UPDATE OF INDICATORS OF ATLANTIC SALMON (*SALMO SALAR*) IN DFO GULF REGION SALMON FISHING AREAS 15 – 18 FOR 2017

Context

The last assessment of stock status of Atlantic Salmon for Fisheries and Oceans Canada (DFO) Gulf Region was completed after the 2013 return year (DFO 2014) and updates on stock status in 2014 to 2016 for each of the four Salmon Fishing Areas (SFA 15-18) were prepared (DFO 2015a; DFO 2015b, DFO 2016, DFO 2017). DFO Fisheries and Aquaculture Management (FAM) requested an update of the status of the Atlantic Salmon stocks in DFO Gulf Region for 2017. Indicators for adult and juvenile Atlantic Salmon in SFAs 15 to 18 are provided in this report. This Science Response Report results from the Science Response Process of February 20, 2018 on the update of indicators of Atlantic salmon to 2017 for Salmon Fishing Areas 15 to 18, DFO Gulf Region.

Background

All rivers flowing into the southern Gulf of St. Lawrence are included in DFO Gulf Region. Atlantic Salmon (*Salmo salar*) management areas in DFO Gulf Region are defined by four salmon fishing areas (SFA 15 to 18) encompassing portions of the three Maritime provinces (New Brunswick, Nova Scotia, and Prince Edward Island) (Fig. 1).

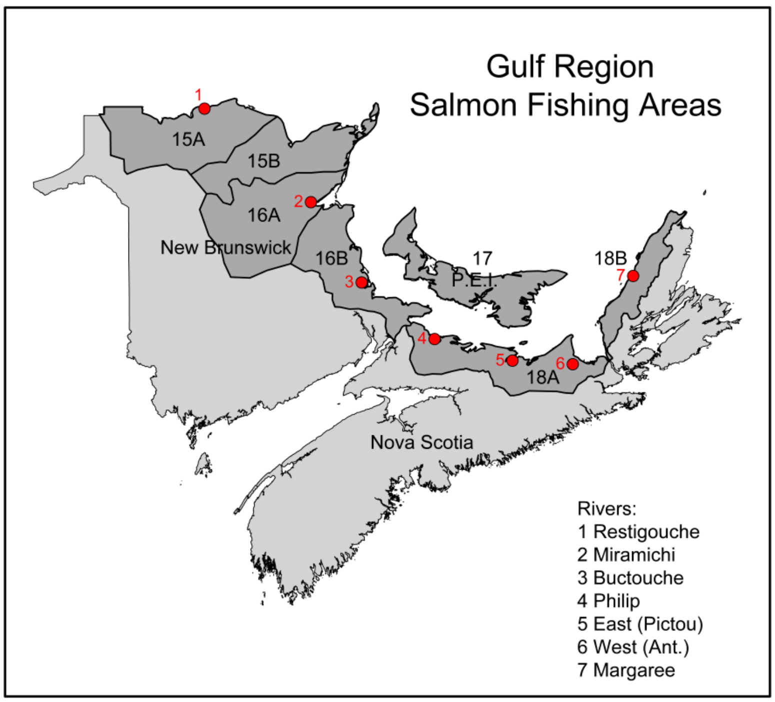

Figure 1. Salmon Fishing Areas in the DFO Gulf Region and locations of rivers mentioned in the report.

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).

This report presents indicators of abundance of adult salmon and juvenile life stages. To provide a perspective on recent trends, the changes (exponential regression of change) in the indicators over the recent twelve years, approximately two generations, are presented.

During 2015 to 2017, mandatory catch and release measures for the recreational fishery were in effect in all Salmon Fishing Areas where recreational fisheries were authorized. This was a change from 2014 and previous years when retention of small salmon had been allowed in SFA 15, SFA 16A, and SFA 18. In 2015 to 2017, rivers in south east New Brunswick (SFA 16B) remained closed to all directed salmon fishing.

Analysis and Response

Abundance indices of adult salmon

SFA 15A Restigouche River

Information on adult salmon abundance from the Restigouche River (NB; excluding Matapedia River which is entirely within the province of Quebec) comes primarily from angling catches and effort as well as end of season spawner counts. For recreational fisheries, catches in the Restigouche River are based on lodge catch reports compiled by DFO Science and Crown Reserve angling catches compiled by the province of New Brunswick excluding catches from public water. As of the date of this review, the catch data from lodges for 2017 were incomplete with information missing for 3 of 24 lodges. Catches from all lodges was estimated by assuming that the catch data from the missing lodges was of the same proportion to total catches based on the previous three years.

Effort from lodges and leases in 2017 was estimated at 5,285 rod days, a 5% increase in effort compared to 2016. However, monthly effort analysis showed that effort decreased by over 50% in August and September compared to the long term means (2001-2016). Lodges reduced or stopped their fishing activity in August and September because of low water levels which were interfering with navigation on the river. Total parties registered in Crown Reserve waters in 2017 decreased by 2% from 2016 (908 anglers in 2017 compared to 929 in 2016). Of the registered parties, 54% had returned creel forms. Estimated Crown Reserve catches were raised to totals based on the returned creel forms. Combined, the provisional recreational fishery catches for 2017 are 1,682 large salmon and 1,685 small salmon from the Restigouche (NB) waters (excluding Matapedia River).

Based on an assumed angling exploitation rate of 40% and raised by estimates of aboriginal fishery harvests in the estuary, an approach similar to previous assessments (DFO 2014), returns to the Restigouche River (NB) in 2017 were estimated at 4,457 large salmon and 4,254 small salmon (Fig. 2). Over the recent 12 year period, (approximately two generations), the median annual abundance of large and small salmon has decreased by 10% and 42%, respectively.

Based on the angling catches index, the returns of large salmon were equivalent to 79% of the conservation requirement. Accounting for losses from fishing (in river FSC harvests and 6% catch and release mortality), the potential egg depositions by large salmon represented 72% of the conservation requirement. Based on an angling exploitation rate of 40%, the Restigouche River (NB portion) has met or exceeded the conservation egg requirement in 6 of the last 10 years (Fig. 3).

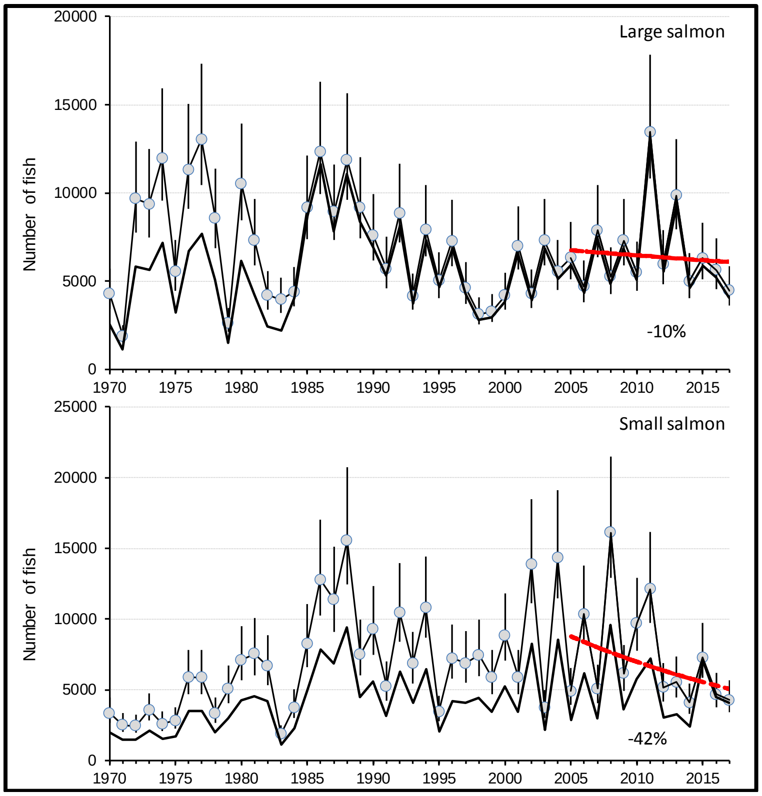

Figure 2. Returns (grey circle are for 40% catch rate and vertical error bars show range based on catch rates of 30% to 50%) and spawners (solid line for 40% catch rate assumption) based on angling catches of large salmon (upper) and small salmon (lower) to Restigouche River (NB portion), 1970 to 2017. The data for 2017 are preliminary. The red dashed line is the trend line (exponential regression) of the returns and the corresponding percent change over the twelve year time period (2005 to 2017) are also shown.

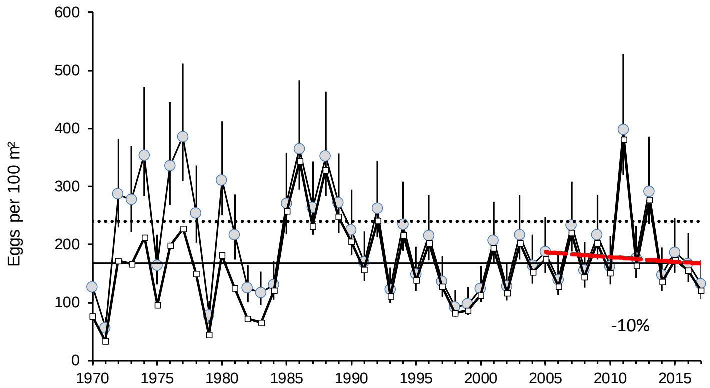

Figure 3. The potential eggs (expressed as eggs per 100 m² of wetted habitat area; total area of 21.6 million m²) by large salmon for the returns (grey circles are assumed catch rate of 40%, error bars show range for catch rates of 30% to 50%) and the spawners (white square symbols for an assumed catch rate of 40%) in the New Brunswick portion of the Restigouche River, 1970 to 2017. The solid horizontal line is the egg deposition rate of 168 eggs per 100 m² presently used to assess attainment of conservation for the Restigouche River. The dashed horizontal line is the egg deposition rate corresponding to 240 eggs per 100 m² used in other rivers of Gulf Region. The estimates for 2017 are based on preliminary data. The red dashed trend line (exponential regression) and the corresponding percent change for spawners over the twelve year time period (2005 to 2017) are also shown.

Assessments on the Restigouche River are also informed by spawner counts at the end of the season, after all fisheries and in river losses. In late September 2017, end of season spawner counts were conducted in four Restigouche (NB) tributaries (Kedgwick, Little Main Restigouche, Upsalquitch, and Patapedia) and the main stem Restigouche (Fig. 4). Based on the end of season spawner count index, the eggs from large salmon spawners in 2017 were above the conservation (1.68 eggs per m^2) requirement (135%).

The difference in status in 2017 based on angling catches with assumed exploitation rates compared to end of season snorkel counts can be largely explained by unfavourable angling conditions which likely resulted in lower catches and a lower exploitation rate than the assumed value of 0.4. For 2017, the spawner counts are considered to be more representative of status than the estimates derived from angling catches.

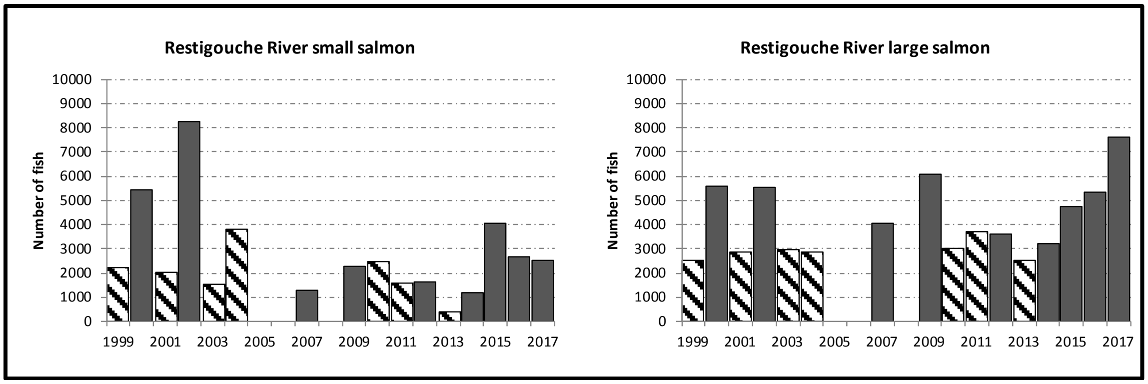

Figure 4. Summary of end of season salmon counts by size group (small salmon left panel, large salmon right panel) from four tributaries and the main stem of the Restigouche River for 1999 to 2017. Spawner counts could not be completed (hatched bars) in all years depending on water conditions.

SFA 16A Miramichi River

The Miramichi River is the largest river in SFA 16 and DFO Gulf Region. 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 estimates of returns and spawners of Atlantic Salmon for the Miramichi River and to each of the Northwest Miramichi and Southwest Miramichi branches are repeated here from DFO (2018).

The estimated returns of large salmon to the Miramichi River in 2017 were 14,600 fish (median; 5^{th} to 95^{th} percentile range 11,000 to 19,900) while small salmon returns were estimated at 13,300 fish (median; 5^{th} to 95^{th} percentile range 10,500 to 16,600). Returns of both large salmon and small salmon to the Miramichi River in 2017 were below 2016 levels and below the average returns estimated for each size group over the time series 1971 to 2017 (Fig. 5).

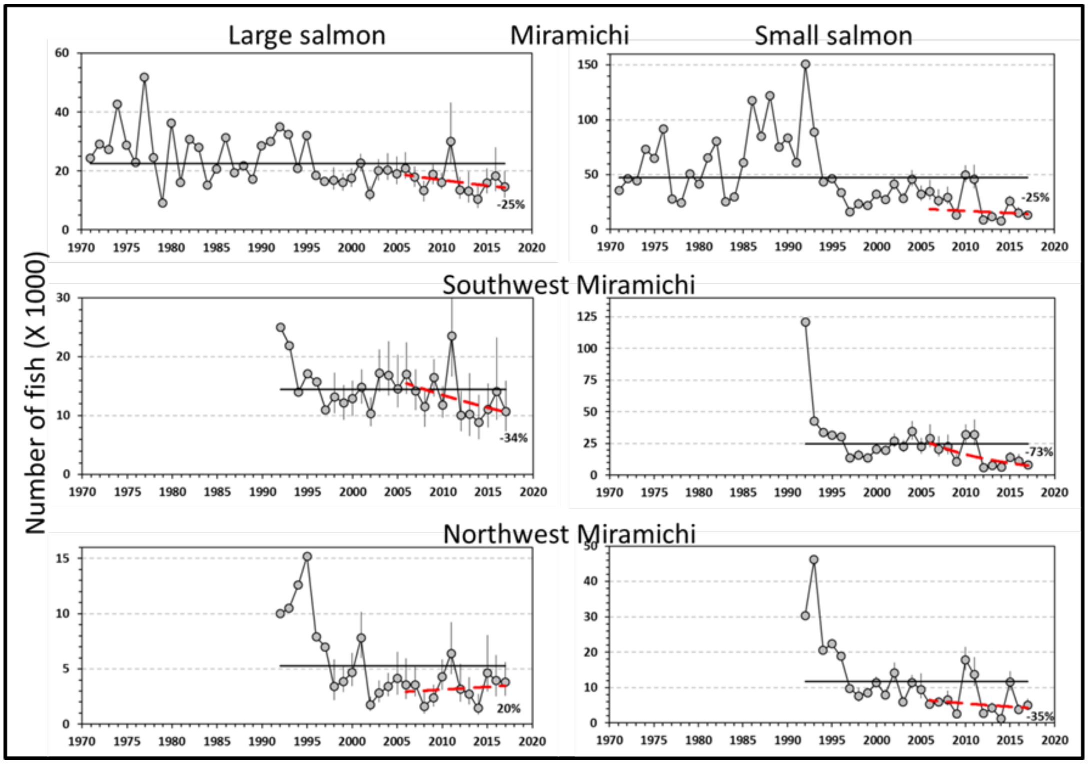

Figure 5. Estimates (median and 5th to 95th percentile range) of large salmon (left column) and small salmon (right column) returns for the Miramichi River for 1971 to 2017 (upper row), the Southwest Miramichi River 1992 to 2017 (middle row), and the Northwest Miramichi River 1992 to 2017 (bottom row). The black horizontal line is the average of the median return estimates of large salmon or small salmon for the available time series. The red dashed line is the trend line (exponential regression) and the corresponding percent change over twelve years estimated for the period 2006 to 2017 are also shown.

Estimated returns for the two main branches of the Miramichi River are available since 1992 (Fig. 5). The returns of large salmon to the Southwest Miramichi River in 2017 were estimated at 10,700 fish (median; 5th to 95th percentile range 7,400 to 15,900), whereas small salmon returns were estimated at 8,100 fish (median; 5th to 95th percentile range 5,700 to 11,300) (Fig. 5). Returns of both large salmon and small salmon to the Southwest Miramichi River in 2017 were below 2016 levels and below the average of the median return estimates for each size group over the period 1992 to 2016 (Fig. 5).

The returns of large salmon to the Northwest Miramichi River in 2017 were estimated at 3,800 fish (median; 5th to 95th percentile range 2,600 to 5,600), whereas small salmon returns were estimated at 5,000 fish (median; 5th to 95th percentile range 3,600 to 6,900) (Fig. 5). Relative to 2016 levels, the return estimates in 2017 represented a decrease for large salmon but an increase for small salmon. Both large salmon and small salmon return estimates in 2017 were below the average of the median return estimates for each size group over the period 1992 to 2016 (Fig. 5).

Over the recent 12 year period, approximately two generations, the estimated returns of large salmon in the Miramichi overall and the Southwest Miramichi have declined by 25% and 34% respectively, while estimated returns of large salmon to the Northwest Miramichi have increased by 20% (Fig. 5). The estimated returns of small salmon have declined in the Miramichi River overall and in each of the main branches, particularly in the Southwest Miramichi (73% decline) (Fig. 5).

Biological characteristics of adult Atlantic Salmon, including mean fork length, proportion female, and eggs per fish for small salmon and large salmon were updated to 2017 (DFO 2018). Considering these biological characteristics, the estimated total eggs in the returns of large and small salmon combined in 2017 were equivalent to 78% of the conservation requirement for the Miramichi River overall, 85% of the conservation requirement for the Southwest Miramichi River, and 63% of the conservation requirement for the Northwest Miramichi River.

With the introduction of the mandatory release of small salmon in the recreational fishery in 2015, losses due to catch and release mortality were assumed to be 0.9% of total returns (3% mortality on catches equivalent to 30% of the small salmon return), identical to the formula for calculating large salmon losses in the recreational fishery since 1984. After accounting for harvests in aboriginal food, social, and ceremonial fisheries and losses from recreational fisheries, eggs from small salmon and large salmon spawners combined were equivalent to 76% of the conservation requirement for the Miramichi River overall, 83% of the conservation requirement for the Southwest Miramichi River, and 60% of the conservation requirement for the Northwest Miramichi River (Fig. 6).

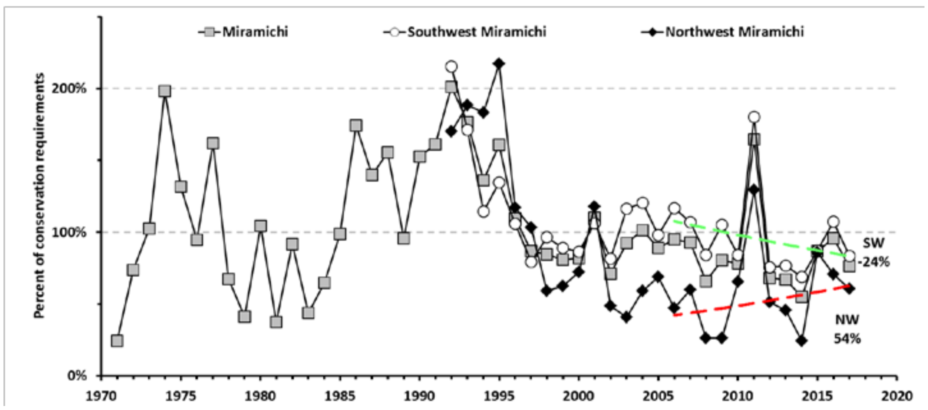

Figure 6. Percentages of the conservation requirements (eggs) attained for small salmon and large salmon spawners combined for the Miramichi River overall (1971 to 2017), the Southwest Miramichi (1992 to 2017) and the Northwest Miramichi (1992 to 2017) rivers (DFO 2018). The trend lines (exponential regressions) for the Northwest Miramichi (red) and the Southwest Miramichi (black) and their corresponding percent change over the twelve year period 2006 to 2017 are also shown.

Conservation requirements for both major branches and the Miramichi River overall were last achieved in 2011 although the Southwest Miramichi exceeded conservation in 2016. The eggs in combined small salmon and large salmon spawners in the Southwest Miramichi River exceeded the conservation requirement in eight of the last 20 years and in three of the last 10 years. The eggs in the combined small salmon and large salmon spawners in the Northwest Miramichi River were sufficient to meet or exceed the conservation requirement in two of the last 20 years and once in the last 10 years (Fig. 6).

SFA 17 Prince Edward Island

Salmon redds have been surveyed at least once since 1990 in all rivers in PEI that currently have salmon. The methods for converting redd counts to female salmon spawners and assessing against attainment of river specific conservation requirements are described by Cairns and MacFarlane (2015).

There are 25 rivers in SFA 17 with current or recent Atlantic Salmon occupancy, based on confirmed observations of redds or juveniles (Table 1). Seal River (Vernon) has been removed from the list of salmon rivers (DFO 2017) because the identity of redds reported to be those of salmon has not been independently verified, and because electrofishing has failed to locate salmon juveniles. Redd surveys were completed in 24 of the 25 salmon rivers in 2017. Estimated spawners exceeded conservation requirements in five of 24 rivers and were below 50% of conservation requirements in 17 of 24 rivers. Three of the five rivers that exceeded conservation requirement are located in the northeast extremity of PEI (Fig. 7).

Increasing trends in the percent attainment of conservation requirements are noted in seven of 10 rivers in which redds were surveyed at least seven times during 2006 to 2017 (Table 1). However, this should not be taken as indicating an overall positive trend in Atlantic Salmon status on PEI, because the analysis does not cover rivers with small and precarious populations which are generally surveyed only intermittently.

Table 1. The percentage attainment of Atlantic Salmon conservation requirements in monitored SFA 17 rivers, 2011 to 2017. A dash indicates no survey was completed. The spawner requirement column is the estimated number of spawners, sexes and sea ages combined, corresponding to the conservation egg requirement for the river (Cairns and MacFarlane 2015). Also shown is the percent change (over 12 years) in the percent conservation attained for rivers in which redd surveys were conducted at least seven times between 2006 and 2017. Percentages of conservation attainment for previous years are available in Cairns and MacFarlane (2015).

River	Spawner Req.	2011	2012	2013	2014	2015	2016	2017	Percent change
Cains Brook	26	139	102	95	-	95 [a]	110	187	-
Carruthers Brook	40	472	210	*157* [a]	-	165 [a]	151	191	-
Trout River, Coleman	160	-	-	24	15	15	18	17	-
Trout River, Tyne Valley	46	-	-	0	0	-	-	4 [a]	-
Little Trout River	20	61	-	0	0 [c]	4	-	44	-96
Bristol (Berrigans) Creek	39	-	7	11	0	1 [a]	-	9	-
Morell River	270	108	58 [a]	78 [a]	93	34 [a]	49	46	-
Midgell River	61	80	59	26 [a]	55	102	-	76	+37
St. Peters River	42	55	73	46	45	70	21 [a]	20	-64
Cow River	22	-	2	102	24	137	114	78	-
Naufrage River	41	459	46	484	232	165	115	95	+208
Bear River	16	-	-	43	8	35	95	19	-
Hay River	25	2	5	78	27	65	74	27	> 300
Cross Creek	42	200	87	282	203	250	179	202	+ 220
Priest Pond Creek	24	37	39	283	242	258	131	281	> 300
North Lake Creek	45	346	103	325	178	256	245	208	+17
Vernon River	66	-	5	7	5 [a]	0	-	11	-
Clarks Creek	44	-	0	3	-	0 [a]	-	4	-
Pisquid River	45	67	34	38	15 [a]	46	28	27	-42
Head of Hillsborough R.	51	0	0	2	-	0	-	0	-
North River	94	5	-	10	-	-	-	4	-
Clyde River	40	0	- [b]	- [b]	- [b]	- [b]	-	0	-
West River	210	28	27	52	35	35	45	46	+76
Dunk River	220	-	4 [a]	-	-	-	-	23	-
Wilmot River	79	-	-	-	- [c]	- [c]	-	3	-

[a] Considered to be a minimum value due to 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.

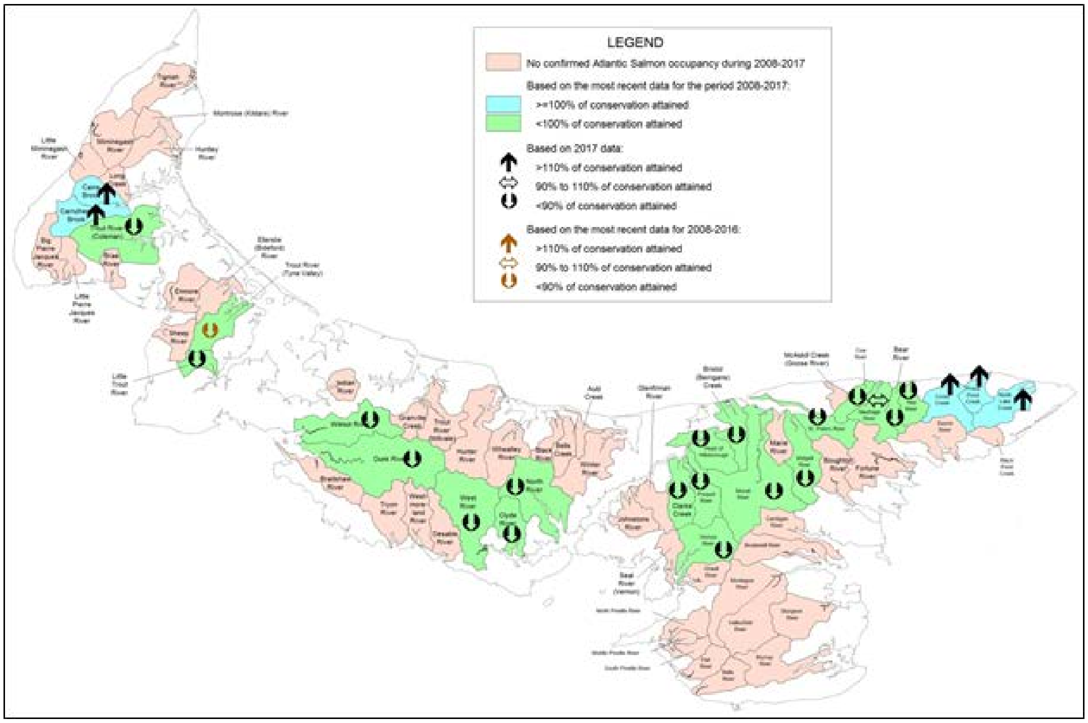

Figure 7. Location of SFA 17 watersheds with historic or current Atlantic Salmon occupancy and summary of their status relative to the percentage of the conservation requirements attained in 2014 (Trout River Tyne Valley) and in 2017 (all other watersheds). Blue shading indicates watersheds which have met or exceeded conservation requirements. Green shading indicates watersheds that are below conservation requirements. Pink shading indicates watersheds with no evidence of salmon presence since 2008. The symbols are as follows: ⇩ less than 90% of conservation requirements attained, ⇔ between 90% and 110% of conservation requirements, and ⇧ greater than 110% of conservation requirements.

SFA 18 Gulf Nova Scotia

Indices of abundance from the recreational fishery for 2017 are preliminary and based on extracts from the licence stub return database to Feb. 16, 2018 (379 licence stubs returned out of 1,954 licences sold in 2017; 19.4% return rate). Catches and efforts from the returned licence stubs are raised to total licence sales to estimate total catch and effort.

SFA 18A Mainland Gulf Nova Scotia

The estimated catches of large salmon for West River (Antigonish) and East River (Pictou) were the lowest values since 1984, and River Philip had the lowest value since 2007 (Fig. 8). Values for all three rivers were much lower than their respective long term (1984 to 2016) average (Fig. 8). The catch rates, estimated catch per rod day, of large salmon were lower for all three rivers in 2017 compared to 2016. West River (Antigonish) and East River (Pictou) both had the lowest values in the time series and it was the lowest value since 2007 for River Philip (Fig. 8).

Over the recent 12 year period, the catch rates of large salmon declined by 46% in West River (Antigonish) and by 71% in East River (Pictou). Catch rates of large salmon in River Philip increased 52% over that time period (Fig. 8). All three rivers also had notable declines in catches and catch rates of small salmon. Catches on West River (Antigonish) and East River (Pictou) were the lowest in the times series. Catch rates declined by 85% for East River (Pictou), by 74% for West River (Antigonish), and by 18% for River Philip (Fig. 8).

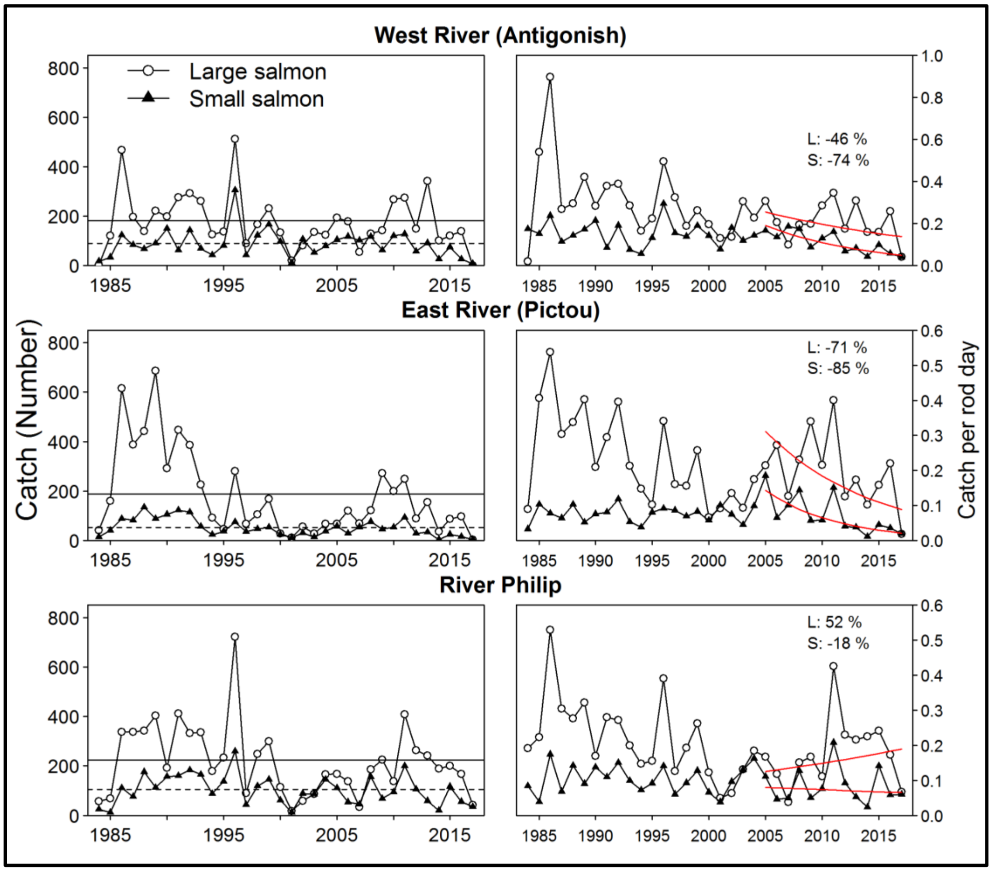

Figure 8. Estimated catches (left panels) and catch rates (catch per rod day; right panels) of large salmon and small salmon from the recreational fishery in the three largest rivers of SFA 18A, 1984 to 2017. In the left panels, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed line) for the time series (1984 to 2016). The solid red lines in the right panels are the exponential regression over the recent twelve years, 2005 to 2017. The percent change over that time period is shown in the upper right corner for L = large salmon and S = small salmon. The data for 2017 are preliminary. Note the different y axes range for the figures in the right panels.

SFA 18B Margaree River

The estimated catch of large salmon for the Margaree River was lower in 2017 compared to 2016, and the estimated catch of small salmon was similar to 2016. Catches of both size groups were well below their respective long term averages, and were the 3rd lowest value in the time series (Fig. 9). In 2017, the estimated catch per rod day of large salmon for the Margaree River was lower than in 2016 whereas for small salmon, it was similar to 2016 (Fig. 9). Trends in catch rates over the recent twelve years show a decline of 27% for large salmon and 53% for small salmon (Fig. 9).

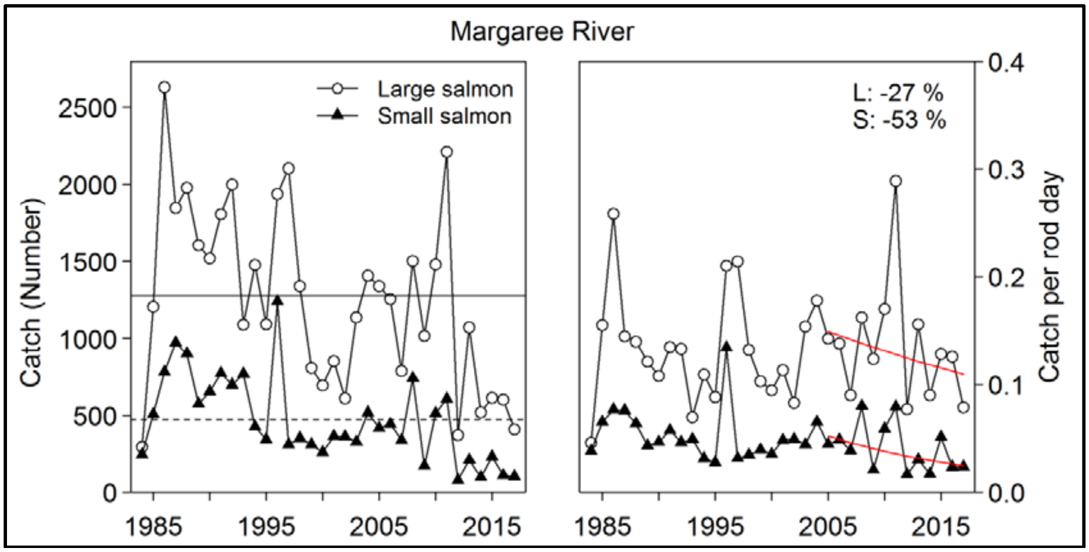

Figure 9. Estimated catches (left panel) and catch rates (catch per rod day; right panel) of large salmon and small salmon from the recreational fishery on the Margaree River (SFA 18B), 1984 to 2017. In the left panel, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed) for the time series (1984 to 2016). The solid red lines in the right panel are the exponential regression over the recent twelve years, 2005 to 2017. The percent change over that time period is shown in the upper right corner for L = large salmon and S = small salmon. The data for 2017 are preliminary.

Adult salmon abundance for the Margaree River is derived with a model that uses estimates of exploitation rates in the recreational fishery, mark and recapture experiments conducted between 1988 and 1996, corresponding recreational fishery catch and effort data recorded in volunteer angler logbooks, and licence stub returns (Breau and Chaput 2012). Estimates for 2017 are based on catch and effort data from volunteer angler logbook returns and licence stubs processed as of February 16, 2018.

The estimated returns of large salmon to the Margaree River in 2017 were 1,513 fish (median; 5^{th} to 95^{th} percentile range of 1,160 to 1,940), well below the long term average of 2,750 fish, and at 146% of the conservation requirement of 1,036 large salmon (Fig. 10). Conservation requirements have been exceeded every year since 1987. The returns of large salmon in 2017 are the second lowest estimate of the time series, after those of 2012. The preliminary estimated returns of small salmon to the Margaree River in 2017 were 371 fish (median; 5^{th} to 95^{th} percentile range of 250 to 550) (Fig. 10), below the long term average of 885 fish. The 2017 season was marked by low water levels, with very few rain events between June and end of August. For the 31-year time series (1987 to 2017), the three lowest returns of large salmon occurred in the past six years, and for small salmon, the five lowest values of the time series were in the last six years. For the Margaree River, trends over the recent 12 year period show a decline of 30% for large salmon and a decline of 57% for small salmon.

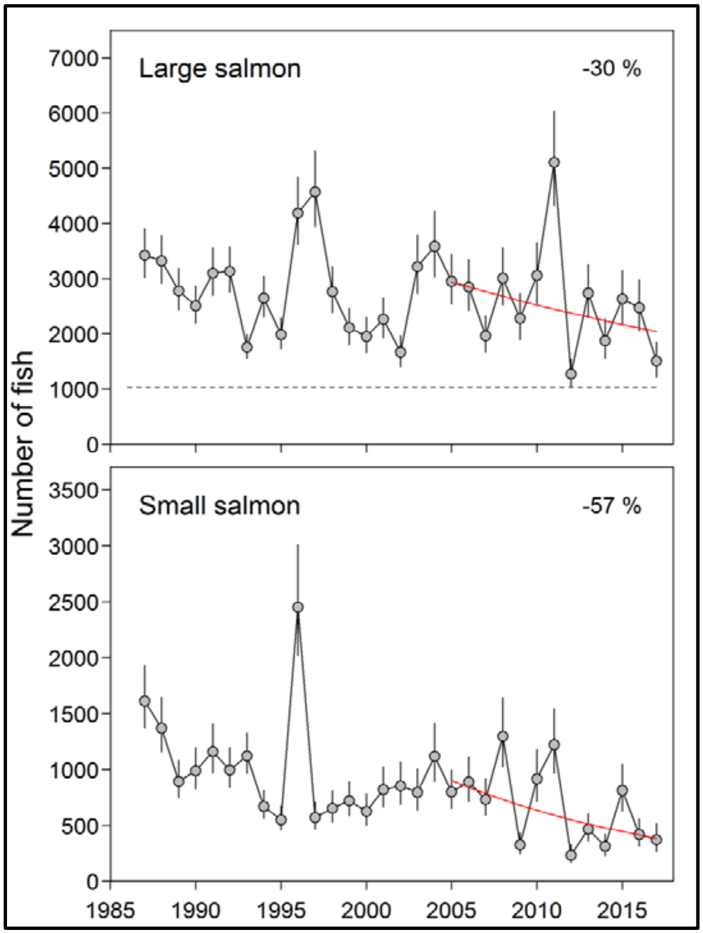

Figure 10. Posterior distributions (medians; 5th to 95th percentile range) of estimated returns of large salmon (upper panel) and small salmon (lower panel) to the Margaree River, 1987 to 2017. Values for 2017 are preliminary. The dashed line in the upper panel indicates the large salmon conservation requirement of 1,036 spawners. The solid red lines in the panels are the exponential regression over the recent twelve years, 2005 to 2017 and the corresponding percent change over that time period is also shown in each panel.

Gulf Region

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).

Returns of large salmon to Gulf Region in 2017 were estimated at 27,000 fish (5th to 95th percentile range of 21,600 to 32,400 fish), 61% of the long-term average (44,200 fish) of the 1970 to 2017 time series (Fig. 11). Small salmon returns to Gulf Region were estimated at 22,600 fish (5th to 95th percentile range of 18,600 to 26,600 fish), only 32% of the average abundance (70,700 fish) of the time series from 1970 to 2017 (Fig. 11).

Over the recent 12 years, approximately two generations, the estimated abundances of large salmon have increased in SFA 17 (+41%) but decreased in SFA 5 (-12%), SFA 16 (-20%), and and SFA 18 (-28%) (Fig. 11). Overall in Gulf Region rivers, large salmon abundance has declined by 19% over the period 2005 to 2017. For small salmon, abundances have declined by 39% to 65% in the four Gulf Region SFAs with a decline in estimated small salmon abundance of 60% to Gulf Region rivers overall (Fig. 11).

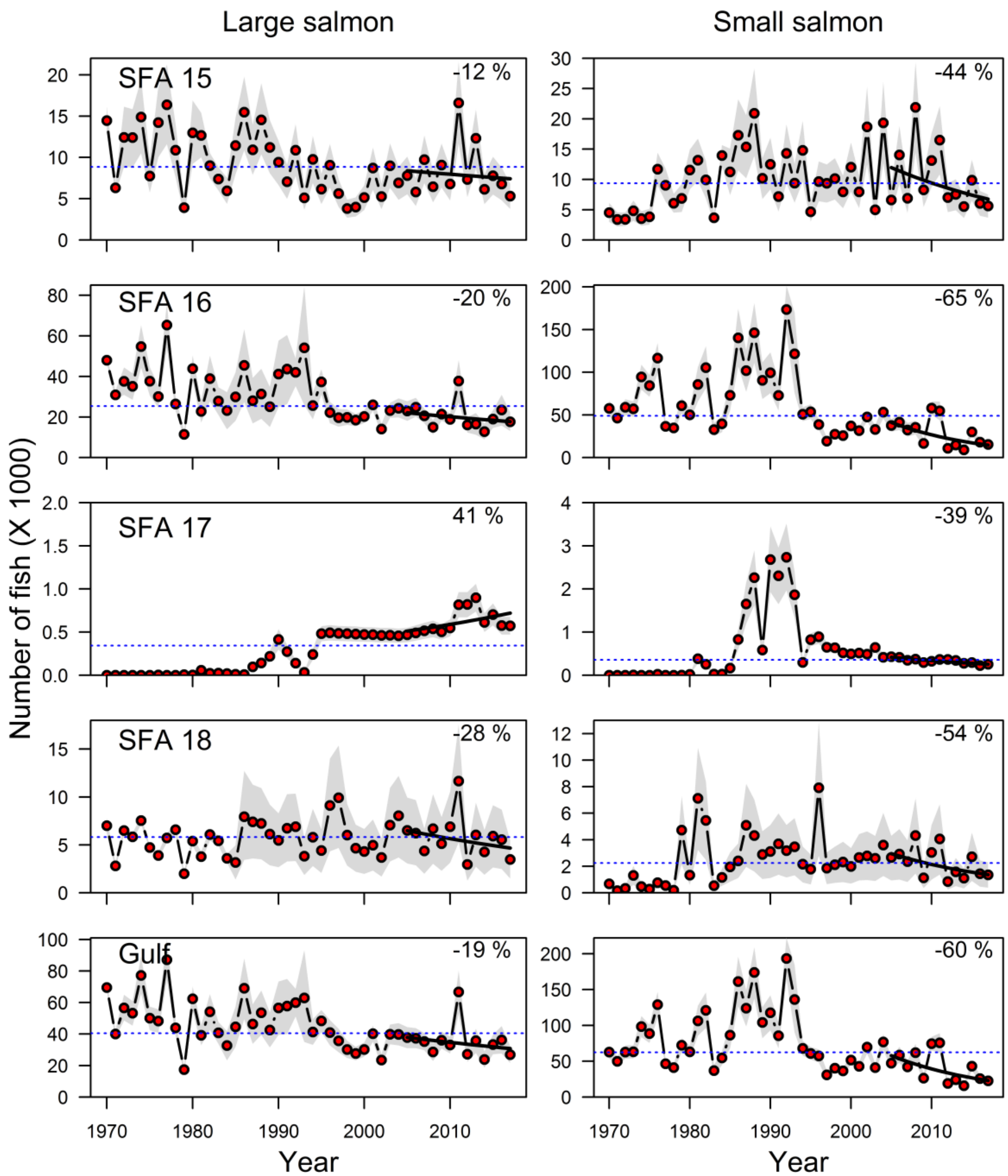

Figure 11. Estimates (medians are coloured symbols, shaded contours are the 5th to 95th percentile ranges) of total returns of large salmon (left panels) and small salmon (right panels) to each of SFA 15, 16, 17, and 18, and to Gulf Region rivers overall, 1970 to 2017. The solid black line in each panel is the exponential change prediction over the recent twelve years, 2005 to 2017. The percent change over that time period is also shown in the upper right corner of each panel. The light horizontal dashed line in each panel is the time series median abundance for 1970 to 2017.

Abundance indices of juvenile salmon

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. Abundances at sites, in terms of number of fish per habitat area sampled by age or size group (densities), are obtained using successive removal sampling or catch per unit effort sampling calibrated to densities. 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 the introduction of mandatory catch-and-release for large salmon in the recreational fishery.

SFA 15A Restigouche River

In 2017, two to three cohorts (fry, small parr, large parr) were captured at most sampling sites (n = 85) indicating that there had been multiple years of spawning success. Three sites had no salmon juveniles, three sites had fry only, and two sites had only parr. Salmon juveniles are broadly distributed in the river with the exception of some small streams which are prone to periodic blockages to spawners by beaver dams. Densities of Atlantic salmon fry, small parr (mostly one-year old), and large parr (mostly two-year and older) all increased post-1984 and remain at moderate levels (Fig. 12). Over the past twelve years, the abundances of juvenile salmon have increased by 15% for fry, while decreasing by 22% for small parr and 21% for large parr (Fig. 12). Results from juvenile salmon surveys in 2008 and 2011, which showed decreased abundance of some age classes, could be biased due to difficult sampling conditions (extremely high water) rather than an indicator of actual lower abundance.

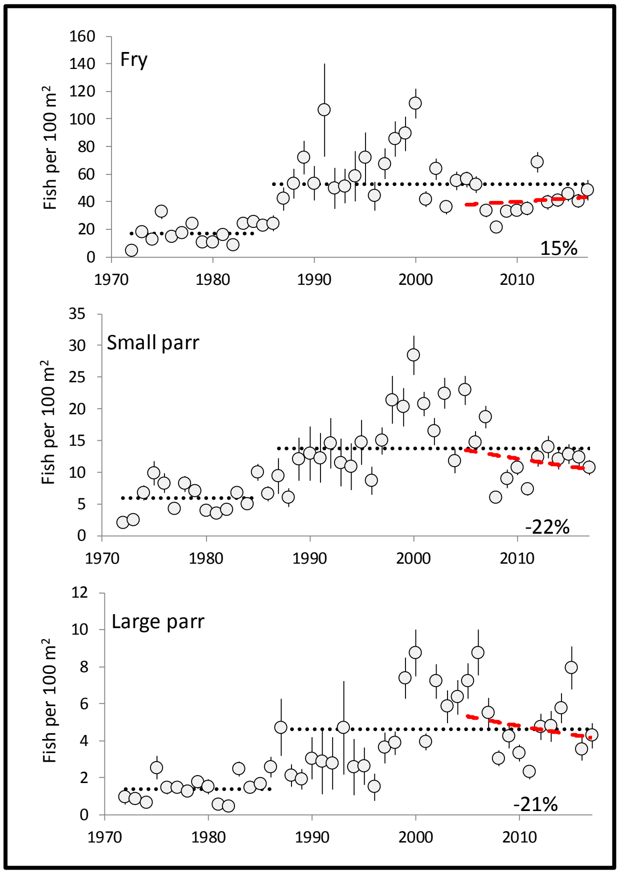

Figure 12. Mean juvenile densities (fish per 100 m²) for fry (upper panel), small parr (middle panel) and large parr (lower panel) for the sites sampled in the Restigouche River (NB waters only, excluding Matapedia and Patapedia rivers), 1972 to 2017. The horizontal solid line and the horizontal dashed line in each panel are the average densities corresponding to periods before and after, respectively, the significant management changes were implemented to the commercial and recreational salmon fisheries in 1984. The exponential regression (solid line) over the recent 12 years (2005 to 2017) and the percent change over that time period are also shown in each panel. Vertical bars are one standard error.

SFA 16A Miramichi River

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

Electrofishing surveys were carried out at six sites in the LSW, at 18 sites in the NW, at ten sites in the Renous and at 22 sites in the SW for a total of 56 sites throughout the Miramichi watershed in 2017. Salmon fry were captured at all but one site (LSW) and salmon parr at all but two sites (NW, SW) in 2017 which indicates that adult salmon continue to spawn throughout the Miramichi watershed.

In 2017, average fry densities in all rivers decreased from levels observed in 2016 and remained below the average post-1984 fry densities in those rivers (Fig. 13). Average small parr densities in 2017 decreased from levels observed in 2016 and were the lowest for each tributary since 1985 and well below the long term (1986 to 2015) average for this life stage in each river (Fig. 13). In 2017, the average small parr densities ranged from 5 (LSW) to 11 (NW) fish per 100 m^2. The average large parr densities in 2017 ranged from 6 (LSW) to 11 (NW) fish per 100 m^2 and they were higher than levels observed in 2016 and among the highest levels of the time series for each tributary (Fig. 13). Low small parr abundance in 2016 appears not to have translated into low large parr abundance in 2017 (Fig. 13).

Overall, juvenile salmon abundances in the Miramichi watershed have varied and remained at higher average levels since the 1984 closure of the commercial fishery and the mandatory release of large salmon in the recreational fishery. Average fry and small parr abundances in 2017 have decreased from higher levels of the 1990s while large parr abundances have increased.

While the average abundance of fry in the Southwest Miramichi has remained relatively stable over the last 12 years, fry abundance in the other monitored rivers has declined between 19% and 36% (Fig. 13). Small parr abundance has decreased in all monitored rivers over the last 12 years and by >50% in three of the four tributaries (Fig. 13). The abundance of large parr has increased significantly in the SW, remained stable in the LSW, and decreased by more than 20% in the NW and Renous over the recent 12 year period (Fig. 13).

SFA 16B Buctouche River

In 2017, six sites were surveyed on the Buctouche River in SFA 16B; fry were captured at five sites and parr at six sites. The average densities of salmon fry and parr in 2017 were improved over levels in 2016 but below the average values for both life stages since the recreational and aboriginal fisheries were closed in 1998 (Fig. 14). Salmon fry densities of over 40 per 100 m^2 were observed in the Buctouche River in 2000 following an adult salmon assessment the previous year that determined that the conservation requirement had been met. Similar levels of fry have only been observed once since then, in 2005, suggesting that spawning requirements may have been achieved in 2004. The abundances of fry and parr have decreased substantially by more than 60% over the recent twelve years (Fig. 14).

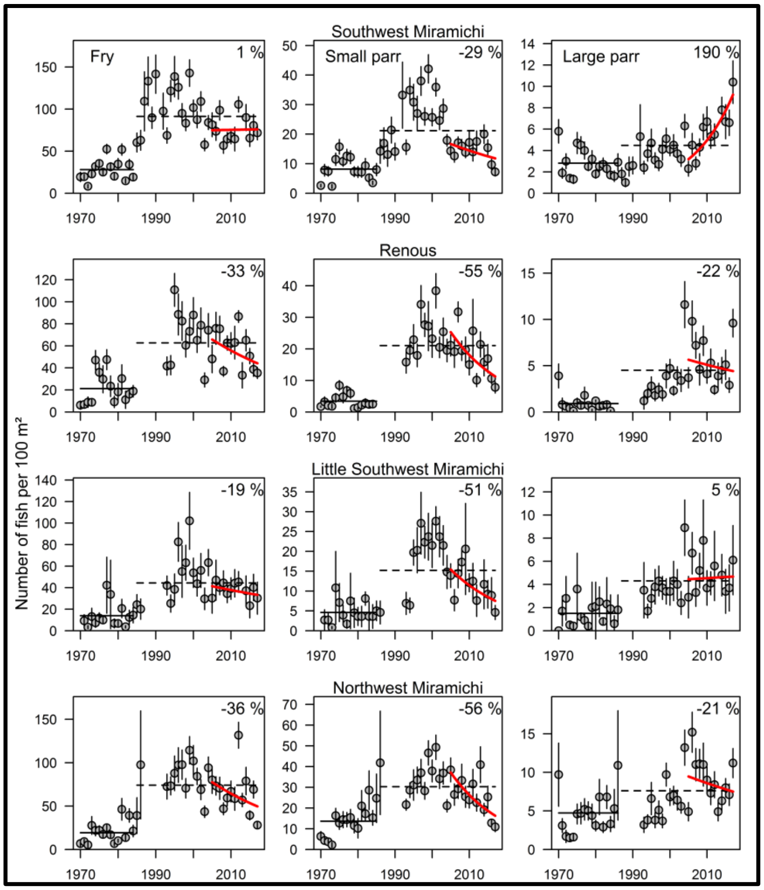

Figure 13. Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column), small parr (middle column), and large parr (right column) at sampled sites in the four major rivers of the Miramichi watershed: Southwest Miramichi (upper row), Renous River (second row), Little Southwest Miramichi (third row), and Northwest Miramichi (bottom row) for 1970 to 2017. Vertical bars are one standard error. The horizontal solid and dashed lines in each panel are the average densities corresponding to periods before and after, respectively, significant management changes were implemented to the commercial and recreational salmon fisheries in 1984. The trend (exponential regression) over the recent 12 years (2005 to 2017) and the percent change over that time period are also shown in each panel.

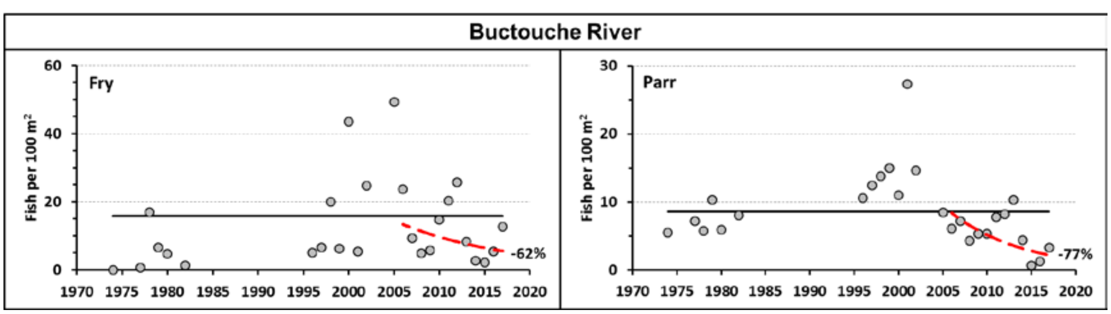

Figure 14. Average densities, expressed as fish per 100 m² of sampled area, for fry (left panel) and parr (size groups combined, right panel) from sampled sites in the Buctouche River 1974 to 2017 sampling years. The horizontal lines represent average fry and parr abundance for the years after the closure of the aboriginal and recreational fisheries in 1998. The red trend lines (exponential regressions) over the recent 12 years (2005 to 2017) and the percent change over that time period are also shown in each panel.

SFA 18A Mainland Gulf Nova Scotia

Juvenile salmon surveys have been conducted in three index 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 have been sampled per river. All sites sampled in 2017 were occupied by juveniles. Two to three size groups (fry, small parr, large parr; proxy for cohorts) were captured at all sampling sites in 2017 except for two sites on West River (Antigonish) (one site had only fry and another site had only large parr), indicating that there had been multiple years of spawning success.

Fry abundances have been at moderate to high levels (≥ 50 fry per 100 m^2) in all three rivers with a notable decline over the past 12 years in East River (Pictou) and River Philip (33% and 47% respectively) (Fig. 15). In 2017, parr abundances (small and large combined) were lower on West River (Antigonish) and River Philip than in 2016, and similar to 2016 for East River (Pictou). Parr abundances reflect the same pattern of annual abundances as fry, at moderate to high levels (≥ 20 fish per 100 m^2) for most years, except for River Philip with 16 fry per 100 m^2. Over the recent 12 year period, all three rivers have a decreasing trend in the abundance of parr, with West River (Antigonish) and River Philip having the highest declines at 57% and 55% respectively, followed by East River (Pictou) at 3% (Fig. 15).

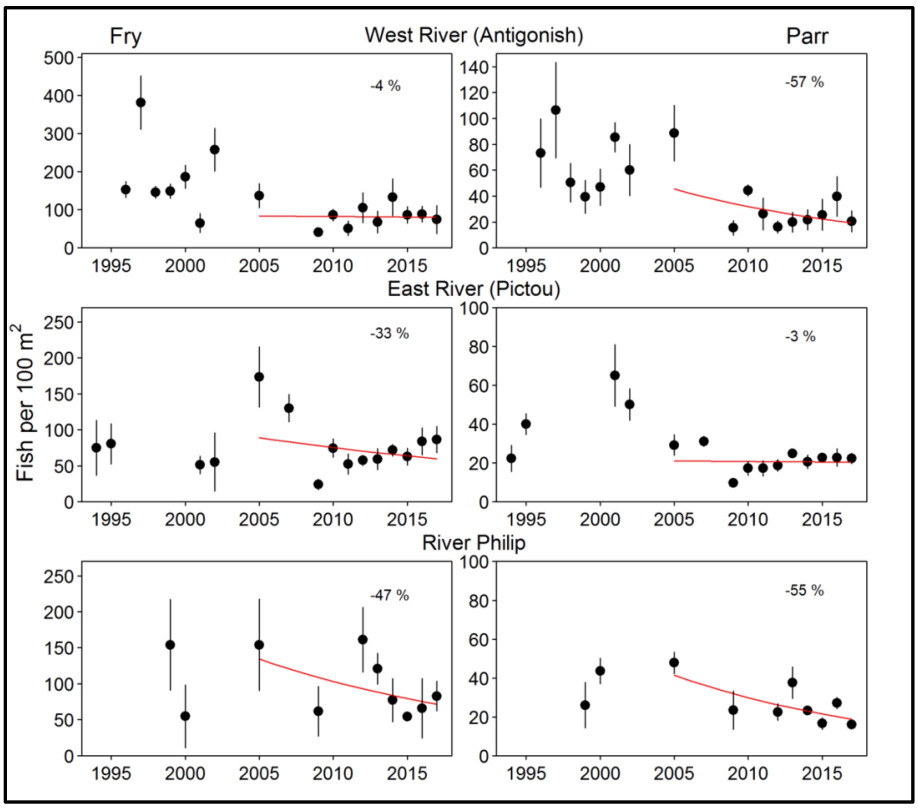

Figure 15. Mean juvenile Atlantic Salmon densities (fish per 100 m²) for fry (left panels) and parr (right panels; small and large size groups combined) for sites sampled in the West River (Antigonish), East River (Pictou) and River Philip, 1994 to 2017. Only years for which at least three sites per river were sampled are presented. Vertical bars are one standard error. The red trend lines (exponential regressions) over the recent 12 years (2005 to 2017) and the percent change over that time period are shown in the top right corner of each panel. Note different range in y-axes.

SFA 18B Margaree River

Thirteen sites were surveyed in the Margaree River during 2017. Two to three size groups (proxy for cohorts) were captured at all sampling sites except for one site on the main branch of the Southwest Margaree River that had only large parr, indicating that there had been multiple years of spawning success. Fry abundance in 2017 was lower than in 2016 and similar to recent years of lower abundance. Parr (small and large parr combined) abundance in 2017 was slightly higher than 2016 but similar to recent years of lower abundance (Fig. 16). Fry and parr abundances have declined greatly over the recent 12 year period, with declines of 59% for fry and 72% for parr (Fig. 16). The lowest abundance of fry in 2011 was related to a 100-year flood event in December 2010.

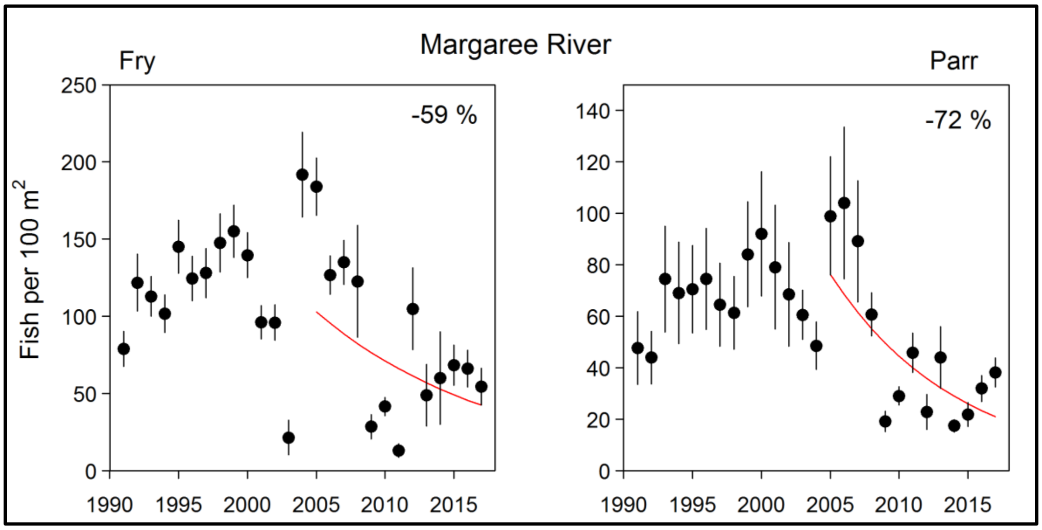

Figure 16. Mean juvenile densities (fish per 100 m² ± one standard error) for fry (left panel) and parr (right panel) for all sites sampled each year in the Margaree River, 1991 to 2017. Vertical bars are one standard error. The red trend lines (exponential regressions) over the recent 12 years (2005 to 2017) and the percent change over that time period are shown in each panel.

Sources of Uncertainty

A number of indicators of Atlantic Salmon adult abundance (Restigouche River partially, SFA 18 rivers of mainland Gulf Nova Scotia) are based on catches, and catch per unit effort data reported from the recreational fishery. Conditions for recreational fishing can be quite variable and success can be dependent upon water levels and water temperatures. In 2017, low water conditions in the summer that continued into the fall likely impacted both the August fishing effort in the Restigouche River and possibly the availability of salmon to the fishery in SFA 18 rivers resulting in a potentially biased view of abundance based on these indicators.

In the Margaree River model, catch rates and a derived catchability value (per rod day) from the early 1990s are used to estimate returns. The applicability of this value in the recent years is uncertain given the changes in fisheries management measures that have occurred over the past two decades, including mandatory catch and release measures for all size groups of the past three years.

The declines in the indices of small parr in the four major tributaries of the Miramichi were not expected in 2017, at least based on the increased abundances of fry in 2016 relative to the previous years. Equally unexpected were the increased indices of abundance of the large parr in 2017 throughout the Miramichi since small parr abundances in 2016 had declined from the previous year. The freshwater life history dynamics in the Gulf Region rivers show variable patterns among rivers and over time and the juvenile population dynamics linked with environmental variables such as summer water temperatures and water levels and hydrological conditions during the winter should be examined for their potential consequences on future adult recruitment and abundance.

Conclusions

In three of the four monitored river systems of Gulf Region (Restigouche NB, Southwest Miramichi, and Margaree) estimated returns of small salmon in 2017 were lower than those of 2016. With exception of the Restigouche, returns of large salmon in 2017 were lower than in 2016. Over the recent 12 years, approximately two generations, the estimated abundances of large salmon have increased in SFA 17 (+41%) but decreased in SFAs 15 (-12%), 16 (-20%), and 18 (-28%). For small salmon, abundances have declined by 39% to 65% in the four Gulf Region SFAs.

Estimated eggs in the combined returns of small and large salmon in 2017 exceeded the conservation requirement for the Margaree River (SFA 18B; 146%). For the Restigouche River (NB portion), large salmon spawning escapement estimates based on end of season spawner counts were higher than the estimate based on catches in the recreational fishery and the former estimate exceeded (135%) the spawning requirements in 2017. The estimated number of eggs in the returns of large salmon and small salmon combined were insufficient to meet the conservation requirements of the Miramichi River overall or its two main branches. Combined eggs of large salmon and small salmon spawners attained 76%, 83%, and 60% of the conservation requirement for the Miramichi, Southwest Miramichi, and Northwest Miramichi rivers, respectively.

For SFA 17, the near-complete coverage of redd surveys in 2017 (24 of 25 rivers) confirmed the precarious status of salmon in several small rivers, especially those in which spawning appears to occur only in intermittent years. Estimated spawners were below 50% of conservation requirements in 17 of 24 rivers. The five rivers that exceeded conservation requirements in 2017 were Cains Brook and Carruthers Brook (part of the Mill River system, western PEI) and in three rivers of the northeast extremity of PEI.

Juvenile abundance indices in 2017 were generally below the post 1984 period average in all monitored areas. Juvenile abundance indices generally show a declining trend over the past 12 years from peak values observed during the mid-1990s to mid-2000s, but on average they remain above the levels of the 1970s and early 1980s.

Returns of large salmon to Gulf Region overall in 2017 were estimated at 27,000 fish (5^{th} to 95^{th} percentile range of 21,600 to 32,400 fish), 61% of the long-term average (44,200 fish) of the 1970 to 2017 time series. Small salmon returns to Gulf Region were estimated at 22,600 fish (5^{th} to 95^{th} percentile range of 18,600 to 26,600 fish), only 32% of the average abundance (70,700 fish) of the time series from 1970 to 2017. Overall in Gulf Region rivers, large salmon abundances have declined by 19% over the period 2005 to 2017. Estimated small salmon abundances in Gulf Region rivers have declined by 60% over the period 2005 to 2017. Abundances of adult salmon in Gulf Region rivers are constrained by low marine survival, which begins from the point of assessment in freshwater near the head of tide and ends with adult returns back to the river one and two or more years later. The phenomenon of reduced marine survival is widespread for Atlantic Salmon stocks from eastern North America (ICES 2017).

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February 27, 2018

Sources of information

This Science Response Report results from the Science Response Process of February 20, 2018 on update of indicators of Atlantic Salmon for Salmon Fishing Areas 15 to 18, DFO Gulf Region. No additional publications from this process are anticipated.

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This Report is Available from the :

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ISSN 1919-3769

Correct Citation for this Publication:

DFO. 2018. Update of indicators of Atlantic Salmon (*Salmo salar*) in DFO Gulf Region Salmon Fishing Areas 15 - 18 for 2017. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/017.

Aussi disponible en français :

MPO. 2018. Mise à jour en 2017 des indicateurs pour le saumon atlantique (Salmo salar) dans les zones de pêche du saumon 15 à 18 de la région du Golfe du MPO. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2018/017.