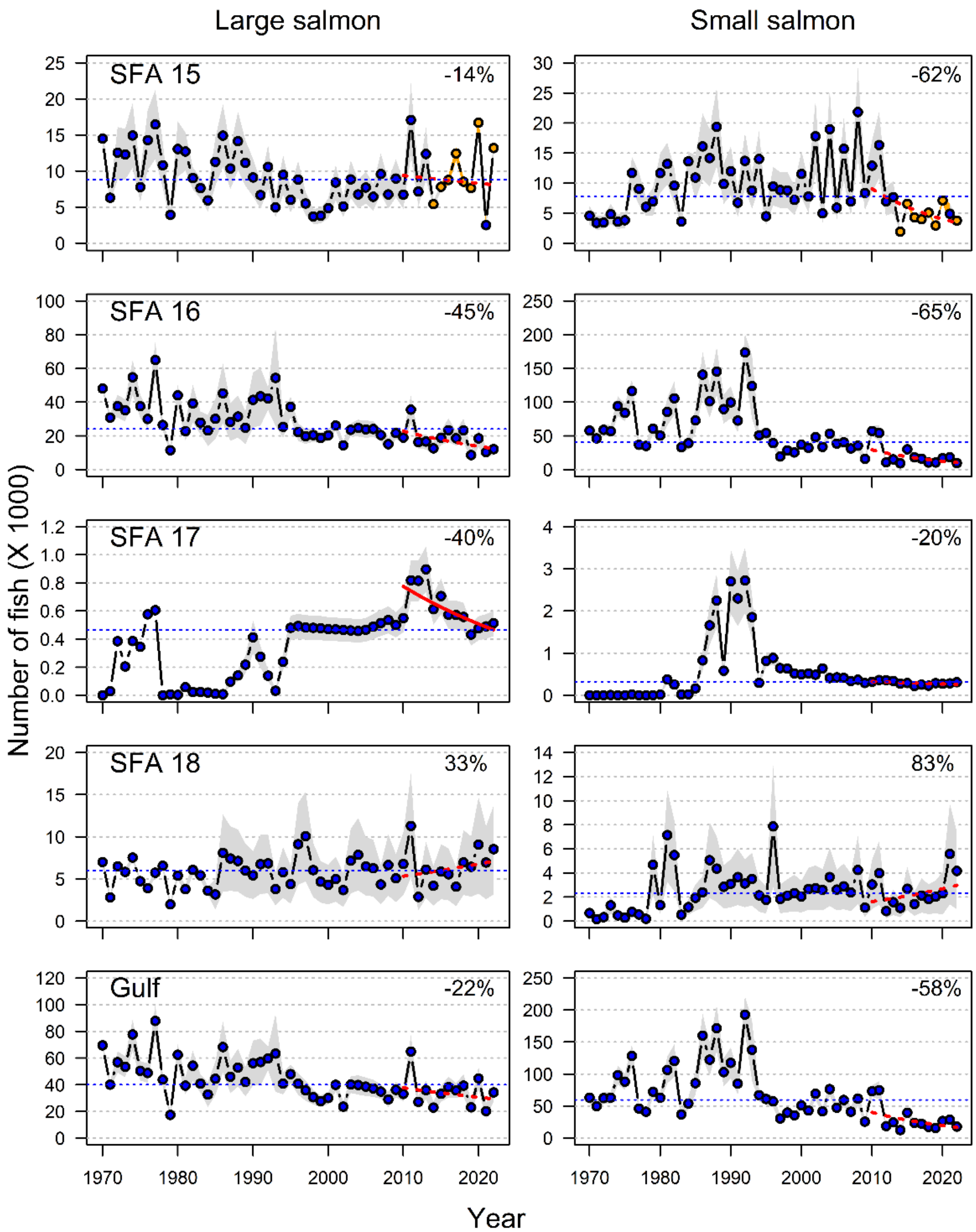

Figure 8: Estimates (medians are coloured symbols, shaded contours are the 5th to 95th percentile ranges) of total returns of large salmon (left panels) and small salmon (right panels) to each of SFA 15, 16, 17, and 18, and to Gulf Region rivers overall, 1970 to 2022. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated returns over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel. The light horizontal dashed line in each panel is the average of the median abundance for the time-series 1970 to 2022. Note: For SFA 15, from 2014 onwards, estimates of returns are based on visual spawner counts when they are available, they are represented in orange (ICES 2021, Annex 5). Data from this figure is available on the Open Government Portal ([Large and small salmon total returns estimates in the Gulf region - Open Government Portal (canada.ca)](#)).

Indicators of freshwater production of Atlantic Salmon based on juvenile salmon abundances

Indices of freshwater production are derived from electrofishing surveys. Fixed site sampling for juvenile salmon has been conducted most consistently since the early 1970s in the Restigouche (SFA 15) and Miramichi (SFA 16) rivers, and since the mid-1980s for SFA 18 rivers. Juvenile salmon abundances at sites, in terms of number of fish per habitat area sampled by age or size group, are obtained using successive removal sampling or catch per unit effort sampling calibrated to densities, methodology described in Dauphin et al. 2019, 2021 for SFA 15, Chaput et al. 2005 for SFA 16, and Chaput and Claytor 1989 for SFA 18. Sampling intensities vary among years and among rivers. When information is available, annual densities are referenced to averages for two time periods, prior to 1984 and post-1984 (or later depending upon the age group) corresponding to the year (1984) when commercial fisheries were closed and mandatory catch-and-release for large salmon in the recreational fishery was introduced. Size groups of juveniles (fry, small parr, large parr) are used as proxies for cohorts.

SFA 15A Restigouche River (NB)

Juvenile densities are estimated and presented for four main tributaries of the Restigouche watershed (main Restigouche, Upsalquitch, Little Main Restigouche, and Kedgwick). In 2022, 78 sites were sampled (n = 60 sites excluding those of the Matapedia and Patapedia rivers which are in QC), all sites had at least one salmon juvenile, four sites had no fry, four sites had no small parr, and five sites had no large parr.

The detection of multiple cohorts at almost all sampling sites indicates that there have been multiple years of spawning success throughout the watershed. Salmon juveniles are broadly distributed in the four surveyed rivers.

Over the past 12 years, the abundances of salmon fry, small parr, and large parr have not changed significantly, except for small and large parr in the Kedgwick tributary which increased by 144% and 290% respectively (Figure 9). However, these large percentage changes have to be put in the context of very low densities (i.e., large parr were close to 0 fish per 100 m^2 in the early 2010's and 5-10 fish per 100 m^2 in recent years). Similarly, small and large parr are at or below the long-term averages in all rivers except the Kedgwick and Little Main Restigouche. In 2022, fry were below or just above (Upsalquitch) the long-term average in all sampled rivers.

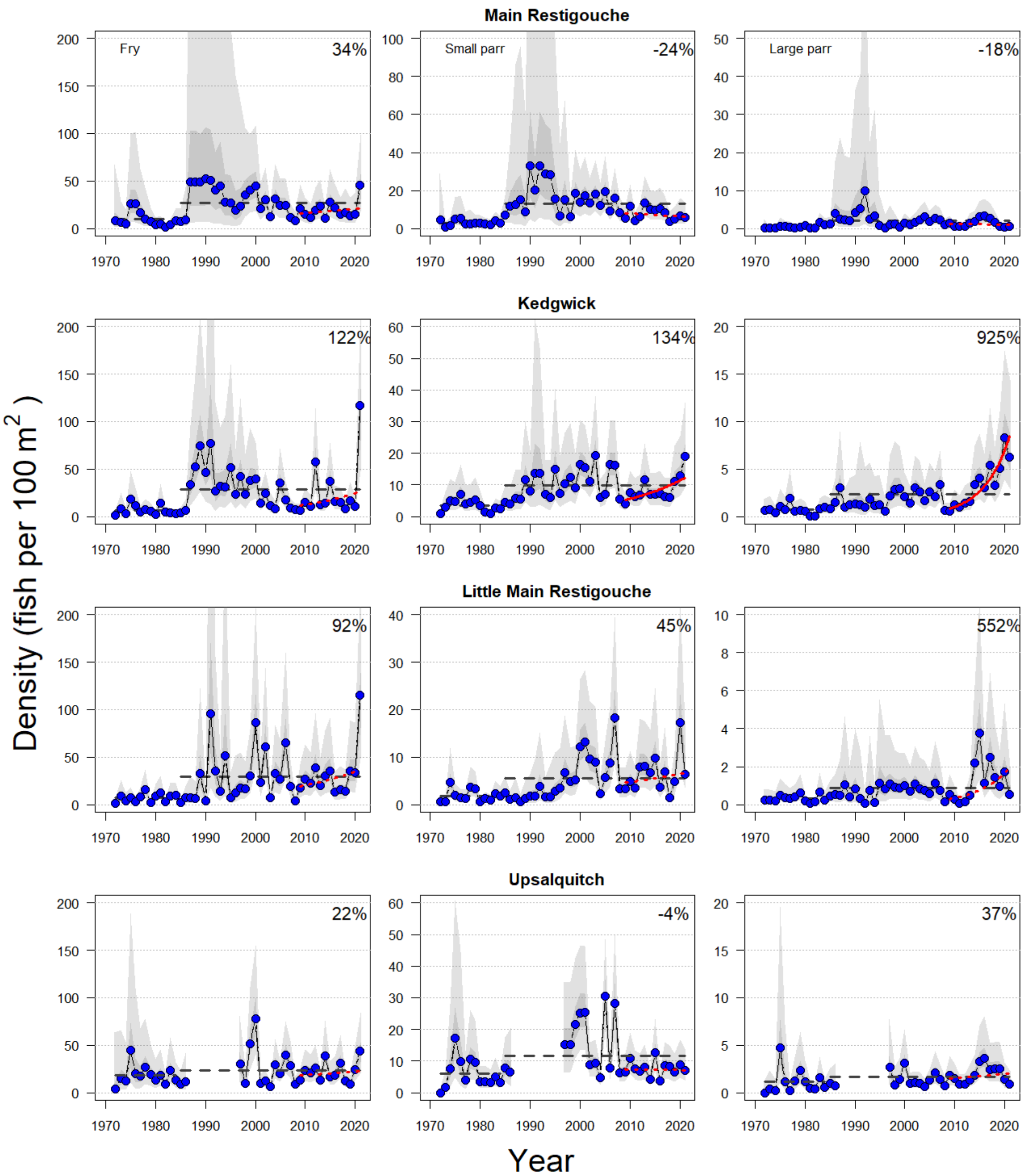

Figure 9: Average juvenile densities (median, fish per 100 m²) for fry (left column), small parr (middle column), and large parr (right column) in the main Restigouche, Kedgwick, Little Main Restigouche and Upsalquitch rivers, 1972 to 2022. Dots indicate the median of the posterior distribution, the light and dark shaded areas indicate the 2.5th-97.5th and 25th-75th percentile ranges, respectively. The horizontal dashed lines in each panel are the average densities corresponding to periods before and after the significant management changes that were implemented to the commercial and recreational salmon fisheries in 1984. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel. Note: larger uncertainties are observed in the mid-1980s to mid-1990s time period due to a much lower number of sites sampled.

SFA 16A Miramichi River

Densities of Atlantic Salmon fry, small parr, and large parr in the Miramichi watershed are summarized according to the four major tributaries which drain into tidal waters (Southwest Miramichi [SW], Renous, Northwest Miramichi [NW], and Little Southwest Miramichi [LSW] rivers). Average juvenile densities were only calculated when four or more sites per major tributary were surveyed in a given year.

In 2022, electrofishing surveys were carried out at eight sites in the LSW, at 17 sites in the NW, at ten sites in the Renous and at 19 sites in the SW, for a total of 54 sites throughout the Miramichi watershed. Water conditions in September and October were generally favorable for the electrofishing survey in 2022.

In 2022, salmon fry were captured at all but one site and salmon parr (small and large combined) at all but five sites which indicates that adult salmon continue to spawn throughout the Miramichi watershed.

Average fry densities in the four monitored rivers in 2022 ranged from 15 (LSW) to 38 (NW) fish per 100 m^2. Fry densities in 2022 remained below the post-1984 average fry densities in each river (Figure 10).

The average small parr densities in 2022 ranged from 8 (LSW) to 10 (NW) fish per 100 m^2. Average small parr densities in 2022 remained below the long-term (1986 to 2022) average densities for this life stage in each river (Figure 10). The average large parr density in 2022 ranged from 1 (Renous) to 3 (SW) fish per 100 m^2 and also remained below the long-term (1987 to 2022) average for this life stage in all monitored rivers (Figure 10).

The average density of all juvenile life stages has decreased in the four monitored rivers over the last 12 years, although the decrease for large parr in SW Miramichi was not statistically significant (Figure 10). The decrease in average densities over the last 12 years has ranged from 54% (LSW) to 78% (Renous) for fry, from 56% (LSW) to 83% (NW) for small parr, and from 54% (LSW) to 76% (Renous) for large parr (Figure 10).

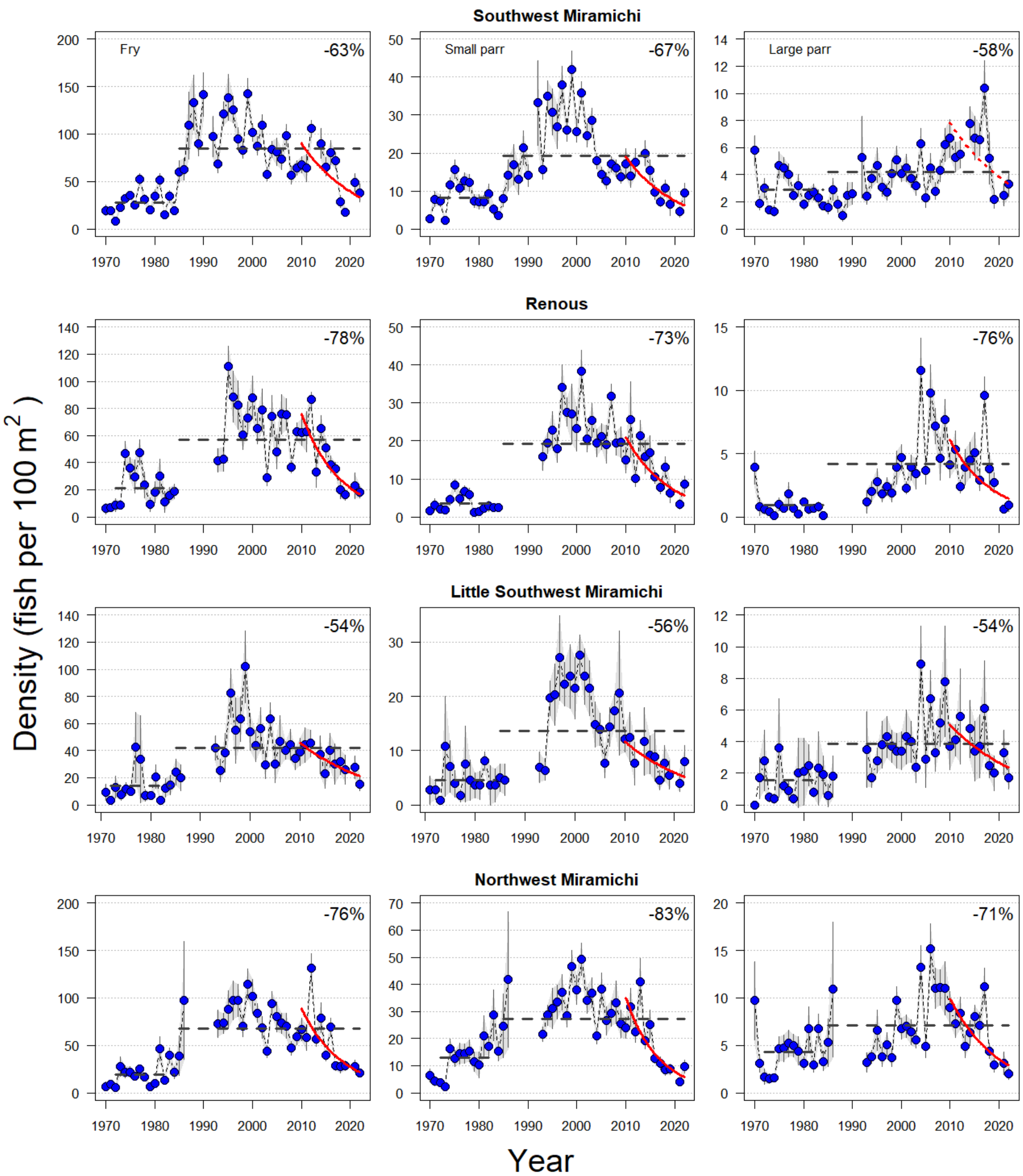

Figure 10: Annual average densities (blue circles), expressed as fish per 100 m² of sampled area, for fry (left column), small parr (middle column), and large parr (right column) at sampled sites in the four major rivers of the Miramichi watershed: Southwest Miramichi (upper row), Renous River (second row), Little Southwest Miramichi (third row), and Northwest Miramichi (bottom row) for 1970 to 2022. Covid-19 restrictions precluded the Miramichi electrofishing program in 2020. Vertical bars are standard error. The horizontal dashed lines in each panel represent the average densities, they are calculated separately for the periods before and after 1984 when significant management changes were implemented to the commercial and recreational salmon fisheries. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 16B Southeast New Brunswick

Electrofishing surveys in five rivers (Buctouche, Cocagne, Richibucto/Coal Branch, Kouchibouguacis, and Kouchibouguac) of southeastern New Brunswick have been conducted intermittently since 1974 and most consistently since the late 1990s (Atkinson 2004). Densities of Atlantic Salmon fry and parr (cohorts combined) were calculated when three or more sites per river were surveyed in a given year.

In 2022, electrofishing surveys were carried out at eight sites in the Buctouche River, five sites in the Cocagne River, five sites in the Richibucto/Coal Branch rivers (combined), four sites in the Kouchibouguacis River, and five sites in the Kouchibouguac River, for a total of 26 sites sampled throughout southeastern NB. Water conditions in late September were considered favorable for the southeastern NB electrofishing survey in 2022.

In 2022, salmon fry were captured at all but one site in the Cocagne River and salmon parr at all but one site in the Richibucto/Coal Branch River, which indicates that adult salmon continue to spawn throughout the sampled rivers of southeastern New Brunswick.

Average fry densities in the five monitored rivers in 2022 ranged from 17 (Kouchibouguacis) to 41 (Kouchibouguac) fish per 100 m^2 and were at or above the long-term (1999 – 2022) average of fry densities for each river (Figure 11).

The average parr densities in the five monitored rivers in 2022 ranged from 3 (Kouchibouguacis) to 22 (Kouchibouguac) fish per 100 m^2. Average parr densities in the Buctouche, Cocagne, and Kouchibouguac rivers were above the long-term (1999 – 2022) average parr densities for those rivers while average parr densities in the Richibucto/Coal Branch and Kouchibouguacis rivers were below the long-term average for those rivers (Figure 11).

Over the last 12 years, the change in abundance of all size classes of juvenile Atlantic Salmon in all rivers sampled in SFA 16B was not statistically significant.

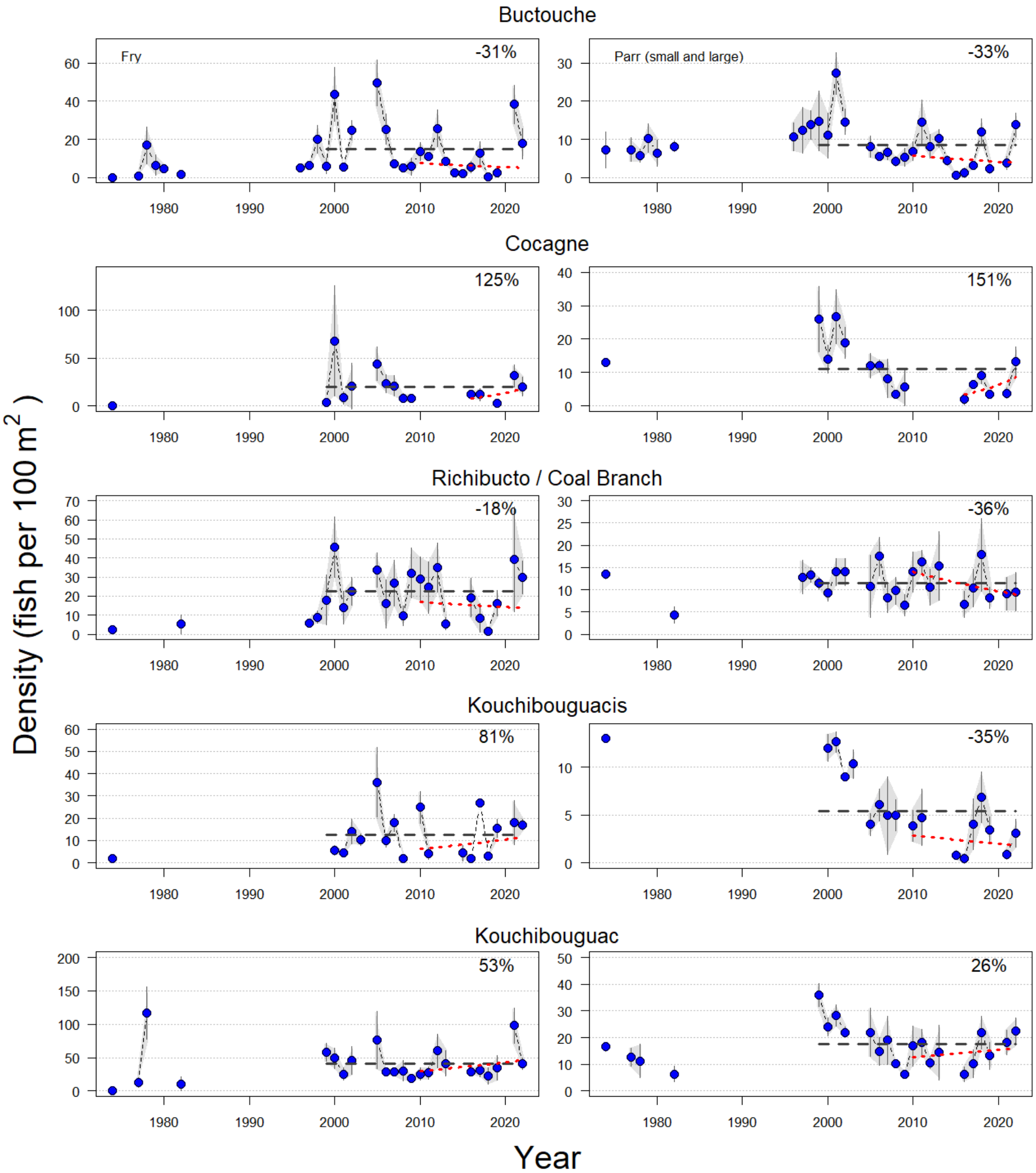

Figure 11: Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column) and parr (size groups combined, right column) from sampled sites in five major rivers of southeastern New Brunswick: Buctouche River (upper row), Cocagne River (second row), Richibucto/Coal Branch rivers (third row), Kouchibouguacis River (fourth row), and Kouchibouguac River (bottom row) for 1974 to 2022 sampling years. Vertical bars and grey shading represent standard error when shown. The horizontal dashed lines represent average fry and parr abundance for the years after the closure of the Indigenous and recreational fisheries in 1998. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel. For the Cocagne River, the percent change is calculated from the last year (2016) there is available data in the 12-year time period.

SFA 18A Mainland Gulf Nova Scotia

Juvenile salmon surveys have been conducted in three rivers in SFA 18A: West River (Antigonish), East River (Pictou), and River Philip. Results are presented for years with at least three sites sampled per river. Since 2012, six sites per river have been sampled. All sites sampled in 2022 were occupied by juvenile salmon.

Over the past 12 years, change in juvenile abundances was only significant for parr in the East River (Pictou), where abundances increased by 81%. Fry abundances were below the long-term average in all rivers, whereas parr were above the long-term average (Figure 12).

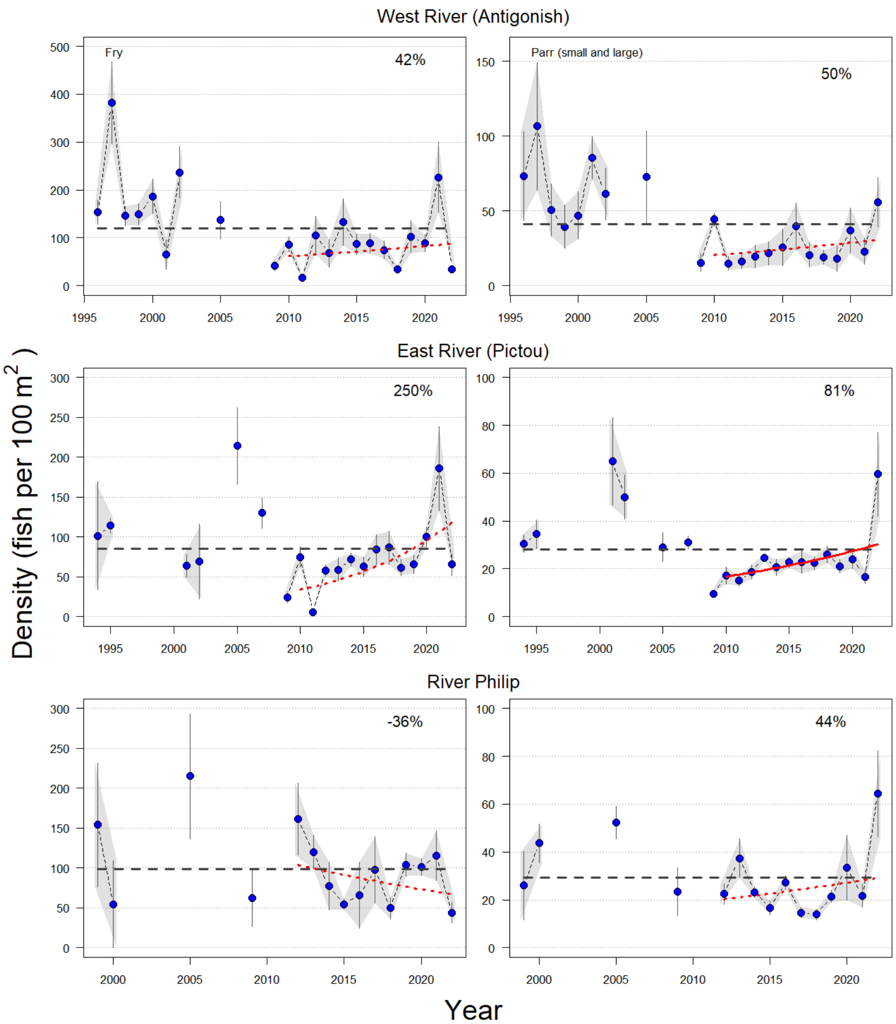

Figure 12: Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column) and parr (right column) at sites sampled in the three mainland NS rivers of Gulf Region. Vertical bars and grey shading are standard error. The horizontal dashed line in each panel represents the average densities for the time-series presented. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 18B Margaree River

Thirteen sites were surveyed in the Margaree River during 2022. All sites sampled were occupied by parr and fry, with the exception of one site where fry were not detected. Over the past 12 years, change in juvenile abundances for both fry and parr was not significant. In 2022 fry were below the long-term average and parr abundance was slightly above the long-term average (Figure 13).

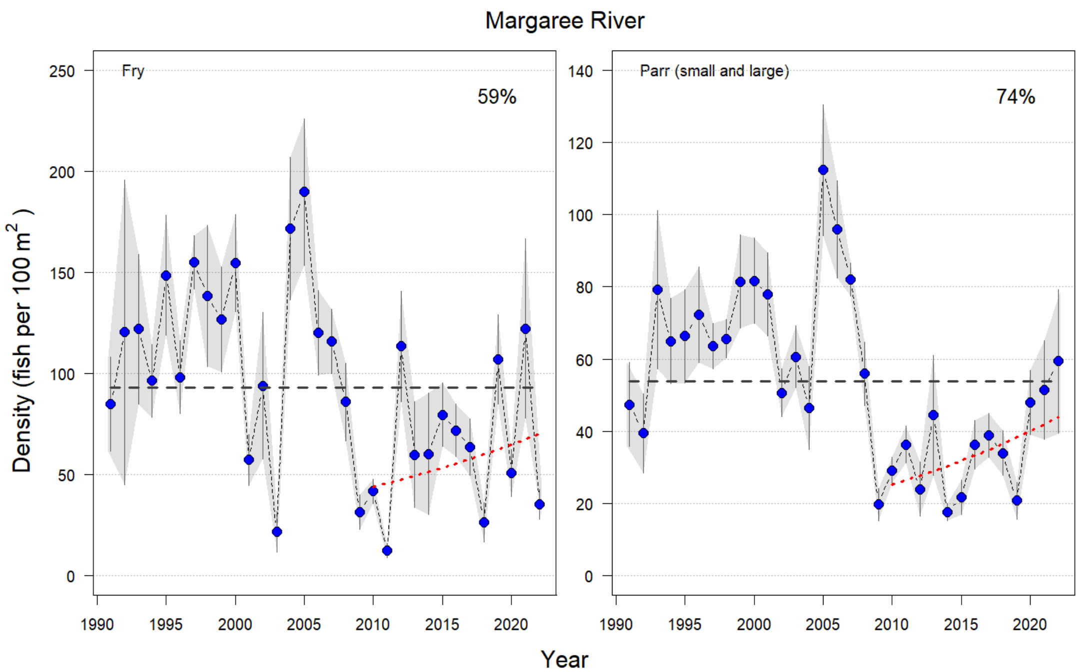

Figure 13: Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column) and parr (right column) at sites sampled in the Margaree River since 1990. Vertical bars and grey shading are standard error. The horizontal dashed line in each panel represents the average densities for the time-series presented. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated densities over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

Conclusions

Based on the trends in abundance of small salmon and large salmon and the generally declining or stable juvenile abundance indices, there is no expectation of increased abundance of salmon in rivers of DFO Gulf Region in 2023.

Stock Status of Atlantic Salmon

In 2022 the Atlantic Salmon populations in the Restigouche River in SFA 15 and Miramichi River in SFA 16 were in the critical zone (Table 2).

In SFA 17 the majority of rivers surveyed had populations below the LRP. The assessments of status confirm the precarious status of salmon in several small rivers, especially those in which spawning appears to occur only in intermittent years. In 2022, only two rivers in this SFA exceeded LRP, however, this could partly be due to incomplete redd surveys (Table 2).

The population in the Margaree River in SFA 18 was above the USR in 2022 and therefore in the healthy zone, with the caveat that the estimate has high uncertainty due to changes in angling effort since the model was developed.

Table 2: Summary of Atlantic salmon stock status for 2022 in assessed rivers of salmon fishing areas (SFA) 15-18.

SFA	River	Percentage of LRP attainment (prob. > LRP)	PA status
15	Restigouche	77%	Critical
16A	SW Miramichi	92% (37%)	Critical
16A	NW Miramichi	54% (2%)	Critical
17	13 Rivers in PEI[1]	2 of 13 above LRP; range: 3% - 320%	Critical to Cautious
18	Margaree	523% (100%)	Healthy

[1]Status is presented for 13 rivers that had surveys in 2022. The number of rivers in which spawners exceeded the LRP in 2022 is shown along with the range of percent attainment for all surveyed rivers.

Freshwater production of Atlantic Salmon

Although the juvenile indices in the surveyed rivers of SFA 15A, SFA 16B, and SFA 18 since 2010 are generally lower than during the previous decade, the trends over the past 12 years are either stable or increasing in these areas (Figures 9, 11, 12, 13). This contrasts with the trends for both fry and parr indices in the surveyed rivers of SFA 16A (Miramichi) most of which have been significantly declining over the same time period (Figure 10).

Sources of Uncertainty

Fisheries-dependent data

SFA 15 and 18 estimates of Atlantic Salmon adult abundance rely on fisheries-dependent data which could bias population estimates.

For the Restigouche River (NB; SFA 15A), high river temperatures and low water conditions during the summer and early fall have impacted the fishing effort and possibly the availability of salmon to the fishery. Reporting of recreational fishery data is also incomplete. In 2022, 16 of 22 lodges returned catch reports, an improvement from the previous two years. Similar to previous years, missing catches were estimated based on the assumption that the proportion of the total catch remained the same as in years when catch reports were available during a comparable time period in the time-series. Of the registered Crown Reserve parties, 63% had returned creel forms. Total Crown Reserve catches were estimated by raising the reported catches to all registered parties. As of the date of this update, the 2022 Crown Reserve data is considered preliminary.

The Margaree River (NS; SFA 18B) assessment model was built from fisheries-independent data collected at a trap net from 1988 to 1996 in conjunction with effort from recreational license stub data. Since 1997, only fisheries-dependent data have been available as input for the model. However, recreational angling effort has decreased outside the range of values used during the years when the model was developed and therefore invites caution when using salmon population estimates derived by the model. Options, including a mark and recapture study conducted using a trap net, are being explored to obtain fishery-independent data on adult salmon to recalibrate the model but results are not expected for several years.

Visual spawner surveys (snorkel counts)

Spawner counts rely on estimations of abundance and size. When large numbers of fish are present in holding pools there can be biases (yet to be quantified) resulting in over and/or under counting. Observers must also estimate the proportion of large and small fish which leads to uncertainty in the relative contribution of the two size groups. Additionally, environmental conditions have impacts on the observation process that are not yet accounted for. Currently, snorkel counts are reported without error but efforts are underway to develop an estimate of uncertainty for this index.

Rain events can delay or in some cases terminate the snorkel survey prematurely which leads to incomplete spawner counts. Delays in the survey until water conditions allow for snorkelling to resume may also allow salmon time to migrate into areas of the river already surveyed.

Redd counts

Assessment of salmon status in SFA 17 is entirely reliant on redd surveys which are commonly affected by high water conditions during the spawning period leading to incomplete counts. Additional sources of uncertainty arise from watershed groups' ability to devote resources to conducting rigorous redd surveys, the difficulty in distinguishing between brook trout redds and salmon redds, and the potential for interannual variation in the timing of spawning events. Overall, methods to assess salmon abundance on PEI are not well developed and status is very uncertain in the majority of rivers.

Incomplete accounting of losses

In all SFAs, adult Atlantic Salmon losses not accounted for in the estimation of spawners include those from incomplete reporting of fisheries catches, poaching, experimental manipulation, and broodstock collections. Losses due to natural factors including disease, mortalities from warm water, predation on adult salmon, and others are also not accounted for in the estimation of spawners. Consequently, the egg depositions are considered to be over-estimates of the realized egg depositions in any year.

A planned fish kill occurred in a 15 km stretch of the SW Miramichi River and Lake brook in the fall of 2022 with the intention to control Smallmouth Bass (*Micropterus dolomieu*), an invasive species. Based on juvenile salmon habitat being similar throughout the watershed and recent density estimates, it's possible that hundreds of thousands of juvenile salmon died. However, the impact on adult returns in the future is unknown and unquantifiable. Similarly, the number of adult salmon that died as a result of the fish kill is also unknown and was not taken into account when calculating the number of spawners for the SW Miramichi in 2022.

Electrofishing surveys

Electrofishing surveys across the region occur from mid-July to early October depending upon the area and meteorological conditions. Catchability of juvenile Atlantic Salmon may vary as a function of size, water temperature, stream size, water levels, visibility, etc. Some of the annual variations in juvenile indices may be associated with variations in sampling conditions that affect catchability, and which are not accounted for in the current models used to estimate juvenile abundance indices.

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Date: June 19, 2023

Sources of Information

This Science Response Report results from the regional Peer Review of March 1, 2023 on the Update of Atlantic salmon SFA 15-18 stock indicators.

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Appendices

Appendix I: Environmental Conditions

Elevated water temperatures are a threat to Atlantic Salmon as they have been documented to increase stress (Breau and Caissie 2013) and mortality rates for this species. (Van Leeuwen et al. 2020)

Elevated air temperatures coincide with high water temperatures in SFAs 15, 16, and 18 but not 17 due to large groundwater contributions to rivers in PEI. Air temperature data collected from the Environment and Climate Change Canada meteorological stations in Miramichi (NB; SFA 16), Bathurst (NB; SFA 15) and Sydney (NS; SFA 18) were used to characterize summer conditions in 2022. The mean air temperature during the summer months (July and August) in 2022 was 20.1 °C at Miramichi, 19.4 °C at Bathurst, and 19.6 °C at Sydney (Figure AI-1). There are statistically significant ($p < 0.001$) increasing trends over the time-series with data from the 1870s to 2022 (Bathurst: 1922 to 2022); the mean summer air temperature has increased by an average of 1.06 °C per 100 years at Miramichi, 1.25 °C per 100 years at Bathurst and 1.34 °C per 100 years at Sydney (Figure AI-1).

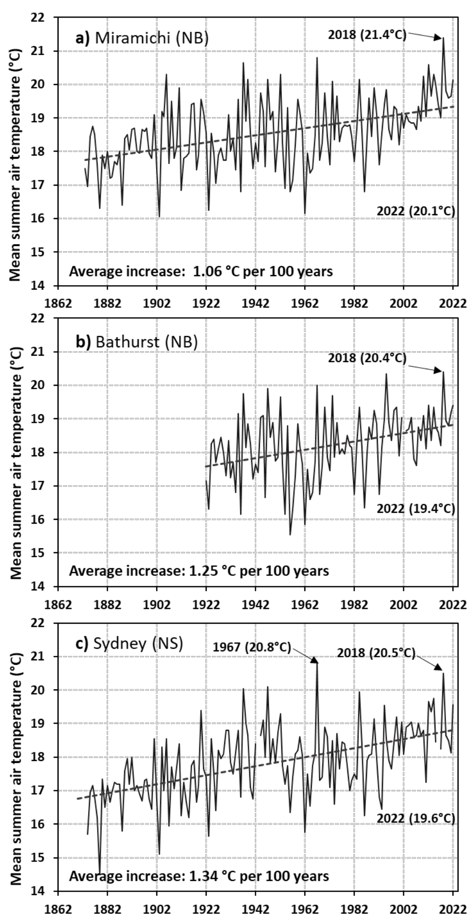

Figure AI-1: Mean annual summer (July and August) air temperatures and linear trend in mean temperature based on data from the Environment and Climate Change Canada meteorological stations in a) Miramichi, NB (station 8100989), 1873 to 2022, b) Bathurst, NB (station 8100505), 1922 to 2022, and c) Sydney, NS (station 8205702), 1870 to 2022.

High air temperatures during the summer of 2022 resulted in high water temperature (> 23 °C; temperatures stressful for Atlantic Salmon) events in the monitored rivers. Daily mean, maximum, and minimum water temperatures for 2022 are presented in Figures AI-2 a, b and c. The maximum summer temperature was 27.6 °C in the Little Southwest Miramichi River above Catamaran Brook (Aug. 7; Figure AI-2 a), 24.5 °C in the Restigouche River at Butters Island (Aug. 21; Figure AI-2 b) and 26.4 °C in the Margaree River (Aug. 7; Figure AI-2 c).

The number of days between the first and last day where T_{max} > 23 °C was 78 days at the Little Southwest Miramichi River site, 53 days at the Restigouche River site and 46 days at the Margaree River site; these events are identified in Figure AI-2 d, e and f where days when T_{min} > 20 °C are indicated by red dots and consecutive days where T_{min} > 20 °C are indicated by red lines. At the Little Southwest Miramichi site (Figure AI-2 d), there were 14 days where T_{min} > 20 °C; two one-day events, one two-day event, and two five-day events At the Restigouche River site (Figure AI-2 e), there were four one-day events, one two-day event, one three day event, one five-day event, and one six day event for a total of 20 days. At the Margaree River site (Figure AI-2 f), there were two one-day events, one three-day event, and one six-day event for a total of 11 days. Although the Restigouche River site did not reach as high temperatures as the Little Southwest Miramichi or the Margaree sites, the diurnal variation was less pronounced, resulting in a greater amount of days where T_{min} > 20 °C. One should note that the water temperatures used and described in this section come from different monitoring stations than the ones recording real-time temperature data used in the application of the Warm Water Protocol.

The daily maximum water temperature at the Little Southwest Miramichi River monitoring station exceeded 23 °C for 36 days in 2022, fewer days than in 2020 (59 days), 2018 (60 days) and 1999 (62 days). For the Restigouche area (SFA 15), water temperatures exceeded 23 °C for 10 days at the Restigouche River Butters Island monitoring site and for seven days at the Northwest Upsalquitch 10 Mile pool monitoring site in 2022. Water temperatures experienced at different locations in large rivers can be variable and water temperatures in the Miramichi River (SFA 16) are generally much warmer than those of the Restigouche (SFA 15) and Margaree (SFA 18) rivers.

Monthly flow conditions in 2022 and long-term average conditions for four rivers in Gulf Region are presented in Figure AI-3, where excessive flows (E) indicate months when the mean monthly flow was greater than the long-term average 75^{th} percentile and deficient flows (D) indicate months when the mean monthly flow was lower than the long-term 25^{th} percentile. Among the four rivers, only the Northeast Margaree River had a deficient flow month (October; Figure AI-3 c). All rivers had three or four excessive flow months during 2022. The Southwest Miramichi River had excessive flow months in February, March, June, and December (Figure AI-3 a). The Upsalquitch River had excessive flow months in April, May, June, and December (Figure AI-3 b). The Northeast Margaree River had excessive flow months in January, February, and July (Figure AI-3 c). The Wilmot River had excessive flows in February, September, and December (Figure AI-3 d), where the February monthly flow was a record high at 2.66 m^3/s, exceeding the previous highest monthly flow for February of 2.39 m^3/s from 1981.

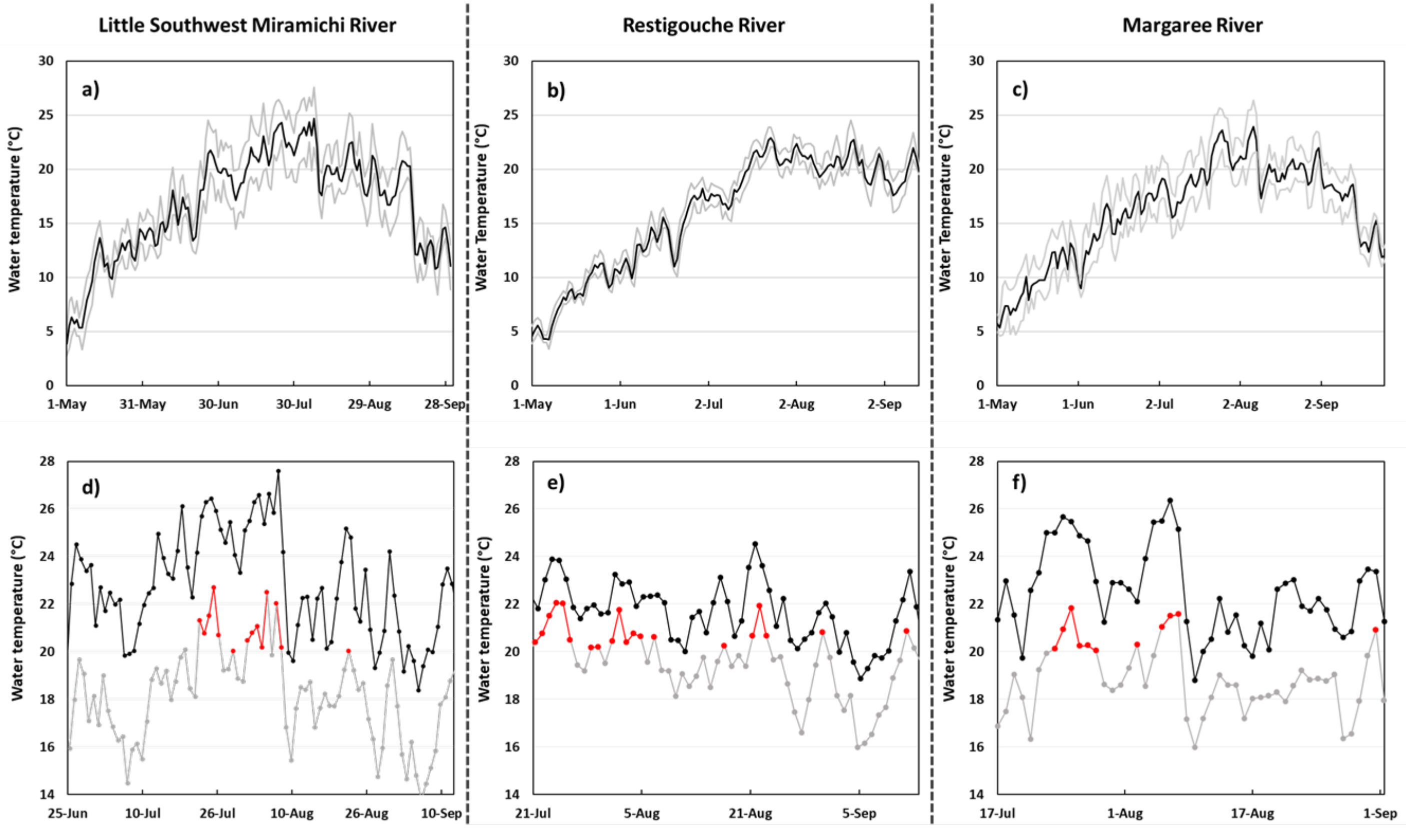

Figure AI-2: Top row: mean (black), max and min (grey) daily water temperatures monitored in the a) Little Southwest Miramichi River (SFA 16) above the confluence of Catamaran Brook, b) Restigouche River at Butters Island (SFA 15) and c) Margaree River (SFA 18). Bottom row: max (black) and min (grey and red) daily water temperatures between the first and last date where T_{max} > 23 °C in the d) Little Southwest Miramichi River above the confluence of Catamaran Brook, e) Restigouche River at Butters Island and f) Margaree River. Red dots indicate days where T_{min} > 20 °C and red lines indicate consecutive days where T_{min} > 20 °C.

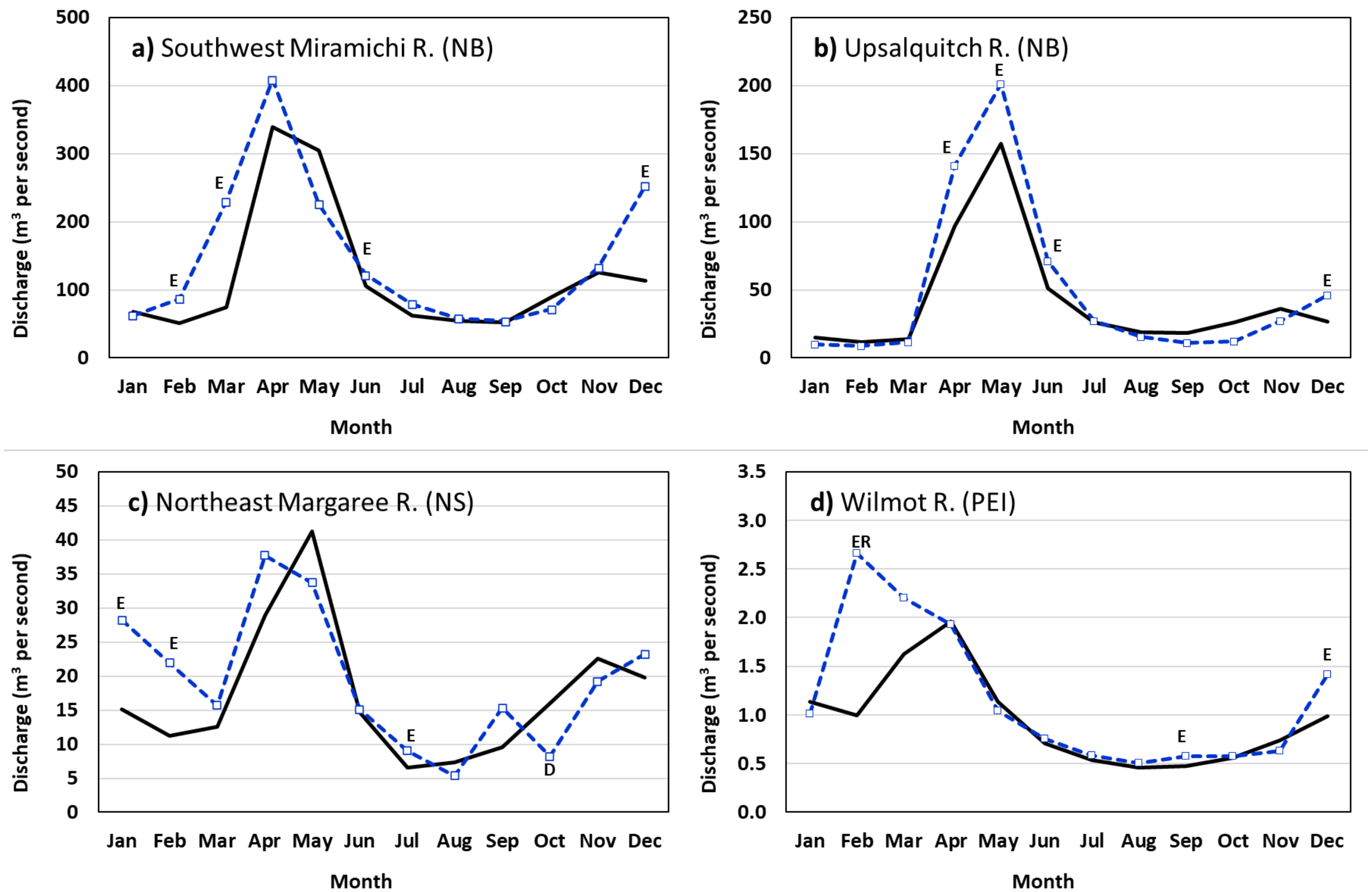

Figure AI-3: Monthly flow conditions in 2022 (blue dashed line) and long-term average monthly flow conditions (black line; 1919-2020) for rivers within the DFO Gulf Region monitored by Environment and Climate Change Canada. In the graphs, E = excessive flow (above 75th percentile), ER = excessive and record flow, D = deficient flow (below the 25th percentile), and DR = deficient and record flow.

Appendix II: Supplementary figures and data relating to adult Atlantic Salmon monitoring

SFA 15A

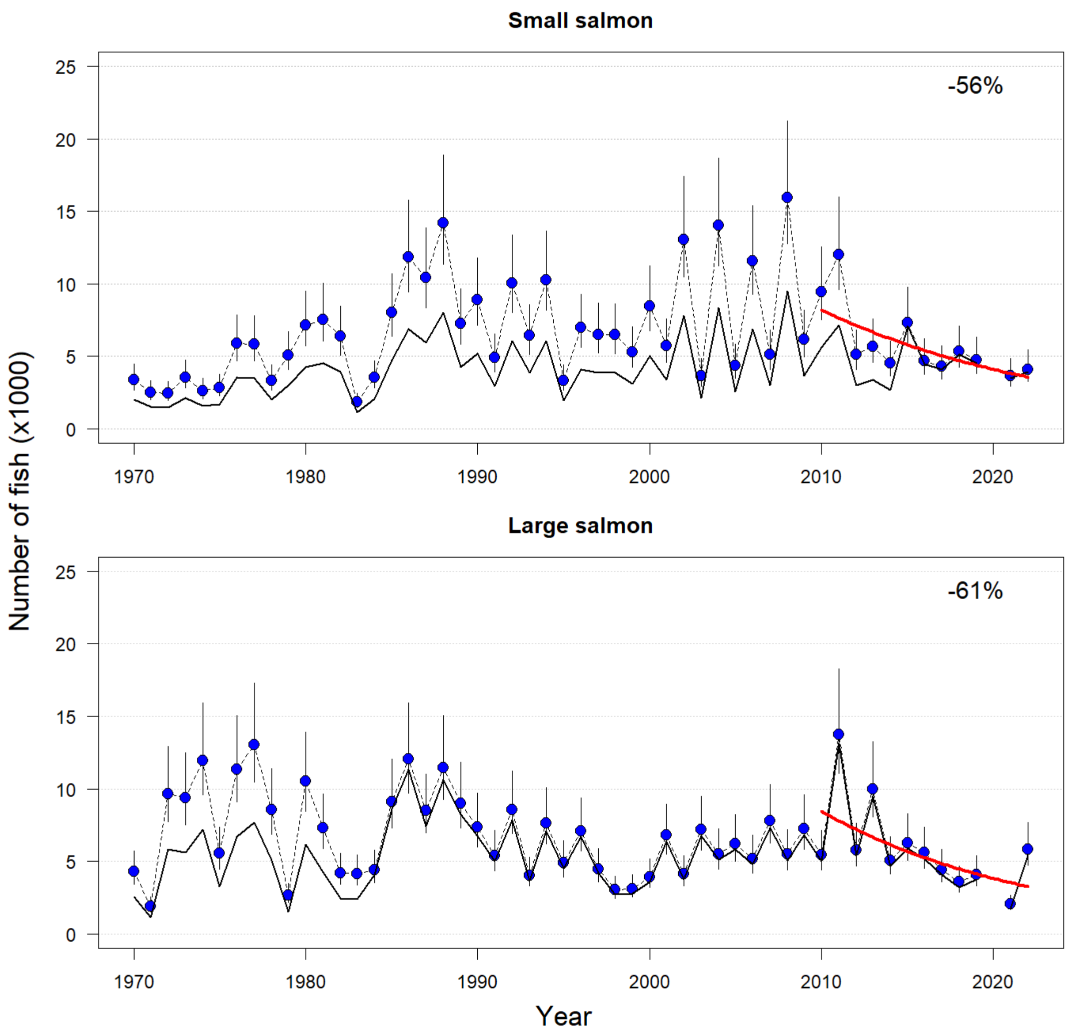

Figure AII-1: Estimated returns (blue circles and thin dashed line are for 40% catch rate and the vertical error bars show range based on catch rates of 30% to 50%) and spawners (thick solid line and no symbols, for 40% catch rate assumption) based on angling catches of small salmon (upper panel) and large salmon (lower panel) to the Restigouche River (NB), 1970 to 2022. The data for 2022 are preliminary. The trend (exponential regression, red line) for returns over the previous twelve-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

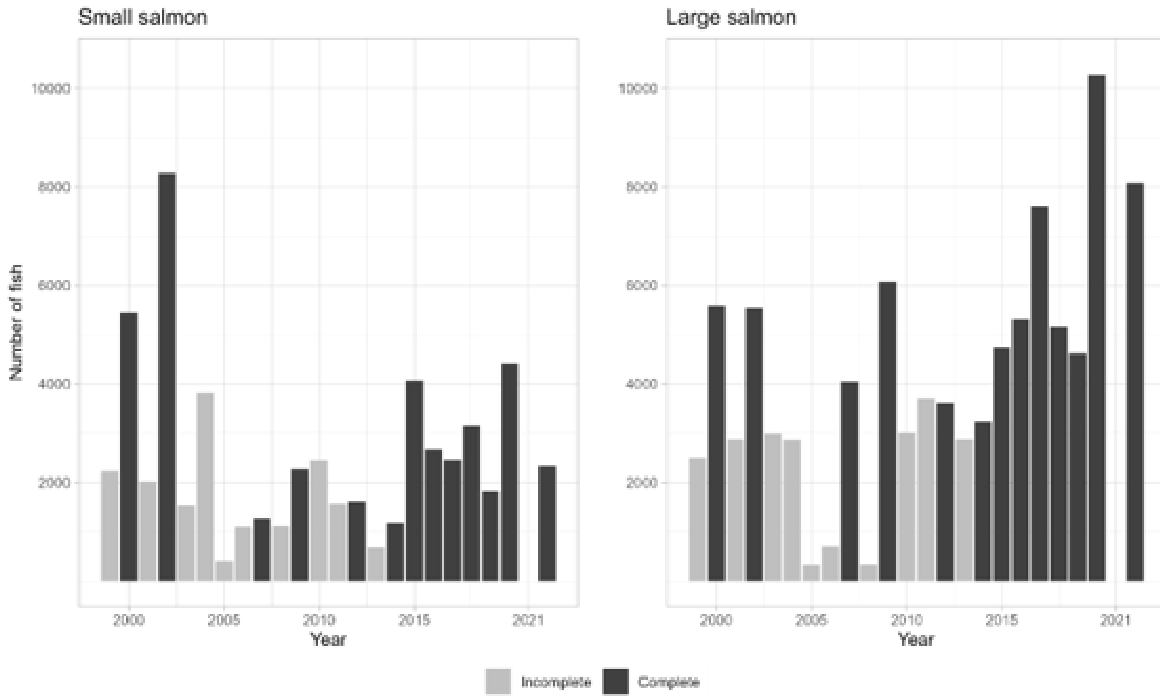

Figure AII-2: Total end of season visual spawner counts of Atlantic Salmon, by size group (small salmon left panel, large salmon right panel) from four tributaries and the main stem of the Restigouche River for 1999 to 2022 (no counts in 2021). Complete and incomplete (mainly due to high water conditions) visual spawner counts are indicated in dark and light grey, respectively.

SFA 16A

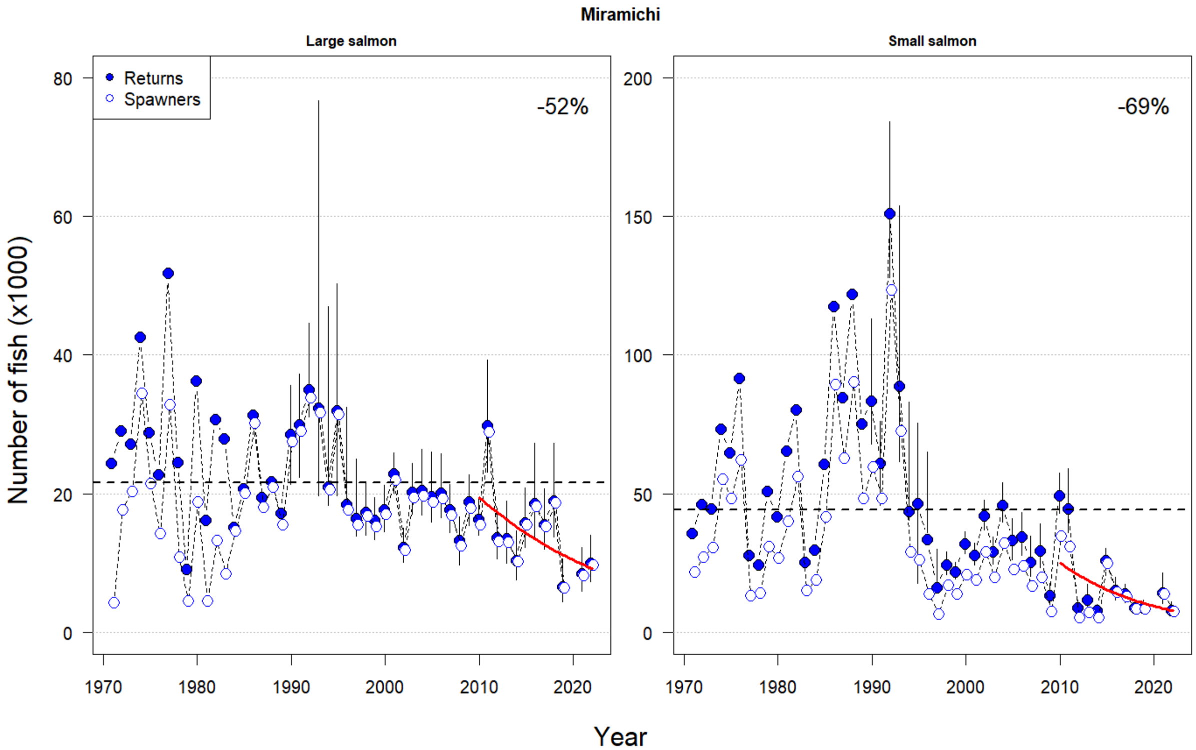

Figure AII-3: Estimated (median and 5th to 95th percentile range) returns and spawners of large salmon (left panel) and small salmon (right panel) for the Miramichi River for 1971 to 2022. Covid restrictions in 2020 precluded the Miramichi assessment program and estimates of large and small salmon returns are unavailable for that year. The horizontal dashed line is the average of the median return estimates of large salmon or small salmon for the available time-series The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated returns over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

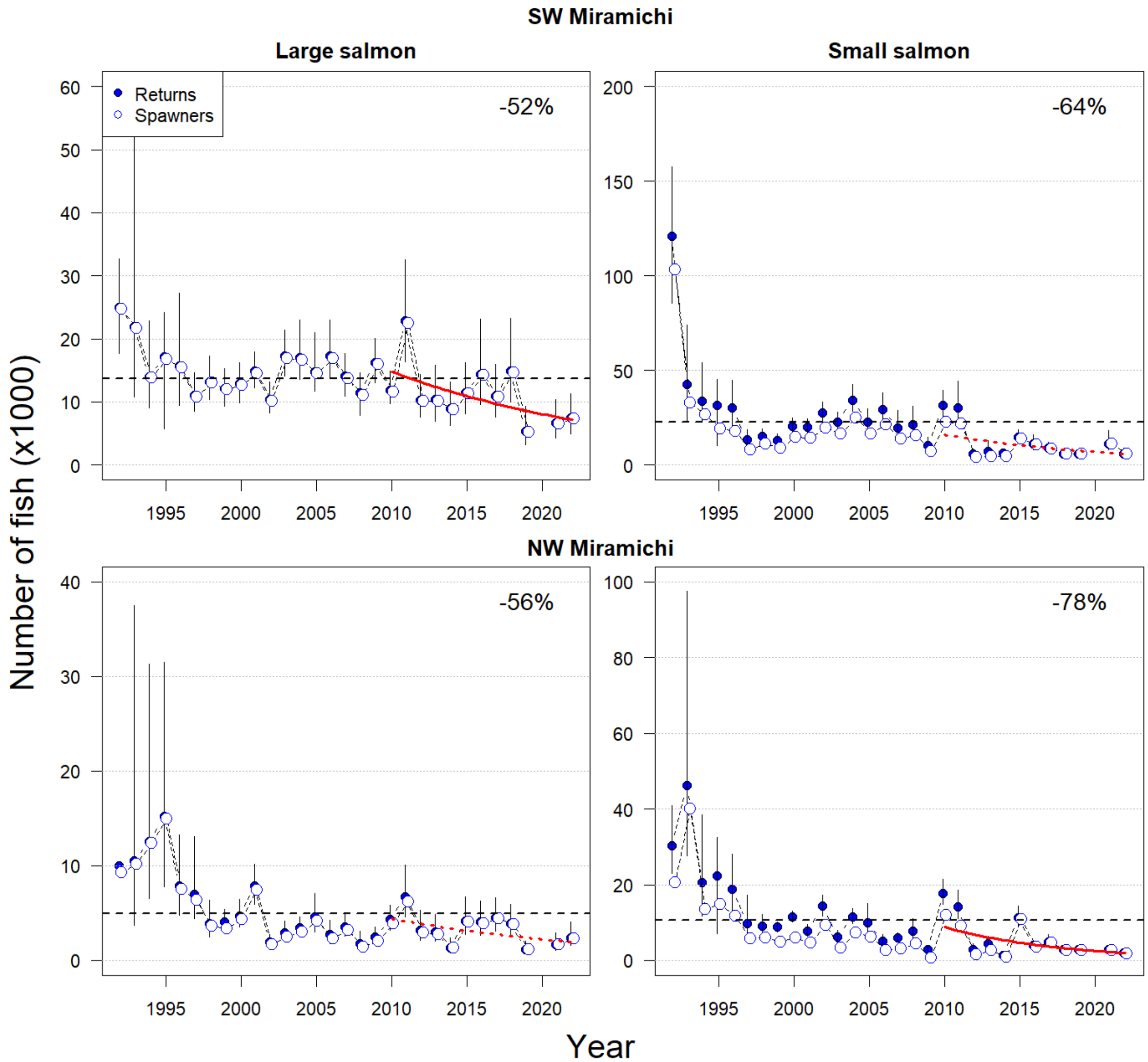

Figure AII-4: Estimated returns (median and 5th to 95th percentile range) and spawners (median) of large salmon (left panels) and small salmon (right panels) for the Southwest Miramichi River 1992 to 2022 (top row), and the Northwest Miramichi River 1992 to 2022 (bottom row). Covid restrictions in 2020 precluded the Miramichi assessment program and estimates of large and small salmon returns are unavailable for that year. The horizontal dashed line is the average of the median return estimates of large salmon or small salmon for the available time-series. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated returns over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

SFA 18

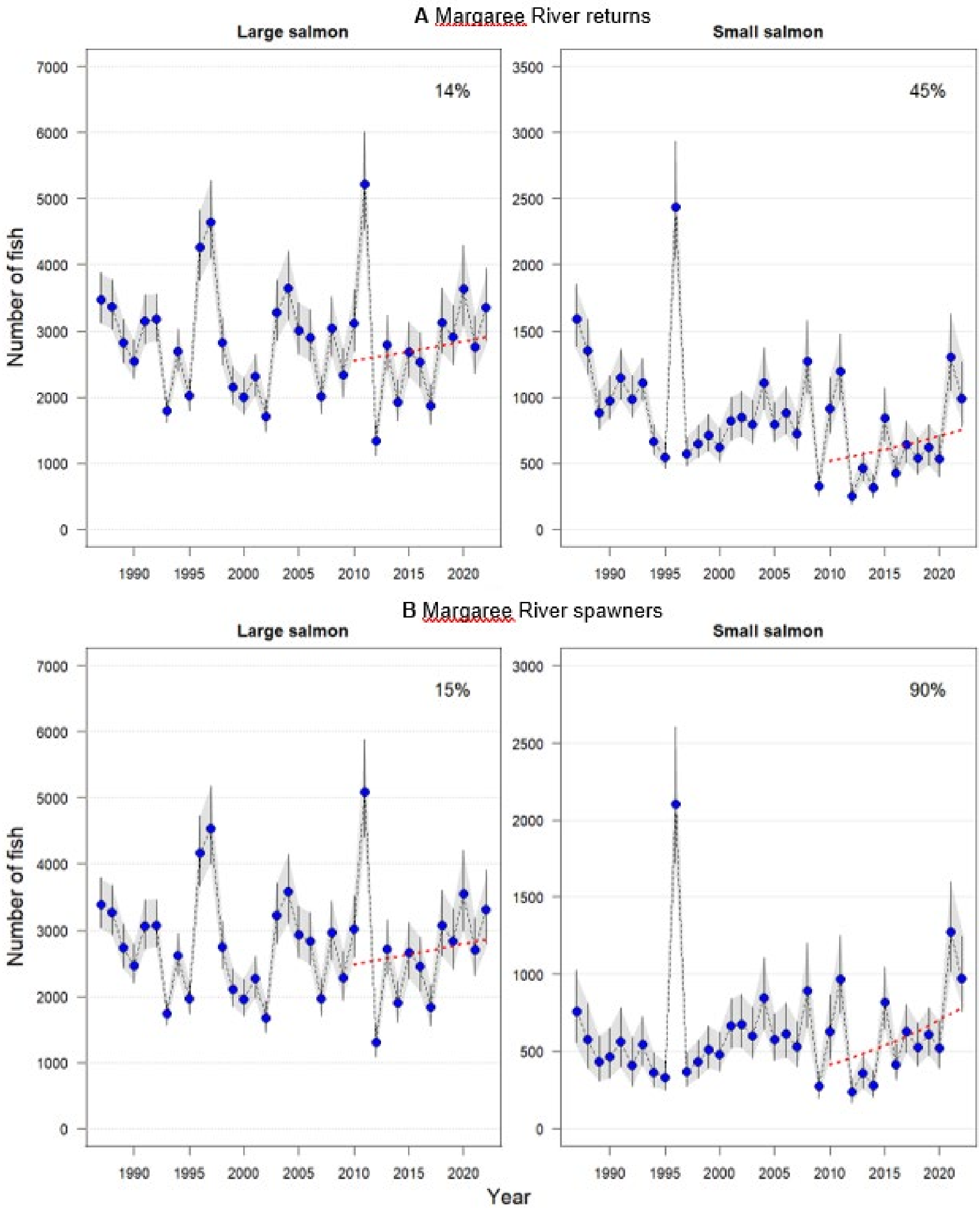

Figure AII-5: Posterior distributions (medians; 5th to 95th percentile range in the shaded region) of estimated returns (A) and spawners (B) of large salmon (left panels) and small salmon (right panels) to the Margaree River, 1987 to 2022. The trend (exponential regression, solid or dashed red line when the slope is significantly different than 0 or not, respectively) in the median of the estimated returns and spawners over the previous 12-year time period (2010 to 2022) and the corresponding percent change over that period are shown in each panel.

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