Atlantic salmon from North America

Summary of the advice for 2019 to 2021

ICES advises that when the Framework of Indicators (FWI) was applied in 2019 there was no indication of underestimated abundance forecasts. Therefore, a full reassessment was not required in 2019 and the 2018 ICES advice remains valid. Consequently, in line with the management objectives agreed by the North Atlantic Salmon Conservation Organization (NASCO) and consistent with the MSY approach, there are no mixed-stock fishery options on 1SW non-maturing and 2SW salmon components from North American stocks in the period 2019 to 2021.

ICES advises that when the MSY approach is applied, fishing should only take place on salmon from rivers where stocks are at full reproductive capacity. Mixed-stock fisheries present particular threats, and should be managed based on the individual status of all stocks exploited in the fishery.

NASCO 3.1 Describe the key events of the 2018 fisheries (including the fishery at Saint Pierre and Miquelon)

The provisional catch of Atlantic salmon in eastern North America in 2018 was estimated at 90.8 tonnes (t), of which 89.5 t was reported from Canada, 1.3 t from France (Islands of Saint Pierre and Miquelon, located off the southern coast of Newfoundland), and 0 t from USA (Tables 1 and 2; Figure 1). There were no commercial or recreational fisheries for Atlantic salmon in USA in 2018. The dramatic decline in harvested tonnage since 1980 is in large part the result of the reductions in commercial fisheries effort, with the closure of the Newfoundland commercial fishery in 1992, the Labrador commercial fishery in 1998, and the Québec commercial fishery in 2000. All commercial fisheries for Atlantic salmon remained closed in Canada in 2018.

Unreported catch for Canada in 2018 was 24.4 t and 0 t for USA. France (Islands of Saint Pierre and Miquelon) did not provide an unreported catch value.

The assessment regions for North America are shown in Figure 2.

Three groups exploited salmon in Canada in 2018: Indigenous people, residents fishing for food in Labrador, and recreational fishers. No rivers in the Gulf and Scotia–Fundy were opened for retention recreational fisheries. Mandatory catch-and-release measures were in effect during the period 2015–2018 in the recreational fisheries for the Gulf region. Fishing regulations in Québec limited the retention of small (< 63 cm, fork length) and large salmon to 14 of 114 rivers, and the retention of small salmon only to 59 rivers. Eight rivers were opened to catch-and-release only, and 33 rivers were closed to salmon fishing. Retention of small salmon was only allowed in rivers which were open for recreational fisheries in Newfoundland and Labrador.

For Canada in 2018, 8% of the harvests were taken in coastal areas, entirely from Labrador. The harvest from France (Islands of Saint Pierre and Miquelon) was entirely from coastal areas. Overall for eastern North America in 2018, 40% of the harvests were in-river, 51% from estuaries, and 9% from coastal areas.

Exploitation rates of both large salmon (≥ 63 cm – MSW and repeat spawners) and small salmon (mostly 1SW) remained relatively stable until 1984 and 1992, then declined sharply with the introduction of restrictive management measures (Figure 3). Declines continued in the 1990s. In the last few years, exploitation rates have remained among the lowest in the time-series.

In the recreational fisheries of Canada, 50 184 salmon (27 708 small and 22 476 large) were estimated to have been caught and released, representing about 73% of the total catch by number.

Table 1 Salmon catches and catch locations in the NAC area in 2018. Catches of NAC-origin salmon at Greenland are reported in the West Greenland Commission area.

	Canada					St Pierre & Miquelon	USA	North America
	Commercial	Indigenous	Labrador resident	Recreational	Total			
2018 reported harvests (t)	0	53	2	35	90	1	0	91
% of NAC total	-	59	2	38	99	1	0	100
Unreported catch (t)	24					na	0	24
Location of catches								
% in-river					41	0	-	40
% in estuaries					51	0	-	51
% coastal					8	100	-	9

Table 2 Total reported nominal harvest (in tonnes, round fresh weight) of salmon in home waters in North America for Canada (small salmon, large salmon, and total), for USA, and for France (Saint Pierre and Miquelon [SPM]), from 1980 to 2018. The 2018 figures include provisional data.

Year	Canada			USA	SPM
	Small salmon	Large salmon	Total		
1980	917	1763	2680	6	-
1981	818	1619	2437	6	-
1982	716	1082	1798	6	-
1983	513	911	1424	1	3
1984	467	645	1112	2	3
1985	593	540	1133	2	3
1986	780	779	1559	2	3
1987	833	951	1784	1	2
1988	677	633	1310	1	2
1989	549	590	1139	2	2
1990	425	486	911	2	2
1991	341	370	711	1	1
1992	199	323	522	1	2
1993	159	214	373	1	3
1994	139	216	355	0	3
1995	107	153	260	0	1
1996	138	154	292	0	2
1997	103	126	229	0	2
1998	87	70	157	0	2
1999	88	64	152	0	2
2000	95	58	153	0	2
2001	86	61	148	0	2
2002	99	49	148	0	2
2003	81	60	141	0	3
2004	94	68	161	0	3
2005	83	56	139	0	3
2006	82	55	137	0	3
2007	63	49	112	0	2
2008	100	57	158	0	4
2009	74	52	126	0	3
2010	100	53	153	0	3
2011	110	69	179	0	4
2012	74	52	126	0	3
2013	72	66	137	0	5
2014	77	41	118	0	4
2015	86	54	140	0	4
2016	79	56	135	0	5
2017	55	55	110	0	3

<table>
<tr><th rowspan="2">Year</th><th colspan="3">Canada</th><th rowspan="2">USA</th><th rowspan="2">SPM</th></tr>
<tr><th>Small salmon</th><th>Large salmon</th><th>Total</th></tr>
<tr><td>2018</td><td>50</td><td>40</td><td>90</td><td>0</td><td>1</td></tr>
</table>

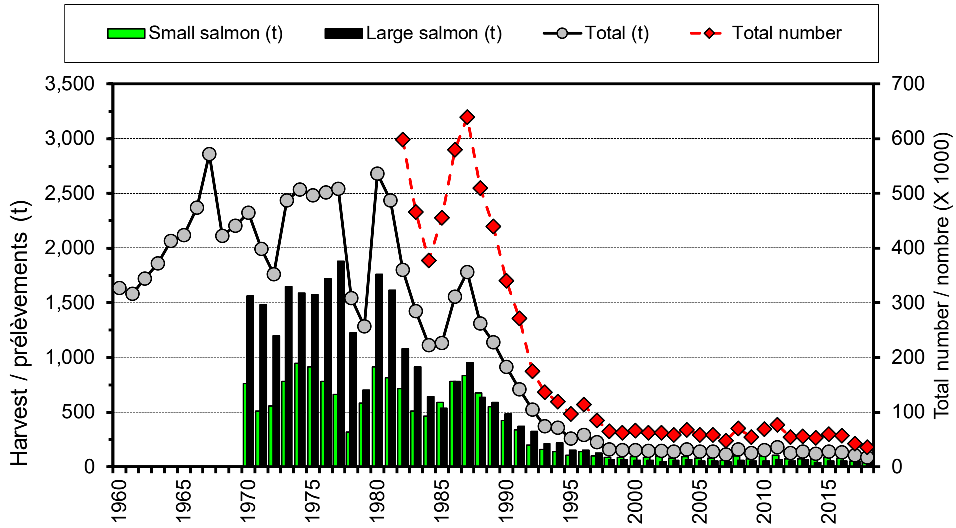

Figure 1 Nominal catch (harvest; t) of small (< 63 cm) and large salmon in Canada (combined harvests in USA and Saint Pierre and Miquelon are ≤ 6 t in any year), from 1960 to 2018.

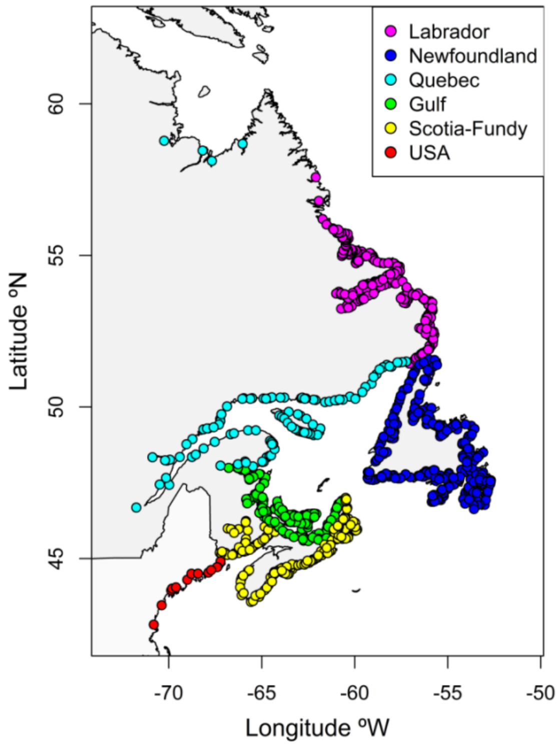

Figure 2 Assessment regions for salmon in the North American Commission. Dots indicate locations of salmon rivers.

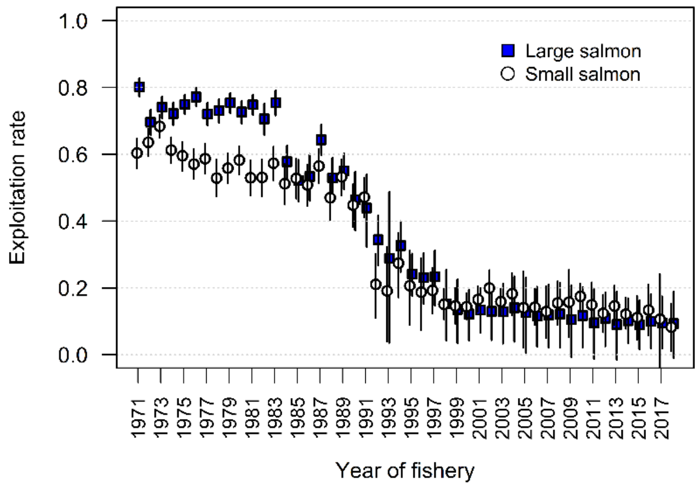

Figure 3 Exploitation rates in North America on small (1SW) and large (MSW and repeat spawners) salmon, from 1971 to 2018.

Origin and composition of catches

In the past, salmon from both Canada and the USA were taken in the commercial fisheries of eastern Canada. Sampling programmes of current marine fisheries (Labrador subsistence and Saint Pierre and Miquelon (SPM)) are used to monitor the stock composition of these mixed-stock fisheries.

The stock composition was previously determined using a North American genetic baseline for Atlantic salmon, which allowed assignment to twelve regional groups in North America based on 15 microsatellite loci (Bradbury *et al.*, 2014; Moore *et al.*, 2014). The origin of salmon in the mixed-stock fisheries has been previously reported for the Labrador subsistence fishery (Bradbury *et al.,* 2015; ICES, 2015) and for the SPM fishery (ICES, 2015; Bradbury *et al.,* 2016). The accuracy of assignment in these analyses was very high (94.5%). A single nucleotide polymorphism (SNP) panel range wide baseline has been developed and was used in 2019 to provide assignment to one of 21 North American or 10 European reporting groups, comprising 189 rivers in all (Jeffery *et al.*, 2018; Figure 4). The accuracy of assignment in the SNP analyses was 90%. The reporting groups from the genetic assignments do not correspond directly to the regions used by ICES to characterize stock status and to provide catch advice. Assessment of stock status and provision of catch advice is not possible at the scale of the genetic groups, because historical catch reporting is available at a jurisdictional scale that is broader than the genetic reporting groups. However, the genetic reporting groups can be aligned to the assessment regions (Figure 4).

Assessment region	Genetic Reporting group	Group acronym
Québec (North)	Ungava	UNG
Labrador	Labrador Central	LAC
	Lake Melville	MEL
	Labrador South	LAS
Québec	St Lawrence North Shore Lower	QLS
	Anticosti	ANT
	Gaspe Peninsula	GAS
	Québec City Region	QUE
Gulf	Gulf of St Lawrence	GUL
Scotia–Fundy	Inner Bay of Fundy	IBF
	Eastern Nova Scotia	ENS
	Western Nova Scotia	WNS
	Saint John River & Aquaculture	SJR
Newfoundland	Northern Newfoundland	NNF
	Western Newfoundland	WNF
	Newfoundland 1	NF1
	Newfoundland 2	NF2
	Fortune Bay	FTB
	Burin Peninsula	BPN
	Avalon Peninsula	AVA
USA	Maine, United States	USA

Assessment region	Genetic Reporting group	Group acronym
Europe	Spain	SPN
	France	FRN
	European Broodstock	EUB
	United Kingdom/Ireland	BRI
	Barents-White Seas	BAR
	Baltic Sea	BAL
	Southern Norway	SNO
	Northern Norway	NNO
	Iceland	ICE
	Greenland	GL

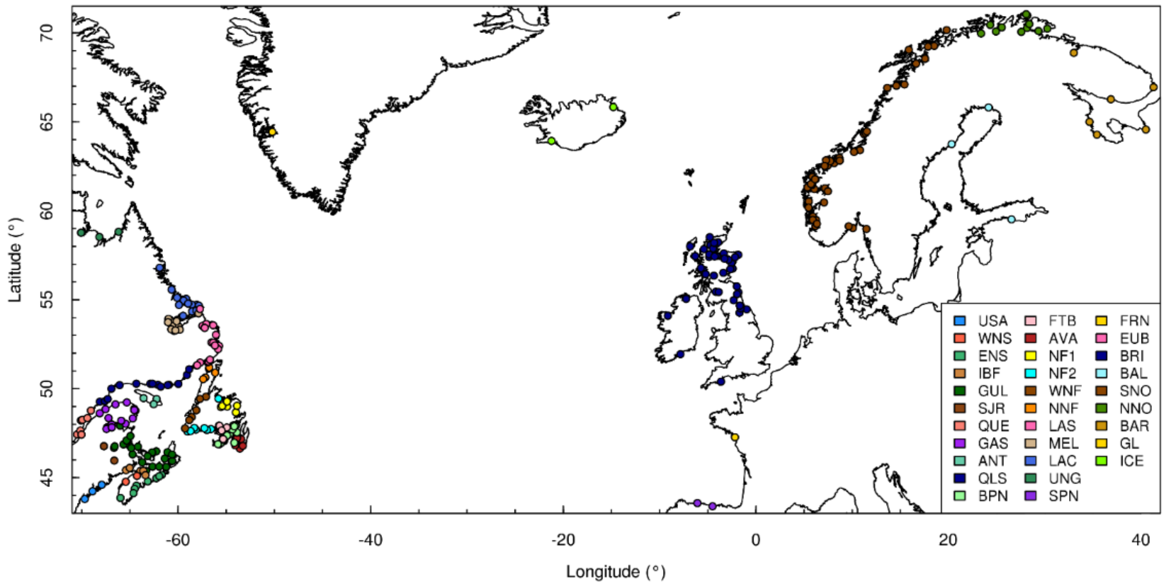

Figure 4 Map of sample locations used in the range-wide genetic baseline (single nucleotide polymorphisms [SNPs]) for Atlantic salmon, which provided 21 North America and 10 European genetic reporting groups (labelled and identified by colour) and correspondence between genetic reporting groups and assessment regions for eastern North America (upper table). The EUB (European Broodstock) reporting group is not represented on the map.

Labrador fishery origin and composition of the catches

In all, 994 samples from the Labrador subsistence salmon fisheries in 2017 (495 samples) and 2018 (499 samples) were analysed using the SNP panel (4% of catch by number in both years). As in previous years, the estimated origin of the samples was dominated (> 98%) by the Labrador genetic reporting groups. Although two samples of USA origin salmon were detected in 2017, none were detected in 2018. The dominance of the Labrador genetic reporting groups is consistent with previous analyses conducted for the period 2006–2016 which assigned > 95% of the harvest to Labrador groups. Assignment of harvest within the three Labrador genetic reporting groups suggest largely local harvest within salmon fishing areas (Figure 5).

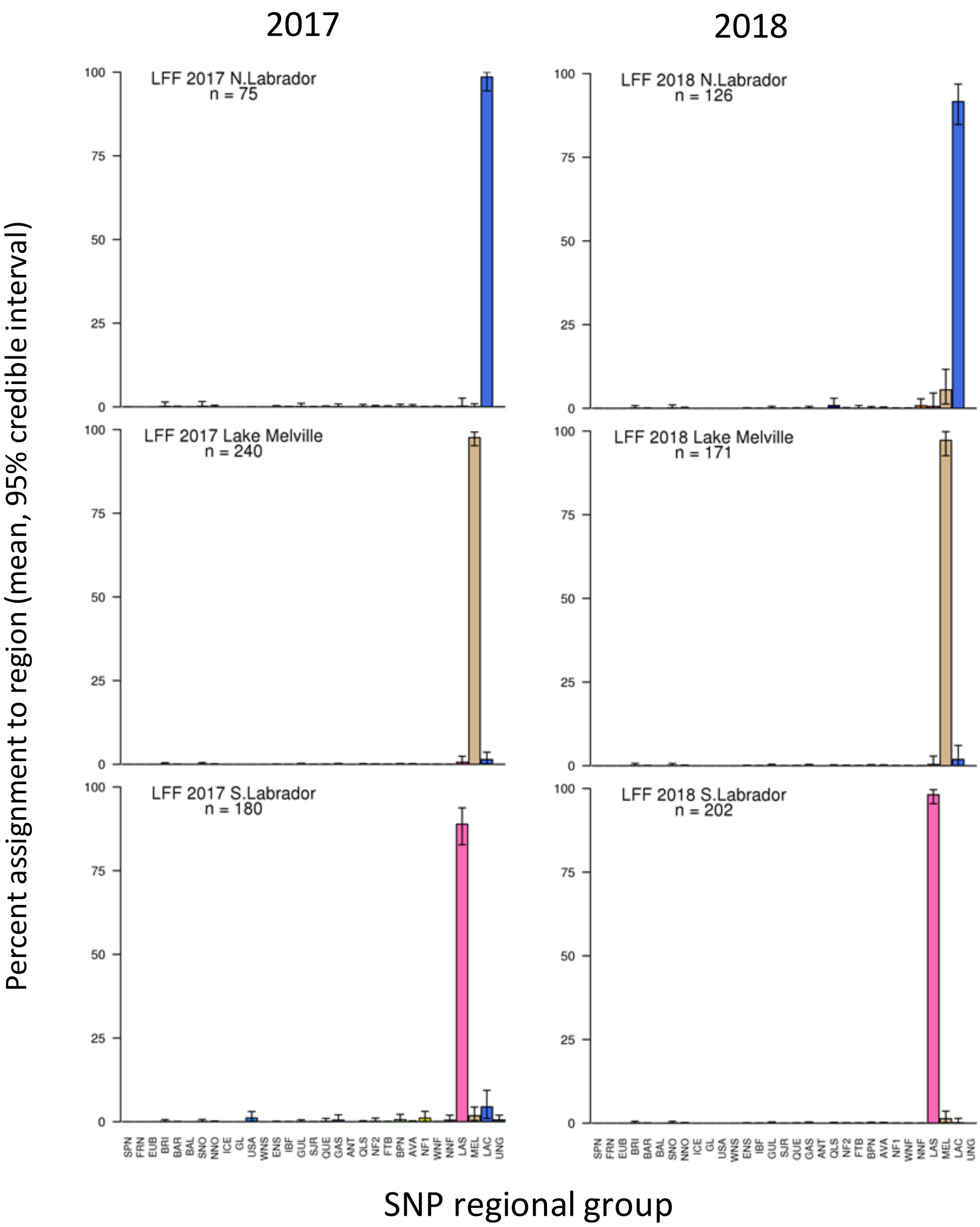

Figure 5 Percentages of Labrador subsistence fishery samples, by Salmon Fishing Area of Labrador, assigned to SNP-derived regional groups of the North Atlantic for the fishery years 2017 and 2018.

Saint Pierre and Miquelon (SPM) fishery origin and composition of the catches

In all, 193 samples (137 in 2017 and 56 in 2018) collected from the Saint Pierre and Miquelon fishery were analysed using the SNP panel range wide baseline (12% and 9% of catch by number). In contrast to previous years when samples of the catch were dominated by large salmon (≥ 63 cm), samples for 2017 and 2018 were dominated by small salmon (< 63 cm). Regional analysis using the SNP panel showed the consistent dominance of three genetic reporting groups, and few differences between the two years (83–89%: from southern Gulf of St Lawrence, Gaspe Peninsula, and Newfoundland), consistent with previous studies (ICES, 2018a; Bradbury *et al.,* 2016) (Figure 6). The largest contribution in both years was from the Newfoundland genetic reporting groups, totalling > 60% in each year.

The Saint Pierre and Miquelon harvest of Atlantic salmon has been dominated by small salmon in recent years (Figure 7). The proportion of the samples assigning to the Newfoundland genetic reporting group was positively associated with the proportion of small salmon in the samples. Samples from the 2017 and 2018 fisheries were dominated by small salmon (< 63 cm). The sampling was not fully representative of the harvest, as 77% of the catch was reported to be small salmon whereas 93% of the samples were from small salmon.

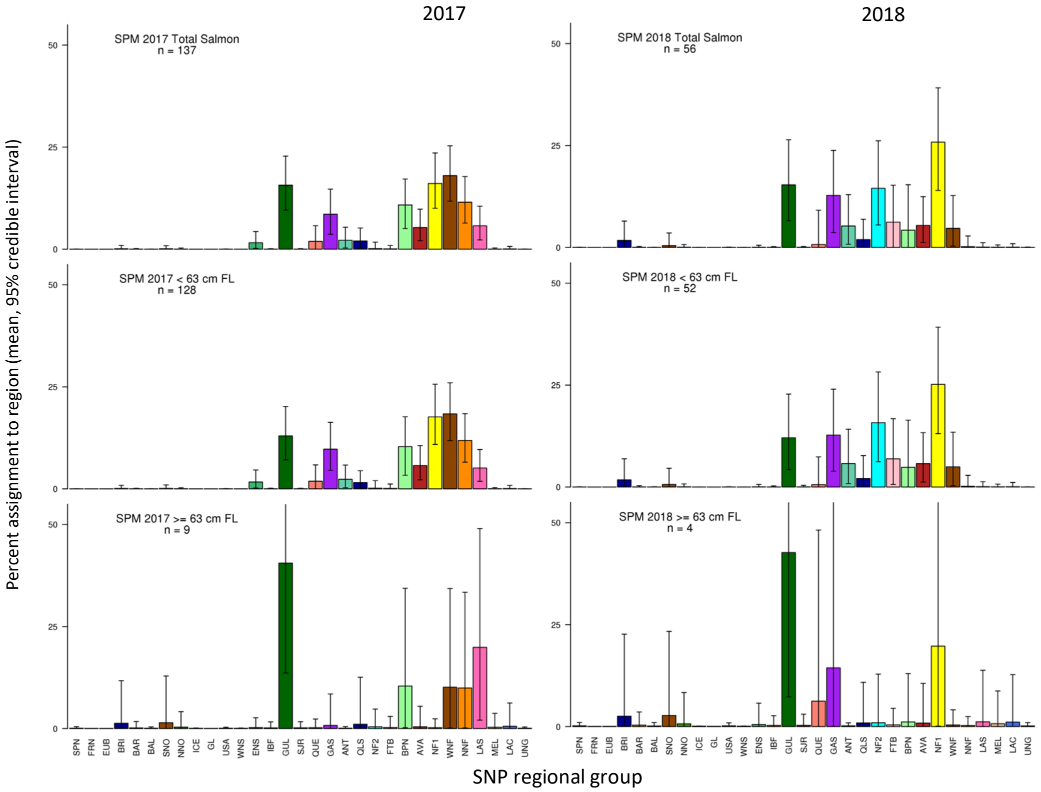

Figure 6 Percentages of the Saint Pierre and Miquelon fishery samples assigned to SNP derived genetic reporting groups of the North Atlantic for the fishery years 2017 and 2018.

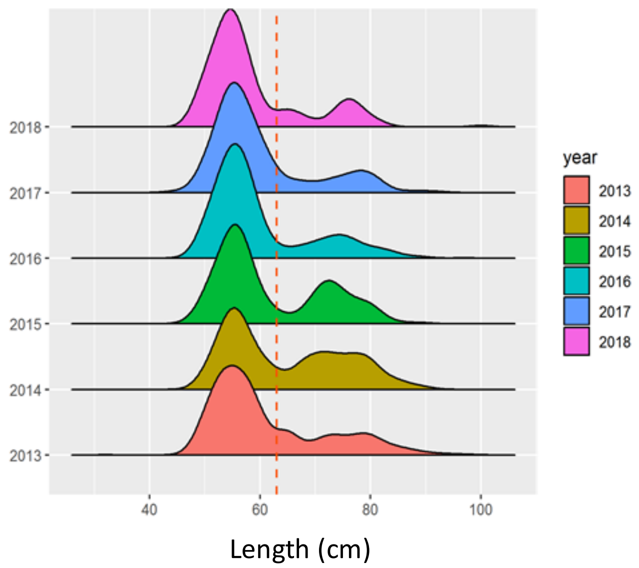

Figure 7 Variations in the size (length in cm) distribution of Atlantic salmon from the Saint Pierre and Miquelon Atlantic salmon fishery over the period 2013 to 2018. The percentage of small salmon in the catches in 2018 was reported to be 77%.

NASCO 3.2 Update age-specific stock conservation limits based on new information as available, including updating the time-series of the number of river stocks with established CLs by jurisdiction

Limit reference points were revised for some areas in North America by Fisheries and Oceans Canada (DFO, 2009, 2012, 2017, 2018) and the Province of Québec (Dionne *et al.*, 2015; MFFP, 2016). As a result of these revisions, the 2SW conservation limit (CL) for Gulf decreased 38% from the previous value whereas Québec's increased slightly (9%). No other changes to the 2SW CLs or the management objectives were made from those identified previously (ICES, 2015).

Rebuilding management objectives have been defined for Scotia–Fundy and USA. For Scotia–Fundy, the management objective is based on an increase of 25% in returns of 2SW salmon from the mean return in the base years 1992 to 1996. For USA, the management objective is to achieve 2SW adult returns of 4549 or greater (Table 3).

Table 3 2SW CLs and management objectives for the regional groups in North America in 2018.

Country and Commission area	Assessment regional group	2SW conservation limit in number of fish (*previous value*)	2SW Management objective (number of fish)
Canada	Labrador	34 746	
	Newfoundland	4 022	
	Québec	32 085 (*29 446*)	
	Southern Gulf of St Lawrence	18 737 (*30 430*)	
	Scotia–Fundy	24 705	10 976
	Total	114 295 (*123 349*)	
USA		29 199	4 549
North American Commission		143 494 (*152 548*)	

In Canada, conservation limits (CLs) were first established in 1991 for 74 rivers. Since then the number of rivers with defined CLs increased to 266 in 1997, and to 498 in 2018 (Figure 8). Conservation limits have been established for 33 river stocks in USA since 1995 (Figure 8).

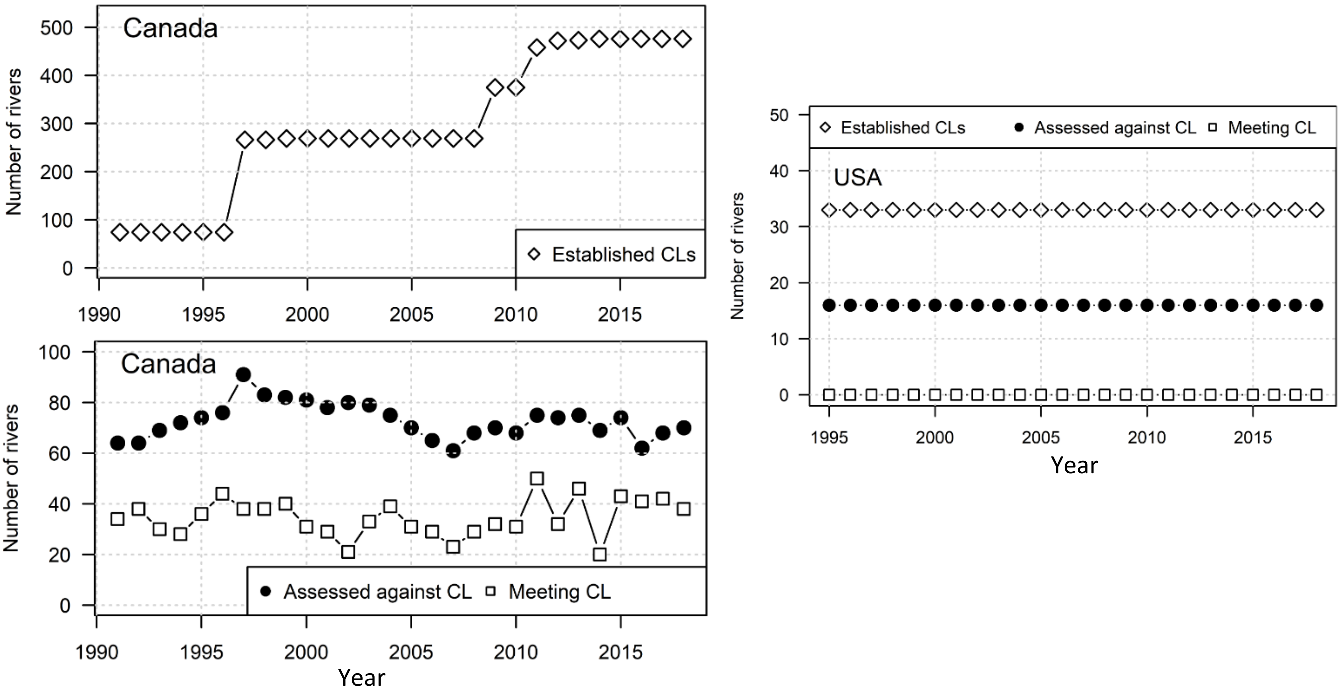

Figure 8 Time-series for Canada and the USA showing the number of rivers with established CLs, the number of rivers assessed, and the number of assessed rivers meeting CLs, for the period 1991 to 2018. Further details can be found in ICES (2019a).

NASCO 3.3 Describe the status of the stocks, including updating the time-series of trends in the number of river stocks meeting CLs by jurisdiction

Stock status is presented for six assessment regions (Figure 2) and overall for North America.

Returns of small (1SW), large (MSW and repeat spawners), and 2SW salmon (a subset of large) to each region are estimated by the methods reported by ICES (1993). The 2SW component of the returns of large salmon was determined using the sea-age composition of one or more indicator stocks. Returns are the number of salmon that returned to the geographic region, including fish caught by home water commercial fisheries, except in the case of the Newfoundland and Labrador regions where returns do not include landings in commercial and subsistence fisheries.

The non-maturing component of 1SW salmon, destined to be 2SW returns (excluding 3SW and repeat spawners) is the estimated number of salmon in the North Atlantic on 1 August of the second summer at sea. The pre-fishery abundance (PFA) estimates account for returns to rivers, fisheries at sea in North America, fisheries at West Greenland, and are corrected for natural mortality. Harvests of North American origin salmon in the fishery at Faroes are not included. As the PFA estimate for potential 2SW salmon requires an estimate of returns to rivers, the most recent year for which an estimate of PFA is available is 2017. Maturing 1SW salmon are in some areas (particularly Newfoundland) a major component of salmon stocks, and their abundance when combined with that of the 2SW age group provides an index of the majority of a cohort.

The total estimate of returns of small salmon to North America in 2018 (581 700) was 29% higher than in 2017 and the third highest of the 48-year time-series (Figure 9). Returns of small salmon in 2018 decreased from the previous year in the four southern assessment regions (Québec, Gulf, Scotia–Fundy, and USA), and increased in the two northern regions of Newfoundland and Labrador. Returns of small salmon to Labrador (285 000) and Newfoundland (252 400) combined represented 92% of the total returns of small salmon to North America (581 700) in 2018.

The total estimate of returns of large salmon to North America in 2018 (131 800) was 24% lower than in 2017. Returns of large salmon in 2018 decreased from the previous year in four of the six assessment regions (Labrador, Newfoundland, Québec, and USA), and increased in Gulf and Scotia–Fundy (Figure 10). Returns of large salmon to Labrador (45 900), Québec (27 800), and Gulf (33 100) combined represented 81% of the total returns of large salmon to North America in 2018.

The total estimate of 2SW salmon returns (subset of returns of large salmon) to North America in 2018 (78 100) was 23% lower than in 2017 (102 000; Figure 11). Returns of 2SW salmon in 2018 decreased from the previous year in four of the six assessment regions (Labrador, Newfoundland, Québec, and USA), but increased in the Gulf. Returns of 2SW salmon in 2018 were among the lowest values in the time-series, with the exception of Labrador. Three assessment regions (Labrador, Québec, and Gulf) collectively accounted for 95% of the returns of 2SW salmon to North America in 2018.

In 2018, the estimates (median) of 2SW salmon returns to rivers and spawners were below CLs (suffering reduced reproductive capacity) for five of the six assessment regions, ranging from 3% in the USA to 127% in the Gulf (Figure 12). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the Scotia–Fundy and USA regions.

River-specific assessments are provided for 86 rivers in 2018. Egg depositions by all sea ages combined in 2018 exceeded or equaled the river-specific CLs in 38 of the 86 assessed rivers (44%) and were at or less than half of CLs in 28 rivers (33%) (Figure 13). The number of rivers assessed annually has ranged from 61 to 91, and the annual percentages of these rivers achieving CL has ranged from 26% to 67% (44% in 2018) with no temporal trend (Figure 8). Sixteen rivers in the USA are assessed against CL attainment annually, with none meeting CLs to date (Figure 8).

Estimates of PFA (defined as the number of maturing and non-maturing 1SW salmon) suggest continued low abundance of North American salmon (Figure 11). The PFA in the Northwest Atlantic has oscillated around a generally declining trend since the 1970s, with a period of persistent low abundance since the early 1990s. During the period 1993 to 2017, the PFA was approximately 610 000 fish, about half of the average abundance during the period 1971 to 1992. PFA of maturing and non-maturing 1SW salmon in 2017 was estimated at 592 700 fish. Abundance declined by 65% over the time-series, from a peak of 1 704 000 fish in 1975 (Figure 14).

Despite major changes in fisheries management two to three decades ago, and increasingly more restrictive fisheries measures since then, returns of salmon have remained near historical lows, with the exception of those in Labrador and Newfoundland. All salmon populations within USA and the Scotia–Fundy regions have been, or are being considered for, listing under country-specific species at risk legislation. The continued low abundance of salmon stocks in USA and in three regions of Canada (Scotia–Fundy, Gulf, and Québec), despite significant fishery reductions, strengthens the conclusions that factors acting on survival in the first and second years at sea at both local and broad ocean scales are constraining abundance of salmon. Declines in smolt production in some rivers of eastern Canada may also be contributing to lower adult abundance.

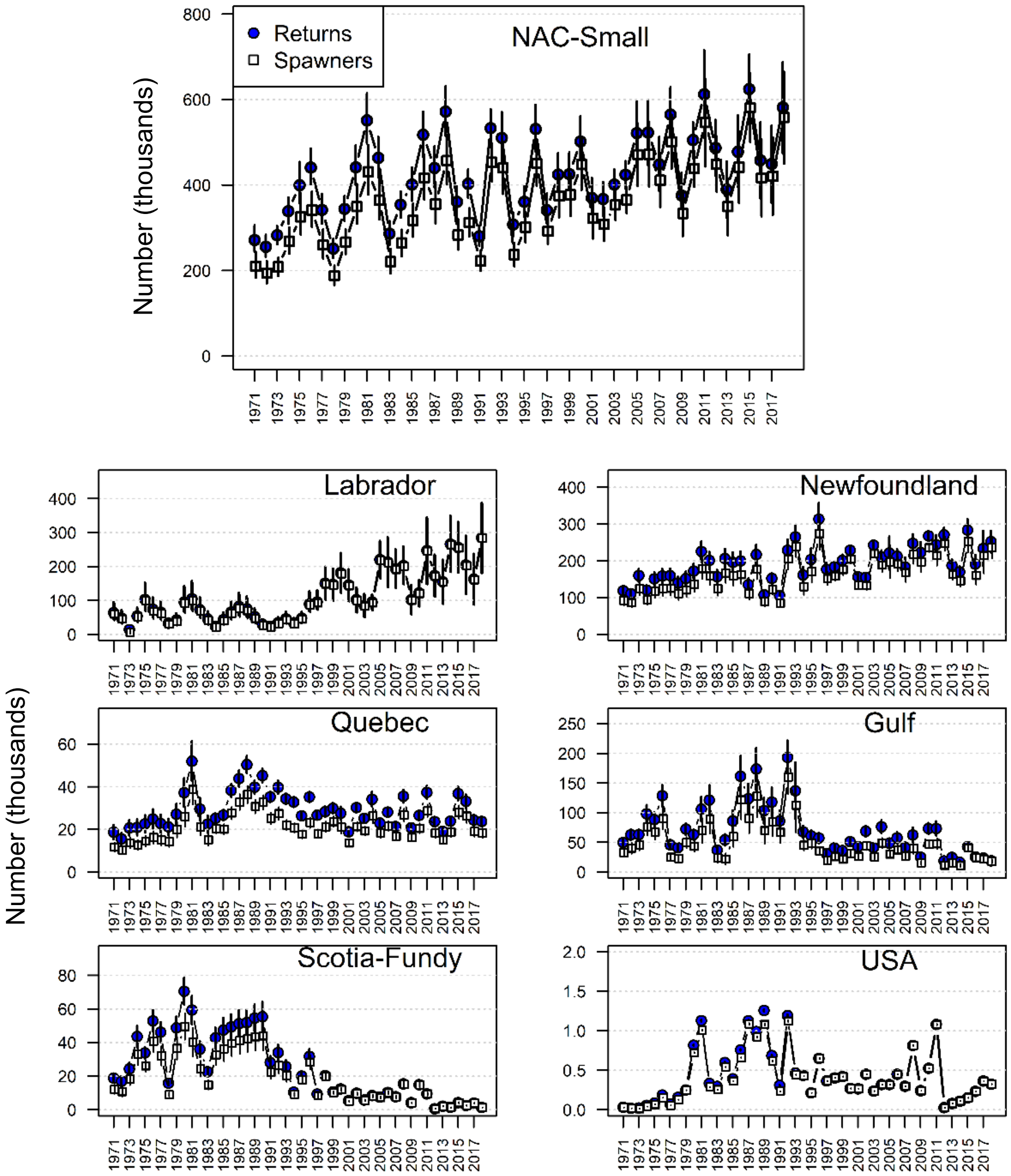

Figure 9 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of small salmon (primarily 1SW) for eastern North America overall and for each of the six regions, 1971 to 2018.

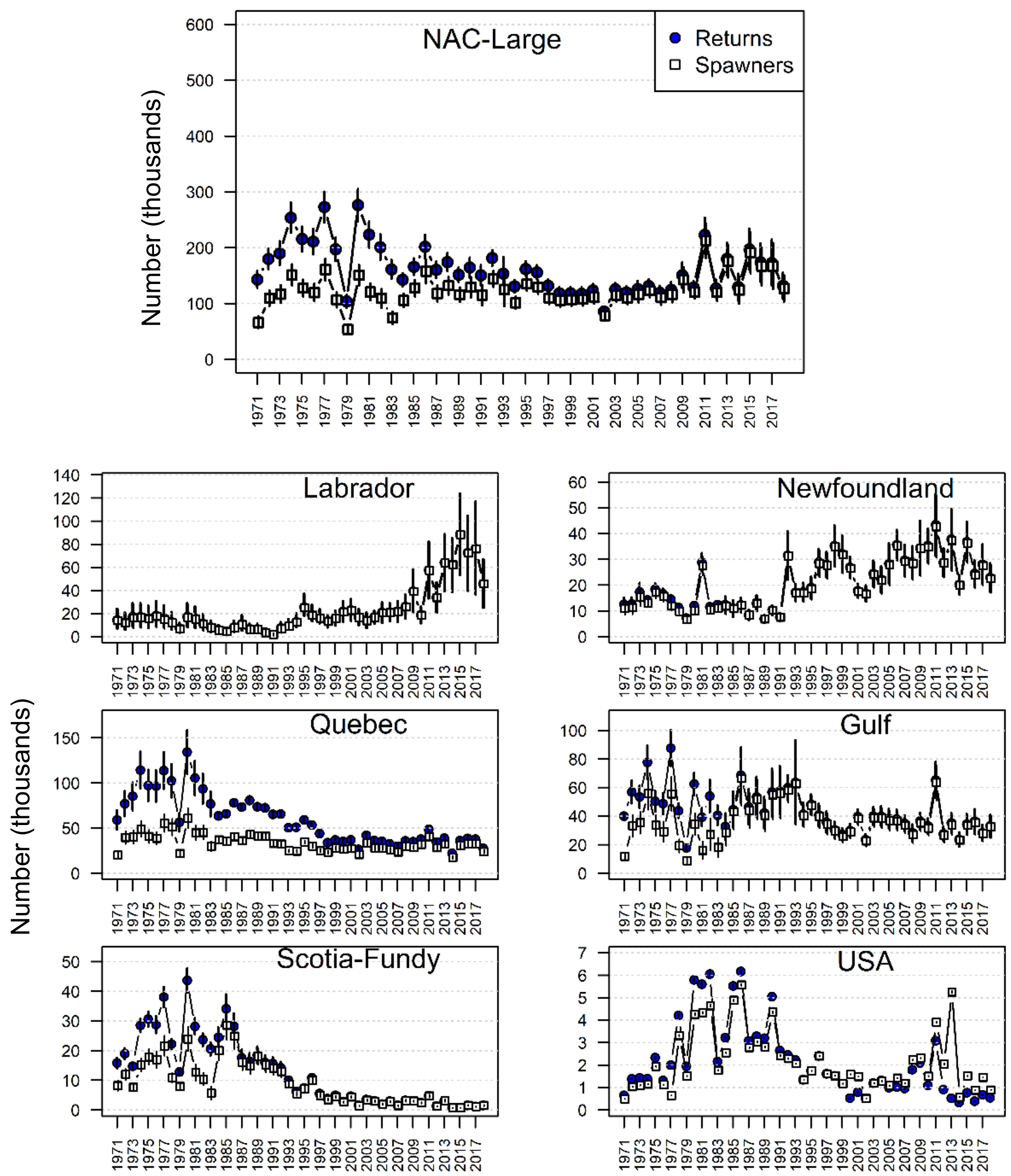

Figure 10 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of large salmon (primarily MSW and repeat spawners) for eastern North America overall and for each of the six regions, 1971 to 2018.

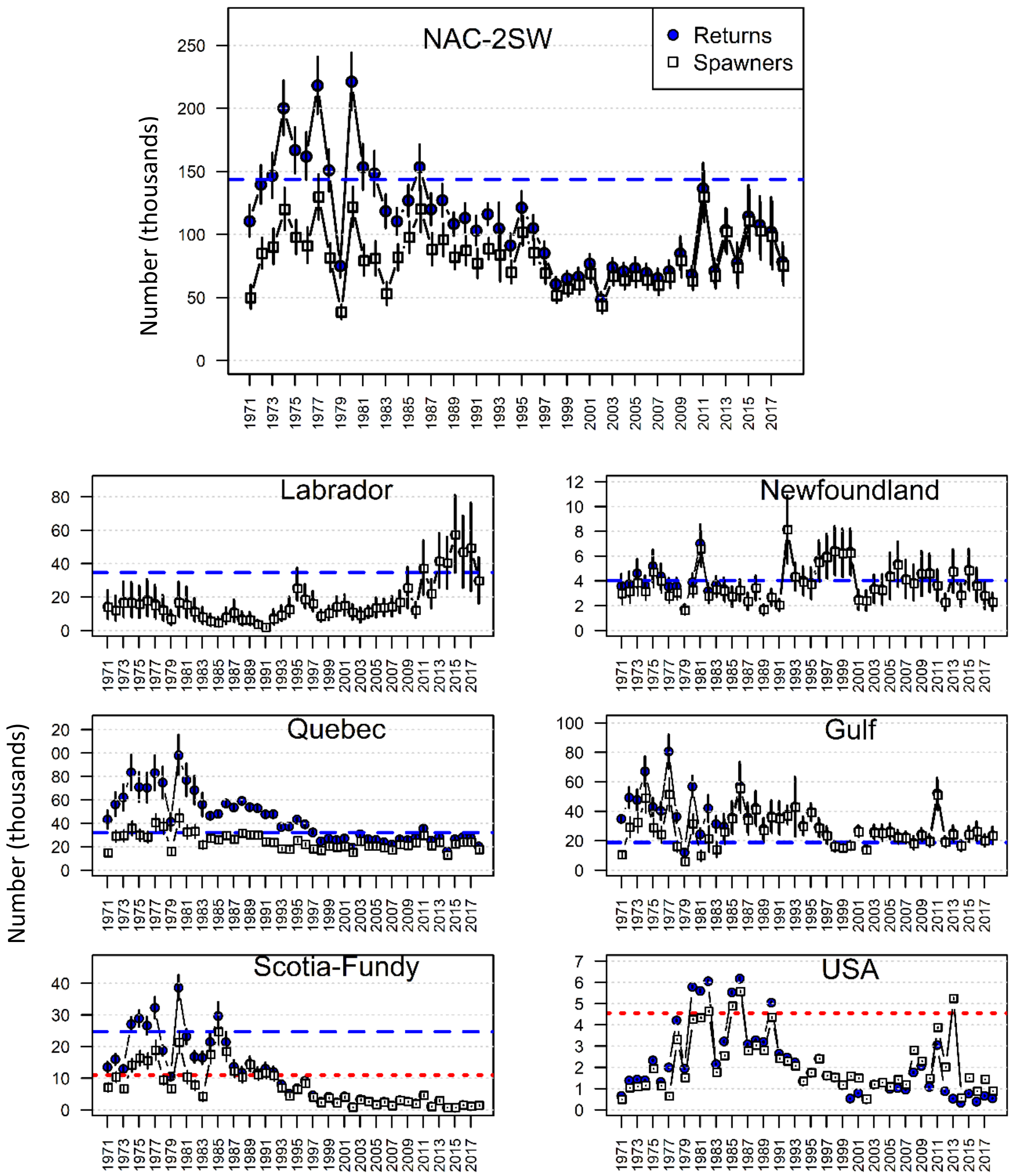

Figure 11 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of 2SW salmon for eastern North America overall and for each of the six regions. The dashed line is the corresponding 2SW CL; the 2SW CL (29 199 fish) is off scale in the plot for USA. The dotted lines in the Scotia–Fundy and USA panels are the region-specific management objectives. For USA, estimated spawners exceed the estimated returns in some years as a result of adult stocking restoration efforts, 1971 to 2018.

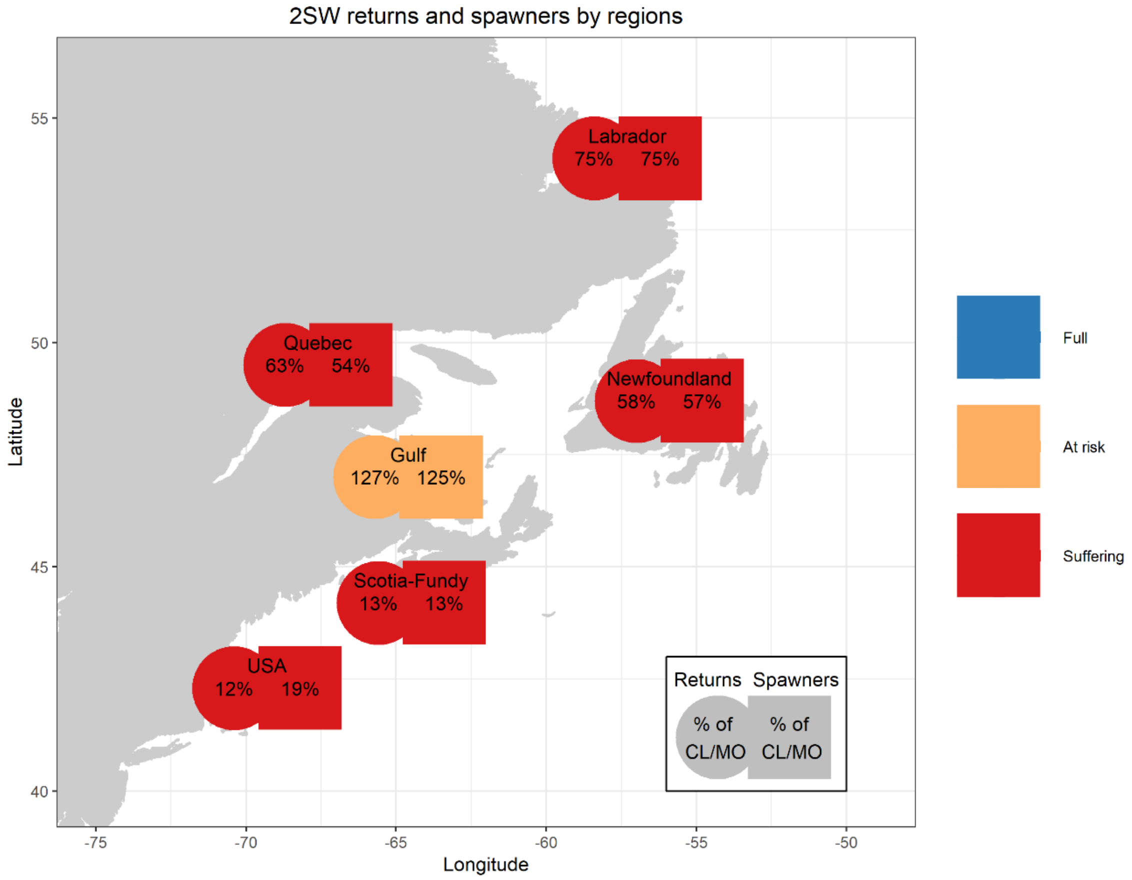

Figure 12 Estimated returns (circle symbol) and spawners (square symbol) of 2SW salmon in 2018 to six regions of North America relative to the stock status categories. The percentage of the 2SW CLs for the four northern regions and to the rebuilding management objectives (MO) for the two southern areas are shown based on the median of the Monte Carlo distribution. The colour shading is interpreted as follows: blue refers to the stock being at full reproductive capacity (median and 5th percentile of the Monte Carlo distributions are above the CL), orange refers to the stock being at risk of suffering reduced reproductive capacity (median is above but the 5th percentile is below the CL), and red refers to the stock suffering reduced reproductive capacity (the median is below the CL).

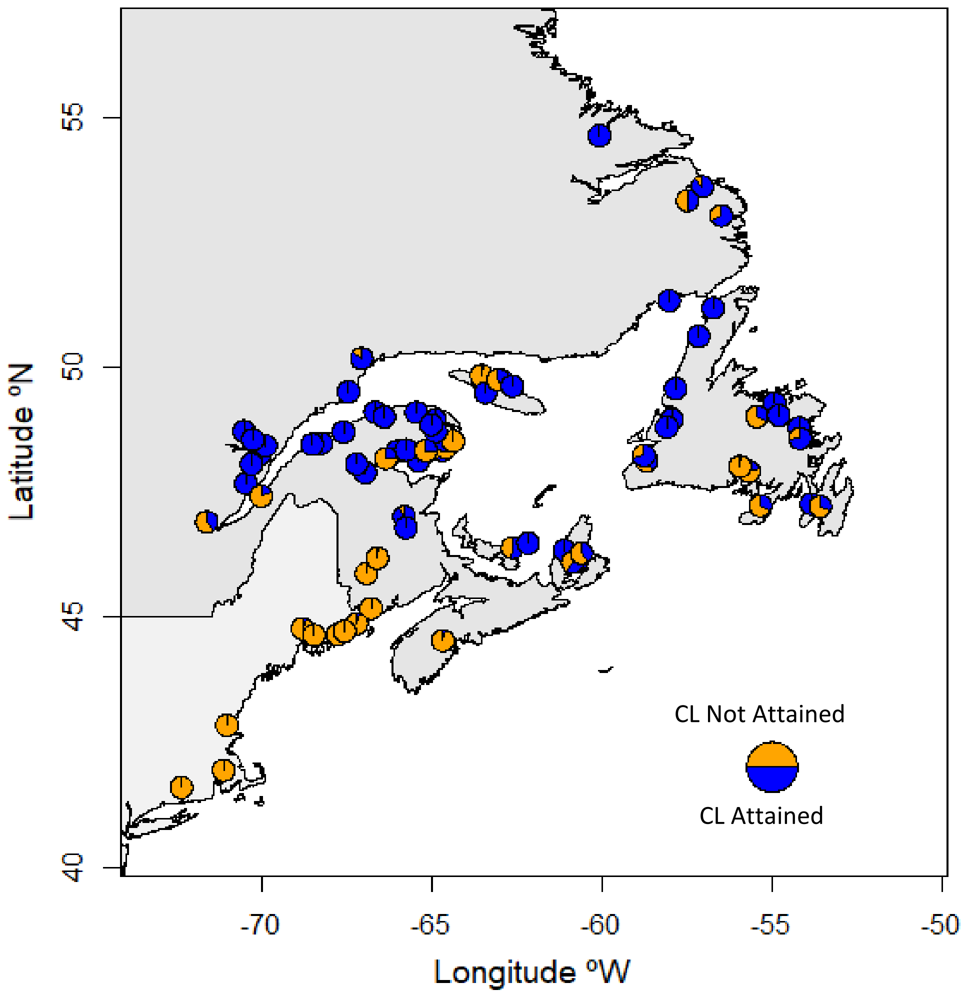

Figure 13 Degree of attainment for the river-specific conservation egg requirement (CL) in the 86 rivers of the North American Commission area assessed in 2018. Eight rivers in the USA are not shown because they were partially assessed but they are considered not to have attained CLs in 2018.

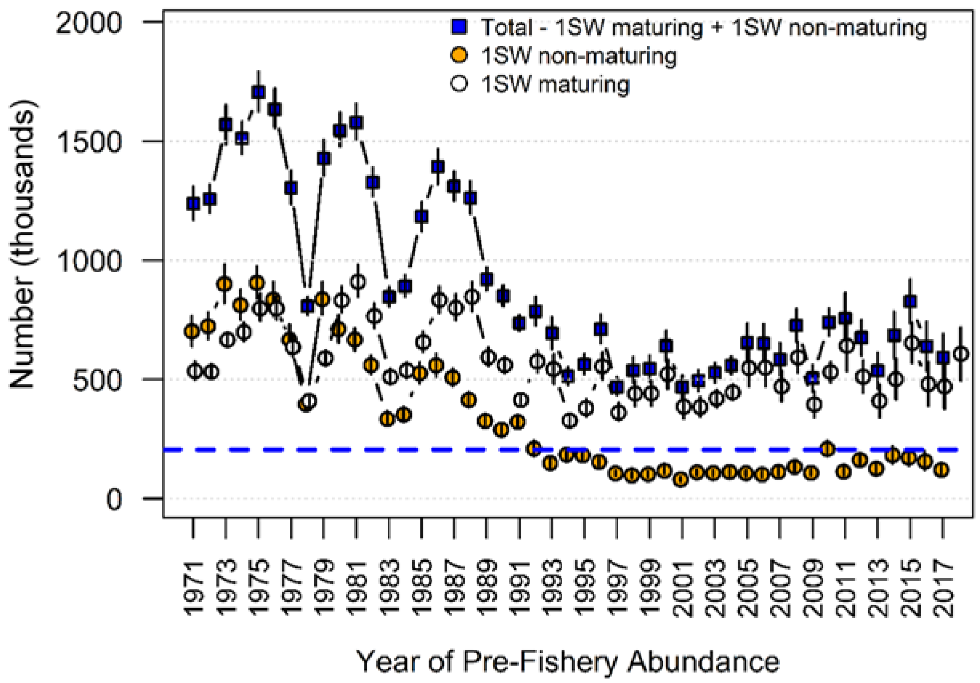

Figure 14 Estimated (median, 5th to 95th percentile range) pre-fishery abundance (PFA) for 1SW maturing, 1SW non-maturing, and total cohort of 1SW salmon for North America. The dashed blue horizontal line is the corresponding sum of the 2SW conservation limits for North America, corrected for 11 months of natural mortality, against which 1SW non-maturing abundance is assessed.

Relevant data deficiencies, monitoring needs, and research requirements

The following data deficiencies, monitoring needs, and research requirements were identified as being relevant to the North American Commission:

1) Complete and timely reporting of catch statistics from all fisheries for all areas of eastern Canada is recommended.
2) Improved catch statistics and sampling of the Labrador and Saint Pierre and Miquelon fisheries is recommended. Improved catch statistics and sampling of all aspects of the fishery across the fishing season will improve the information on biological characteristics and stock origin of salmon harvested in these mixed-stock fisheries.
3) Additional monitoring be considered in Labrador to estimate stock status for that region. Additionally, efforts should be undertaken to evaluate the utility of other available data sources (e.g. Indigenous and recreational catches and effort) to describe stock status in Labrador.

The full list of data deficiencies, monitoring needs, and research requirements for North Atlantic salmon is presented in Section 1.5 of the sal.oth.nasco advice (ICES, 2019b).

References

Bradbury, I. R., Hamilton, L. C., Robertson, M. J., Bourgeois, C. E., Mansour, A., and Dempson, J. B. 2014. Landscape structure and climatic variation determine Atlantic salmon genetic connectivity in the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences, 71: 1–13. https://doi.org/10.1139/cjfas-2013-0240

Bradbury, I. R., Hamilton, L. C., Rafferty, S., Meerburg, D., Poole, R., Dempson, J. B., *et al*. 2015. Genetic evidence of local exploitation of Atlantic salmon in a coastal subsistence fishery in the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences, 72: 83–95. https://doi.org/10.1139/cjfas-2014-0058

Bradbury, I. R., Hamilton, L. C., Chaput, G., Robertson, M. J., Goraguer, H., Walsh, A., *et al*. 2016. Genetic mixed stock analysis of an interceptory Atlantic salmon fishery in the Northwest Atlantic. Fisheries Research, 174: 234–244. https://doi.org/10.1016/j.fishres.2015.10.009

DFO. 2009. A Fishery Decision-Making Framework Incorporating the Precautionary Approach. Available at: http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm [Accessed 30 April 2019].

DFO. 2012. Reference Points Consistent with the Precautionary Approach for a Variety of Stocks in the Maritimes Region. Canadian Science Advisory Secretariat Science Advisory Report, 2012/035. Available at: https://waves-vagues.dfo-mpo.gc.ca/Library/347513.pdf [Accessed 30 April 2019].

DFO. 2017. Stock Assessment of Newfoundland and Labrador Atlantic Salmon – 2016. Canadian Science Advisory Secretariat Science Advisory Report, 2017/035. Available at: https://waves-vagues.dfo-mpo.gc.ca/Library/40619655.pdf [Accessed 30 April 2019].

DFO. 2018. Limit Reference Points for Atlantic Salmon Rivers in DFO Gulf Region. Canadian Science Advisory Secretariat Science Response, 2018/015. Available at: https://waves vagues.dfo-mpo.gc.ca/Library/40689104.pdf [Accessed 30 April 2019].

Dionne, M., Dauphin, G., Chaput, G., and Prévost, E. 2015. Actualisation du modèle stock-recrutement pour la conservation et la gestion des populations de saumon atlantique du Québec, ministère des Forêts, de la Faune et des Parcs du Québec, Direction générale de la gestion de la faune et des habitats, Direction l'expertise sur la faune aquatique. 66 pp.

ICES. 1993. Report of the North Atlantic Salmon Working Group, 5–12 March 1993, Copenhagen, Denmark. ICES CM 1993/Assess:10. 216 pp. https://doi.org/10.17895/ices.pub.5171

ICES. 2015. Report of the Working Group on North Atlantic Salmon (WGNAS), 17–26 March 2015, Moncton, Canada. ICES CM 2015/ACOM:09. 461 pp.

ICES. 2018a. Report of the Working Group on North Atlantic Salmon (WGNAS), 4–13 April 2018, Woods Hole, USA. ICES CM 2018/ACOM:21. 383 pp.

ICES. 2018b. Advice basis. *In* Report of the ICES Advisory Committee, 2018. ICES Advice 2018, Book 1, Section 1.2. https://doi.org/10.17895/ices.pub.4503

ICES. 2019a. Report of the Working Group on North Atlantic Salmon (WGNAS), 25 March–4 April 2019, Bergen, Norway. ICES Scientific Reports, 1:16. 368 pp. http://doi.org/10.17895/ices.pub.4978.

ICES. 2019b. North Atlantic Salmon Stocks. *In* Report of the ICES Advisory Committee, 2019. ICES Advice 2019, Book 14, sal.oth.nasco, https://doi.org/10.17895/ices.advice.5230.

ICES. 2019c. Stock Annex: Atlantic salmon (*Salmo salar*). Created 28 March 2014 by the Working Group on North Atlantic Salmon (WGNAS). Updated: April 2019. 140 pp.

Jeffrey, N. W., Wringe, B. F., McBride, M., Hamilton, L. C., Stanley, R. R. E., Bernatchez, L., Bentzen, P., *et al.* 2018. Range-wide regional assignment of Atlantic salmon (*Salmo salar*) using genome wide single-nucleotide polymorphisms. Fisheries Research, 206: 163–175. https://doi.org/10.1016/j.fishres.2018.05.017

MFFP (Ministère des Forêts, de la Faune et des Parcs). 2016. Plan de gestion du saumon Atlantique 2016–2026, ministère des Forêts, de la Faune et des Parcs, Direction générale de l'expertise sur la faune et ses habitats, Direction de la faune aquatique, Québec, 40 pp. Available at: https://mffp.gouv.qc.ca/faune/peche/pdf/PG_saumon_FR.pdf [Accessed 30 April 2019].

Moore, J-S., Bourret, V., Dionne, M., Bradbury, I., O'Reilly, P., Kent, M., Chaput, G., and Bernatchez, L. 2014. Conservation genomics of anadromous Atlantic salmon across its North American range: outlier loci identify the same patterns of population structure as neutral loci. Molecular Ecology, 23: 5680–5697. https://doi.org/10.1111/mec.12972

Recommended citation: ICES. 2019. Atlantic salmon from North America. *In* Report of the ICES Advisory Committee, 2019. ICES Advice 2019, sal.nac.all, https://doi.org/10.17895/ices.advice.5228

Annex 1 Glossary of acronyms and abbreviations

1SW *(one-sea-winter).* Maiden adult salmon that have spent one winter at sea.
2SW *(two-sea-winter).* Maiden adult salmon that have spent two winters at sea.
3SW *(three-sea-winter).* Maiden adult salmon that have spent three winters at sea.
CL, i.e. S_{lim} *(conservation limit).* Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing stocks and regulating fisheries will be to ensure that there is a high probability that undesirable levels are avoided.
FWI *(Framework of Indicators).* The FWI is a tool used to indicate if any significant change in the status of stocks used to inform the previously provided multi-annual management advice has occurred.
ICES (*International Council for the Exploration of the Sea*).
NAC (*North American Commission*). A commission under NASCO.
NASCO (*North Atlantic Salmon Conservation Organization*).
PFA *(pre-fishery abundance).* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time.
SPM (*the islands of Saint Pierre and Miquelon [France]*).

Annex 2 General considerations

Management plans

The North Atlantic Salmon Conservation Organization (NASCO) has adopted an Action Plan for Application of the Precautionary Approach, which stipulates that management measures should be aimed at maintaining all stocks above their conservation limits through the use of management targets. NASCO has adopted the region-specific CLs as limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability. Within the agreed management plan for the North American Commission, the following has been agreed for the provision of catch advice on 2SW salmon exploited in North America (as non-maturing 1SW and 2SW salmon): a risk level (probability) of 75% for simultaneous attainment of the 2SW CLs for the four northern regions (Labrador, Newfoundland, Québec, Gulf), management objectives defined as achieving a 25% increase in 2SW returns relative to a baseline period (average returns in the period 1992–1996) for the Scotia–Fundy region, and the achievement of 2SW adult returns of 4549 fish or greater. A framework of indicators has been developed to identify any significant change in the multi-annual management advice in the intervening years of the three-year assessment cycle.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northwest Atlantic they range from the Connecticut River (USA, 41.6°N) northward to the Ungava Bay rivers (58.8°N; Québec, Canada). Juveniles emigrate to the ocean at ages of one to eight years (dependent on latitude) and generally return after one or two years at sea. Long-distance migrations to ocean feeding grounds are known to take place, with adult salmon from both the North American and Northeast Atlantic stocks migrating to West Greenland to feed in their second summer and autumn at sea. Recent genetic information has demonstrated that fish from North America were also exploited in the historical Faroes fishery.

Environmental influence on the stock

Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. Across the North Atlantic, a range of problems in the freshwater environment play a significant role in explaining the poor status of stocks. In many cases, river damming and habitat deterioration have had a devastating effect on freshwater environmental conditions. In the marine environment, return rates of adult salmon have declined through the 1980s and are now at the lowest levels in the time-series for some stocks, even after closure of marine fisheries. Climatic factors modifying ecosystem conditions and the impact of predators of salmon at sea are considered to be the main contributory factors to lower productivity, which is expressed almost entirely in terms of lower marine survival.

Effects of the fisheries on the ecosystem

The current salmon fisheries probably have no influence, or only a minor influence, on the marine ecosystem. However, the exploitation rate on salmon may affect the riverine ecosystem through changes in species composition. Knowledge on the magnitude of these effects is limited.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. The reliability of catch statistics could be improved in all North America. Estimates of abundance of adult salmon in some areas, in particular Labrador, are based on a small number of counting facilities raised to a large production area.

Basis of the assessment

ICES stock data category	1 (ICES, 2018b).
Assessment type	Run-reconstruction models and Bayesian forecasts, taking into account uncertainties in the data.
Input data	Nominal catches (by sea-age class) for commercial, indigenous, and recreational fisheries. Estimates of unreported/illegal catches. Estimates of exploitation rates. Natural mortalities (from earlier assessments).
Discards and bycatch	It is illegal to retain salmon that are incidentally captured in fisheries not directed at salmon (no bycatch). In the directed recreational fishery, mortality from catch and release is accounted for in the regional assessments to estimate spawners. There is no accounting of discarding mortality in non-salmon directed fisheries.
Indicators	The Framework of Indicators is used to indicate whether a significant change has occurred in the status of stocks in intermediate years where multiannual management advice applies.
Other information	Advice subject to annual review. A stock annex was developed in 2014 and updated in 2019 (ICES, 2019c).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2019a).