Agenda Item 4.4
For information

Council

CNL(19)08

Report of the ICES Advisory Committee

NORTH ATLANTIC SALMON STOCKS

Introduction

Main tasks

At its 2018 Statutory Meeting, ICES resolved (C. Res. 2018/2/ACOM21) that the Working Group on North Atlantic Salmon (WGNAS, chaired by Martha Robertson, Canada) would meet in Bergen, Norway, 26 March–4 April 2019 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO).

The table below identifies the sections of the report that provide response to the questions posed by NASCO in the terms of reference (ToR). Questions regarding data requirements under the EU Data Collection Framework (DCF) and the EU Multi-Annual Programme (EU-DCMAP) in the terms of reference are addressed in section EU-DCF/DCMAP of this advice, and in detail in Annex 10 of ICES (2019a).

ToR	Question	Section
1	With respect to Atlantic salmon in the North Atlantic area:	sal.oth.nasco
1.1	provide an overview of salmon catches and landings by country, including unreported catches and catch and release, and production of farmed and ranched Atlantic salmon in 2018[1].	
1.2	report on significant new or emerging threats to, or opportunities for, salmon conservation and management[2];	
1.3	provide a compilation of tag releases by country in 2018; and	
1.4	identify relevant data deficiencies, monitoring needs and research requirements.	
2	With respect to Atlantic salmon in the Northeast Atlantic Commission area:	sal.neac.all
2.1	describe the key events of the 2018 fisheries[3];	
2.2	review and report on the development of age-specific stock conservation limits, including updating the time-series of the number of river stocks with established CLs by jurisdiction;	
2.3	describe the status of the stocks, including updating the time-series of trends in the number of river stocks meeting CLs by jurisdiction;	
3	With respect to Atlantic salmon in the North American Commission area:	sal.nac.all
3.1	describe the key events of the 2018 fisheries (including the fishery at St Pierre and Miquelon)[3]	
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;	
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;	
4	With respect to Atlantic salmon in the West Greenland Commission area:	sal.wgc.all
4.1	describe the key events of the 2018 fisheries[3];	
4.2	describe the status of the stocks[4];	

[1] With regard to question 1.1, for the estimates of unreported catch the information provided should, where possible, indicate the location of the unreported catch in the following categories: in-river; estuarine; and coastal. Numbers of salmon caught and released in recreational fisheries should be provided

[2] With regard to question 1.2, ICES is requested to include reports on any significant advances in understanding of the biology of Atlantic salmon that is pertinent to NASCO, including iriformation on any new research into the migration and distribution of salmon at sea and the potential implications of climate change for salmon management.

[3] In the responses to questions 2.1, 3.1 and 4.1, ICES is asked to provide details of catch, gear, effort, composition and origin of the catch and rates of exploitation. For homewater fisheries, the information provided should indicate the location of the catch in the following categories: in-river; estuarine; and coastal. Information on any other sources of fishing mortality for salmon is also requested (For 4.1, if any new phone surveys are conducted, ICES should review the results and advise on the appropriateness for incorporating resulting estimates of unreported catch into the assessment process).

[4] In response to questions 2.4, 3.4 and 4.3, provide a detailed explanation and critical examination of any changes to the models used to provide catch advice and report on any developments in relation to incorporating environmental variables in these models.

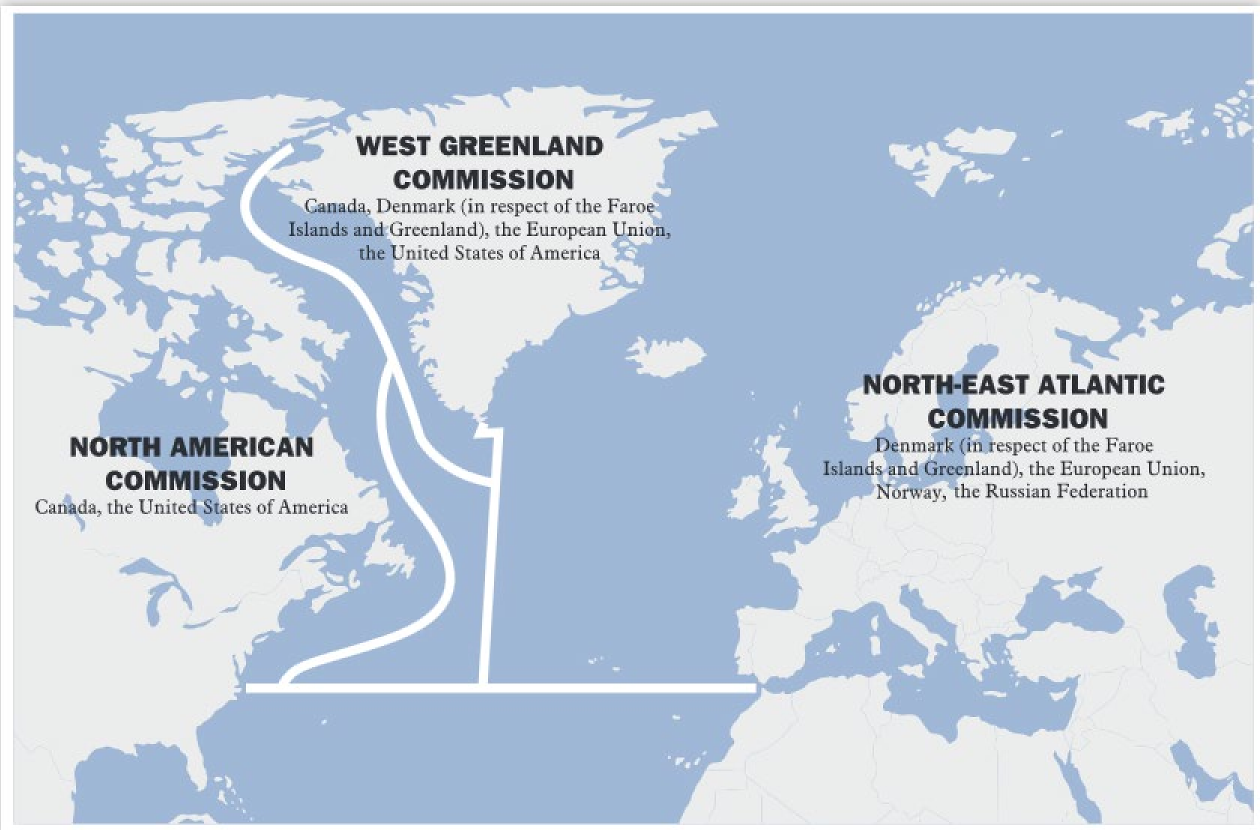
In response to the terms of reference, the WGNAS considered 35 working documents. A complete list of acronyms and abbreviations used in this report is provided in Annex 1. References cited are given in Annex 2.

Please note that for practical reasons Tables 5–8 are found at the end, immediately before the annexes.

Management framework for salmon in the North Atlantic

This advice has been generated by ICES in response to the terms of reference posed by the North Atlantic Salmon Conservation Organization (NASCO), pursuant to its role in international management of salmon. NASCO was set up in 1984 by international convention (the Convention for the Conservation of Salmon in the North Atlantic Ocean), with a responsibility for the conservation, restoration, enhancement, and rational management of wild salmon in the North Atlantic. Although sovereign states retain their role in the regulation of salmon fisheries for salmon originating in their own rivers, distant-water salmon fisheries, such as those at Greenland and Faroes, which take salmon originating in rivers of another Party, are regulated by NASCO under the terms of the Convention. NASCO now has six Parties that are signatories to the Convention, including the EU which represents its Member States.

NASCO's three commission areas, the North American Commission (NAC), the West Greenland Commission (WGC), and the North East Atlantic Commission (NEAC), are shown in the map below. The islands of St Pierre and Miquelon, located off the southern coast of Newfoundland, are not part of the NAC, but France (in respect of St Pierre and Miquelon) participates as an observer to NASCO. The mid-Atlantic area is not covered by any of the three NASCO commissions; however, under Article 4 of the NASCO Convention, NASCO provides a forum for consultation and cooperation on matters concerning the salmon stocks in this area.



Management objectives

NASCO's objective is:

"..to contribute through consultation and co-operation to the conservation, restoration, enhancement and rational management of salmon stocks… taking into account the best scientific evidence available…".

NASCO further stated that "the Agreement on the Adoption of a Precautionary Approach states that an objective for the management of salmon fisheries is to provide the diversity and abundance of salmon stocks", and NASCO's Standing Committee on the Precautionary Approach interpreted this as being "to maintain both the productive capacity and diversity of salmon stocks" (NASCO, 1998).

NASCO's Action Plan for Application of the Precautionary Approach (NASCO, 1998) provides an interpretation of how this is to be achieved:

> "Management measures should be aimed at maintaining all stocks above their conservation limits by the use of management targets".
> "Socio-economic factors could be taken into account in applying the precautionary approach to fisheries management issues".
> "The precautionary approach is an integrated approach that requires, *inter alia*, that stock rebuilding programmes (including as appropriate, habitat improvements, stock enhancement, and fishery management actions) be developed for stocks that are below conservation limits".

Reference points and application of precaution

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because the adult spawning stock consists of only few age groups. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, the ICES maximum sustainable yield (MSY) approach is aimed at achieving a target escapement (MSY $B_{escapement}$, the minimum amount of biomass left to spawn). No catch should be allowed unless this escapement can be achieved. The escapement level should be set so there is a low risk of future recruitment being impaired.

For salmon, this approach has led to defining river-specific conservation limits (CLs) as equivalent to MSY $B_{escapement}$. ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to differences in status of individual stocks within stock complexes, mixed-stock fisheries present particular threats.

In many counties/jurisdictions CLs are now defined using stock and recruitment relationships and the corresponding CLs are not updated annually. In the other jurisdictions where such relationships are not available, stock–recruitment proxies are used to define the CLs and these may vary from year to year as new data are added. NASCO has adopted the CLs as limit reference points (NASCO, 1998). CLs are used in reference to spawners. When referring to abundance prior to fisheries in the ocean (pre-fishery abundance, PFA) the CLs are adjusted to account for natural mortality, and the adjusted value is referred to as the spawner escapement reserve (SER).

Management targets have not yet been defined for all North Atlantic salmon stocks. Where there are no specific management objectives, the MSY approach shall apply:

- ICES considers that if the lower bound of the 90% confidence interval of the current estimate of spawners is above the CL, then the stock is at full reproductive capacity (equivalent to a probability of at least 95% of meeting the CL).
- When the lower bound of the confidence interval is below the CL, but the midpoint is above, then ICES considers the stock to be at risk of suffering reduced reproductive capacity.
- Finally, when the midpoint is below the CL, ICES considers the stock to suffer reduced reproductive capacity.

For catch advice on the mixed-stock fishery at West Greenland (catching non-maturing one-sea-winter (1SW) fish from North America and non-maturing 1SW fish from southern NEAC [NEAC–S]), NASCO has adopted a risk level (probability) of 75% of simultaneous attainment of management objectives in seven assessment regions (ICES, 2003) as part of an agreed management plan. NASCO uses the same approach for catch advice for the mixed-stock fishery, affecting six assessment regions for the North American stock complex. ICES notes that the choice of a 75% risk (probability) for simultaneous attainment of six or seven stock assessment regions is approximately equivalent to a 95% probability of attainment for each individual unit (ICES, 2013).

There is no formally agreed management plan for the fishery at the Faroes. However, ICES has developed a risk-based framework for providing catch advice for fish exploited in this fishery (mainly multi-sea-winter (MSW) fish from NEAC countries). Catch advice is provided at both the stock complex and country level, with catch options tables providing the probability of meeting CLs in the individual stock complexes or countries, as well as in all the stock complexes or countries simultaneously. ICES has recommended (ICES, 2013) that management decisions should be based principally on a 95% probability of attainment of CLs in each stock complex/country individually. The simultaneous attainment probability may also be used as a guide, but managers should be aware that this probability will generally be quite low when large numbers of management units are used.

NASCO 1.1 Catches of North Atlantic salmon

Nominal catches of salmon

In this document, catches are equivalent to harvest, with the exception of the recreational fishery where catch-and-release is referred to. For clarity, detailed Tables 5–8 are provided at the end of the report.

Reported total nominal catches of salmon in four North Atlantic regions from 1960 to 2018 are shown in Figure 1. Nominal catches reported by country are given in Table 5. Catch statistics in the North Atlantic include fish farm escapees, and in some Northeast Atlantic countries also ranched fish.

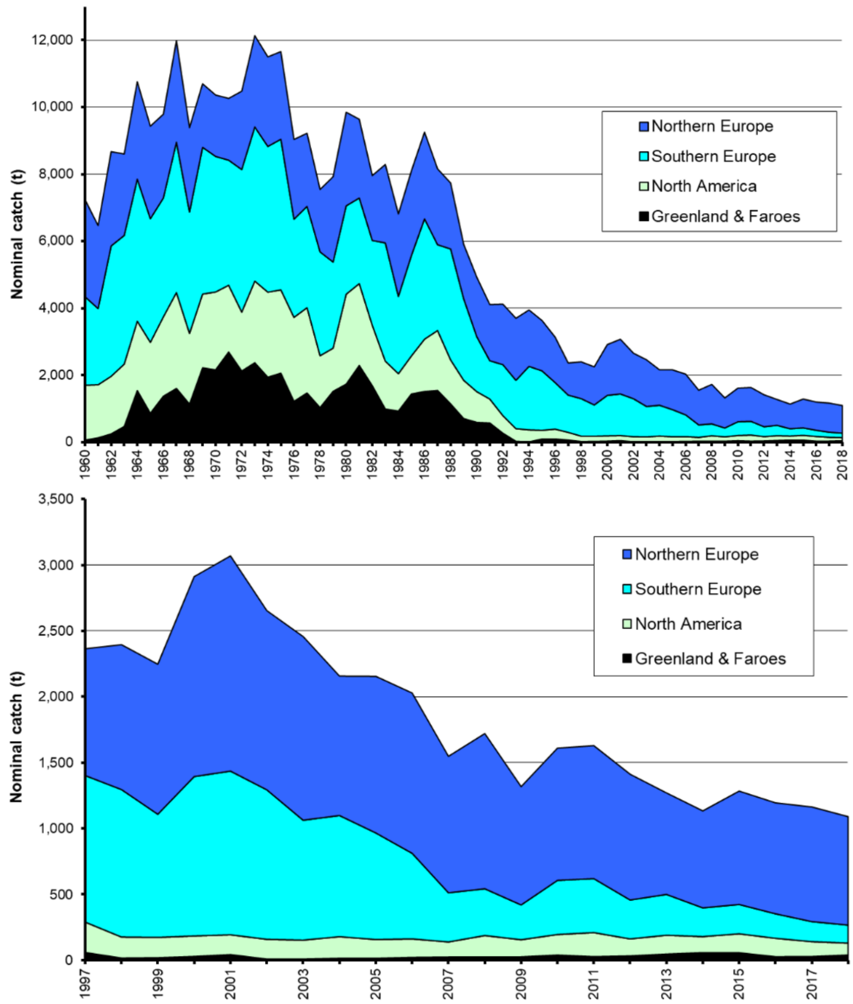


Figure 1 Total reported nominal catch of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960–2018 (top) and 1997–2018 (bottom).

Icelandic catches have traditionally been separated into wild and ranched, reflecting the fact that Iceland has been the main North Atlantic country where large-scale ranching has been undertaken, with the specific intention of harvesting all returns at the release site and with no prospect of wild spawning success. The release of smolts for commercial ranching purposes ceased in Iceland in 1998, but ranching for angling fisheries in two Icelandic rivers continued into 2017 (Table 5). Catches in Sweden are also separated into wild and ranched over the entire time-series. The latter fish represent adult salmon originating from hatchery-reared smolts that have been released under programmes to mitigate hydropower. These fish are also exploited very heavily in home waters and have no possibility to spawn naturally in the wild. While ranching does occur in some other countries, it is on a much smaller scale. The ranched components in Iceland and Sweden have therefore been included in the nominal harvest.

Table 1 Reported catches (in tonnes) for the three NASCO commission areas for 2009–2018.

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NEAC	1162	1414	1419	1250	1080	954	1083	1041	1038	960
NAC	129	156	182	129	143	122	144	140	115	90
WGC	26	40	28	33	47	58	57	27	28	40
Total	1318	1610	1629	1412	1270	1134	1284	1208	1182	1090

The provisional total nominal catch for 2018 was 1090 t, the second lowest in the time-series. NASCO requested that the nominal catches in homewater fisheries be partitioned according to whether the catch is taken in coastal, estuarine, or in-river fisheries (Table 2).

Table 2 The 2018 nominal catches (in tonnes) for the NEAC and NAC commission areas.

Area	Coastal		Estuarine		In-River		Total
	Weight	%	Weight	%	Weight	%	Weight
NEAC 2018	394	41	38	4	528	55	960
NAC 2018	7	8	46	51	37	41	90

Coastal, estuarine, and in-river catch data aggregated by commission area are presented in Figure 2. In northern NEAC (NEAC–N), a decreasing proportion and weight of the nominal catch was taken in coastal fisheries until 2013, followed by a modest increase since then to 2017. There are no coastal fisheries in Iceland, Denmark, or Finland. At the beginning of the time-series about half the catch was reported from coastal fisheries and half from in-river fisheries, whereas since 2008 the coastal fisheries catches have represented only around one-third of the total. In NEAC–S, catches in coastal and estuarine fisheries have declined dramatically since 2006. While coastal fisheries have historically made up the largest component of the catch, these fisheries have declined the most, reflecting widespread measures to reduce exploitation in a number of countries. Since 2007, the majority of the catch in this area has been reported from in-river fisheries. In NAC, except for 2018, two-thirds of the total catch has been reported from in-river fisheries; the catch in coastal fisheries has been relatively small throughout the time-series (13 t or less).

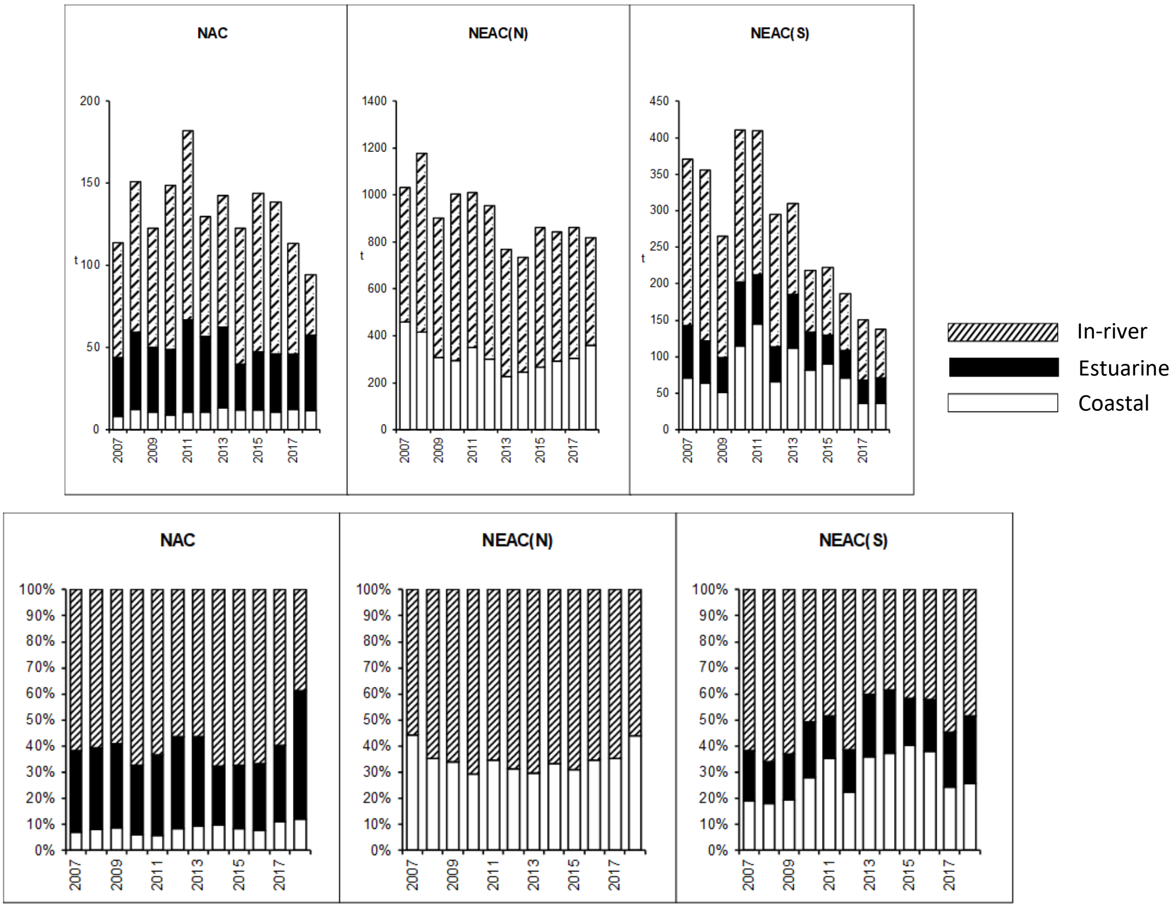


Figure 2 Nominal catches (tonnes; top panels) and percentages of the nominal catches (bottom panels) reported from coastal, estuarine, and in-river fisheries for the NAC area, and for the northern (NEAC–N) and southern (NEAC–S) NEAC areas, 2006–2018. Note that scales of vertical axes in the top panels vary.

There is considerable variability in the distribution of the catch among individual countries (Figure 3 and Table 6). In most countries the majority of the catch is now reported from in-river fisheries, and across the time-series the coastal catches have declined markedly. However, nominal catches from in-river fisheries have also declined in many countries as a result of increasing use of catch-and-release in angling fisheries.

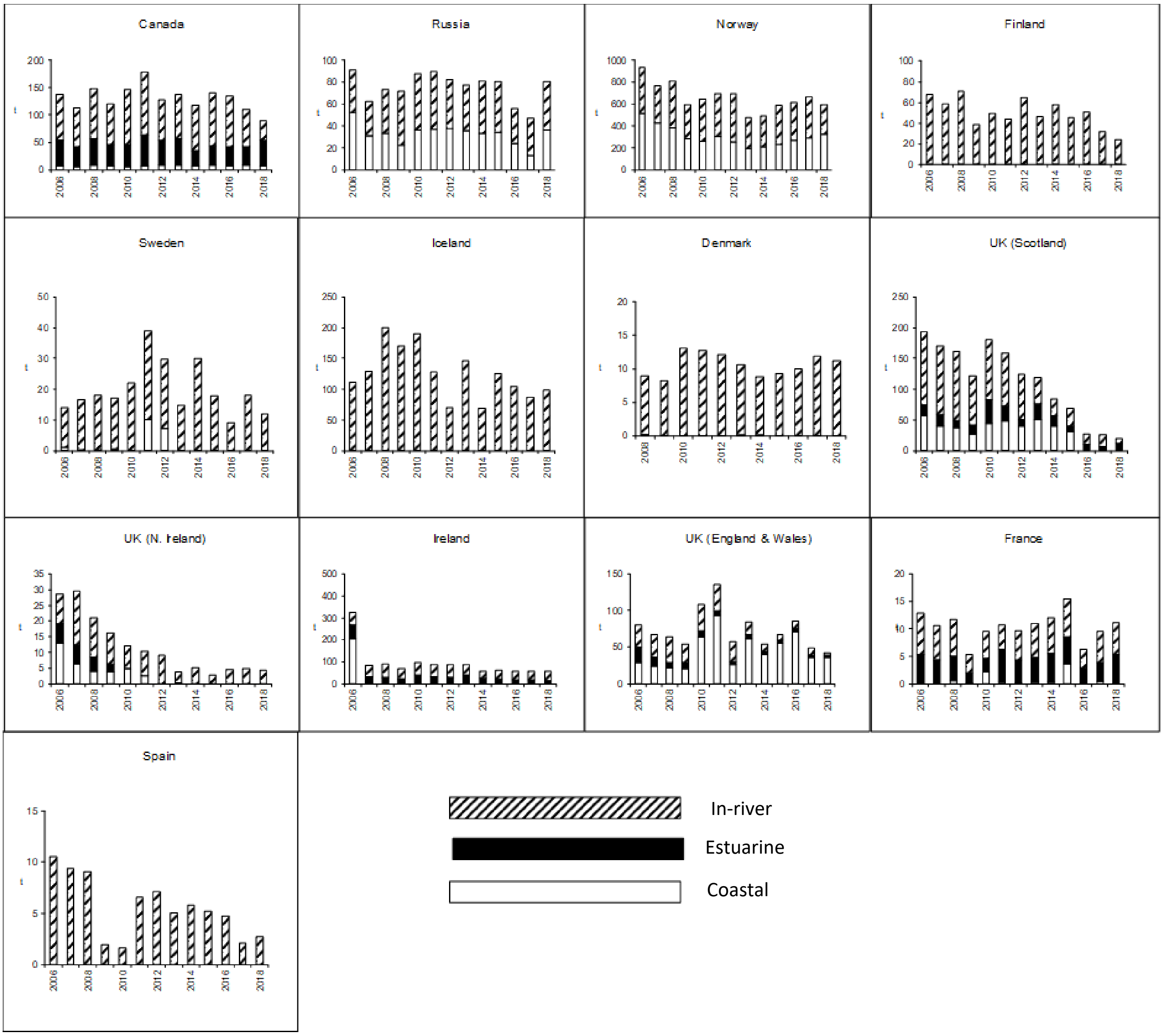


Figure 3 Nominal catch (tonnes) by country taken in coastal, estuarine, and riverine fisheries, 2006–2018 (except Denmark: 2008–2018). Note that scales on the *y*-axes vary. USA is not included because there has been no catch. 100% of the fishery at St Pierre and Miquelon and at West Greenland occurs in coastal areas. These catches are not shown.

Unreported catches

The total unreported catch in NASCO areas in 2018 was estimated at 313 t. No estimates were provided for Russia, France, Spain, or St Pierre and Miquelon in 2018. The unreported catch in the NEAC area in 2018 was estimated at 279 t, and that for the West Greenland and North American commission areas at 10 t and 24 t, respectively.

Table 3 Unreported catch (in tonnes) by NASCO commission area in the last ten years.

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NEAC	317	357	382	363	272	256	298	298	318	279
NAC	16	26	29	31	24	21	17	27	25	24
WGC	10	10	10	10	10	10	10	10	10	10
Total	343	393	421	403	306	287	325	335	353	313

The 2018 unreported catch by country is provided in Table 7. Unreported catch data were not provided by category (coastal, estuarine, and in-river). Over recent years, efforts have been made to reduce the level of unreported catch in a number of countries.

Catch-and-release

The practice of catch-and-release (C&R) in angling fisheries has become increasingly common as a salmon management/conservation measure in light of the widespread decline in salmon abundance in the North Atlantic. In some areas of Canada and USA, C&R became widely applied as a management measure in 1984, and in recent years this has been introduced in many European countries, both as a result of statutory regulation and through voluntary practice.

The nominal catches do not include salmon that have been caught and released. Table 8 presents C&R information from 1991 to 2018 for countries that provide records; C&R may also be practised in other countries while not being formally recorded. There are large differences in the percentage of the total angling catch that is released. In 2018, it ranged from 19% in Sweden to 93% in UK (Scotland), reflecting varying management practices and angler attitudes among countries. Within countries, the percentage of released fish has increased over time. There is also evidence from some countries that larger MSW fish are released in higher proportions than smaller fish. Overall, more than 166 000 salmon were reported to have been caught and released in the North Atlantic area in 2018.

Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2018 was 1 575 000 tonnes (Figure 4). The production of farmed salmon in this area has exceeded one million tonnes since 2009. Norway and UK (Scotland) continue to produce the majority of the farmed salmon in the North Atlantic (81% and 10%, respectively). Farmed salmon production in 2018 was above the previous five-year mean in all countries, with the exception of Canada (production in 2018 estimated from 2017 data), Faroes, and UK (Scotland) (production in 2018 represents a projected estimate). Data for UK (N. Ireland) since 2001 and data for the east coast of the USA are not publicly available; this is also the case for some regions within countries in some years.

Worldwide production of farmed Atlantic salmon has been in excess of one million tonnes since 2001 and over two million tonnes since 2012. The worldwide production in 2018 is provisionally estimated at 2 335 000 tonnes (Figure 4), which is similar to 2017 and higher than the previous five-year mean (2 272 000 tonnes). Production outside the North Atlantic is estimated to have accounted for one-third of the total worldwide production in 2018, dominated by Chile (82%).

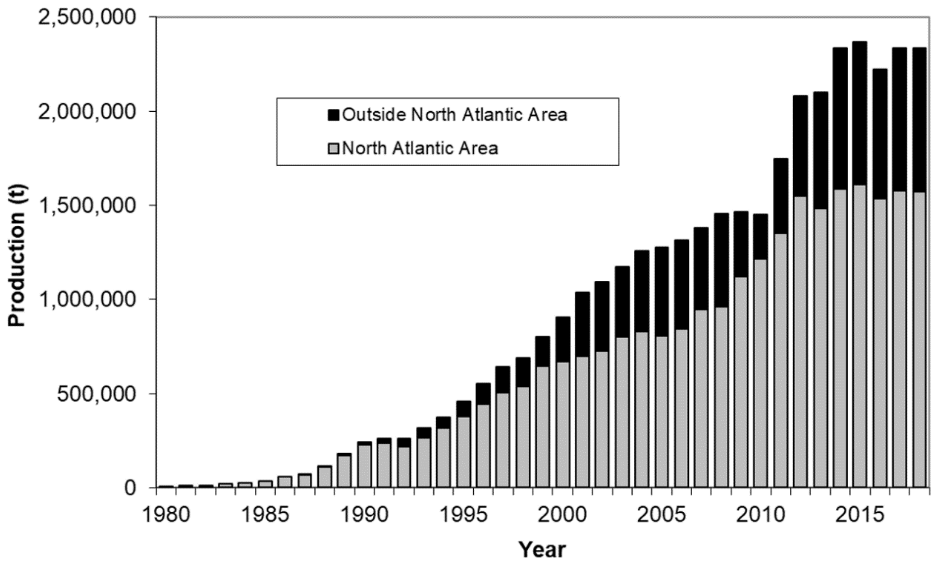


Figure 4 Worldwide production of farmed Atlantic salmon, 1980 to 2018.

The reported nominal catch of Atlantic salmon in the North Atlantic was in the order of 0.05% of the worldwide production of farmed Atlantic salmon in 2018.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic in 2018 was 40 tonnes, all taken in Iceland, Sweden, and Ireland (Figure 5), with the majority of the catch taken in Iceland (33 tonnes). No estimate was made of the ranched salmon production in Norway in 2018, where such catches have been very low in recent years (< 1 tonne), or in UK (N. Ireland), where the proportion of ranched fish has not been assessed since 2008.

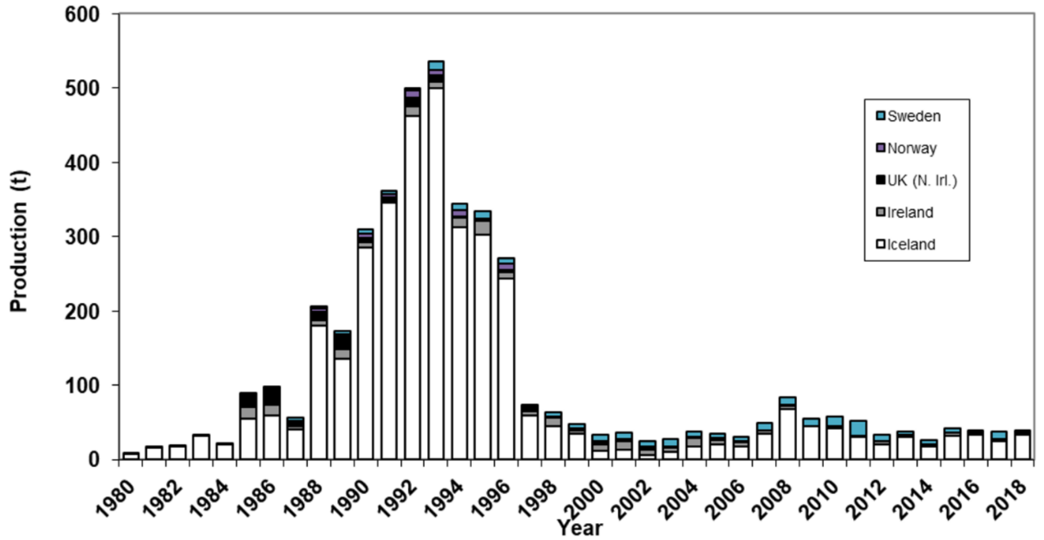


Figure 5 Harvest of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2018.

NASCO 1.2 Significant, new, or emerging threats to, or opportunities for, salmon conservation and management

A number of topics related to this term of reference were considered by ICES (2019a) and a summary of these is presented below, sorted by threats to salmon stocks followed by opportunities. Details for these are available in the working group report (ICES, 2019a).

Diseases and parasites

Updates to previously identified diseases and parasites affecting North Atlantic salmon are reported in ICES (2019a).

- Update on red vent syndrome (*Anisakiasis*) (RVS): Monitoring for the presence of RVS has continued on three rivers in the UK (England & Wales) in 2018, showing that the levels of RVS were higher in 2018 than in the previous year and the highest in the time-series for two rivers. Some cases of red vent syndrome were also reported from Sweden in 2018.
- Update on *Gyrodactylus salaris* eradication efforts in Norway: Actions to eradicate the parasite from salmon rivers has primarily consisted of rotenone treatment. No new rivers were declared free of the parasite in 2018. Of the 50 Norwegian salmon rivers with the parasite, 32 have been declared free of the parasite, 11 have been treated against the parasite and are currently awaiting parasite-free declaration, and seven rivers are still infected.
- The presence of *Gyrodactylus salaris* was confirmed in two rivers in Russia in 2017. No new information is available for 2018.
- Disease outbreaks continued to impact the health of returning salmon in Swedish rivers in 2018. The number of reports of fish with severe fungal infections increased; the causative agent is believed to have been *Saprolegnia* sp. and is likely a secondary infection following injury or exposure to other stressors. The extremely warm and dry summer in 2018 probably put extra stress on returning salmon. About 20% of broodstock fish had ulcerative dermal necrosis (UDN)-like symptoms and occasional fungal infections.
- In 2018, adult salmon in the Kola and the Tuloma rivers of Russia continued to show signs of disease; however, there was no large-scale mortality of fish as in previous years. In 2015 to 2017, mortality of spawning fish attributed to UDN was observed in the Kola River and in the Tuloma River (ICES, 2018).

- Update on sea lice investigations and sea lice management programmes in Norway: The surveillance programme for sea lice infections on wild salmon post-smolts and sea trout at specific localities along the Norwegian coast continued in 2018 (Nilsen *et al.,* 2018a). In general, the surveillance programme demonstrated varying infestation pressure along the coast during the post-smolt migration period in 2018. The sea lice situation on the fish farms did not change significantly compared to 2017, though the level of mature female lice in spring was at the lowest level observed since 2013. The results from the monitoring programme for sea lice in 2018 were evaluated by an expert group (Nilsen *et al.*, 2018b). The expert group concluded that, based on results from monitoring in 2018, the added mortality from sea lice was below 10% in eight production areas, between 10% and 30% (red zone) in four areas, and above 30% in one area. A decision on any reductions in production in "red" zones is expected to be made in late 2019, based on the combined results from monitoring in 2018 and 2019.
- Two projects reported on monitoring programmes for pathogens and parasites from wild salmon sampled from the marine environment at West Greenland. In 2016 and 2017, tissue samples from individual fish were collected as part of the International Sampling Programme at West Greenland. The objectives of the research were to assess whether there were differences in a suite of 47 agents (pathogens and parasites) on salmon from North America and Europe. Nine agents were detected overall, including one species of bacteria, three viruses, and five microparasites with a greater richness among the North American compared to European origin salmon. In 2017, heart and spleen tissue were collected from salmon sampled at West Greenland for the purpose of investigating the presence of four viral pathogens (VHSV, PRV-1, PRV-3, and PMCV) that are considered ubiquitous and known to cause disease outbreaks in farmed fish. All samples tested were negative for the presence of the pathogens.

Environmental and ecosystem interactions with Atlantic salmon

The higher temperatures predicted as a result of climate change are also predicted to affect all components of the global freshwater system. The most likely future scenarios include higher temperatures, wetter winters, drier summers, and more extreme events of flooding and drought. In 2018, a number of jurisdictions around the North Atlantic reported exceptionally dry and warm conditions over the summer period, resulting in particularly low flows and above-average temperatures. River flow is a key factor affecting river entry and upstream migration of returning salmon, with consequent effects on angler effort and catches, and likely contributed to the relatively low catches reported in many jurisdictions. In addition, high temperatures can affect the survival of salmon subject to catch-and-release and may result in management interventions that reduce effort.

- In eastern Canada, 83% of scheduled salmon rivers in Newfoundland region were closed for part of the season due to extreme environmental conditions. In the Gulf region, different sections of the Miramichi and Margaree rivers were closed to recreational fishing for 47 and 18 days, respectively, due to warm water temperature and low flow events in 2018.
- In France, flood events in winter occurred in many rivers, followed by spring and summer periods which were very dry, with August being the 4th hottest on record.
- Ireland experienced an extended period of above-average temperatures and exceptionally low rainfall in the summer of 2018. Uncharacteristically large late runs of fish were observed in two drought-impacted rivers.
- In UK (England and Wales), many rivers experienced flows that were less than 50% of the long-term average in the period May to August and above-average water temperatures were recorded in many river catchments, leading to some restrictions on fishing.
- In 2018, UK (Northern Ireland) experienced a prolonged warm and dry period during the summer months, resulting in very low flows, and restricting the accessibility of these rivers to returning adults.
- In UK (Scotland), rivers experienced a prolonged period of extremely low flows throughout 2018. Both the size of the catch in 2018 (historical low) and the allocation of catch among fishing methods may have been influenced by these environmental conditions.
- In the River Säveån on the Swedish west coast, the water temperature was on average 3°C higher during the period of July to November compared to the average of 1999–2018, with water temperatures above 20°C for 36 consecutive days. The high water temperature was accompanied by extremely low flows in all salmon rivers on the west coast.

- In Norway, the second half of June and the whole of July were unusually hot and dry in large areas of the country. This led to low catches and late migration into rivers, especially in smaller rivers. The delayed migration into rivers probably led to higher nominal catches in the marine environment than in rivers for the first time since 2004.

Opportunities for salmon conservation and management

Updates on projects related to restoration programmes in Germany, carryover effects from freshwater to marine survival, activities to improve the information on salmon distribution and characteristics at sea, and modelling of population dynamics were reported to ICES (2019a).

Update on the Atlantic salmon stock situation in Germany

Atlantic salmon populations in Germany were lost by the 1950s. Re-introduction programmes began in the late 1970s in specific parts of main German rivers and their tributaries. The overarching management objective for Atlantic salmon in Germany is the re-establishment of self-sustaining stocks in the catchment areas of the rivers Ems, Rhine, Weser, and Elbe. Re-introduction programmes in German river systems are currently driven by stakeholders in both the public and private sector, and include international commissions, river management cooperatives, and pan-regional and local angling associations. Recreational harvest of salmon in two federal states is legal under restricted conditions, whereas targeted commercial fisheries for salmon do not exist in Germany. However, illegal fisheries and/or accidental bycatch of salmon as well as by recreational fishers may exist and potentially hinder the success of recovery programmes. Although many recovery projects have been running for over 20 years, German salmon populations are still heavily dependent on artificial stocking. Identifying potential habitats and risks to the reproductive capacity of Atlantic salmon is a main emphasis of Atlantic salmon restoration efforts in Germany. The implementation of the EU Water Framework Directive remains the most important tool for restoring degraded and lost habitat as well as for improving river connectivity and habitat accessibility. Today, more salmon habitats are being restored than destroyed. However, only a fraction of the vast salmon habitats that once existed in German rivers are still available.

Smolt size and marine survival

There is increasing evidence that effects carried over from the freshwater phase are important determinants of Atlantic salmon marine return rates (Russell *et al.*, 2012). However, the relationships between smolt characteristics and their marine survival are not clear. Using individual smolt data collected on the River Frome for an 11-year period and Bayesian model selection, the study shows that Atlantic salmon smolt length affects the 1SW marine return rate. This effect was substantial within the normal range of River Frome smolt sizes. With increased smolt size the probability of a 1SW return rate increased by a factor of three, from < 1% to 3.5% for a 12 cm to a 16 cm smolt, respectively (Figure 6). Many other factors might explain a non-negligible amount of the overall or unexplained variation in marine return rates besides smolt length, including migration timing and marine conditions. These findings therefore add support to the growing, yet still equivocal evidence that “bigger is better” among salmon smolts (Gregory *et al.*, 2018). The precise mechanism of this effect deserves further study, but could include differences in predator avoidance due to size or swimming ability or different migration routes.

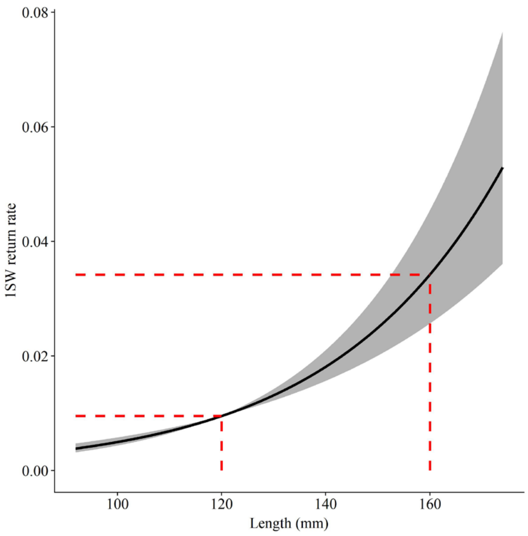


Figure 6 Estimated marine return rate after one winter at sea (1SW) as a function of fork length of individual Atlantic salmon (*Salmo salar*) smolt emigrating from the River Frome (Dorset, UK). The solid black line shows the estimated effect while the grey bands delimit the estimated 25 to 75% Bayesian credibility interval band around that effect (approximate standard errors).

Update on opportunities for investigating salmon at sea

- **The International Ecosystem Summer Survey of the Nordic Seas (IESSNS)**: A collaborative programme involving research vessels from Iceland, the Faroes, and Norway. The area surveyed (2.8 million km^2 in 2018) overlaps in time (July–August) and space with the known distribution of post-smolts in the North Atlantic, and as these cruises target pelagic species such as herring and mackerel with surface trawling at predetermined locations, bycatch of salmon post-smolts and adult salmon is not uncommon. In 2018 a total of 80 post-smolt and adult salmon were caught by the participating vessels in different regions of the North Atlantic (Figure 7). The Institute of Marine Research (Bergen, Norway) is developing a plan to collate all the information from the analysis of the samples over all years.

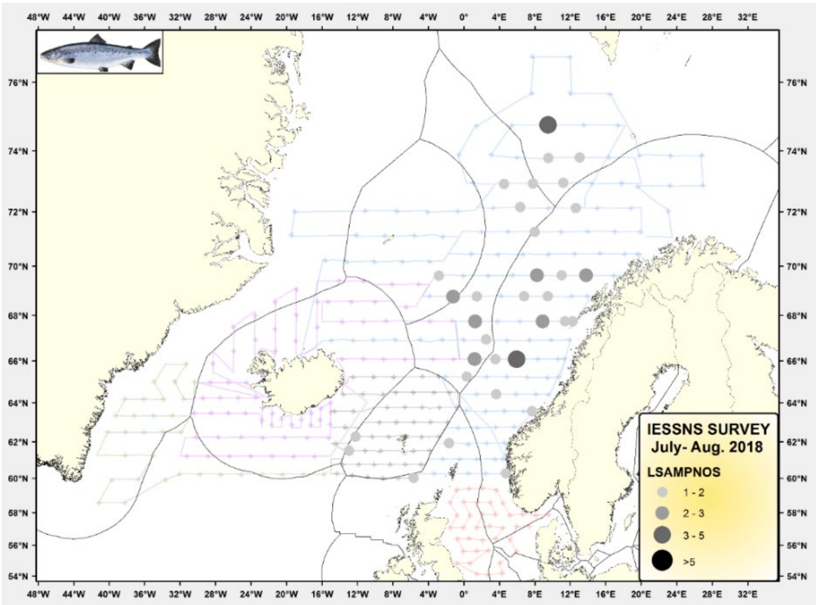


Figure 7 Catches in number of Atlantic salmon taken by the IESSNS survey in the Northeast Atlantic in July 2018. The catches are dominated by post-smolts. This is the main survey where salmon would be expected to be taken by the survey nets.

- **Project "SeaSalar":** A new research project focusing on salmon at sea was initiated in Norway in 2018 (https://www.seasalar.no). The main aim of the project is to examine factors impacting variation in marine survival and growth of Atlantic salmon in the North Atlantic over time and in different geographical areas. An important part of the project is to utilize existing datasets and activities, including salmon collected at sea, genetic material, archival scale samples, survival data, population size data, and dataseries on other marine species and oceanic ecosystems. The project will also apply new genetic, stable isotope and fatty acid analyses and electronic tagging technologies as well as modelling to provide novel results. The project, which is funded by the Research Council of Norway, started 1 August 2018 and will last four years.
- **PIT tag screening programmes**: Screening of bycatch of salmon using automatic screening of PIT tags (Passive Integrated Tags) at factories processing pelagic fish is now possible. Screening of commercial landings currently takes place at 23 European (UK, Iceland, Norway, Denmark, Faroes) factories processing pelagic fish. In 2018 more than 120 000 salmon were released with such tags. Lists of unknown tags detected at factories, 339 unknown tags as of September 2018, have in previous years been distributed to countries with PIT-tagging programmes, and salmon post-smolts in catches have been identified. A more efficient identification of the origin of detected PIT-tagged salmon would be possible if lists of individual PIT tag numbers or codes were made available in a public database.
- **Select tracking and acoustic tagging studies in Canada:** NASCO's International Atlantic Salmon Research Board (IASRB) adopted a resolution in 2014 to further support the development of telemetry programmes in the ocean. The Atlantic Salmon Federation in Canada in partnership with the Oceans Tracking Network and a number of collaborators have continued to capture, sample, and tag with acoustic transmitters smolts and kelts from a number of rivers in eastern Canada. Acoustic arrays have been positioned at key points in the Gulf of St. Lawrence leading to the Labrador Sea. Results from activities in 2018 indicated that kelts and smolts from various rivers crossed the Strait of Belle Isle array to the Labrador Sea during a three-week period from late June to mid-July (Figure 8). These studies provide useful information on migration routes and timing and have provided estimates of survival rates at several points along the migration corridor. The smolt tracking programmes have also provided estimates of survival rates of tagged smolts at various points along the migration route. The differences in apparent survival rates in two neighbouring coastal areas of the Gulf of the St Lawrence have been hypothesized to be in part related to differences in predation pressures on migrating smolts. Once the smolts leave the coastal bays, inferred apparent survival rates through the Gulf of St. Lawrence were generally in the range of 0.4 to 0.7, with survival rates exceeding 0.999 per km and 0.96 to 0.99 per day.

In 2017, an array of 20 receivers (approx. 16 km) was placed off the coast of southern Labrador (Canada), and in 2018 the line was extended to 32 km offshore. As of August 2018, a total of 30 acoustic tags placed in Atlantic salmon were detected, including kelts and post-smolts from Labrador (Lake Melville), Newfoundland (two rivers), Québec (4 rivers), New Brunswick (two rivers), and the USA (post-smolts from two rivers).

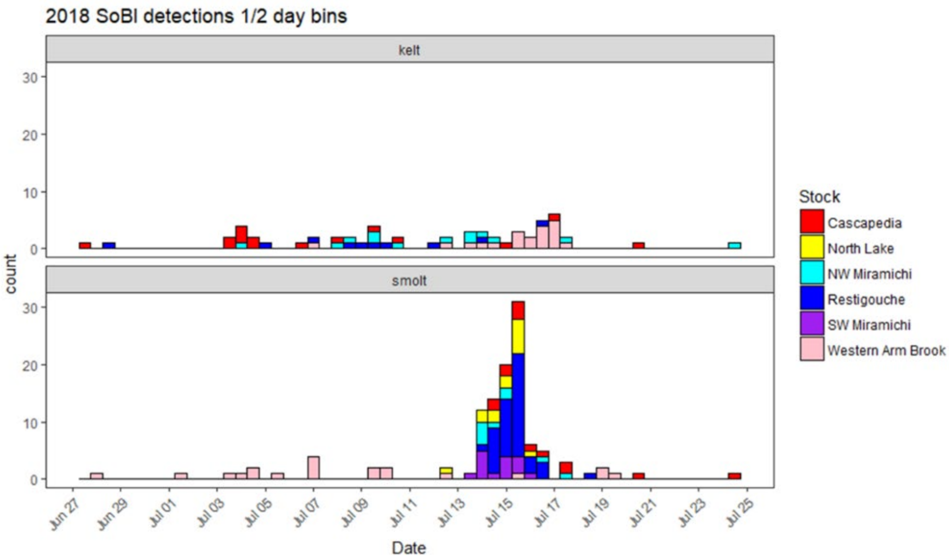


Figure 8 Counts and dates of acoustically tagged Atlantic salmon kelts (upper panel) and smolts (lower panel) from various Gulf of St Lawrence rivers crossing the Strait of Belle Isle receiver array in 2018.

- **Pop-up satellite tagging of Atlantic salmon at Greenland:** A study was initiated in 2018 to map the marine distribution and migration patterns for maiden Atlantic salmon tagged in coastal waters off the west coast of Greenland and to examine the oceanographic (physical and biological) features occurring in the salmon's distribution and migratory routes. Atlantic salmon were captured, primarily via trolling, and tagged with pop-up satellite archival tags (PSATs – X-tags from Microwave Telemetry Inc. [Colombia, Maryland]) at West Greenland near Qaqortoq in October 2018. PSAT tags were programmed to detach and begin transmitting data approximately five months post-release, or on 1 May 2019. A total of 12 Atlantic salmon were captured in early October and tagged and released with PSATs. These tagged salmon had an average fork length of 65.8 cm and an average whole weight of 3.7 kg; six fish were identified as North American origin and six were identified as European origin. As of mid-March 2019, all tags had been released due to the constant depth release mechanisms, except for one that was released in March 2019 on its pre-programmed release schedule. Of these tags eight had popped up and transmitted (Figure 9). Much time was spent ground-truthing methodologies in 2018 and solidifying contacts in the region. In 2019, modifications will be implemented with the objective of tagging 50 salmon with PSATs, primarily using trolling for capture from early September to late October. These techniques are being implemented in other areas, both in the Northwest and the Northeast Atlantic (e.g. SALSEA Track), in line with the NASCO themes.

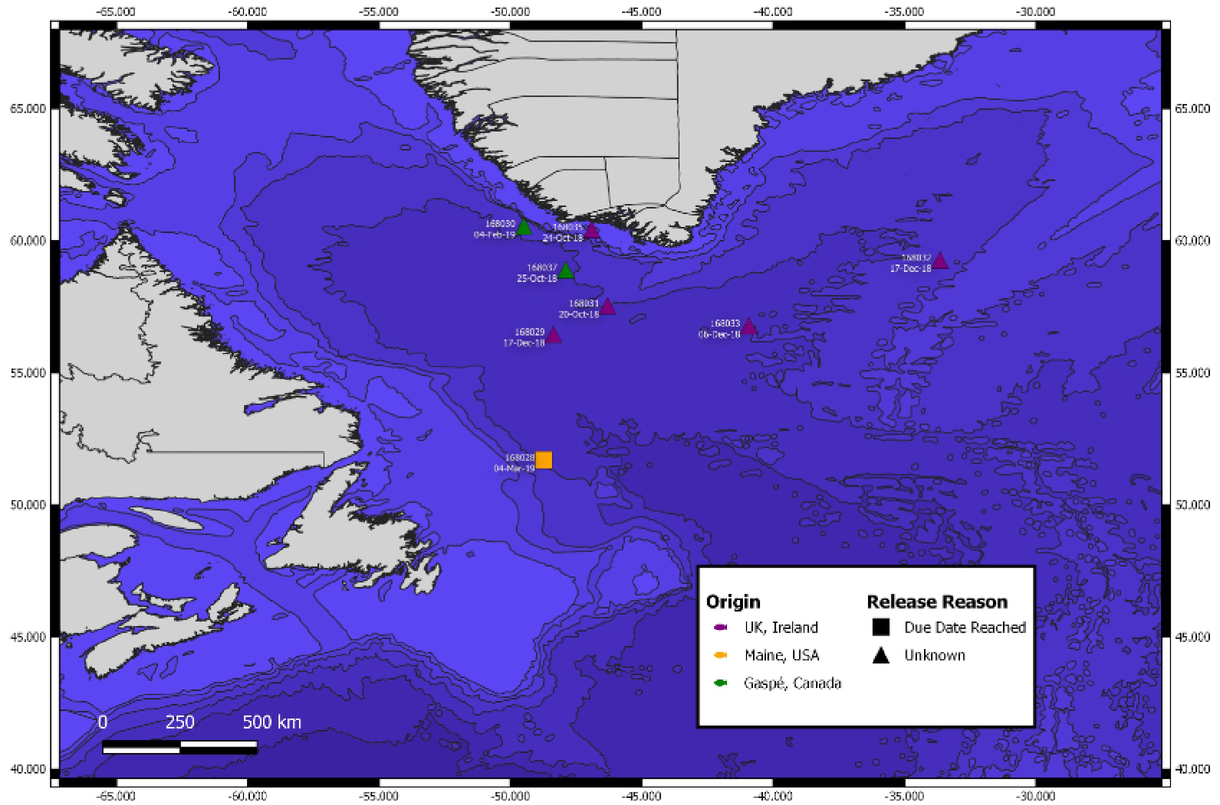


Figure 9 Pop-up location of Atlantic salmon tagged at Greenland in October 2018, identifying fish origin and pop-up mechanism as of 17 March 2019.

<u>Progress in stock assessment models</u>

- **Life cycle model for catch advice:** A life cycle model has been developed that improves on the current assessment and catch advice model and also provides a framework to improve the examination of the drivers and mechanisms of changes in Atlantic salmon population dynamics and productivity in the North Atlantic. This new version of the life cycle model incorporates the dynamics of six stock units in NAC, seven stock units in NEAC–S, and eleven stock units in NEAC–N in a single hierarchical model (Figure 10). The model offers modelling covariation in the dynamics of the different populations that share migration routes and feeding areas at sea, and which are harvested in mixed-stock fisheries, particularly at West Greenland for NAC and NEAC and at the Faroes for NEAC. The model provides estimates of trends in marine productivity (expressed as post-smolt survival rate to 1 January of the first winter at sea) and the proportion maturing as one-sea-winter salmon for all stock units in Northern and Southern NEAC, and in NAC (Figure 11). The model also provides a major improvement to the assessment and forecast models of Atlantic salmon currently used by ICES by providing catch options for the combined West Greenland and Faroes salmon fisheries.

- **Investigating the drivers of Atlantic salmon population declines across the Atlantic basin:** The life cycle was applied to examine the environmental drivers and the demographic mechanisms of the widespread decline of marine survival rates of Atlantic salmon in the North Atlantic. The temporal variations and the degree of synchrony in post-smolt survivals of the 13 stock units from the NAC and NEAC–S complexes were examined. The model and data were used to investigate whether the temporal variations in the post-smolt survival were best explained by the environmental variations encountered by salmon either during the early part of the post-smolt marine phase when salmon use transitional habitats, or during the subsequent part of the first year at sea when salmon of different origins concentrate in common foraging areas. The environmental variables examined include the sea surface temperature (SST) and primary production (PP) as well as large-scale climate-forcing metrics (the North Atlantic Oscillation [NAO] and the Atlantic Multidecadal Oscillation [AMO]). Results show a strong coherence in the temporal variation in post-smolt survival among the 13 stock units of NAC and NEAC–S, with a common trend explaining 37% of the temporal variability of survival and describing a decline by a factor of 1.8 over the 1971–2014 time-series. Synchrony in survival is stronger between stocks within each complex. Temporal patterns of the post-smolt marine survival are best explained by SST (negative correlation) and PP (positive correlation) variations encountered by salmon, corresponding specifically to late summer/early autumn feeding areas in the Labrador Sea/Grand Banks for the NAC complex and in the Norwegian Sea for the NEAC–S complex. These findings support the hypothesis of a simultaneous response of salmon populations to large-scale bottom–up environmentally driven changes in the North Atlantic that can impact populations originating in distant continental habitats. The ecological drivers and/or mechanisms differ between NAC and NEAC–S populations because of different migration routes at sea during the initial post-smolt phase.

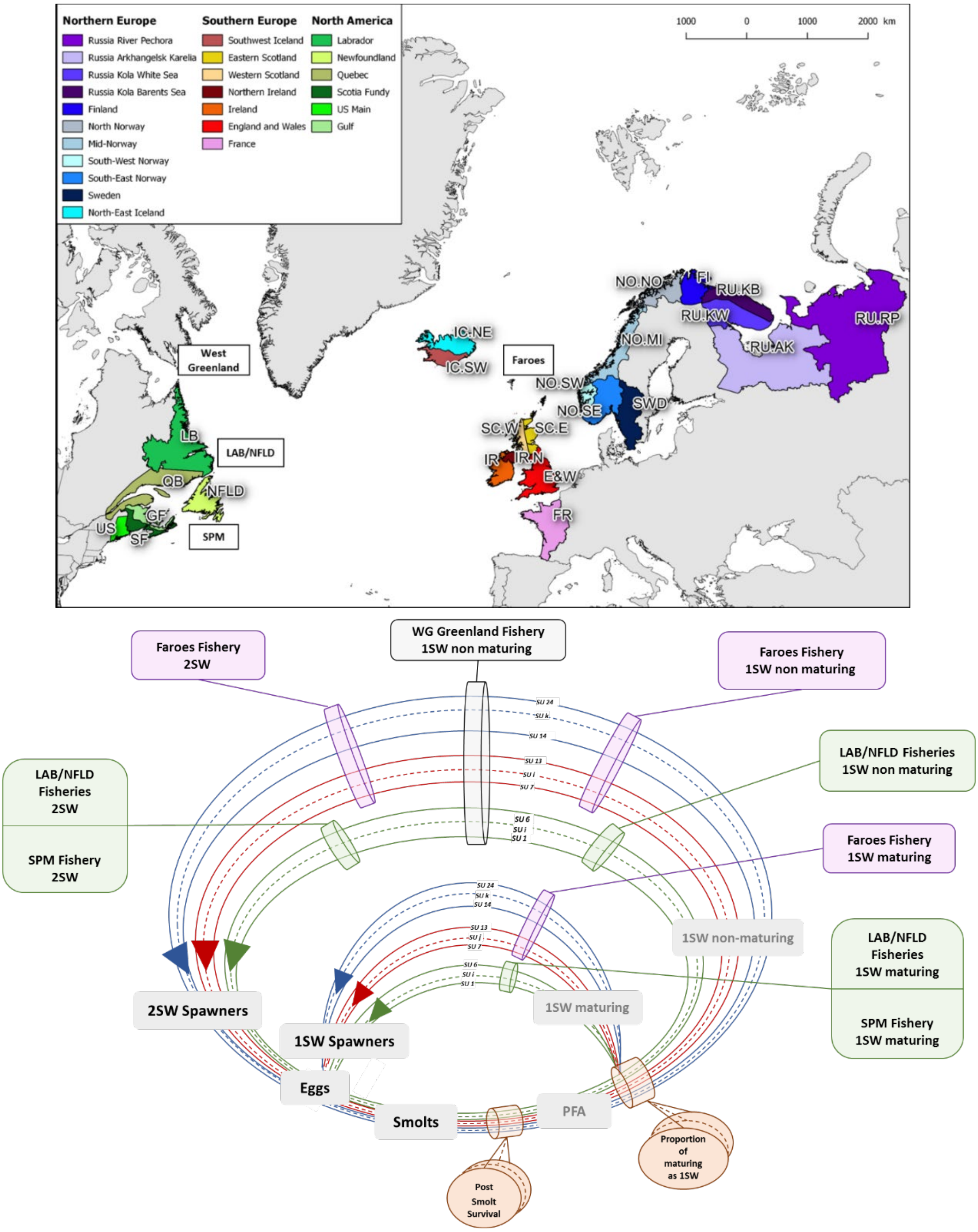


Figure 10 Schematic of the life cycle model applied to the 24 stock units of NEAC–N, NEAC–S, and North America. Variables in light blue are the main stages considered in the stage-structured model. The smolt-to-PFA survival (post-smolt survival) and the proportion of maturing PFA are estimated for the time-series (1971 to 2014). Stock units of the NEAC–N and NEAC–S complexes are potentially harvested by the mixed-stock fishery operating around the Faroe Islands as 1SW maturing and non-maturing fish, and as 2SW fish. Stock units of the NAC complex are potentially harvested by the mixed-stock fishery operating around Labrador, Newfoundland, and Saint Pierre and Miquelon as 1SW maturing and non-maturing fish, and as 2SW fish. Stock units of the NEAC–N and NEAC–S complexes are potentially harvested by the mixed-stock fishery operating at West Greenland as 1SW non maturing fish.

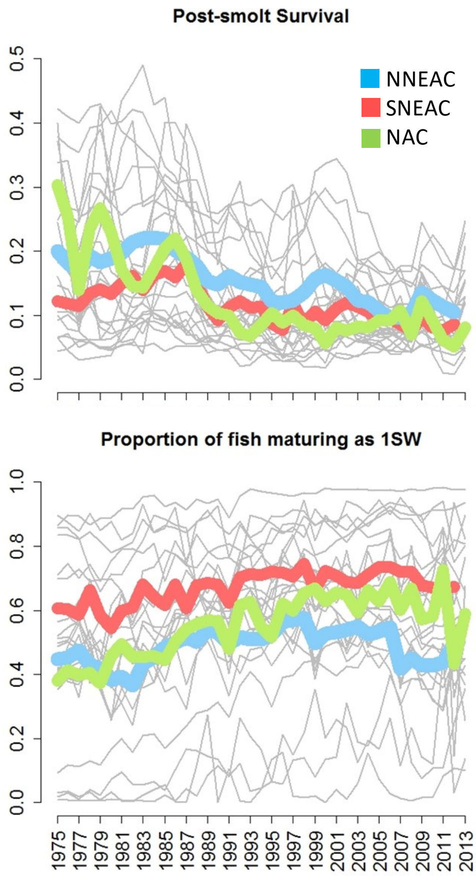


Figure 11 Time-series of (top panel) smolt-PFA survival (plotted in the natural scale) and (bottom panel) proportion of fish maturing as 1SW for the 24 stock units (thin grey lines) and averaged over the three continental stock groups (thick coloured lines). NAC = green, NEAC–N = blue, NEAC–S = red.

- **SAlmonids Management ARound the CHannel (SAMARCH):** SAMARCH is a five-year project initiated in April 2017 (due to end April 2022) and partly funded by the France–England Interreg Channel programme (www.samarch.org). The project will provide new transferable scientific knowledge to inform the fisheries management of salmon and sea trout in the estuaries and coastal waters of both the French and English sides of the Channel. The four technical work-packages in the SAMARCH project include: WP T1 Fish Tracking (acoustic tracking technology to follow salmon and sea trout smolts through estuaries and to apportion smolt mortality rates between the estuary and the near-shore coast); WP T2 Genetic Tool Development (focus on brown trout); WP T3 Salmonid Stock Assessment Models (collecting new data on the marine survival of salmonids and using this together with historical data to develop new, and improve existing, models used for salmonid stock assessment in England and France, and to focus also on analyses of growth rate changes inferred from scales); and WP T4 Stakeholders and Training (inform, improve, and develop new policies for the fisheries management of salmonids in estuaries and coastal waters).

NASCO 1.4 Provision of a compilation of tag releases by country in 2018

Data on releases of tagged, fin-clipped, and other marked salmon in 2018 are compiled as a separate report (ICES, 2019b). In summary (Table 4):

- Approximately 2.7 million salmon were marked in 2018, similar to the 2.8 million salmon marked in 2017.
- The adipose clip was the most commonly used primary marker (2.1 million), with coded wire microtags (CWT) (0.242 million) being the next most common primary marker.
- A total of 189 022 salmon were externally marked.

- Most marks or tags were applied to hatchery-origin juveniles (2.6 million), while 62 296 199 wild juveniles and 7903 wild adults were also marked.
- The use of PIT tags, data storage tags (DSTs), and radio and/or sonic transmitting tags (pingers) has increased in recent years. In 2018, 135 157 salmon were tagged with these tag types (Table 4), similar to the number in 2018 (132 725 salmon). ICES noted that not all electronic tags were being reported in the tag compilation. Tag users should be encouraged to include these tags or tagging programmes in the tag compilation as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions. A previous section (PIT tag screening programmes) recommends the creation, on a European scale, of a database recording and programmes using PIT tags.

Since 2003, ICES has reported information on markers being applied to farmed salmon to facilitate tracing the origin of farmed salmon captured in the wild in the case of escape events. In the USA, genetic "marking" procedures have been adopted where broodstock are genetically screened. The resulting database is used to match genotyped escaped farmed salmon to a specific parental mating pair and subsequent hatchery of origin, stocking group, and marine site from which the salmon escaped.

Table 4 Summary of Atlantic salmon tagged and marked in 2018 – "Hatchery" and "Wild" juvenile refer to smolts and parr.

Country	Origin	Primary tag or mark			Other internal[1]	Total
		Microtag	External mark[2]	Adipose clip		
Canada	Hatchery Adult	0	75	0	1 240	1 315
	Hatchery Juvenile	0	191	180 501	38	180 730
	Wild Adult	0	1 907	300	214	2 421
	Wild Juvenile	0	5 654	10 853	2 065	18 572
	Total	**0**	**7 827**	**191 654**	**3 557**	**203 038**
Denmark	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	20 000	317 000	0	337 000
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**20 000**	**317 000**	**0**	**337 000**
France	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile[3]	0	0	98 774	0	98 774
	Wild Adult[3]	0	0	0	313	313
	Wild Juvenile	0	0	0	3 700	3 700
	Total	**0**	**0**	**98 774**	**4 013**	**102 787**
Iceland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	62 931	0	0	0	62 931
	Wild Adult	0	98	0	0	98
	Wild Juvenile	4 736	0	0	0	4 736
	Total	**67 667**	**98**	**0**	**0**	**67 765**
Ireland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	157 832	0	0	0	157 832
	Wild Adult	0	0	0	0	0
	Wild Juvenile	3 701	0	0	0	3 701
	Total	**161 533**	**0**	**0**	**0**	**161 533**
Norway	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	4 000	0	106 544	110 544
	Wild Adult	0	175	0	588	763
	Wild Juvenile	0	257	0	12 393	12 650
	Total	**0**	**4 432**	0	**119 525**	**123 957**
Russia	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	1 059 924	0	1 059 924
	Wild Adult	0	1 254	0	0	1 254
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**1 254**	**1 059 924**	**0**	**1 061 178**
Spain	Hatchery Adult	0	0	0	0	**0**
	Hatchery Juvenile	0	154 464	0	0	**154 464**
	Wild Adult	0	0	0	0	**0**
	Wild Juvenile	0	0	0	0	**0**

Country	Origin	Primary tag or mark			Other internal[1]	Total
		Microtag	External mark[2]	Adipose clip		
	Total	**0**	**154 464**	**0**	**0**	**154 464**
Sweden	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	166 648	0	166 648
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	218	218
	Total	**0**	**0**	**166 648**	**218**	**166 866**
UK (England & Wales)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	3 463	239	3 702
	Wild Adult	0	628	0	0	628
	Wild Juvenile	4 521	0	10 150	96	14 767
	Total	**4 521**	**628**	**13 613**	**335**	**19 097**
UK (N. Ireland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	8 199	0	53 713	0	61 912
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**8 199**	**0**	**53 713**	**0**	**61 912**
UK (Scotland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	1	1
	Wild Adult	0	319	0	18	337
	Wild Juvenile	0	0	0	3 952	3 952
	Total	**0**	**319**	**0**	**3 971**	**4 290**
USA	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	240 304	1 449	241 753
	Wild Adult	0	0	0	2 089	2 089
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**240 304**	**3 538**	**243 842**
All countries	Hatchery Adult	0	75	0	1 240	1 315
	Hatchery Juvenile	228 962	178 655	2 120 327	108 271	2 636 215
	Wild Adult	0	4 381	300	3 222	7 903
	Wild Juvenile	12 958	5 911	21 003	22 424	62 296
	Total	**241 920**	**189 022**	**2 141 630**	**135 157**	**2 707 729**

1) Includes other internal tags (PIT, ultrasonic, radio, DST, etc.).
2) Includes Carlin, spaghetti, streamers, VIE, etc.

NASCO 1.5 Identify relevant data deficiencies, monitoring needs, and research requirements

ICES recommends that the WGNAS should meet in 2020 (Chair: Martha Robertson, Canada) to address questions posed by NASCO and by ICES. Unless otherwise notified, the working group intends to convene at the headquarters of ICES in Copenhagen, Denmark. The meeting will be held from 24 March to 2 April 2020.

The following relevant data deficiencies, monitoring needs, and research requirements were identified:

North Atlantic

1) A recommendation has been developed by the working group for more efficient identification of the origin of PIT-tagged salmon. A creation of a database listing individual PIT tag numbers or codes identifying the origin, source, or programme of the tags should be recorded on a North Atlantic basin-wide scale. This is needed to facilitate identification of individual tagged fish taken in marine fisheries or surveys back to the source. Data on individual PIT tags used in Norway have now been compiled, but a coordinated database, where the data could be stored, is needed.

Northeast Atlantic Commission

No recommendations specific to NEAC are provided.

North American Commission

2) Complete and timely reporting of catch statistics from all fisheries for all areas of eastern Canada is recommended.
3) 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.
4) Additional monitoring should 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.

West Greenland Commission

5) Efforts to improve the reporting system of catch in the Greenland fishery should continue and spatially and temporally explicit catch and effort data from all fishers should be made available for analyses.
6) The broad geographic sampling programme including in Nuuk (multiple NAFO divisions including factory landings when permitted) should be expanded across the fishing season to ensure that samples are representative of the entire catch. This will allow accurate estimates of region of origin and biological characteristics of the mixed-stock fishery.

EU-DCF/DCMAP	**Data requirements under the EU Data Collection Framework (DCF) and EU Multi-Annual Programme (EU-DCMAP)**

ICES WGNAS ToR (b) states: "In relation to EU Member States and their obligations to collect data on salmon fisheries and stocks under the EU Data Collection Framework (DCF) and EU Multi-Annual Programme (EU-DCMAP), and to address European Commission and Regional Coordination Group (RCG) requirements ahead of June 2019." ICES replies to the individual articles in this ToR are given below.

WGNAS ToR (b), article i) – Comment on specific data needs of the WG from those specified in the DCF and recommend actions to improve data quality for the work of the WG and in the context of future usage of the RDBES database as the source of ICES data for analyses on salmon.

With regards to "specific data needs", assessment of Atlantic salmon differs from the approaches commonly adopted for other species, for example in respect of the need for at-sea surveys and the collection of commercial catch per unit of effort (CPUE) data. Instead, the assessment of salmon is based mainly on data collected on individual river stocks (e.g. catches and counts of returning fish), which are raised and aggregated to provide estimates of the number of fish returning to homewaters for different stock groupings. These estimates are used, in turn, to estimate abundance at earlier points in the life cycle of the fish and to inform the development of catch advice.

The provision of management advice for the mixed-stock fisheries at Faroes and West Greenland is based on assessments of the status of stocks at broad geographic scales. The North American Commission (NAC) is divided into six management units, and the North East Atlantic Commission (NEAC) is divided into 19 regions. Assessment of the status of the stocks in these areas is based on estimates of the total abundance – the pre-fishery abundance (PFA) – of different cohorts of salmon at a stage before the distant water fisheries operate (Rago *et al.*, 1993).

The PFA models require estimates of the number of salmon returning to homewaters, natural mortality (M) occurring during the return migration to homewaters (M assumed at 0.03 per month), and total catch in distant water fisheries. WGNAS (the working group) is developing a Life Cycle Model (LCM) which is likely to replace the current PFA models in the near future. The LCM requires similar data inputs but can be more readily modified to incorporate other covariates (e.g. environmental variables) and will provide greater flexibility in exploring hypotheses. In the context of the DCF, the working group identified several data requirements of the new life cycle model at both the regional and the river scale.

With regards to "Actions to improve data quality", the working group quantifies uncertainty in all of its assessments using the data provided; ICES takes this information into account when providing advice. However, the working group recognizes potential challenges associated with (i) the timeliness and (ii) the completeness of data reporting.

Timely provision of national data is challenging because the working group has to meet in March/April to prepare the information required for ICES to develop the advice ahead of the annual NASCO meeting in June. As a consequence, data for the most recent year are always regarded as provisional but are routinely updated the following year.

Not all EU Member States with Atlantic salmon stocks report fully to WGNAS ahead of its annual meeting. Though the potential effect of incomplete or no reporting on the quality of the working group outputs has not been specifically tested, it is considered of relatively minor significance as those EU Member States that do not report typically support small numbers of stocks. However, the development of an ICES data call during 2019 will formalize the data provision to the working group in advance of its 2020 meeting and this, along with standardization of data report formatting and storage should improve data quality through timely reporting and the availability of new data from other EU Member States.

With regards to "the future use of the RDBES database as a source of ICES data for analyses on salmon", the working group is developing approaches to streamline data collection, storage, and presentation (facilitated through an ICES data call approach) to facilitate analyses. It is unclear at this stage whether the RDBES will benefit the work of working group (the INTERCATCH database has previously been unsuitable for Atlantic salmon). However, the working group is happy to liaise with the ICES Data Centre and the RDBES Steering Group to explore possible opportunities.

WGNAS ToR (b), article ii) – Address the following recommendations from the RCG in 2018: 1) Explain and review the selection of national index rivers by the various Member States (noting that "rivers" in the Legal Text is interpreted to represent "water bodies" (STECF, 2017)), and comment on whether these selections are appropriate and sufficient for the WG to perform analyses and provide stock advice

The working group notes that the term "index river" may hold a specific meaning within the context of NASCO and prefers the term "monitored river" when referring to data collection to reflect that data were available on a regular (usually annual) basis. The assumption would be that all required data would be collected on monitored rivers, as this would minimize the need for sampling the multitude of rivers for separate parameters. However, it may not be practical to collect all data in every monitored river. The selection of rivers to monitor has historically been based on national competencies and according to what each jurisdiction deemed appropriate, affordable, and necessary for the fisheries management of their salmon stocks.

From a salmon biology perspective, it is useful if monitored rivers are representative of the geographic and demographic variation in a jurisdiction/country. However, proposing that a set proportion of rivers should be established as monitored stocks, such as the one river in 30 suggested by ICES Workshop on Eel and Salmon DCF Data (WKESDCF – ICES, 2012), is considered unrealistic by some jurisdictions, particularly those with very large numbers of stocks. WGNAS currently has no formal process for the selection of monitored rivers, but the working group recommends that selection remains within the competence of individual EU Member States. The working group considers the information on monitored rivers provided at present is appropriate and sufficient to meet its requirements in providing advice to NASCO.

The working group recognises the particular practical challenge of data collection in rivers with very small populations of salmon, including those where stocks are recovering, and the need to balance investment in data collection with the relative contribution to national and international assessments.

WGNAS ToR (b), article ii) – Address the following recommendations from the RCG in 2018: 2) Identify the stocks from which salmon variables should be collected (for parr, smolts, and adults), and advise on sampling frequency and effort (sampling level) to collect these variables

The variables currently collected for the working group are provided for stocks defined at the country or regional level within countries. Stock assessment models are performed at the regional/country level and aggregated to the complex level (North Atlantic (NAC)/North East Atlantic (NEAC)). Information is also provided at the level of the monitored river. Information on adult abundance and age composition is required on an annual basis. In contrast, information on sex ratio of adult fish, fecundity, and smolt age composition is required periodically, but time-series might be included in the LCM in future. Information on parr abundance (densities) is used for national assessment and management but not required by the working group for present purposes (though the developing LCM might also use such data). Annual indices of survival (requiring monitoring/handling of smolts and adult salmon) are also included in ICES advice to NASCO.

Current sampling effort is considered to be adequate for salmon stocks (information provided on total catch or abundance on an annual basis).

Table 5 Total reported nominal catch of salmon by country (in tonnes round fresh weight), 1960–2018 (2018 data are provisional).

Year	NAC area			NEAC–N (Northern area)								NEAC–S (Southern area)						Faroes & Greenland				Total nominal catch	
	CA (1)	US	SPM	NO (2)	RU (3)	IS Wild	IS Ranch. (4)	SE Wild	SE Ranch. (5)	DK	FI	IE (6,7)	UK E/W	UK NI (7,8)	UK SO	FR (9)	ES (10)	FO (11)	East GL	West GL (12)	Other (13)	Reported nominal catch	Un-reported catch (14)
1960	1 636	1	-	1 659	1 100	100	-	40	0	-	-	743	283	139	1 443	-	33	-	-	60	-	7 237	-
1961	1 583	1	-	1 533	790	127	-	27	0	-	-	707	232	132	1 185	-	20	-	-	127	-	6 464	-
1962	1 719	1	-	1 935	710	125	-	45	0	-	-	1 459	318	356	1 738	-	23	-	-	244	-	8 673	-
1963	1 861	1	-	1 786	480	145	-	23	0	-	-	1 458	325	306	1 725	-	28	-	-	466	-	8 604	-
1964	2 069	1	-	2 147	590	135	-	36	0	-	-	1 617	307	377	1 907	-	34	-	-	1 539	-	10 759	-
1965	2 116	1	-	2 000	590	133	-	40	0	-	-	1 457	320	281	1 593	-	42	-	-	861	-	9 434	-
1966	2 369	1	-	1 791	570	104	2	36	0	-	-	1 238	387	287	1 595	-	42	-	-	1 370	-	9 792	-
1967	2 863	1	-	1 980	883	144	2	25	0	-	-	1 463	420	449	2 117	-	43	-	-	1 601	-	11 991	-
1968	2 111	1	-	1 514	827	161	1	20	0	-	-	1 413	282	312	1 578	-	38	5	-	1 127	403	9 793	-
1969	2 202	1	-	1 383	360	131	2	22	0	-	-	1 730	377	267	1 955	-	54	7	-	2 210	893	11 594	-
1970	2 323	1	-	1 171	448	182	13	20	0	-	-	1 787	527	297	1 392	-	45	12	-	2 146	922	11 286	-
1971	1 992	1	-	1 207	417	196	8	17	1	-	-	1 639	426	234	1 421	-	16	-	-	2 689	471	10 735	-
1972	1 759	1	-	1 578	462	245	5	17	1	-	32	1 804	442	210	1 727	34	40	9	-	2 113	486	10 965	-
1973	2 434	3	-	1 726	772	148	8	22	1	-	50	1 930	450	182	2 006	12	24	28	-	2 341	533	12 670	-
1974	2 539	1	-	1 633	709	215	10	31	1	-	76	2 128	383	184	1 628	13	16	20	-	1 917	373	11 877	-
1975	2 485	2	-	1 537	811	145	21	26	0	-	76	2 216	447	164	1 621	25	27	28	-	2 030	475	12 136	-
1976	2 506	1	3	1 530	542	216	9	20	0	-	66	1 561	208	113	1 019	9	21	40	<1	1 175	289	9 327	-
1977	2 545	2	-	1 488	497	123	7	9	1	-	59	1 372	345	110	1 160	19	19	40	6	1 420	192	9 414	-
1978	1 545	4	-	1 050	476	285	6	10	0	-	37	1 230	349	148	1 323	20	32	37	8	984	138	7 682	-
1979	1 287	3	-	1 831	455	219	6	11	1	-	26	1 097	261	99	1 076	10	29	119	<0 5	1 395	193	8 118	-
1980	2 680	6	-	1 830	664	241	8	16	1	-	34	947	360	122	1 134	30	47	536	<0 5	1 194	277	10 127	-
1981	2 437	6	-	1 656	463	147	16	25	1	-	44	685	493	101	1 233	20	25	1 025	<0 5	1 264	313	9 954	-
1982	1 798	6	-	1 348	364	130	17	24	1	-	54	993	286	132	1 092	20	10	606	<0 5	1 077	437	8 395	-
1983	1 424	1	3	1 550	507	166	32	27	1	-	58	1 656	429	187	1 221	16	23	678	<0 5	310	466	8 755	-
1984	1 112	2	3	1 623	593	139	20	39	1	-	46	829	345	78	1 013	25	18	628	<0 5	297	101	6 912	-
1985	1 133	2	3	1 561	659	162	55	44	1	-	49	1 595	361	98	913	22	13	566	7	864	-	8 108	-
1986	1 559	2	3	1 598	608	232	59	52	2	-	37	1 730	430	109	1 271	28	27	530	19	960	-	9 255	315
1987	1 784	1	2	1 385	564	181	40	43	4	-	49	1 239	302	56	922	27	18	576	<0 5	966	-	8 159	2 788
1988	1 310	1	2	1 076	420	217	180	36	4	-	36	1 874	395	114	882	32	18	243	4	893	-	7 737	3 248
1989	1 139	2	2	905	364	141	136	25	4	-	52	1 079	296	142	895	14	7	364	-	337	-	5 904	2 277
1990	911	2	2	930	313	141	285	27	6	13	60	567	338	94	624	15	7	315	-	274	-	4 925	1 890
1991	711	1	1	876	215	129	346	34	4	3	70	404	200	55	462	13	11	95	4	472	-	4 106	1 682
1992	522	1	2	867	167	174	462	46	3	10	77	630	171	91	600	20	11	23	5	237	-	4 119	1 962
1993	373	1	3	923	139	157	499	44	12	9	70	541	248	83	547	16	8	23	-	-	-	3 696	1 644
1994	355	0	3	996	141	136	313	37	7	6	49	804	324	91	649	18	10	6	-	-	-	3 945	1 276
1995	260	0	1	839	128	146	303	28	9	3	48	790	295	83	588	10	9	5	2	83	-	3 629	1 060
1996	292	0	2	787	131	118	243	26	7	2	44	685	183	77	427	13	7	-	0	92	-	3 136	1 123
1997	229	0	2	630	111	97	59	15	4	1	45	570	142	93	296	8	4	-	1	58	-	2 364	827
1998	157	0	2	740	131	119	46	10	5	1	48	624	123	78	283	8	4	6	0	11	-	2 395	1 210

Year	NAC area			NEAC–N (Northern area)								NEAC–S (Southern area)						Faroes & Greenland				Total nominal catch	
	CA (1)	US	SPM	NO (2)	RU (3)	IS		SE		DK	FI	IE (6,7)	UK E/W	UK NI (7,8)	UK SO	FR (9)	ES (10)	FO (11)	East GL	West GL (12)	Other (13)	Reported nominal catch	Un-reported catch (14)
						Wild	Ranch. (4)	Wild	Ranch. (5)														
1999	152	0	2	811	103	111	35	11	5	1	62	515	150	53	199	11	6	0	0	19	-	2 247	1 032
2000	153	0	2	1 176	124	73	11	24	9	5	95	621	219	78	274	11	7	8	0	21	-	2 912	1 269
2001	148	0	2	1 267	114	74	14	25	7	6	126	730	184	53	251	11	13	0	0	43	-	3 069	1 180
2002	148	0	2	1 019	118	90	7	20	8	5	93	682	161	81	191	11	9	0	0	9	-	2 654	1 039
2003	141	0	3	1 071	107	99	11	15	10	4	78	551	89	56	192	13	9	0	0	9	-	2 457	847
2004	161	0	3	784	82	111	18	13	7	4	39	489	111	48	245	19	7	0	0	15	-	2 157	686
2005	139	0	3	888	82	129	21	9	6	8	47	422	97	52	215	11	13	0	0	15	-	2 155	700
2006	137	0	3	932	91	93	17	8	6	2	67	326	80	29	192	13	11	0	0	22	-	2 028	670
2007	112	0	2	767	63	93	36	6	10	3	58	85	67	30	171	11	9	0	0	25	-	1 548	475
2008	158	0	4	807	73	132	69	8	10	9	71	89	64	21	161	12	9	0	0	26	-	1 721	443
2009	126	0	3	595	71	126	44	7	10	8	36	68	54	16	121	4	2	0	0.8	26	-	1 318	343
2010	153	0	3	642	88	147	42	9	13	13	49	99	109	12	180	10	2	0	1.7	38	-	1 610	393
2011	179	0	4	696	89	98	30	20	19	13	44	87	136	10	159	11	7	0	0.1	27	-	1 629	421
2012	126	0	3	696	82	50	20	21	9	12	64	88	58	9	124	10	7	0	0.5	33	-	1 412	403
2013	137	0	5	475	78	116	31	11	4	11	46	87	84	4	119	11	5	0	0.0	47	-	1 270	306
2014	118	0	4	490	81	51	18	24	6	9	58	57	54	5	84	12	6	0	0.1	58	-	1 134	287
2015	140	0	4	583	80	94	31	11	7	9	45	63	68	3	68	16	5	0	1.0	56	-	1 284	325
2016	135	0	5	612	56	71	34	6	3	9	51	58	86	4	27	6	5	0	1.5	26	-	1 195	335
2017	110	0	3	666	47	62	24	17	10	12	32	59	49	5	27	10	2	0	0.3	28	-	1 163	353
2018	90	0	1	594	80	66	33	12	4	11	24	58	42	4	19	10	3	0	0.8	39	-	1 090	314
Avg.																							
2013–2017	128	0	4	565	68	79	28	14	6	10	46	65	68	4	65	11	5	0	1	43	-	1 209	321
2008–2017	138	0	4	626	75	95	34	13	9	10	50	75	76	9	107	10	5	0	1	36	-	1 374	361

Country/Jurisdiction codes: CA (Canada), US (United States of America), SPM (Saint Pierre and Miquelon), NO (Norway), RU (Russia), IS (Iceland), SE (Sweden), DK (Denmark), FI (Finland), IE (Ireland), UK E/W (United Kingdon England and Wales), UK NI (Northern Ireland), UK SO (Scotland), FR (France), ES (Spain), FO (Faroes), GL (Greenland).

Footnotes:

1. Includes estimates of some local sales, and, prior to 1984, bycatch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches taken in the recreational (rod) fishery.
4 From 1990, catch includes fish ranched for both commercial and angling purposes.
5. Catches from hatchery-reared smolts released under programmes to mitigate for hydropower development.
6. Improved reporting of rod catches in 1994 and data derived from carcase tagging and logbooks from 2002.
7. Catch on River Foyle allocated 50% to Ireland and 50% to N. Ireland.
8. Angling catch (derived from carcase tagging and logbooks) first included in 2002.
9. Data for France include some unreported catches.
10. Weights estimated from mean weight of fish caught in Asturias (80–90% of Spanish catch).
11. Between 1991 and 1999, there was only a research fishery at Faroes. In 1997 and 1999 no fishery took place; the commercial fishery was resumed in 2000, but has not operated since 2001.
12. Includes catches made in the West Greenland area by Norway, Faroes, Sweden, and Denmark in 1965–1975.
13. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway, and Finland.
14. No unreported catch estimate available for Canada in 2007 and 2008. Data for Canada in 2009 and 2010 are incomplete. No unreported catch estimates available for Russia since 2008.

Table 6 The catches (tonnes round fresh weight) and % of the nominal catches by country taken in coastal, estuarine, and in-river fisheries, 2000 to 2018. Data for 2018 include provisional data.

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	weight
Spain	2000	0	0	0	0	7	100	7
	2001	0	0	0	0	13	100	13
	2002	0	0	0	0	9	100	9
	2003	0	0	0	0	7	100	7
	2004	0	0	0	0	7	100	7
	2005	0	0	0	0	13	100	13
	2006	0	0	0	0	11	100	11
	2007	0	0	0	0	10	100	10
	2008	0	0	0	0	10	100	10
	2009	0	0	0	0	2	100	2
	2010	0	0	0	0	2	100	2
	2011	0	0	0	0	7	100	7
	2012	0	0	0	0	8	100	8
	2013	0	0	0	0	5	100	5
	2014	0	0	0	0	7	100	7
	2015	0	0	0	0	5	100	5
	2016	0	0	0	0	5	100	5
	2017	0	0	0	0	2	100	2
	2018	0	0	0	0	3	100	3
France	2000	0	4	4	35	7	61	11
	2001	0	4	5	44	6	53	11
	2002	2	14	4	30	6	56	12
	2003	0	0	6	44	7	56	13
	2004	0	0	10	51	9	49	19
	2005	0	0	4	38	7	62	11
	2006	0	0	5	41	8	59	13
	2007	0	0	4	42	6	58	11
	2008	1	5	5	39	7	57	12
	2009	0	4	2	34	3	62	5
	2010	2	22	3	26	5	52	10
	2011	0	3	6	54	5	43	11
	2012	0	1	4	44	5	55	10
	2013	0	3	4	40	6	57	11
	2014	0	2	5	43	7	55	12
	2015	4	23	5	32	7	45	16
	2016	0	2	3	45	3	52	6
	2017	1	5	3	36	6	59	10
	2018	0	0	5	54	5	46	10
Ireland	2000	440	71	79	13	102	16	621
	2001	551	75	109	15	70	10	730
	2002	514	75	89	13	79	12	682
	2003	403	73	92	17	56	10	551
	2004	342	70	76	16	71	15	489
	2005	291	69	70	17	60	14	421
	2006	206	63	60	18	61	19	327
	2007	0	0	31	37	52	63	83
	2008	0	0	29	33	60	67	89
	2009	0	0	20	30	47	70	67
	2010	0	0	38	39	60	61	99
	2011	0	0	32	37	55	63	87
	2012	0	0	28	32	60	68	88
	2013	0	0	38	44	49	56	87
	2014	0	0	26	46	31	54	57
	2015	0	0	21	33	42	67	63

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	weight
	2016	0	0	19	33	39	67	58
	2017	0	0	18	31	41	69	59
	2018	0	0	15	26	43	74	58
UK (England & Wales)	2000	157	72	25	12	37	17	219
	2001	129	70	24	13	31	17	184
	2002	108	67	24	15	29	18	161
	2003	42	47	27	30	20	23	89
	2004	39	35	19	17	53	47	111
	2005	32	33	28	29	36	37	97
	2006	30	37	21	26	30	37	80
	2007	24	36	13	20	30	44	67
	2008	22	34	8	13	34	53	64
	2009	20	37	9	16	25	47	54
	2010	64	59	9	8	36	33	109
	2011	93	69	6	5	36	27	136
	2012	26	45	5	8	27	47	58
	2013	61	73	6	7	17	20	84
	2014	41	76	4	8	9	16	54
	2015	55	82	4	6	8	12	68
	2016	71	82	6	6	10	11	86
	2017	36	74	3	7	10	20	49
	2018	36	84	3	8	4	8	42
UK (Scotland)	2000	76	28	41	15	157	57	274
	2001	77	30	22	9	153	61	251
	2002	55	29	20	10	116	61	191
	2003	87	45	23	12	83	43	193
	2004	67	27	20	8	160	65	247
	2005	62	29	27	12	128	59	217
	2006	57	30	17	9	119	62	193
	2007	40	24	17	10	113	66	171
	2008	38	24	11	7	112	70	161
	2009	27	22	14	12	79	66	121
	2010	44	25	38	21	98	54	180
	2011	48	30	23	15	87	55	159
	2012	40	32	11	9	73	59	124
	2013	50	42	26	22	43	36	119
	2014	41	49	17	20	26	31	84
	2015	31	45	9	14	28	41	68
	2016	0	1	10	37	17	63	27
	2017	0	0	7	27	19	73	27
	2018	0	0	12	63	7	37	19
UK (N. Ireland)	2000	63	82	14	18	-	-	77
	2001	41	77	12	23	-	-	53
	2002	40	49	24	29	18	22	81
	2003	25	45	20	35	11	20	56
	2004	23	48	11	22	14	29	48
	2005	25	49	13	25	14	26	52
	2006	13	45	6	22	9	32	29
	2007	6	21	6	20	17	59	30
	2008	4	19	5	22	12	59	21
	2009	4	24	2	15	10	62	16
	2010	5	39	0	0	7	61	12
	2011	3	24	0	0	8	76	10
	2012	0	0	0	0	9	100	9
	2013	0	1	0	0	4	99	4
	2014	0	0	0	0	2	100	2

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	weight
	2015	0	0	0	0	3	100	3
	2016	0	0	0	0	5	100	5
	2017	0	0	0	0	5	100	5
	2018	0	0	0	0	4	100	4
Iceland	2000	0	0	0	0	85	100	85
	2001	0	0	0	0	88	100	88
	2002	0	0	0	0	97	100	97
	2003	0	0	0	0	110	100	110
	2004	0	0	0	0	130	100	130
	2005	0	0	0	0	149	100	149
	2006	0	0	0	0	111	100	111
	2007	0	0	0	0	129	100	129
	2008	0	0	0	0	200	100	200
	2009	0	0	0	0	171	100	171
	2010	0	0	0	0	190	100	190
	2011	0	0	0	0	128	100	128
	2012	0	0	0	0	70	100	70
	2013	0	0	0	0	147	100	147
	2014	0	0	0	0	68	100	68
	2015	0	0	0	0	125	100	125
	2016	0	0	0	0	105	100	105
	2017	0	0	0	0	86	100	86
	2018	0	0	0	0	98	100	98
Denmark	2000							
	2001							
	2002							
	2003							
	2004							
	2005							
	2006							
	2007							
	2008	0	1	0	0	9	99	9
	2009	0	0	0	0	8	100	8
	2010	0	1	0	0	13	99	13
	2011	0	0	0	0	13	100	13
	2012	0	0	0	0	12	100	12
	2013	0	0	0	0	11	100	11
	2014	0	0	0	0	9	100	9
	2015	0	0	0	0	9	100	9
	2016	0	0	0	0	10	100	10
	2017	0	1	0	0	12	99	12
	2018	0	1	0	0	11	99	11
Sweden	2000	10	30	0	0	23	70	33
	2001	9	27	0	0	24	73	33
	2002	7	25	0	0	21	75	28
	2003	7	28	0	0	18	72	25
	2004	3	16	0	0	16	84	19
	2005	1	7	0	0	14	93	15
	2006	1	7	0	0	13	93	14
	2007	0	1	0	0	16	99	16
	2008	0	1	0	0	18	99	18
	2009	0	3	0	0	17	97	17
	2010	0	0	0	0	22	100	22
	2011	10	26	0	0	29	74	39
	2012	7	24	0	0	23	76	30
	2013	0	0	0	0	15	100	15

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	weight
	2014	0	0	0	0	30	100	30
	2015	0	0	0	0	18	100	18
	2016	0	0	0	0	9	100	9
	2017	0	0	0	0	18	100	18
	2018	0	0	0	0	17	100	17
Norway	2000	619	53	0	0	557	47	1176
	2001	696	55	0	0	570	45	1266
	2002	596	58	0	0	423	42	1019
	2003	597	56	0	0	474	44	1071
	2004	469	60	0	0	316	40	785
	2005	463	52	0	0	424	48	888
	2006	512	55	0	0	420	45	932
	2007	427	56	0	0	340	44	767
	2008	382	47	0	0	425	53	807
	2009	284	48	0	0	312	52	595
	2010	260	41	0	0	382	59	642
	2011	302	43	0	0	394	57	696
	2012	255	37	0	0	440	63	696
	2013	192	40	0	0	283	60	475
	2014	213	43	0	0	277	57	490
	2015	233	40	0	0	350	60	583
	2016	269	44	0	0	343	56	612
	2017	290	44	0	0	376	56	666
	2018	323	54	0	0	271	46	594
Finland	2000	0	0	0	0	96	100	96
	2001	0	0	0	0	126	100	126
	2002	0	0	0	0	94	100	94
	2003	0	0	0	0	75	100	75
	2004	0	0	0	0	39	100	39
	2005	0	0	0	0	47	100	47
	2006	0	0	0	0	67	100	67
	2007	0	0	0	0	59	100	59
	2008	0	0	0	0	71	100	71
	2009	0	0	0	0	38	100	38
	2010	0	0	0	0	49	100	49
	2011	0	0	0	0	44	100	44
	2012	0	0	0	0	64	100	64
	2013	0	0	0	0	46	100	46
	2014	0	0	0	0	58	100	58
	2015	0	0	0	0	45	100	45
	2016	0	0	0	0	51	100	51
	2017	0	0	0	0	32	100	32
	2018	0	0	0	0	24	100	24
Russia	2000	64	52	15	12	45	36	124
	2001	70	61	0	0	44	39	114
	2002	60	51	0	0	58	49	118
	2003	57	53	0	0	50	47	107
	2004	46	56	0	0	36	44	82
	2005	58	70	0	0	25	30	82
	2006	52	57	0	0	39	43	91
	2007	31	50	0	0	31	50	63
	2008	33	45	0	0	40	55	73
	2009	22	31	0	0	49	69	71
	2010	36	41	0	0	52	59	88
	2011	37	42	0	0	52	58	89
	2012	38	46	0	0	45	54	82

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	weight
	2013	36	46	0	0	42	54	78
	2014	33	41	0	0	48	59	81
	2015	34	42	0	0	46	58	80
	2016	24	42	0	0	32	58	56
	2017	13	28	0	0	34	72	47
	2018	36	45	0	0	44	55	80
Canada	2000	2	2	29	19	117	79	148
	2001	3	2	28	20	112	78	143
	2002	4	2	30	20	114	77	148
	2003	5	3	36	27	96	70	137
	2004	7	4	46	29	109	67	161
	2005	7	5	44	32	88	63	139
	2006	8	6	46	34	83	60	137
	2007	6	5	36	32	70	63	112
	2008	9	6	47	32	92	62	147
	2009	7	6	40	33	73	61	119
	2010	6	4	40	27	100	69	146
	2011	7	4	56	31	115	65	178
	2012	8	6	46	36	73	57	127
	2013	8	6	49	36	80	58	137
	2014	7	6	28	24	83	71	118
	2015	8	6	35	25	97	69	140
	2016	24	42	0	0	32	58	56
	2017	13	28	0	0	34	72	47
	2018	7	8	46	51	37	41	90
France (Islands of St. Pierre and Miquelon)	2000	2	100	0	0	0	0	2
	2001	2	100	0	0	0	0	2
	2002	2	100	0	0	0	0	2
	2003	3	100	0	0	0	0	3
	2004	3	100	0	0	0	0	3
	2005	3	100	0	0	0	0	3
	2006	4	100	0	0	0	0	4
	2007	2	100	0	0	0	0	2
	2008	3	100	0	0	0	0	3
	2009	3	100	0	0	0	0	3
	2010	3	100	0	0	0	0	3
	2011	4	100	0	0	0	0	4
	2012	1	100	0	0	0	0	1
	2013	5	100	0	0	0	0	5
	2014	4	100	0	0	0	0	4
	2015	4	100	0	0	0	0	4
	2016	5	100	0	0	0	0	5
	2017	3	100	0	0	0	0	3
	2018	1	100	0	0	0	0	1
Total NEAC	2018	396	41	34	4	531	55	960
Total NAC	2018	8	9	46	51	36	40	91

Table 7 Estimates for 2018 of unreported catches by various methods, in tonnes by country/jurisdiction within national EEZs in the North East Atlantic, North American, and West Greenland commissions of NASCO.

Commission area	Country/Jurisdiction	Unreported catch (tonnes)	Unreported as % of total North Atlantic catch (Unreported + reported)	Unreported as % of total national catch (Unreported)
NEAC	Denmark	5	0.3	31
NEAC	Finland	3	0.2	11
NEAC	Iceland	2	0.1	2
NEAC	Ireland	6	0.4	9
NEAC	Norway	255	16.6	30
NEAC	Sweden	2	0.1	12
NEAC	UK (England & Wales)	5	0.3	11
NEAC	UK (N. Ireland)	0	0.0	6
NEAC	UK (Scotland)	2	0.1	9
NAC	USA	0	0.0	0
NAC	Canada	24	1.6	21
WGC	Greenland	10	0.7	20
Total unreported catch *		314	22.4	
Total reported catch of North Atlantic salmon		1087		

* No unreported catch estimates are available for France, Spain, St. Pierre and Miquelon, or Russia in 2018.

Table 8 Numbers of fish caught-and-released (C&R) in angling fisheries along with the % of the total angling catch (released + retained) for countries in the North Atlantic where records are available, 1991–2018. Data for 2018 are provisional.

Year	Canada [4]		USA		Iceland		Russia [1]		UK (E and W)		UK (Scotland)		Ireland		UK (N. Ireland) [2]		Denmark		Sweden		Norway [3]	
	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch	Total C&R	% of rod catch
1991	22 167	28	239	50			3 211	51														
1992	37 803	29	407	67			10 120	73														
1993	44 803	36	507	77			11 246	82	1 448	10												
1994	52 887	43	249	95			12 056	83	3 227	13	6 595	8										
1995	46 029	46	370	100			11 904	84	3 189	20	12 151	14										
1996	52 166	41	542	100	669	2	10 745	73	3 428	20	10 413	15										
1997	50 009	50	333	100	1 558	5	14 823	87	3 132	24	10 965	18										
1998	56 289	53	273	100	2 826	7	12 776	81	4 378	30	13 464	18										
1999	48 720	50	211	100	3 055	10	11 450	77	4 382	42	14 846	28										
2000	64 482	56	0	-	2 918	11	12 914	74	7 470	42	21 072	32										
2001	59 387	55	0	-	3 611	12	16 945	76	6 143	43	27 724	38										
2002	50 924	52	0	-	5 985	18	25 248	80	7 658	50	24 058	42										
2003	53 645	55	0	-	5 361	16	33 862	81	6 425	56	29 170	55										
2004	62 316	57	0	-	7 362	16	24 679	76	13 211	48	46 279	50					255	19				
2005	63 005	62	0	-	9 224	17	23 592	87	11 983	56	46 165	55	2 553	12			606	27				
2006	60 486	62	1	100	8 735	19	33 380	82	10 959	56	47 669	55	5 409	22	302	18	794	65				
2007	41 192	58	3	100	9 691	18	44 341	90	10 917	55	55 660	61	15 113	44	470	16	959	57				
2008	54 887	53	61	100	17 178	20	41 881	86	13 035	55	53 347	62	13 563	38	648	20	2 033	71			5 512	5
2009	52 151	59	0	-	17 514	24			9 096	58	48 436	67	11 422	39	847	21	1 709	53			6 696	6
2010	55 895	53	0	-	21 476	29	14 585	56	15 012	60	78 041	70	15 142	40	823	25	2 512	60			15 041	12
2011	71 358	57	0	-	18 593	32			14 406	62	64 870	73	12 688	38	1 197	36	2 153	55	424	5	14 303	12
2012	43 287	57	0	-	9 752	28	4 743	43	11 952	65	63 628	74	11 891	35	5 014	59	2 153	55	404	6	18 611	14
2013	50 630	59	0	-	23 133	34	3 732	39	10 458	70	54 002	80	10 682	37	1 507	64	1 932	57	274	9	15 953	15
2014	41 613	54	0	-	13 616	41	8 479	52	7 992	78	37 355	82	6 537	37	1 065	50	1 918	61	982	15	20 281	19
2015	65 440	64	0	-	21 914	31	7 028	50	8 113	79	46 836	84	9 383	37	111	100	2 989	70	647	18	25 433	19
2016	68 925	65	0	-	22 751	43	10 793	76	9 700	80	49 469	90	10 280	41	280	100	3 801	72	362	17	25 198	21
2017	57 357	66	0	-	19 667	42	10 110	77	11 255	83	44 257	90	11 259	36	126	100	4 435	69	625	17	25 924	21
2018	50 184	73	0	-	20 957	42	10 779	73	6 486	88	34 721	93	12 562	32	3 249	65	4 613	79	710	19	22 024	22
Avg. 2013–2017	56 793	62	0	-	20 216	38	8 028	59	9 504	78	46 384	85	9 628	38	618	83	3 015	66	578	15	22 558	19
% change from Avg. 2013–2017	−12	19	-	-	4	10	34	24	−32	13	−25	9	30	−15	426	−21	53	20	23	25	−2	18

1. Since 2009 data have been either unavailable or incomplete; however, catch-and-release is understood to have remained at similar high levels as before.
2. Data for 2006–2009. 2014 is for the DCAL area only; the figures from 2010 are a total for UK (N. Ireland). Data for 2015, 2016, and 2017 are for River Bush only.
3. The statistics were collected on a voluntary basis; the numbers reported must be viewed as a minimum.
4. The numbers of released fish in the kelt fishery of New Brunswick are not included in the totals for Canada.

Annex 1 Glossary of acronyms and abbreviations

1SW (*one-sea-winter*). Maiden adult salmon that has spent one winter at sea.

2SW (*two-sea-winter*). Maiden adult salmon that has spent two winters at sea.

ACOM (*ICES Advisory Committee*). The Committee works on the basis of scientific assessment prepared in ICES expert groups. The advisory process includes peer review of the assessment before it can be used as the basis for advice. The Advisory Committee has one member from each ICES Member Country under the direction of an independent chair appointed by the Council.

AST *(Atlantic Salmon Trust).* A non-governmental organization dedicated to salmon and sea trout survival through research on the problems impacting migratory salmonids.

CL, i.e. S_{lim} (*conservation limit*). Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective of fisheries management will be to ensure a high probability of undesirable levels being avoided.

C&R (*catch-and-release*). Catch-and-release is a practice within recreational fishing intended as a technique of conservation. After capture, the fish are unhooked and returned to the water before experiencing serious exhaustion or injury. Using barbless hooks, it is often possible to release the fish without removing it from the water (a slack line is frequently sufficient).

CWT (*coded wire tag*). The CWT is a length of magnetized stainless steel wire 0.25 mm in diameter. The tag is marked with rows of numbers denoting specific batch or individual codes. Tags are cut from rolls of wire by an injector that hypodermically implants them into suitable tissue. The standard length of a tag is 1.1 mm.

DBERAAS (*Database on Effectiveness of Recovery Actions for Atlantic Salmon*). Database output from ICES Working Group on Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS).

DFO *(Department of Fisheries and Oceans*). DFO and its Special Operating Agency, the Canadian Coast Guard, deliver programmes and services that support sustainable use and development of Canada's waterways and aquatic resources.

DNA (*deoxyribonucleic acid*). DNA is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms (with the exception of RNA – Ribonucleic Acid viruses). The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints, like a recipe or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules.

DST *(data storage tag*). A miniature data logger that is attached to fish and other marine animals, measuring salinity, temperature, and depth.

eDNA *(environmental DNA).* DNA that is collected from environmental samples such as soil, water, or air, rather than directly sampled from an individual organism. As various organisms interact with the environment, DNA is released and accumulates in their surroundings.

EEZ *(Exclusive Economic Zone*). EEZ is a concept adopted at the Third United Nations Conference on the Law of the Sea, whereby a coastal state assumes jurisdiction over the exploration and exploitation of marine resources in its adjacent section of the continental shelf, taken to be a band extending 200 miles from the shore.

FWI (*Framework of Indicators*). The FWI is a tool used to indicate if any significant change has occurred in the status of stocks used to inform the previously provided multiannual management advice.

IASRB (*International Atlantic Salmon Research Board*). A platform established by NASCO in 2001 to encourage and facilitate cooperation and collaboration on research related to marine mortality in Atlantic salmon.

ICES (*International Council for the Exploration of the Sea*). A global organization that develops science and advice to support the sustainable use of the oceans through the coordination of oceanic and coastal monitoring and research, and advising international commissions and governments on marine policy and management issues.

IESSNS (*International Ecosystem Survey of the Nordic Seas*). A collaborative programme involving research vessels from Iceland, the Faroe Islands, and Norway.

IHN *(Infectious Haematopoietic Necrosis).* An infectious disease caused by the IHN virus.

IPN *(Infectious Pancreatic Necrosis).* An infectious disease caused by the IPN virus.

ISA *(Infectious Salmon Anaemia).* An infectious disease caused by the ISA virus.

MSA (*mixed-stock analysis*). Genetic analytical technique to estimate the proportions of various origins of fish in a mixed-stock fishery.

MSAT *(microsatellite).* A tract of repetitive DNA in which certain DNA motifs are repeated, typically 5–50 times. Can be used to estimate the region of origin for salmon.

MSY (*maximum sustainable yield*). The largest average annual catch that may be taken from a stock continuously without affecting the catch of future years. A constant long-term MSY is not a reality in most fisheries, where stock sizes vary with the strength of year classes moving through the fishery.

MSW (*multi-sea-winter*). A MSW salmon is an adult salmon that has spent two or more winters at sea and may be a repeat spawner.

NAC (*North American Commission*). The North American Atlantic Commission of NASCO or the North American Commission area of NASCO.

NAFO (*Northwest Atlantic Fisheries Organization*). NAFO is an intergovernmental fisheries science and management organization that ensures the long-term conservation and sustainable use of the fishery resources in the Northwest Atlantic.

NASCO (*North Atlantic Salmon Conservation Organization*). An international organization, established by an inter-governmental convention in 1984. The objective of NASCO is to conserve, restore, enhance, and rationally manage the fisheries of Atlantic salmon through international cooperation, taking account of the best available scientific information.

NEAC (*North-East Atlantic Commission*). The North-East Atlantic Commission of NASCO or the North-East Atlantic Commission area of NASCO.

NEAC–N (*North-East Atlantic Commission- northern area*). The northern portion of the North-East Atlantic Commission area of NASCO.

NEAC–S (*North-East Atlantic Commission – southern area*). The southern portion of the North-East Atlantic Commission area of NASCO.

NPAFC (*North Pacific Anadromous Fish Commission*). An international intergovernmental organization established by the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean. The Convention was signed on February 11, 1992, and took effect on February 16, 1993. The member countries are Canada, Japan, Republic of Korea, Russian Federation, and United States of America. As defined in the Convention, the primary objective of the NPAFC is to promote the conservation of anadromous stocks in the Convention Area. The Convention Area is the international waters of the North Pacific Ocean and its adjacent seas north of 33°North beyond the 200-mile zones (exclusive economic zones) of the coastal States.

PFA (*pre-fishery abundance*). The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time. In the previous version of the stock complex Bayesian PFA forecast model two productivity parameters are calculated, for the *maturing* (PFAm) and *non-maturing* (PFAnm) components of the PFA. In the updated version only one productivity parameter is calculated; this parameter is used to calculate total PFA, which is then split into PFAm and PFAnm based upon the *proportion of PFAm* (p.PFAm).

PIT (*passive integrated transponder*). PIT tags use radio frequency identification technology. PIT tags lack an internal power source. They are energized on encountering an electromagnetic field emitted from a transceiver. The tag's unique identity code is programmed into the microchip's nonvolatile memory.

ROO *(region of origin)*

RVS (*red vent syndrome*). This condition has been noted since 2005, and has been linked to the presence of a nematode worm, *Anisakis simplex*. This is a common parasite of marine fish and is also found in migratory species. The larval nematode stages in fish are usually found spirally coiled on the mesenteries, internal organs, and less frequently in the somatic muscle of host fish.

SALSEA (*Salmon at Sea*). An international programme of cooperative research, adopted in 2005, designed to improve understanding of the migration and distribution of salmon at sea in relation to feeding opportunities and predation.

SALSEA-Track (*Salmon at Sea Track*). SALSEA-Track is the second phase of the SALSEA programme. It employs advances in telemetry technology to precisely track Atlantic salmon along their migration routes through cooperative international research initiatives.

SER (*spawning escapement reserve*). The CL increased to take account of natural mortality between the recruitment date (assumed to be 1st of January) and the date of return to home waters.

S_{lim}, i.e. CL (*conservation limit*). Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing fisheries of these stocks will be to ensure that there is a high probability that the undesirable levels are avoided.

S_{MSY} (*spawners for maximum sustainable yield*). The spawner abundance that generates recruitment at a level that provides a maximum exploitable yield (recruitment minus spawners).

SNP (*Single Nucleotide Polymorphism*). Type of genetic marker used in stock identification and population genetic studies.

S–R (*stock–recruitment*).

TAC (*total allowable catch*). TAC is the quantity of fish that can be taken from each stock each year.

ToR (*terms of reference*).

UDN (*Ulcerative Dermal Necrosis*). Disease mainly affecting wild Atlantic salmon, sea trout, and sometimes other salmonids. It usually occurs in adult fish returning from the sea in the colder months of the year and starts as small lesions on the scaleless regions of the fish, mainly on the snout, above the eye, and near the gill cover. On entry to freshwater lesions ulcerate and may become infected with secondary pathogens like the fungus *Saprolegnia* spp. Major outbreaks of UDN occurred in the 1880s (UK) and 1960s–1970s (UK and Ireland), but the disease has also been reported from France, and in 2015 from the Baltic and Russia.

VHS *(Viral Haemorrhagic Septicaemia)*. An infectious fish disease caused by the VHS virus.

WGC (*West Greenland Commission*). The West Greenland Commission of NASCO or the West Greenland Commission area of NASCO.

WGF (*West Greenland Fishery*). Regulatory measures for the WGF have been agreed by the West Greenland Commission of NASCO for most years since NASCO's establishment. These have resulted in greatly reduced allowable catches in the WGF, reflecting declining abundance of the salmon stocks in the area.

WGNAS (*Working Group on North Atlantic Salmon*). ICES working group responsible for the annual assessment of the status of salmon stocks across the North Atlantic and formulating catch advice for NASCO.

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Atlantic salmon from the Northeast Atlantic

Summary of advice for fishing seasons 2019/2020 and 2020/2021

ICES advises that when the Framework of Indicators (FWI) was applied in 2019 there was no indication of underestimated abundance forecasts. A full reassessment was, therefore, not required in 2019 and the 2018 ICES advice remains valid: "when the MSY approach is applied there are no mixed-stock fisheries options on the NEAC complexes at the Faroes for the fishing seasons 2018/2019 to 2020/2021".

The FWI previously developed in support of the multiyear catch advice was revised in 2018. ICES recommended that, since the zero catch options at Faroes are the result of the current status of both Southern NEAC stock complexes (i.e. maturing and non-maturing sea age groups) and the Northern NEAC maturing stock complex, the FWI applied in January 2019 and 2020 should be based only on these three stock complexes (ICES, 2018a). NASCO agreed that this revised FWI would be used in these years.

ICES advises that when the MSY approach is applied, fishing should only take place on salmon from rivers where stocks have been shown to be 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 2.1 NASCO has asked ICES to describe the key events of the 2018 fisheries

No significant changes in gear type used were reported in the NEAC area in 2018.

No fishery for salmon has been prosecuted at the Faroes since 2000.

Reported nominal catch in the NEAC area in 2018 is 960 t, with 136 t reported in the Southern NEAC and 824 t in the Northern NEAC areas. Estimates of unreported catches in the NEAC area were 279 t in total. As in previous years, the location of catches differed between Southern NEAC and Northern NEAC (Table 1). In 2018, in-river fisheries accounted for 48% of the catches in Southern NEAC; this figure was 26% for estuarine fisheries, and 26% from coastal fisheries. In Northern NEAC, coastal fisheries accounted for 44% of the catches, with the remaining 56% of the catches coming from in-river fisheries.

Table 1 Salmon catches (in t)	Southern NEAC	Northern NEAC	Faroes	Total NEAC
2018 nominal catch (tonnes)	136	824	0	960
Catch as % of NEAC total	14	86	0	
Unreported catch (tonnes)	13	266	-	279
Location of catches	Southern NEAC	Northern NEAC	Faroes	Total NEAC
% in-river	48	56	-	55
% in estuaries	26	0	-	4
% coastal	26	44	-	41

The NEAC area has seen a general reduction in catches since the 1980s (Figure 1, Table 2). This reflects the decline in fishing effort as a consequence of management measures, as well as a reduction in the size of stocks. The nominal catch for 2018 (960 t) was below that in 2017 (1020 t), and among the lowest in the time-series in both areas (lowest in the time-series for Southern NEAC). The catch in Southern NEAC, which constituted around two-thirds of the total NEAC catch in the early 1970s, has been lower than that in Northern NEAC since 1999 (Figure 1).

1SW salmon constituted 60% of the total catch in Northern NEAC in 2018 (Figure 2). For the Southern NEAC countries, the overall percentage of 1SW fish in the catch in 2018 was estimated at 50%.

The contribution of escaped farmed salmon to national catches in the NEAC area in 2018 was generally low in most countries, and similar to the values that have been reported in previous years. Estimates of farmed fish in Norwegian angling catches were in the lower range of observed values in the time-series (3%), while the proportion estimated in Norwegian river populations in the autumn was equal to the lowest in the time-series (4%). No current data are available for the proportion of farmed salmon in coastal fisheries. Small numbers of escaped farmed salmon (11 fish) were also reported from catches in Icelandic rivers in 2018; low proportions (< 0.5%) were also reported in catches from Ireland and UK (Scotland).

Estimated exploitation rates have decreased since the early 1980s in both the Northern and Southern NEAC areas (Figure 3). The exploitation rates on 1SW and MSW salmon have become similar, with higher exploitation rates in Northern NEAC at around 40% compared to 10% in Southern NEAC.

Estimates of the number of salmon caught and released in angling fisheries are not complete for all NEAC countries. There are large differences between countries in the percentage of the total angling catch that is released: in 2018 this ranged from 19% in Sweden to 93% in UK (Scotland), reflecting varying management practices and angler attitudes among these countries. There are also catch and release mortality estimated for some countries, but these are not included in the nominal catch.

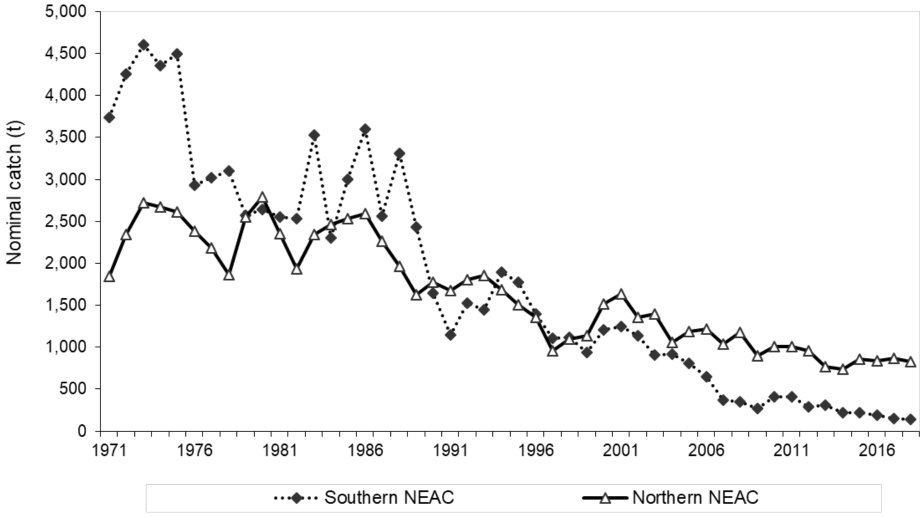

Figure 1 Nominal catches of salmon in the Southern NEAC and Northern NEAC areas (1971–2018).

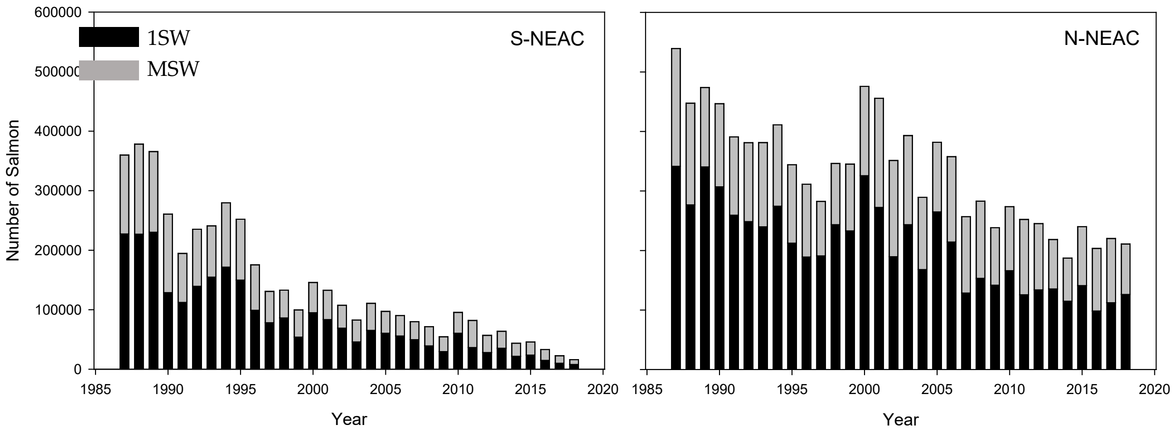

Figure 2 Number of 1SW (black bar) and MSW (grey bar) salmon in the reported catch for Southern NEAC (left) and Northern NEAC (right) areas, 1987–2018.

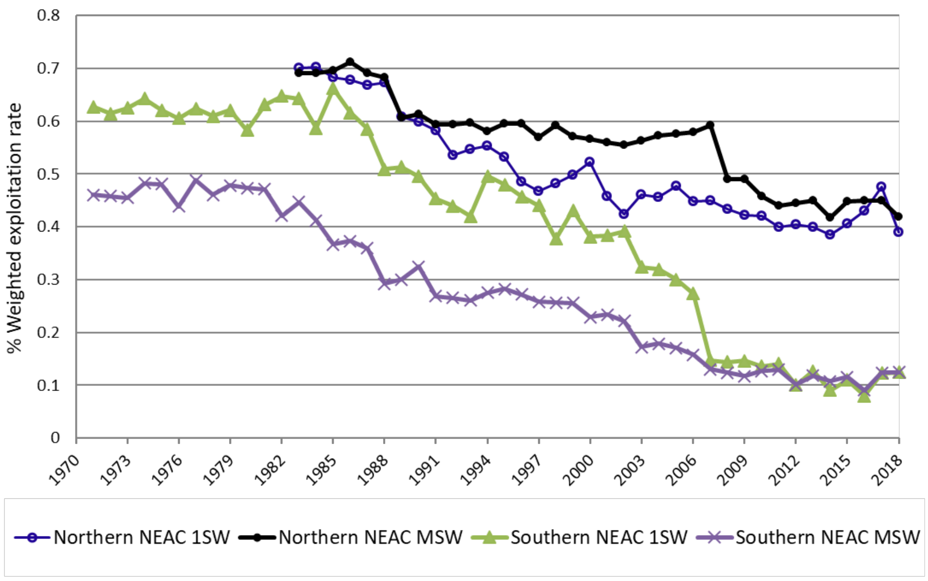

Figure 3 Exploitation rates of 1SW and MSW salmon in homewater fisheries in the Northern (1983–2018) and Southern (1971–2018) NEAC areas.

Table 2 Nominal catch of salmon in the NEAC area (in t, round fresh weight), 1960 to 2018 (2018 figures are provisional).

Year	Southern NEAC	Northern NEAC[1]	Faroes[2]	Other catches in international waters	Total reported catch	Unreported catches	
						NEAC area[3]	International waters[4]
1960	2641	2899	-	-	5540	-	-
1961	2276	2477	-	-	4753	-	-
1962	3894	2815	-	-	6709	-	-
1963	3842	2434	-	-	6276	-	-
1964	4242	2908	-	-	7150	-	-
1965	3693	2763	-	-	6456	-	-
1966	3549	2503	-	-	6052	-	-
1967	4492	3034	-	-	7526	-	-
1968	3623	2523	5	403	6554	-	-
1969	4383	1898	7	893	7181	-	-
1970	4048	1834	12	922	6816	-	-
1971	3736	1846	-	471	6053	-	-
1972	4257	2340	9	486	7092	-	-
1973	4604	2727	28	533	7892	-	-
1974	4352	2675	20	373	7420	-	-
1975	4500	2616	28	475	7619	-	-
1976	2931	2383	40	289	5643	-	-
1977	3025	2184	40	192	5441	-	-
1978	3102	1864	37	138	5141	-	-
1979	2572	2549	119	193	5433	-	-
1980	2640	2794	536	277	6247	-	-
1981	2557	2352	1025	313	6247	-	-
1982	2533	1938	606	437	5514	-	-
1983	3532	2341	678	466	7017	-	-
1984	2308	2461	628	101	5498	-	-
1985	3002	2531	566	-	6099	-	-
1986	3595	2588	530	-	6713	-	-
1987	2564	2266	576	-	5406	2554	-
1988	3315	1969	243	-	5527	3087	-
1989	2433	1627	364	-	4424	2103	-
1990	1645	1775	315	-	3735	1779	180–350
1991	1145	1677	95	-	2917	1555	25–100

Year	Southern NEAC	Northern NEAC[1]	Faroes[2]	Other catches in international waters	Total reported catch	Unreported catches	
						NEAC area[3]	International waters[4]
1992	1523	1806	23	-	3352	1825	25–100
1993	1443	1853	23	-	3319	1471	25–100
1994	1896	1684	6	-	3586	1157	25–100
1995	1775	1503	5	-	3283	942	-
1996	1392	1358	-	-	2750	947	-
1997	1112	962	-	-	2074	732	-
1998	1120	1099	6	`	2225	1108	-
1999	934	1139	0	-	2073	887	-
2000	1210	1518	8	-	2736	1135	-
2001	1242	1634	0	-	2876	1089	-
2002	1135	1360	0	-	2496	946	-
2003	908	1394	0	-	2303	719	-
2004	919	1059	0	-	1978	575	-
2005	809	1189	0	-	1998	605	-
2006	650	1217	0	-	1867	604	-
2007	373	1036	0	-	1408	465	-
2008	355	1178	0	-	1533	433	-
2009	266	898	0	-	1164	317	-
2010	411	1003	0	-	1414	357	-
2011	410	1009	0	-	1419	382	-
2012	295	955	0	-	1250	363	-
2013	310	770	0	-	1080	272	-
2014	218	736	0	-	954	256	-
2015	222	859	0	-	1081	298	-
2016	186	842	0	-	1028	298	-
2017	150	870	0		1020	318	-
2018	136	824	0	-	960	279	-
Average							
2013–2017	234	815	0	-	1032	288	-
2008–2017	282	912	0	-	1194	329	-

[1] All Icelandic catches have been included in Northern NEAC.
[2] Since 1991, fishing carried out at the Faroes has only been for research purposes.
[3] No unreported catch estimate available for Russia since 2008.
[4] Estimates refer to season ending in the given year.

NASCO 2.2 NASCO has asked ICES to review and report on the development of age-specific stock conservation limits

River-specific conservation limits (CLs) (in terms of either egg or spawner requirements) for both 1SW and MSW salmon have been estimated for stocks in most countries/jurisdictions in the NEAC area (France, Ireland, UK (England & Wales), UK (Northern Ireland), Finland, Norway, and Sweden). Preliminary results are also available for a small number of rivers in Russia. Where sufficient numbers of CL estimates are available for individual rivers, these are summed to provide estimates at a country/jurisdiction level. For countries/jurisdictions that have not applied this approach (Russia, UK (Scotland), and Iceland), an interim approach has been used for estimating national CLs. This approach is based on the establishment of pseudo stock–recruitment relationships for salmon stocks that are updated annually and as a result the CLs may change slightly year to year.

In UK (Scotland), there has been further progress in establishing CLs at the scale of the river stock, or on groups of smaller neighbouring rivers where angling data are not yet available by river. A new approach to defining river-specific CLs has been developed using a Bayesian hierarchical modelling framework. This has been used to define CLs for 11 Scottish rivers with stock and recruitment data. By pooling information from multiple rivers and incorporating information about local environmental covariates, CL estimates have also been transferred to other rivers without such data. Developments are

continuing to investigate whether alternative stock–recruitment relationships and additional river covariates can improve the current model.
To provide catch advice to NASCO, CLs are required for stock complexes. These have been derived either by summing individual river CLs to country/jurisdiction level, or by taking overall CLs as provided by the model, and then summing to the level of the four NEAC stock complexes. Spawner escapement reserves (SERs) are CLs (expressed in terms of spawner numbers), adjusted to take account of natural mortality (M = 0.03 per month) between 1 January of the first winter at sea and return time to homewaters for each of the maturing (6–9 months) and non-maturing (16–21 months) 1SW salmon components from the Northern NEAC and Southern NEAC stock complexes.

National stocks within the NEAC area are combined into two geographic groups for the provision of management advice for the distant-water fisheries at West Greenland and the Faroes. The Northern group consists of Russia, Finland, Norway, Sweden, and the northeastern region of Iceland. The Southern group consists of UK (Scotland), UK (England & Wales), UK (Northern Ireland), Ireland, France, and the southwestern region of Iceland.

CLs and SERs are provided for the four stock complexes, defined as two sea ages per geographic group (Table 3), by summing country/jurisdiction CLs to the level of the four NEAC stock complexes.

Table 3 Conservation limits (CL) and spawner escapement reserves (SER) for the salmon stock complexes in the NEAC area in 2018.

Complex	Age group	CL (number)	SER (number)
Northern NEAC	1SW	131 753	166 564
	MSW	119 717	203 658
Southern NEAC	1SW	600 500	761 074
	MSW	292 241	493 022

For the nine countries/jurisdictions where river-specific CLs are available, time-series indicating the development in the definition of river-specific CLs, the number of rivers annually assessed against CLs, and the number of rivers that annually meet or exceed CLs (based on spawner numbers, after fisheries) are provided in Figure 4. This figure illustrates the increase in the number of CLs established within individual countries/jurisdictions. Iceland has one river with an established CL and this river has been assessed annually since 2000. Ten of the 17 year time-series has been below the CL and four out of the past five years have been above the CL. The time-series for the river in Iceland is not included in Figure 4 or Table 4.

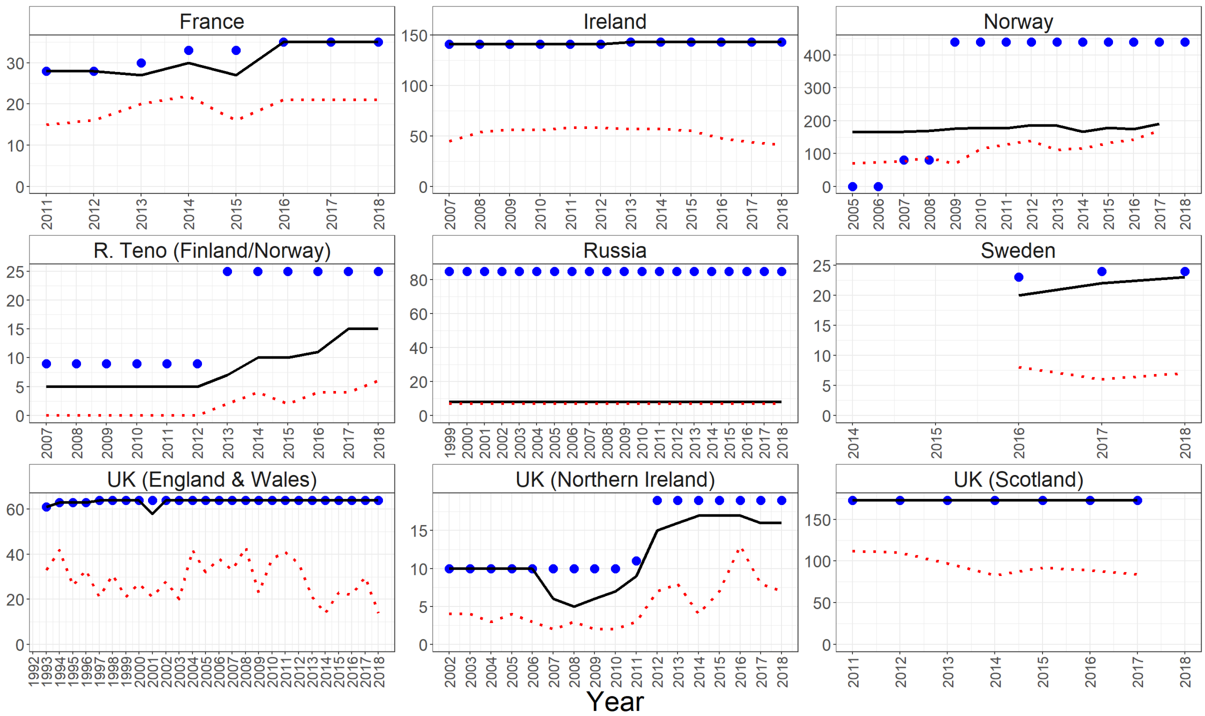

Figure 4 Time-series of countries/jurisdictions in the NEAC area, showing the number of rivers with established CLs and trends in the number of stocks meeting CLs (•–•–• number of rivers with established CLs; — number of rivers assessed for attainment of CLs; . . . . . . number of rivers meeting or exceeding CLs).

NASCO 2.3 NASCO has asked ICES to describe the status of the stocks

Recruitment, expressed as pre-fishery abundance (PFA; split by maturing and non-maturing 1SW salmon, at 1 January of the first winter at sea) is estimated by geographic groups (Northern NEAC and Southern NEAC), and individual country/jurisdiction, and assessed relative to the spawner escapement reserve (SER).

The assessment of PFA against SER for the four complexes over the time-series is shown in Figure 5, and by country/jurisdiction for the most recent year in Figure 6. The time-series of returns and spawners against CLs are shown by sea age groups for the Northern NEAC and Southern NEAC complexes (Figure 5) and for 2018 by individual countries/jurisdictions for 1SW maturing and MSW (1SW non-maturing at the PFA stage) salmon (Figure 6). These assessments show the same broad contrasts between Northern and Southern NEAC stocks that are seen in the stock complex data.

PFA relative to SER

For Northern NEAC PFAs of both maturing 1SW and non-maturing 1SW salmon show a general decline over the time period (since 1983), with the decline being more marked in the maturing 1SW stock (Figure 5, Tables 5 and 6). Both stock complexes have, however, been at full reproductive capacity prior to the distant-water fisheries (i.e. meeting the SER with at least 95% probability) throughout the time-series. In the most recent year, both maturing and non-maturing 1SW salmon in all Northern NEAC countries were at full reproductive capacity with the exception of non-maturing 1SW salmon in Finland (River Tana/Teno) which was at risk of suffering reduced reproductive capacity (Figure 6).

For Southern NEAC PFAs of maturing 1SW and of non-maturing 1SW salmon (Figure 5, Tables 5 and 6) demonstrate broadly similar declining trends over the time period (since 1971). Both stock complexes were at full reproductive capacity prior to distant-water fisheries throughout the early part of the time-series. However, in most years since the early 1990s, the non-maturing 1SW stock has either been at risk of suffering or suffering reduced reproductive capacity before any fisheries took place. The maturing 1SW stock, on the other hand, was first assessed as being at risk of suffering reduced reproductive capacity in 2009, and has been either at risk of suffering or suffering reduced reproductive capacity in the majority of the years since then. With the exception of UK (Northern Ireland), the maturing 1SW salmon in all Southern NEAC countries/jurisdictions in the most recent year were suffering reduced reproductive capacity (Figure 6); UK (Northern Ireland) was at full reproductive capacity. For the non-maturing 1SW salmon, stocks are either at risk of suffering or suffering reduced reproductive capacity prior to distant-water fisheries in most countries, except UK (England and Wales) and UK (Northern Ireland) where stocks are assessed to be at full reproductive capacity (Figure 6).

Spawners relative to CLs

In the Northern NEAC stock complex 1SW spawners have been at full reproductive capacity (i.e. meeting the CL with at least 95% probability) throughout the time-series. However, spawners have been at reduced levels since 2007 (Figure 5). MSW spawners have been at full reproductive capacity since 2006. Both 1SW and MSW stock complexes were at full reproductive capacity in 2018, although 1SW spawners were among the lowest in the time-series. In the most recent year, 1SW spawners in Northern NEAC countries were at full reproductive capacity in Sweden and Norway, but at risk of suffering reduced reproductive capacity in Iceland and Finland, and suffering reduced reproductive capacity in Russia (Figure 7). MSW salmon were at full reproductive capacity in Norway, Sweden, and Iceland, but suffering reduced reproductive capacity in Finland and Russia (Figure 8).

For the Southern NEAC, there has been a progressive decline in 1SW spawner numbers (Figure 5). This sea age group has been either at risk of suffering or suffering reduced reproductive capacity for most of the time-series, and has been suffering reduced reproductive capacity consistently over the last five years. MSW spawners in Southern NEAC declined up to the late 1990s but have increased since this time. However, this sea age group has been either at risk of suffering or suffering reduced reproductive capacity in most years throughout the time-series. In 2018, the MSW sea age group was suffering reduced reproductive capacity. In the most recent year, 1SW spawners in Southern NEAC countries have been suffering reduced reproductive capacity, with the exception of stocks in UK (Northern Ireland) (Figure 7). For MSW spawners, stocks in UK (England and Wales) and UK (Northern Ireland) were at full reproductive capacity in the most recent year, whereas stocks in France, Ireland, and UK (Scotland) were suffering reduced reproductive capacity (Figure 8).

Trends in rivers meeting CLs

In the NEAC area, nine jurisdictions currently assess salmon stocks using river-specific CLs (Figure 4 and Table 4). The attainment of CLs is assessed based on spawners, after fisheries.

Table 4 Summary of the attainment of CLs in 2018 (2017 for Norway and UK Scotland) and trends based on all available data in the NEAC area. Further details can be found in ICES (2019b).

Country /Jurisdiction	Number of rivers with CLs	Number of rivers assessed for compliance	Number of rivers attaining CL	% of assessed rivers attaining CL	Trend statement
Northern NEAC					
Russia	85	8	7	88	No trend
Finland/Norway (Tana/Teno)	25	15	6	40	Increasing
Norway	439	191	170	89	Increasing
Sweden	24	23	7	30	Stable (data for 2016 to 2018 only)
Southern NEAC					
UK (Scotland)	173	173	84	49	Decreasing
UK (Northern Ireland)	19	16	7	44	Increasing
UK (England and Wales)	64	64	14	22	Decreasing
Ireland	143	143	41	29	Decreasing
France	35	35	21	60	Stable

Marine survival

Return rate estimates, a proxy for marine survival, are derived for a limited number of rivers, of different time-series duration. Despite management measures aimed at reducing exploitation in recent years, there has been an overall declining trend since 1980 in the return rates of 1SW wild and hatchery-origin smolts in both Northern and Southern NEAC areas indicating poor survival of 1SW salmon in the marine environment (Figure 9).

A declining trend is not evident for the 2SW wild components in either area (no data are available for hatchery-origin 2SW return rates for Southern NEAC).

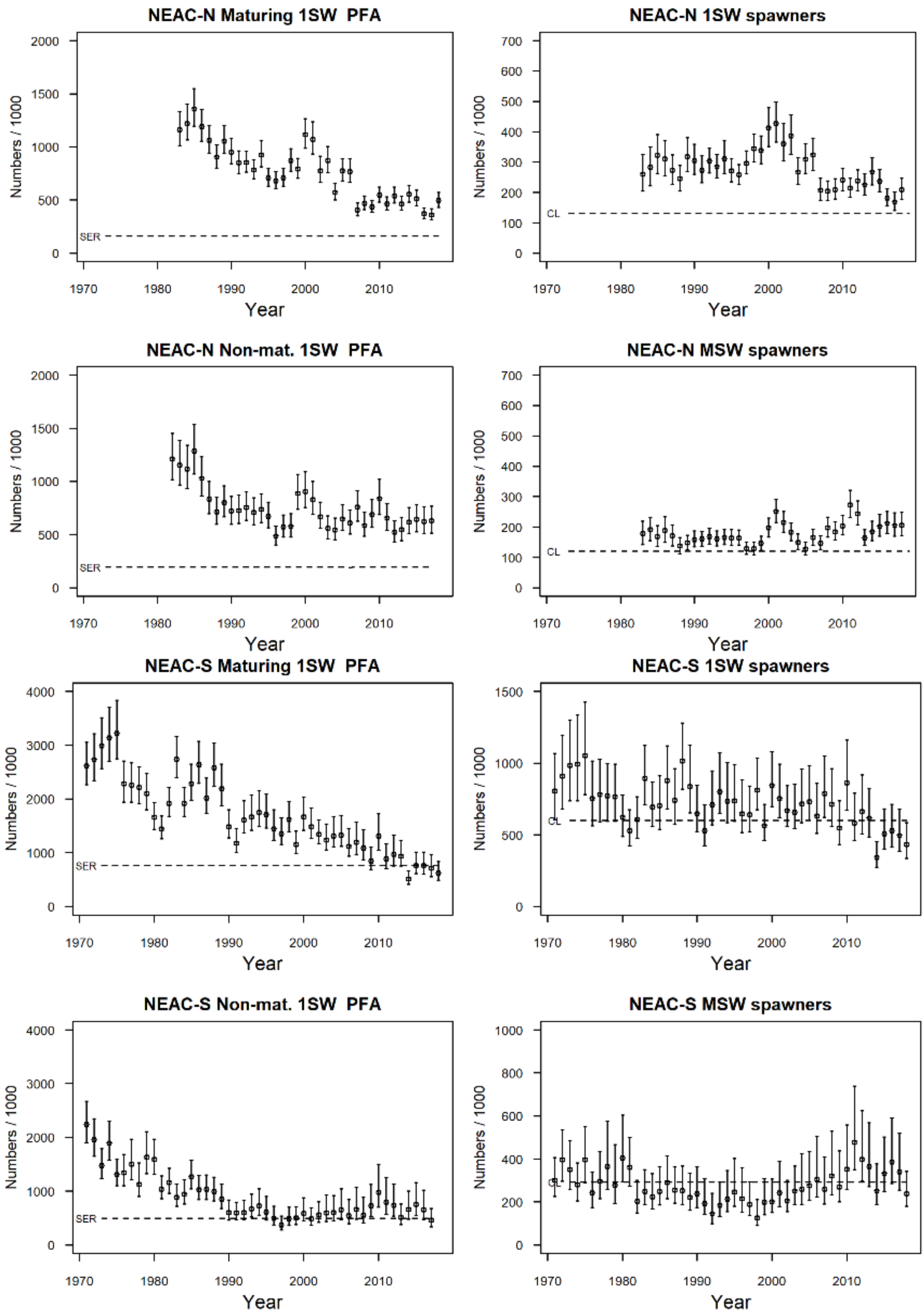

Figure 5 Pre-fishery abundance (PFA – recruits; left panels) and spawners (right panels), with 90% confidence limits, for maturing 1SW (spawning as 1SW) and non-maturing 1SW (spawning as MSW) salmon in Northern Europe (NEAC-N) and Southern Europe (NEAC-S). The dashed horizontal lines in the left panels are the respective 2018 spawning escapement reserve (SER) values, and in the right panels the conservation limit (CL) values.

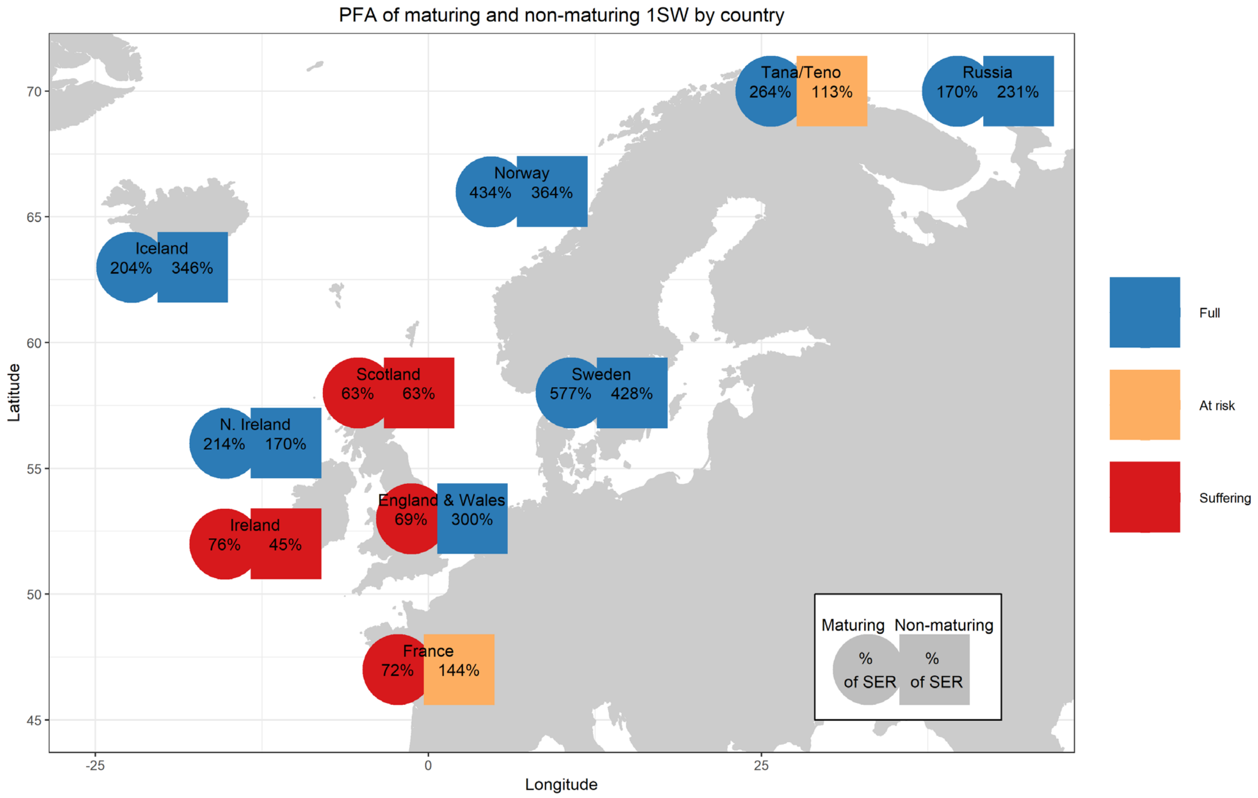

Figure 6 PFA of maturing (for 2018) and non-maturing (for 2017) as percentage of the respective spawner escapement reserve (% of SER). The percentage of SER is based on the median of the Monte Carlo distribution. The colour shading represents the three stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the SER); At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the SER, but the 5th percentile is below); and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the SER).

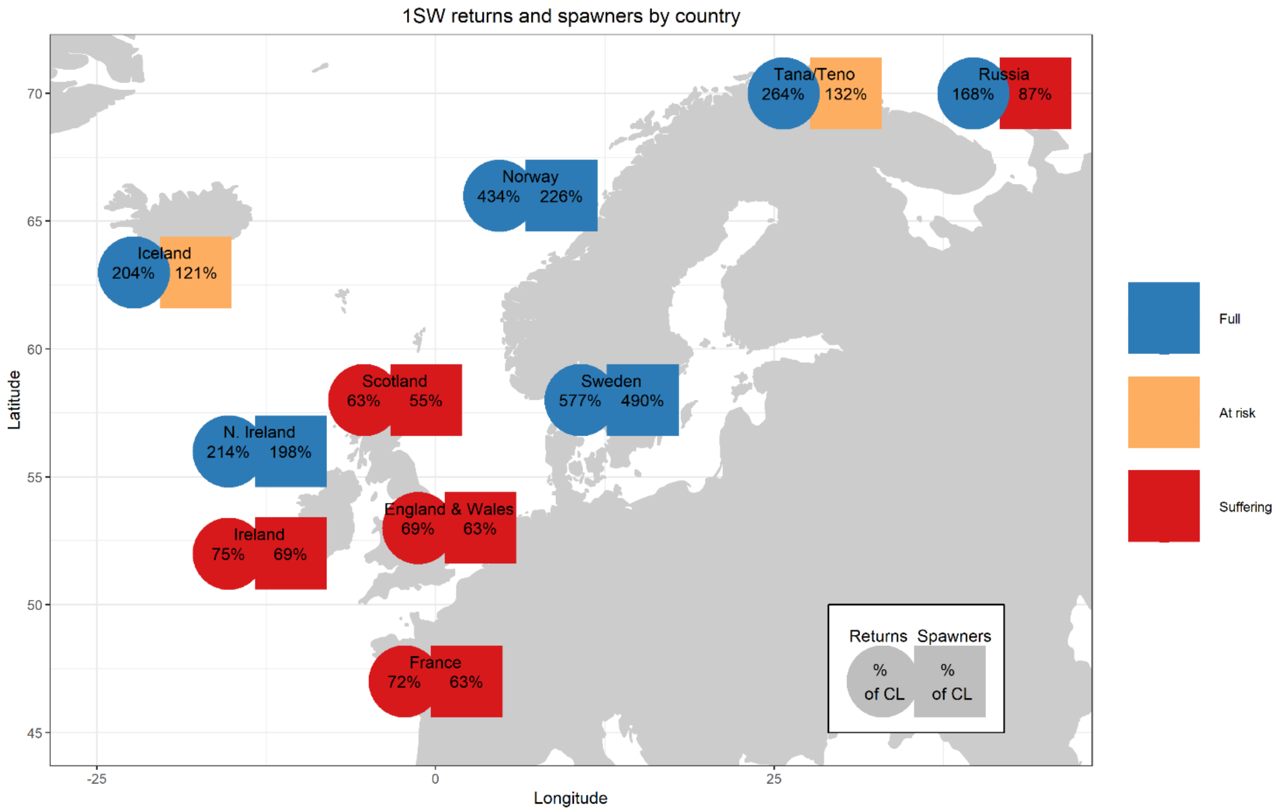

Figure 7 1SW returns and spawners as percentage of respective conservation limit (% of CL) for 2018. The percentage of CL is based on the median of the Monte Carlo distribution. The colour shading represents the three stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL); At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below); and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL).

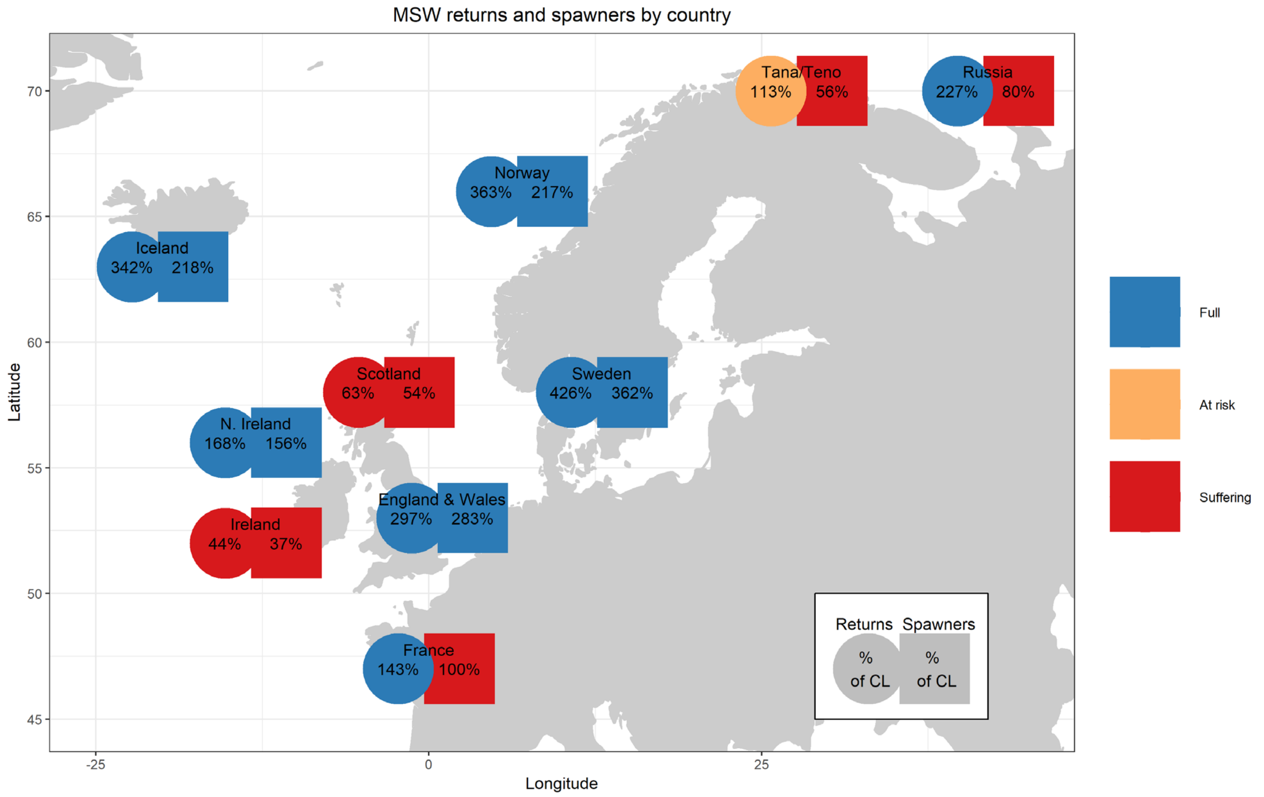

Figure 8 MSW returns and spawners as percentage of respective conservation limit (% of CL) for 2018. The percentage of CL is based on the median of the Monte Carlo distribution. The colour shading represents the three stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL); At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below); and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL).

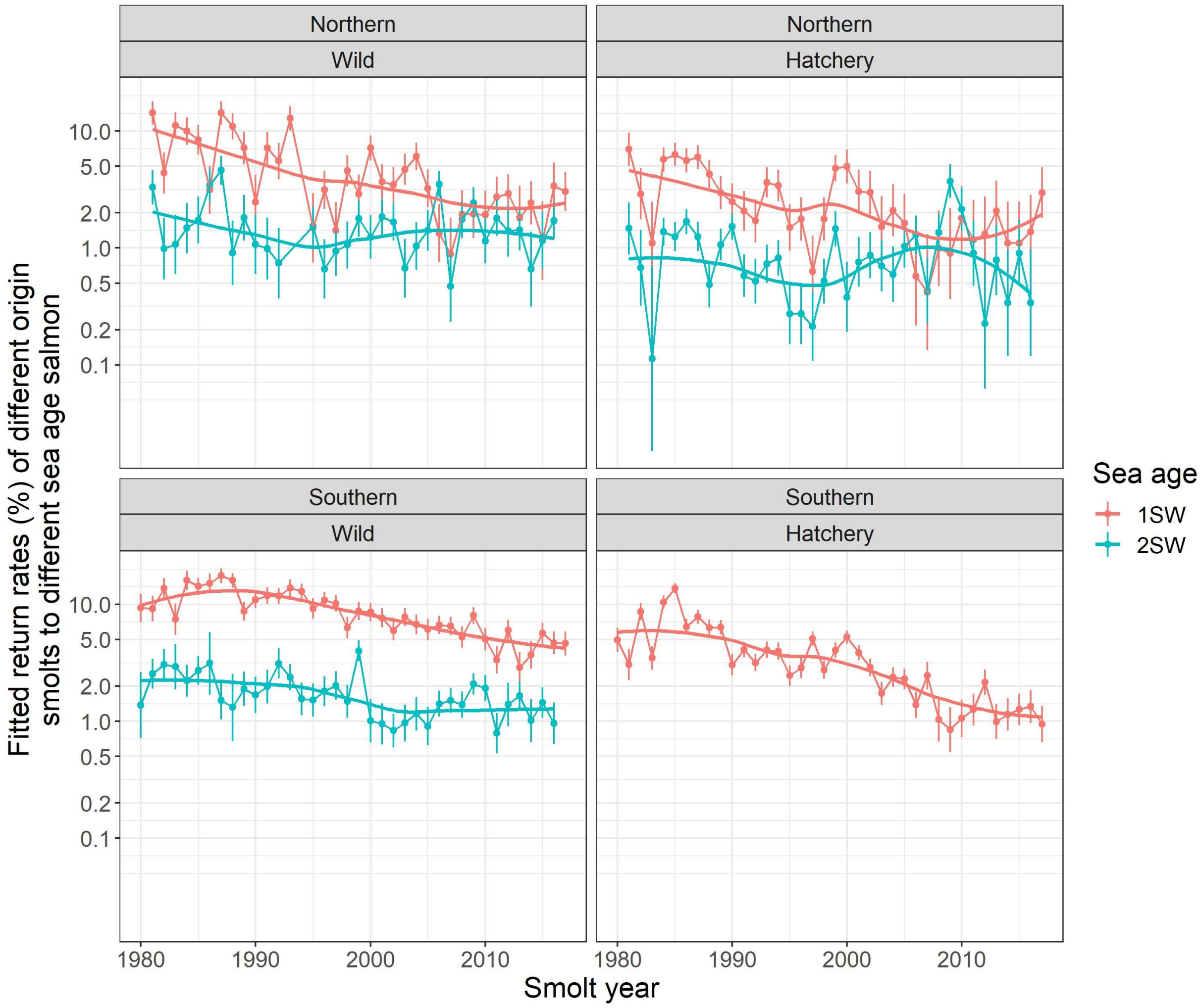

Figure 9 Return Rates: Annual least squared (marginal mean) estimates of return rates (%) of wild (left-hand panels) and hatchery origin smolts (right-hand panels) to 1SW (red) and 2SW (blue) salmon to Northern (top panels) and Southern NEAC areas (bottom panels). For most rivers in Southern NEAC, the values are returns to the coast prior to the homewater coastal fisheries. Annual means derived from a general linear model analysis of rivers in a region with a quasi-Poisson distribution (log-link function). Error bars are standard errors. Note the *y*-axis scale is on a log scale.

Table 5 Estimated pre-fishery abundance (by number, median values) of maturing 1SW salmon (potential 1SW returns) by NEAC country/jurisdiction and year. Bold values represent the median estimate of pre-fishery abundance (PFA) by year.

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N&E	Norway	Russia	Sweden	Total			France	Iceland S&W	Ireland	UK (EW)	UK (NI)	UK (SCO)	Total			Total		
						5%	50%	95%							5%	50%	95%	5%	50%	95%
1971	31 757	11 730		NA	22 214				64 468	77 623	1 344 654	105 475	222 707	777 783	2 261 352	**2 613 117**	3 050 847			
1972	124 127	10 739		151 278	17 647				128 296	62 677	1 436 122	101 708	194 958	780 753	2 339 321	**2 732 267**	3 213 846			
1973	57 720	12 846		222 703	21 808				78 631	67 509	1 563 202	120 321	170 648	961 499	2 563 473	**2 988 197**	3 509 891			
1974	79 311	12 755		220 821	31 380				36 636	47 956	1 777 591	150 016	185 480	923 127	2 695 184	**3 137 379**	3 713 632			
1975	95 263	15 557		339 328	34 160				73 019	74 322	1 966 242	153 853	152 754	777 318	2 744 912	**3 217 178**	3 831 819			
1976	86 624	15 642		236 469	19 284				67 587	58 883	1 336 499	103 303	106 243	588 606	1 939 227	**2 280 927**	2 707 904			
1977	48 971	21 678		150 727	8 772				52 011	59 956	1 155 299	116 610	104 468	748 744	1 938 194	**2 258 367**	2 672 634			
1978	46 751	22 034		152 403	10 358				53 199	78 585	1 010 675	133 314	136 042	784 283	1 912 598	**2 217 680**	2 599 012			
1979	41 661	21 133		211 417	10 606				60 825	72 704	927 365	127 596	95 379	789 453	1 803 993	**2 098 887**	2 472 487			
1980	33 099	3 311		150 714	13 756				126 481	33 234	708 898	120 421	121 635	527 461	1 438 765	**1 661 855**	1 935 303			
1981	29 817	16 661		125 419	25 137				101 007	43 145	379 762	126 943	96 398	679 845	1 257 845	**1 443 881**	1 686 477			
1982	17 879	7 792		110 021	22 046				62 193	44 222	776 456	108 836	138 130	766 474	1 676 055	**1 914 630**	2 214 582			
1983	43 196	11 406	890 700	182 736	29 380	1 014 111	**1 161 166**	1 332 240	66 639	55 878	1 360 698	157 763	193 550	884 205	2 399 848	**2 741 307**	3 162 711	3 485 689	**3 904 831**	4 404 517
1984	47 054	4 176	926 579	196 197	41 243	1 065 197	**1 219 592**	1 404 350	109 558	34 289	715 555	137 225	76 416	823 619	1 675 004	**1 919 560**	2 214 974	2 806 128	**3 143 988**	3 523 651
1985	62 416	28 002	943 783	269 405	49 455	1 196 788	**1 357 095**	1 548 441	40 517	54 761	1 179 567	136 661	97 953	743 032	1 977 740	**2 278 798**	2 650 752	3 247 082	**3 639 061**	4 099 460
1986	49 029	34 936	821 110	230 207	51 374	1 053 961	**1 190 967**	1 350 930	62 080	90 273	1 321 702	158 353	110 271	857 871	2 291 487	**2 636 962**	3 067 782	3 417 290	**3 833 894**	4 336 335
1987	59 156	20 626	691 157	245 987	40 910	940 246	**1 063 414**	1 204 760	113 259	56 403	856 539	163 984	61 117	723 523	1 733 352	**2 016 234**	2 389 121	2 736 335	**3 087 666**	3 516 356
1988	35 072	29 674	635 174	169 630	34 079	802 439	**905 373**	1 021 923	37 862	101 149	1 157 331	226 057	142 241	881 673	2 232 041	**2 584 630**	3 033 147	3 085 298	**3 490 420**	3 984 386
1989	76 398	16 097	698 532	252 141	9 997	935 778	**1 055 767**	1 203 396	20 809	56 484	833 543	152 192	136 434	960 842	1 876 268	**2 190 670**	2 646 637	2 877 536	**3 250 421**	3 752 836
1990	76 107	12 035	626 414	208 652	23 336	840 303	**949 196**	1 076 911	34 700	51 928	519 689	108 865	113 040	638 066	1 279 303	**1 488 847**	1 802 965	2 174 459	**2 447 181**	2 810 053
1991	74 660	17 423	546 360	177 769	29 215	748 648	**848 970**	962 078	25 381	57 297	370 327	106 635	63 102	536 843	1 006 174	**1 178 377**	1 449 640	1 805 865	**2 032 941**	2 341 890
1992	105 368	32 855	460 907	218 734	32 621	762 074	**855 373**	959 051	46 570	65 461	537 665	112 390	127 239	692 567	1 372 352	**1 608 537**	1 969 504	2 186 361	**2 466 601**	2 859 338
1993	71 110	26 988	462 206	188 265	32 079	700 124	**785 383**	880 882	66 167	64 241	437 751	155 021	149 055	765 287	1 420 738	**1 670 418**	2 075 262	2 168 878	**2 460 595**	2 887 837
1994	39 637	8 630	625 826	223 056	24 916	812 472	**925 989**	1 058 103	51 617	53 144	559 169	173 035	102 516	778 002	1 496 353	**1 747 101**	2 154 535	2 370 853	**2 681 674**	3 126 656
1995	39 458	22 539	407 752	200 145	36 387	631 537	**710 491**	799 029	17 118	65 152	623 902	131 470	95 233	758 005	1 463 976	**1 711 655**	2 093 991	2 137 705	**2 425 712**	2 842 033
1996	60 560	12 075	310 240	271 564	21 705	605 782	**680 560**	767 650	21 275	56 367	583 186	97 952	98 468	569 163	1 229 861	**1 444 494**	1 796 509	1 876 254	**2 129 089**	2 505 983
1997	55 244	16 517	359 408	266 877	9 862	631 857	**710 598**	802 572	10 868	41 109	580 642	88 123	116 595	494 243	1 148 591	**1 348 794**	1 653 134	1 822 992	**2 064 540**	2 396 827
1998	69 299	28 084	467 673	292 607	7 977	772 781	**870 422**	983 774	21 342	56 284	608 810	96 440	253 964	551 613	1 383 299	**1 614 241**	1 949 950	2 208 966	**2 490 147**	2 865 911
1999	102 136	14 270	435 371	226 215	12 478	705 549	**793 969**	892 745	7 179	45 752	568 222	75 953	66 103	376 840	988 243	**1 156 519**	1 399 673	1 737 929	**1 957 140**	2 237 841
2000	110 531	15 021	716 909	247 747	23 091	988 135	**1 117 172**	1 264 564	18 231	40 738	787 996	117 192	96 068	584 129	1 421 677	**1 669 971**	2 036 189	2 474 282	**2 795 401**	3 209 244
2001	80 055	13 613	619 458	335 445	14 245	931 738	**1 070 757**	1 236 232	15 822	36 501	626 076	101 395	77 253	605 861	1 269 350	**1 483 872**	1 836 285	2 266 759	**2 563 304**	2 972 140
2002	49 521	23 639	378 400	302 414	13 694	668 331	**774 155**	913 450	36 447	45 360	547 332	95 812	139 884	458 114	1 167 889	**1 343 918**	1 608 673	1 888 630	**2 127 983**	2 440 501

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N&E	Norway	Russia	Sweden	Total			France	Iceland S&W	Ireland	UK (EW)	UK (NI)	UK (SCO)	Total			Total		
						5%	50%	95%							5%	50%	95%	5%	50%	95%
2003	48 917	12 586	525 644	270 815	7 524	758 536	**870 444**	1 004 911	23 794	54 469	536 856	73 875	85 778	438 252	1 055 485	**1 233 017**	1 531 723	1 869 462	**2 112 540**	2 448 404
2004	20 769	33 871	317 752	189 658	6 237	501 393	**572 213**	658 952	28 996	54 490	396 300	132 780	82 468	595 843	1 108 682	**1 312 298**	1 665 945	1 654 549	**1 891 181**	2 264 871
2005	45 483	30 090	471 777	215 735	6 096	680 636	**775 968**	887 140	18 563	80 300	393 102	108 361	103 427	597 776	1 120 876	**1 323 926**	1 692 236	1 849 190	**2 106 919**	2 504 236
2006	79 819	31 702	381 389	261 242	6 815	668 223	**765 561**	886 045	26 149	56 772	301 474	106 898	70 199	536 493	933 545	**1 120 046**	1 455 332	1 656 835	**1 895 513**	2 254 643
2007	23 290	23 565	213 106	140 759	2 125	354 153	**405 487**	471 252	20 334	65 183	305 881	102 002	103 354	551 300	964 433	**1 196 364**	1 566 665	1 350 177	**1 607 730**	1 991 474
2008	25 199	21 577	267 446	146 723	3 328	408 910	**467 102**	539 583	20 264	78 730	323 031	100 835	65 129	447 066	867 408	**1 084 391**	1 429 509	1 315 155	**1 557 225**	1 916 391
2009	44 539	34 666	214 240	137 521	3 528	384 819	**437 017**	497 917	5 755	88 818	262 661	62 384	40 527	347 653	676 988	**841 567**	1 105 688	1 091 176	**1 282 807**	1 563 668
2010	35 885	27 787	317 126	156 152	5 969	481 338	**546 729**	622 880	19 536	91 081	350 944	125 954	40 462	632 607	1 044 137	**1 314 544**	1 728 979	1 573 327	**1 865 424**	2 296 225
2011	40 754	22 868	223 552	167 603	6 498	407 252	**464 168**	530 045	13 409	64 299	301 416	83 618	29 269	355 537	708 190	**883 651**	1 169 074	1 153 176	**1 351 735**	1 652 865
2012	70 334	11 886	248 079	195 208	7 230	471 951	**537 735**	620 403	14 418	36 440	307 872	48 571	66 731	439 502	756 398	**970 573**	1 327 517	1 269 759	**1 513 767**	1 884 173
2013	40 658	28 254	234 602	152 291	4 197	405 293	**464 580**	536 534	20 522	108 591	260 614	67 527	74 849	352 647	758 232	**940 614**	1 231 595	1 201 243	**1 409 266**	1 715 469
2014	57 684	13 327	320 920	143 921	12 492	479 712	**554 319**	640 531	18 118	26 799	160 062	39 957	33 690	204 351	412 452	**512 546**	661 199	930 153	**1 070 769**	1 248 916
2015	36 091	37 382	281 796	150 174	3 954	449 660	**515 098**	592 031	16 806	74 359	227 674	49 022	35 947	318 963	610 625	**760 911**	1 007 637	1 098 053	**1 282 585**	1 545 499
2016	28 121	16 027	218 471	106 611	2 152	328 075	**374 771**	429 171	15 150	43 767	230 194	51 991	68 214	306 167	601 411	**761 380**	1 014 153	961 861	**1 137 360**	1 402 103
2017	15 273	15 617	288 281	38 347	3 352	316 350	**362 702**	418 965	19 166	45 371	249 055	37 924	57 382	256 401	555 861	**708 744**	959 243	903 866	**1 075 827**	1 331 834
2018	38 479	16 588	294 602	127 574	14 108	433 332	**497 187**	572 162	16 056	39 324	203 748	47 612	51 378	225 351	491 803	**621 465**	839 630	963 840	**1 122 833**	1 357 633
10 yr avg.	40 782	22 440	264 167	137 540	6 348	415 778	**475 431**	546 064	15 894	61 885	255 424	61 456	49 845	343 918	661 610	**831 599**	1 104 471	1 114 645	**1 311 237**	1 599 838

Table 6 Estimated pre-fishery abundance (by numbers, median values) of non-maturing 1SW salmon (potential MSW returns) by NEAC country/jurisdiction and year. Estimates for 2018 will only be available in 2019 for this component.

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N & E	Norway	Russia	Sweden	Total			France	Iceland S & W	Ireland	UK (EW)	UK (NI)	UK (SCO)	Total			Total		
						5%	50%	95%							5%	50%	95%	5%	50%	95%
1971	52 160	27 077		266 270	4 522				61 253	65 638	394 543	375 760	32 794	1 292 654	1 897 001	2 239 843	2 668 632			
1972	79 480	25 416		429 252	7 093				39 672	59 240	385 131	281 161	28 877	1 148 655	1 648 861	1 956 749	2 346 132			
1973	125 208	23 813		397 697	4 520				20 367	51 035	390 675	194 896	31 219	776 755	1 234 174	1 477 266	1 788 095			
1974	160 407	26 426		430 889	3 387				35 035	54 254	450 838	267 909	25 896	1 038 318	1 572 500	1 890 551	2 308 450			
1975	125 123	21 709		366 563	4 382				29 333	46 777	333 918	174 120	17 993	698 043	1 105 946	1 312 982	1 592 113			
1976	86 457	29 683		253 510	2 471				21 395	45 458	278 200	178 718	17 625	790 657	1 106 532	1 346 469	1 681 827			
1977	45 152	38 071		218 700	2 535				21 752	58 512	247 640	158 220	22 789	975 791	1 209 542	1 499 193	1 969 965			
1978	47 394	25 481		199 245	4 374				21 018	37 827	211 860	88 334	16 242	744 649	900 093	1 130 267	1 523 337			
1979	54 359	36 037		346 129	8 767				40 488	53 636	245 583	229 758	21 177	1 029 163	1 329 638	1 636 505	2 106 519			
1980	69 872	14 367		239 548	5 754				30 868	36 979	193 859	306 781	17 734	997 011	1 316 901	1 596 524	1 966 875			
1981	84 984	15 983		214 525	10 207				21 332	26 627	125 029	145 332	24 570	688 626	861 260	1 038 090	1 288 130			
1982	87 271	12 255	831 970	269 694	7 216	1 016 613	1 213 361	1 453 542	20 707	42 628	207 405	149 276	33 156	694 628	957 415	1 156 685	1 426 121	2 008 177	2 375 230	2 820 913
1983	70 065	14 716	807 217	251 487	7 531	965 010	1 153 967	1 385 555	26 901	35 752	143 287	109 254	13 449	550 867	720 553	889 233	1 134 646	1 723 691	2 049 478	2 456 835
1984	68 949	9 909	754 702	276 642	4 149	934 718	1 118 002	1 340 281	20 667	26 304	153 286	149 482	17 175	564 806	762 663	943 556	1 209 520	1 731 048	2 068 108	2 491 454
1985	60 444	25 357	910 476	280 325	3 885	1 069 409	1 284 463	1 534 232	25 023	22 340	193 106	220 225	19 367	777 644	1 044 149	1 272 166	1 577 071	2 148 974	2 561 019	3 041 330
1986	74 151	26 100	704 149	215 483	7 325	863 801	1 029 816	1 232 893	15 777	19 870	225 857	178 911	10 443	564 952	842 045	1 026 300	1 290 268	1 739 937	2 062 693	2 467 980
1987	50 467	16 709	559 114	197 720	6 661	696 169	834 026	998 057	31 814	21 930	168 444	216 443	26 725	552 917	842 187	1 032 637	1 303 637	1 571 787	1 871 661	2 251 046
1988	51 036	14 404	427 583	197 197	19 716	596 946	712 281	848 795	18 529	19 820	162 740	187 477	21 508	576 190	817 056	997 024	1 262 859	1 437 654	1 711 923	2 068 802
1989	53 565	14 942	478 753	242 000	10 531	669 711	801 494	958 140	14 779	19 528	73 607	198 798	19 520	515 569	679 231	852 828	1 133 973	1 375 631	1 662 916	2 031 220
1990	67 904	10 350	393 833	231 643	13 298	598 135	719 950	859 203	12 563	19 245	98 922	88 109	10 122	362 825	466 807	600 573	837 839	1 091 171	1 328 866	1 641 546
1991	63 867	15 005	412 442	214 070	17 973	607 537	726 529	871 420	16 480	21 388	83 709	74 824	22 371	366 259	468 282	592 680	797 773	1 100 565	1 326 625	1 613 645
1992	67 049	16 970	396 529	253 233	20 222	632 769	756 135	903 471	8 262	10 626	78 836	76 940	52 660	362 598	471 080	601 598	827 317	1 130 457	1 367 710	1 673 137
1993	63 216	14 375	385 950	226 175	15 306	591 413	707 612	846 969	14 387	17 053	113 807	98 222	18 646	400 955	522 290	672 501	941 074	1 139 252	1 390 454	1 719 703
1994	42 507	9 202	417 298	257 854	7 810	613 644	736 391	883 804	7 117	17 512	110 165	98 075	15 832	466 364	552 699	725 225	1 040 616	1 195 489	1 476 013	1 861 975
1995	39 055	11 945	414 009	194 029	12 520	564 196	672 974	806 268	12 718	11 345	75 858	102 932	17 322	382 187	463 369	612 017	905 777	1 056 113	1 298 967	1 641 803
1996	45 392	6 654	266 064	154 600	8 863	402 613	483 776	580 600	6 608	12 609	96 148	63 726	21 457	282 206	375 723	495 977	717 956	798 959	988 328	1 255 223
1997	43 118	9 701	320 346	192 143	4 924	476 118	573 320	685 404	5 441	7 785	55 776	41 079	29 432	225 758	284 122	371 729	538 698	781 019	952 400	1 178 776
1998	51 277	11 113	341 106	169 050	3 475	478 790	577 633	694 813	11 346	15 140	86 457	79 828	13 332	263 628	365 269	490 978	707 446	871 997	1 076 486	1 351 615
1999	97 343	6 525	471 587	295 410	12 467	738 830	886 266	1 065 034	7 951	4 138	107 332	83 730	17 774	267 879	382 642	500 950	710 386	1 154 321	1 399 209	1 713 187
2000	117 719	7 483	555 662	207 066	14 784	753 398	905 933	1 092 853	9 698	7 247	97 623	92 509	13 082	357 066	446 831	591 279	881 265	1 237 974	1 513 045	1 890 488
2001	103 119	7 062	480 610	225 979	10 144	692 276	830 298	1 000 253	8 787	7 829	110 734	82 231	14 198	252 237	374 411	489 512	688 772	1 095 428	1 328 950	1 628 195

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N & E	Norway	Russia	Sweden	Total			France	Iceland S & W	Ireland	UK (EW)	UK (NI)	UK (SCO)	Total			Total		
						5%	50%	95%							5%	50%	95%	5%	50%	95%
2002	74 509	7 457	426 306	158 446	2 447	557 974	669 284	806 252	12 577	12 545	117 429	105 190	8 504	291 159	425 649	566 318	807 752	1 013 694	1 244 798	1 560 378
2003	33 722	7 321	387 075	121 858	7 425	461 038	558 467	674 974	23 153	10 140	63 977	88 815	8 999	390 145	439 088	600 286	927 167	932 280	1 169 045	1 536 796
2004	27 940	9 048	355 298	145 975	5 002	452 147	544 507	655 840	14 408	8 956	82 849	97 189	11 287	376 906	449 572	605 399	921 255	929 084	1 160 773	1 511 990
2005	44 023	8 678	449 590	139 087	5 213	539 315	648 037	779 206	14 373	7 407	60 256	87 106	8 909	455 720	472 794	650 555	1 040 634	1 046 786	1 311 854	1 740 103
2006	64 053	8 359	383 308	145 409	4 900	507 345	607 864	728 929	13 648	4 563	42 265	84 018	9 228	376 124	395 667	544 977	841 854	934 254	1 164 661	1 512 256
2007	64 333	10 758	442 643	229 740	6 825	625 110	757 114	914 539	15 106	5 237	31 483	91 891	7 181	496 757	477 739	664 284	1 070 194	1 144 249	1 435 950	1 896 637
2008	27 668	8 729	347 204	194 629	6 082	483 268	586 351	710 248	7 032	8 082	39 864	70 819	7 307	412 561	404 958	556 747	889 165	921 734	1 153 539	1 521 665
2009	44 297	12 269	382 698	240 433	7 035	568 767	689 269	828 862	5 734	16 703	36 999	105 101	10 672	537 467	529 105	728 630	1 128 173	1 136 473	1 432 234	1 880 267
2010	34 137	13 765	531 116	240 403	16 490	690 526	838 410	1 020 871	16 099	8 522	40 629	175 791	13 711	696 951	705 119	980 267	1 501 952	1 451 500	1 833 883	2 412 148
2011	41 061	7 723	466 953	117 494	18 800	538 202	655 024	794 053	12 781	4 855	35 271	138 894	31 774	541 628	573 657	794 451	1 250 057	1 154 739	1 460 917	1 961 231
2012	39 726	8 868	328 834	134 164	7 969	431 840	521 652	631 014	13 159	13 357	40 623	135 120	10 161	499 158	538 225	736 116	1 138 055	1 005 190	1 266 517	1 702 526
2013	43 147	10 601	338 495	133 527	17 132	445 638	545 916	660 052	16 477	8 189	34 153	91 206	5 586	343 401	376 553	514 176	765 104	855 857	1 067 601	1 367 603
2014	41 403	10 177	427 454	125 808	11 678	508 311	618 072	756 167	18 673	7 460	36 382	150 531	7 210	420 317	481 996	662 006	1 006 094	1 027 903	1 290 768	1 688 133
2015	44 454	14 245	469 670	107 305	4 580	525 535	641 920	777 853	7 990	10 641	35 284	194 512	13 372	462 309	544 131	751 233	1 161 739	1 112 673	1 402 587	1 867 833
2016	30 719	8 012	474 583	99 246	8 897	511 473	623 431	761 422	9 043	9 076	32 547	155 574	10 777	418 445	475 850	657 627	1 022 565	1 030 114	1 292 251	1 712 059
2017	18 844	8 796	447 179	130 772	19 741	514 364	628 627	769 431	13 558	9 675	35 223	153 517	9 697	219 851	338 492	461 196	678 970	887 397	1 097 408	1 389 271
10 yr avg.	41 095	10 515	420 965	162 275	10 549	532 867	647 716	785 508	12 209	9 212	36 323	130 944	11 775	482 899	510 733	704 554	1 093 310	1 084 043	1 363 625	1 801 010

Scientific basis

Assessment type	Run-reconstruction models and Bayesian forecasts, taking into account uncertainties in data and process error. Results presented in a risk analysis framework.
Input data	Nominal catches (by sea-age class) for commercial and recreational fisheries. Estimates of unreported/illegal catches. Estimates of exploitation rates. Natural mortalities (from earlier assessments).
Discards and bycatch	Discards included in risk-based framework for the Faroes fishery. Not relevant for other NEAC assessments.
Indicators	Framework of Indicators (FWI) is used to indicate if a significant change has occurred in the status of stocks in intermediate years where multi-annual management advice applies.
Other information	Advice subject to annual review. Stock annex developed in 2014 and updated in 2019 (ICES, 2019c).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2019a).

Identify relevant data deficiencies, monitoring needs, and research requirements

No data deficiencies, monitoring needs, or research requirements of relevance to the Northeast Atlantic Commission were identified.

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).

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Annex 1 Glossary of acronyms and abbreviations

1SW *(one-sea-winter).* Maiden adult salmon that has spent one winter at sea.

2SW (*two-sea-winter*). Maiden adult salmon that has spent two winters at sea.

CL (or **CLs**)**, 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*).

MSY (*maximum sustainable yield*). The largest average annual catch that may be taken from a stock continuously without affecting the catch of future years; a constant long-term MSY is not a reality in most fisheries, where stock sizes vary with the strength of year classes moving through the fishery.

MSW (*multi-sea-winter*). A MSW salmon is an adult salmon which has spent two or more winters at sea and may be a repeat spawner.

NASCO (*North Atlantic Salmon Conservation Organization*). An international organization, established by an inter-governmental convention in 1984. The objective of NASCO is to conserve, restore, enhance, and rationally manage Atlantic salmon through international cooperation, taking account of the best available scientific information.

NEAC (*North East Atlantic Commission).* The commission within NASCO with responsibility for Atlantic salmon in the Northeast Atlantic.

PFA *(pre-fishery abundance).* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time.

SER *(spawning escapement reserve).* The CL increased to take account of natural mortality between the recruitment date (assumed to be 1st January) and the date of return to homewaters.

TAC (*total allowable catch*). TAC is the quantity of fish that can be taken from each stock each year.

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 (CLs) by the use of management targets. CLs for North Atlantic salmon stock complexes have been defined by ICES as the level of a stock (number of spawners) that will achieve long-term average maximum sustainable yield (MSY). 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. Advice for the Faroes fishery (which historically harvested both 1SW and MSW salmon) is currently based upon all NEAC area stocks. The advice for the West Greenland fishery (ICES, 2019d) is based upon the Southern NEAC non-maturing 1SW stock and the non-maturing 1SW salmon from North America. A 75% risk level (probability) of achieving the management objectives simultaneously in the six North American regions and Southern NEAC has been agreed by NASCO for the provision of catch advice at West Greenland. No specific risk level has so far been agreed by NASCO for the provision of catch advice for the Faroes fishery; in the absence of this, ICES uses a 95% probability of meeting individual conservation limits, which can be applied at the level of the European stock complexes (two areas and two age classes) and the NEAC countries (ten countries and two age classes). A framework of indicators has been developed in support of the multi-annual catch options.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northeast Atlantic area, their current distribution extends from northern Portugal to the Pechora River in Northwest Russia and Iceland. 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 the Northeast Atlantic stocks being exploited at both West Greenland and the Faroes.

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, for some stocks, are now at their lowest levels in the time-series, 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 contributing factors of lower productivity, which is expressed almost entirely in terms of lower marine survival.

Effects of the fisheries on the ecosystem

Salmon fisheries have no, or only minor, influence on the marine ecosystem. The exploitation of salmon in freshwater may affect the riverine ecosystem through changes in species composition. There is limited knowledge of the magnitude of these effects.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment.

Scientific basis

ICES stock data category	1 (ICES, 2018b).
Assessment type	Run–reconstruction models and Bayesian forecasts, taking into account uncertainties in data and process error. Results presented in a risk analysis framework.
Input data	Nominal catches (by sea-age class) for commercial and recreational fisheries. Estimates of unreported/illegal catches. Estimates of exploitation rates. Natural mortalities (from earlier assessments).
Discards and bycatch	Discard data are included in risk-based framework for the Faroes fishery. Not relevant for other NEAC assessments.
Indicators	Framework of Indicators (FWI) is used to indicate if a significant change has occurred in the status of stocks in intermediate years where multi-annual management advice applies.
Other information	Advice subject to annual review. Stock annex developed in 2014 and updated in 2019 (ICES, 2019c).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2019a).

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

Year	Canada			USA	SPM
	Small salmon	Large salmon	Total		
2018	50	40	90	0	1

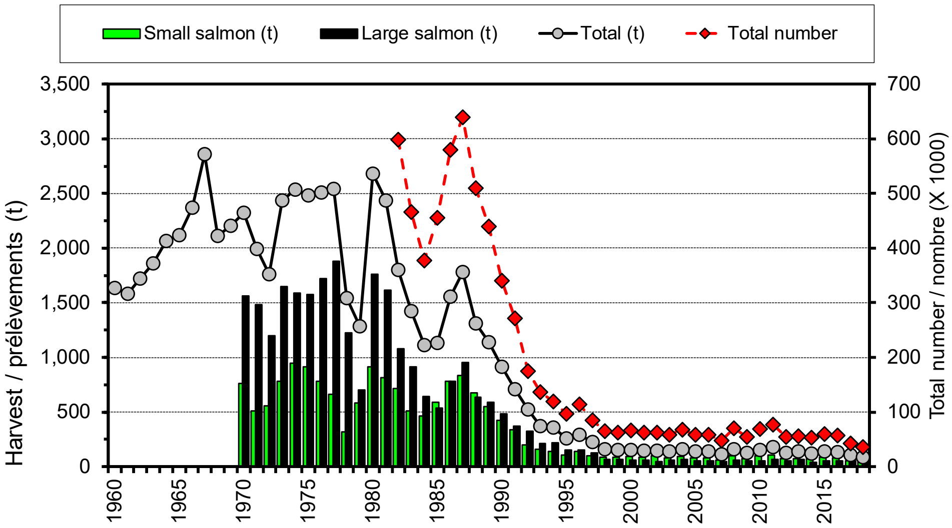

Figure 1 Nominal catch (harvest; t) of small (< 63 cm) and large salmon in Canada (combined harvests in USA and Saint Pierre and Miquelon are ≤ 6 t in any year), from 1960 to 2018.

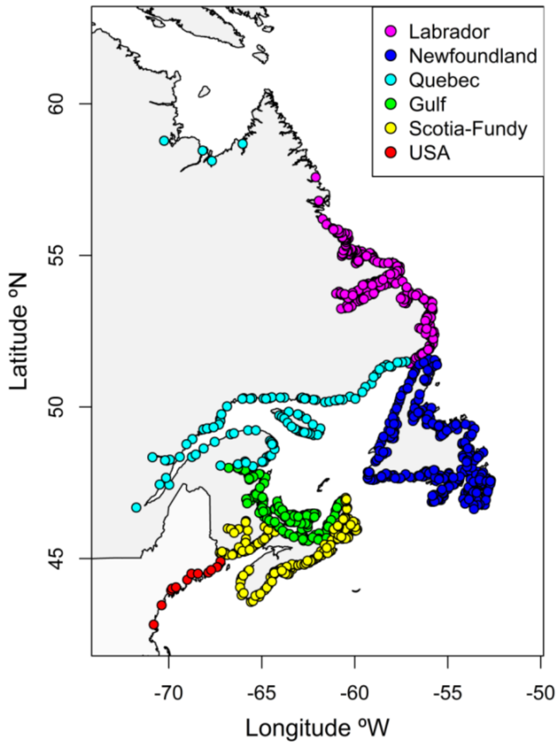

Figure 2 Assessment regions for salmon in the North American Commission. Dots indicate locations of salmon rivers.

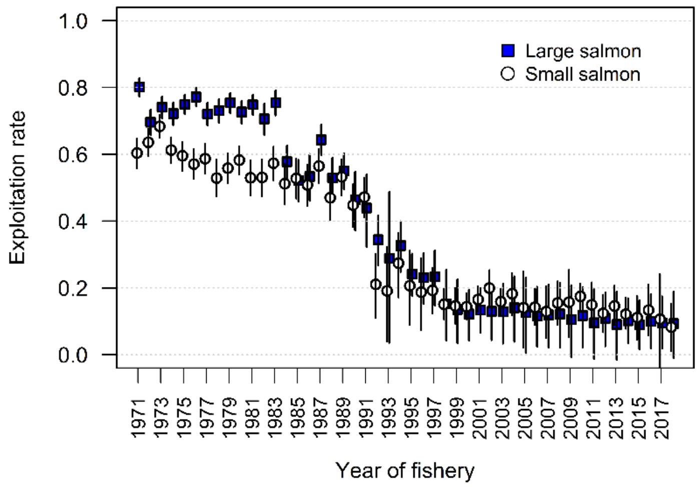

Figure 3 Exploitation rates in North America on small (1SW) and large (MSW and repeat spawners) salmon, from 1971 to 2018.

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

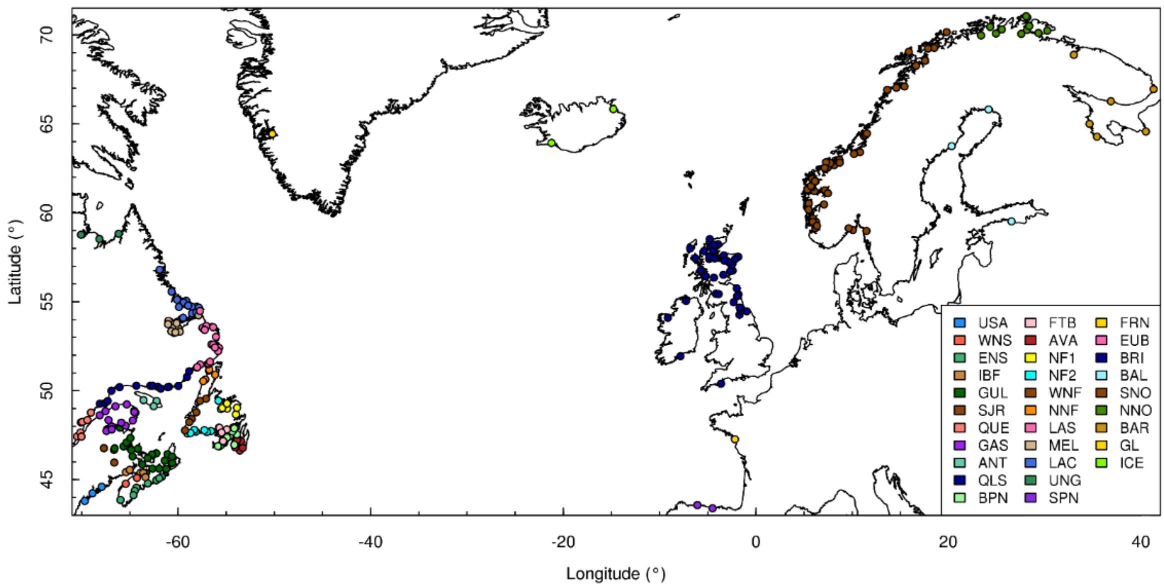

Figure 4 Map of sample locations used in the range-wide genetic baseline (single nucleotide polymorphisms [SNPs]) for Atlantic salmon, which provided 21 North America and 10 European genetic reporting groups (labelled and identified by colour) and correspondence between genetic reporting groups and assessment 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).

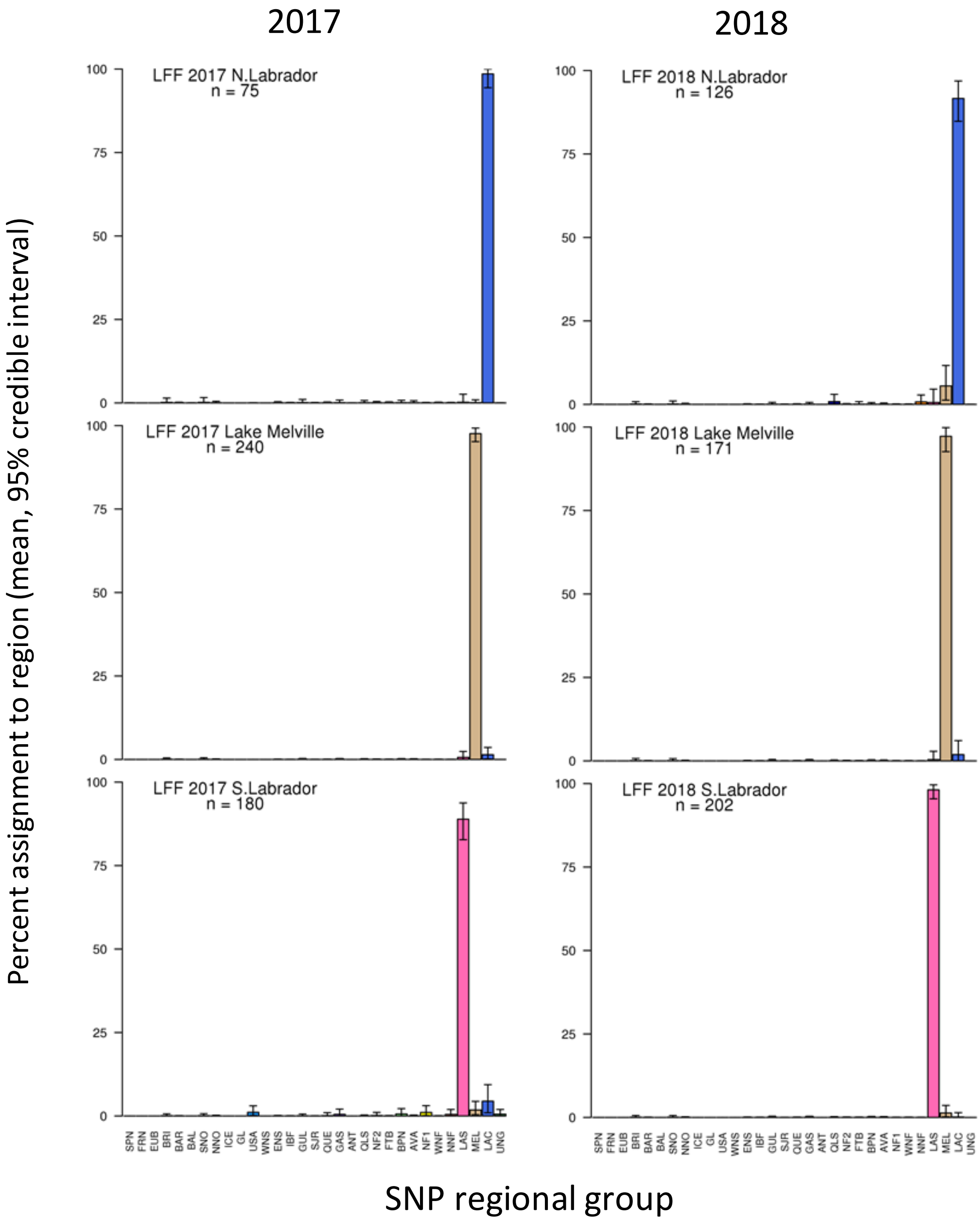

Figure 5 Percentages of Labrador subsistence fishery samples, by Salmon Fishing Area of Labrador, assigned to SNP-derived regional groups of the North Atlantic for the fishery years 2017 and 2018.

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.

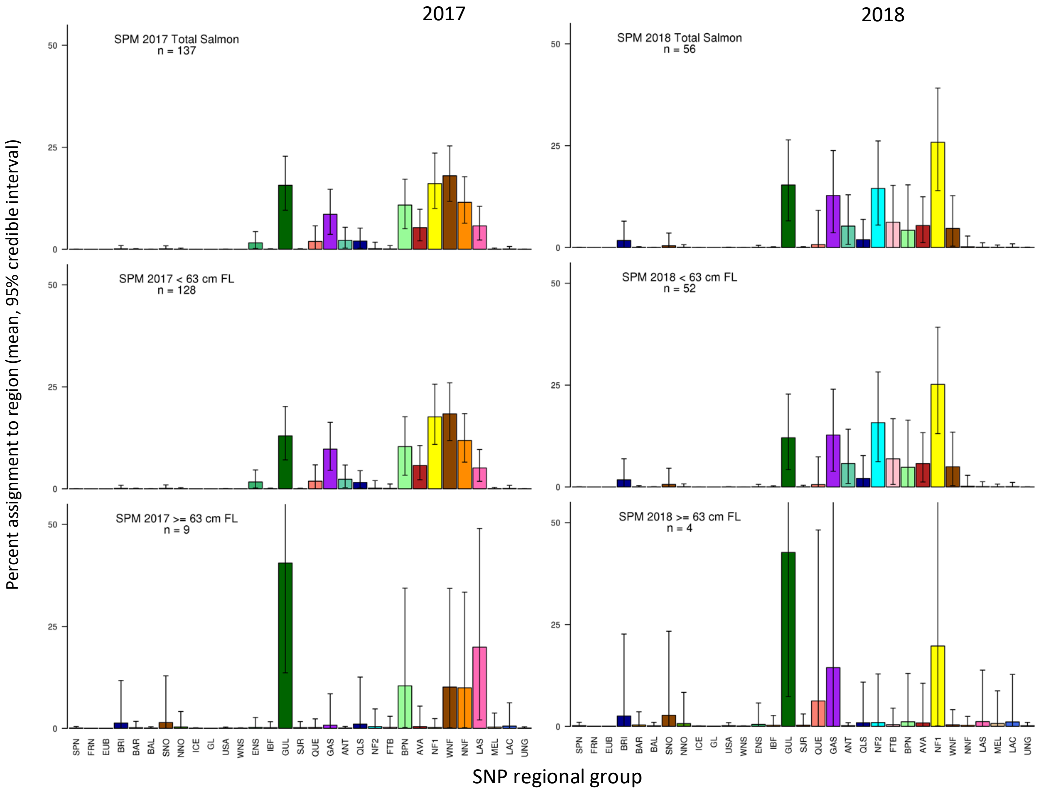

Figure 6 Percentages of the Saint Pierre and Miquelon fishery samples assigned to SNP derived genetic reporting groups of the North Atlantic for the fishery years 2017 and 2018.

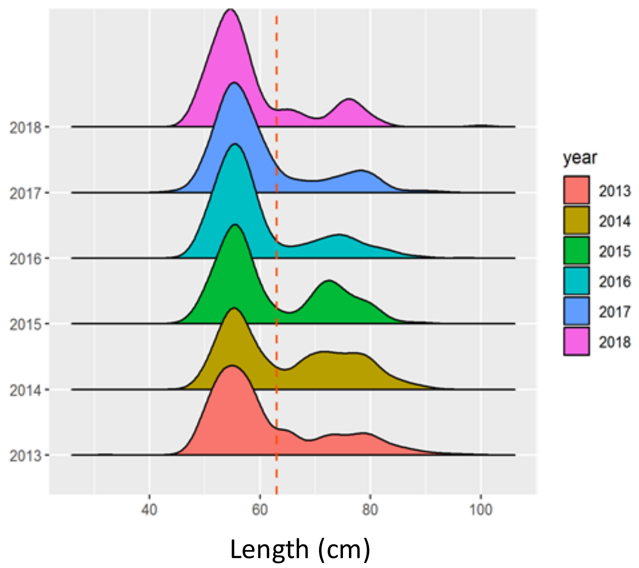

Figure 7 Variations in the size (length in cm) distribution of Atlantic salmon from the Saint Pierre and Miquelon Atlantic salmon fishery over the period 2013 to 2018. The percentage of small salmon in the catches in 2018 was reported to be 77%.

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).

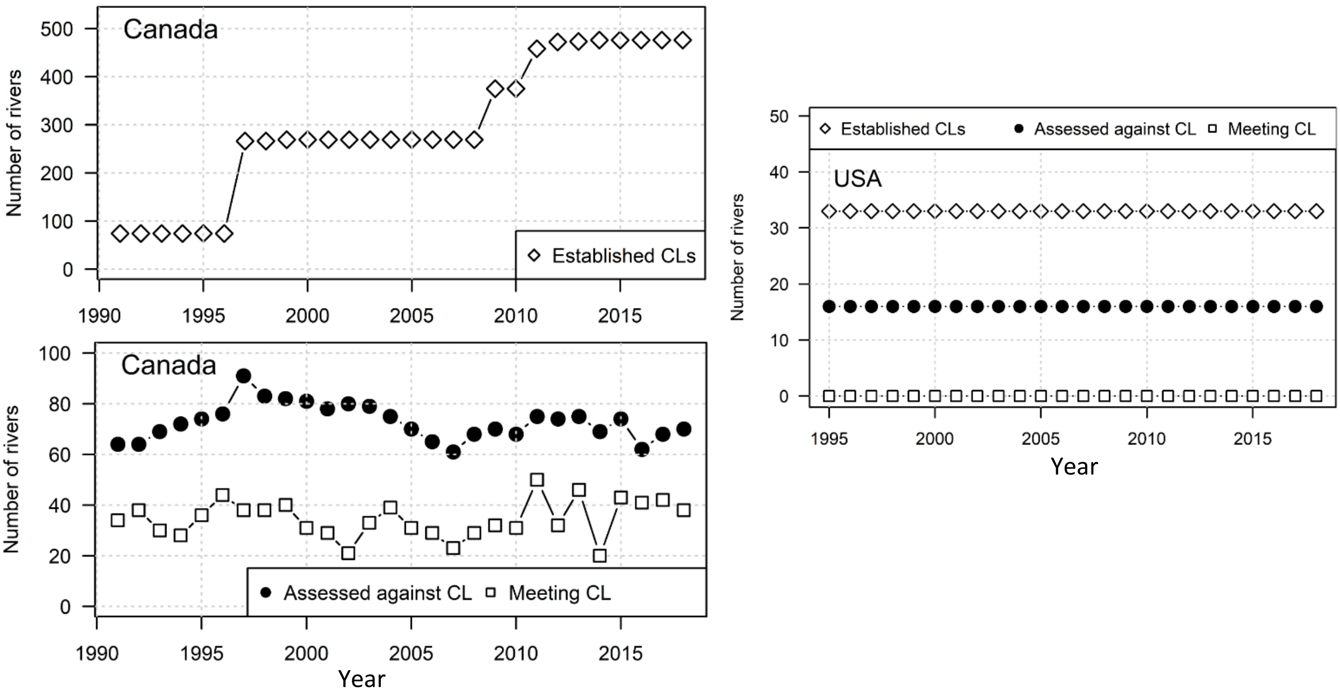

Figure 8 Time-series for Canada and the USA showing the number of rivers with established CLs, the number of rivers assessed, and the number of assessed rivers meeting CLs, for the period 1991 to 2018. Further details can be found in ICES (2019a).

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.

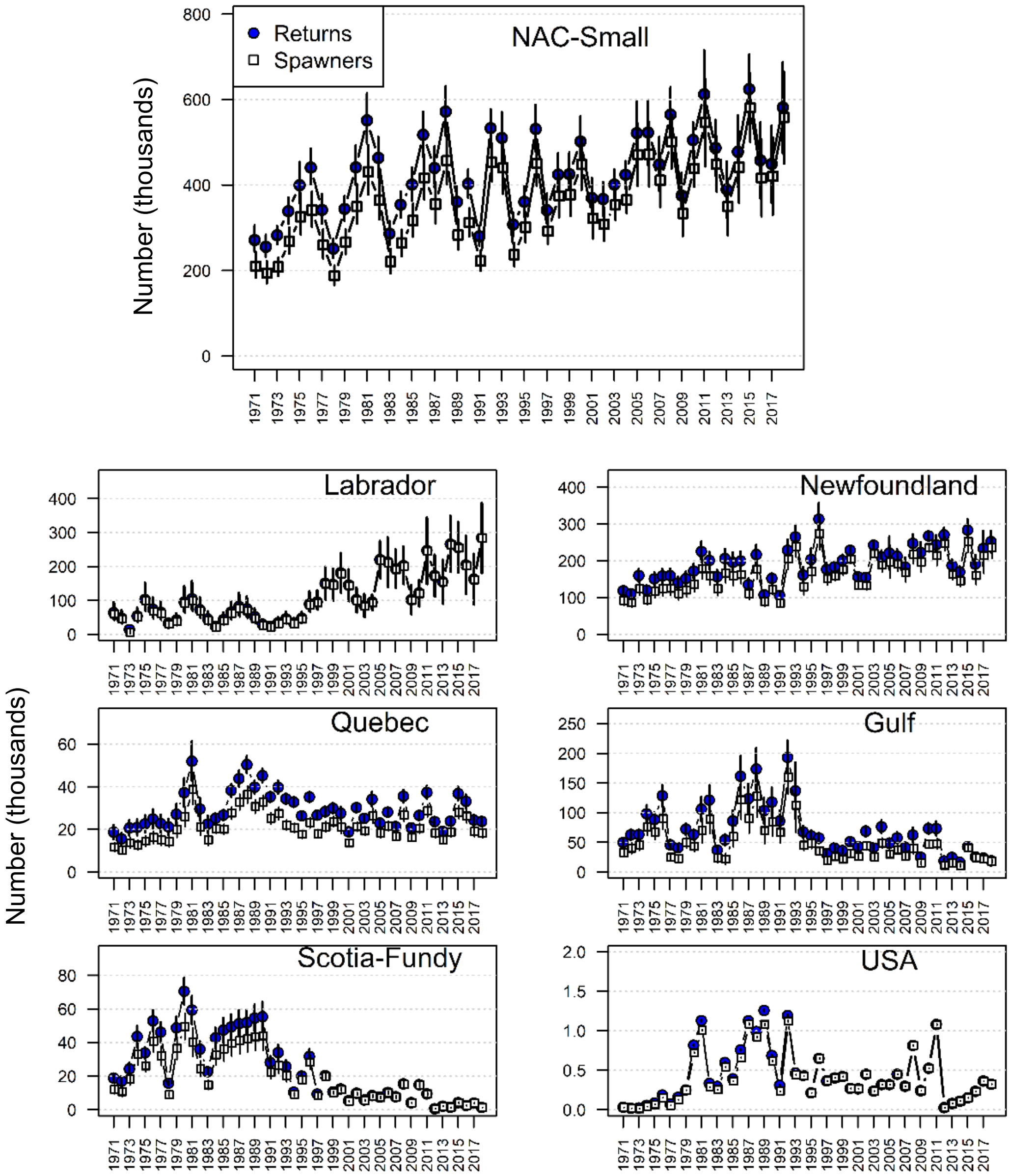

Figure 9 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of small salmon (primarily 1SW) for eastern North America overall and for each of the six regions, 1971 to 2018.

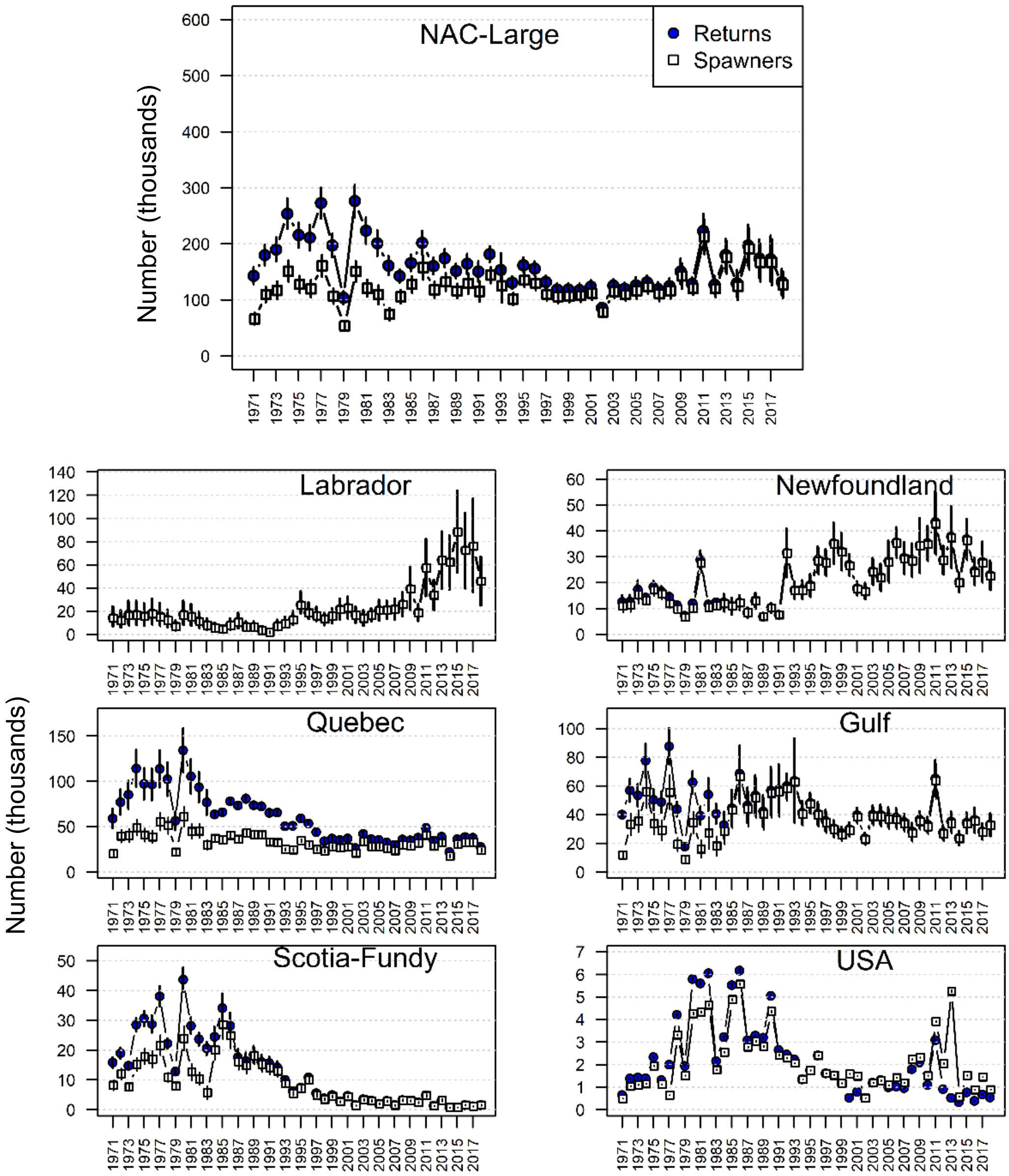

Figure 10 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of large salmon (primarily MSW and repeat spawners) for eastern North America overall and for each of the six regions, 1971 to 2018.

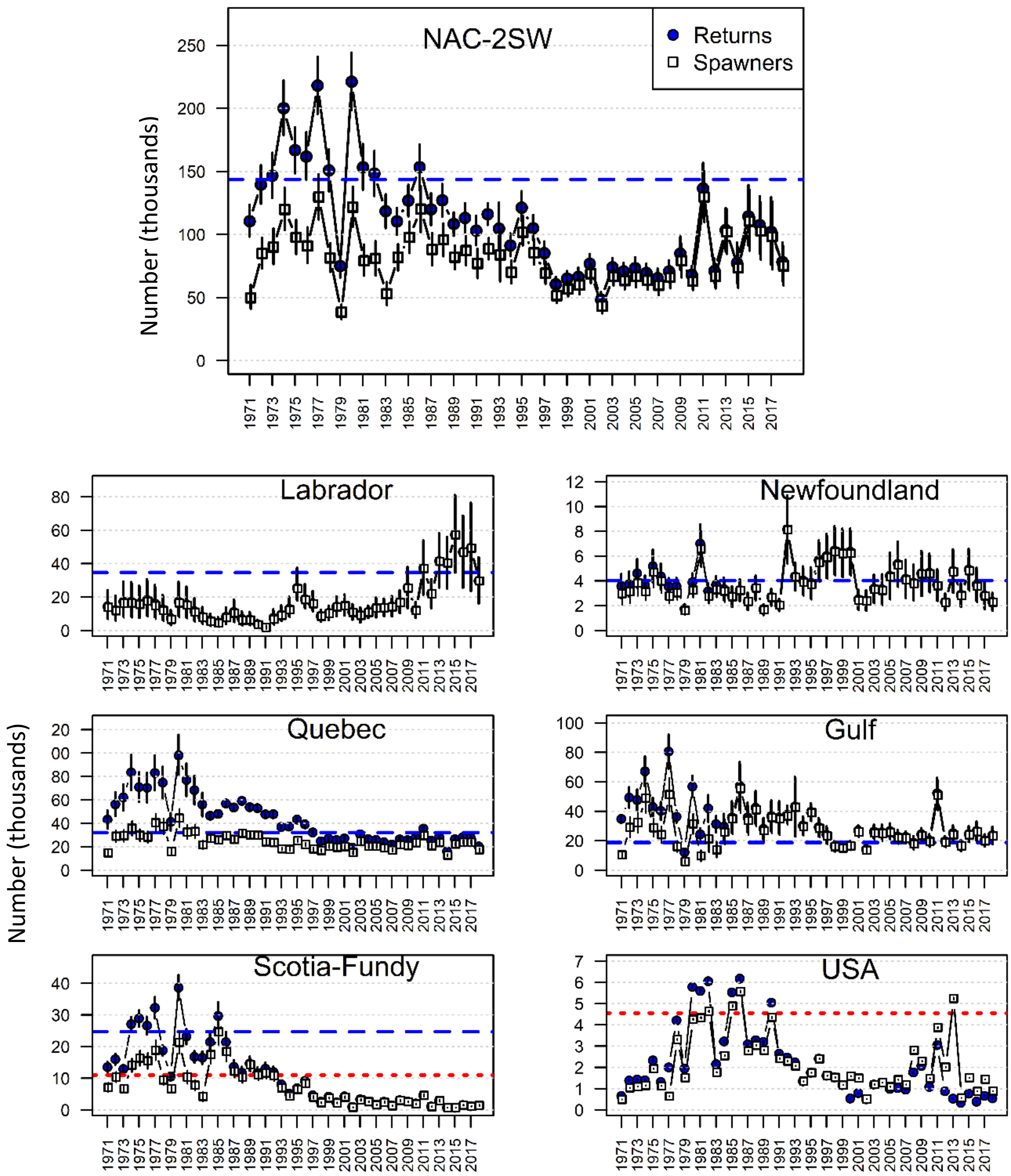

Figure 11 Estimated (median, 5th to 95th percentile range) returns (shaded circles) and spawners (open squares) of 2SW salmon for eastern North America overall and for each of the six regions. The dashed line is the corresponding 2SW CL; the 2SW CL (29 199 fish) is off scale in the plot for USA. The 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.

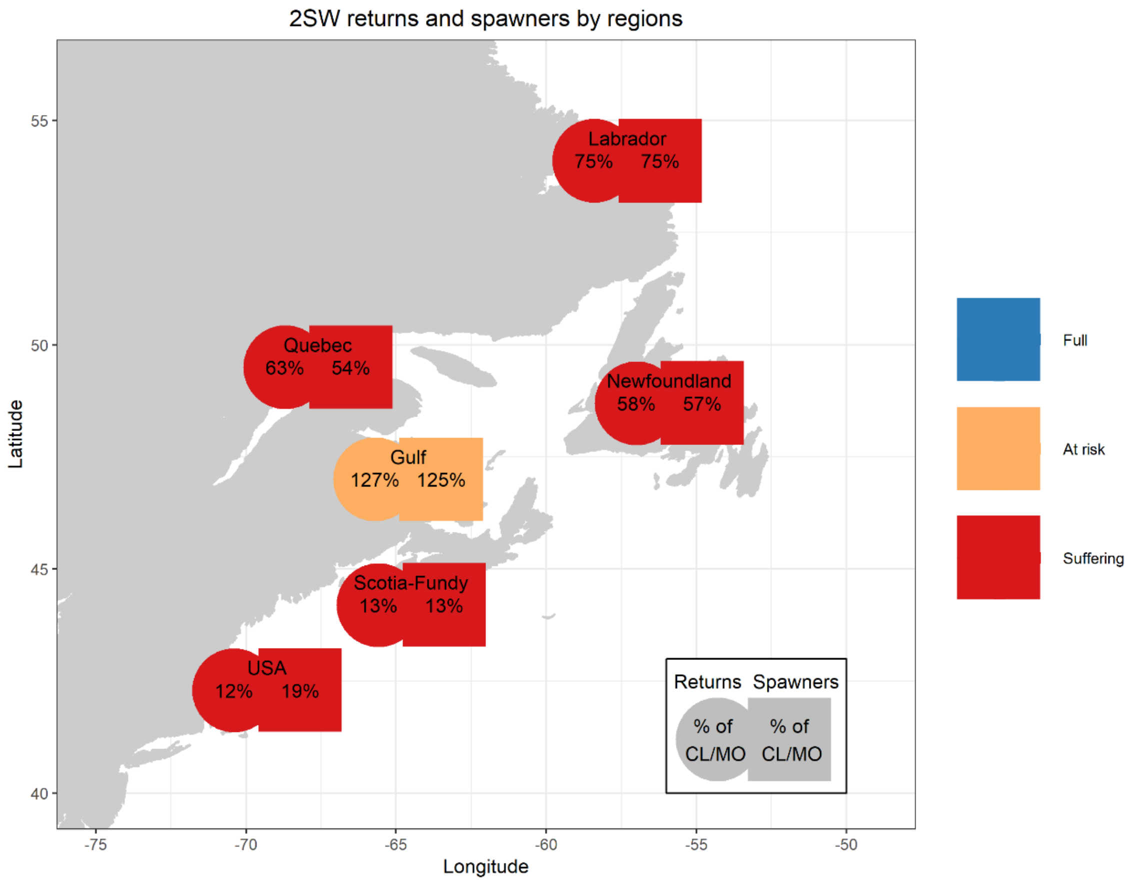

Figure 12 Estimated returns (circle symbol) and spawners (square symbol) of 2SW salmon in 2018 to six regions of North America relative to the stock status categories. The percentage of the 2SW CLs for the four northern regions and to the rebuilding management objectives (MO) for the two southern areas 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).

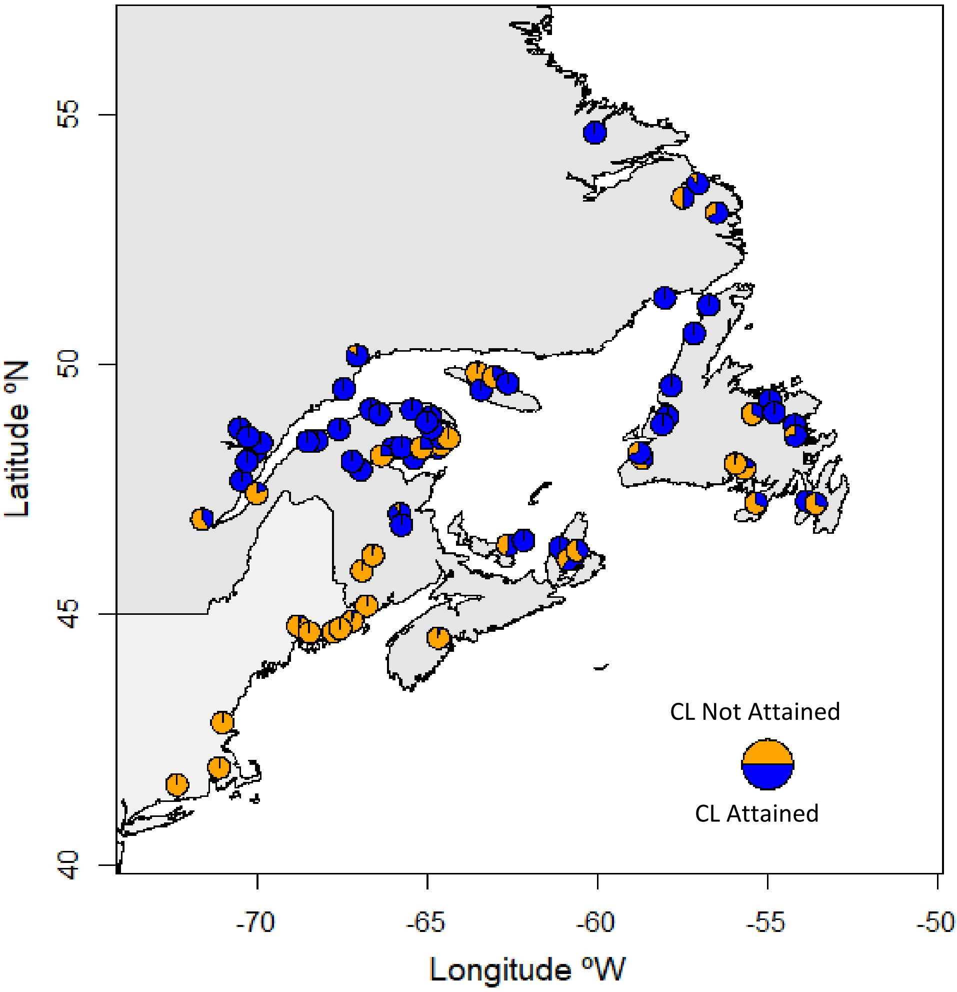

Figure 13 Degree of attainment for the river-specific conservation egg requirement (CL) in the 86 rivers of the North American Commission area assessed in 2018. Eight rivers in the USA are not shown because they were partially assessed but they are considered not to have attained CLs in 2018.

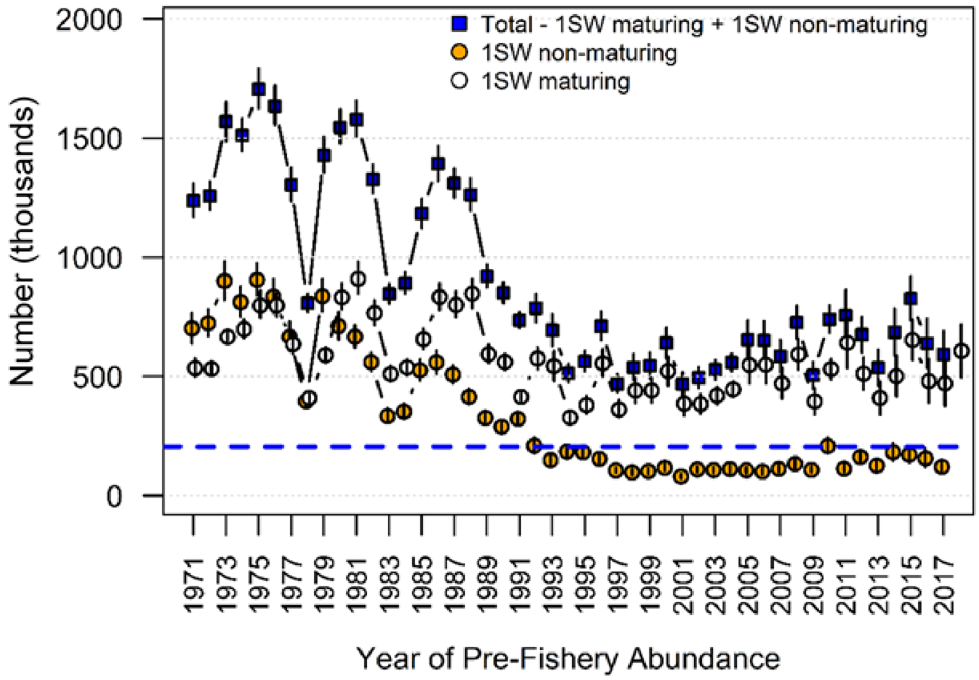

Figure 14 Estimated (median, 5th to 95th percentile range) pre-fishery abundance (PFA) for 1SW maturing, 1SW non-maturing, and total cohort of 1SW salmon for North America. The dashed blue horizontal line is the corresponding sum of the 2SW conservation limits for North America, corrected for 11 months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

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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).

Atlantic salmon at West Greenland

Summary of the advice for 2019–2020

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 (ICES, 2018a). 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 at West Greenland for the fishing years 2019 to 2020. The FWI can be applied again at the beginning of 2020, with the returns or return-rate data for 2019, in order to evaluate the appropriateness of the advice for 2020.

NASCO 4.1 Describe the key events of the 2018 fishery, including details of catch, gear, effort, composition and origin of the catch, rates of exploitation, and location of the catch as in-river, estuarine, and coastal

Fishing for salmon at Greenland is currently allowed using hook, fixed gillnets, and driftnets along the entire coast (Figure 1). The commercial fishery for export closed in 1998; the fishery for internal use, however, continues. Since 2002, licensed commercial fishers have only been allowed to sell salmon to hotels, institutions, and local markets. People fishing for private consumption only, were not required to have a licence until 2018, and are prohibited from selling salmon. The Government of Greenland has unilaterally set the quota for the fishery since 2012, as there was no agreement on the quota by all parties of the West Greenland Commission of NASCO (Table 1). Licensed fishers were also permitted to sell to factories from 2012 to 2015, although the export ban persisted. Specific factory quotas were set at 35 tonnes (t) for 2012 and 2013, and 30 t in 2014. The Government of Greenland set a quota in 2015 for all components of the fishery (private, commercial, and factory landings) at 45 t, but stated that any overharvest in a particular year would result in an equal reduction in the quota the following year. As a result of an overharvest in 2015, the 2016 quota was set by Greenland at 32 t. The quota for 2017 remained at 45 t. Factory landings were not permitted in 2016 and 2017.

In 2018, the Government of Greenland set an annual quota for the 2018–2020 fisheries to 30 t; as agreed by all parties of the West Greenland Commission of NASCO. A 10 t quota was allocated for the private fishery, with the balance (20 t) for the commercial fishery. Within the regulatory measure, the Government of Greenland agreed to continue its ban on the export of both wild Atlantic salmon and its products from Greenland and to prohibit landings and sales to fish processing factories. They also agreed the fishery should be restricted to run from 15 August to no later than 31 October each year, and that any overharvest in a particular year would result in an equal reduction in the total allowable catch in the following year. The regulatory measure also set out a number of provisions aimed at improving the monitoring, management control, and surveillance of the fishery. These include a new requirement for all fishers (private and commercial) to obtain a licence to fish for Atlantic salmon, an agreement to collect catch and fishing activity data from all fishers, and mandatory reporting requirements. The measure also stated that as a condition of the licence, all fishers would be required to allow samplers from the NASCO sampling programme to take samples of their catches upon request.

Catches of Atlantic salmon at West Greenland (Figure 2 and Table 1) increased through the 1960s, reaching a peak reported harvest of approximately 2700 t in 1971, and then decreased until the closure of the commercial fishery for export in 1998. Catches are reported from all six NAFO divisions and proportions vary annually (Table 2). A total salmon catch of 39.9 t was reported for the 2018 fishery, an increase over the 2017 catch (28 t; Table 2). In 2018, commercial landings represented the majority of the harvest at 32.6 t (81.8%) and the remaining 7.3 t was for private use, compared to 15.3 t and 12.7 t respectively in 2017 (Table 3). Only 0.4% (0.1 t) of commercial fishery landings were identified as being for private use in 2018, compared to 39% (9.7 t) in 2017. Given the new licence requirements in 2018, the number of private fishers reporting their landings increased, from 50 fishers in 2017 to 322 fishers in 2018. Reports of commercial landings also increased from 93 fishers in 2017 to 255 fishers in 2018 (Table 3).

When the fishery closed on 31 October 2018, 18.4 t of landings had been registered; this number was later corrected to 39.9 t in March 2019, resulting in an overharvest of approximately 10 t. The Greenlandic authorities indicated a further 10 t of unreported harvest.

The variations in the number of people reporting catches, variation in reported landings in each of the NAFO divisions, and documentation of underreporting of landings suggest that there are inconsistencies in the reported catch data in both the commercial and private fisheries. A phone survey to gain further information on catch and effort was conducted after the fishing season from 2014 to 2016. Unreported catches of 12.2 t (2014), 5 t (2015), and 4.2 t (2016) were identified from these surveys (referred to as adjusted landings (survey) for assessment). With just nine fishers taking part, the phone survey conducted in 2017 was not considered adequate to adjust the reported landings. A phone survey was not conducted in 2018.

An adjustment for some unreported catch, primarily for commercial landings, has been done since 2002. This was done by comparing the weight of salmon observed by the sampling teams and the corresponding community-specific reported landings for the entire fishing season (commercial and private landings combined; referred to as adjusted landings (sampling) for assessment). Sampling only occurs during a portion of the fishing season, and therefore these adjustments are considered to be minimum adjustments for unreported catch (Table 6).

The international sampling programme continued in 2018 (Figure 1). A summary of the biological characteristics of the 2018 catch is presented in Table 7. The 2018 total number of fish harvested (13 200) was an increase over the 2016 and 2017 estimates, and is only 3.9% of the maximum estimate of 336 000 fish harvested since 1982 (Figure 4). Estimates prior to 1982 may be biased due to non-random sampling of catch, but approach approximately 900 000 individuals harvested in the early 1970s.

In 2018, 83.1% of the salmon sampled were determined to be of North American origin and 16.9% of European origin (Figure 3), approximately 10 600 (32.4 t) North American and 2600 (6.6 t) fish of European origin were harvested in 2018 (Figure 4). The origin of salmon harvested at West Greenland (2017 and 2018) has been further refined, based on an updated genetic range-wide baseline (using Single Nucleotide Polymorphisms [SNPs]). This uses samples from 189 rivers, and can discriminate salmon from 21 North American and 10 European genetic reporting groups with an average accuracy of 90% (Jeffery *et al*., 2018) (Figure 5). The North American contributions to the West Greenland fishery are dominated by (74%) the Gaspe Peninsula, Gulf of St Lawrence, and Labrador (Central and South) genetic reporting groups (Tables 8). The Northeast Atlantic contributions were dominated by the United Kingdom/Ireland genetic reporting group (84%). There are smaller, but consistent contributions to the harvest for a number of other genetic reporting groups. Results are similar to those reported for the 2017 fishery (ICES, 2018a). A single sample, based on the individual assignment method, was identified as having originated from the Greenland genetic reporting group (Kapisillit River).

Table 1 Nominal catches of salmon at West Greenland since 1960 (tonnes [t], round fresh weight) by participating nations. For Greenlandic vessels specifically, all catches up to 1968 were taken with set gillnets only and catches after 1968 were taken with set gillnets and driftnets. All non-Greenlandic vessel catches from 1969 to 1975 were taken with driftnets. The quota figures applied to Greenlandic vessels only, and parenthetical entries identify when quotas did not apply to all sectors of the fishery.

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
1960	-	-	-	-	60	60		
1961	-	-	-	-	127	127		
1962	-	-	-	-	244	244		
1963	-	-	-	-	466	466		
1964	-	-	-	-	1539	1539		
1965	-	36	-	-	825	858		Norwegian harvest figures not available, but known to be less than Faroese catch.
1966	32	87	-	-	1251	1370		
1967	78	155	-	85	1283	1601		
1968	138	134	4	272	579	1127		
1969	250	215	30	355	1360	2210		
1970	270	259	8	358	1244	2139		Greenlandic total includes 7 t caught by longlines in the Labrador Sea.
1971	340	255	-	645	1449	2689	-	
1972	158	144	-	401	1410	2113	1100	
1973	200	171	-	385	1585	2341	1100	
1974	140	110	-	505	1162	1917	1191	
1975	217	260	-	382	1171	2030	1191	
1976	-	-	-	-	1175	1175	1191	
1977	-	-	-	-	1420	1420	1191	
1978	-	-	-	-	984	984	1191	
1979	-	-	-	-	1395	1395	1191	
1980	-	-	-	-	1194	1194	1191	

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
1981	-	-	-	-	1264	1264	1265	Quota set to a specific opening date for the fishery.
1982	-	-	-	-	1077	1077	1253	Quota set to a specific opening date for the fishery.
1983	-	-	-	-	310	310	1191	
1984	-	-	-	-	297	297	870	
1985	-	-	-	-	864	864	852	
1986	-	-	-	-	960	960	909	
1987	-	-	-	-	966	966	935	
1988	-	-	-	-	893	893	840	1988–1990 quota was 2520 t with a 1 August opening date. Annual catches were not to exceed an annual average (840 t) by more than 10%. Quota adjusted to 900 t in 1989 and 924 t in 1990 for later opening dates.
1989	-	-	-	-	337	337	900	
1990	-	-	-	-	274	274	924	
1991	-	-	-	-	472	472	840	
1992	-	-	-	-	237	237	258	Quota set by Greenlandic authorities.
1993	-	-	-	-			89	The fishery was suspended. NASCO adopted a new quota allocation model.
1994	-	-	-	-			137	Fishery suspended and quotas were bought out.
1995	-	-	-	-	83	83	77	Quota advised by NASCO.
1996	-	-	-	-	92	92	174	Quota set by Greenlandic authorities.
1997	-	-	-	-	58	58	57	Private (non-commercial) catches to be reported after 1997.
1998	-	-	-	-	11	11	20	Fishery restricted to catches used for internal consumption in Greenland.
1999	-	-	-	-	19	19	20	
2000	-	-	-	-	21	21	20	
2001	-	-	-	-	43	43	114	Final quota calculated according to the *ad hoc* management system.
2002	-	-	-	-	9	9	55	Quota bought out; quota represented the maximum allowable catch (no factory landing allowed), and higher catch figures based on sampling programme information are used for the assessments.
2003	-	-	-	-	9	9		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2004	-	-	-	-	15	15		Same as previous year.
2005	-	-	-	-	15	15		Same as previous year.
2006	-	-	-	-	22	22		Quota set to nil (no factory landing allowed) and fishery restricted to catches used for internal consumption in Greenland.
2007	-	-	-	-	25	25		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2008	-	-	-	-	26	26		Same as previous year.
2009	-	-	-	-	26	26		Same as previous year.
2010	-	-	-	-	40	40		No factory landing allowed and fishery restricted to catches used for internal consumption in Greenland.
2011	-	-	-	-	28	28		Same as previous year.

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
2012	-	-	-	-	33	33	(35)	Unilateral decision made by Greenland for a 35 t quota for factory landings only, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2013	-	-	-	-	47	47	(35)	Same as previous year.
2014	-	-	-	-	58	58	(30)	Unilateral decision made by Greenland to allow factory landing with a 30 t quota for factory landings only, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assessments.
2015	-	-	-	-	57	57	45	Unilateral decision made by Greenland to set a 45 t quota for all sectors of the fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assessments.
2016	-	-	-	-	27	27	32	Unilateral decision made by Greenland to reduce the previously set 45 t quota for all sectors of the fishery to 32 t based on overage of 2015 fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assessments.
2017	-	-	-	-	28	28	45	Unilateral decision made by Greenland to set a 45 t quota for all sectors of the fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2018	-	-	-	-	40	40	30	No factory landing allowed and fishery restricted to catches used for internal consumption in Greenland.

Table 2 Annual distribution of nominal catches (t) at Greenland by NAFO division when known. NAFO divisions are shown in Figure 2. Since 2005, gutted weights have been reported and converted to total weight by a factor of 1.11. Rounding issues are evident for some totals.

Year	NAFO Division						Unknown	West Greenland	East Greenland	Total
	1A	1B	1C	1D	1E	1F				
1960							60	60		60
1961							127	127		127
1962							244	244		244
1963	1	172	180	68	45			466		466
1964	21	326	564	182	339	107		1 539		1 539
1965	19	234	274	86	202	10	36	861		861
1966	17	223	321	207	353	130	87	1 338		1 338
1967	2	205	382	228	336	125	236	1 514		1 514
1968	1	90	241	125	70	34	272	833		833
1969	41	396	245	234	370		867	2 153		2 153
1970	58	239	122	123	496	207	862	2 107		2 107
1971	144	355	724	302	410	159	560	2 654		2 654
1972	117	136	190	374	385	118	703	2 023		2 023
1973	220	271	262	440	619	329	200	2 341		2 341
1974	44	175	272	298	395	88	645	1 917		1 917
1975	147	468	212	224	352	185	442	2 030		2 030
1976	166	302	262	225	182	38		1 175		1 175
1977	201	393	336	207	237	46	-	1 420	6	1 426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1 395	+	1 395
1980	52	275	404	231	158	74	-	1 194	+	1 194
1981	105	403	348	203	153	32	20	1 264	+	1 264
1982	111	330	239	136	167	76	18	1 077	+	1 077
1983	14	77	93	41	55	30	-	310	+	310
1984	33	116	64	4	43	32	5	297	+	297
1985	85	124	198	207	147	103	-	864	7	871
1986	46	73	128	203	233	277	-	960	19	979
1987	48	114	229	205	261	109	-	966	+	966
1988	24	100	213	191	198	167	-	893	4	897
1989	9	28	81	73	75	71	-	337	-	337
1990	4	20	132	54	16	48	-	274	-	274
1991	12	36	120	38	108	158	-	472	4	476
1992	-	4	23	5	75	130	-	237	5	242
1993 *	-	-	-	-	-	-	-	-	-	-
1994 *	-	-	-	-	-	-	-	-	-	-
1995	+	10	28	17	22	5	-	83	2	85
1996	+	+	50	8	23	10	-	92	+	92
1997	1	5	15	4	16	17	-	58	1	59
1998	1	2	2	4	1	2	-	11	-	11
1999	+	2	3	9	2	2	-	19	+	19
2000	+	+	1	7	+	13	-	21	-	21
2001	+	1	4	5	3	28	-	43	-	43
2002	+	+	2	4	1	2	-	9	-	9
2003	1	+	2	1	1	5	-	9	-	9
2004	3	1	4	2	3	2	-	15	-	15
2005	1	3	2	1	3	5	-	15	-	15
2006	6	2	3	4	2	4	-	22	-	22
2007	2	5	6	4	5	2	-	25	-	25
2008	4.9	2.2	10.0	1.6	2.5	5.0	0	26.2	0	26.2
2009	0.2	6.2	7.1	3.0	4.3	4.8	0	25.6	0.8	26.3
2010	17.3	4.6	2.4	2.7	6.8	4.3	0	38.1	1.7	39.6
2011	1.8	3.7	5.3	8.0	4.0	4.6	0	27.4	0.1	27.5
2012	5.4	0.8	15.0	4.6	4.0	3.0	0	32.6	0.5	33.1
2013	3.1	2.4	17.9	13.4	6.4	3.8	0	47.0	0.0	47.0

Year	NAFO Division						Unknown	West Greenland	East Greenland	Total
	1A	1B	1C	1D	1E	1F				
2014	3.6	2.8	13.8	19.1	15.0	3.4	0	57.8	0.1	57.9
2015	0.8	8.8	10.0	18.0	4.2	14.1	0	55.9	1.0	56.8
2016	0.8	1.2	7.3	4.6	4.5	7.3	0	25.7	1.5	27.1
2017	1.1	1.7	9.3	6.9	3.2	5.6	0	27.8	0.3	28.0
2018	2.4	5.7	13.7	8.2	4.2	4.8	0	39.0	0.8	39.9

* The fishery was suspended.
+ Small catches < 5 t.
- No catch.

Table 3 Reported 2017 and 2018 catches by fisher. Licences for private fishers were introduced in 2018.

Licence status	Landings type	Reported 2017 catch (t)	Reported 2018 catch (t)
Licensed	Commercial (from commercial fishers)	15.3	32.5
	Private use (from commercial fishers)	9.7	0.1
	Private use (from private fishers)	-	7.2
Unlicensed	Commercial	0.0	-
	Private use	3.1	-
	Total Commercial catch	15.3	32.6
	Total Private use catch	12.8	7.3
	Total catch	28.0	39.9

Table 4 Reported landings (t) by licence type, landing category, the number of fishers reporting, and the total number of landing reports received in 2018. Empty cells identify categories with no reported landings and 0.0 entries represent reported values of < 0.1. Rounding issues are evident for some totals.

NAFO/ICES	Licence type	No. of fishers	No. of reports	Commercial	Private	Factory	Total
NAFO 1A	Private	35	58	0.0	0.2		0.2
	Commercial	63	177	2.2	0.0		2.2
	TOTAL	**98**	**235**	**2.2**	**0.2**		**2.4**
NAFO 1B	Private	47	105		1.0		1.0
	Commercial	31	125	4.6			4.6
	TOTAL	**78**	**230**	**4.6**	**1.0**		**5.7**
NAFO 1C	Private	25	51		0.8		0.8
	Commercial	56	200	12.9			12.9
	TOTAL	**81**	**251**	**12.9**	**0.8**		**13.7**
NAFO 1D	Private	125	163	0.0	1.4		1.4
	Commercial	18	120	6.8			6.8
	TOTAL	**143**	**283**	**6.8**	**1.4**		**8.2**
NAFO 1E	Private	20	86		1.5		1.5
	Commercial	24	98	2.7	0.1		2.8
	TOTAL	**44**	**184**	**2.7**	**1.6**		**4.2**
NAFO 1F	Private	65	169	0.0	2.0		2.0
	Commercial	40	130	2.8			2.8
	TOTAL	**105**	**299**	**2.8**	**2.0**		**4.8**
ICES Subarea 14	Private	5	42		0.4		0.4
	Commercial	3	12	0.4			0.4
	TOTAL	**8**	**54**	**0.4**	**0.4**		**0.8**
ALL	Private	322	674	0.0	7.2		7.3
	Commercial	235	862	32.5	0.1		32.6
	TOTAL	**557**	**1536**	**32.5**	**7.4**		**39.9**

Table 5 Reported landings (t) by landing category, the number of fishers reporting, and the total number of landing reports received for licensed and unlicensed fishers in 2017. Empty cells identify categories with no reported landings and 0.0 entries represents reported values of < 0.1. Rounding issues are evident for some totals.

NAFO/ICES	Licensed	No. of fishers	No. of reports	Commercial	Private	Factory	Total
NAFO 1A	NO	2	12	0	0		0
	YES	15	66	0.3	0.8		1.1
	TOTAL	**17**	**78**	**0.3**	**0.9**		**1.1**
NAFO 1B	NO						0
	YES	9	40	1.4	0.2		1.7
	TOTAL	**9**	**40**	**1.4**	**0.2**		**1.7**
NAFO 1C	NO	7	23	0	0.4		0.4
	YES	33	135	5.9	3		8.9
	TOTAL	**40**	**158**	**5.9**	**3.4**		**9.3**
NAFO 1D	NO	17	44	0	0.9		0.9
	YES	7	23	5.1	0.9		5.9
	TOTAL	**24**	**67**	**5.1**	**1.8**		**6.9**
NAFO 1E	NO	8	24	0	0.6		0.6
	YES	15	114	0.7	1.9		2.6
	TOTAL	**23**	**138**	**0.7**	**2.5**		**3.2**
NAFO 1F	NO	16	51	0	1.2		1.2
	YES	12	78	1.8	2.6		4.4
	TOTAL	**28**	**129**	**1.8**	**3.8**		**5.6**
ICES Subarea 14	NO						0
	YES	2	21	0.1	0.2		0.3
	TOTAL	**2**	**21**	**0.1**	**0.2**		**0.3**
ALL	NO	50	154	0	3.1		3.1
	YES	93	477	15.3	9.7		24.9
	TOTAL	**143**	**631**	**15.3**	**12.7**		**28**

Table 6 Reported landings and adjusted landings (t) for assessment of Atlantic salmon at West Greenland 2002–2018. The total adjusted landings number does not include the unreported catch (10 t per year since 2000).

Year	Reported landings (West Greenland)	Adjusted landings (Sampling)	Adjusted landings (Survey)	Total adjusted landings
2002	9.0	0.7	-	9.8
2003	8.7	3.6	-	12.3
2004	14.7	2.5	-	17.2
2005	15.3	2.0	-	17.3
2006	23.0	0.0	-	23.0
2007	24.6	0.2	-	24.8
2008	26.1	2.5	-	28.6
2009	25.5	2.5	-	28.0
2010	37.9	5.1	-	43.1
2011	27.4	0.0	-	27.4
2012	32.6	2.0	-	34.6
2013	46.9	0.7	-	47.7
2014	57.7	0.6	12.2	70.5
2015	55.9	0.0	5.0	60.9
2016	25.7	0.3	4.2	30.2
2017	27.8	0.3	-	28.0
2018	39.0	-	-	39.0

Table 7 Summary of biological characteristics of catches of Atlantic salmon at West Greenland in 2018 (NA = North America, E = Europe).

River-age distribution (%) by origin								
Continent of origin	1	2	3	4	5	6	7	8
NA	0.5	29.8	38.4	24.1	6.5	0.7	0	0
E	13.7	62.1	19.0	5.2	0	0	0	0

Length and weight by origin and sea age								
Continent of origin	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length	Whole	Fork length	Whole	Fork length	Whole	Fork	Whole
NA	63.8	2.91	87.5	9.27	77.1	4.53	64.2	2.97
E	63.9	2.93	76.3	5.59	-	-	64.2	3.00

Continent of origin (%)	
North America	Europe
83.1	16.9

Sea-age composition (%) by continent of origin			
Continent of origin	1SW	2SW	Previous spawners
NA	97.4	0.4	2.2
E	97.4	2.6	0

Table 8 Bayesian estimates of mixture composition for the West Greenland Atlantic salmon fishery, by region and overall for 2018. Baseline locations refer to regional reporting groups identified in Figure 5. Sample locations are identified by NAFO divisions. Mean estimates provided with 95% credible interval in parentheses. Credible intervals with a lower bound of zero, or close to zero, indicate little support for the mean assignment value; reporting groups with such low credible intervals are indicated with grey font.

Regional group	COO	NAFO 1B	NAFO 1C	NAFO 1E	NAFO 1F	Overall
Baltic Sea	EUR	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.2)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Barents–White Seas	EUR	0.0 (0.0, 0.1)	0.0 (0.0, 0.0)	0.1 (0.0, 0.7)	0.0 (0.0, 0.1)	0.0 (0.0, 0.0)
European Broodstock	EUR	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
France	EUR	0.6 (0.1, 1.7)	0.8 (0.2, 1.9)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.5 (0.2, 1.1)
Greenland	EUR	0.0 (0.0, 0.0)	0.2 (0.0, 0.9)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.1 (0.0, 0.4)
Iceland	EUR	0.0 (0.0, 0.0)	0.5 (0.1, 1.3)	0.0 (0.0, 0.0)	0.9 (0.1, 2.6)	0.4 (0.1, 0.9)
Northern Norway	EUR	0.1 (0.0, 0.6)	0.0 (0.0, 0.1)	0.2 (0.0, 1.8)	0.0 (0.0, 0.2)	0.0 (0.0, 0.1)
Southern Norway	EUR	0.6 (0.0, 1.7)	1.0 (0.2, 2.1)	0.6 (0.0, 5.5)	0.6 (0.0, 2.3)	0.6 (0.2, 1.2)
Spain	EUR	2.5 (1.0, 4.5)	0.6 (0.1, 1.7)	0.0 (0.0, 0.1)	0.7 (0.0, 2.3)	1.2 (0.6, 2.0)
United Kingdom/Ireland	EUR	10.9 (7.7, 14.6)	15.8 (12.5, 19.4)	41.1 (23.5, 60.0)	11.3 (7.4, 15.9)	14.5 (12.3, 16.8)
Anticosti	NA	0.2 (0.0, 1.2)	0.3 (0.0, 1.0)	0.1 (0.0, 1.6)	0.9 (0.1, 2.6)	0.4 (0.1, 0.9)
Avalon Peninsula	NA	0.0 (0.0, 0.2)	0.0 (0.0, 0.1)	0.2 (0.0, 1.9)	0.0 (0.0, 0.2)	0.0 (0.0, 0.1)
Burin Peninsula	NA	0.0 (0.0, 0.6)	0.0 (0.0, 0.2)	0.5 (0.0, 5.6)	0.5 (0.0, 2.8)	0.0 (0.0, 0.1)
Eastern Nova Scotia	NA	0.0 (0.0, 0.1)	0.1 (0.0, 0.9)	0.1 (0.0, 0.9)	1.0 (0.1, 2.7)	0.2 (0.0, 0.8)
Fortune Bay	NA	0.1 (0.0, 0.7)	0.0 (0.0, 0.1)	0.1 (0.0, 1.0)	1.2 (0.0, 3.5)	0.1 (0.0, 0.5)
Gaspe Peninsula	NA	34.2 (28.7, 39.9)	29.2 (24.6, 34.1)	15.7 (2.9, 35.5)	21.8 (16.0, 27.8)	29.1 (26.1, 32.3)
Gulf of St Lawrence	NA	16.4 (12.1, 21.1)	12.6 (9.2, 16.4)	3.8 (0.0, 19.0)	13.4 (8.8, 18.7)	13.8 (11.5, 16.2)
Inner Bay of Fundy	NA	0.0 (0.0, 0.0)	0.0 (0.0, 0.1)	0.1 (0.0, 0.5)	0.0 (0.0, 0.1)	0.0 (0.0, 0.0)
Labrador Central	NA	1.4 (0.2, 3.5)	4.1 (1.9, 6.7)	3.9 (0.1, 13.6)	5.9 (2, 10.5)	3.3 (1.8, 5.2)
Labrador South	NA	15.6 (11.7, 19.9)	12.4 (9.1, 16.0)	11.4 (2.5, 25.4)	18.4 (12.6, 24.7)	14.8 (12.4, 17.3)
Lake Melville	NA	4.8 (2.7, 7.5)	5.2 (3.2, 7.7)	3.8 (0.1, 13.6)	4.3 (1.6, 8.0)	4.9 (3.5, 6.4)
Maine, United States	NA	1.9 (0.7, 3.6)	2.7 (1.3, 4.4)	0.0 (0.0, 0.2)	1.8 (0.4, 4.0)	2.2 (1.4, 3.3)
Newfoundland 1	NA	1.6 (0.5, 3.3)	0.7 (0.1, 1.7)	1.8 (0.0, 11.1)	0.7 (0.0, 3.5)	1.2 (0.6, 2.1)
Newfoundland 2	NA	0.6 (0.0, 2.0)	0.1 (0.0, 0.7)	0.6 (0.0, 6.7)	1.1 (0.0, 3.8)	0.5 (0.0, 1.3)
Northern Newfoundland	NA	0.9 (0.2, 2.3)	0.6 (0.1, 1.6)	1.2 (0.0, 8.9)	1.0 (0.1, 2.9)	0.9 (0.4, 1.6)
Quebec City Region	NA	1.0 (0.0, 3.1)	1.0 (0.0, 2.9)	4.1 (0.0, 19.1)	3.6 (1.3, 6.8)	1.5 (0.5, 2.7)
St John River & Aquaculture	NA	0.0 (0.0, 0.1)	0.0 (0.0, 0.1)	2.7 (0.0, 12.6)	0.0 (0.0, 0.3)	0.0 (0.0, 0.2)
St Lawrence N. Shore Lower	NA	2.8 (1.2, 5.0)	6.3 (4.1, 9.0)	3.9 (0.1, 13.7)	3.7 (1.4, 6.9)	4.5 (3.3, 6.0)
Ungava	NA	2.8 (1.3, 4.8)	3.4 (1.9, 5.3)	3.7 (0.1, 13.1)	6.4 (3.6, 10.0)	3.9 (2.8, 5.2)
Western Newfoundland	NA	1.0 (0.0, 2.5)	2.4 (1.0, 4.2)	0.1 (0.0, 0.7)	0.6 (0.0, 2.3)	1.3 (0.6, 2.2)
Western Nova Scotia	NA	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.1)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)

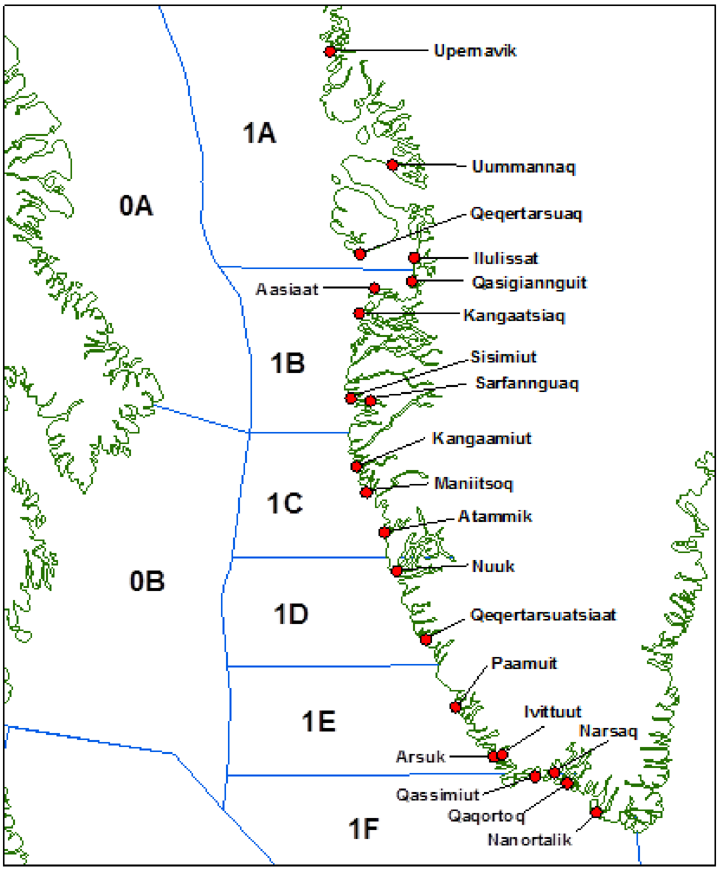

Figure 1 Map of communities in West Greenland where Atlantic salmon have historically been landed and the corresponding NAFO divisions (1A–1F). In 2018, samples were obtained from Sisimuit (1B), Maniitsoq (1C), Paamuit (1E), and Qaqortoq (1F).

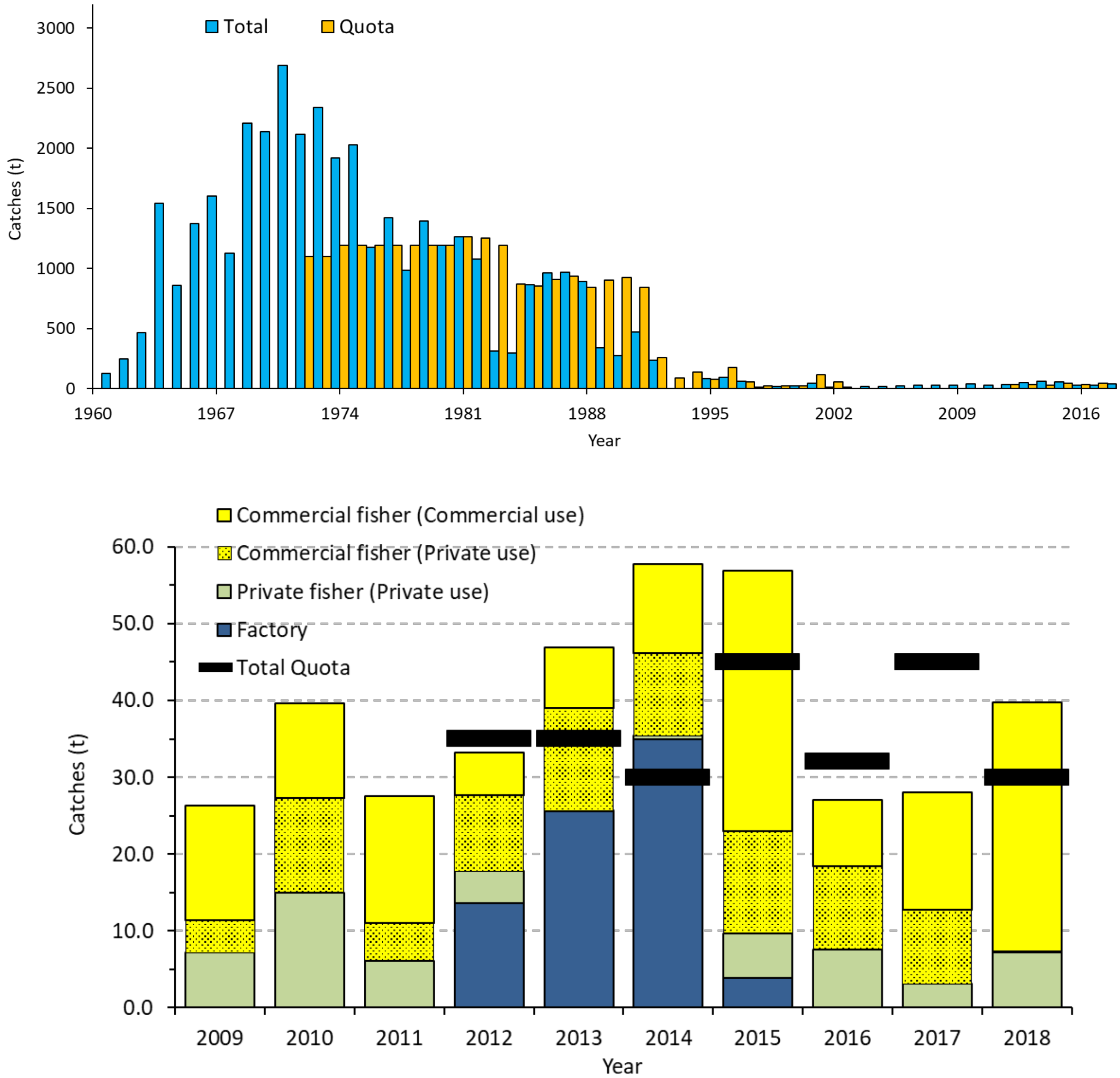

Figure 2 Nominal landings and commercial quotas (t, round fresh weight) of salmon at West Greenland from 1960 to 2018 (top panel). Landings from 2009 to 2018 are also displayed by landing type (lower panel). No quotas were set for 2002–2011 and the quotas for 2012–2014 were for factory landings only.

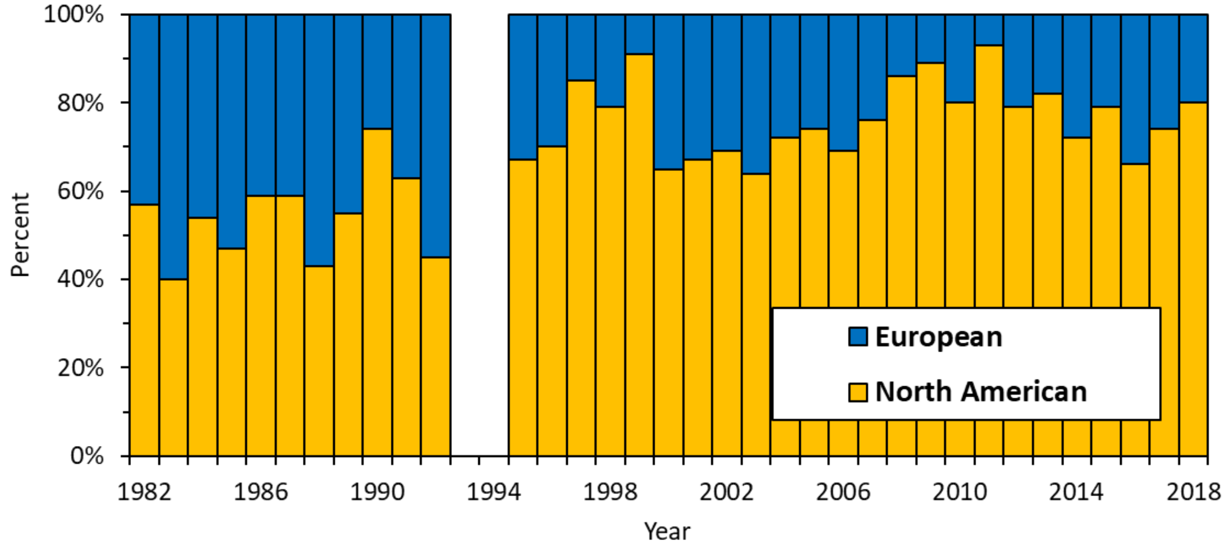

Figure 3 Estimated percent continent of origin of Atlantic salmon harvested at West Greenland from 1982 to 2018.

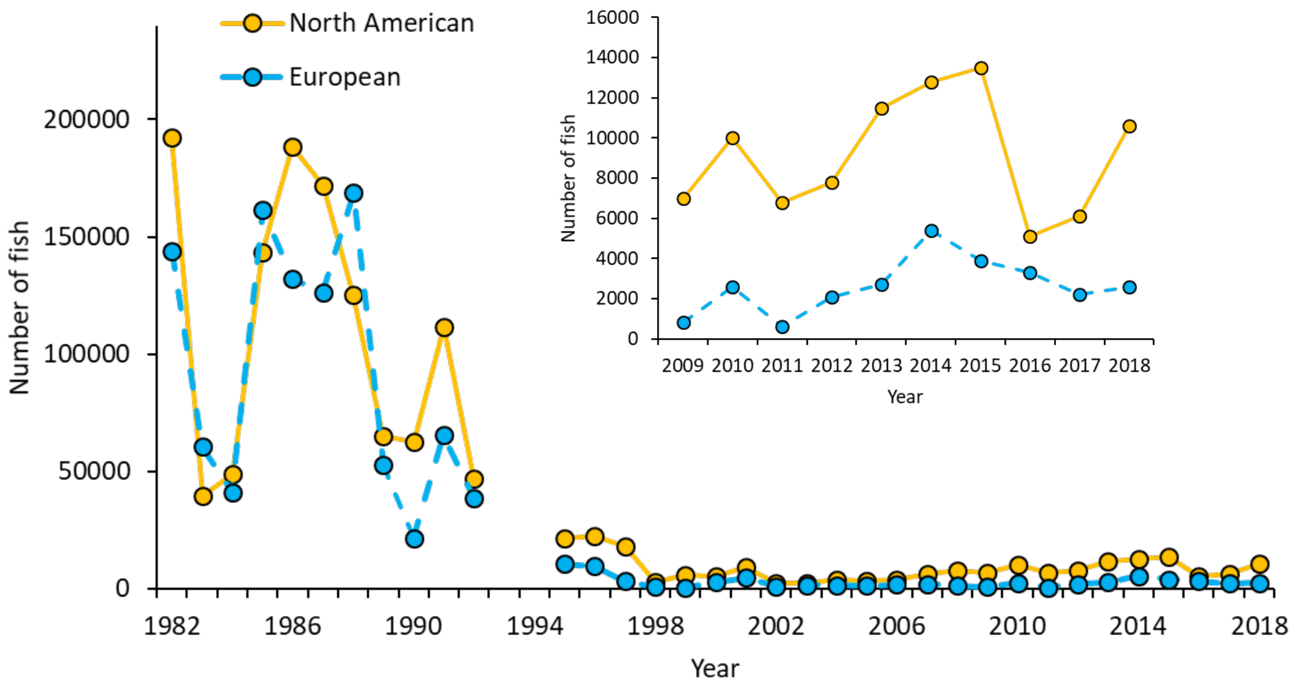

Figure 4 Number of North American and European Atlantic salmon caught at West Greenland in 1982–2018 and 2009–2018 (inset). Estimates are based on continent of origin by NAFO division, weighted by catch (weight) in each division. Numbers are rounded to the nearest hundred fish. Unreported catch not included.

ICES region	Regional group	Group acronym
Quebec (North)	Ungava	UNG
Labrador	Labrador Central	LAC
	Lake Melville	MEL
	Labrador South	LAS
Quebec	St Lawrence North Shore Lower	QLS
	Anticosti	ANT
	Gaspe Peninsula	GAS
	Quebec 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

ICES region	Regional 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

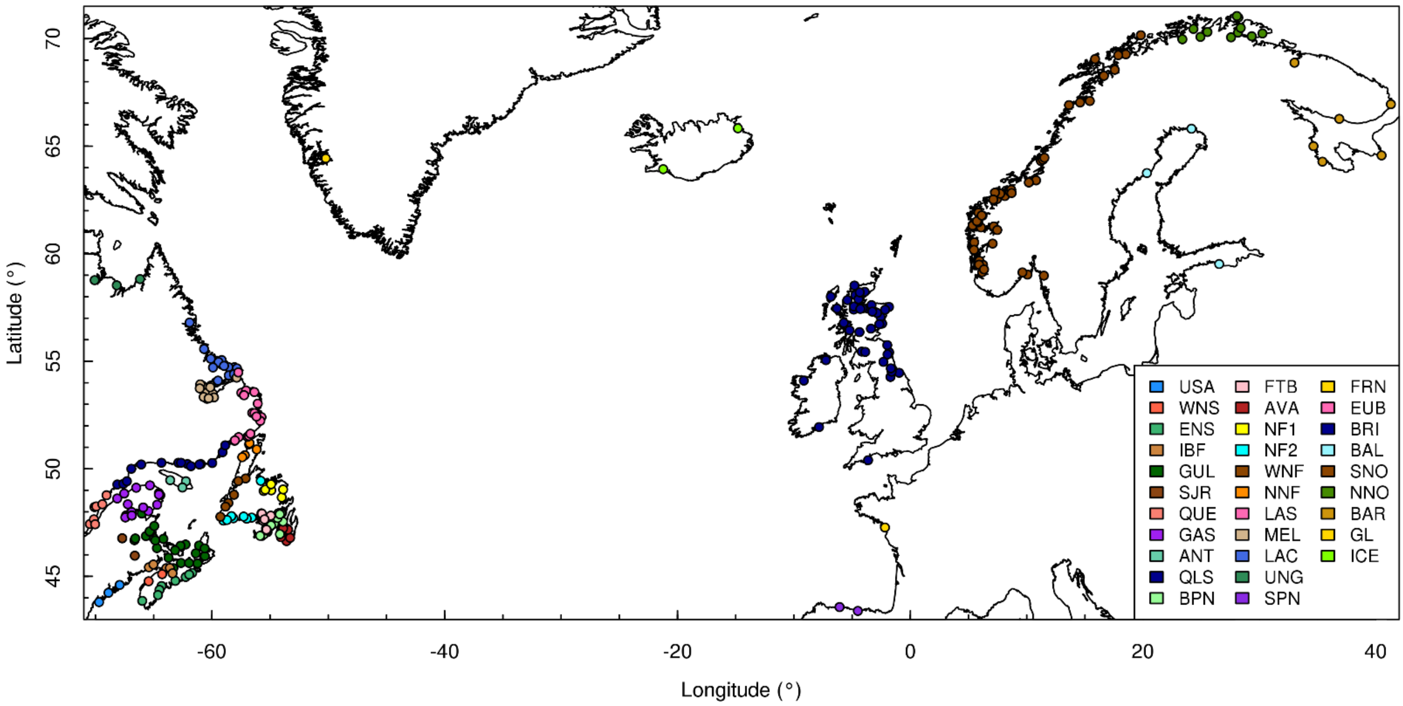

Figure 5 Regional groupings and codes from the SNP-based genetic baseline (upper table) and location map. The EUB (European Broodstock) regional grouping does not have a geographic location and therefore is not represented on the map.

NASCO 4.2 Describe the status of the stocks

Recruitment (pre-fishery abundance) estimates of non-maturing 1SW salmon at Greenland show continued low abundance compared to historical levels and are currently below the spawner escapement reserves (SER) for North American (Figure 6) and Southern NEAC (Figure 7).

In 2018, the median estimates of spawners were below the conservation limits (CLs) (suffering reduced reproductive capacity) for 2SW salmon in five of the six regions of NAC, and for MSW salmon in Southern NEAC (Figure 8). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the NAC Scotia–Fundy and USA regions.

The exploitation rate (catch in Greenland divided by pre-fishery abundance [PFA]) in 2017 was 6.7% for NAC fish and 0.8% for Southern NEAC fish (Figure 9). Despite major changes in fisheries management in the past few decades and increasingly more restrictive fisheries measures, returns have remained near historical lows. It is likely, therefore, that other factors besides fisheries are constraining production.

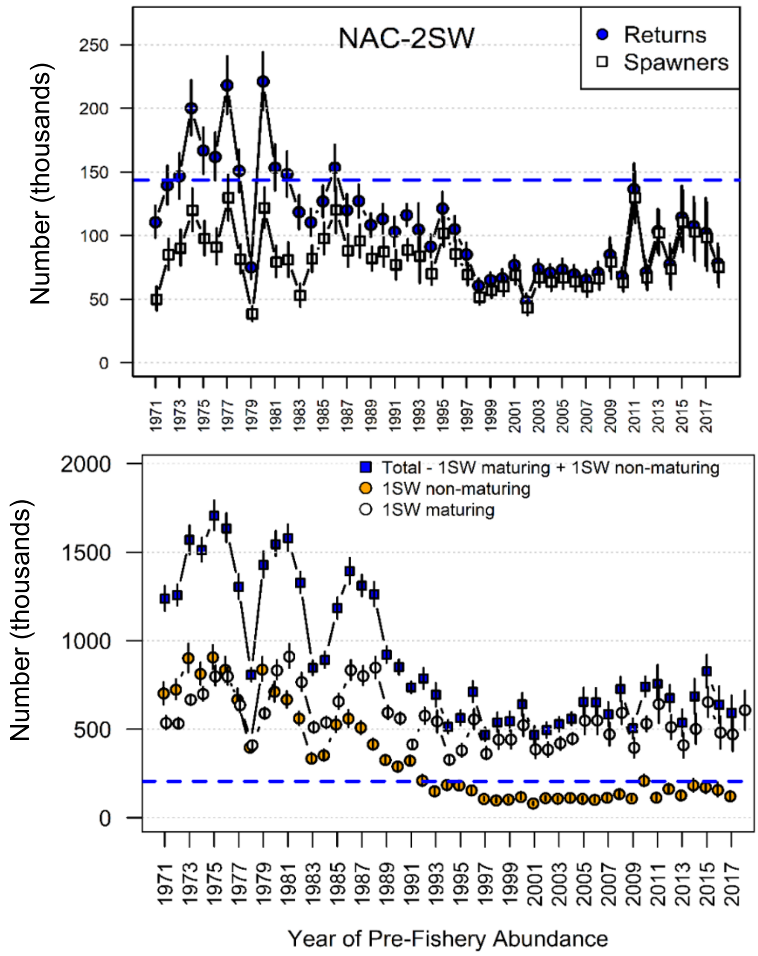

Figure 6 Top panel: Estimated (median, 5th to 95th percentile range, in thousands) returns (blue circles) and spawners (white square) of 2SW salmon for NAC 1971 to 2018. The dashed line is the corresponding 2SW conservation limit for NAC. Bottom panel: Estimated (median, 5th to 95th percentile range, in thousands) pre-fishery abundance (PFA) for 1SW maturing, 1SW non-maturing, and the total cohort of 1SW salmon for NAC, PFA years 1971 to 2017. The dashed blue horizontal line is the corresponding sum of the 2SW conservation limits for NAC (143 494) corrected for 11 months of natural mortality (193 697) against which 1SW non-maturing salmon are assessed.

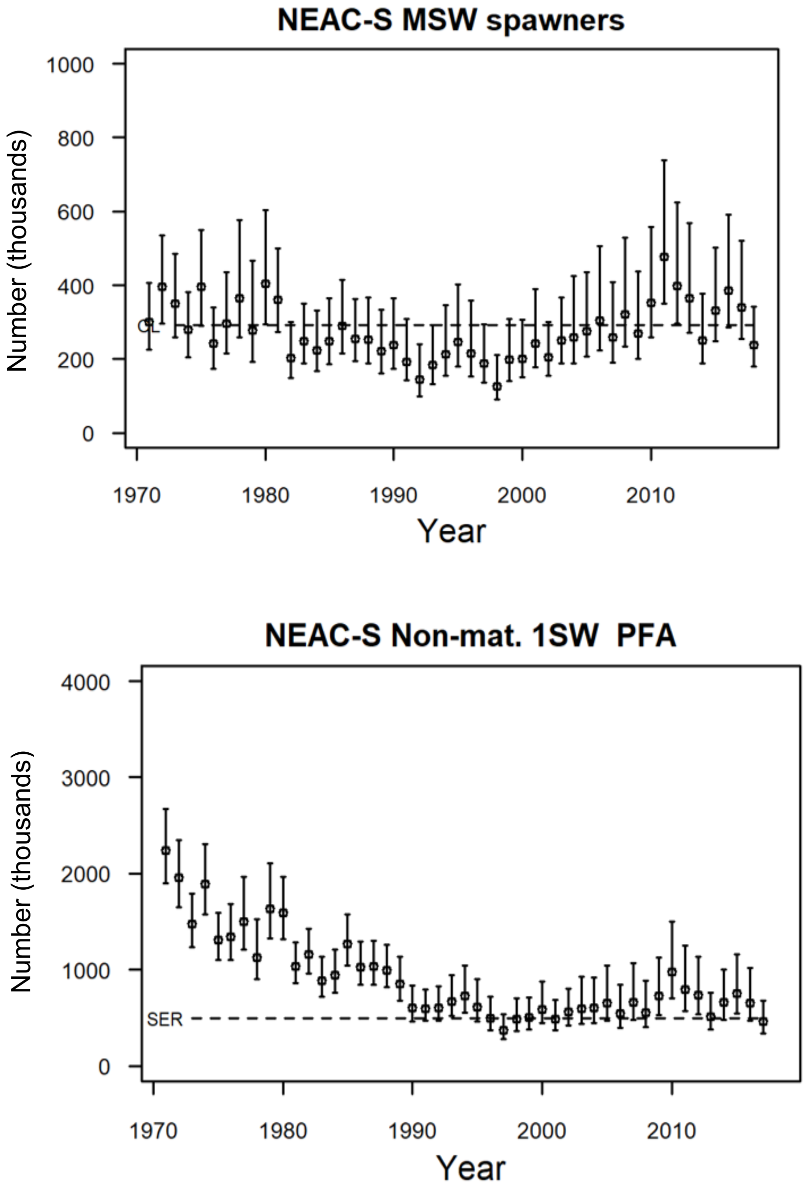

Figure 7 Estimated spawning escapement (upper panel) and PFA (lower panel) and spawning escapement with 90% confidence limits, for non-maturing 1SW (MSW spawners) salmon in the Southern NEAC (NEAC–S) stock complex.

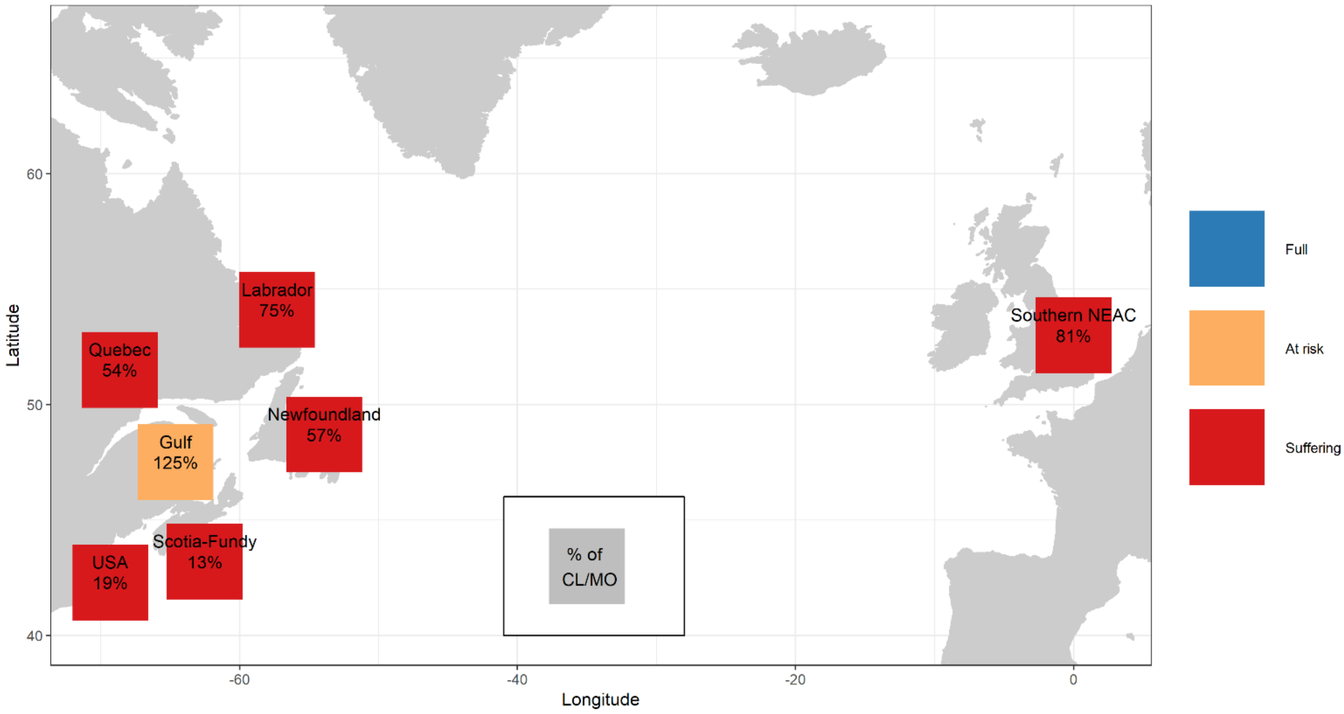

Figure 8 Summary 2SW (NAC regions) and MSW (Southern NEAC) 2018 median (from the Monte Carlo posterior distributions) spawner estimates in relation to conservation limits/management objectives (CL/MO). The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At Risk (at risk of suffering reduced reproductive capacity: the median spawner estimate is above the CL, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: the median spawner estimate is below the CL).

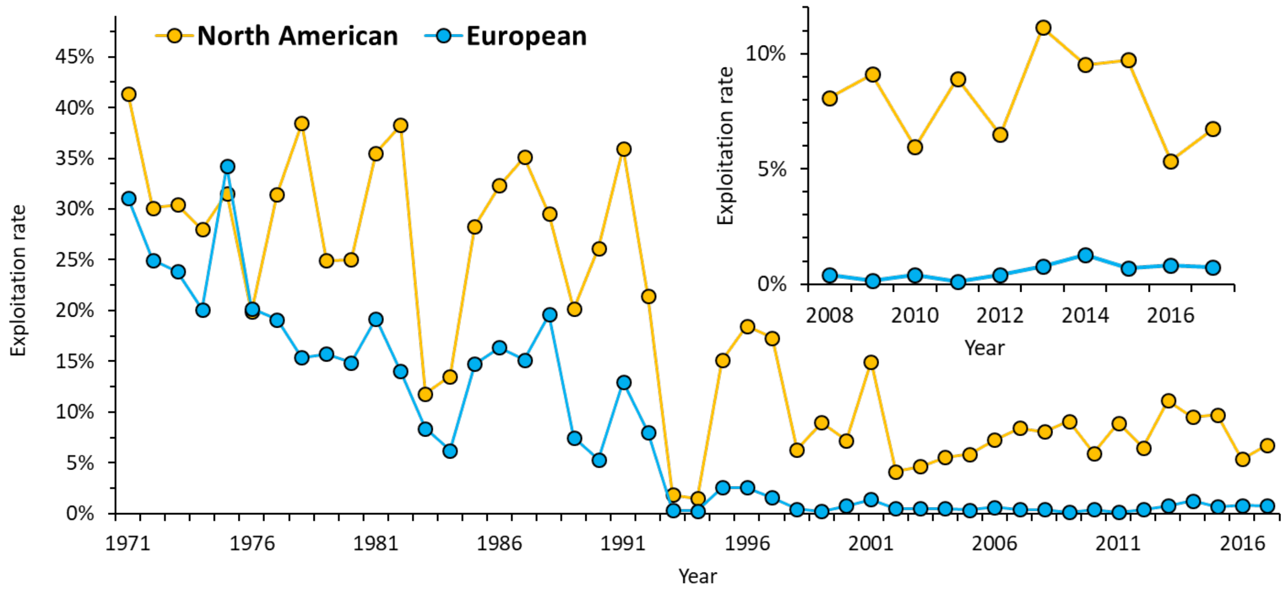

Figure 9 Exploitation rate (%) for NAC 1SW non-maturing and southern NEAC non-maturing Atlantic salmon at West Greenland, 1971–2017 and 2008–2017 (inset). Exploitation rate estimates are only available to 2017, as 2018 exploitation rates are dependent on 2019 returns.

Relevant data deficiencies, monitoring needs, and research requirements

The following data deficiencies, monitoring needs, and research requirements were identified as being of relevance to the West Greenland Commission:

1) Efforts to improve the reporting system of catch in the Greenland fishery should continue, while spatially and temporally explicit catch and effort data from all fishers should be made available for analyses.
2) The broad geographic sampling programme including in Nuuk (multiple NAFO divisions including factory landings when permitted) should be expanded across the fishing season to ensure that samples are representative of the entire catch. This will allow more accurate estimates of region of origin and biological characteristics of the mixed-stock fishery.

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, 2019a).

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Recommended citation: ICES. 2019. Atlantic salmon at West Greenland. *In* Report of the ICES Advisory Committee, 2019. ICES Advice 2019, sal.wgc.all, https://doi.org/10.17895/ices.advice.5227

Annex 1 Glossary of acronyms and abbreviations

1SW *(one-sea-winter).* Maiden adult salmon that has spent one winter at sea.
2SW *(two-sea-winter).* Maiden adult salmon that has spent two 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.
ICES (*International Council for the Exploration of the Sea*).
NAC (*North American Commission*). A commission under NASCO.
NAFO (*Northwest Atlantic Fisheries Organization*). NAFO is an intergovernmental fisheries science and management organization that ensures the long-term conservation and sustainable use of the fishery resources in the Northwest Atlantic.
NASCO (*North Atlantic Salmon Conservation Organization*).
NEAC (*North East Atlantic Commission*). A commission under NASCO.
PFA *(pre-fishery abundance).* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time.

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 (CLs) by 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, a simultaneous risk level (probability) of 75% has been agreed for the provision of catch advice on the stock complexes exploited at West Greenland (non-maturing 1SW fish from North America and Southern NEAC). The management objectives are to meet (a) the Southern NEAC MSW CL, (b) the 2SW CLs for the four northern areas of NAC (Labrador, Newfoundland, Québec, and Gulf) to achieve a 25% increase in returns of 2SW salmon from the average returns in the period 1992–1996 for the Scotia–Fundy region of NAC, and (c) to achieve 2SW adult returns of 4549 fish or greater for the USA region of NAC. A framework of indicators has been developed in support of the multi-annual catch options.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northeast Atlantic area their current distribution extends from northern Portugal to the Pechora River in northwestern Russia and Iceland. In the Northwest Atlantic distribution ranges from the Connecticut River in USA (41.6°N) to the Leaf River in Ungava Bay (Quebec, Canada; 58.8°N). Juveniles migrate to the ocean at ages 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 during their second summer and autumn at sea.

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 factors contributing to lower productivity, which is expressed almost entirely in terms of lower marine survival.

Effects of the fisheries on the ecosystem

The current salmon fishery uses nearshore surface gillnets. There is no information on bycatch of other species with this gear. The fisheries probably have no influence, or only a minor influence, on the marine ecosystem.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. Catch reporting at Greenland is considered to be incomplete.

Scientific basis

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 and continent of origin) for internal use fisheries. Estimates of unreported/illegal catches. Estimates of exploitation rates. Natural mortalities (from earlier assessments).
Discards and bycatch	No salmon discards in the directed salmon fishery.
Indicators	A framework of indicators (FWI) is used to indicate whether a significant change has occurred in the status of stocks in intermediate years where multi-annual management advice applies.
Other information	Advice subject to annual review. Stock annex completed in 2014 and updated in 2019 (ICES, 2019c).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2019b).