Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Maritimes Region | Science Response 2023/043

STOCK STATUS UPDATE OF ATLANTIC SALMON TO 2022 IN SALMON FISHING AREAS (SFAs) 19–21 AND 23

Context

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identified four large groups of Atlantic Salmon (*Salmo salar*), referred to as Designatable Units (DUs), in the Maritimes Region: Eastern Cape Breton (ECB; corresponding to Salmon Fishing Area (SFA) 19), Nova Scotia Southern Upland (SU; SFAs 20, 21 and part of 22), Outer Bay of Fundy (OBoF; corresponding to the western part of SFA 23), and Inner Bay of Fundy (IBoF; part of SFAs 22 and 23) (see Appendix).

Abundance of Atlantic Salmon in the Maritimes Region has been in decline for more than two decades. Populations in many rivers are extirpated, and IBoF Salmon are listed as Endangered under the *Species at Risk Act* (SARA). In November 2010, COSEWIC assessed the ECB, SU and OBoF population assemblages as Endangered. Fisheries and Oceans Canada (DFO) has completed scientific Recovery Potential Assessments (RPAs), socio-economic analyses, and public consultations for these DUs to inform the decision on whether or not they will be listed under SARA.

Science advice on the status of Salmon in SFAs 19–21 and 23 for 2022 was requested by Fisheries Management. This advice is used to inform Indigenous communities, clients, and the provinces of Nova Scotia and New Brunswick of the status of the Salmon resource in advance of developing harvest agreements and recreational fishing plans for 2023. The objective of the request was to assess the status of Salmon stocks in SFAs 19, 20, 21, and 23 up to the end of 2022 using the following indicators:

- adult abundance relative to reference levels;
- juveniles densities; and
- smolt production estimates.

Given that this request is for an update of previous advice using established methods (DFO 2023 and references therein), the Science Response Process was used.

This Science Response Report results from the Regional Peer Review of March 8, 2023 on the Stock Status Update of Atlantic Salmon in Salmon Fishing Areas (SFAs) 19–21 and 23.

Analysis and Response

Methods

Evaluation of the status of Salmon in the Maritimes Region is based on abundance monitoring for a number of index populations. For most index populations where adult returns are available, status is evaluated using a comparison of the estimated egg deposition (calculated from the estimated abundance and biological characteristics of Salmon stocks) relative to a reference point known as the conservation egg requirement. The river-specific conservation egg requirement is based on an egg deposition of 2.4 eggs/m^2 multiplied by the amount of

accessible fluvial rearing habitat that is of suitable gradient. An egg deposition of 2.4 eggs/m^2 is considered to be a Limit Reference Point (LRP) in the context of DFO's Precautionary Approach Framework (DFO 2009, DFO 2012, Gibson and Claytor 2012) for DFO's Maritimes Region. Conservation requirements for many of the rivers in the Maritimes Region are reported in O'Connell et al. (1997).

In this report, Salmon less than 63 cm in fork length are referred to as small, which are typically one-sea-winter (1SW) Salmon that return to spawn following a single winter at sea (also termed grilse); Salmon greater than or equal to 63 cm in fork length are referred to as large, which are typically multi-sea-winter (MSW) Salmon that return following two or more winters at sea and repeat spawners.

Juvenile Salmon abundance determined from electrofishing surveys is compared to Elson's norm values of 29 fry/100 m^2 and 38 parr/100 m^2 (Elson 1967). A smolt production estimate of 3.8 smolt/100 m^2 (Symons 1979) is sometimes used as a general reference value for rivers at or near the egg conservation requirement, and is provided here to allow for a comparison of smolt production estimates.

Eastern Cape Breton (Salmon Fishing Area 19)

Salmon population monitoring by DFO in ECB is currently focused on three river systems: the Middle, Baddeck, and North rivers (Table 1, Figure A1). Parks Canada (PC) monitors adult Salmon abundance on Clyburn Brook (Table 1) using dive surveys similar to those conducted by DFO. The Unama'ki Institute of Natural Resources (UINR) began monitoring smolts on Middle River in 2011, and smolt population estimates are available for 2013–2016, and 2018 (Table 2). Smolt assessments were not conducted since 2019. Details on the assessment methods for ECB Salmon populations are provided in Levy and Gibson (2014), DFO (2013), Gibson and Bowlby (2009), and Robichaud-LeBlanc and Amiro (2004). Within a recent working paper to update information on ECB Atlantic Salmon populations of relevance to a COSEWIC status report, a review of all available data and abundance estimates was conducted for ECB ([1]Taylor et al., In prep.) This process resulted in some updates to escapement estimates in the North River time-series (see DFO 2021).

In 2022, all rivers within SFA 19, with the exception of the Middle, Baddeck, and North rivers, were closed to Salmon fishing all year. The Middle and Baddeck rivers were open to catch-and-release angling from October 1st to October 31st, and North River (downstream from the area known as "The Benches") was open to catch-and-release angling from June 1st to July 14th and September 1st to October 31st (Table 1). A Provincial stocking program exists on Middle and Baddeck rivers, which aims to numerically offset anticipated catch and release mortalities on these rivers (DFO 2010). Food, Social and Ceremonial (FSC) allocations were available to First Nations on these three rivers in 2022; however, the 2022–2023 Atlantic Salmon, Plamu, Conservation Harvesting Plan discouraged FSC harvest where rivers are not expected to exceed their conservation egg requirement, and no harvest of returning Salmon was reported by Indigenous communities in ECB.

Indicators of Stock Status

In 2022, the ECB index populations of Middle and Baddeck rivers were assessed to be below conservation egg requirements (Table 1), with estimated values of 68 and 87 percent of the

[1] Taylor, A.D., D. Raab, D.C. Hardie, and E.B. Brunsdon. In prep. Updated information on Atlantic salmon (*Salmo salar*) Eastern Cape Breton populations (ECB; SFA 19) of relevance to the development of a 2nd COSEWIC status report. DFO Can. Sci. Advis. Sec. Res. Doc.

requirements, respectively. North River was assessed to be above the conservation egg requirement, estimated at 101 percent. The Salmon abundance in Clyburn Brook continues to remain low, with 23 wild Salmon counted in 2022. An additional 37 Salmon were identified during the dive count survey that were released from the Parks Canada Salmon Recovery Project (Parks Canada 2022). The program released 79 adult Salmon in Clyburn Brook in October 2022. A summary of the 2022 assessment results is provided in Table 1, and time series showing the status of adult Salmon populations for the Middle and Baddeck, North, and Clyburn rivers are provided in Figures 1, 2, and 3, respectively.

Table 1. Atlantic Salmon assessment information for index rivers in Salmon Fishing Area 19 during 2022, including catch-and-release angling seasons, conservation egg requirements, preliminary recreational catch and effort estimates, catch and release mortality estimates, dive count results, escapement estimates, percent conservation egg requirement attained, and Provincial stocking information.

	Middle River	Baddeck River	North River	Clyburn Brook
Angling Season (2022)	October 1st to 31st	October 1st to 31st	June 1st to July 14th; September 1st to October 31st	Closed
Assessment Information	- Recreational Catch Estimates - Dive Counts - Mark Recapture Data (historical) - Electrofishing Data (historical)	- Recreational Catch Estimates - Dive Counts - Mark Recapture Data (historical) - Electrofishing Data (historical)	- Recreational Catch Estimates - Dive Counts - Mark Recapture Data (historical)	- Dive Counts
Conservation Egg Requirement (millions of eggs)	2.07	2.01	0.92	0.28
Preliminary Recreational Catch Estimates:*				
Small Salmon	26	15	46	Not Applicable
Large Salmon	91	109	55	Not Applicable
Effort (rod-days)	298	243	165	Not Applicable
Total Catch and Release Mortality Estimates**	5	5	4	Not Applicable
Dive Counts:***				
Small Salmon	74	34	51	9
Large Salmon	329	179	100	14
Marks / Recaptures‡	22 / 19	20 / 9	Not Applicable	Not Applicable
Estimated Escapement:				
Small Salmon	75	45	109	Not Applicable
Large Salmon	393	333	213	Not Applicable
% Conservation Egg Requirement‡‡	**68 (51–80)**	**87 (71–110)**	**101 (89–116)**	**Not Applicable**
Provincial Stocking:				
Broodstock Collections	4 large; 3 small (October)	8 large; 0 small (October)	Not Applicable	Not Applicable
Juvenile Releases	25,500 fin clipped 0+ parr (October)	27,350 fin clipped 0+ parr (October)	Not Applicable	Not Applicable

*Salmo-NS Database queried on Feb. 21, 2023.
**An assumed 4% mortality rate is applied to estimate catch-and-release mortalities (DFO 2013).
*** Middle River dive count was conducted October 25, 2022; Baddeck River dive count was conducted October 26, 2022; North River dive count was conducted November 2, 2022, and Parks Canada conducted the Clyburn Brook dive count on November 2, 2022.
‡Marking was conducted on October 12, 2022 on Middle River and October 13, 2022 on Baddeck River.
‡‡Middle and Baddeck rivers % conservation egg requirement calculated with a Bayesian 90% credible interval and North River is calculated with a 95% confidence interval.

Table 2. Estimates of Atlantic Salmon smolt abundance, production per unit area of habitat (smolts/100 m^2), as well as one-sea-winter (1SW) and two-sea-winter (2SW) return rates for Middle River. Smolt assessments were not conducted since 2019.

Smolt Year (t)	Smolt Estimate*	95% Confidence Interval	Production Per Unit Area (smolts/100 m^2)	Return Rate (%)**	
				1SW (t+1)	2SW (t+2)
2013	11,103	6,848–15,359	1.43	0.20	1.68
2014* **	11,907	2,471–21,343	1.53	0.37	1.52
2015	24,110	12,057–36,164	3.10	0.15	1.96
2016	14,848	8,451–21,244	1.91	0.90	2.15
2017‡	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2018* **	9,554	1,265–17,842	1.23	0.41	3.83
2019‡	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

*Source: Smolt estimates provided by Unama'ki Institute of Natural Resources. For 2013–2016 and 2018, the smolt population was estimated using a single trap mark recapture experiment and the Adjusted Peterson Estimate (Ricker 1975).
**Ninety percent of large Salmon were assumed to be maiden 2SW Salmon based on the aging of scale samples collected from adult Salmon on Middle River during 1995–1998, 2003, and 2004. All small Salmon were assumed to be 1SW Salmon for these return rate calculations.
***The number of recaptures were low in 2014 (207 marked smolts, 276 captured smolts, and 4 recaptured smolts) and 2018 (193 marked smolts, 196 captured smolts, and 3 recaptured smolts), resulting in greater uncertainty associated with these estimates.
‡ Smolt estimates were attempted in 2017 and 2019, but were interrupted by high flow events during critical migration periods.

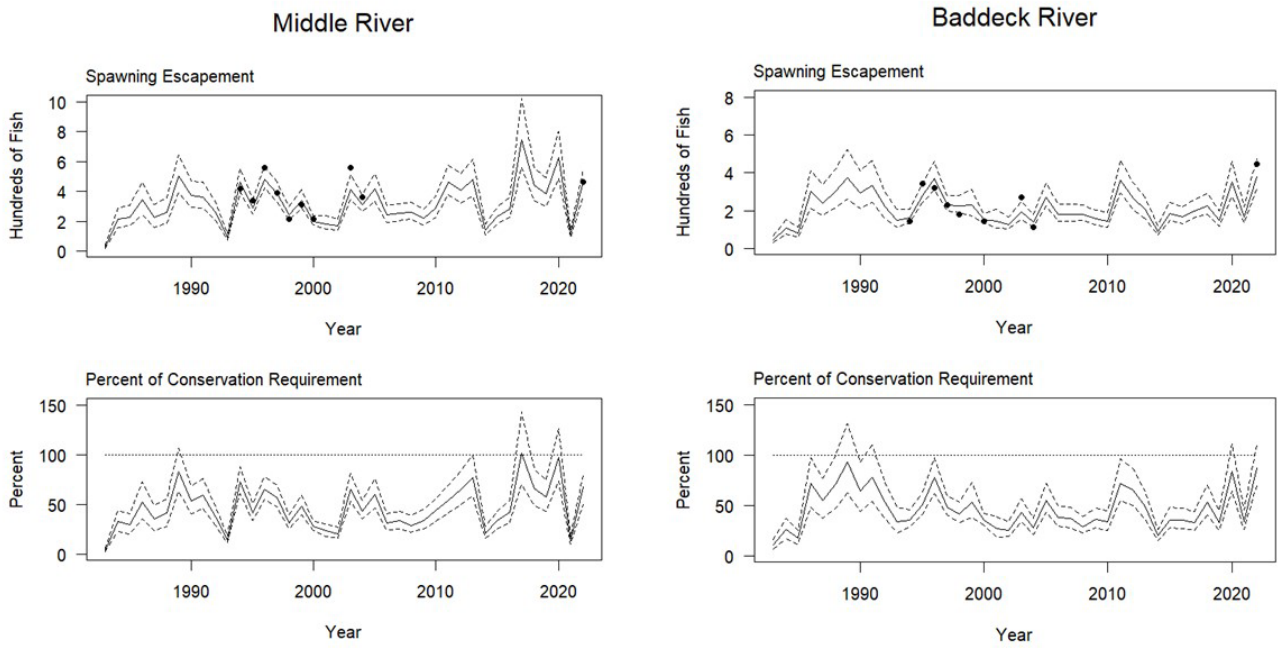

Figure 1. Estimated total number of spawners (top graph) and the percent of the conservation egg requirement attained (bottom graph) for Middle River (left panel) and Baddeck River (right panel), NS, from 1983 to 2022. Model fits derived from two methods are shown. The solid lines show the maximum likelihood estimates of annual abundance. The dashed lines show the Bayesian 90% credible interval for the annual abundance estimates. The points in the top graphs are the population estimates obtained by mark recapture during the dive surveys. The horizontal dashed line in the bottom graphs indicates 100% of the conservation egg requirement for each river.

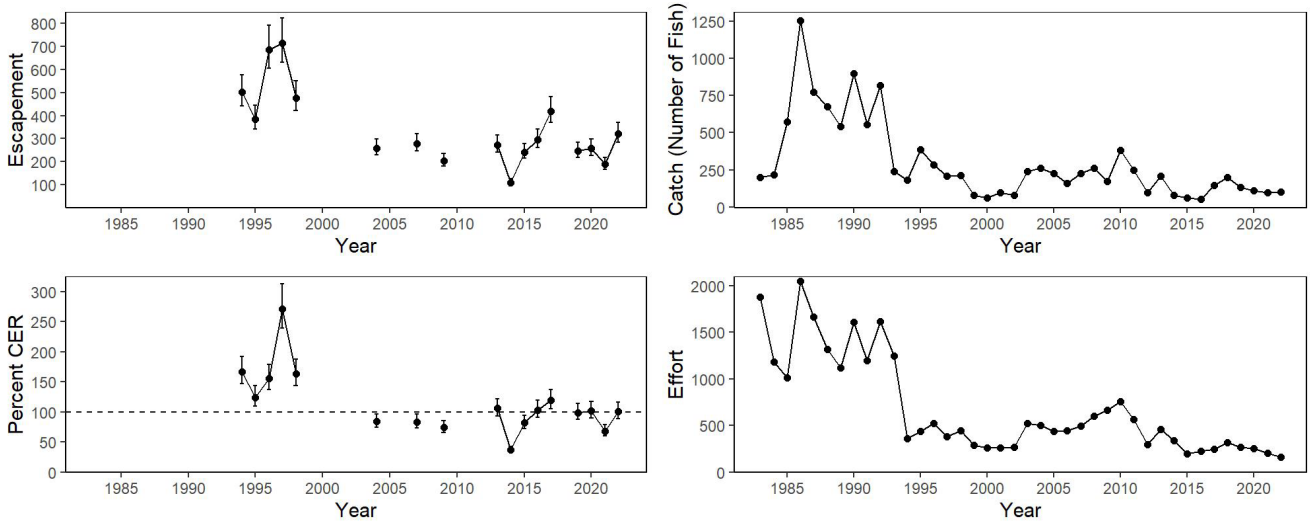

Figure 2. Estimated spawning escapement (top left) and percent of the conservation egg requirement (bottom left) of Atlantic Salmon returning to North River, NS, as derived from dive survey counts and catch (top right) and effort (bottom right) adjusted for non-returned stubs from the license stub return program (see Sources of Uncertainty). The horizontal dashed line in the bottom left indicates 100% of the conservation egg requirement. Error bars represent 95% confidence intervals.

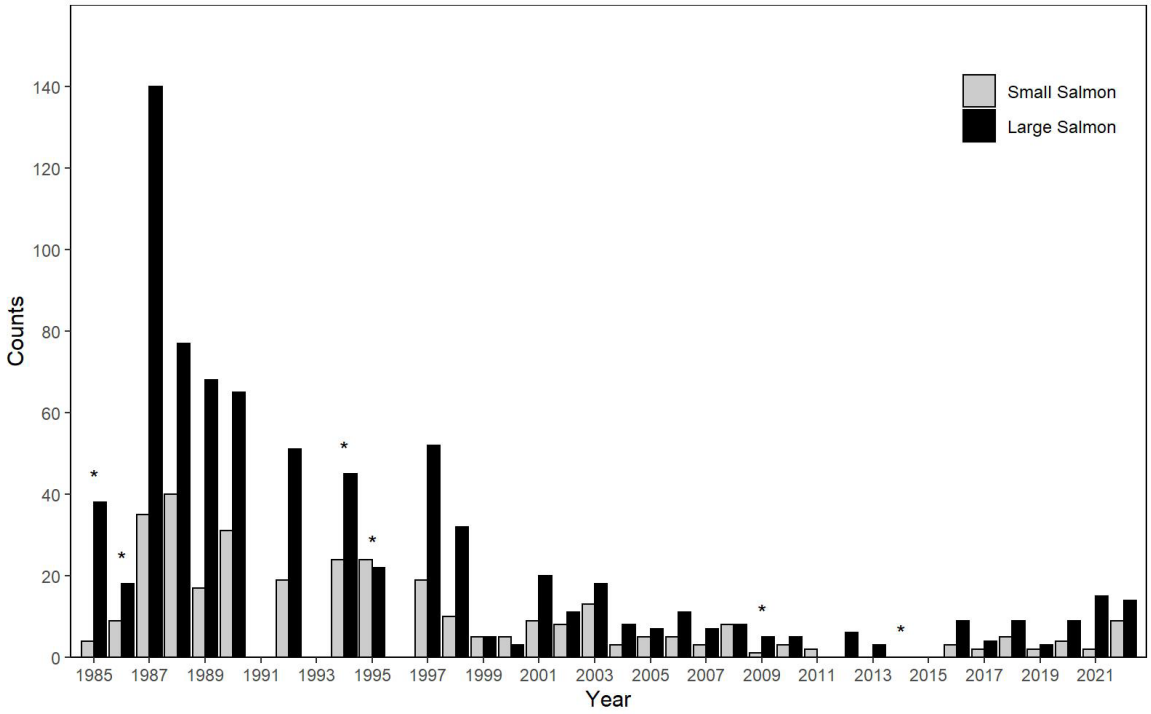

Figure 3. Counts of small and large Atlantic Salmon in Clyburn Brook, NS, from 1985 to 2022. These counts do not include the adult Salmon releases from the Parks Canada Salmon Recovery Project in 2021 and 2022. Years where only the lower section of the river was surveyed (partial counts) are identified with an asterisk (*). No count was conducted in 1991, 1993, 1996, and 2015. Source: Parks Canada.

Southern Upland of Nova Scotia (SFAs 20, 21 and Part of SFA 22)

Atlantic Salmon assessment activities in the SU region are currently focused on two populations: the St. Mary's River, the index population for SFA 20, and the LaHave River, the index population for SFA 21. Beginning in 2010, all rivers within SFA 20 and SFA 21 were closed to recreational fishing for Atlantic Salmon and there were no FSC allocations. Details on the assessment methods for SU Salmon populations are provided in DFO (2013) and Gibson et al. (2009).

Indicators of Stock Status

In 2022, the LaHave River Salmon population above Morgan Falls remained below the conservation egg requirement with an estimated egg deposition of 11% of the requirement (Table 3, Figure 4). Fry and total parr (age one and older) densities (Table 3) on the St. Mary's and LaHave rivers were also low and remain well below Elson's norm values. Smolt-to-adult return rates (a proxy for marine survival) for 1SW Salmon on the LaHave River remained low for the 2021 smolt cohort (Table 4, Figure 5). A summary of the 2022 assessment results is provided in Table 3, time series showing adult returns and estimated egg depositions in the LaHave River above Morgan Falls are provided in Figure 4, and a time series showing smolt-to-adult Salmon return rates is provided in Figure 5. A smolt assessment was not completed on the LaHave River in 2022.

Table 3. Atlantic Salmon assessment information for index rivers in SFAs 20 and 21 during 2022, including angling seasons, conservation egg requirements, fishway counts, percent conservation egg requirement attained, and juvenile assessment results.

	St. Mary's River	LaHave River
Angling Season (2022)	Closed	Closed
Assessment Information	- Juvenile Electrofishing Surveys	- Juvenile Electrofishing Surveys (above and below Morgan Falls) - Fishway Count (above Morgan Falls)
Conservation Egg Requirement (millions of eggs)	9.56	6.22*
Fishway Count:**		
Small Salmon	Not Applicable	59
Large Salmon	Not Applicable	87
% Conservation Egg Requirement:	Not Applicable	**11**
Number of Sites Surveyed and Electrofishing Densities (fish/100 m^2):		
Number of Sites	9	7
Age-0 Parr (Fry)	15.4	4.4
Total Age-1 and Older Parr	9.4	1.4

*The conservation egg requirement reported by O'Connell et al. (1997) has been scaled according to the proportion of habitat area above Morgan Falls (i.e., 51%).
**Corrected for observed fallbacks (i.e., Salmon are marked when they ascend the fishway for the first time, and they are not included in the count if they ascend the fishway again).

Table 4. Estimates of wild-origin Atlantic Salmon smolt abundance, 95% confidence interval, production per unit area of habitat (smolts/100 m^2) and the smolt-to-adult return rates for the LaHave River.

Smolt Year (t)	Wild Smolt Estimate	95% Confidence Interval	Production Per Unit Area (smolts/100 m^2)	Return Rate (%)	
				1SW (t+1)	2SW (t+2)
1996	20,511	19,886–21,086	0.79	1.47	0.23
1997	16,550	16,000–17,100	0.63	4.33	0.43
1998	15,600	14,675–16,600	0.60	2.04	0.34
1999	10,420	9,760–11,060	0.40	4.82	0.86
2000	16,300	15,950–16,700	0.63	1.16	0.11
2001	15,700	15,230–16,070	0.60	2.70	0.59
2002	11,860	11,510–12,210	0.46	1.95	0.45
2003	17,845	8,821–26,870	0.68	1.75	0.17
2004	20,613	19,613–21,513	0.79	1.13	0.33
2005	5,270	4,670–5,920	0.20	7.95	0.54
2006	22,971	20,166–26,271	0.88	1.48	0.40
2007	24,430	23,000–28,460	0.98	2.33	0.16
2008	14,450	13,500–15,500	0.55	1.16	0.30
2009	8,644	7,763–9,659	0.33	3.47	0.88
2010	16,215	15,160–17,270	0.62	1.81	0.19
2011*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2012*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2013	7,159	5,237–10,259	0.27	0.60	0.24
2014	29,175	23,387–37,419	1.12	0.55	0.15
2015	6,664	6,011–7,413	0.26	0.35	0.35
2016	25,849	23,311–28,750	0.99	0.74	0.20
2017*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2018*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2019*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2020*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2021	5,293	3,116–7,470	0.20	1.11	Not Applicable
2022*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

*Smolt assessment not conducted.

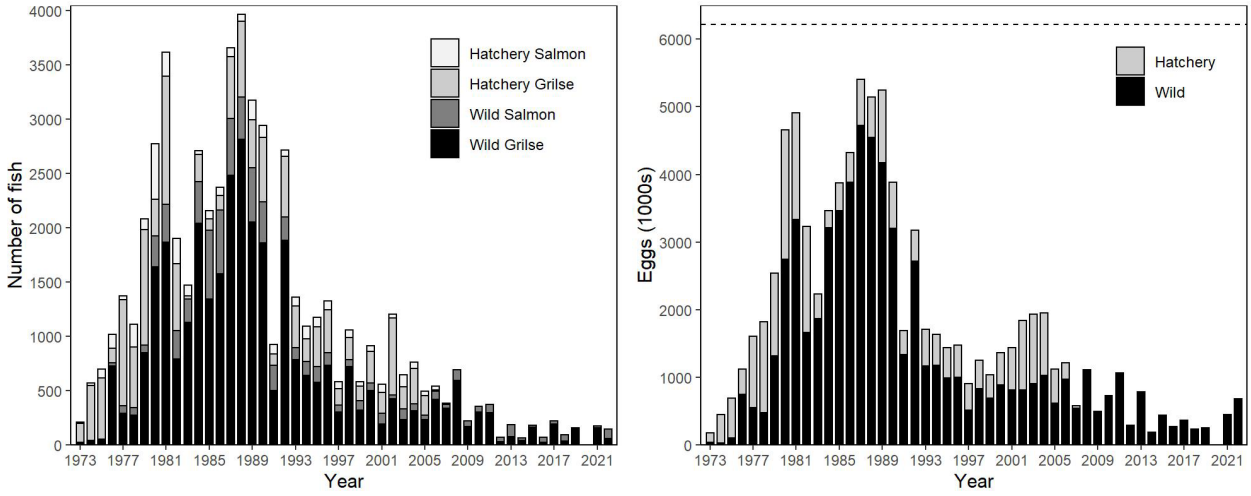

Figure 4. Counts of small and large adult Atlantic Salmon (left panel) and estimated egg deposition (1000s) relative to the conservation egg requirement (right panel) by wild-origin and hatchery-origin Salmon at the Morgan Falls fishway on the LaHave River, NS, from 1973 to 2022. Adult assessment was not possible in 2020 due to COVID-19 restrictions. The horizontal dashed line in the right panel indicates the conservation egg requirement above Morgan Falls. Hatchery-origin smolts were no longer introduced after 2005. Genetic sex determination was used when available (2012–2017) to estimate egg deposition, and visual external sex identification was used in all other years.

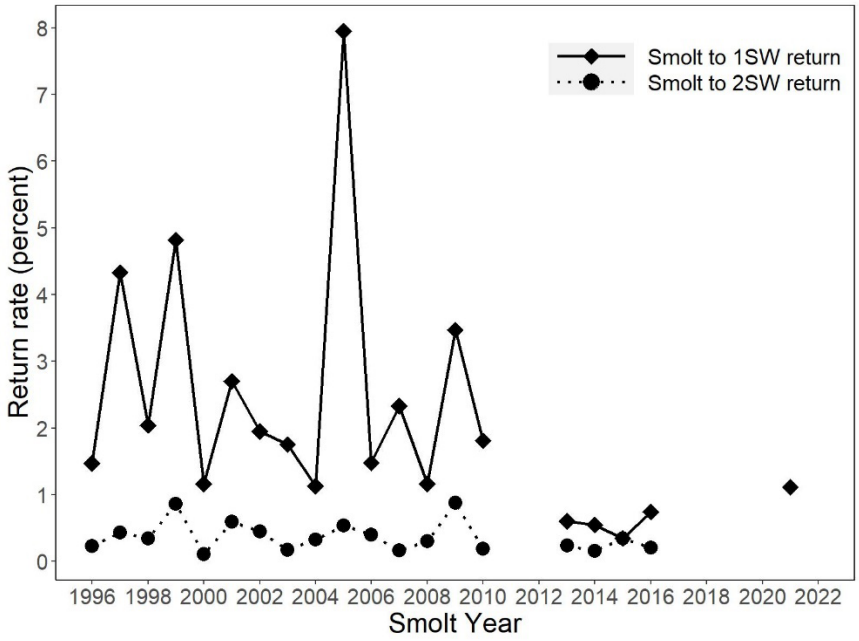

Figure 5. Estimated smolt-to-adult return rates for maiden one-sea-winter (1SW) and two-sea-winter (2SW) Salmon on the LaHave River (above Morgan Falls). Data gaps are the result of periods of non-operational smolt assessment infrastructure (see Table 4).

Outer Bay of Fundy (Outer Portion of Salmon Fishing Area 23)

Salmon assessment activities led by DFO in the OBoF region are currently focused on two river systems: Saint John River (upriver of Mactaquac Dam, which includes the Tobique tributary) and Nashwaak River (tributary of Saint John River downriver of Mactaquac Dam). The Atlantic Salmon Federation (ASF) monitors adult Salmon at the St. George fishway and juvenile Salmon

abundance on the Magaguadavic River. A detailed Recovery Potential Assessment for the OBoF population was published in 2014 with a detailed status update covering the period of 2003–2012 (Jones et al. 2014).

All commercial fisheries for Salmon in SFA 23 have been closed since 1984. Low abundance of Salmon has resulted in no FSC allocations and no recreational fisheries since 1998. In 2022, all rivers within SFA 23 remained closed to Salmon fishing year-round.

The Mactaquac Biodiversity Facility (MBF) was constructed to numerically offset the effects of hydroelectric development on Salmon populations in the Saint John River, primarily by producing smolts from sea-run broodstock captured at fish collection facilities at Mactaquac Dam. Based on an agreement within the 'Saint John River Management Advisory Committee' in 2002, the Salmon supplementation program at the MBF was modified to focus on conserving and restoring a declining resource utilizing captive-reared adults, originally collected from the wild as juveniles, for both broodstock and adult releases to naturally spawn upriver of Mactaquac Dam (Jones et al. 2004). Approximately 90 broodstock matings per year are still carried out at the MBF for the production of smolts to release downriver of Mactaquac Dam and unfed fry to release in the Tobique River. Unfed fry have also been released into the Nackawic River and River de Chute, tributaries of the Saint John River above Mactaquac Dam, since 2018 and 2019 respectively.

Indicators of Stock Status

Returns to the three SFA 23 index rivers in 2022 were all estimated to contribute less than 5% of their conservation egg requirements (CER; Table 5). Egg deposition from spawners in the Saint John River, above the Mactaquac Dam increased to 2% of the CER; however, it remains well below the CER. Assuming the captive-reared adults spawn successfully, spawners released upriver of Mactaquac Dam in 2022 potentially increased the estimated egg depositions to 7% of the requirement on that section of the Saint John River. Below the dam, on the Nashwaak River, estimated egg deposition decreased to 3% of the CER. However, egg deposition estimates ranged from 1%–33% of the CER (see sources of uncertainty; Table 5). In 2022, mean fry and parr (Age 1 and older) densities (Table 5) on the Tobique, Nashwaak, and Magaguadavic rivers were also low at < 3 fish/100 m^2 and remain well below Elson's norm values. On the Nashwaak, an additional 13 non-index sites were sampled for fry and parr and the mean density of fish on the Nashwaak was 5.1/100 m^2 and 2.7/100 m^2, respectively, when those sites were included. Only 3 parr were caught on the Magaguadavic River; they were collected immediately downstream of a fish hatchery on the river. These fish are suspected hatchery escapes since wild returns to Magaguadavic have totaled 1 adult fish in the preceding 2 years. The pre-smolt (Tobique) abundance estimate in 2022 was 0.07 fish/100 m^2 of productive habitat, which is significantly lower than the reference value of 3.8 smolts/100 m^2 (Symons 1979). Smolt estimates from the Nashwaak River were approximately 15,000 smolts, however this estimate has a high level of uncertainty as the 95% confidence interval ranged as high as 211,000 smolts. Smolt-to-adult return rate for 1SW and MSW Salmon were not calculable due to a lack of smolt data in 2021 and 2020, respectively (Table 6). There were 59 aquaculture-origin escapes (determination based on external morphology and scale analysis) captured at the St. George fishway and trap near the head of the tide on the Magaguadavic River in 2022. These 59 Salmon were sacrificed for disease testing. A summary of the 2022 assessment results is provided in Table 5. Time series showing the status of Salmon populations for the Saint John (upriver of Mactaquac Dam) and Nashwaak rivers are provided in Figures 6–9, and a time series showing smolt-to-adult Salmon return rates is provided in Figure 10.

Table 5. Salmon assessment information for index rivers in Salmon Fishing Area 23 during 2022, including angling seasons, conservation egg requirements, fish collection facilities/fishway/fence counts, estimated returns, percentage of conservation egg requirements attained, captive-reared adult and juvenile releases, and juvenile and smolt assessment results.

	Saint John River (Above Mactaquac Dam)	Nashwaak River (Above Durham Bridge)	Magaguadavic River
Angling Season (2022)	Closed	Closed	Closed
Assessment Information	- Fish Collection Facilities Count - Juvenile Electrofishing Surveys - Pre-smolt Assessment	- Counting Fence (Mark Recapture) - Juvenile Electrofishing Surveys (above and below Counting Fence) - Smolt Assessment (Mark Recapture)	- Fishway Count - Juvenile Electrofishing Surveys
Conservation Egg Requirement (millions of eggs)	32.30	12.8*	1.35
Fishway or Fence Count:			
1SW Salmon	163	30	0
MSW Salmon	84	11	0
Aquaculture Escapes	4	0	59
Marks (M) / Recaptures (R) / Captures (C)	Not Applicable	M= 38 / R= 1 / C= 7	Not Applicable
Estimated Returns:			
1SW Salmon	165	114	0
MSW Salmon	87	41	0
% Conservation Egg Requirement (95% CI):			
Without Captive-Reared	**2**	**3 (1–33)**	**0**
Including Captive-Reared	**7**	Not Applicable	Not Applicable
Captive-Reared Adult Releases	453**	Not Applicable	Not Applicable
Juvenile Releases:			
Unfed Fry (Tobique)	24,026 (June)	Not Applicable	Not Applicable
Unfed Fry (River de Chute)	15,027 (June)	Not Applicable	Not Applicable
Unfed Fry (Nackawic)	95,122 (June)	Not Applicable	Not Applicable
Number of Sites Surveyed and Electrofishing Densities (fish/100 m^2):			
Number of Sites	12***	7	1
Age-0 Parr (Fry)	1.08***	2.34	0.0
Total Age-1 and Older Parr	1.38***	0.91	0.024
Wild-Origin Pre-Smolt or Smolt Estimate (2.5 and 97.5 percentiles)	5,552*** (3,841–9,815)	15,400‡ (6,900–211,750) ‡	Not Applicable
Pre-Smolt or Smolt (fish/100 m^2)	0.07***	0.29	Not Applicable

*The conservation egg requirement reported by Marshall et al. (1997) is calculated based on the habitat area above the counting fence (above Durham Bridge) on the Nashwaak River (i.e., 90%).
**324 captive-reared adults were released into the Tobique River, while 129 adults were released into the main Saint John River below Perth-Andover and allowed to free swim throughout the upper part of the system; captive-reared adults were collected as parr from the Odell River, and pre/smolts from the Tobique River, and reared at the Mactaquac Biodiversity Facility.
***Electrofishing and pre-smolt results are for the Tobique River (index tributary and represents 54.4% of the accessible rearing habitat upriver of Mactaquac Dam within Canadian boundaries).
‡The number of smolt recaptures were low in 2022 (140 marked, 221 captured, and 2 recaptured), resulting in greater uncertainty associated with this estimate.

Table 6. Estimates of wild-origin Salmon smolt abundance from upriver of Durham Bridge, 95% confidence interval, production per unit area of habitat (smolts/100 m^2), and the smolt-to-adult return rates for the Nashwaak River, 1998–2022.

Smolt Year (t)	Wild Smolt Estimate	95% Confidence Interval	Production Per Unit Area (smolts/100 m^2)	Return Rate (%)	
				1SW (t+1)	2SW (t+2)
1998	22,750	17,900–32,850	0.43	2.91	0.67
1999	28,500	25,300–33,200	0.54	1.79	0.84
2000	15,800	13,400–19,700	0.30	1.53	0.28
2001	11,000	8,100–17,400	0.21	3.11	0.90
2002	15,000	12,300–19,000	0.28	1.91	1.26
2003	9,000	6,800–13,200	0.17	6.38	1.58
2004	13,600	10,060–20,800	0.26	5.13	1.28
2005	5,200	3,200–12,600	0.10	12.73	1.52
2006	25,400	21,950–30,100	0.48	1.81	0.62
2007	21,550	16,675–30,175	0.41	5.63	1.26
2008	7,300	5,500–11,200	0.14	3.86	2.05
2009	15,900	12,150–22,850	0.30	12.41	3.31
2010	12,500	9,940–16,740	0.24	7.86	0.35
2011	8,750	7,130–11,300	0.17	0.33	0.98
2012	11,060	8,030–17,745	0.21	1.63	0.29
2013	10,120	8,840–11,800	0.19	1.61	0.45
2014	11,100	8,150–17,200	0.21	2.86	0.60
2015	7,900	6,520–9,980	0.15	5.04	1.18
2016	7,150	5,575–9,925	0.13	2.84	0.41
2017*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2018*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2019	8,710	5,690–17,815	0.16	Not Applicable**	0.91
2020**	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2021*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2022‡	15,400	6,900–211,750	0.29	Not Applicable	Not Applicable

* Smolt estimate was attempted but was not successful due to field logistical issues and/or high/low flow events that prevented successful operation of the Rotary Screw Trap.

** Smolt and adult assessment was not possible due to the COVID-19 restrictions in 2020, affecting return rate estimation in 2019, as well as all assessment in 2020.

‡The number of smolt recaptures were low in 2022 (140 marked, 221 captured, and 2 recaptured), resulting in greater uncertainty associated with this estimate.

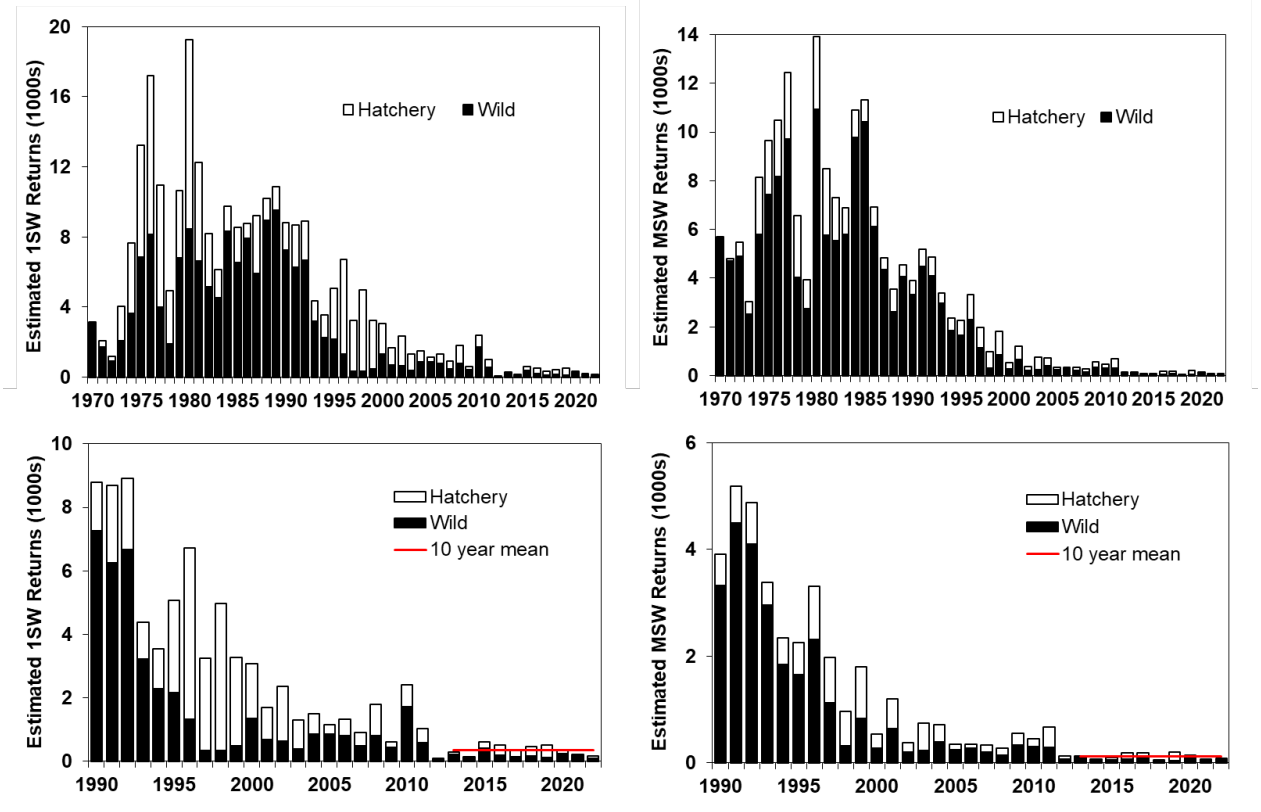

Figure 6. Estimated wild and hatchery-origin one-sea-winter (1SW) and multi-sea-winter (MSW) Salmon returns destined for upriver of Mactaquac Dam, Saint John River, 1970–2022 (upper panels) and 1990–2022 (lower panels).

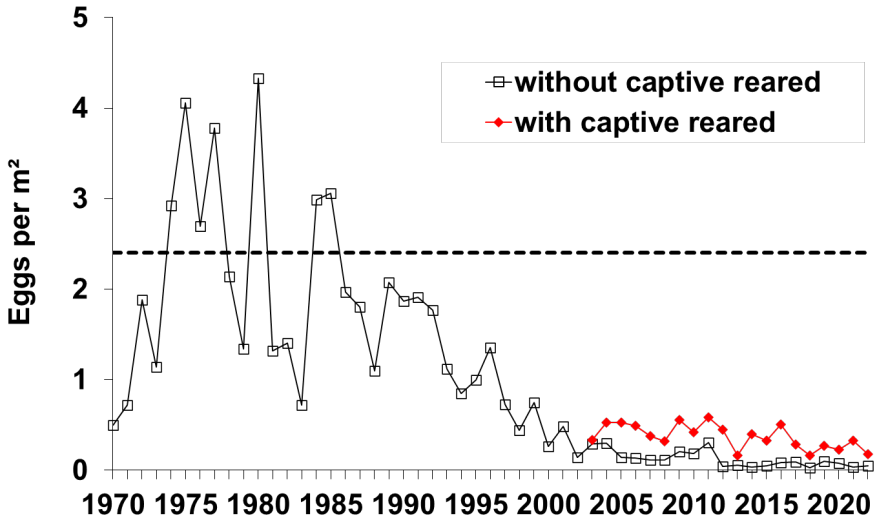

Figure 7. Estimated egg deposition per m² (wild and hatchery combined, and captive-reared) upriver of Mactaquac Dam, Saint John River,1970–2022. The horizontal dashed line is the conservation egg requirement (2.4 eggs per m²).

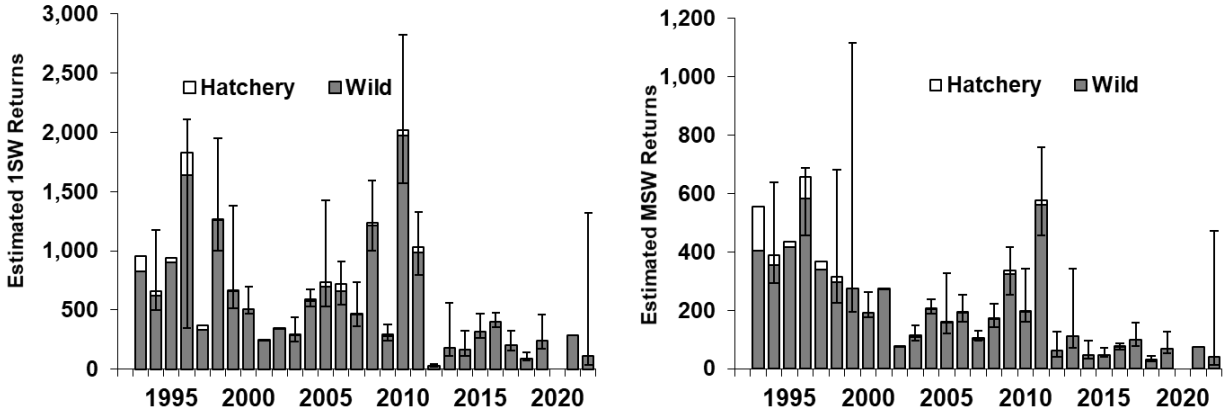

Figure 8. Estimated wild and hatchery-origin one-sea-winter (1SW) and multi-sea-winter (MSW) Salmon returns, and 95% confidence intervals to the Nashwaak River, 1993–2022. No hatchery-origin releases since 2010. Estimates are missing for 2020 due to COVID-19 restrictions that prevented the undertaking of assessment activities in that year.

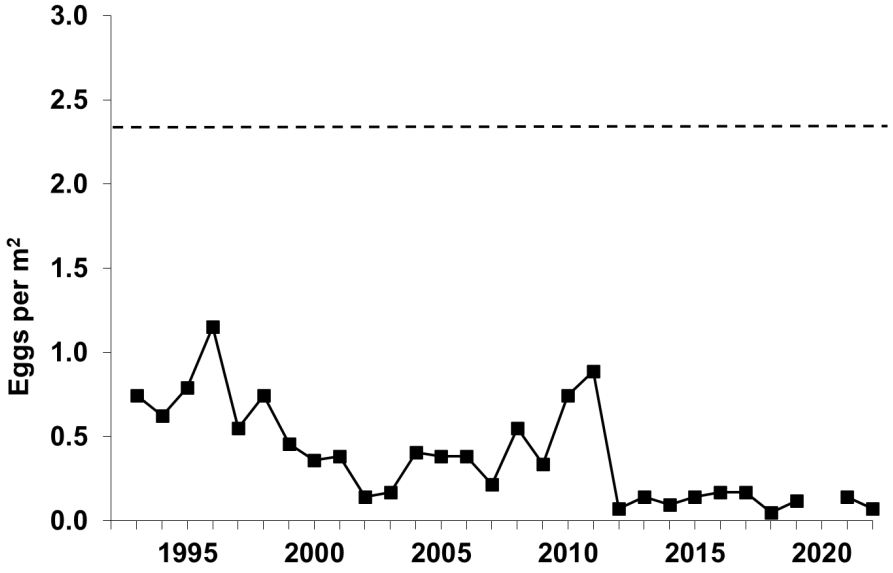

Figure 9. Estimated egg deposition per m^2 upriver of the counting fence operated just below Durham Bridge, Nashwaak River, 1993–2022. The horizontal dashed line is the conservation egg requirement (2.4 eggs per m^2). Data gap in 2020 indicates no assessment activities due to COVID-19 restrictions.

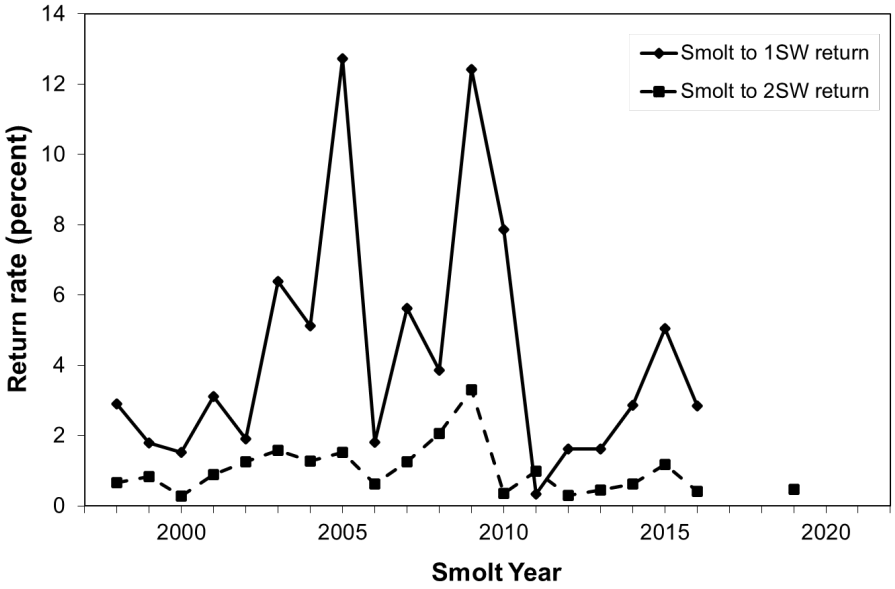

Figure 10. Estimated smolt-to-adult return rates for one-sea-winter (1SW) and maiden two-sea-winter (2SW) Salmon on the Nashwaak River (above Durham Bridge). Data gaps are due to high/low water events during the smolt runs in 2017, 2018, 2021, and COVID-19 restrictions in 2020.

Sources of Uncertainty

There are on-going informal reports of illegal fishing activities (e.g., fishing in closed areas and illegal fishing), but the combined contribution of these activities to the depressed status of populations is not known.

Further details on the uncertainty associated with these assessment methods can be found in DFO (2013).

Eastern Cape Breton

The number of small and large Salmon caught and released, fishing effort, and catch and release mortality within SFA 19 are estimated from licence stub returns from the recreational Salmon fishery. Catch and effort values are adjusted for non-returned stubs using a relationship based on the reported catch as a function of the number of reminder letters sent to licensed anglers. For recreational catch data, under- or over-reporting of numbers of Salmon caught and fishing effort would impact assessment results based on these data. Estimates for 2022 are considered to be preliminary at the time of this status update since licence sale information and licence stubs are still being returned. In recent years, catch and effort estimates prior to sending reminder letters to anglers have generally been systematically higher than catch and effort estimates after reminder letters have been sent. In an attempt to reduce this bias in years where reminder letters were not sent to anglers (i.e., 2004, 2008–2010, and 2018), individual river mean scaling factors (i.e., estimate after reminder letter information divided by reported value prior to reminder letter information) for small Salmon, large Salmon and effort have been applied to reported values to estimate catch and effort.

A pool count of Salmon returns was conducted on North River on August 23, 2022, where 143 large and 62 small Salmon were counted. Water levels were low and the visibility was considered to be good during this count. High summer water temperatures preclude a mark recapture approach to determine observation efficiency; therefore, it has not been used for population assessment purposes.

An exploratory dive count was conducted upstream of the upper-most reach typically counted on Middle River on October 26, 2022. A total of 24 large and 2 small Salmon were observed (no tagged fish counted). These counts were not included in Table 1 or in the modelled escapement estimate to remain consistent with the reaches used for the index count. The exploratory count was conducted to gather information on the number of Salmon outside the index reaches to understand Salmon distribution within the river. This is particularly valuable to determine whether marked Salmon are moving outside of index reaches to inform the interpretation of dive count observation efficiencies. Continuation of the collection of supplementary information on Salmon distribution during fall dive counts of all index rivers would be valuable.

Although some populations in ECB have been closer to their conservation egg requirements than those in the OBoF and SU regions, substantial declines are evident in other ECB populations (e.g., Grand River and Clyburn Brook; (Levy and Gibson 2014)). There is uncertainty in the status of populations in non-index rivers, which has been inferred from recreational catch data and limited electrofishing data (Levy and Gibson 2014).

Southern Upland

LaHave River electrofishing fry and parr densities were low at the majority of survey sites in 2022; in recent years fry and parr densities have been higher on the West Branch LaHave River than elsewhere in the watershed.

The 2021 LaHave River smolt estimate reported in DFO (2023) was updated to incorporate differences in smolt capture efficiency at the Morgan Falls Power smolt bypass facility while generating (May 6–14) and not generating (April 12–6; May 14–28). Smolt abundance was calculated separately for the two generating status using a mark recapture technique and combined for the total run estimate. This methodology has been applied in years with variable generating status in the past (2010) as efficiency is higher while generating.

Outer Bay of Fundy

Adult population estimates (1SW and 2SW) for the Nashwaak River were highly uncertain (Table 5). Range in the Bayesian estimate was two orders of magnitude larger than the mode. This is in part due to the relatively low percentage of adults captured and marked at the Nashwaak counting fence. The fence, where adults are enumerated, was not fishing for 35 days of the adult migration run (29% of the time). High flow events due to precipitation in late summer/fall 2022 caused the disruptions to counting activities. It is possible that many adults passed upstream without being caught and marked during these high-flow periods. In addition, encounter rates with adult Salmon and the recapture rates of marked fish on seine and snorkel surveys upstream of the fence were very low. Surveys occurred late in the migration season, and spawners may have moved into headwaters to spawn before the surveys took place. The late timing was partly because high flow events prevented earlier surveys. The relatively low percentage of marked adults may also have affected the recapture rate.

Although an estimate of the smolt population in the Nashwaak was possible in 2022, low recapture rates due to low RST efficiency create high levels of uncertainty in the estimate (Table 5–6). This is the second smolt estimate calculated since 2017 for the Nashwaak. Aside from disruptions in field work due to COVID-19 in 2020, Nashwaak smolt estimates were not possible in 2017, 2018, and 2021 due wholly or in part to extremes in river discharge. In 2017 and 2018 river discharge was too high to deploy or safely monitor the rotary screw traps (RST) throughout the spring smolt run. In 2021, spring river discharge was very low, reducing the RSTs efficiency. As a result, return rates for 1SW adults have not been calculated and 2SW adult return rates were estimated for 2019 only in that time frame. It is uncertain how future extremes in river discharge due to climate change may affect the ability to estimate smolt

populations on the Nashwaak or other OBoF rivers, although it is possible that extreme discharge events will increase in frequency with climate change.

Egg deposition in 2022, from wild-spawned adults in the Saint John River, above the Mactaquac Dam, was within the lowest 10% of estimates since 1970. Although the number of released, captive-reared adults potentially increased egg deposition, low contribution of wild spawners may lead to low densities of smolts in upcoming years. Uncertainty in sex-identification of returning spawners in the field is also a source of error in egg deposition calculations on all of our rivers. A pilot study comparing field-based sex-identifications using external characteristics to genetic sex-identifications indicated that up to 29% of fish were assigned an incorrect sex in the field. This may have significant implications for egg deposition and for determining whether the CER is being met or exceeded. Further genetic sex data will be needed in order to determine the amount of error in field-based sex identifications occurring for OBoF rivers. With a time-series of genetic sex identifications, it may be possible to correct for field-ID errors for each river. Lastly, outside of the index rivers monitored in this report, Salmon densities and spawning activity are not well known, particularly in rivers downstream of Mactaquac Dam for which electro fishing surveys have not been conducted since 2008. Data on the condition of Salmon populations outside of the index rivers are much needed for fulsome assessment of the population to assist recovery planning.

While the number of captive-reared spawning adults released above the Mactaquac Dam may have increased the egg deposition up to as much as 7% of the conservation egg requirement, it should be noted that this is a maximum estimate. Some studies indicate that captive-reared females exhibit lower lifetime reproductive output than wild Salmon (O'Sullivan et al. 2020) and so egg deposition is likely lower than that.

Conclusions

All Atlantic Salmon index populations within DFO's Maritimes Region were assessed to be below conservation egg requirements in 2022, with the exception of North River in ECB. SU and OBoF Atlantic Salmon populations remain critically low. Wild adult Salmon returns to the LaHave River (SU), the Saint John River upriver of Mactaquac Dam, and the Nashwaak River (OBoF) remain among the lowest returns on record with estimated egg depositions ranging between 2–11% of conservation egg requirements in 2022. Moreover, recent smolt-to-adult return rates (a proxy for marine survival) for 1SW Salmon on the LaHave River were estimated to be very low, at 1.1% for the 2021 smolt year. Similarly, smolt-to-adult return rates on the Nashwaak River were below 1% for 2SW returns in 2019, the most recent year it was assessed. In ECB, two index populations, Middle River and Baddeck River, had estimated egg depositions below conservation egg requirements and one index population, North River, had estimated egg depositions above conservation egg requirements, with values ranging between 68–101% of these requirements in 2022.

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Appendix

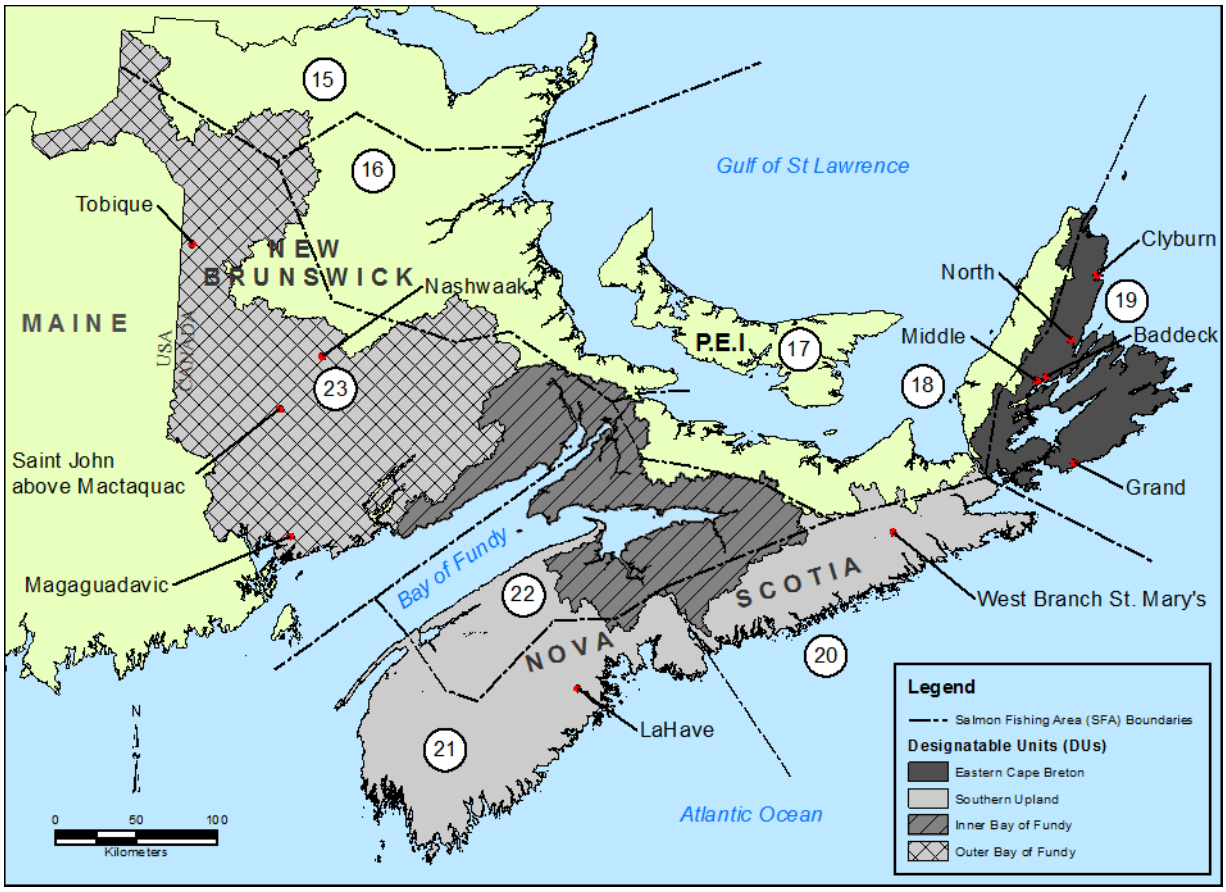

Figure A1. Map showing the locations of Salmon rivers where monitoring predominately occurred, Salmon Fishing Areas (SFAs), and Committee on the Status of Endangered Wildlife in Canada) Designatable Units (DUs) mentioned in this update. SFA numbers are labeled inside the white circles. Data Source for DUs derived from Nova Scotia Secondary Watershed Layer (Nova Scotia Department of Environment) and New Brunswick Watershed Level 1 Layer (New Brunswick Department. of Natural Resources).

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