Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Gulf Region | **Canadian Science Advisory Secretariat**
Science Response 2019/021

UPDATE OF INDICATORS OF ATLANTIC SALMON (*SALMO SALAR*) IN DFO GULF REGION SALMON FISHING AREAS 15 – 18 FOR 2018

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 2017 for each of the four Salmon Fishing Areas (SFA 15-18) were prepared (DFO 2015a; 2015b, 2016, 2017, 2018a). DFO Fisheries and Aquaculture Management (FAM) requested an update of the status of the Atlantic Salmon stocks in DFO Gulf Region for 2018. 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 19, 2019 on the update of indicators of Atlantic salmon to 2018 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).

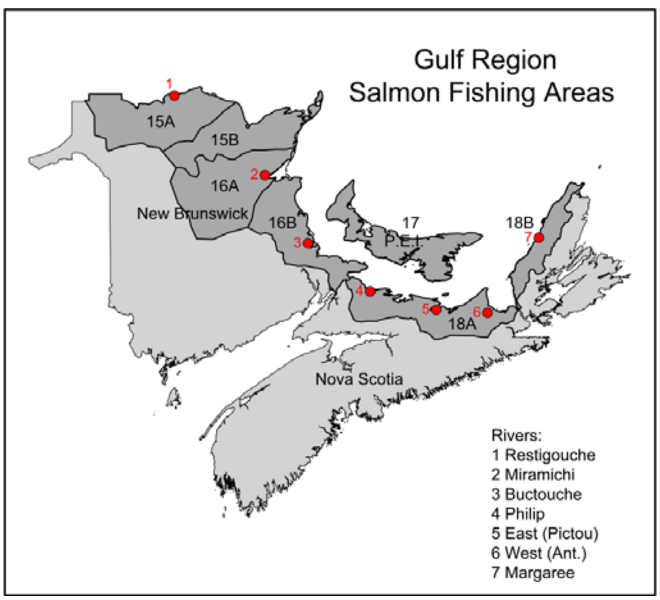

Figure 1. Salmon Fishing Areas in the DFO Gulf Region and locations of New Brunswick and Nova Scotia rivers mentioned in the report.

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 12 years, approximately two generations for Atlantic Salmon, are presented.

During 2015 to 2018, 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. Since 1998, rivers in southeast New Brunswick (SFA 16B) have been closed to all directed salmon fishing.

In previous assessments, status was assessed relative to a conservation requirement of 2.4 eggs per 100 m^2. In this report, status is assessed relative to a Limit Reference Point (LRP) consistent with the precautionary approach (PA) (DFO 2009), as recently defined for Atlantic Salmon rivers in DFO Gulf Region (DFO 2018b).

Environmental conditions in 2018

In 2018, air temperatures were particularly high during the summer months (July and August). The mean summer (July and August) air temperature of 21.3°C at Miramichi in 2018 was the highest of the time series (1873-2018) (Fig. 2). Data over this period show a significant increasing trend (2.15°C over the past 100 years).

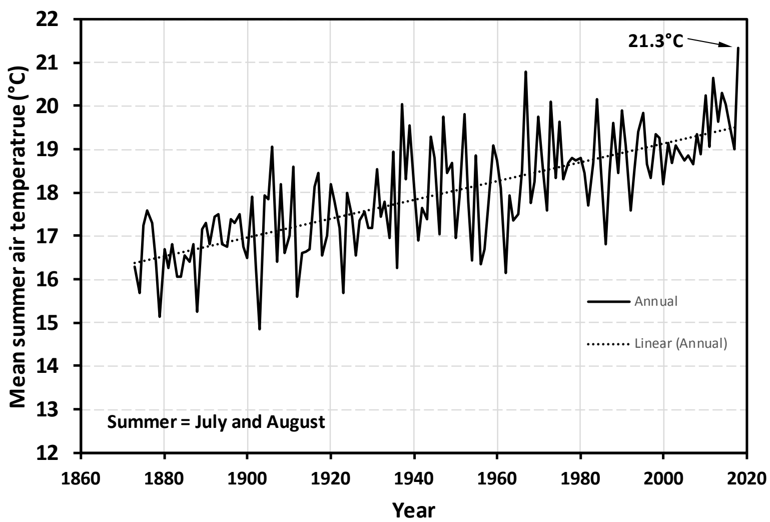

Figure 2. Mean summer (July and August) air temperatures at the Miramichi meteorological station (8100989; data from 1873 to 2018).

High air temperatures during the summer resulted in high water temperatures in monitored rivers. High river temperatures occurred between 3 July and 3 August in the Miramichi River. The Little Southwest Miramichi River daily maximum water temperature exceeded 23°C for 57 days in 2018, second only to 1999 (Fig. 3). The resulting high water temperatures prompted angling restrictions in the Miramichi system to mornings only (6 am to 11 am) between 24 July and 11 August and the closure of cold water holding pools between 5 July and 20 August (Gulf Variation Order (GVO) 2018-051, GVO 2018-062, GVO 2018-076, GVO 2018-081). Water temperatures experienced at different locations in large rivers can be quite variable and generally water temperatures in the Miramichi River (SFA 16) are much warmer than those of the Restigouche (SFA 15) and Margaree (SFA 18) rivers.

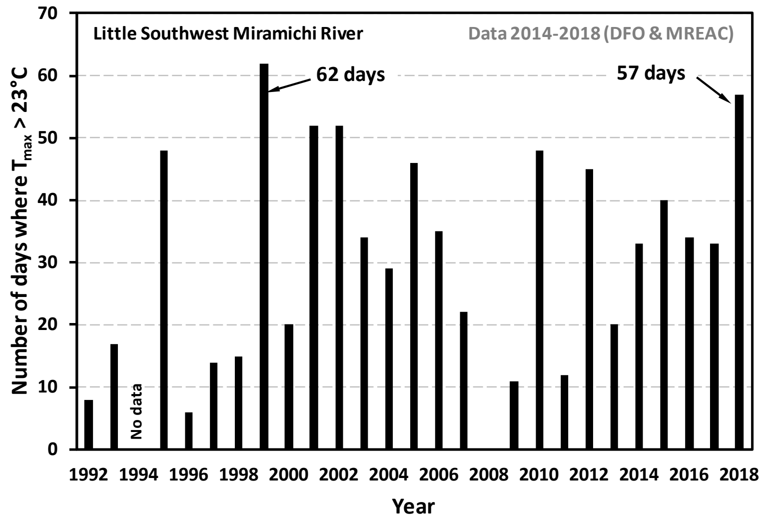

Figure 3. Number of days per year where the daily maximum river temperature exceeded 23°C for the Little Southwest Miramichi River during 1992 to 2018.

In the winter of 2018, flows were excessive in most rivers of the Maritime Provinces (Jan-Feb; Fig. 4). A record high monthly flow was observed for the Southwest Miramichi River in January 2018 (325 m^3/s compared to a long-term monthly flow for January of 62 m^3/s). A significant rainfall (109.6 mm in 24 hours) in the Buctouche and surrounding areas (SFA 16) on January 13, 2018 caused flooding and premature ice breakup.

The spring high flows were particularly important in the Southwest Miramichi River with two consecutive excessive high flow months (April and May; Fig. 4a). The Upsalquitch River (tributary of the Restigouche River) had an excessive flow in May (Fig. 4b). Rather normal spring high flows were observed in both the Northeast Margaree River and Wilmot River (Fig. 4c and 4d). Excessive flows, particularly during the winter, can have negative consequences on egg survival and juvenile abundances in subsequent years.

The low flow period was particularly severe (prolonged duration) in 2018 where deficient flows were observed throughout the Maritime Provinces from June to October (Fig. 4). For instance, the Southwest Miramichi River experienced deficient flows in June, July and September. The Upsalquitch River experienced deficient flows in September and October and the Northeast Margaree River experienced deficient flows in July and September. The Wilmot River experienced deficient flows from May to September, with the exception of August although flows were slightly lower than the long-term average.

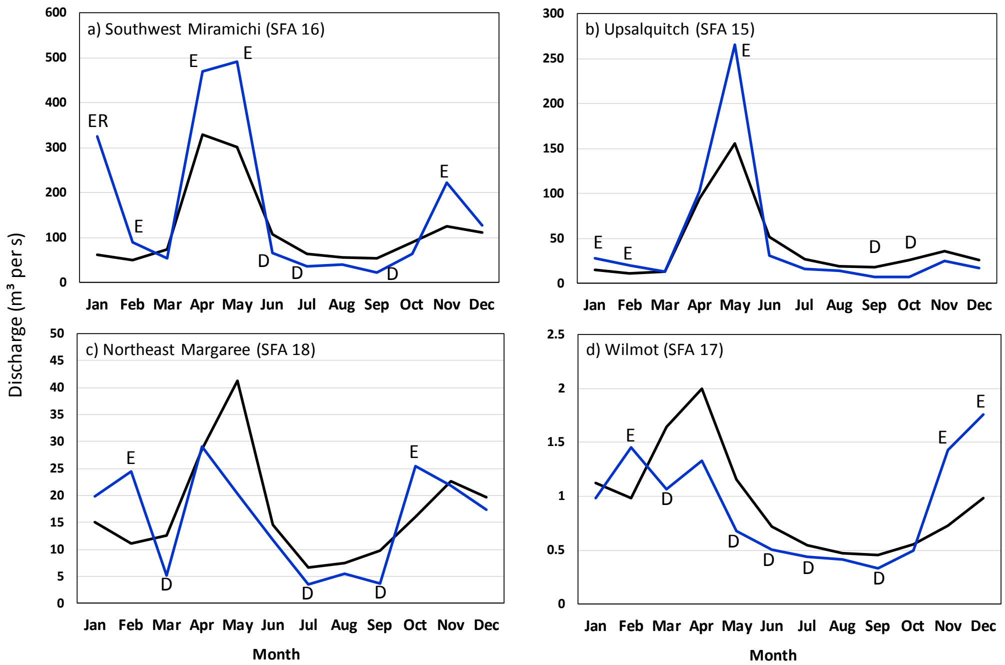

Figure 4. Monthly flow (m³ per s) conditions for Environment and Climate Change Canada index rivers within the Maritime Provinces in 2018 (blue line) and the long-term monthly flow conditions (black line; 1919-2015). E = excessive flow (above 75th percentile); ER excessive and record flow, and D = deficient flow (below the 25th percentile).

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 2018 were incomplete with information missing from 4 of 24 lodges. Catches from all lodges were estimated by assuming that the catch data from the missing lodges were of the same proportion of the total catch based on the three most recent years with available data.

Effort from lodges and leases in 2018 was estimated at 6,119 rod days, a 14% increase in effort compared to 2017. As in 2017, lodges reduced the extent of their fishing activity to certain pools in August and September 2018 because of low water levels which interfered with navigation on the river. Contrary to 2017 that noted a decrease in angling effort in August and September, monthly fishing effort in 2018 was close to the long term monthly average (2001-2017). Total parties registered in Crown Reserve waters in 2018 increased by 4% from 2017 (943 anglers in 2018 compared to 908 in 2017). Of the registered parties, 68% 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 2018 are 1,316 large salmon and 2,067 small salmon from the Restigouche (NB) waters (excluding Matapedia River).

Similar to previous assessments, returns to the Restigouche River were calculated from an assumed angling exploitation rate of 40% combined with estimates of aboriginal fishery harvests in the estuary (DFO 2014). Returns to the Restigouche River (NB) in 2018 were estimated at 3,542 large salmon and 5,209 small salmon (Fig. 5). As in 2017, unfavourable angling conditions likely resulted in lower catches and a lower exploitation rate than the assumed value of 0.4. Over the recent 12 year period (approximately two generations), the median annual abundance of large and small salmon has decreased by 30% and 54%, respectively, (Fig. 5).

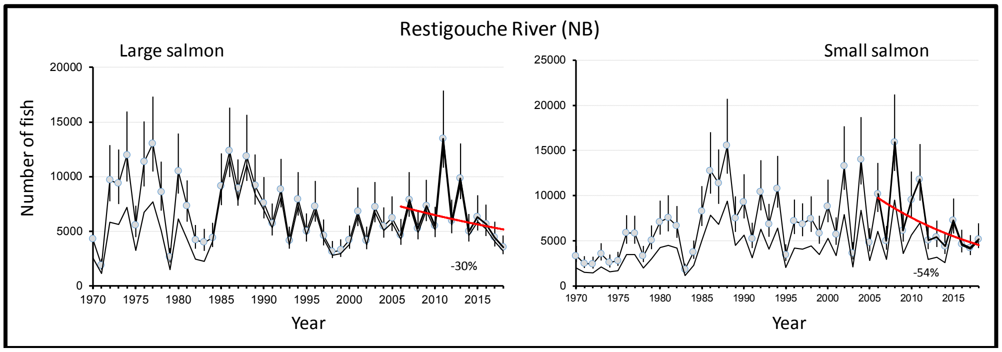

Figure 5. Returns (grey circles are for 40% catch rate and vertical error bars show range based on catch rates of 30% to 50%) and spawners (solid line for 40% catch rate assumption) based on angling catches of large salmon (left panel) and small salmon (right panel) to the Restigouche River (NB portion), 1970 to 2018. The data for 2018 are preliminary. The red trend line (exponential regression) of the returns and the corresponding percent change over the 12 year time period (2006 to 2018) 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 2018, 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. 6). Water and weather conditions were generally ideal for the snorkel counts in 2018.

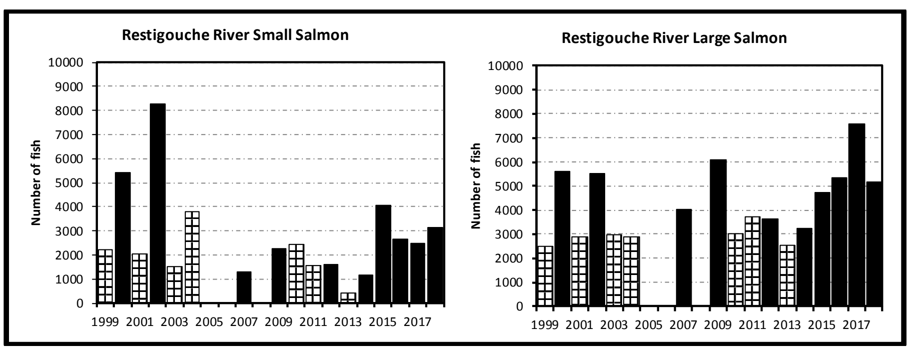

Figure 6. End of season salmon counts by size group (small salmon left panel, large salmon right panel) from four tributaries and the main stem of the Restigouche River for 1999 to 2018. Spawner counts could not be completed (hatched bars) in all years depending on water conditions.

The egg deposition for the Restigouche River (NB portion) corresponding to the LRP is estimated based on values summarized in Table 1. The habitat areas were revised upward (22%) from the previous assessment; the habitat area of the main stem of the Restigouche River was not discounted for lower productivity to the width of the river. As well, revised biological characteristics of the salmon as used to define the LRP are used in this assessment. The revisions to the inputs (Table 1) resulted in an increase in the LRP total egg requirement from 36.3 million to 40.1 million eggs.

Table 1. Input values from the previous assessment (DFO 2018a) used to define the conservation requirements and the revised values for defining LRP egg requirements (DFO 2018b) for the Restigouche River (NB).

Characteristic	Restigouche (NB) Previous value	Restigouche (NB) LRP specific value
Habitat area (million m²)	21.60	26.39
Egg deposition rate (per 100 m²)	168	152
Total egg requirement (million)	36.288	40.113
Eggs per large salmon	6,400	5,656
Eggs per small salmon	na	64

Based on the angling catches and assumed exploitation rates, the eggs in the returns of large salmon and small salmon combined in 2018 were equivalent to 50% of the LRP in the Restigouche River (NB) (Fig. 7). In 2018, the potential egg depositions from spawners based on the recreational fisheries model (accounting for losses in river such as FSC harvests and 6% catch and release mortality) and on the end of season spawner count index represented 45% and 73% of the LRP, respectively (Fig. 7).

At an assumed angling exploitation rate of 40%, the Restigouche River (NB portion) has been below the LRP in 8 of the last 12 years, with a 30% decline over the same time period (Fig. 7).

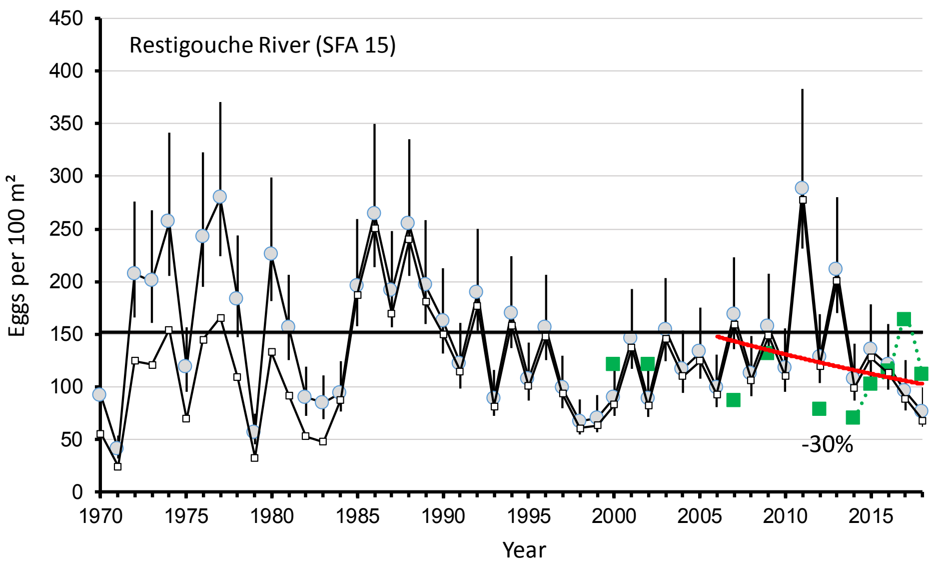

Figure 7. The potential eggs (expressed as eggs per 100 m² of wetted habitat area; total area of 26.39 million m²) by large salmon for the returns (grey circles are assumed catch rate of 40%, vertical bars show range for catch rates of 30% to 50%) and the spawners (white square symbols for an assumed catch rate of 40%) in the New Brunswick portion of the Restigouche River, 1970 to 2018. The eggs in spawners based on the end of season spawner counts are shown as square green symbols for the years with complete coverage. The solid horizontal line is the Limit Reference Point egg deposition rate of 152 eggs per 100 m² defined for the Restigouche River (NB portion). The estimates for 2018 are based on preliminary data. The red trend line (exponential regression) and the corresponding percent change for spawners over the 12 year time period (2006 to 2018) are also shown.

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 (2019).

The estimated returns of large salmon to the Miramichi River in 2018 were 18,800 fish (median; 5th to 95th percentile range 13,500 to 27,100). Small salmon returns were estimated at 8,600 fish (median; percentile range 6,600 to 11,300). Returns of both large salmon and small salmon to the Miramichi River in 2018 were below the average returns estimated for each size group over the time series 1971 to 2017 (Fig. 8).

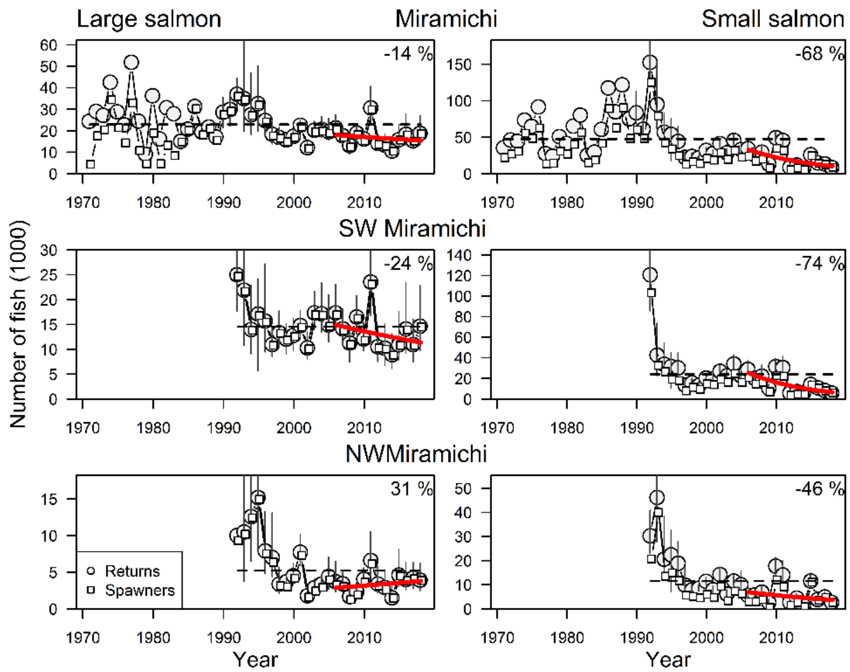

Figure 8. Estimated (median and 5th to 95th percentile range) returns and spawners of large salmon (left column) and small salmon (right column) for the Miramichi River for 1971 to 2018 (upper row), the Southwest Miramichi River 1992 to 2018 (middle row), and the Northwest Miramichi River 1992 to 2018 (bottom row).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 line (exponential regression) for returns over the previous 12 year time period (2006 to 2018) and the corresponding percent change is shown in the upper right corner of each panel.

Estimated returns for the two main branches of the Miramichi River are available since 1992 (Fig. 8). The returns of large salmon to the Southwest Miramichi River in 2018 were estimated at 14,700 fish (median; percentile range 9,800 to 22,800), whereas small salmon returns were estimated at 5,900 fish (median; percentile range 4,200 to 8,400) (Fig. 8). Returns of large salmon to the Southwest Miramichi River in 2018 were improved over 2017 levels and just above the average of the median returns over the 1992 to 2017 period (Fig. 8). Returns of small salmon to the Southwest Miramichi River in 2018 decreased from 2017 levels, and were equal to the lowest estimated return of small salmon (in 2012) of the time series, 1992 to 2018 (Fig. 8).

The returns of large salmon to the Northwest Miramichi River in 2018 were estimated at 3,900 fish (median; percentile range 2,500 to 6,300), whereas small salmon returns were estimated at 2,700 fish (median; percentile range 1,700 to 3,900) (Fig. 8). Relative to 2017 levels, the return estimates in 2018 represented a decrease in both large and small salmon. Both large salmon and small salmon return estimates in 2018 were below the average of the median return estimates for each size group over the period 1992 to 2018 (Fig. 8). For small salmon, the estimated return in 2018 was almost twice the record low return of 2014 but similar to the low returns estimated in 2009 and 2012.

Over the recent 12 year period, approximately two generations for Atlantic Salmon, the estimated returns of large salmon in the Miramichi River overall and the Southwest Miramichi have declined by 14% and 24%, respectively, while estimated returns of large salmon to the Northwest Miramichi have increased by 31% (Fig. 8). 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 River (74% decline) (Fig. 8).

Estimates of egg depositions relative to LRPs

The Southwest Miramichi system, that includes the Barnaby River, Southwest Miramichi River, and the Renous River, has an LRP egg deposition rate value of 152 eggs per 100 m^2 (DFO 2018b). The Northwest Miramichi system, that includes the Northwest Millstream, Little Southwest Miramichi River and the Northwest Miramichi River, has an LRP egg deposition rate value of 176 eggs per 100 m^2 (DFO 2018b). The LRP for the Miramichi River (Southwest Miramichi system, Northwest Miramichi system) is calculated as the habitat weighted average of the Southwest Miramichi system and Northwest Miramichi system LRP values, equivalent to 160 eggs per 100 m^2.

Considering the biological characteristics (mean fork length, proportion female, eggs per fish) for small salmon and large salmon in 2018 and the LRPs developed for the Miramichi River and its two main branches (DFO 2018b), the estimated total eggs in the returns of large salmon and small salmon combined in 2018 exceeded the LRP for the Miramichi River overall (median of 243 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 175 to 340 eggs per 100 m^2) and the Southwest Miramichi River (median of 275 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 183 to 411 eggs per 100 m^2) (Fig. 9). Eggs in the returns of large and small salmon to the Northwest Miramichi River were below the LRP in 2018 (median of 167 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 109 to 260 eggs per 100 m^2) (Fig. 9).

Spawners are calculated as returns minus losses from 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 on catches equivalent to 30% of the small salmon return), identical to the formula used for calculating large salmon losses in the recreational fishery since 1984.

There was greater than 95% chance of the estimated eggs from small and large salmon spawners combined exceeding the LRP for the Miramichi River overall (median of 240 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 172 to 338 eggs per 100 m^2) and the Southwest Miramichi River (272 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 180 to 408 eggs per 100 m^2) in 2018 (Fig. 9). There was a 60% chance that the eggs in small and large salmon spawners combined were below the LRP for the Northwest Miramichi River in 2018 (median of 165 eggs per 100 m^2; 5^{th} to 95^{th} percentile range of 107 to 258 eggs per 100 m^2) (Fig. 9).

For the Southwest Miramichi, there was greater than 95% chance of the egg depositions having been above the LRP in 15 of 21 years since 1998, and in all years, there was greater than 50% chance of having met or exceeded the LRP (Fig. 9). For the Northwest Miramichi, the estimated eggs in the spawners exceeded the LRP with greater than 95% chance in only 2 of 21 years since 1998. In 17 of 21 years, there was greater than 50% chance of the eggs being below the LRP for the Northwest Miramichi (Fig. 9).

Over the previous 12 year period, the estimated number of eggs in the returns of small and large salmon combined have declined in the Miramichi River overall (-10%) and the Southwest Miramichi River (-17%) but have increased in the Northwest Miramichi River (+18%) (Fig. 9). The trends in the number of eggs in spawners is similar with decreases over the last 12 years for the Miramichi River overall (-2%) and the Southwest Miramichi River (-14%) but an increase in the Northwest Miramichi River (+61%) (Fig. 9).

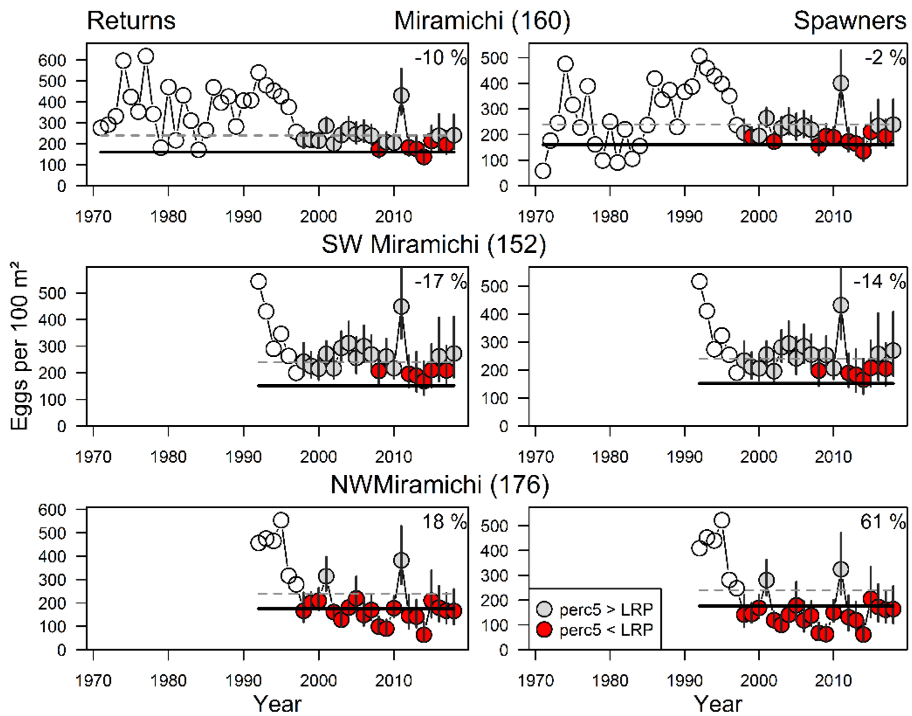

Figure 9. The estimated median (1970-2018) and 5th to 95th percentile range (1998-2018) of the number of eggs (expressed per 100 m² of habitat) from the returns (left panels) and spawners (right panels) of small and large salmon combined to the Miramichi River overall (top row), the Southwest Miramichi River (middle row) and the Northwest Miramichi River (bottom row) in relation to the Limit Reference Point for each river (solid horizontal line) (DFO 2018b). Grey 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 percent change in the number of eggs in the returns (left panels) and spawners (right panels) of large and small salmon combined over the previous 12 year period (2006-2018) is identified in the top right corner of each panel. For reference to previous assessments, the dashed horizontal line is the conservation level of 240 eggs per 100 m².

SFA 17 Prince Edward Island

Salmon redds have been surveyed at least once since 1990 in all but two rivers in PEI that currently have salmon. The method for converting redd counts to female salmon spawners and assessing against attainment of river-specific conservation requirements and LRPs is 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 2). This excludes the Cardigan River, where juvenile salmon are considered to be hatchery escapees. Juvenile salmon were observed in two rivers (Murray, Miminegash) in 2017 or 2018 but these rivers were not included in the list of rivers with defined LRPs and their status is unknown. Redd surveys were conducted in 14 rivers in 2018. However, heavy precipitation and early cold weather led to poor counting conditions, and counts are considered to be complete in only three rivers (Cains, Carruthers, and Trout River Coleman, all in northwestern PEI).

Considering the most recent data for the years 2017 and 2018, for the 24 rivers with full counts, seven (29%) were above LRP and 17 (71%) were below. Five of the seven rivers that exceeded their LRP are located in northeastern PEI (Fig. 10).

Table 2. The percentage attainment of the Limit Reference Point value for Atlantic Salmon monitored rivers in SFA 17, 2011 to 2018. A dash indicates no survey was performed. The spawner requirement is the estimated number of spawners, sexes and sea ages combined, corresponding to the Limit Reference Point for the river (DFO 2018b). Status of rivers for previous years is available in Cairns and MacFarlane (2015).

River	Spawner Req.	2011	2012	2013	2014	2015	2016	2017	2018
Cains Brook	15	235	173	161	-	161 [a]	186	316	96
Carruthers Brook	24	792	352	263 [a]	-	277 [a]	253	320	293
Trout River, Coleman	94	-	-	41	25	25	31	29	22
Trout River, Tyne Valley	26	-	-	0	0	-	-	7 [a]	-
Little Trout River	11	106	-	0	0	7	-	77	-
Bristol (Berrigans) Creek	22	-	12	19	0	2 [a]	-	16	-
Morell River	160	183	98 [a]	132 [a]	157	58 [a]	83	78	51 [a]
Midgell River	34	142	105	46 [a]	97	181	-	135	-
St. Peters River	24	96	128	80	79	122	37	35	-
Cow River	12	-	4	182	43	245	204	139	48 [a]
Naufrage River	23	801	80	845	405	288	201	166	80 [a]
Bear River	9	-	-	74	14	60	164	33	5 [a]
Hay River	14	4	9	140	49	117	133	49	13 [a]
Cross Creek	24	352	153	496	357	440	315	355	109 [a]
Priest Pond Creek	13	66	70	506	433	462	234	503	13 [a]
North Lake Creek	26	605	180	568	311	447	428	364	68 [a]
Vernon River	37	-	9	12	9 [a]	0	-	19	7 [a]
Clarks Creek	25	-	0	5	-	0 [a]	-	7	-
Pisquid River	26	118	60	67	26 [a]	81	49	47	28 [a]
Head of Hillsborough R.	29	0	0	4	-	0	-	0	-
North River	53	9	-	18	-	-	-	7	-
Clyde River	22	0	- [b]	- [b]	- [b]	- [b]	-	0	-
West River	124	47	46	88	59	59	76	78	64 [a]
Dunk River	130	-	7 [a]	-	-	-	-	39	-
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

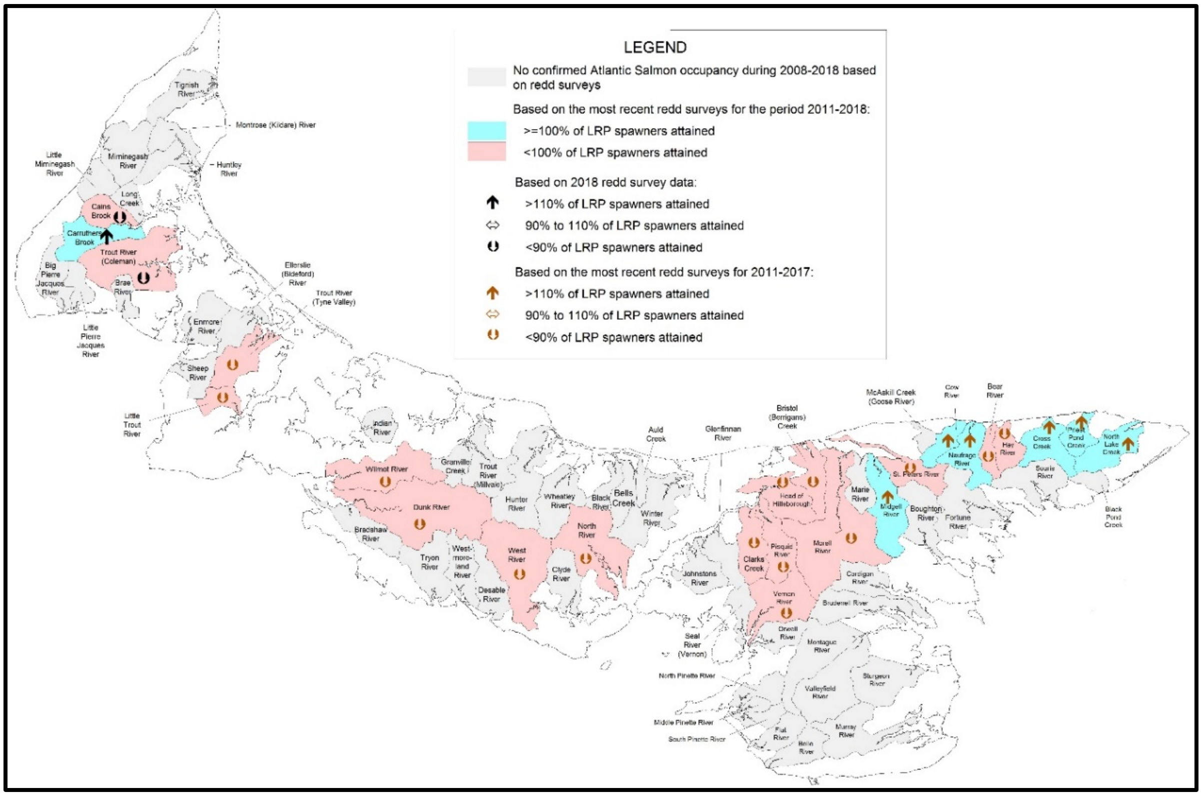

Figure 10. Location of SFA 17 watersheds with historic or current Atlantic Salmon occupancy and summary of their status relative to the percentage of the LRP attained in 2018 (Cains, Carruthers, Trout River Coleman) and in 2017 or earlier (all other watersheds). Blue shading indicates watersheds which met or exceeded the LRP whereas pink shading indicates watersheds that are below the LRP. Grey shading indicates watersheds with no evidence of salmon redds since 2008. The symbols are as follows: less than 90% of LRP attained, ⇔ between 90% and 110% of LRP, and greater than 110% of LRP.

SFA 18 Gulf Nova Scotia

Indices of abundance from the recreational fishery for 2018 are preliminary and based on extracts from the licence stub return database to February 11, 2019 (412 licence stubs returned out of 2,012 licences sold in 2018; 20.5% return rate). Catch and effort from the returned licence stubs are raised by total licence sales to estimate total catch and effort.

SFA 18A Mainland Gulf Nova Scotia

In 2018, there was an increase in the estimated catches of large salmon for West River (Antigonish) and River Philip relative to 2017, while East River (Pictou) had similar values to 2017 (Fig. 11). Values for West River (Antigonish) and East River (Pictou) were lower than their respective long term (1984 to 2017) average, while River Philip was just above the long-term average (Fig. 11). Estimated catches for small salmon increased slightly for all three rivers in 2018 relative to 2017, but remained below their long term average.

The catch rates (catch per rod day) of large salmon for West River (Antigonish) and River Philip were the highest values since 1996 and 2011, respectively. The 2018 catch rate on East River (Pictou) was much lower than 2017, and the 9th lowest value over the 1984 to 2018 period. Over the recent 12 year period, the catch rates of large salmon declined by 8% in West River (Antigonish) and by 31% in East River (Pictou). Catch rates of large salmon in River Philip increased 169% over the same time period (Fig. 11).

In 2018, catch rates of small salmon decreased slightly for East River (Pictou) and River Philip relative to 2017, and were among the lowest values in the time series. West River (Antigonish) saw an increase in catch rates in 2018 relative to 2017. Declines in catch rates of small salmon over the recent 12 year period were noted on all three rivers: 70% for West River (Antigonish), 69% for East River (Pictou) and 13% for River Philip (Fig. 11).

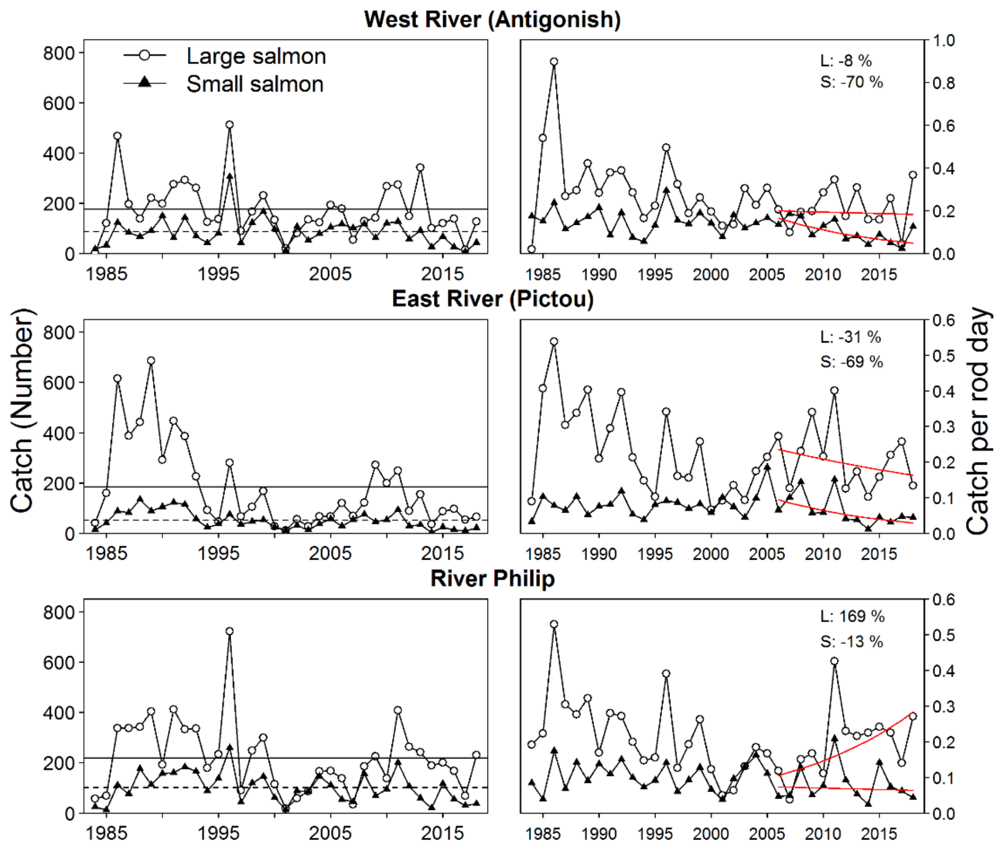

Figure 11. Estimated catches (left panels) and catch rates (catch per rod day; right panels) of large salmon and small salmon from the recreational fishery in the three largest rivers of SFA 18A, 1984 to 2018. In the left panels, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed line) for the time series (1984 to 2017). The solid red lines in the right panels are the exponential regression over the recent 12 years, 2006 to 2018. 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 2018 are preliminary. Note the different y axes range for the figures in the right panels.

SFA 18B Margaree River

The estimated catches of small and large salmon for the Margaree River were similar in 2018 compared to 2017 (Fig. 12). Catches of both size groups were well below their respective long term averages, and were the 4th and 5th lowest value in the time series for small and large salmon respectively (Fig. 12). In 2018, the estimated catch per rod day of large salmon for the Margaree River was slightly higher than in 2017 whereas for small salmon, it was slightly lower than in 2017 (Fig. 12). Trends in catch rates over the recent 12 years show a decline of 23% for large salmon and 45% for small salmon (Fig. 12).

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 2018 are based on catch and effort data from volunteer angler logbook returns (n = 9) and licence stubs processed as of February 11, 2019.

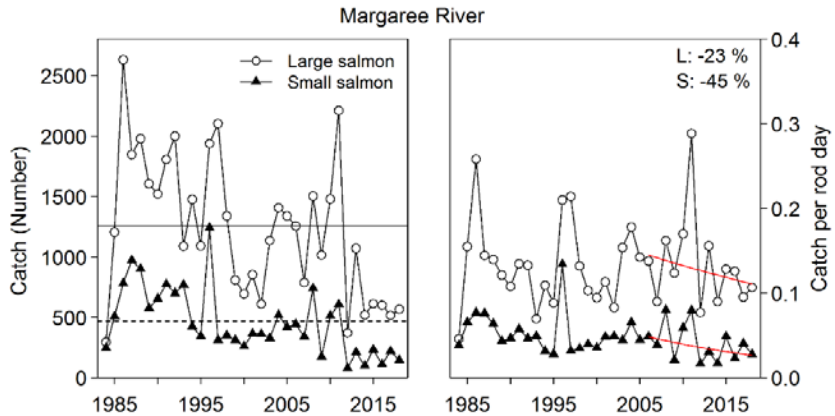

Figure 12. Estimated catches (left panel) and catch rates (catch per rod day; right panel) of large salmon and small salmon from the recreational fishery on the Margaree River (SFA 18B), 1984 to 2018. In the left panel, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed) for the time series (1984 to 2017). The solid red lines in the right panel are the exponential regression over the recent 12 years, 2006 to 2018. 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 2018 are preliminary.

The estimated returns of large salmon to the Margaree River in 2018 were 2,250 fish (median; 5th to 95th percentile range of 1,740 to 2,902), below the long term average of 2,730 fish. The preliminary estimated returns of small salmon to the Margaree River in 2018 were 456 fish (median; 5th to 95th percentile range of 310 to 660), below the long term average of 860 fish (Fig. 13). For the 32-year time series (1987 to 2018), the three lowest returns of large salmon and the five lowest returns of small salmon occurred in the past seven years of the time series. For the Margaree River, trends over the recent 12 year period show a decline of 25% for large salmon and a decline of 50% for small salmon.

The input values for estimating the LRP equivalent values are summarized in Table 3. The estimated eggs in the returns of small salmon and large salmon combined in 2018 were 3.5 times the LRP value (529 eggs per 100 m²; 5th to 95th percentile range of 409 to 604 eggs per 100 m²). The eggs in the combined returns of small and large salmon exceeded the LRP value every year since 1987 (Fig. 14).

Table 3. Input values from the previous assessment (DFO 2018a) used to defined the conservation requirements and the revised values for defining LRP egg requirements (DFO 2018b) for the Margaree River (SFA 18B).

Characteristic	Margaree (NS) Previous value	Margaree (NS) LRP specific value
Habitat area (million m²)	2.7976	2.7976
Egg deposition rate (per 100 m²)	240	152
Total egg requirement (million)	6.71	4.25
Eggs per large salmon	6483	6483
Eggs per small salmon	480	480

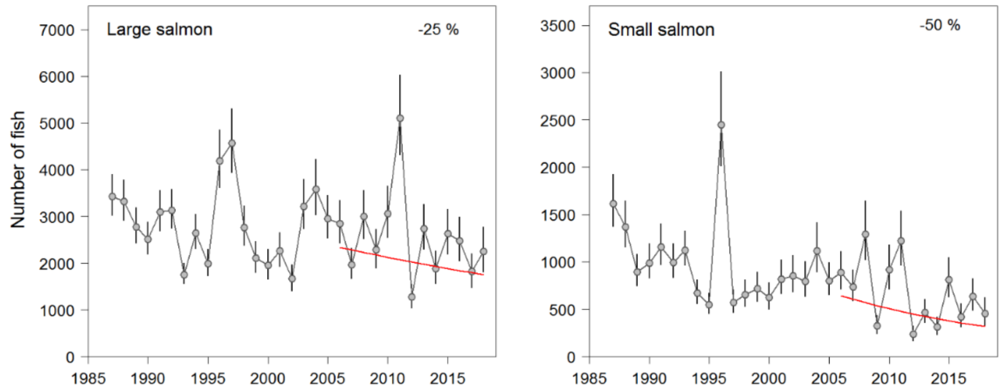

Figure 13. Posterior distributions (medians; 5th to 95th percentile range) of estimated returns of large salmon (left panel) and small salmon (right panel) to the Margaree River, 1987 to 2018. Values for 2018 are preliminary. The solid red lines in the panels are the exponential regression over the recent 12 years, 2006 to 2018 and the corresponding percent change over that time period is also shown in each panel.

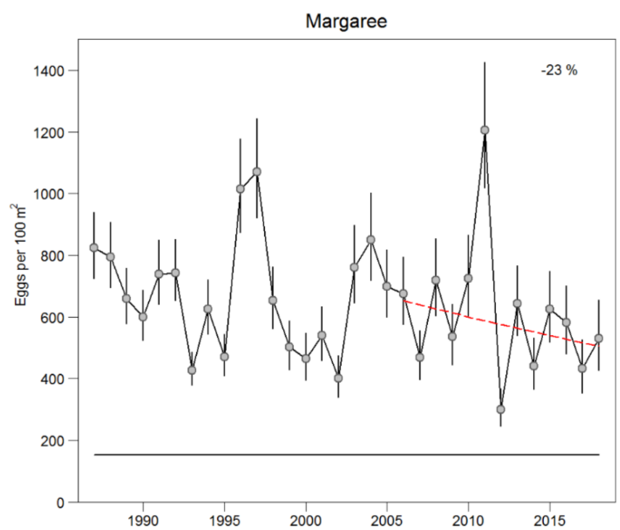

Figure 14. Median and 5th to 95th percentile range of the estimated number of eggs (expressed per 100 m² of habitat) in the returns of small and large salmon combined to the Margaree River, 1987 to 2018. The LRP value (152 eggs per 100 m²) is shown as the solid horizontal line. The percent change in the number of eggs in the returns of large and small salmon combined over the previous 12 year period (2006-2018) is identified in the top right corner.

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 2018 were estimated at 33,000 fish (5th to 95th percentile range of 25,000 to 41,000 fish), 75% of the long-term average (44,100 fish) of the 1970 to 2018 time series (Fig. 15). Small salmon returns to Gulf Region were estimated at 19,000 fish (5th to 95th percentile range of 15,000 to 23,000 fish), only 27% of the average abundance (70,000 fish) of the time series from 1970 to 2018 (Fig. 15).

Over the recent 12 years, approximately two generations, the estimated abundances of large salmon have increased in SFA 17 (21%) but decreased in SFA 15 (29%), SFA 16 (7%), and

SFA 18 (19%) (Fig. 15). Overall in Gulf Region rivers, large salmon abundance has declined by 14% over the period 2006 to 2018. For small salmon, abundances have declined by 39% to 69% in the four Gulf Region SFAs with a decline in estimated small salmon abundance of 64% to Gulf Region rivers overall (Fig. 15).

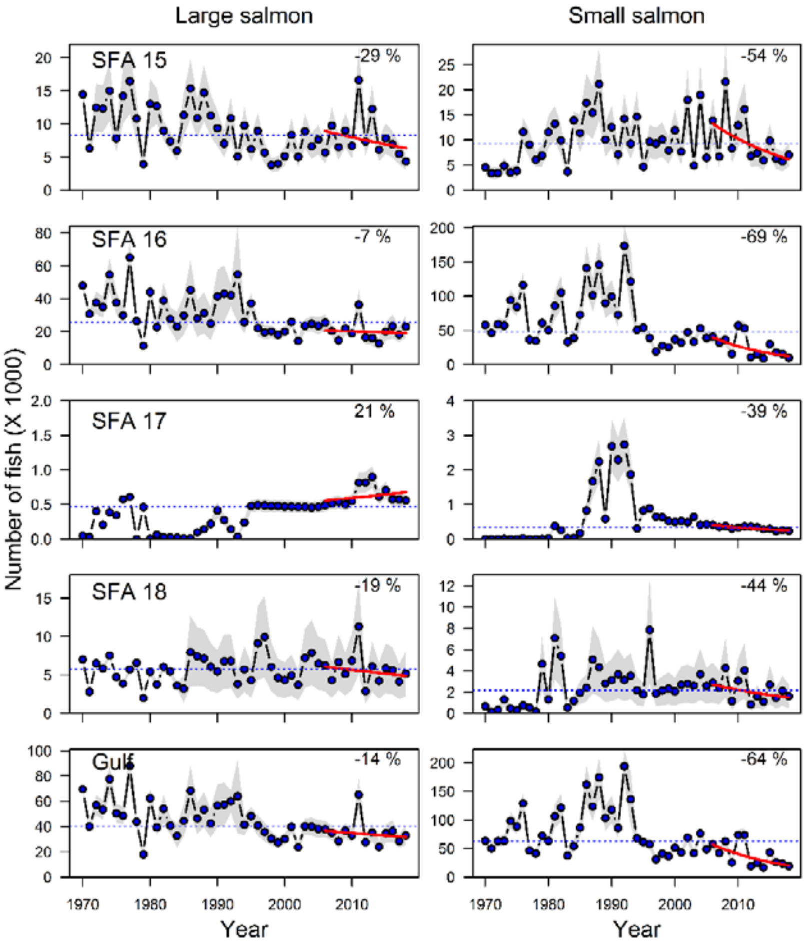

Figure 15. Estimates (medians are coloured symbols, shaded contours are the 5th to 95th percentile ranges) of total returns of large salmon (left panels) and small salmon (right panels) to each of SFA 15, 16, 17, and 18, and to Gulf Region rivers overall, 1970 to 2018. The solid red line in each panel is the exponential change over the recent 12 years, 2006 to 2018. 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 median abundance for the time series 1970 to 2018.

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. Juvenile salmon 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 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

In 2018, one to three cohorts (fry, small parr, large parr) were captured at most sampling sites (n = 62) indicating that there had been multiple years of spawning success (NB waters only, excluding Matapedia and Patapedia rivers). Two sites had no salmon juveniles, eight sites had fry only, and eight 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. 16). Over the past 12 years, the abundances of juvenile salmon have increased by 6% for fry and by 5% for small parr, while decreasing by 4% for large parr (Fig. 16). 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.

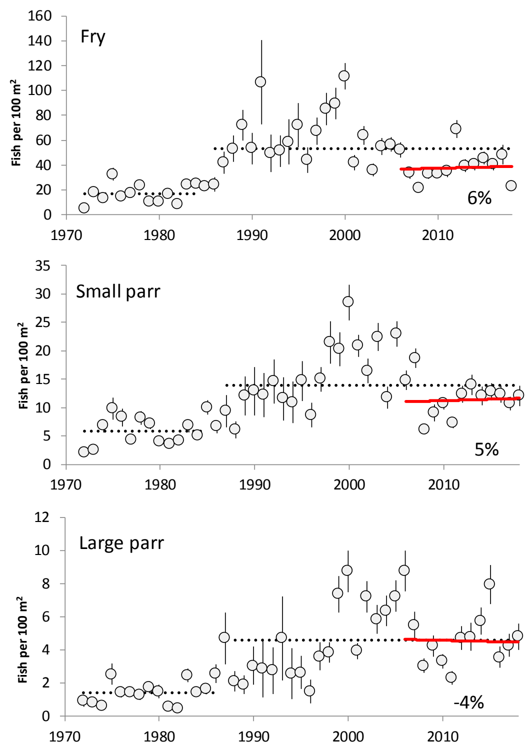

Figure 16. Mean juvenile densities (fish per 100 m²) for fry (upper panel), small parr (middle panel) and large parr (lower panel) for the sites sampled in the Restigouche River (NB waters only, excluding Matapedia and Patapedia rivers), 1972 to 2018. The horizontal dashed lines in each panel are the average densities corresponding to periods before and after, respectively, the significant management changes that were implemented to the commercial and recreational salmon fisheries in 1984. The exponential regression (solid line) over the recent 12 years (2006 to 2018) 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 five sites in the LSW, at 18 sites in the NW, at ten sites in the Renous and at 20 sites in the SW for a total of 53 sites throughout the Miramichi watershed in 2018. Salmon fry and parr were captured at all but two sites (SW, NW) in 2018 which indicates that adult salmon continue to spawn throughout the Miramichi watershed.

In 2018, average fry densities ranged between 20 (Renous) and 32 (LSW) fish per 100 m^2; similar to 2017 levels in the NW and LSW Miramichi rivers but a decrease from 2017 levels in the SW and Renous rivers. Average fry densities in 2018 remained below the post-1984 average fry densities in all rivers and also fell below the pre-1984 average fry densities in the SW and Renous rivers (Fig. 17).

The average small parr densities in 2018 ranged from 8 (LSW) to 13 (Renous) fish per 100 m^2 and increased from 2017 levels in all rivers except the NW Miramichi. The average small parr densities in 2018 remained below the long term (1986 to 2017) average for this life stage in each river and was among the lowest values of the complete NW Miramichi data series (1970-2018). The average large parr densities in 2018 ranged from 3 (LSW) to 5 (SW) fish per 100 m^2 and were lower in each river relative to levels observed in 2017 (Fig. 17). With the exception of the SW Miramichi, the average large parr abundance in 2018 was below the long term (1987 to 2017) average for this life stage in each river (Fig. 17).

With the exception of the average large parr density in the SW Miramichi river, the average density of all juvenile life stages has decreased in each of the four monitored rivers over the last 12 years (Fig. 17). The decrease in the average fry and small parr densities over the last 12 years has been the most pronounced in the Renous (57%) and the NW Miramichi (65%) rivers. Despite a decrease in the average density of large parr in the SW Miramichi in 2018, the recent 12-year trend remains increasing (91%) (Fig. 17).

SFA 16B Buctouche River

The Buctouche River in SFA 16B is used as an index river to inform on the status of the Atlantic Salmon in southeastern New Brunswick. In 2018, a single salmon fry was captured during the survey while parr were present at all but one of the eight sites sampled. The average density of salmon fry in 2018 dropped to near zero, a decrease from levels observed in 2017 and well below the average fry density for this river since 1998 when recreational and aboriginal fisheries were closed (Fig. 18). The average density of parr increased in 2018 relative to 2017 and was above the average levels of parr for this river since 1998. During the recent 12-year period, the abundances of fry and parr in the Buctouche River have decreased by 88% and 48%, respectively (Fig. 18). Significant rainfall in the Buctouche and surrounding areas in January 2018 caused flooding and premature ice breakup and this may have impacted survival during the incubation stage of salmon eggs.

Abundances of Atlantic Salmon fry were also low in other southeastern New Brunswick rivers during the 2018 electrofishing survey. A combined total of 11 fry were captured from eight sites distributed throughout the Richibucto and Kouchibouguacis rivers and no fry was captured from the five sites surveyed in the Cocagne River. Salmon fry were present at most sites in the Kouchibouguac River and salmon parr were captured throughout all southeastern NB rivers in 2018.

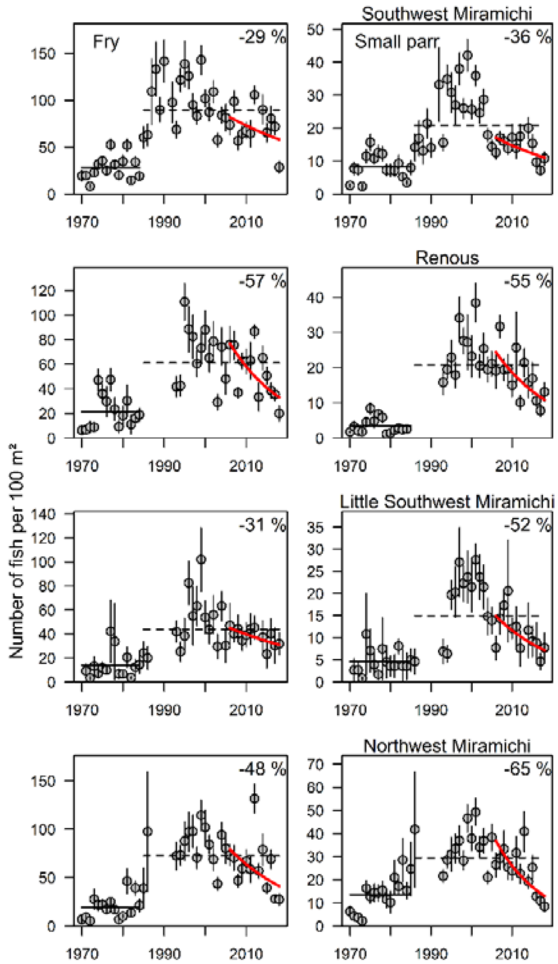

Figure 17. Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column), small parr (middle column), and large parr (right column) at sampled sites in the four major rivers of the Miramichi watershed: Southwest Miramichi (upper row), Renous River (second row), Little Southwest Miramichi (third row), and Northwest Miramichi (bottom row) for 1970 to 2018. 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 (2006 to 2018) and the percent change over that time period are also shown in each panel.

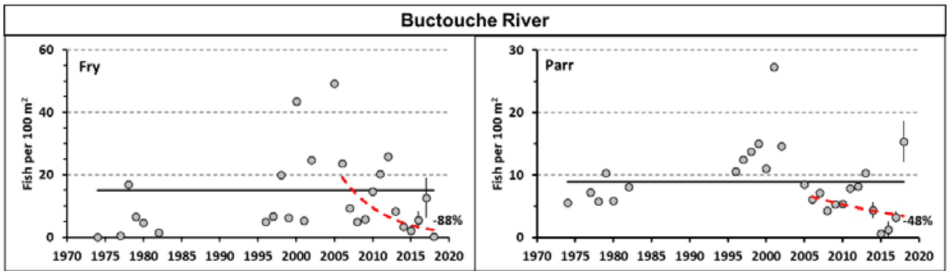

Figure 18. Average densities, expressed as fish per 100 m² of sampled area, for fry (left panel) and parr (size groups combined, right panel) from sampled sites in the Buctouche River 1974 to 2018 sampling years. Vertical bars (2014-2018) are one standard error The horizontal lines represent average 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 (2006 to 2018) 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 2018 were occupied by juvenile salmon. Two to three size groups (fry, small parr, large parr) were captured at all sampling sites in 2018 except for one site on West River (Antigonish) where only large parr were present, indicating that there had been multiple years of spawning success.

Fry abundances have declined on all three rivers in 2018 compared to 2017 (Fig. 19). West River (Antigonish) and River Philip had the lowest fry densities in the time series with 34 and 50 fry per 100 m^2 respectively (Fig. 19). Over the past 12 years, River Philip has seen a decline of 46% while East River (Pictou) saw an increase of 17%, and no change for West River (Antigonish) (Fig. 19).

In 2018, River Philip had the lowest parr abundance (small and large combined) of the time series (14 parr per 100 m^2) whereas West River (Antigonish) had the third lowest parr abundance (19 parr per 100 m^2). East River (Pictou) had a slight increase in parr abundance in 2018 compared to 2017. Over the recent 12 year period, River Philip had a decreasing trend in the abundance of parr (50%); East River (Pictou) has an increase of 42%, and no change for West River (Antigonish) (Fig. 19).

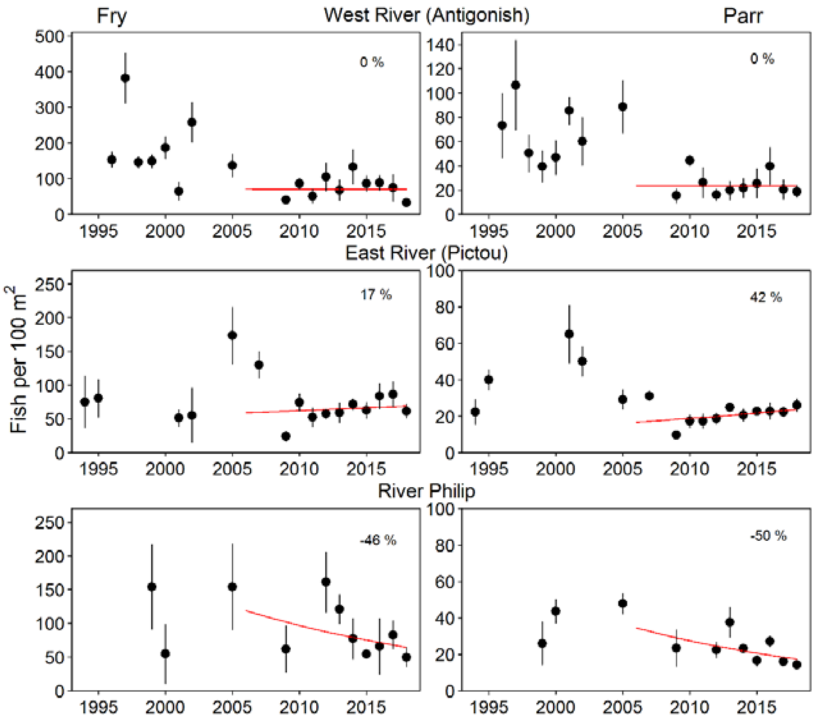

Figure 19. Mean juvenile Atlantic Salmon densities (fish per 100 m²) for fry (left panels) and parr (right panels; small and large size groups combined) for sites sampled in the West River (Antigonish; top row), East River (Pictou; middle row) and River Philip (bottom row), 1994 to 2018. Only years for 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 (2006 to 2018) 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 2018. Two to three size groups were captured at all sampling sites except for one site on the main branch of the Southwest Margaree River that had only fry, indicating that there had been multiple years of spawning success.

Fry abundance in 2018 was much lower than in 2017, and the second lowest value since 1991 (20 fry per 100 m^2) (Fig. 20). Parr (small and large parr combined) abundance in 2018 was lower than 2017 but similar to recent years of lower abundance (Fig. 20). Fry and parr abundances have declined over the recent 12 year period, with declines of 58% for fry and 63% for parr (Fig. 20).

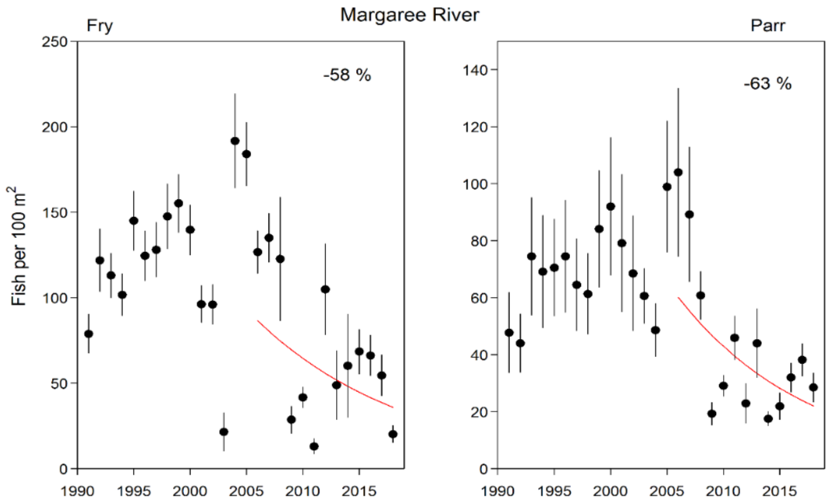

Figure 20. Juvenile densities (fish per 100 m²; mean ± one standard error) for fry (left panel) and parr (right panel) for all sites sampled each year in the Margaree River, 1991 to 2018. The red trend lines (exponential regressions) over the recent 12 years (2006 to 2018) and the percent change over that time period are shown in each panel.

Sources of Uncertainty

A number of indicators of Atlantic Salmon adult abundance (Restigouche River (NB), 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 all areas. In 2018, 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 the Margaree River assessment 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 four years.

For SFA 17, difficult monitoring conditions limited completion of redd counts to only three rivers, of which one met or exceeded the LRP. One other river with an incomplete count exceeded the LRP. There is ongoing uncertainty with respect to salmon occupancy status for a number of small rivers that are not consistently surveyed and in which spawning may be intermittent.

The generally widespread very low abundance indices of fry in 2018 were not expected based on spawning escapements in 2017 and may be attributed to poor overwinter survival of the eggs and possibly emergent fry resulting from the excessive discharges in January and in the early spring, although there are no empirical data to confirm this. The freshwater life history dynamics of Atlantic Salmon in the Gulf Region rivers show variable patterns within and among rivers over time and the juvenile population dynamics linked with environmental variables such as summer water temperatures, water levels, and hydrological conditions during the winter need to be examined for their potential consequences on future adult recruitment and abundance.

The status of the Atlantic Salmon population in the Restigouche River (NB) is uncertain. As a result of the changes to the LRP calculation for the Restigouche River (NB) relative to the previous values used, the status of the Restigouche River (NB) in this update is more pessimistic than was indicated last year. In addition to a reliance historically on recreational fishery catches and an assumed exploitation rate, the appropriate habitat areas and the biological characteristics to be used for calculating the total egg requirement are under reconsideration and the total egg requirement for the LRP will likely be revised in the near future.

Conclusions

Estimated returns of large salmon to Gulf Region rivers in 2018 were 33,000 fish (5th to 95th percentile range of 25,000 to 41,000 fish), representing 75% of the long-term average (44,100 fish) of the 1970 to 2018 time series. Small salmon returns to Gulf Region in 2018 were estimated at 19,000 fish (5th to 95th percentile range of 15,000 to 23,000 fish), only 27% of the average abundance (70,000 fish) of the time series from 1970 to 2018.

Over the recent 12 years, approximately two generations for Atlantic Salmon, the estimated abundance of large salmon in Gulf Region rivers has declined by 14% whereas the small salmon abundance has declined by 64%. Among the four SFAs, small salmon abundance has declined by 39% to 69% over the past 12 years, whereas large salmon abundance, exclusive of SFA 17, have declined by 7% to 29%, the strongest declines occurring in SFA 15.

River specific stock status for Gulf Region rivers is summarized in Tables 4a and 4b. All monitored rivers show strong declines (46% to 74%, except R. Philip 13%) in estimated abundances of small salmon over the recent 12 years, with the strongest decline in the Southwest Miramichi (SFA 16A; Table 4a). Large salmon abundances show lower declines than small salmon, except for the Northwest Miramichi and River Philip (abundance based on catch rates in the recreational fishery) which show an increasing trend. The Northwest Miramichi status is however generally the lowest of the four assessed rivers, having met or exceeded the LRP value based on the median in only two of the past 12 years. The Restigouche River was below the LRP in eight of the past 12 years, whereas the Southwest Miramichi and Margaree rivers have been above the LRP every year of their respective time series.

For SFA 17, 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 2018, poor conditions limited completion of redd counts to only three rivers, of which one met or exceeded the LRP. Of 24 rivers with complete counts in 2017 or 2018, seven exceeded their LRP and 17 were deficient. Five of seven rivers that exceeded their LRP are in northeastern PEI.

With the exception of the Restigouche River (SFA 15A) and East River (Pictou; SFA 18A), the abundance indices for juvenile salmon show strong declines over the recent 12 years (Table 4a). In all monitored rivers, juvenile abundances of the past decade are lower than the values from the mid-1990s to early 2000s.

There were a number of warm water temperature and low flow events in 2018 that affected fisheries access to Atlantic Salmon in several DFO Gulf Region rivers. Exceptionally high winter discharge noted in several rivers may have contributed to lower survival of eggs and emergent fry that resulted in lower than expected indices of abundance of fry. The potential consequences of these events on future adult recruitment and abundance is unknown.

Based on the trends in abundance of small salmon and large salmon and the generally declining juvenile abundance indices, there is no expectation of increased abundance of salmon in rivers of DFO Gulf Region in 2019.

Table 4a. Summary of trends over the recent 12 years of DFO Gulf Region river-specific Atlantic Salmon adult return and juvenile indicators to 2018. The symbol na means no data.

	Trend in returns (12 years)		Trend in juvenile abundance (12 years)	
River (SFA)	Small salmon	Large salmon	Fry [1]	Parr [1,2]
Restigouche (15)	-54%	-30%	+6%	+5%
Northwest Miramichi (16A)	-46%	+31%	-31% / -48%	-52% / -65%
Southwest Miramichi (16A)	-74%	-24%	-29% / -57%	-36% / -55%
Buctouche (16B)	na	na	-88%	-48%
River Philip (18A) [3]	-13%	+169%	-46%	-50%
East River (18A) [3]	-69%	-31%	+17%	+42%
West River (18A) [3]	-70%	-8%	0%	0%
Margaree (18B)	-50%	-25%	-58%	-63%

[1] For the Northwest Miramichi, trends in juveniles are presented for Little Southwest and Northwest Miramichi, respectively. For the Southwest Miramichi, trends in juveniles are presented for the Southwest Miramichi and Renous, respectively.
[2] For the Restigouche, Northwest Miramichi, and Southwest Miramichi, parr refers to small parr. For all others rivers, parr refers to small and large parr combined.
[3] For the trends in returns for the three rivers in SFA 18A, the catch rates (catch per rod day) in the recreational fishery are used.

Table 4b. Summary of status in 2018 (median relative to the LRP) and the trends over the recent 12 years of Atlantic Salmon in DFO Gulf Region monitored rivers.

	Returns relative to LRP		Spawners relative to LRP	
River (SFA)	In 2018 (prob. > LRP)	trend	In 2018 (prob. > LRP)	trend
Restigouche (15)	50%; na [1]	-30%	45%; 73% [1]	-30%
Northwest Miramichi (16A)	94% (41%)	+18%	93% (40%)	+61%
Southwest Miramichi (16A)	179% (99%)	-17%	178% (99%)	-14%
PEI (three rivers) [2]	na	na	1 of 3; 22% to 293%	na
Margaree (18B)	348% (100%)	-23%	na	na

[1] For the Restigouche, the values represent the estimate relative to LRP based on the catches and a catch rate of 40% and to the right based on the end of season spawner counts.
[2] Status for three rivers (Cains Brook, Carruthers Brook, Trout River Coleman) with complete surveys in 2018. The number of rivers in which spawners exceeded the LRP are shown along with the range of percent attainment among the three rivers with complete surveys in 2018.

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Gulf Region

March 13, 2019

Sources of information

This Science Response Report results from the Science Response Process of February 19, 2019 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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MPO. 2019. Mise à jour en 2018 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. 2019/021.