UPDATE OF INDICATORS OF ATLANTIC SALMON (*SALMO SALAR*) IN DFO GULF REGION SALMON FISHING AREAS 15 – 18 FOR 2016

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 and 2015 for each of the four Salmon Fishing Areas (SFA 15-18) were prepared (DFO 2015a; DFO 2015b, DFO 2016). DFO Fisheries and Aquaculture Management (FAM) requested an update of the status of the Atlantic Salmon stocks in DFO Gulf Region for 2016. 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 17, 2017. This Science Response Report results from the Science Response Process of February 17, 2017 on update of indicators of Atlantic salmon 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).

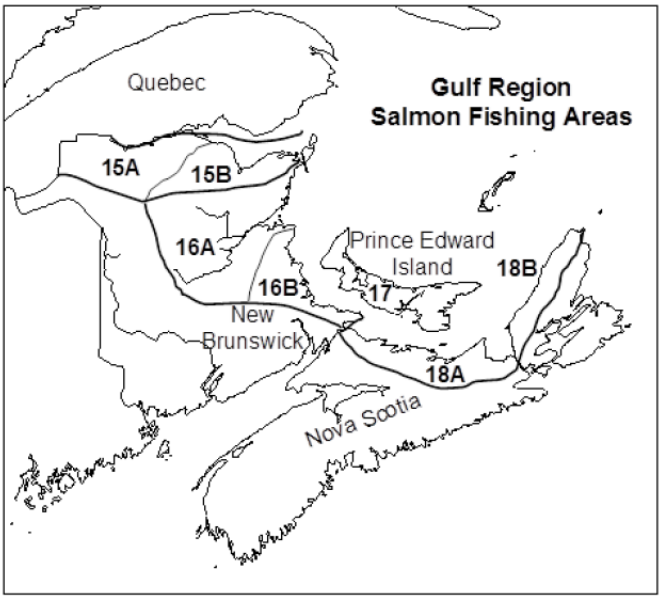

Figure 1. Salmon Fishing Areas in the DFO Gulf Region.

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 in the indicators over the recent twelve years, approximately two generations, are presented.

In 2015 and 2016, mandatory catch and release measures were introduced in all Salmon Fishing Areas. 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 and 2016, 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 2016 were incomplete with information missing for 6 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 2016 was estimated at 5,047 rod days, a 5% decrease in effort compared to 2015. Total parties registered in Crown Reserve waters in 2016 decreased by 6% from 2015 (929 anglers in 2016 compared to 986 in 2015). Of the registered parties, 60% 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 2016 are 2,113 large salmon and 1,740 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 2016 were estimated at 5,535 large salmon and 4,400 small salmon (Fig. 2). Over the recent 12 year period, (approximately two generations), the median annual abundance of large salmon has increased by 11%, whereas the median annual abundance of small salmon has decreased by 47%.

The returns of large salmon were equivalent to 98% of the conservation requirement. Accounting for losses from fishing, the potential egg depositions by large salmon represented 90% 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 5 of the last 10 years (Fig. 3). There is a positive trend in the estimated egg depositions over the recent 12 year period.

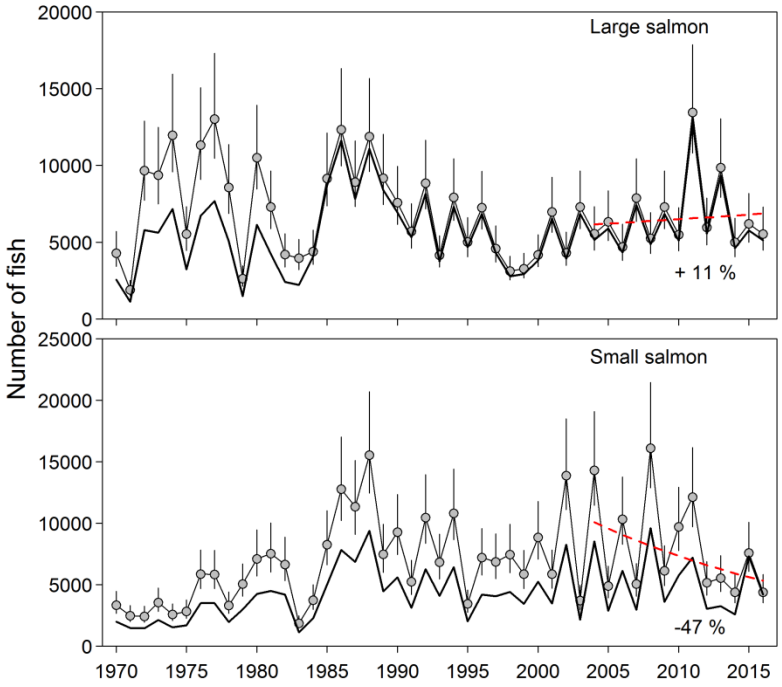

Figure 2. Returns (grey circle are for 40% catch rate and vertical error bars show range based on catch rates of 30% to 50%) and spawners (solid line for 40% catch rate assumption) based on angling catches of large salmon (upper) and small salmon (lower) to Restigouche River (NB portion), 1970 to 2016. The data for 2016 are preliminary. The trend shown as dashed red line and the corresponding percent change over the twelve year time period are shown in each panel.

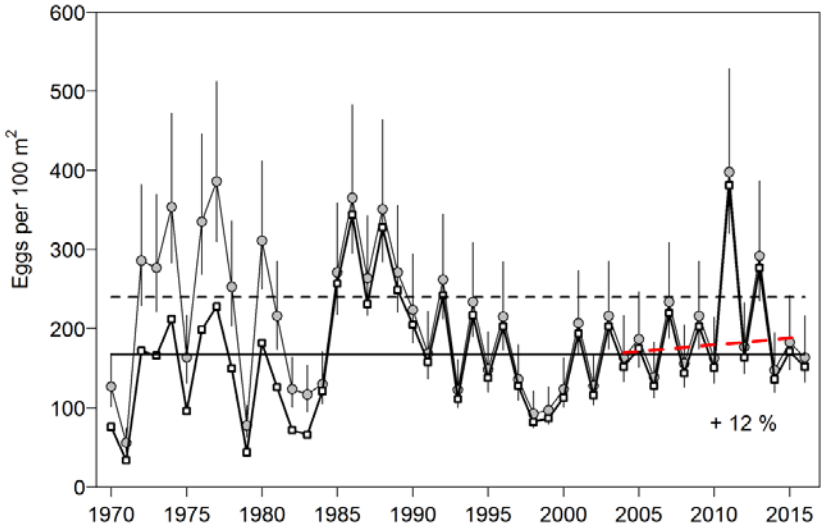

Figure 3. The potential eggs (expressed as eggs per 100 m² of wetted habitat area; total area of 21.6 million m²) by large salmon for the returns (grey circles are assumed catch rate of 40%, error bars show range for catch rates of 30% to 50%) and the spawners (white square symbols for an assumed catch rate of 40%) in the New Brunswick portion of the Restigouche River, 1970 to 2014. 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 2016 are based on preliminary data. The trend and the corresponding percent change over the twelve year time period are also shown as dashed red line.

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 – early October 2016, 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). Counts derived from snorkelling should be considered a minimum estimate of spawners. Visibility was generally fair during 2016 surveys. The large salmon spawner counts in 2016 were all below the area specific conservation requirements in each tributary (77% for the Kedgwick, 63% for the Little Main Restigouche, 89% for the Upsalquitch, 34% for the Patapedia) but above for the main stem Restigouche River (129%).

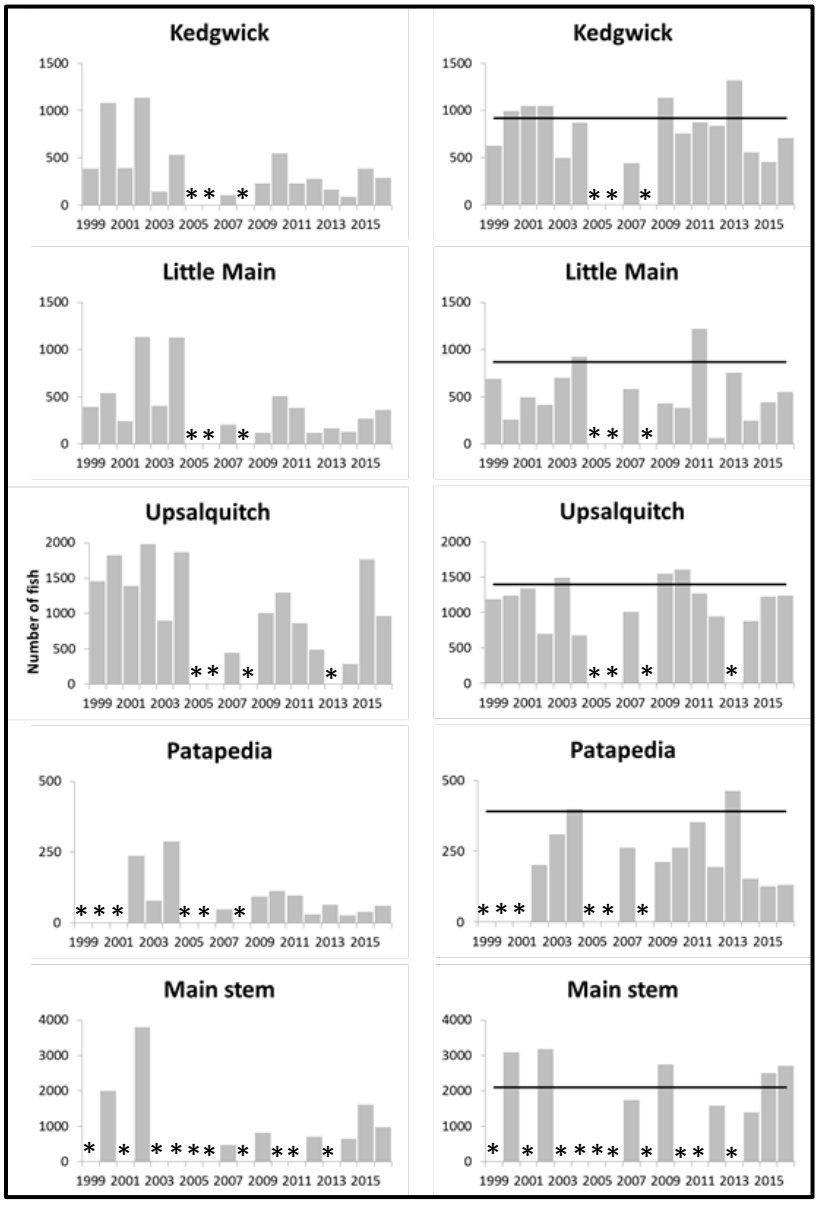

Figure 4. Summary of end of season salmon counts by size group (small salmon left column, large salmon right column) from four tributaries and the main stem of the Restigouche River for 1999 to 2016. The solid horizontal lines in the large salmon panels are the area specific conservation requirements expressed as large salmon. Spawner counts could not be completed (*) 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 in the time series are not adjusted for periods when the counting facilities were not operating due to maintenance or high water conditions.

Season catches of small and large salmon have been available from DFO index trapnets located in the Southwest Miramichi at Millerton since 1994 and in the Northwest Miramichi at Cassilis since 1998. In 2016, the trapnet at Millerton operated between 31 May and 21 October while the trapnet at Cassilis operated between 16 May and 21 October. With the exception of approximately three days between June 9 and 14, both trapnets operated continuously throughout the remainder of the Atlantic Salmon spawning migration. Catches of large salmon in 2016 were improved at both trapnet facilities relative to 2015 and were at or above the long term average catches for this size group at each facility (Fig. 5). Catches of small salmon decreased at both trapnets relative to 2015 and were below the long term average catch levels for this size group at each facility (Fig. 5).

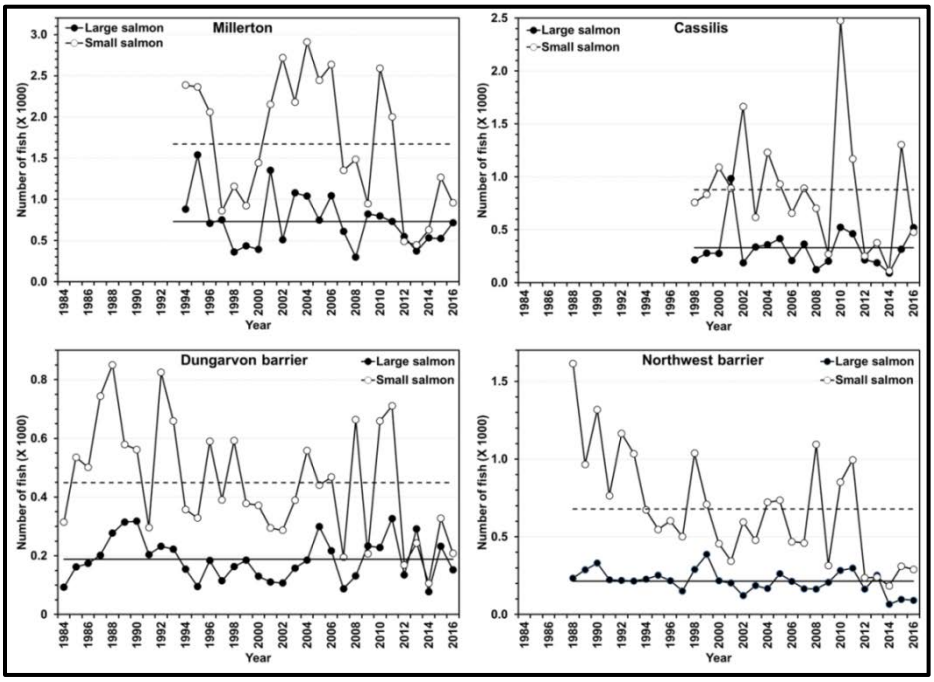

Figure 5. Catches of small and large salmon at DFO index trapnets (top row) at Millerton on the Southwest Miramichi River (left panel) and at Cassilis on the Northwest Miramichi River (right panel) and at provincial headwater barriers (bottom row) in the Dungarvon River, tributary of the Southwest Miramichi River (left panel) and the Northwest Miramichi River (right panel) between 1984 and 2016.The horizontal solid and dashed lines represent the average catch or count of large and small salmon, respectively, for the time series of the facility depicted.

Annual counts of small and large salmon have been available from the NB Department of Energy and Resource Development protection barriers in the headwaters of the Dungarvon River, tributary of the Renous and Southwest Miramichi rivers, since 1984 and from the Northwest Miramichi River, since 1988. In 2016, the barrier on the Dungarvon River operated continuously between 2 June and 20 October. Counts of both large and small salmon at the Dungarvon Barrier in 2016 decreased from levels observed in 2015 and were below the long term average counts for both size groups at this facility (Fig. 5).The Northwest Miramichi Barrier

operated between June 6 and October 20, 2016 but was lifted during June 8 to 16 due to high water conditions. Counts at the Northwest Miramichi Barrier in 2016 were very similar to 2015 levels and below the long term average for each size group at that facility (Fig. 5).

The estimated returns of large salmon to the Miramichi River in 2016 were 18,200 fish (median; 95% confidence interval of 13,200 to 26,300) whereas small salmon returns were estimated at 15,200 fish (median; 95% C.I. 11,700 to 20,500). Returns in 2016 of large salmon were improved over 2015 while the returns of small salmon were not. Returns of both large and small salmon to the Miramichi River in 2016 were below the average return estimates for each size group over the time series (1971 to 2016) (Fig. 6).

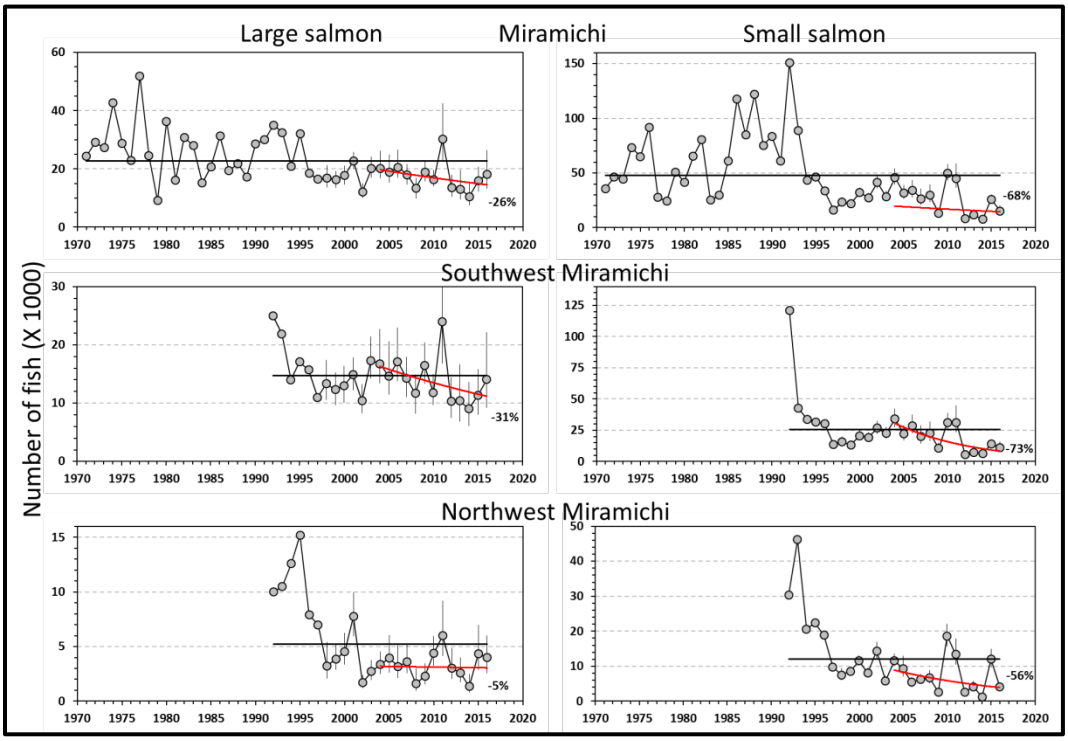

Figure 6. Estimates (median and 5th to 95th percentile range) of large salmon (left column) and small salmon (right column) returns for the Miramichi River for 1971 to 2016 (upper row), the Southwest Miramichi River 1992 to 2016 (middle row), and the Northwest Miramichi River 1992 to 2016 (bottom row).The black horizontal line is the average of the median return estimates of large or small salmon for the time series. The red dashed line is the trend line and the corresponding percent change over the twelve year time period is shown next to each line.

Estimates for the two main branches of the Miramichi River are available since 1992 (Fig. 6). The returns of large salmon to the Southwest Miramichi River in 2016 were estimated at 14,100 fish (median; 95% C.I. 9,300 to 22,100), while small salmon returns were estimated at 11,100 fish (median; 95% C.I. 7,800 to 16,200) (Fig. 6). Relative to 2015 levels, the return estimates in 2016 represented an increase for large salmon but a decrease for small salmon. Both large and particularly small salmon return estimates in 2016 were below the average return estimates for each size group since 1992 (Fig. 6).

The returns of large salmon to the Northwest Miramichi River in 2016 were estimated at 4,000 fish (median; 95% C.I. 2,600 to 6,000), while small salmon returns were estimated at 4,100 fish (median; 95% C.I. 3,100 to 5,300) (Fig. 6). These return estimates represented a decrease of both large and particularly small salmon to the Northwest Miramichi in 2016 relative to 2015.

Return estimates for both size groups to the Northwest Miramichi in 2016 were below average for the complete time series of information (1992 to 2016) (Fig. 6).

Over the recent 12 year period, the abundances of large salmon in the Miramichi overall and to each of the Southwest Miramichi and the Northwest Miramichi branches have declined, by 26%, 31%, and 5%, respectively. The decline has been more pronounced for small salmon, with estimated declines of 56% for the Northwest Miramichi, 73% for the Southwest Miramichi, and 68% overall to the Miramichi (Fig. 6). For both small salmon and large salmon, the declines have been more pronounced in the Southwest Miramichi than in the Northwest Miramichi.

Considering the biological characteristics (length, proportion female) of salmon in 2016, the estimated total eggs in the returns of large and small salmon combined were equivalent to 98% of the conservation requirement for the Miramichi River overall, 108% of the conservation requirement for the Southwest Miramichi River, and 75% of the conservation requirement for the Northwest Miramichi River (Fig. 7).

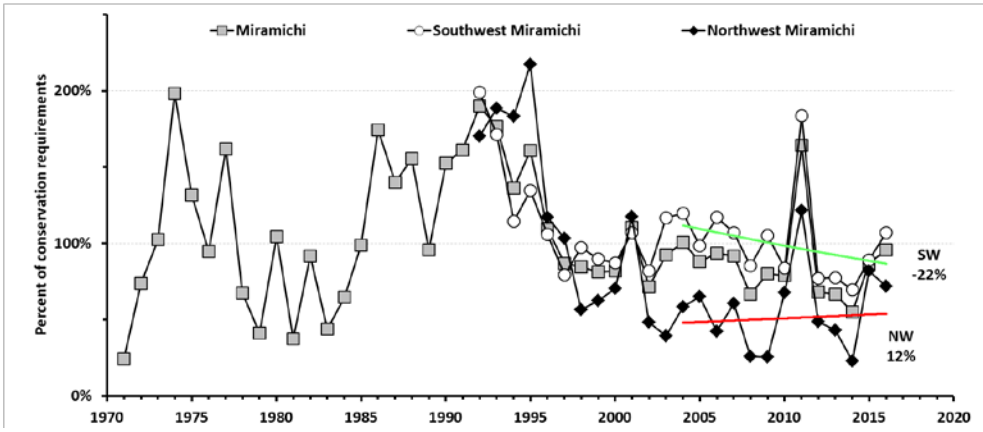

Figure 7. Percentages of the conservation requirements (eggs) attained from spawners of small salmon and large salmon combined for the Miramichi River overall (1971 to 2016), the Southwest Miramichi (1992 to 2016) and the Northwest Miramichi (1992 to 2016) rivers. The red trend line is for the Northwest Miramichi and the green trend line is for the Southwest Miramichi, and the percent change for the period 2004 to 2016 is shown next to each line.

With the mandatory release measure for small salmon implemented in the recreational fishery in 2015 and 2016, losses due to catch and release mortality were assumed to be just under 1% (3% mortality on 30% of the small salmon return) and identical to the treatment of large salmon losses in the recreational fishery since 1984. After accounting for harvests and losses from fisheries, eggs in the spawners of small and large salmon combined were equivalent to 96% of the conservation requirement for the Miramichi River overall, 107% of the conservation requirement for the Southwest Miramichi River, and 72% of the conservation requirement for the Northwest Miramichi River (Fig. 7).

Conservation requirements for the Miramichi River overall were last achieved in 2011. The eggs in the spawners of small and large salmon combined to the Southwest Miramichi River have exceeded the conservation requirement in eight of the last 20 years and in four of the last 10 years. The eggs in the combined spawners of small and large salmon to the Northwest Miramichi River have been sufficient to meet the conservation requirement in three of the last 20 years and once in the last 10 years (Fig. 7). Over the recent 12 years, the estimated egg depositions show a modest increasing trend (12%) for the Northwest Miramichi, and a decreasing trend (22%) in the Southwest Miramichi (Fig. 7).

SFA 17

Salmon redds have been surveyed in all rivers in PEI that currently have salmon at least once since 1990. 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 26 rivers in SFA 17 in which Atlantic Salmon occupancy has been confirmed at least once during 2008 to 2016, based on observations of redds or juveniles (Table 1). Estimated spawners exceeded conservation requirements in seven of 13 surveyed rivers which had complete surveys in 2016 (Table 1). Based on the most recent available data, estimated escapements exceeded requirements in eight of the 26 rivers. Rivers exceeding conservation requirement are concentrated in the Northeast extremity of PEI (Fig. 8). On a number of rivers, estimated spawning escapement has regularly been less than 50% of conservation.

Table 1. The percentage attainment of the Atlantic Salmon conservation requirements in monitored rivers of SFA 17 from 2010 to 2016. 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 during the period 2004 to 2016. The percentage of conservation attainment for the time series beginning in 1990 to 2013 is available in Cairns and MacFarlane (2015).

River	Spawner Req.	2010	2011	2012	2013	2014	2015	2016	Percent change
Cains Brook	26	-	139	102	95	-	95[a]	110	-
Carruthers Brook	40	-	472	210	*157*[a]	-	165[a]	151	-
Trout River, Coleman	160	-	-	-	24	15	15	18	-
Trout River, Tyne Valley	46	-	-	-	0	0	-	-	-
Little Trout River	20	20[a]	61	-	0	0[c]	4	-	-99
Bristol (Berrigans) Creek	39	26	-	7	11	0	1[a]	-	-96
Morell River	270	-	108	58[a]	78[a]	93	34[a]	49	-
Midgell River	61	-	80	59	26[a]	55	102	-	+71
St. Peters River	42	-	55	73	46	45	70	21[a]	-
Cow River	22	-	-	2	102	24	137	114	-
Naufrage River	41	35	459	46	484	232	165	115	+332
Bear River	16	-	-	-	43	8	35	95	-
Hay River	25	-	2	5	78	27	65	74	-
Cross Creek	42	119	200	87	282	203	250	179	+284
Priest Pond Creek	24	26	37	39	283	242	258	131	+138
North Lake Creek	45	200	346	103	325	178	256	245	+210
Vernon River	66	-	-	5	7	5[a]	0	-	-
Seal River (Vernon)	22	-	-	-	-	-	36	-	-
Clarks Creek	44	-	-	0	3	-	0[a]	-	-
Pisquid River	45	36[a]	67	34	38	15[a]	46	28	+152
Head of Hillsborough R.	51	-	0	0	2	-	0	-	-
North River	94	-	5	-	10	-	-	-	-
Clyde River	40	-	0	-[b]	-[b]	-[b]	-[b]	-	-
West River	210	27	28	27	52	35	35	45	+65
Dunk River	220	-	-	4[a]	-	-	-	-	-
Wilmot River	79	-	-	-	-	-[c]	-[c]	-	-

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.

In seven of nine rivers in which redds were surveyed at least seven times during 2004 to 2016, increasing trends are noted in the percent attainment of conservation requirements (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.

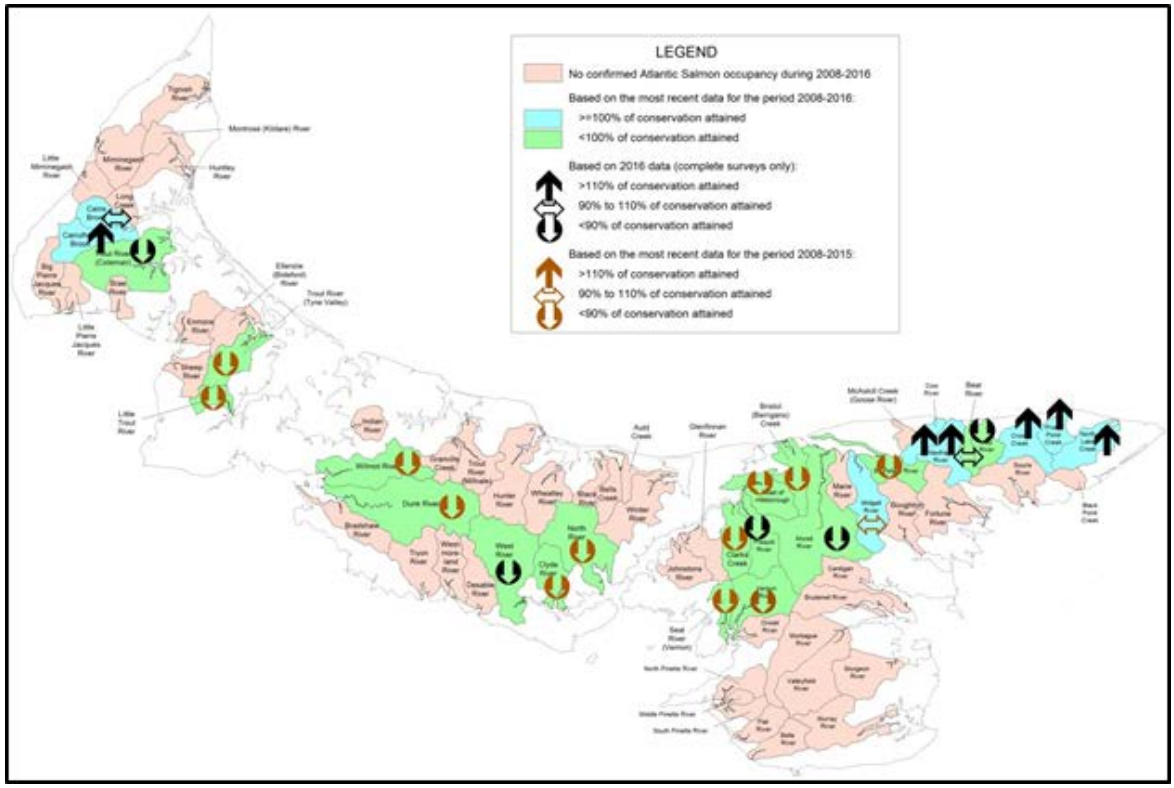

Figure 8. Location of rivers (arrow symbols) for which redd counts were conducted in 2008 to 2016 and summary of the status of the rivers relative to the percentage of the conservation requirements attained in 2016, and in the most recent year assessed if not surveyed in 2016. The symbols are as follows: 🡻 less than 90% of conservation requirements attained, ⇔ between 90% and 110% of conservation requirements, and 🡹 greater than 110% of conservation requirements. The black symbols refer to 2016 values in rivers and the brown symbols refer to the most recent value during 2008-2015 if not surveyed in 2016. The watershed blue shading refers to conservation having been met or exceeded in the most recent year assessed (including 2016), green shading refers to being less than conservation, and pink shading indicates watersheds for which there has been no recent (since 2008) evidence of salmon presence.

SFA 18

Indices of abundance from the recreational fishery for 2016 are preliminary and based on extracts from the licence stub return database to Feb. 15, 2017 (376 licence stubs returned out of 1,857 licences sold in 2016; 20.2% 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 River Philip were both lower in 2016 than in 2015, and East River (Pictou) was slightly higher (Fig. 9). Values for all three rivers were much lower than their respective long term (1984 to 2015) average (Fig. 9). The catch rates, estimated catch per rod day, of large salmon were higher in 2016 for West River (Antigonish) and East River (Pictou), whereas for River Philip, it was the lowest value since 2011 (Fig. 9). Over the recent 12 year period, the catch rates of large salmon declined by 4% in West River (Antigonish) and by 19% in East River (Pictou). Catch rates of large salmon in

River Philip increased 107% over that time period (Fig. 9). All three rivers had important declines in catches and catch rates of small salmon; catch rates declined by 85% for East River (Pictou), by 73% for West River (Antigonish), and by 36% for River Philip (Fig. 9).

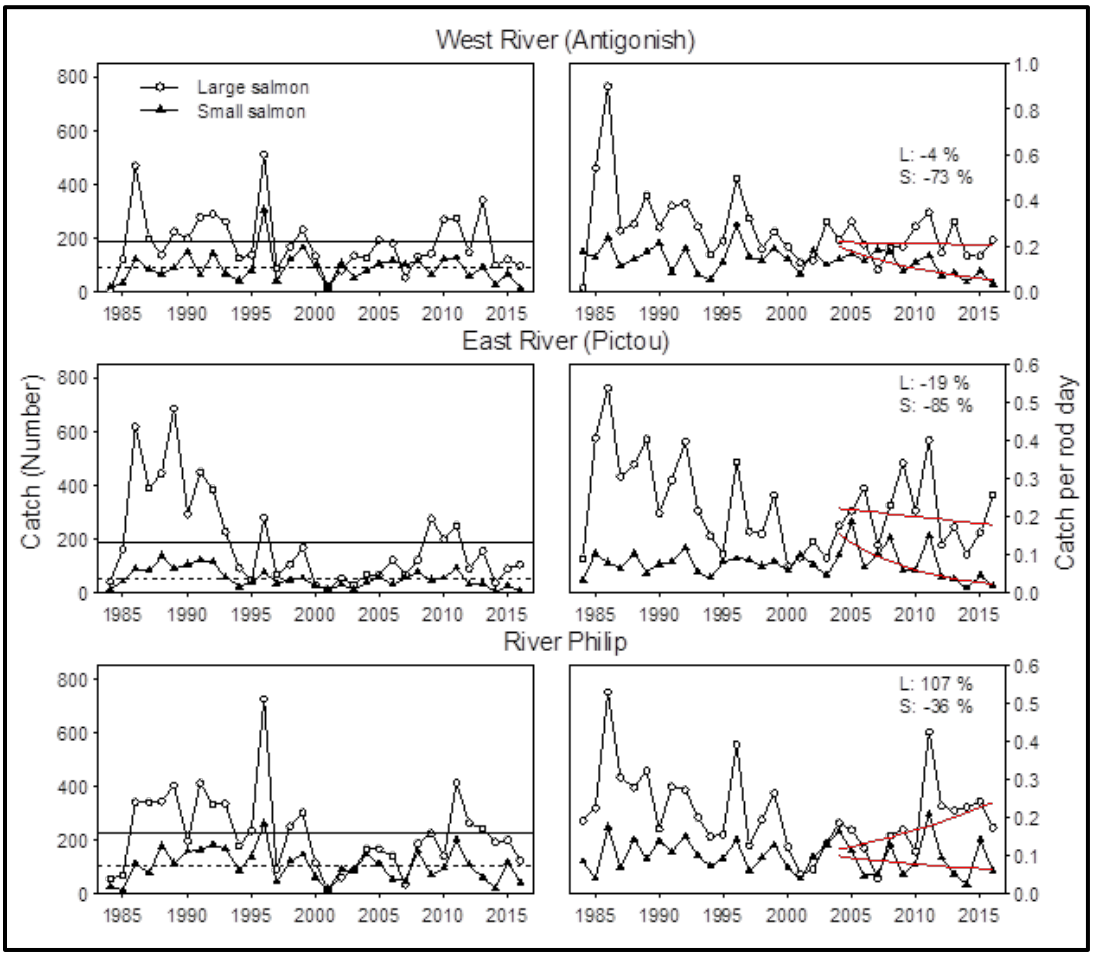

Figure 9. Estimated catches (left panels) and catch rates (catch per rod day; right panels) of large salmon and small salmon from the recreational fishery in the three largest rivers of SFA 18A, 1984 to 2016. In the left panels, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed line) for the time series (1984 to 2015). The solid red line in the right panels are the exponential change prediction over the recent twelve years, 2004 to 2016. 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 2016 are preliminary. Note the different y axes range for the figures in the right panels.

SFA 18B - Margaree River

The estimated catches of large salmon for the Margaree River was higher in 2016 compared to 2015, and estimated catch of small salmon was lower than in 2015. Catches of both size groups were well below their respective long term averages (Fig.10). In 2016, the estimated catch per rod day of large salmon for the Margaree River was similar to 2015 whereas for small salmon, it was the third lowest value of the times series (Fig.10). Trends in catch rates over the recent twelve years show a decline of 18% for large salmon and 60% for small salmon (Fig. 10).

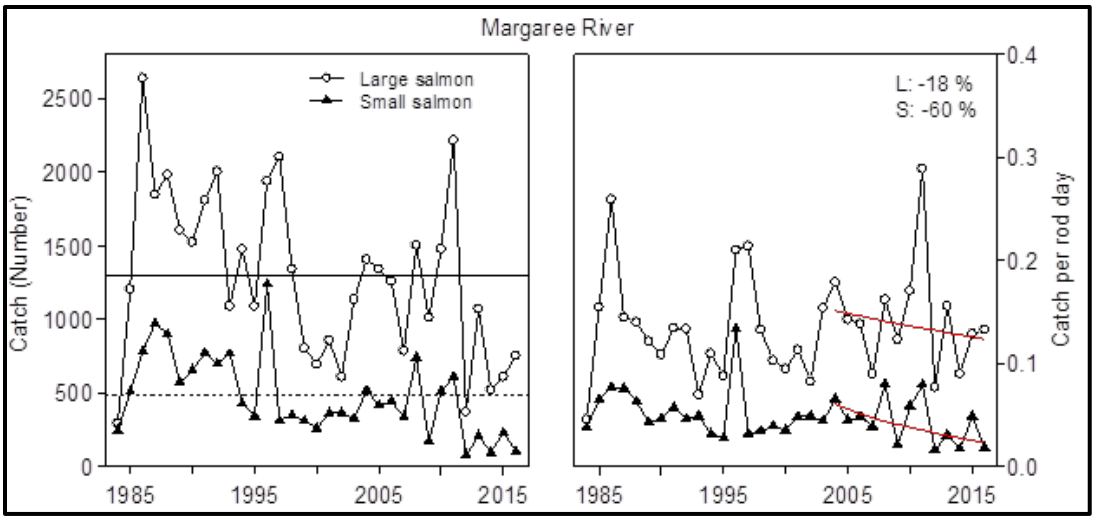

Figure 10. Estimated catches (left panel) and catch rates (catch per rod day; right panel) of large salmon and small salmon from the recreational fishery on the Margaree River (SFA 18B), 1984 to 2016. In the left panel, the horizontal lines are the average catch for large salmon (solid) and for small salmon (dashed) for the time series (1984 to 2015). The solid red lines in the right panel are the exponential change prediction over the recent twelve years, 2004 to 2016. 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 2016 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 2016 are preliminary and based on licence stubs processed as of February 15, 2017.

The estimated returns of large salmon to the Margaree River in 2016 were 2,500 fish (median; 95% confidence interval of 2,000 to 3,200), similar to the long term average of 2,800 fish, and 241% of the conservation requirement of 1,036 large salmon (Fig. 11). Conservation requirements have been exceeded every year since 1987. The lowest estimated returns of large salmon of the time series were in 2012. The preliminary estimated returns of small salmon to the Margaree River in 2016 were 350 fish (median; 95% C.I. 230 to 520) (Fig. 11), below the long term average of 900 fish. The five lowest returns of large salmon occurred at various times over the 30-year time series, from 1987 to present, whereas for small salmon, the five lowest values were in the last eight years. For the Margaree River, trends over the recent 12 year period show a decline of 25% for large salmon and a decline of 62% for small salmon.

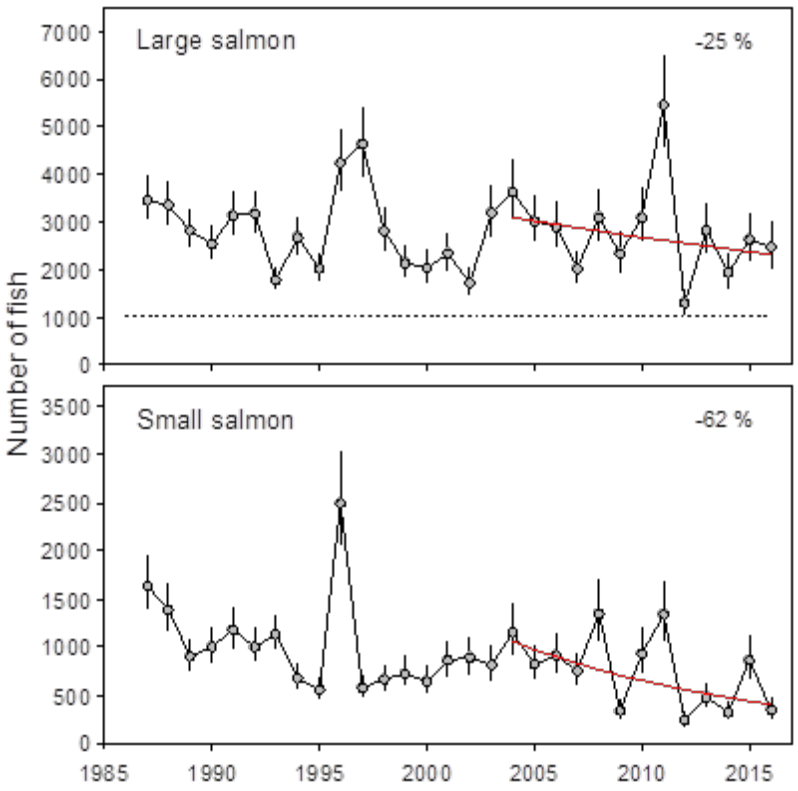

Figure 11. Posterior distributions (medians; 5th to 95th percentile range) of estimated returns of large salmon (upper panel) and small salmon (lower panel) to the Margaree River, 1987 to 2016. Values for 2016 are preliminary. The dashed line in the left panel indicates the large salmon conservation requirement of 1,036 spawners. The trend lines over the previous two generations (2004 to 2016) and the corresponding percent change over twelve years are 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 2016 were estimated at 35,600 fish (5th to 95th percentile range of 27,600 to 43,600 fish), 87% of the long-term average (40,700 fish) of the 1970 to 2016 time series (Fig. 12). Small salmon returns to Gulf Region were estimated at 25,700 fish (5th to 95th percentile range of 20,600 to 30,900 fish), only 41% of the average abundance (62,800 fish) of the time series from 1970 to 2016 (Fig. 12).

Over the recent 12 years, approx. two generations, the estimated abundances of large salmon have increased in SFA 15 (11%) and SFA 17 (62%) whereas abundances in SFA 16 and SFA 18 have declined by 24% and 23%, respectively (Fig. 12). Overall in Gulf Region rivers, large salmon abundance has declined by 15% over the period 2004 to 2016. For small salmon, abundances have declined by 37% to 67% in the four Gulf Region SFAs with a decline in estimated small salmon abundance of 63% to Gulf Region rivers overall (Fig. 12).

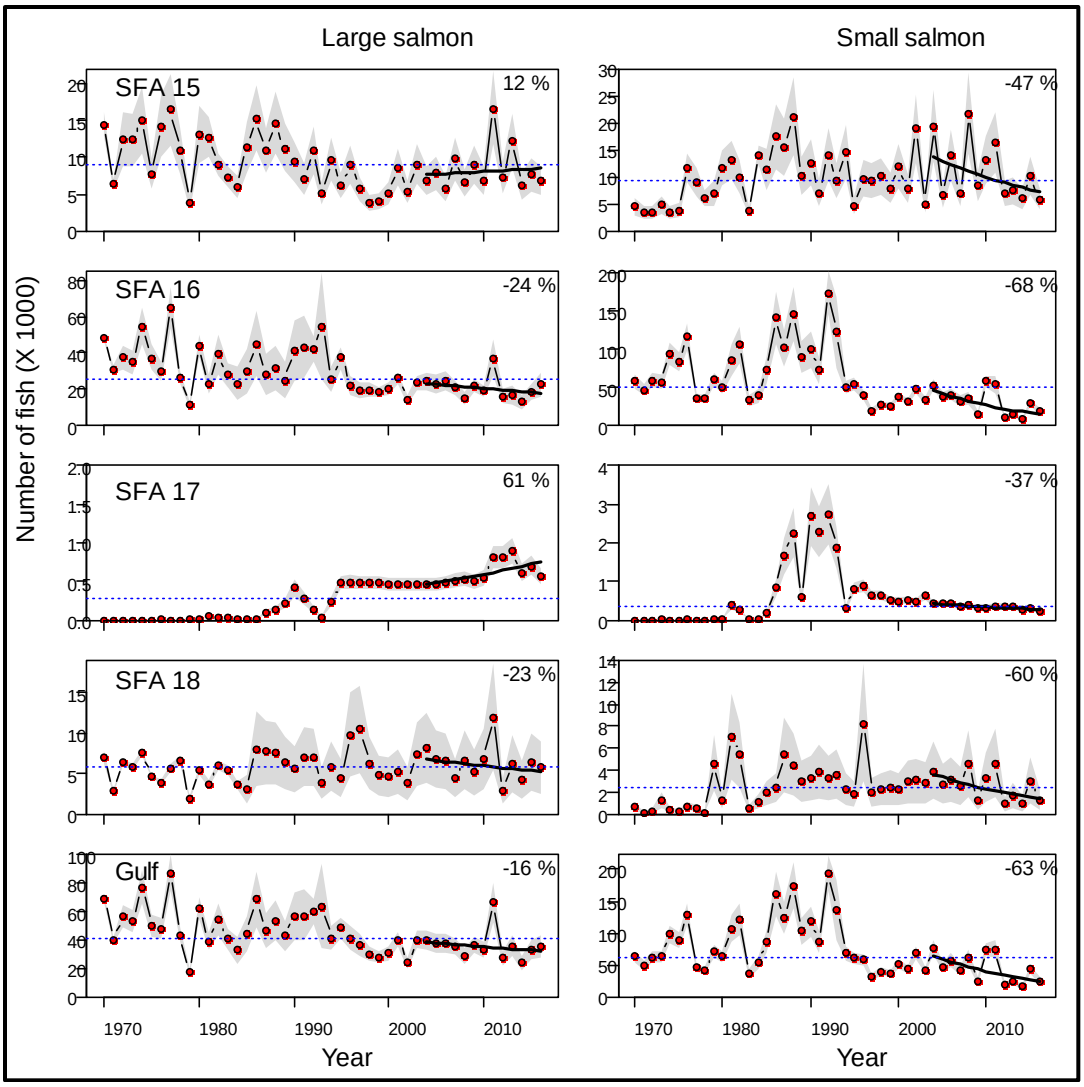

Figure 12. Estimates (medians are coloured symbols, shaded contours are the 5th to 95th percentile ranges) of total returns of large salmon (left panels) and small salmon (right panels) to each of SFA 15, 16, 17, and 18, and to Gulf Region rivers overall, 1970 to 2016. The solid black line in each panel is the exponential change prediction over the recent twelve years, 2004 to 2016. 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 average abundance for 1970 to 2016.

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 2016, 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. All sites sampled have become and remain occupied by juveniles 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. 13). Over the past twelve years, the abundances of juvenile salmon have declined, by 7% for fry, 19% for small parr, and 28% for large parr (Fig. 13). 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.

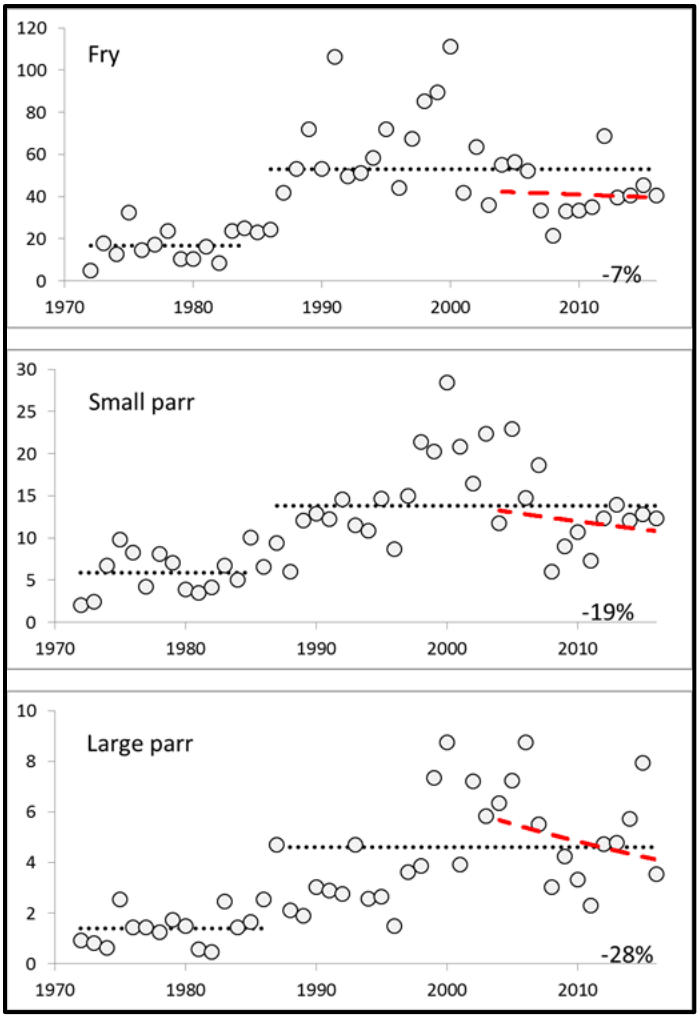

Figure 13. Mean juvenile densities (fish per 100 m²) for fry (upper panel), small parr (middle panel) and large parr (lower panel) for the sites sampled in the Restigouche River (NB waters only, excluding Matapedia and Patapedia rivers), 1972 to 2016. The horizontal solid line and the horizontal dashed 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 trend (solid line) over the recent 12 years (2004 to 2016) and the percent change over that time period are also shown in each panel.

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.

Salmon fry were captured at all 56 sites sampled in 2016 which indicates that adult salmon continue to spawn throughout the Miramichi watershed. With the exception of the Renous, average fry densities increased in 2016 from levels observed in 2015 but all tributaries remained below average (Fig. 14). Increased fry abundance in 2016 is consistent with increased spawning escapement in 2015 that approached conservation requirements in the Southwest and Northwest Miramichi rivers (DFO 2016; Fig. 7).

Average small parr densities in 2016 were relatively similar in the four main rivers (9 fish per 100 m² in LSW to 13 fish per 100 m² in NW), among the lowest since 1985, and below the long term (1986 to 2015) averages (Fig. 14). The average large parr densities in 2016 were similar among the four main rivers and ranged between 3 (Renous) to 7 (NW) fish per 100 m^2. With the exception of the Renous, the average large parr densities in 2016 were near or above the long term averages since 1987 (Fig. 14). The lower small parr abundances in 2016 follow on low fry abundances in 2015 and low egg depositions in 2014 (Fig. 14).

Overall, juvenile salmon abundances 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 have generally decreased since 1984 while large parr abundance has generally increased.

In 3 of the 4 monitored rivers, fry abundances have declined over the recent twelve year period, the exception being the Southwest Miramichi (Fig. 14). Small parr and large parr abundances have declined in all monitored rivers, with exception of large parr in the Southwest Miramichi which show a large increase, +100%, over the past twelve years (Fig. 14).

SFA 16B

In 2016, seven sites were surveyed on the Buctouche River in SFA 16B; fry were captured at four sites, parr at one site, and neither fry nor parr at three sites. The average densities of salmon fry and parr in 2016 were the lowest or among the lowest of their time series and well below the average values since the recreational and aboriginal fisheries were closed in 1998 (Fig. 15). 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 80% over the recent twelve years (Fig. 15).

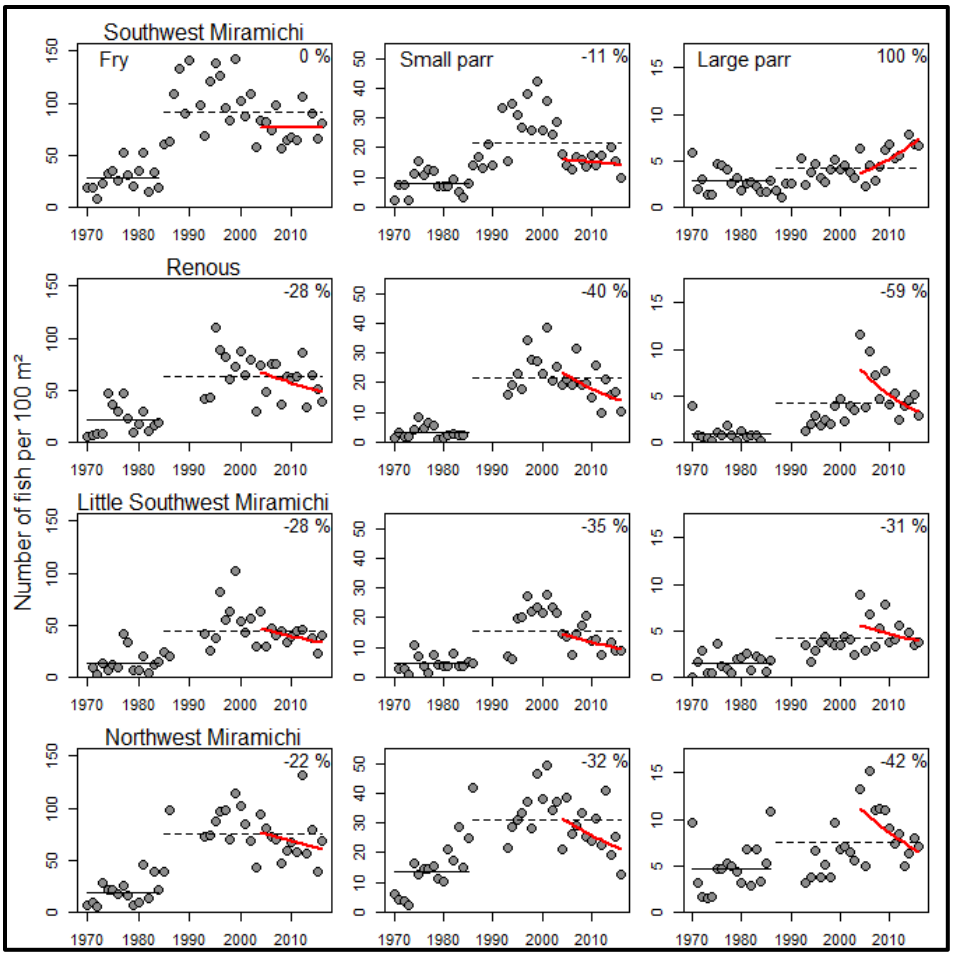

Figure 14. Annual average densities, expressed as fish per 100 m² of sampled area, for fry (left column), small parr (middle column), and large parr (right column) at sampled sites in the four major rivers of the Miramichi watershed: Southwest Miramichi (upper row), Renous River (second row), Little Southwest Miramichi (third row), and Northwest Miramichi (bottom row) for 1970 to 2016. 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 (solid line) over the recent 12 years (2004 to 2016) and the percent change over that time period are also shown in each panel.

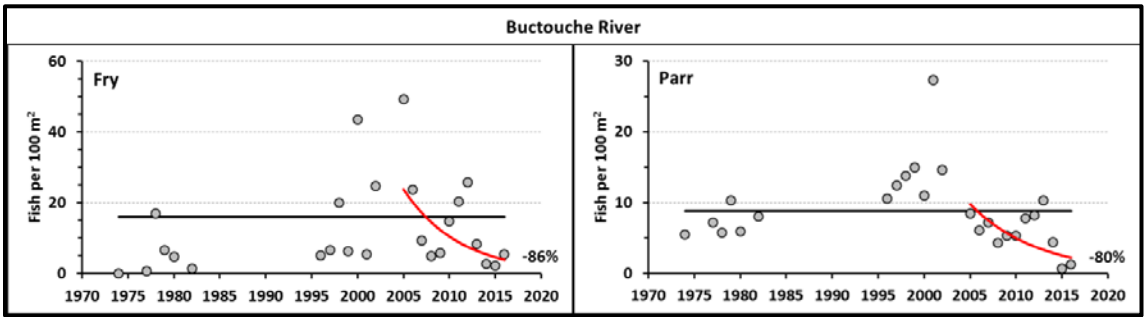

Figure 15. Average densities, expressed as fish per 100 m² of sampled area, for fry (left panel) and parr (size groups combined, right panel) from sampled sites in the Buctouche River 1974 to 2016 sampling years. The horizontal lines represent average fry and parr abundance for the years after the closure of the aboriginal and recreational fisheries in 1998. The trend (solid line) over the recent 12 years (2004 to 2016) and the percent change over that time period are also shown in each panel.

SFA 18A

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 2016 were occupied by juveniles. Two to three cohorts (fry, small parr, large parr) were captured at all sampling sites in 2016 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 (47% and 52% respectively) (Fig. 16). Parr abundances reflect the same pattern of annual abundances as fry, at moderate to high levels (≥ 20 fish per 100m^2) for most years. 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 59% and 49% respectively, followed by East River (Pictou) at 9% (Fig. 16).

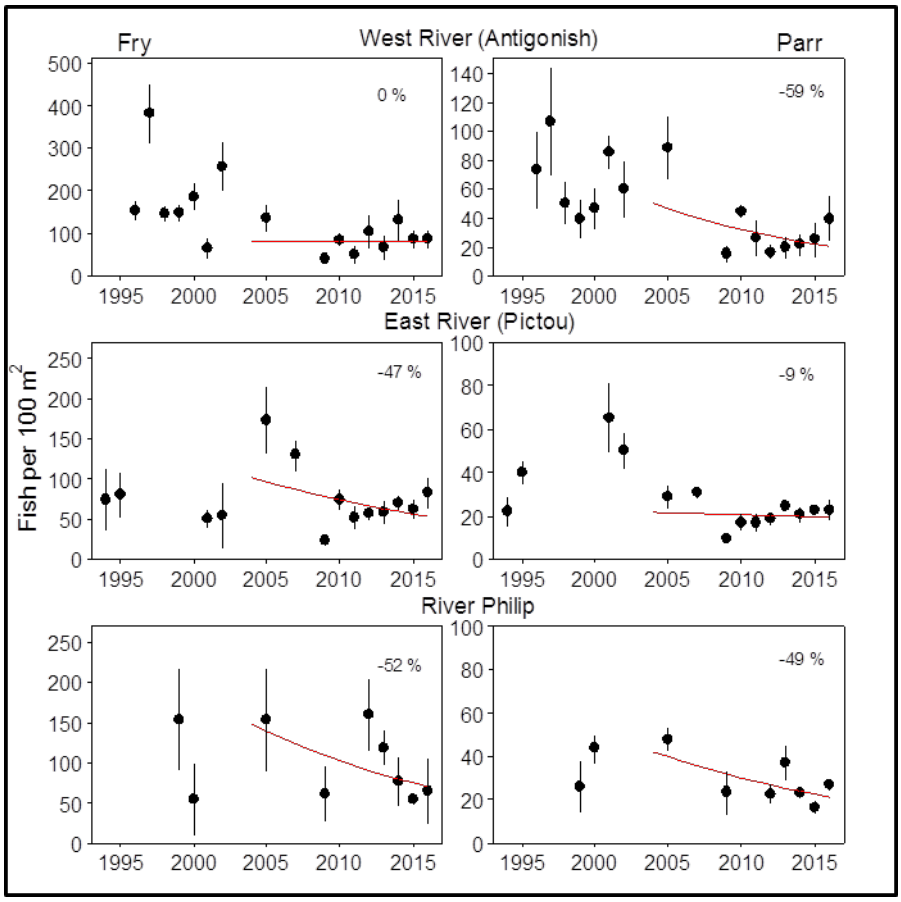

Figure 16. Mean juvenile Atlantic Salmon densities (fish per 100 m²) for fry (left panels) and parr (right panels) for sites sampled in the West River (Antigonish), East River (Pictou) and River Philip, 1994 to 2016. Only years for which at least three sites per river were sampled are presented. Vertical bars are one standard error. The trend line (red line) over the recent 12 years (2004 to 2016) 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

Thirteen sites were surveyed in the Margaree River during 2016. All sites sampled in 2016 were occupied by juveniles. Two to three cohorts (fry, small parr, large parr) were captured at all sampling sites indicating that there had been multiple years of spawning success. Fry abundance in 2016 was slightly lower than in 2015 and similar to recent years of low abundance. Parr abundance in 2016 was slightly higher than 2015 but still within the lowest value of the time series (Fig. 17). Fry and parr abundances have declined greatly over the recent 12 year period, with declines of 70% for fry and 74% for parr (Fig. 17). The lower abundance of fry in 2011 was related to a 100-year flood event in December 2010.

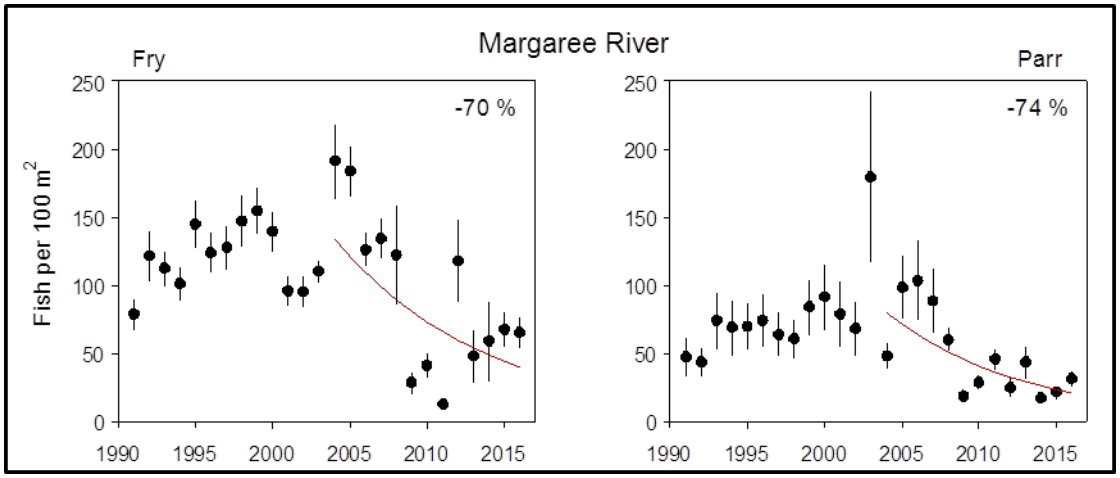

Figure 17. Mean juvenile densities (fish per 100 m² ± one standard error) for fry (left panel) and parr (right panel) for all sites sampled each year in the Margaree River, 1991 to 2016. Vertical bars are one standard error. The trend line (red line) over the recent 12 years (2004 to 2016) and the percent change over that time period are shown in each panel.

Conclusions

In the four monitored river systems of Gulf Region, estimated returns of small salmon in 2016 were lower than those of 2015 but returns in 2016 were above the record low values recorded in 2014. Returns of large salmon in 2016 were improved from 2015 in the Southwest Miramichi only, and were just less than the 2015 returns in the other rivers. Returns of large salmon in 2016 to the monitored rivers were at or very close to the time series average returns. For small salmon, returns in 2016 were all well below the time series average of returns for those rivers. Eggs in the combined returns of small and large salmon exceeded the conservation requirement for the Margaree River (SFA 18B; 241%) and the Southwest Miramichi River (SFA 16A; 108%), were approximately equal to the conservation requirement for the Restigouche River (NB; SFA 15A; 98%), but were below requirements for the Miramichi River overall (96%) and for the Northwest Miramichi River (SFA16A; 75%). The losses from the recreational fisheries in 2015 and 2016 are estimated to be low because of mandatory catch and release measures implemented in all SFAs of DFO Gulf Region.

Juvenile abundance indices for fry, small parr, large parr, and parr sizes combined in 2016 were below the post 1984 period average in all monitored areas. Low small parr abundance indices in 2016 were anticipated in the Miramichi River in particular, consistent with the near record low egg deposition values in 2014 which resulted in low fry abundances in 2015. 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.

For SFA 17, the percentage of monitored rivers that exceeded the conservation requirements in 2016 (54%; 7 of 13 rivers) was improved relative to 2015 (38%; 6 of 16 rivers) and 2014 (27%; 4 of 15 rivers). Salmon status in 2016 was strong in Cains Brook and Carruthers Brook (part of the Mill River system) and in the northeast extremity of PEI, where several rivers are exceeding conservation requirements by a large and growing margin. Status was generally poor elsewhere. Most of the smaller systems are not surveyed every year which makes evaluation of short-term status trends difficult. Salmon are considered to be at risk of extirpation in several rivers where spawning appears to occur in intermittent years.

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 2016). Returns of salmon in 2016 were generally lower than in 2015 but improved from the low values of 2012 to 2014 in most rivers. The abundances of small salmon by SFA in 2016 are less than half the average abundance values over the time series from 1970 to 2016. The abundances of large salmon in 2016, in contrast, are below the long-term average abundance in SFA 15, at the long-term average in SFA 16 and 18, and seemingly above the long-term average value in SFA 17 (PEI) although the estimated abundance of salmon in SFA 17 is very low, at less than 1,000 adults overall.

Contributors

Name	Affiliation
Butruille, Fréderic	DFO Ecosystems and Fisheries Management Gulf Region
Biron, Michel	DFO Science Gulf Region
Cairns, David	DFO Science Gulf Region
Chaput, Gérald	DFO Science Gulf Region
Douglas, Scott	DFO Science Gulf Region
Edwards, Patricia	DFO Science Gulf Region
Fairchild, Wayne	DFO Science Gulf Region
Hardy, Matthew	DFO Science Gulf Region
Hayward, John	DFO Science Gulf Region
LeBlanc, Sophie	DFO Science Gulf Region
Sheasgreen, Joe	DFO Science Gulf Region
Underhill, Kari	DFO Science Gulf Region

Approved by

Doug Bliss
Regional Director of Science
Gulf Region

February 28, 2017

Sources of information

This Science Response Report results from the Science Response Process of February 17, 2017 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.

Breau, C., and Chaput, G. 2012. Analysis of catch options for aboriginal and recreational fisheries for Atlantic salmon from the Margaree River (Nova Scotia) for 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/093. iv + 49 p.

Cairns, D.K., and MacFarlane, R.E. 2015. The status of Atlantic salmon (*Salmo salar*) on Prince Edward Island (SFA 17) in 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/019. iv + 25 p.

DFO. 2014. Stock status of Atlantic salmon (*Salmo salar*) in DFO Gulf Region (Salmon Fishing Areas 15 to 18) to 2013. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/057.

DFO. 2015a. Update of stock status of Atlantic Salmon (*Salmo salar*) in DFO Gulf Region (New Brunswick Salmon Fishing Areas 15 and 16) for 2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/008.

DFO. 2015b. Indicators of Atlantic Salmon (*Salmo salar*) stock status for Prince Edward Island (SFA 17) and Gulf Nova Scotia (SFA 18) in DFO Gulf Region for 2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/016.

DFO. 2016. Update of stock status of Atlantic Salmon (*Salmo salar*) in DFO Gulf Region (Salmon Fishing Areas 15 to 18) for 2015. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/018.

ICES. 2016. Report of the Working Group on North Atlantic Salmon (WGNAS), 30 March–8 April 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:10. 323 pp.

This Report is Available from the

Center for Science Advice (CSA)
Gulf Region
Fisheries and Oceans Canada
P.O. Box 5030, Moncton, NB, E1C 9B6

Telephone: 506-851-6253
E-Mail: csas-sccs@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769

Correct Citation for this Publication:

DFO. 2017. Update of indicators of Atlantic Salmon (*Salmo salar*) in DFO Gulf Region Salmon Fishing Areas 15 - 18 for 2016. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/013.

Aussi disponible en français :

MPO. 2017. Mise à jour des indicateurs du saumon de l'Atlantique (Salmo salar) dans la région du Golfe du MPO (zones de pêche du saumon 15 à 18) pour 2016. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2017/013.