ICES Advice on fishing opportunities, catch, and effort
Northeast Atlantic ecoregions
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North Atlantic salmon stocks

Introduction

Main tasks

At its 2020 Statutory Meeting, ICES resolved (C. Res. 2019/2/ACOM21) that the Working Group on North Atlantic Salmon (WGNAS, chaired by Dennis Ensing, UK) would meet in Copenhagen, Denmark, 21–31 March 2021 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO). Due to the COVID-19 pandemic, the working group met via web conference to address these questions.

The table below identifies the sections of the report (ICES, 2021a) that provide response to the questions posed by NASCO in the terms of reference (ToR).

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 2020[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 2020;	
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 2020 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;	
2.4	provide catch options or alternative management advice for the 2021 / 2022–2023 / 2024 fishing seasons, with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[4]; and	
2.5	update the Framework of Indicators used to identify any significant change in the previously provided multiannual management advice.	
3	With respect to Atlantic salmon in the North American Commission area:	sal.nac.all
3.1	describe the key events of the 2020 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;	
3.4	provide catch options or alternative management advice for 2021–2024 with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[4] ; and	
3.5	update the Framework of Indicators used to identify any significant change in the previously provided multiannual management advice.	
4	With respect to Atlantic salmon in the West Greenland Commission area:	sal.wgc.all
4.1	describe the key events of the 2020 fisheries[3];	
4.2	describe the status of the stocks[5];	
4.3	provide catch options or alternative management advice for 2021–2023 with an assessment of risk relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[4] ; and	
4.4	update the Framework of Indicators used to identify any significant change in the previously provided multiannual management advice.	

[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 information 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, ICES is asked to 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. Also to provide a detailed explanation and critical examination of any concerns with salmon data collected in 2020 which may affect the catch advice considering the restrictions on data collection programmes and fisheries due to the Covid-19 pandemic.
[5] In response to question 4.2, ICES is requested to provide a brief summary of the status of North American and Northeast Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions 2.3 and 3.3.

In response to the ToR, the WGNAS considered 33 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 ToR posed by the 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 the Faroes, which take salmon originating in rivers of another Party, are regulated by NASCO under the terms of the Convention. NASCO now has seven 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 its 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 states 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 the organization's Standing Committee on the Precautionary Approach interprets 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 a few age groups. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, 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 $B_{escapement}$. 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 MSY. 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% 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

Reported (i.e. 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 catches of salmon in four North Atlantic regions from 1960 to 2020 are shown in Figure 1. 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.

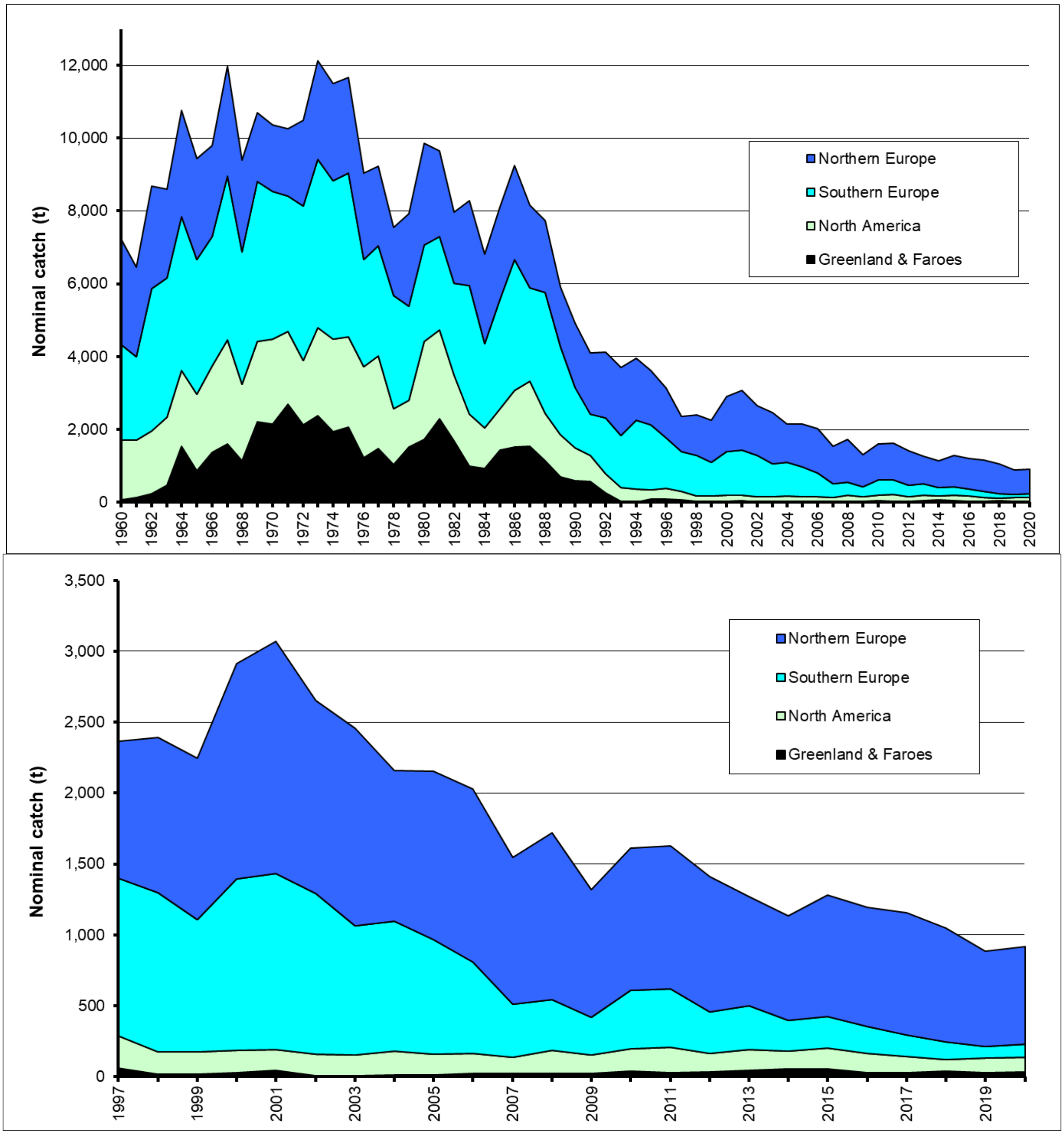

Figure 1 Total reported catch of salmon (tonnes, round fresh weight) in four North Atlantic regions, 1960–2020 (top) and 1997–2020 (bottom).

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 2020 (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 reported catch.

Table 1 Reported catches (in tonnes) for the three NASCO commission areas for 2011–2020.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NEAC	1419	1250	1080	954	1081	1028	1015	929	755	778
NAC	182	129	143	122	144	140	113	80	101	106
WGC	27	34	47	58	57	28	28	40	29	32
Total	1629	1412	1270	1134	1282	1196	1156	1049	886	915

The provisional total reported catch for 2020 was 915 t, the second lowest in the time-series. NASCO requested that the reported 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 2020 reported catches (in tonnes) for the NEAC and NAC commission areas.

Area	Coastal		Estuarine		In-river		Total
	Weight	%	Weight	%	Weight	%	Weight
NEAC 2020	231	30	23	3	524	67	778
NAC 2020	9	8	44	42	53	50	106

Coastal, estuarine, and in-river catch data aggregated by commission area are presented in Figure 2. In Northern NEAC (NEAC–N), catches in coastal fisheries have declined from 306 t in 2009 to 231 t in 2020, and in-river catches have declined from 594 t in 2009 to 454 t in 2020. 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 represent around 30%–40% 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: there have been no coastal catches since 2019. Since 2007, the majority of the catch in this area has been reported from in-river fisheries. In NAC, around two thirds of the total catch in this area has been taken by in-river fisheries, although it was about half since 2018; the catch in coastal fisheries has been relatively small throughout the time-series (13 t or less).

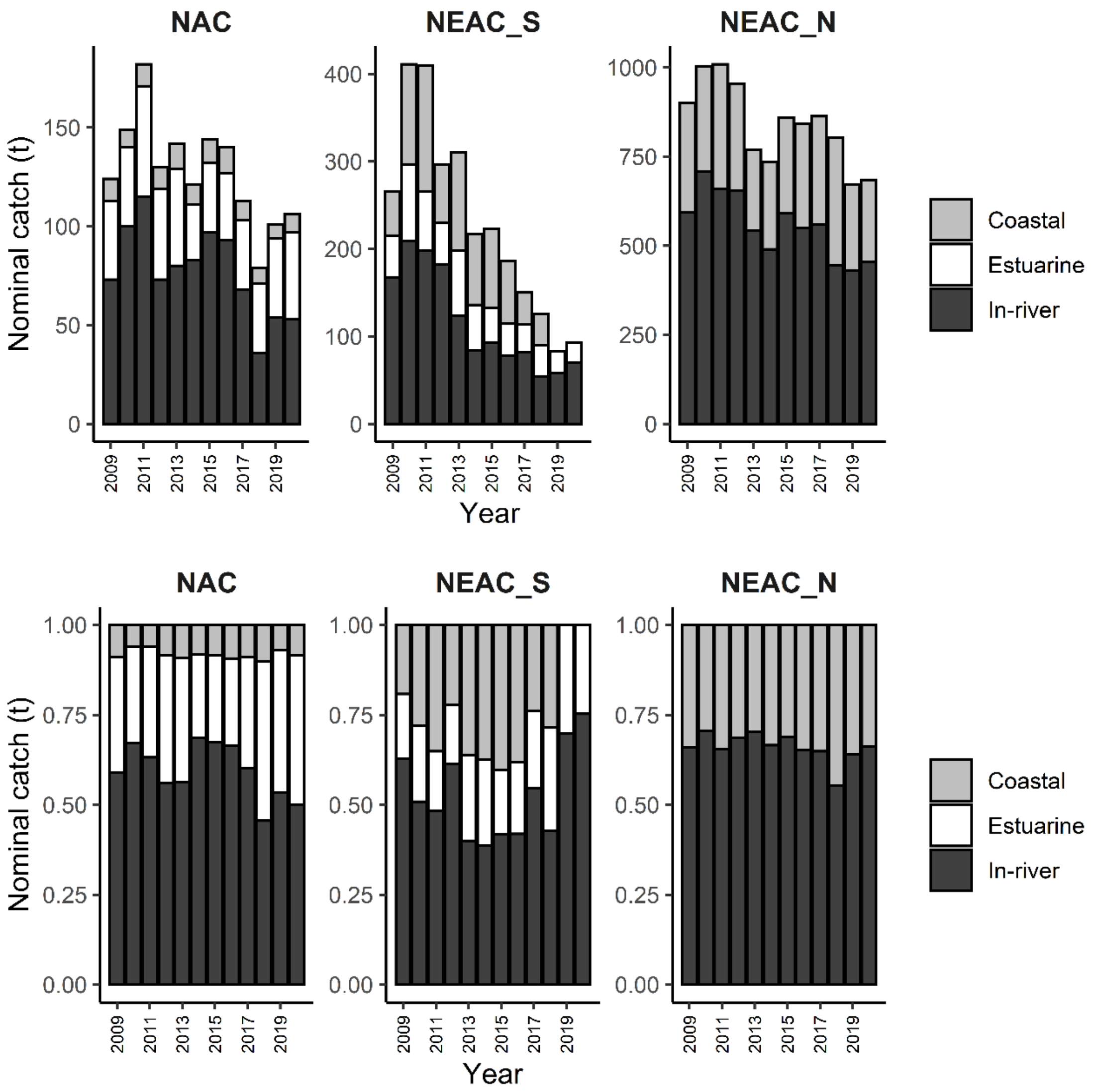

Figure 2 Reported catches (tonnes; top panels) and percentages of the reported catches (bottom panels) from coastal, estuarine, and in-river fisheries for the NAC area, and for the Northern (NEAC–N) and Southern (NEAC–S) NEAC areas in 2009–2020. Note that scales of vertical axes in the top panels vary.

There is considerable variability in the distribution of the catch among individual countries (Figure 3; 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, reported catches from in-river fisheries have also declined in many countries as a result of increasing use of catch-and-release in angling fisheries.

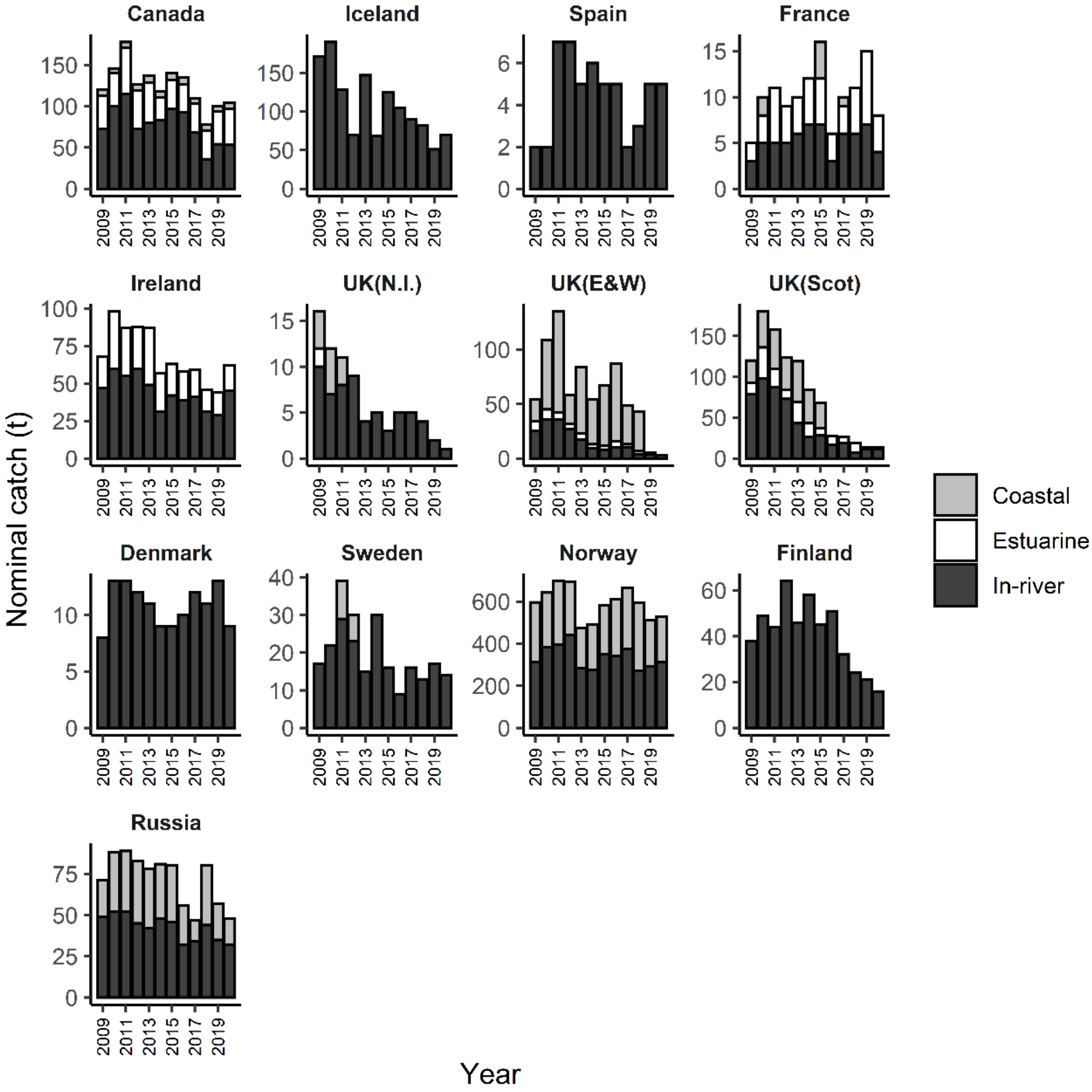

Figure 3 Reported catch (tonnes) by country taken in coastal, estuarine, and riverine fisheries, 2009–2020. Note that scales on the *y*-axes vary. USA is not included because there has been no catch. 100% of the fishery at St Pierre and Miquelon and at West Greenland occurs in coastal areas. These catches are not shown.

Unreported catches

The total unreported catch in NASCO areas in 2020 was estimated at 276 t. No estimates were provided for Russia, France, Spain, or St Pierre and Miquelon in 2020. The unreported catch in the NEAC area in 2020 was estimated at 239 t, and that for the West Greenland and North American commission areas at 10 t and 27 t, respectively.

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

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NEAC	382	363	272	256	298	298	318	277	237	239
NAC	29	31	24	21	17	27	25	24	12	27
WGC	10	10	10	10	10	10	10	10	10	10
Total	421	403	306	287	325	335	353	311	259	276

The 2020 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 reported catches do not include salmon that have been caught and released, nor do they include post-release mortalities. Post-release mortality has not been estimated by every country. Table 8 presents C&R information from 1991 to 2020 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 2020, it ranged from 16% in Sweden to 93% in UK (England and Wales), 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 196 000 salmon were reported to have been caught and released in the North Atlantic area in 2020.

Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2020 was 1 821 000 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 (77% and 11%, respectively). Farmed salmon production in 2020 was above the previous five-year mean in all countries, with the exception of Ireland. Data for UK (Northern Ireland) since 2001 and data for the east coast of 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 2020 is provisionally estimated at 2 638 000 tonnes (Figure 4), which is higher than 2019, and higher than the previous five-year mean (2 394 000 tonnes). Production outside the North Atlantic is estimated to have accounted for one-third of the total worldwide production in 2020, dominated by Chile (81%).

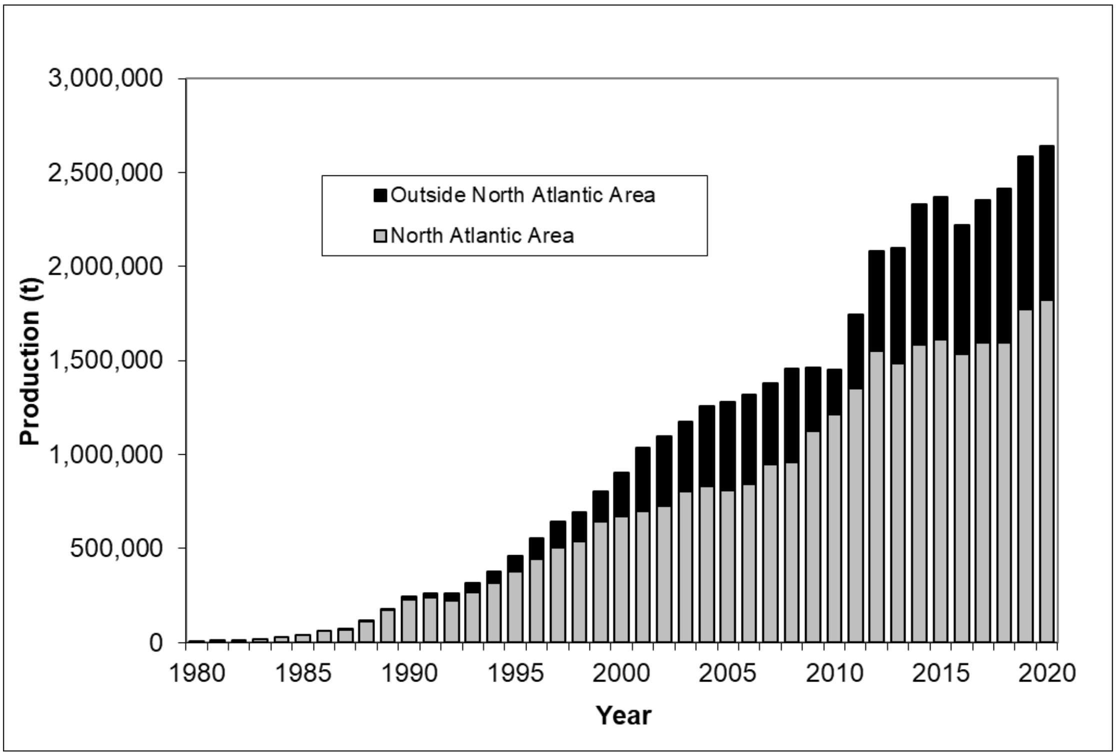

Figure 4 Worldwide production of farmed Atlantic salmon 1980 to 2020.

The reported catch of Atlantic salmon in the North Atlantic was in the order of 0.04% of the worldwide production of farmed Atlantic salmon in 2020.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic in 2020 was 39 tonnes, all taken in Iceland, Sweden, and Ireland (Figure 5), with the majority of the catch taken in Iceland (28 tonnes). No estimate was made of the ranched salmon production in Norway in 2020, where such catches have been very low in recent years (< 1 tonne), or in UK (Northern Ireland), where the proportion of ranched fish has not been assessed since 2008.

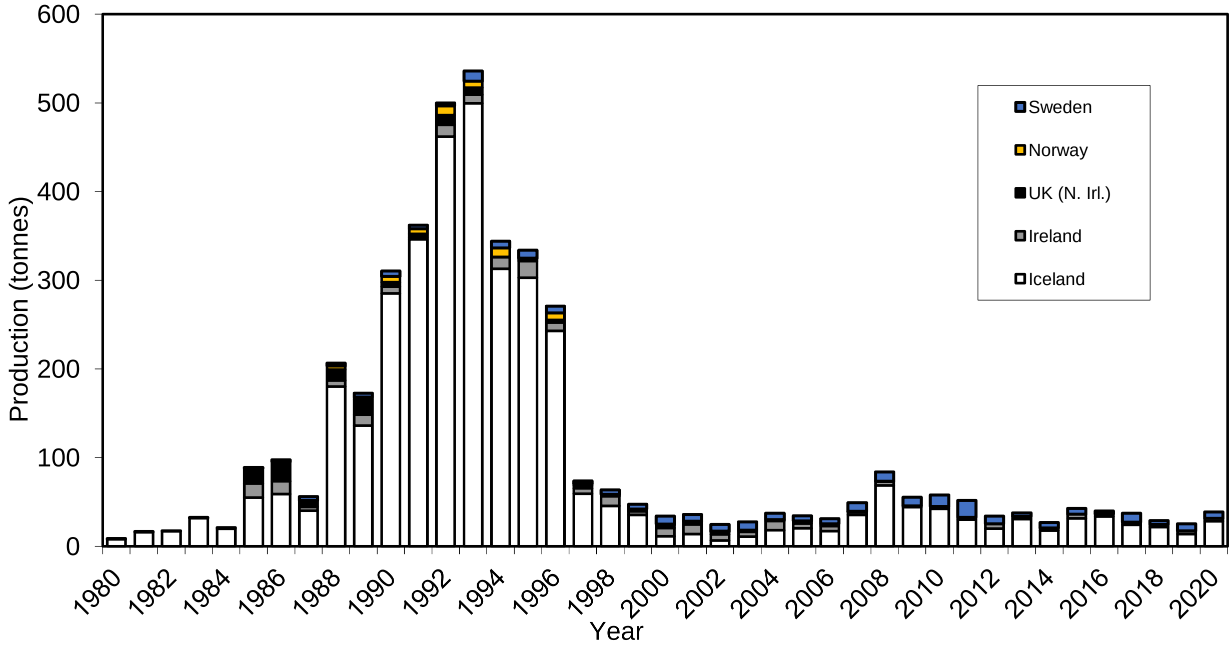

Figure 5 Harvest of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2020.

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 (2021a) and a summary of these is presented below. Details for these are available in the working group report (ICES, 2021a). ICES did not review any recent information on research into the migration and distribution of salmon at sea or the potential implications of climate change for salmon management.

Coronavirus (COVID-19)

The impact of the coronavirus (COVID-19) pandemic was not consistent among jurisdictions with respect to Atlantic salmon fisheries and ICES ability to report 2020 Atlantic salmon catches and status of stocks. There was little or no impact reported for Northern Ireland, Ireland, Iceland, Norway, Sweden and Denmark. In other jurisdictions, stay-at-home orders and travel restrictions affected fishing effort and Atlantic salmon population monitoring activities and also delayed the collection of fisheries statistics.

- In France, UK (Scotland), and UK (England and Wales) recreational fishing effort was reduced because of restrictions due to stay-at-home orders.
- Population monitoring activities were partially disrupted in France and UK (England and Wales), although mainly restricted to the collection of juvenile data. Only in France could adult MSW counts on some rivers not be provided in full.
- In UK (Scotland), collection of fishery statistics was delayed. By the time the 2021 WGNAS meeting convened, these data had not yet been officially published by the Scottish Government, which is a prerequisite for its release to be published by ICES. As an interim measure, 2019 catch statistics were provided for publication in ICES (2021a). However, the 2020 data were used for stock assessment analyses within the run-reconstruction PFA and forecast models.
- In the Maritimes, Gulf, and Labrador, and Newfoundland regions of Canada, population monitoring activities were affected and data could not be collected on every river. In such cases, return and spawner estimates were either estimated using alternative methods such as snorkel counts, or in the absence of that, the previous five-year average values were used, except for Newfoundland where previous six-year averages were used.
- In USA population monitoring activities for smolts were affected but adult monitoring was not.

Threats

- Red Skin Disease (RSD) is a recently defined disease with widespread outbreaks in salmon populations. One such case was in 2019, when several European countries reported Atlantic salmon returning to rivers with RSD in 2020 during late spring into summer. The majority of recorded cases are observed in MSW salmon with the exception of Ireland, where RSD is principally observed in 1SW salmon. This may be a consequence of the Irish stocks being predominantly 1SW. RSD was not reported in Greenland, Canada, or USA.
- A monitoring programme on the Lough Neagh catchment (UK [Northern Ireland]) documented a high incidence of river lamprey (*Lampetra fluviatilis*) parasitisation on Atlantic salmon smolts. An estimated 24% (out of 470) of smolts were considered heavily damaged and unlikely to survive the marine phase. A negative effect on adult salmon recruitment in rivers flowing into Lough Neagh is expected in 2021 (1SW) and 2022 (2SW). The causes of the high parasitism were thought to be associated with low flows restricting smolt migration towards the sea.
- Based on previous observations, substantial returns of odd-year pink salmon (*Oncorhynchus gorbuscha*) in 2021 and 2023 are expected on two major Atlantic salmon rivers in northernmost Finland and Norway, the Teno (Tana in Norwegian) and the Näätämöjoki (Neidenelva in Norwegian). In 2021, a research project funded by the Finnish Ministry of Foreign Affairs, and run in close collaboration with the Norwegian Institute of Nature Research (NINA), will track and sample pink salmon as they migrate within the Teno/Tana. A similar project is planned for tracking pink salmon in the River Näätämöjoki/Neidenelva in 2023. Collaboration and networking between Finland, Norway, and Russia will be further developed, especially with regards to future impacts of pink salmon and possible mitigation measures.

Opportunities

- An assessment of the performance of fishery sampling programmes to estimate catches of non-local origin salmon in mixed-stock fisheries was conducted and presented, using the Labrador subsistence food fishery as a case study. Of particular concern is the impact of the estimated catch of USA-origin salmon at Labrador because of the low abundance and endangered population status of salmon in the eastern USA. At present, sampling rates (% of catch sampled) are low (~4%) for the Labrador fishery and detection of USA-origin salmon (by genetic methods) is a rare event. By simulating catches, varying proportions of non-local origin salmon, and sampling rates it was determined that the current sampling rate produces positively biased and imprecise estimates of catches of USA-origin salmon in the Labrador fishery. A sampling rate of at least 10% of catches in Labrador would be required to achived a relatively unbiased estimate.

- A German project “GeMoLaR[*]”, running from 2020 to2024; is part of international coordinated genetic monitoring of reintroduced Atlantic salmon in the whole Rhine area. As in other countries bordering the Rhine, the salmon are genetically sampled according to a standardized protocol to investigate restocking success and the efficiency of different stocking strategies.
- The process for collecting salmon catch data necessary for fulfilling the ToR from NASCO to ICES was streamlined through the communication of an ICES Data Call for Atlantic salmon in January 2021. The Data Call resulted in more prompt and comprehensive reporting for the 2020 season. Eleven (of 13 reporting to ICES) countries/jurisdictions provided all, or almost all, of the data required for Section 1.1 of this Advice. This bodes well for the automation of this section’s production based on Data Calls in future years.
- In January 2021, a workshop (ICES, 2021b) of jurisdictional experts and modelers was held to advance the application of the Bayesian Life Cycle Model (LCM) to Atlantic salmon stock assessment. The workshop reviewed the LCM, compared the current ICES PFA model with the LCM approach, and discussed the data inputs and process for running the LCM. New online tools were presented which simplify and strengthen the robustness of the stock assessment workflow from data input to production of catch advice. The decision was taken at the workshop to run the LCM in parallel with ICES PFA model during the 2021 WGNAS meeting. The LCM was run during WGNAS 2021 and the results presented to the group. A stock assessment using the new LCM approach is planned to be examined in a benchmark in 2022.

NASCO 1.3 Provision of a compilation of tag releases by country in 2020

Data on releases of tagged, finclipped, and other marked salmon in 2020 are compiled as a separate report (ICES, 2021c). In summary (Table 4):

- Approximately 1.96 million salmon were marked in 2020, reduced from the 2.2 million salmon marked in 2019.
- The adipose clip was the most commonly used primary marker (1.65 million), with coded wire microtags (CWT) (0.836 million) being the next most common.
- Most marks were applied to hatchery-origin juveniles (1.73 million), while 40 678 wild juveniles, 31 032 wild adults, and 160 355 hatchery adults were also marked.
- The use of Passive Integrated Transponder (PIT) tags, data storage tags (DSTs), radio and/or sonic transmitting tags (pingers) has increased in recent years but in 2020, 91 390 salmon were tagged with these tag types (Table 4), which was a marked decrease from previous year (161 705). Reduced numbers of tagged salmon in 2020 may in some countries be related to restrictions due to the COVID-19 pandemic. ICES notes that not all electronic tags were reported in the tag compilation. Tag users should be encouraged to include these tags or tagging programmes as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions.

Since 2003, ICES has reported information on marks being applied to farmed salmon to facilitate tracing the origin of farmed salmon captured in the wild in the case of escape events. In USA, genetic identification procedures have been adopted where broodstock are genetically screened, and 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 individual escaped. This has also been applied in Iceland, where in recent years, 17 out of 21 farmed escapees could be traced to the pens they escaped from by matching their genotypes to known parental genotypes, and a further two could be traced to foreign broodstocks.

[*] https://www.gemolar.fish

Table 4 Summary of Atlantic salmon tagged and marked in 2020. 'Hatchery' and 'wild' juvenile refer to smolts and parr.

Country	Origin	Primary tag or mark			Other internal*	Total
		Microtag	External mark**	Adipose clip		
Canada	Hatchery adult	0	1414	10	513	1937
	Hatchery juvenile	0	964	0	0	964
	Wild adult	0	934	11	758	1703
	Wild juvenile	0	11666	7630	824	20120
	Total	0	14978	7651	2095	24724
Denmark	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	306000	0	306000
	Wild adult	0	0	0	870	870
	Wild juvenile	0	0	0	0	0
	Total	0	0	306000	870	306870
France	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	3960	0	3960
	Wild adult	0	0	0	575	575
	Wild juvenile	0	0	0	2912	2912
	Total	0	0	3960	3487	7447
Iceland	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	60126	0	0	0	60126
	Wild adult	0	165	0	0	165
	Wild juvenile	2687	0	0	382	3069
	Total	62813	165	0	382	63360
Ireland	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	126713	0	0	0	126713
	Wild adult	0	0	0	0	0
	Wild juvenile	0	0	0	2441	2441
	Total	126713	0	0	2441	129154
Norway	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	3609	0	52 965	56574
	Wild adult	0	436	0	23 229	23665
	Wild juvenile	0	501	0	80	581
	Total	0	4546	0	76274	80820
Russia	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	836774	0	836774
	Wild adult	0	238	0	0	238
	Wild juvenile	0	0	0	0	0
	Total	0	238	836774	0	837012
Spain	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	91518	0	91518
	Wild adult	0	0	0	0	0
	Wild juvenile	0	0	0	0	0
	Total	0	0	91518	0	91518
Sweden	Hatchery adult	0	0	158418	0	158418
	Hatchery juvenile	0	0	0	0	0
	Wild adult	0	0	0	0	0
	Wild juvenile	0	0	0	0	0
	Total	0	0	158418	0	158418
UK (England & Wales)	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	9600	0	9600
	Wild adult	0	564	0	0	564
	Wild juvenile	607	0	8263	100	8970
	Total	607	564	17863	100	19134
UK (N. Ireland)	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	5549	0	63440	0	68989
	Wild adult	0	0	0	0	0
	Wild juvenile	0	0	0	0	0
	Total	5549	0	63440	0	68989

Country	Origin	Primary tag or mark			Other internal*	Total
		Microtag	External mark**	Adipose clip		
UK (Scotland)	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	21500	0	21500
	Wild adult	0	585	0	1	586
	Wild juvenile	0	385	0	1995	2380
	Total	0	970	21500	1996	24466
Germany	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	77000	1286	78286
	Wild adult	0	15	0	0	15
	Wild juvenile	0	0	10	0	10
	Total	0	15	77010	1286	78311
Greenland	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	0	0	0
	Wild adult	0	0	0	0	0
	Wild juvenile	0	0	129	66	195
	Total	0	0	129	66	195
USA	Hatchery adult	0	0	0	0	0
	Hatchery juvenile	0	0	68030	0	68030
	Wild adult	0	88	170	2393	2651
	Wild juvenile	0	0	0	0	0
	Total	0	88	68200	2393	70681
All countries	Hatchery adult	0	1414	158428	513	160355
	Hatchery juvenile	192388	4573	1477822	54251	1729034
	Wild adult	0	3025	181	27826	31032
	Wild juvenile	3294	12552	16032	8800	40678
	Total	195682	21564	1652463	91390	1961099

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

NASCO 1.4 Identify relevant data deficiencies, monitoring needs, and research requirements

ICES recommends that WGNAS should meet in 2022 (Chaired by Dennis Ensing, UK) to address questions posed by NASCO and by ICES. Unless otherwise notified, the working group intends to convene at ICES Headquarters in Copenhagen, Denmark. The meeting will be held from 28 March to 7 April 2022.

Recommendations

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

North American Commission

A database is needed that lists individual PIT tag numbers or codes identifying the origin, source, or programme of the tags on a North Atlantic basin-wide scale. This is needed to facilitate identification of individual tagged fish taken in marine fisheries or surveys. Data on individual PIT tags used in Norway have now been compiled, but an ICES coordinated database is needed to store the data and is being considered by ICES. Tag users should be encouraged to include these tags or tagging programmes as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions.

Complete and timely reporting of catch statistics from all fisheries for all areas of eastern Canada is recommended.

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 caught in these mixed-stock fisheries.

A sampling rate of at least 10% of catches in Labrador would be required to achieve a relatively unbiased estimate.

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.

Northeast Atlantic Commission

Tag users should be encouraged to include these tags or tagging programmes as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions.

West Greenland Commission

No recommendations specific to WGC† are provided.

† Version 2: Acronym corrected.

Table 5 Total reported catch of salmon by country@ (in tonnes, round fresh weight), 1960–2020 (2020 data are provisional).

Year	NAC area			NEAC–N (Northern area)								NEAC–S (Southern area)						Faroes & Greenland				Total catch	
	CA *	US	SPM	NO **	RU ***	IS Wild	IS Ranched^	SE Wild	SE Ranched ^^	DK	FI	IE ^^^ $	UK E/W	UK NI $ $$	UK SO £ ££	FR $$$	ES #	FO ##	East GL	West GL ###	Other £	Reported catch	Un-reported catch £ £
1960	1636	1	-	1659	1100	100	-	40	0	-	-	743	283	139	1443	-	33	-	-	60	-	7237	-
1961	1583	1	-	1533	790	127	-	27	0	-	-	707	232	132	1185	-	20	-	-	127	-	6464	-
1962	1719	1	-	1935	710	125	-	45	0	-	-	1459	318	356	1738	-	23	-	-	244	-	8673	-
1963	1861	1	-	1786	480	145	-	23	0	-	-	1458	325	306	1725	-	28	-	-	466	-	8604	-
1964	2069	1	-	2147	590	135	-	36	0	-	-	1617	307	377	1907	-	34	-	-	1539	-	10759	-
1965	2116	1	-	2000	590	133	-	40	0	-	-	1457	320	281	1593	-	42	-	-	861	-	9434	-
1966	2369	1	-	1791	570	104	2	36	0	-	-	1238	387	287	1595	-	42	-	-	1370	-	9792	-
1967	2863	1	-	1980	883	144	2	25	0	-	-	1463	420	449	2117	-	43	-	-	1601	-	11991	-
1968	2111	1	-	1514	827	161	1	20	0	-	-	1413	282	312	1578	-	38	5	-	1127	403	9793	-
1969	2202	1	-	1383	360	131	2	22	0	-	-	1730	377	267	1955	-	54	7	-	2210	893	11594	-
1970	2323	1	-	1171	448	182	13	20	0	-	-	1787	527	297	1392	-	45	12	-	2146	922	11286	-
1971	1992	1	-	1207	417	196	8	17	1	-	-	1639	426	234	1421	-	16	-	-	2689	471	10735	-
1972	1759	1	-	1578	462	245	5	17	1	-	32	1804	442	210	1727	34	40	9	-	2113	486	10965	-
1973	2434	3	-	1726	772	148	8	22	1	-	50	1930	450	182	2006	12	24	28	-	2341	533	12670	-
1974	2539	1	-	1633	709	215	10	31	1	-	76	2128	383	184	1628	13	16	20	-	1917	373	11877	-
1975	2485	2	-	1537	811	145	21	26	0	-	76	2216	447	164	1621	25	27	28	-	2030	475	12136	-
1976	2506	1	3	1530	542	216	9	20	0	-	66	1561	208	113	1019	9	21	40	<1	1175	289	9327	-
1977	2545	2	-	1488	497	123	7	9	1	-	59	1372	345	110	1160	19	19	40	6	1420	192	9414	-
1978	1545	4	-	1050	476	285	6	10	0	-	37	1230	349	148	1323	20	32	37	8	984	138	7682	-
1979	1287	3	-	1831	455	219	6	11	1	-	26	1097	261	99	1076	10	29	119	<05	1395	193	8118	-
1980	2680	6	-	1830	664	241	8	16	1	-	34	947	360	122	1134	30	47	536	<05	1194	277	10127	-
1981	2437	6	-	1656	463	147	16	25	1	-	44	685	493	101	1233	20	25	1025	<05	1264	313	9954	-
1982	1798	6	-	1348	364	130	17	24	1	-	54	993	286	132	1092	20	10	606	<05	1077	437	8395	-
1983	1424	1	3	1550	507	166	32	27	1	-	58	1656	429	187	1221	16	23	678	<05	310	466	8755	-
1984	1112	2	3	1623	593	139	20	39	1	-	46	829	345	78	1013	25	18	628	<05	297	101	6912	-
1985	1133	2	3	1561	659	162	55	44	1	-	49	1595	361	98	913	22	13	566	7	864	-	8108	-
1986	1559	2	3	1598	608	232	59	52	2	-	37	1730	430	109	1271	28	27	530	19	960	-	9255	315
1987	1784	1	2	1385	564	181	40	43	4	-	49	1239	302	56	922	27	18	576	<05	966	-	8159	2788
1988	1310	1	2	1076	420	217	180	36	4	-	36	1874	395	114	882	32	18	243	4	893	-	7737	3248
1989	1139	2	2	905	364	141	136	25	4	-	52	1079	296	142	895	14	7	364	-	337	-	5904	2277
1990	911	2	2	930	313	141	285	27	6	13	60	567	338	94	624	15	7	315	-	274	-	4925	1890
1991	711	1	1	876	215	129	346	34	4	3	70	404	200	55	462	13	11	95	4	472	-	4106	1682
1992	522	1	2	867	167	174	462	46	3	10	77	630	171	91	600	20	11	23	5	237	-	4119	1962
1993	373	1	3	923	139	157	499	44	12	9	70	541	248	83	547	16	8	23	-	-	-	3696	1644
1994	355	0	3	996	141	136	313	37	7	6	49	804	324	91	649	18	10	6	-	-	-	3945	1276
1995	260	0	1	839	128	146	303	28	9	3	48	790	295	83	588	10	9	5	2	83	-	3629	1060
1996	292	0	2	787	131	118	243	26	7	2	44	685	183	77	427	13	7	-	0	92	-	3136	1123
1997	229	0	2	630	111	97	59	15	4	1	45	570	142	93	296	8	4	-	1	58	-	2364	827
1998	157	0	2	740	131	119	46	10	5	1	48	624	123	78	283	8	4	6	0	11	-	2395	1210
1999	152	0	2	811	103	111	35	11	5	1	62	515	150	53	199	11	6	0	0	19	-	2247	1032
2000	153	0	2	1176	124	73	11	24	9	5	95	621	219	78	274	11	7	8	0	21	-	2912	1269

Year	NAC area			NEAC–N (Northern area)								NEAC–S (Southern area)						Faroes & Greenland				Total catch	
	CA *	US	SPM	NO **	RU ***	IS		SE		DK	FI	IE ^^^ $	UK E/W	UK NI $ $$	UK SO £ ££	FR $$$	ES #	FO ##	East GL	West GL ###	Other £	Reported catch	Un-reported catch £ £
						Wild	Ranched^	Wild	Ranched ^^														
2001	148	0	2	1267	114	74	14	25	7	6	126	730	184	53	251	11	13	0	0	43	-	3069	1180
2002	148	0	2	1019	118	90	7	20	8	5	93	682	161	81	191	11	9	0	0	9	-	2654	1039
2003	141	0	3	1071	107	99	11	15	10	4	78	551	89	56	192	13	9	0	0	9	-	2457	847
2004	161	0	3	784	82	111	18	13	7	4	39	489	111	48	245	19	7	0	0	15	-	2157	686
2005	139	0	3	888	82	129	21	9	6	8	47	422	97	52	215	11	13	0	0	15	-	2155	700
2006	137	0	3	932	91	93	17	8	6	2	67	326	80	29	192	13	11	0	0	22	-	2028	670
2007	112	0	2	767	63	93	36	6	10	3	58	85	67	30	171	11	9	0	0	25	-	1548	475
2008	158	0	4	807	73	132	69	8	10	9	71	89	64	21	161	12	9	0	0	26	-	1721	443
2009	126	0	3	595	71	126	44	7	10	8	36	68	54	16	121	4	2	0	0.8	26	-	1318	343
2010	153	0	3	642	88	147	42	9	13	13	49	99	109	12	180	10	2	0	1.7	38	-	1610	393
2011	179	0	4	696	89	98	30	20	19	13	44	87	136	10	159	11	7	0	0.1	27	-	1629	421
2012	126	0	3	696	82	50	20	21	9	12	64	88	58	9	124	10	7	0	0.5	33	-	1412	403
2013	137	0	5	475	78	116	31	10	4	11	46	87	84	4	119	11	5	0	0.0	47	-	1269	306
2014	118	0	4	490	81	51	18	24	6	9	58	57	54	5	84	12	6	0	0.1	58	-	1134	287
2015	140	0	4	583	80	94	31	9	7	9	45	63	68	3	68	16	5	0	1.0	56	-	1282	325
2016	135	0	5	612	56	71	34	6	3	9	51	58	86	4	27	6	5	0	1.5	26	-	1195	335
2017	110	0	3	666	47	66	24	6	10	12	32	59	49	5	27	10	2	0	0.3	28	-	1156	353
2018	79	0	1	594	80	60	22	9	4	11	24	46	42	4	19	10	3	0	0.8	39	-	1049	311
2019	100	0	1	513	57	37	14	9	8	13	21	44	5	2	13	15	5	0	1.4	28	-	885	259
2020	104	0	2	527	49	42	28	7	7	9	16	62	3	1	13	9	5	0	0.8	31	-	915	276
2015–2019	128	0	3	594	64	66	25	8	6	11	35	54	50	4	31	11	4	0	1	35	-	1113	317
2010–2019	128	0	3	597	74	79	27	12	8	11	43	69	69	6	82	11	5	0	1	38	-	1276	339

@ 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).

*Includes estimates of some local sales and, prior to 1984, bycatch.
**Before 1966, sea trout and sea charr included (5% of total).
***Figures from 1991 to 2000 do not include catches taken in the recreational (rod) fishery.

^From 1990, catch includes fish ranched for both commercial and angling purposes.

^^Catches from hatchery-reared smolts released under programmes to mitigate for hydropower development.
^^^Improved reporting of rod catches in 1994 and data derived from carcase tagging and logbooks from 2002.
$Catch on River Foyle allocated 50% to Ireland and 50% to N. Ireland.

$$ Angling catch (derived from carcase tagging and logbooks) first included in 2002.
$$$ Data for France include some unreported catches.
Spanish data until 2018 (inclusive), weights estimated from mean weight of fish caught in Asturias (80–90% of Spanish catch); weight for 2019 and 2020 for all Spain, supplied via data call.
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.
Includes catches made in the West Greenland area by Norway, Faroes, Sweden, and Denmark in 1965–1975.

£ Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway, and Finland.
££ No unreported catch estimate available for Canada in 2007 and 2008. Data for Canada in 2009, 2010 and 2019 are incomplete. No unreported catch estimates available for Russia since 2008.
£££ Scotland data for 2020 not available at time of printing, 2019 used as Provisional.

Table 6 Reported catches (tonnes, round fresh weight) and % of the reported catches by country taken in coastal, estuarine, and in-river fisheries, 2000 to 2020. Data for 2020 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	6	100	6
	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
	2019	0	0	0	0	5	100	5
	2020	0	0	0	0	5	100	5
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	47	5	53	11
	2019	0	2	8	52	7	46	15
	2020	0	1	4	48	4	51	8
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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	Weight
	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
	2016	0	0	19	33	39	67	58
	2017	0	0	18	31	41	69	59
	2018	0	0	15	33	31	67	46
	2019	0	0	15	35	29	65	45
	2020	0	0	17	27	46	73	62
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	75	4	8	9	17	54
	2015	55	82	4	6	8	12	68
	2016	71	82	6	6	10	11	86
	2017	36	73	3	7	10	19	49
	2018	36	84	3	8	4	8	42
	2019	0	0	1	12	4	88	5
	2020	0	0	0	0	3	100	3
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	0	10	37	17	63	27
	2017	0	0	7	27	19	73	27
	2018	0	0	12	63	7	37	19
	2019	0	0	2	14	11	86	13
	2020	0	0	2	14	11	86	13

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	Weight
UK (Northern 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	5	100	5
	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
	2019	0	0	0	0	2	100	2
	2020	0	0	0	0	1	100	1
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	90	100	86
	2018	0	0	0	0	82	100	98
	2019	0	0	0	0	51	100	51
	2020	0	0	0	0	70	100	70
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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	Weight
	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
	2019	0	1	0	0	13	99	13
	2020	0	0	0	0	9	100	9
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
	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	16	100	18
	2018	0	0	0	0	13	100	17
	2019	0	0	0	0	17	100	17
	2020	0	0	0	0	14	100	14
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
	2019	219	43	0	0	293	57	513
	2020	215	41	0	0	312	59	527

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	Weight
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
	2019	0	0	0	0	21	100	21
	2020	0	0	0	0	16	100	16
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
	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
	2019	22	39	0	0	35	61	57
	2020	16	34	0	0	32	66	49

Country	Year	Coastal		Estuarine		In-river		Total
		Weight	%	Weight	%	Weight	%	Weight
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	8	6	34	25	93	69	135
	2017	7	6	35	32	68	62	110
	2018	7	9	35	45	36	46	79
	2019	6	6	40	40	54	54	100
	2020	7	7	44	42	53	51	104
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
	2019	1	100	0	0	0	0	1
	2020	2	100	0	0	0	0	2
Total NEAC	2020	231	30	23	3	524	67	778
Total NAC	2020	9	8	44	42	53	50	106

* An illegal net fishery operated from 1995 to 1998, catch unknown in the first three years but thought to be increasing. Fishery ceased in 1999. 2001/2002 catches from the illegal coastal net fishery in Lower Normandy are unknown.
** Rod catch data for river (rod) fisheries in UK (Northern Ireland) from 2002.
*** Estuarine catch included in coastal catch.
^ Coastal catch included in estuarine catch.
^^ Spain catch to 2018 was Asturias catch raised, 2019 data for All Spain.
^^^ Iceland total catch includes ranched fish.
$ Scotland 2020 data not available at time of printing, 2019 data inserted as Provisional.

Table 7 Estimates for 2020 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	1	0.1	12
NEAC	Finland	2	0.1	19
NEAC	Iceland	1	0.1	2
NEAC	Ireland	6	0.5	9
NEAC	Norway	226	19.8	30
NEAC	Sweden	1	0.1	9
NEAC	UK (England & Wales)	0	0.0	9
NEAC	UK (N. Ireland)	0.3	0.0	22
NEAC	UK (Scotland)**	1	0.1	9
NAC	USA	0	0.0	0
NAC	Canada	27	2.4	21
WGC	Greenland	10	0.9	24
Total unreported catch *		276	24.2	
Total reported catch of North Atlantic salmon		915		

* No unreported catch estimates are available for France, Spain, St. Pierre and Miquelon, or Russia in 2020.

** No Scotland 2020 data at time of printing, 2019 data input as Provisional.

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, 1991–2020. Data for 2020 are provisional.

Year	Canada $		USA		Iceland		Russia *		UK (E and W)		UK (Scotland)$$		Ireland		UK (N. Ireland) **		Denmark		Sweden		Norway ***	
	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	22167	28	239	50			3211	51														
1992	37803	29	407	67			10120	73														
1993	44803	36	507	77			11246	82	1448	10												
1994	52887	43	249	95			12056	83	3227	13	6595	8										
1995	46029	46	370	100			11904	84	3189	20	12151	14										
1996	52166	41	542	100	669	2	10745	73	3428	20	10413	15										
1997	50009	50	333	100	1558	5	14823	87	3132	24	10965	18										
1998	56289	53	273	100	2826	7	12776	81	4378	30	13464	18										
1999	48720	50	211	100	3055	10	11450	77	4382	42	14846	28										
2000	64482	56	0	-	2918	11	12914	74	7470	42	21072	32										
2001	59387	55	0	-	3611	12	16945	76	6143	43	27724	38										
2002	50924	52	0	-	5985	18	25248	80	7658	50	24058	42										
2003	53645	55	0	-	5361	16	33862	81	6425	56	29170	55										
2004	62316	57	0	-	7362	16	24679	76	13211	48	46279	50					255	19				
2005	63005	62	0	-	9224	17	23592	87	11983	56	46165	55	2553	12			606	27				
2006	60486	62	1	100	8735	19	33380	82	10959	56	47669	55	5409	22	302	18	794	65				
2007	41192	58	3	100	9691	18	44341	90	10917	55	55660	61	15113	44	470	16	959	57				
2008	54887	53	61	100	17178	20	41881	86	13035	55	53347	62	13563	38	648	20	2033	71			5512	5
2009	52151	59	0	-	17514	24			9096	58	48436	67	11422	39	847	21	1709	53			6696	6
2010	55895	53	0	-	21476	29	14585	56	15012	60	78041	70	15142	40	823	25	2512	60			15041	12
2011	71358	57	0	-	18593	32			14406	62	64870	73	12688	38	1197	36	2153	55	424	5	14303	12
2012	43287	57	0	-	9752	28	4743	43	11952	65	63628	74	11891	35	5014	59	2153	55	404	6	18611	14
2013	50630	59	0	-	23133	34	3732	39	10458	70	54002	80	10682	37	1507	64	1932	57	274	9	15953	15
2014	41613	54	0	-	13616	41	8479	52	7992	78	37355	82	6537	37	1065	50	1918	61	982	15	20281	19
2015	65440	64	0	-	21914	31	7028	50	8113	79	46836	84	9383	37	111	100	2989	70	647	18	25433	19
2016	68925	65	0	-	22751	43	10793	76	9700	80	50186	90	10934	43	280	100	3801	72	362	17	25198	21
2017	57357	66	0	-	19667	42	10110	77	11255	83	45652	90	12562	45	126	100	4435	69	590	17	25924	21
2018	56011	82	0	-	19409	43	10779	73	6857	88	35066	93	9249	43	3247	49	4613	79	557	19	22024	22
2019	60636	72	0	-	15185	52	12762	74	8171	89	43825	91	9790	48	5000	85	3913	70	678	20	21178	20
2020	59627	72	0	-	21277	51	9508	65	10672	93	43825	91	13240	44	4813	91	4375	69	587	16	28753	23
Avg. 2015–2019	61674	70	0	-	19785	42	10298	70	8819	84	44313	90	10384	43	1753	87	3950	72	567	18	23951	21
% change from Avg. 2015–2019	-3	3	-	-	8	20	-8	-7	21	11	-1	1	28	2	175	5	11	-4	4	-12	20	13

* Since 2009 data have been either unavailable or incomplete; however, catch-and-release is understood to have remained at similar high levels as before.
** Data for 2006–2009. 2014 is for the DCAL area only; the figures from 2010 are a total for UK (Northern Ireland). Data for 2015, 2016, and 2017 are for River Bush only.
*** The statistics were collected on a voluntary basis; the numbers reported must be viewed as a minimum.
$The numbers of released fish in the kelt fishery of New Brunswick are not included in the totals for Canada.
$$ Scotland 2020 data not available at time of printing, 2019 data provided as Provisional.

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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(s) *conservation limit(s)*, **i.e. S_{lim}.** 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.

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

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.

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.

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.

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.

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.

SER *spawner 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.

ToR *terms of reference*

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

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.

Atlantic salmon from the Northeast Atlantic

Summary of advice for fishing seasons 2021/2022 to 2023/2024

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. Furthermore, because of the different status of individual stocks within stock complexes, mixed-stock fisheries present particular threats. The management of a fishery should ideally be based on the individual status of all stocks exploited in the fishery.

In the absence of any fisheries in the fishing seasons 2021/2022 to 2023/2024, there is a less than 95% probability of spawner escapement reserves (SERs) being met for potential 1-sea-winter (1SW) and multi-sea-winter (MSW) salmon from the Southern NEAC stock complex and for the 1SW salmon from the Northern NEAC stock complex. Therefore, in the absence of specific management objectives, ICES advises that the catch on both NEAC complexes at the Faroes in the fishing seasons 2021/2022 to 2023/2024 should be zero. In the absence of any fisheries over these three seasons, the probabilities of individual countries meeting their SERs range from 22% to 97% for maturing 1SW salmon and 17% to 99% for salmon maturing as MSW. Some of the management units (countries/juristictions) are exploited at very low levels; however, in the absence of a management decision on which units should be included in the catch options analysis, all management units are currently included.

A Framework of Indicators (FWI) has previously been developed in support of the multi-year catch advice and the potential approval of multi-year regulatory measures for the Faroes. The FWI has been updated and can be applied at the beginning of 2022, using the returns or return rate data for 2021 to evaluate the appropriateness of the advice for 2022/2023, and again at the beginning of 2023, using the returns or return rate data for 2022 to evaluate the appropriateness of the advice for 2023/2024.

NASCO 2.1 Describe the key events of the 2020 fisheries

No significant changes in gear type used were reported in the NEAC area in 2020.

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

The reported (i.e nominal) catch in the NEAC area in 2020 is 778 t, with 93 t reported in the Southern NEAC area and 685 t in the Northern NEAC area. Estimates of unreported catches in the NEAC area were 238 t in total. As in previous years, the location of the reported catches differed between the Southern and Northern NEAC areas (Table 1). In 2020, in-river and estuarine fisheries accounted for 76% and 24%, respectively, of the catches in the Southern NEAC area. In the Northern NEAC area, coastal fisheries accounted for 34% of the catches, with the remaining 66% of the catches coming from in-river fisheries.

Table 1 Salmon catch by area and location in the NEAC area in 2018. Catches of NEAC origin salmon at Greenland are reported in the West Greenland Commission area. For Iceland all catches are reported in Northern NEAC.

Salmon catches	Southern NEAC	Northern NEAC	Faroes	Total NEAC
2020 reported catch (tonnes)	93	685	0	778
Catch as % of NEAC total	12	88	0	
Unreported catch (tonnes)	8	231	-	239
Location of catches	Southern NEAC	Northern NEAC	Faroes	Total NEAC
% in-river	76	66	-	67
% in estuaries	24	0	-	3
% coastal	0	34	-	30

The NEAC area has seen a general reduction in catches since the 1980s (Figure 1; Table 2). This reflects a decline in fishing effort as a consequence of management measures as well as a reduction in the size of stocks. The reported catch for 2020 (778 t) was slightly higher than for 2019 (755 t) but was below the previous five-year (by 19%) and ten-year (by 29%) means, and the second lowest in the time-series in both areas. 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 area since 1999 (Figure 1).

1SW salmon constituted 59% of the total catch in the Northern NEAC area in 2020 (Figure 2). For Southern NEAC countries, the overall percentage of 1SW fish in the catch in 2020 was estimated at 49%.

The contribution of escaped farmed salmon to national catches in the NEAC area in 2020 was generally low in most countries and similar to the values that have been reported in previous years. The estimated proportion of farmed salmon in Norwegian angling catches in 2020 (2%) was the lowest value in the time-series; the proportion in samples taken from Norwegian rivers in autumn (3%) was also the lowest value in the time-series. No current data are available for the proportion of farmed salmon in coastal fisheries in Norway. A small number of escaped farmed salmon (seven) were also reported from catches in Icelandic rivers in 2020. Three of these, caught in rod fisheries, have been confirmed to be of farmed origin by genetic analysis, while the other four, caught during a monitoring survey, have yet to be confirmed as farmed. A small number (nine) of farmed salmon were also reported in catches by all methods from UK (England and Wales).

Estimated exploitation rates have decreased since the early 1980s in both the Northern and Southern NEAC areas (Figure 3). The exploitation rate on 1SW salmon in the Northern NEAC area was 45% in 2020, which was over the previous five-year (41%) and ten-year (41%) means. Exploitation on 1SW fish in the Southern NEAC complex was 7% in 2020, which was lower than the previous five-year (9%) and ten-year (10%) means. Exploitation on MSW salmon in the Northern NEAC area was 43% in 2020, which was at the same level as the previous five-year (43%) and ten-year (43%) mean. Exploitation on MSW fish in Southern NEAC was 3% in 2020, which was clearly lower than the previous five-year (7%) and ten-year (9%) means.

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 2020 this ranges from 16% in Sweden to 93% in UK (England and Wales), reflecting varying management practices and angler attitudes among these countries. Catch and release mortality is also estimated for some countries, but these data are not included in the reported catch.

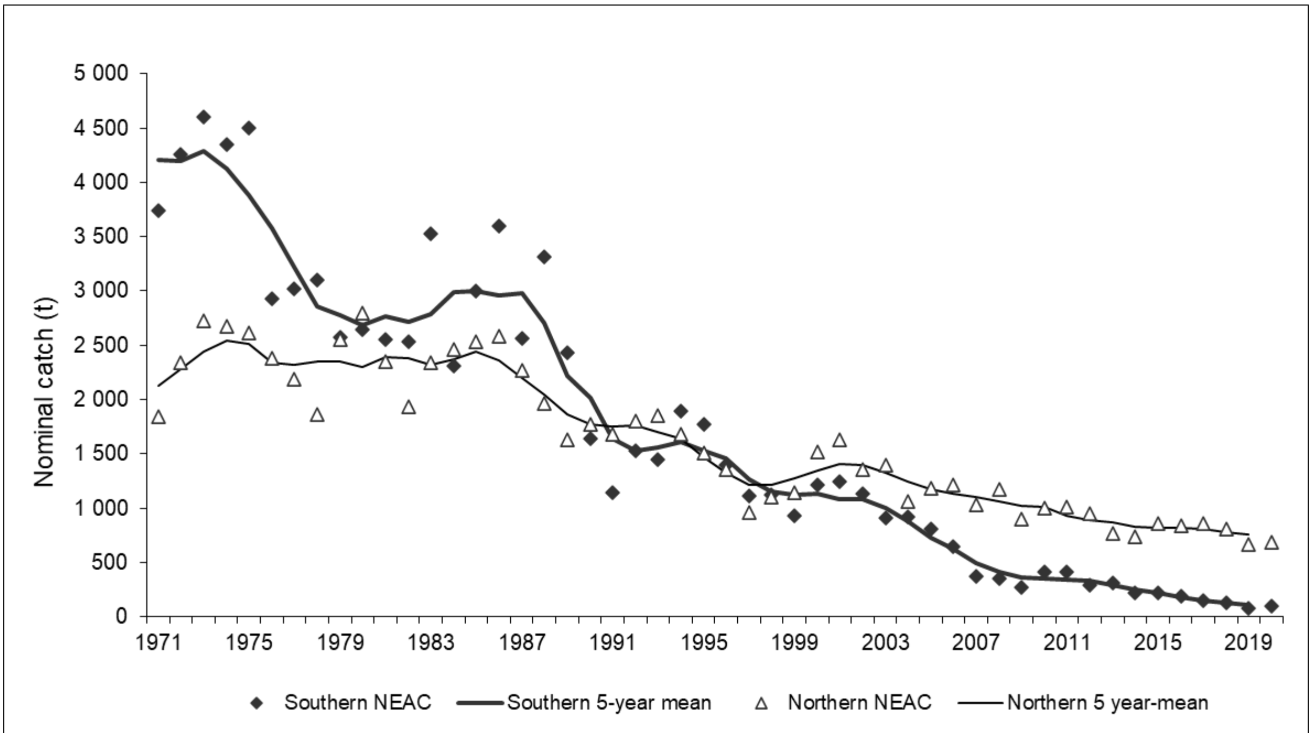

Figure 1 Reported catches of salmon and five-year running means in the Southern and Northern NEAC areas (1971–2020).

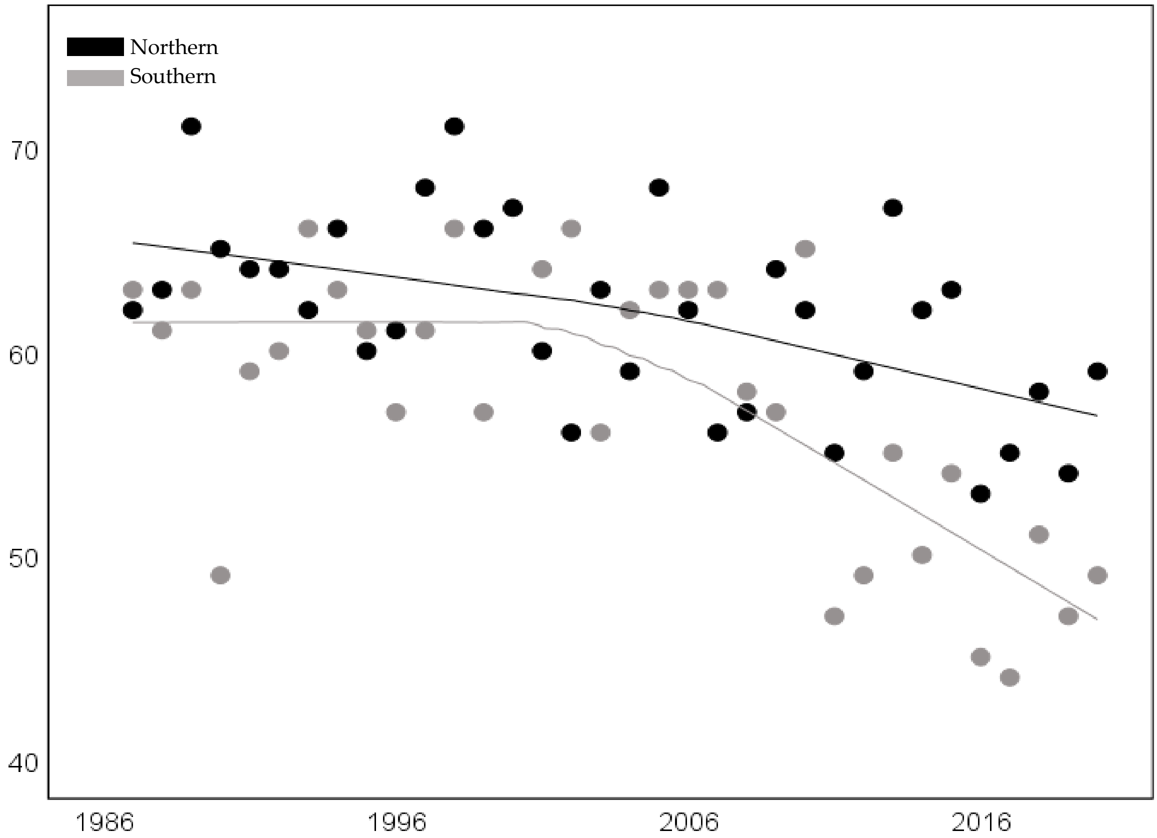

Figure 2 Percentage of 1SW salmon in the reported catch for the Northern (black dots) and Southern (grey dots) stock complexes, 1987–2020. Curves represent the Northern (black line) and Southern (grey line) stock complexes with a Loess smoother (span = 85%) applied to the data.

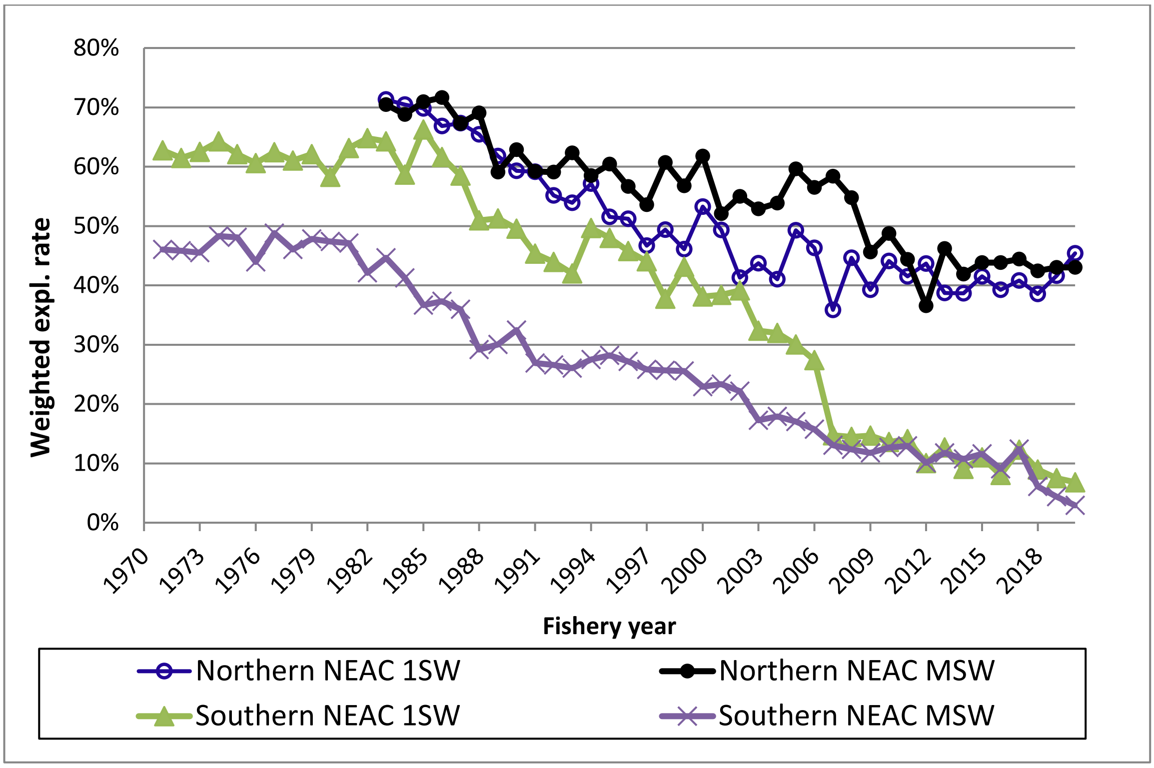

Figure 3 Mean annual exploitation rate of wild 1SW and MSW salmon by fisheries in the Northern (1983–2020) and Southern (1971–2020) NEAC areas.

Table 2 Reported catch of salmon in the NEAC Area (in tonnes round fresh weight), 1960–2020 (2020 values are provisional).

Year	Southern NEAC countries	Northern NEAC countries*	Faroes**	Other catches in international waters	Total reported catch	Unreported catches	
						NEAC Area ***	International waters^
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
1992	1524	1806	23	-	3353	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	1394	1358	-	-	2752	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	372	1036	0	-	1407	465	-
2008	355	1178	0	-	1533	433	-
2009	266	898	0	-	1164	317	-
2010	410	1003	0	-	1414	357	-
2011	410	1009	0	-	1419	382	-
2012	295	955	0	-	1250	363	-
2013	310	770	0	-	1080	272	-

Year	Southern NEAC countries	Northern NEAC countries*	Faroes**	Other catches in international waters	Total reported catch	Unreported catches	
						NEAC Area ***	International waters^
2014	217	736	0	-	953	256	-
2015	222	859	0	-	1081	298	-
2016	186	842	0	-	1028	298	-
2017	151	863	0	-	1015	318	-
2018	125	804	0	-	929	279	-
2019	83	671	0	-	755	237	-
2020	93	685	0	-	778	239	-
Mean							
2015–2019	154	808	0	-	961	286	-
2010–2019	241	851	0	-	1092	306	-

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

NASCO 2.2 Review and report on the development of age-specific stock conservation limits

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 Finland, Norway, Russia, Sweden, and the northeastern region of Iceland. The Southern group consists of France, Ireland, UK (England and Wales), UK (Northern Ireland), UK (Scotland), and the southwestern region of Iceland. Four stock complexes are then defined; each comprised of one of the two sea ages (1SW or MSW) per geographic group (N-NEAC and S-NEAC).
River-specific conservation limits (CLs; in terms of either egg or spawner requirements) have been estimated for salmon stocks in most countries/jurisdictions in the NEAC area (France, Ireland, UK [England and Wales], UK [Northern Ireland], UK [Scotland], Finland, Norway, and Sweden), and these are used in national assessments. In these cases, CL estimates for individual rivers are summed to provide estimates at the national level for these countries/jurisdictions. River-specific CLs have also been estimated for a number of rivers in Russia and Iceland, but these are not yet used in national assessments. An interim approach has been developed for countries/jurisdictions that do not use river-specific CLs in their national assessments. This approach is based on a model (pseudo-stock–recruitment relationships) for salmon stocks that are updated annually and for which, as a result, the CLs may change slightly from year to year.

To provide catch advice to NASCO, CLs are also required for stock complexes. These have been derived either by summing individual river CLs to country/jurisdiction level or by taking overall the CLs provided by the model and summing to the level of the four NEAC stock complexes. Spawner escapement reserves (SERs) are CLs (expressed in terms of spawner numbers) which are adjusted to take account of natural mortality (0.03 per month) between 1 January of the first winter at sea and return time to homewaters. The homewaters are defined as the river of origin including the estuary and associated coastal waters. This was done 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.

CLs and SERs are provided for the four stock complexes (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 2020. Values are in numbers of fish.

Geographic group	Age group	CL	SER
Northern NEAC	1SW	138086	174727
	MSW	122268	209236
Southern NEAC	1SW	436992	553846
	MSW	174735	295582

The CLs and SERs for the Southern NEAC complexes have been revised downwards substantially compared to last year due to changes in the UK (Northern Ireland) and particularly the UK (Scotland) estimates.

For the nine countries/jurisdictions where river-specific CLs are available, time-series indicating the development in the definition of these CLs, the number of rivers annually assessed against CLs, and the number of rivers that annually meet or exceed CLs (based on the number of spawners after fisheries have taken place) are provided in Figure 4. In addition, Iceland has set provisional CLs for all salmon-producing rivers and continues to work towards finalizing an assessment process for determining CL attainment.

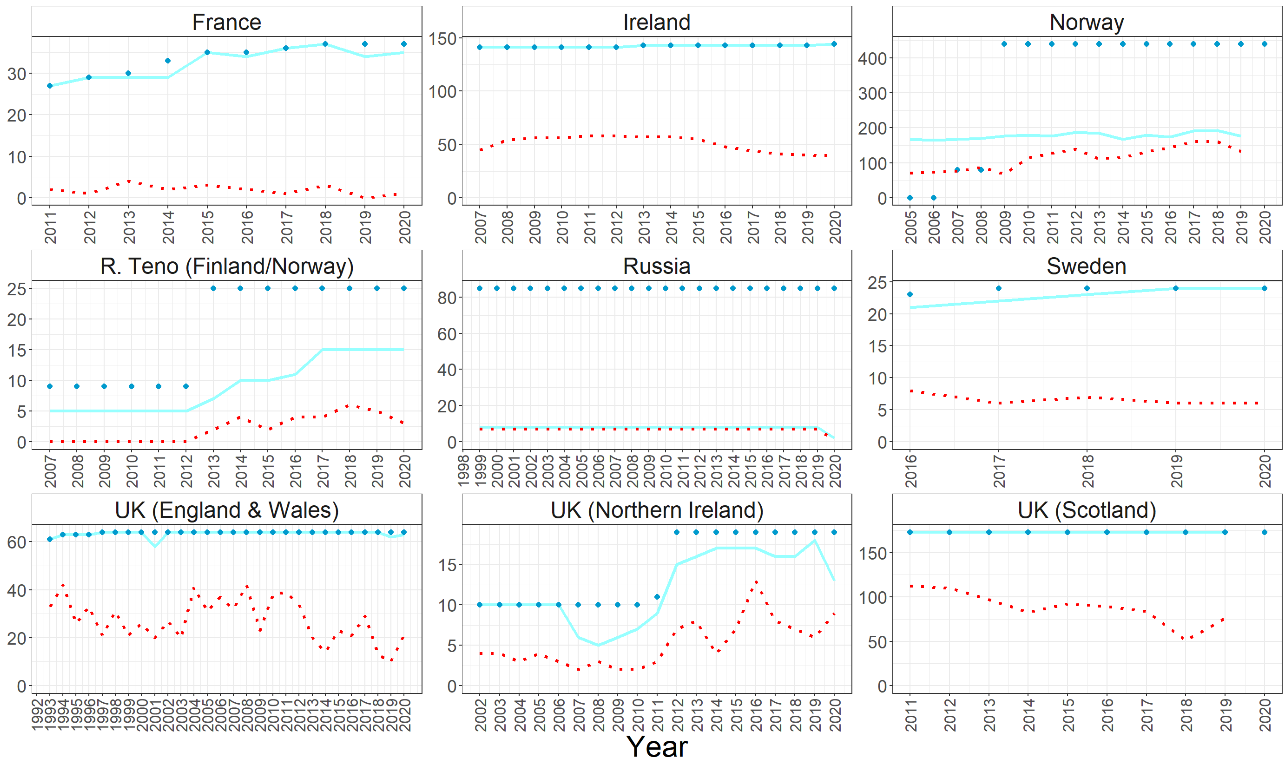

Figure 4 Time-series showing the number of rivers with established CLs (blue dotted lines), the number of rivers assessed annually (light blue solid lines), and the number of rivers meeting CLs annually (red dotted lines) for countries/jurisdictions in the NEAC area.

NASCO 2.3 Describe the status of the stocks

Recruitment, expressed as pre-fishery abundance (PFA; split into 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 is 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 geographic groups (Figure 5) and for 2020 by individual countries/jurisdictions for 1SW maturing and MSW (1SW non-maturing at the PFA stage) salmon (Figure 7 and Figure 8, respectively).

PFA relative to SER and spawners relative to CLs

For the Northern NEAC area, 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 commencement of the distant-water fisheries (i.e. they have met the SER with at least 95% probability) throughout the time-series. The 1SW spawners in the Northern NEAC stock complex have been at full reproductive capacity throughout the time-series. MSW spawners, on the other hand, while generally being at full reproductive capacity, have for some years been at risk of suffering reduced reproductive capacity.

For all countries in the Northern NEAC area, the PFAs of both maturing and non-maturing 1SW stocks were at full reproductive capacity prior to the commencement of distant-water fisheries in the most recent PFA year, except for maturing 1SW stocks in the Rive Tana/Teno (Norway and Finland) and Russia and non-maturing stock in the Tana/Teno that were suffering reduced reproductive capacity (Figure 6). Returning and spawning 1SW and MSW stocks in Sweden and Norway were at full reproductive capacity. However, both 1SW and MSW returns and spawner stock components in the Tana/Teno (Norway and Finland) and in Russia were suffering reduced reproductive capacity, except for MSW returns in Russia that were at full reproductive capacity. In addition, 1SW spawners in Iceland were at risk of suffering reduced reproductive capacity (Figures 7 and 8).

1SW and MSW stocks in the Southern NEAC complex were considered to be at full reproductive capacity prior to the commencement of distant-water fisheries in the latest available PFA year (Figure 5; Tables 5 and 6), although this is due, at least in part, to changes in the UK (Northern Ireland) and UK (Scotland) SERs and CLs. The abundance of maturing 1SW recruits (PFA) for Southern NEAC (Figure 5, Table 5) demonstrates a declining trend over the time period. Both maturing and non-maturing 1SW stocks have, however, been at full reproductive capacity prior to the commencement of distant-water fisheries for all but three and one years, respectively (Figure 5; tables 5 and 6). The 1SW spawners in the Southern NEAC stock complex have either been at risk of suffering reduced reproductive capacity or have suffered reduced reproductive capacity for six of the most recent ten years (Figure 5). In contrast, MSW spawners in the Southern NEAC stock complex have been at full reproductive capacity for all of the most recent ten years (Figure 5).

In Southern NEAC, maturing and non-maturing stocks in UK (Northern Ireland), Ireland, and France were suffering or at risk of suffering reduced reproductive capacity both prior to the commencement of distant-water fisheries and at spawning (Figure 6; Tables 5 and 6). In contrast, maturing and non-maturing stocks in UK (Scotland) were at full reproductive capacity both prior to the commencement of distant-water fisheries and at spawning. In UK (England and Wales), the maturing stock was suffering reduced reproductive capacity both prior to the commencement of distant-water fisheries and at spawning, whereas the non-maturing 1SW stock and MSW spawners were at full reproductive capacity throughout (Figures 6, 7, and 8).

Trends in rivers meeting CLs

In the NEAC area, all jurisdictions except Iceland currently assess salmon stocks using river-specific CLs (Figure 4, Table 4). The attainment of CLs is assessed based on the number of spawners after fisheries have taken place.

Table 4 Summary of the attainment of CLs in 2020 (2019 for Norway and UK [Scotland]) and trends based on all available data in the NEAC area. Further details can be found in ICES (2021a).

Country /Jurisdiction	Number of rivers with CLs	Number of rivers assessed for compliance	Number of rivers attaining CL	% of assessed rivers attaining CL	Trend in %
Northern NEAC					
Russia	85	2	1	50	Stable (fewer rivers assessed in 2020)
Norway/Finland (Tana/Teno)	25	15	3	20	Decreasing
Norway	439	177	133	75	Minor variability
Sweden	24	24	6	25	Minor variability
Southern NEAC					
UK (Scotland)	173	173	76	44	Decreasing (upturn in 2019)
UK (Northern Ireland)	19	13	9	69	Variable (fewer rivers assessed in 2020)
UK (England and Wales)	64	63	21	33	Decreasing (upturn in 2020)
Ireland	144	144	39	27	Decreasing
France	37	35	1	3	Variable

Return rates

Return rate estimates, proxies for marine survival, are derived for a limited number of rivers and have time-series of different durations. Return rates of wild and hatchery smolts to Northern NEAC are variable. They have generally decreased since 1980, although rates of 1SW returns of wild smolts have stabilized since 2010, while those of hatchery smolts have increased since 2005. Rates of 2SW returns of wild and hatchery smolts to the Northern NEAC area are highly variable but have continued to decline in 2019, especially for hatchery smolts. Mean return rates of wild and hatchery smolts to Southern NEAC are less variable, primarily because they are estimated from more rivers. They too have generally decreased since 1980, although rates of 2SW returns of wild smolts have started to increase since 2005, a trend that continued in 2019 (Figure 9).

The low return rates in recent years highlighted in these analyses are broadly consistent with the trends in estimated returns and spawners as derived from the PFA model. These low rates suggest that abundance is strongly influenced by factors in the marine environment.

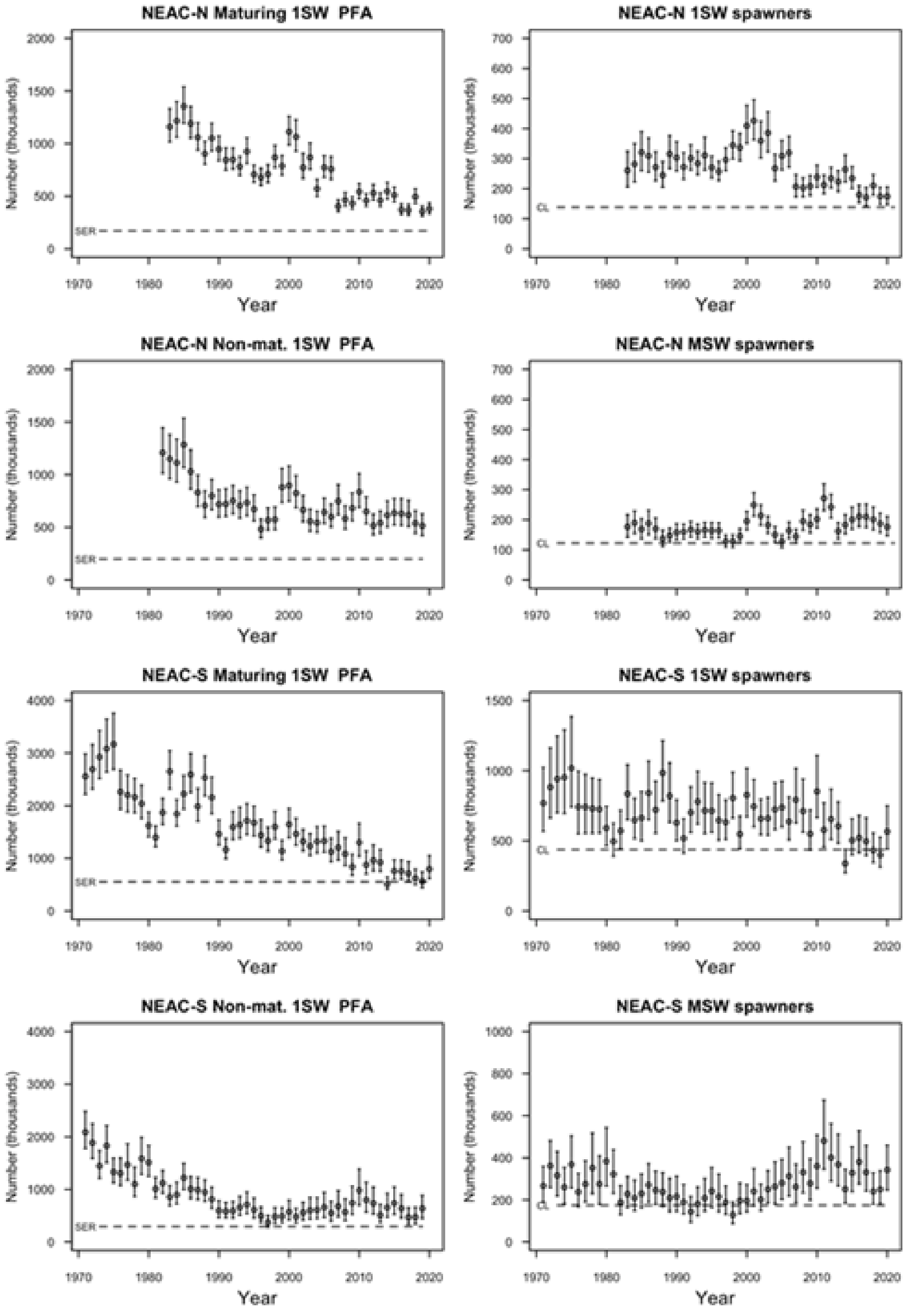

Figure 5 Estimated pre fishery abundance (PFA – recruits; left panels) and spawner escapement (right panels) with 90% confidence limits, for maturing 1SW (1SW spawners) and non-maturing 1SW (MSW spawners) salmon in Northern(NEAC-N) and Southern (NEAC-S) NEAC stock complexes. The dashed horizontal lines in the left panels are the respective 2020 spawner escapement reserve (SER) values and in the right panels the CL values.

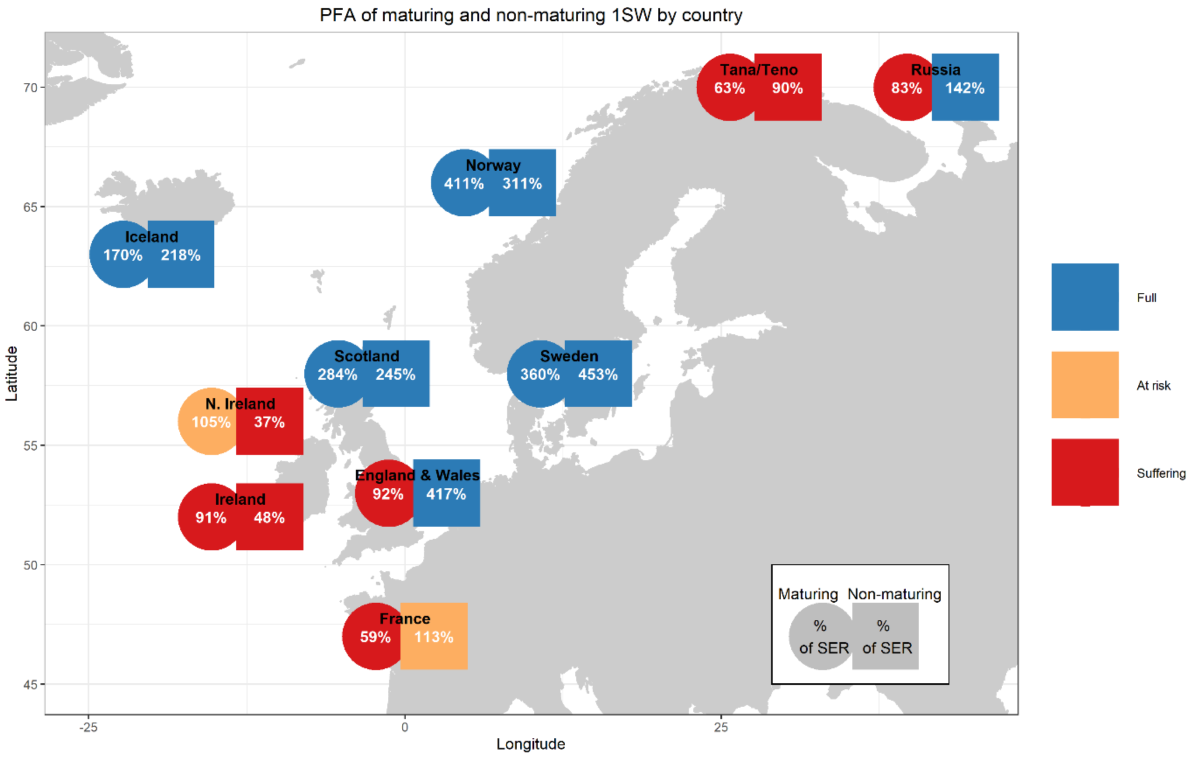

Figure 6 PFA of maturing (2020) and non-maturing (2019) in percent of spawner escapement reserve (% of SER). The percent of SER is based on the median of the Monte Carlo distribution. The three colours used as shading represent the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the SER), At risk (at risk of suffering reduced reproductive capacity: the median spawner estimate is above but the 5th percentile is below the SER), and Suffering (suffering reduced reproductive capacity: the median spawner estimate is below the SER).

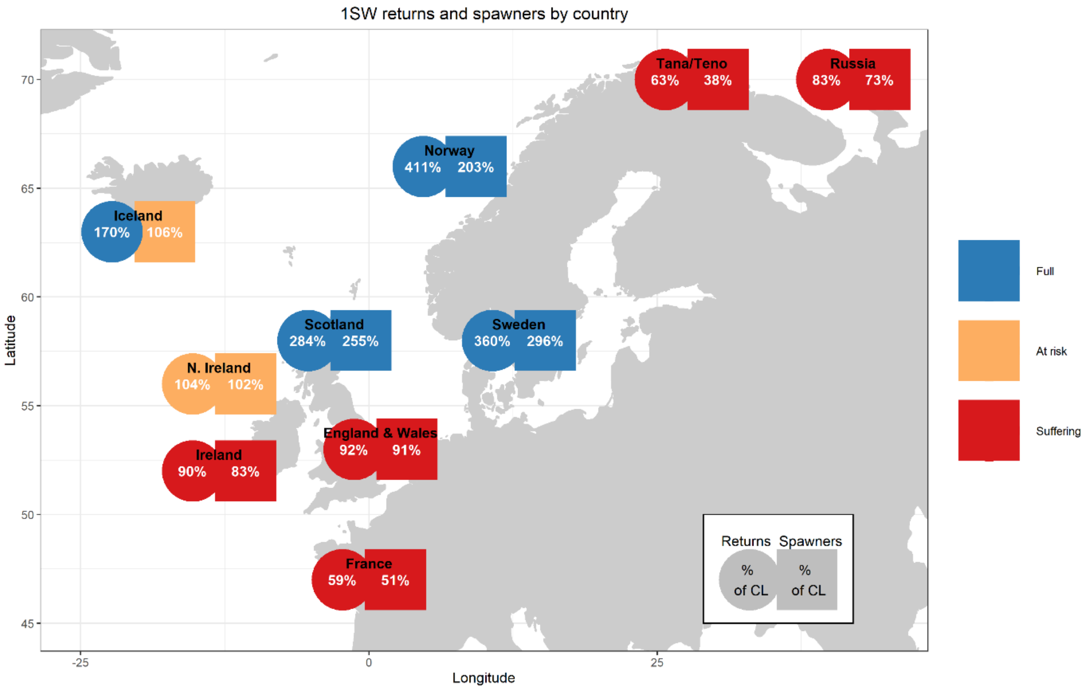

Figure 7 1SW returns and spawners in percent of conservation limit (% of CL) for 2020. The percent of CL is based on the median of the Monte Carlo distribution. The three colours used as shading represent the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At risk (at risk of suffering reduced reproductive capacity: the median spawner estimate is above but the 5th percentile is below the CL), and Suffering (suffering reduced reproductive capacity: the median spawner estimate is below the CL).

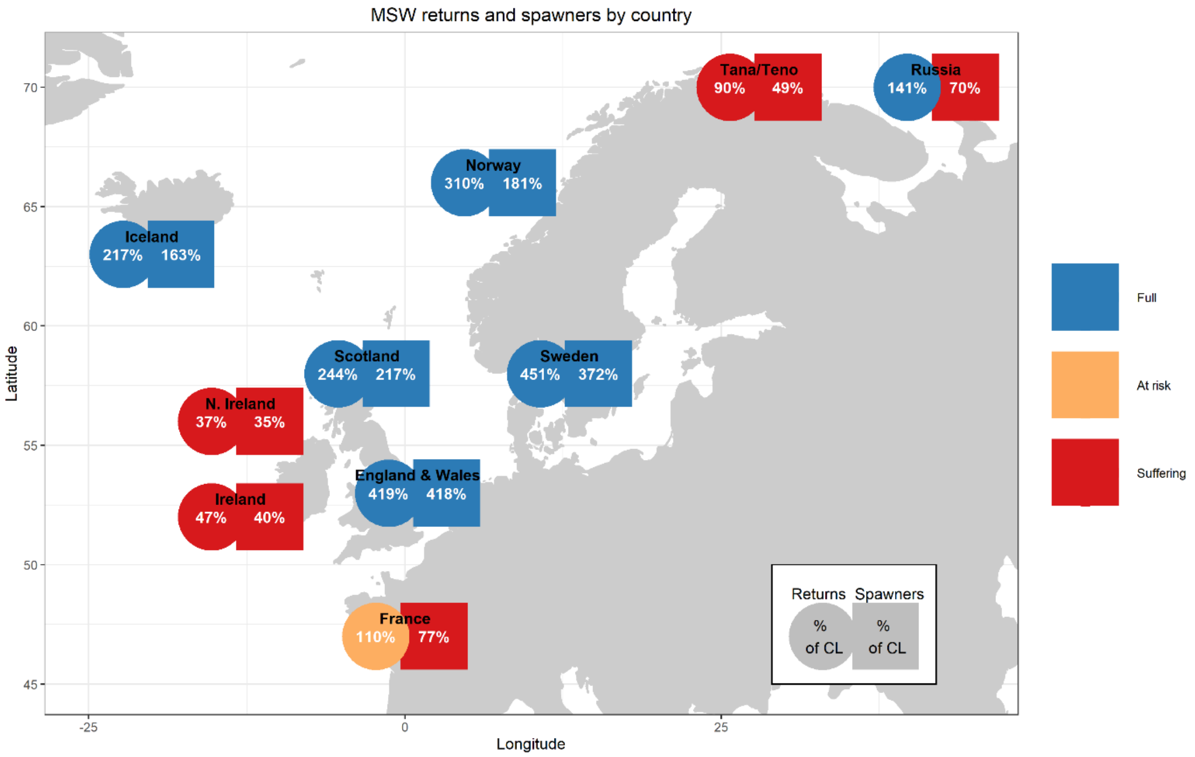

Figure 8 MSW returns and spawners in percent of conservation limit (% of CL) for 2020. The percent of CL is based on the median of the Monte Carlo distribution. The colours used as shading represent the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At risk (at risk of suffering reduced reproductive capacity: the median spawner estimate is above but the 5th percentile is below the CL), and Suffering (suffering reduced reproductive capacity: the median spawner estimate is below the CL).

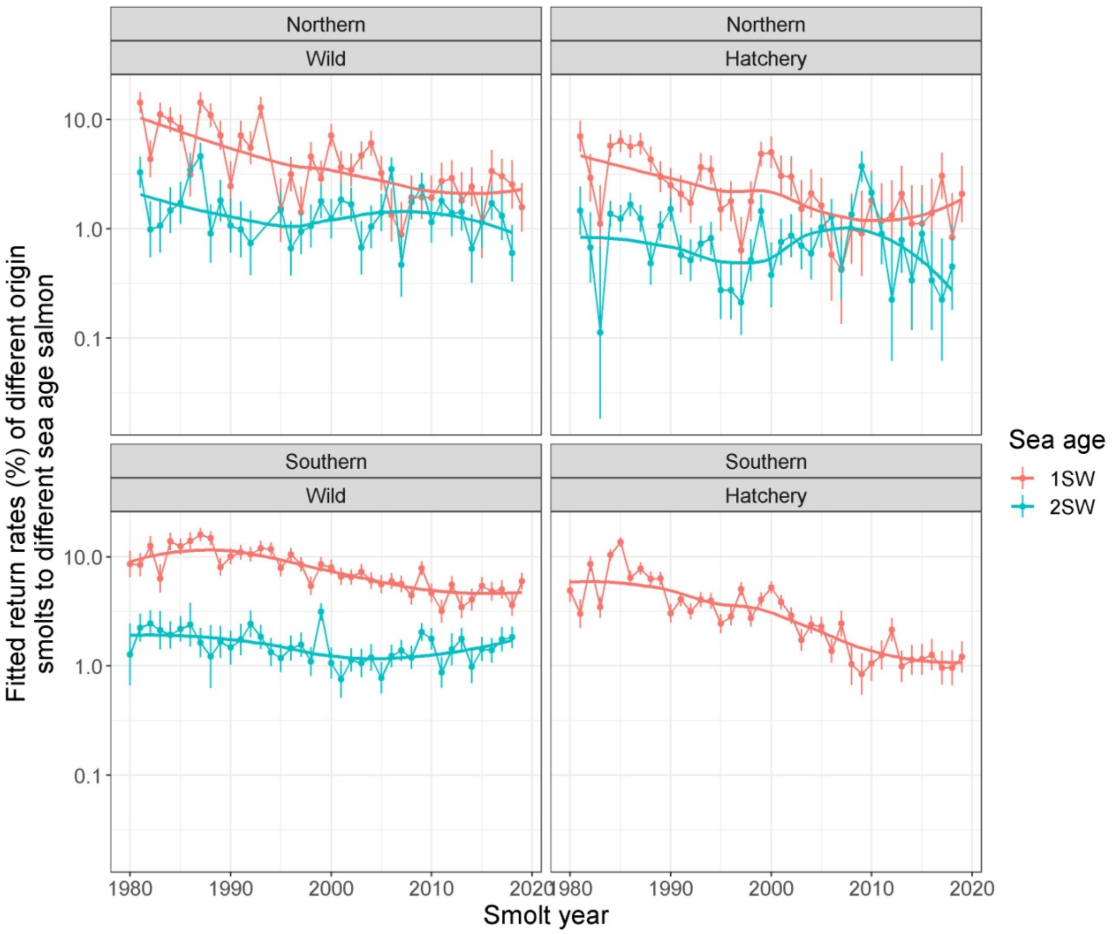

Figure 9 Least squared (marginal mean) average annual return rates (in %) of wild (left-hand panels) and hatchery origin smolts (right-hand panels) of 1SW and 2SW salmon to Northern (top panels) and Southern NEAC areas (bottom panels). For most rivers in Southern NEAC, the values represent returns to the coast prior to the homewater coastal fisheries. Mean annual return rates for each origin and area were estimated from a general linear model assuming quasi-Poisson errors (log-link function). Error bars represent standard errors. Trend lines are from locally weighted polynomial regression (LOESS) and are meant to be a visual interpretation aid. Following details in ICES (2021a; Tables 3.3.6.1 and 3.3.6.2), the analyses included estimated return rates (in %) for 1SW and 2SW returns by smolt year.

Table 5 Estimated pre-fishery abundance of maturing 1SW salmon (potential 1SW returns) by year for NEAC countries (50% quantile of the Monte Carlo distribution only) and region (50%, 5%, and 95% quantiles of the Monte Carlo distribution).

Year	Northern NEAC						Southern NEAC							NEAC Area
	Finland	Iceland (N&E)	Norway	Russia	Sweden	Northern NEAC 50% (5%; 95%)	France	Iceland (S & W)	Ireland	UK (E & W)	UK (NI)	UK (Scot)	Southern NEAC 50% (5%; 95%)	NEAC 50% (5%; 95%)
1971	29931	11698			22176		64342	77642	1347718	105942	222542	723847	2556809 (2215373; 2984956)	
1972	115020	10693		150843	17714		128570	62774	1433839	102038	195001	749042	2692510 (2317010; 3162087)	
1973	53678	12813		222247	21838		79171	67103	1564035	120301	170066	905739	2926114 (2514956; 3430804)	
1974	74352	12781		221060	31577		36890	48130	1777173	149480	185753	868989	3083233 (2638707; 3646536)	
1975	88931	15604		339093	34159		73030	74338	1966250	154667	152816	729709	3170257 (2691890; 3758307)	
1976	81059	15694		236582	19326		67533	58647	1336338	102248	106249	577573	2263820 (1932650; 2676781)	
1977	45815	21656		150659	8782		52116	59880	1152219	116599	104537	697427	2203178 (1882807; 2582860)	
1978	43469	22030		152258	10361		52836	78611	1008375	133847	136402	734033	2162322 (1865770; 2519368)	
1979	39055	21082		210950	10650		60815	72944	926457	127433	95716	737996	2040472 (1755445; 2388810)	
1980	31285	3323		150688	13746		126609	33248	710875	120038	121784	491839	1621777 (1407296; 1879538)	
1981	28039	16643		125338	24982		101061	42956	379959	127616	96368	637339	1399647 (1219221; 1616036)	
1982	16751	7797		110188	22060		63029	44230	776429	108808	138516	725224	1869332 (1641456; 2136780)	
1983	40599	11353	892441	182842	29318	1159105 (1014965; 1330582)	67329	55656	1358385	156570	192876	803075	2650974 (2318527; 3043876)	3817301 (3411808; 4279460)
1984	44250	4119	927270	195876	41239	1215273 (1060321; 1398012)	109019	33994	715073	136962	75931	755696	1844087 (1611346; 2115712)	3062410 (2738055; 3425653)
1985	58664	28089	942411	269254	49323	1352600 (1192347; 1540004)	40579	55414	1183468	137158	98355	695103	2224649 (1937137; 2572965)	3583556 (3197931; 4018259)
1986	46209	35000	822392	230247	51518	1190859 (1049826; 1353184)	63176	90673	1328352	158514	110851	814566	2592257 (2252374; 2993774)	3787360 (3373327; 4261659)
1987	55856	20623	691807	245674	40898	1058712 (938415; 1198733)	112353	56338	855597	165244	60915	698053	1986780 (1703573; 2326474)	3052999 (2708409; 3453989)
1988	32971	29721	634769	169326	34216	903606 (802486; 1021110)	38207	101252	1155545	225444	141969	845526	2532374 (2187832; 2941221)	3440380 (3045913; 3899579)
1989	71453	16057	698626	251638	9965	1051107 (928403; 1193514)	21257	56540	829347	151937	136557	943402	2157735 (1848045; 2545738)	3212659 (2842660; 3656437)
1990	71463	12030	627419	208584	23241	946746 (837536; 1072303)	34826	52226	521116	108995	112906	613253	1461277 (1250782; 1729836)	2414017 (2139409; 2733687)
1991	70538	17443	545940	177967	29023	844193 (747168; 959113)	25090	57266	369823	106893	63033	525167	1164257 (989768; 1378856)	2012269 (1785958; 2274568)
1992	99081	32804	460751	219165	32515	848263 (756603; 957739)	45837	65629	537747	112169	127285	682531	1594307 (1359020; 1888935)	2445408 (2169433; 2779913)
1993	66920	26929	462225	188314	32186	780588 (695535; 876336)	65755	64190	437068	155615	148973	736155	1635991 (1382610; 1973167)	2420268 (2125066; 2783889)
1994	37253	8625	625495	222582	24833	924043 (811797; 1055249)	52127	53059	560343	172766	102491	749709	1715229 (1450920; 2038836)	2642836 (2330504; 3016762)
1995	37159	22580	407245	199532	36336	706632 (631379; 795355)	17548	65295	622688	132401	95077	727394	1675501 (1425355; 1992873)	2384778 (2097836; 2731836)
1996	57073	12063	310814	272306	21660	677536 (602794; 764646)	21522	56341	582181	97619	98350	568157	1438131 (1211597; 1737229)	2120484 (1861995; 2447120)
1997	51817	16460	359314	267601	9859	708748 (628263; 799636)	10892	41219	580224	88073	116416	484954	1332884 (1134722; 1593565)	2046604 (1808844; 2338171)
1998	65193	28090	468716	293944	7962	868378 (770223; 982700)	21381	56261	610929	96639	253198	543393	1598754 (1369974; 1891888)	2473103 (2189329; 2812493)
1999	95524	14306	434658	225876	12477	786888 (699699; 886358)	7118	45803	565892	76390	66127	363839	1137299 (968464; 1344751)	1926741 (1711565; 2175118)
2000	103685	15068	716486	247566	23059	1112276 (986653; 1258805)	18586	40752	789569	116772	97059	563924	1644193 (1391237; 1949857)	2762652 (2443258; 3127731)
2001	75357	13607	618308	332972	14271	1064312 (926591; 1226537)	16001	36446	625684	100917	77307	593771	1463485 (1246676; 1757590)	2532371 (2245460; 2892327)
2002	46794	23633	377473	302812	13704	771934 (666966; 906817)	36007	45370	549142	95817	136947	440124	1321102 (1139535; 1546073)	2098635 (1859394; 2383651)
2003	46102	12499	525103	269915	7462	867956 (754302; 1005895)	23654	54291	537363	74079	85918	440845	1233344 (1050564; 1467609)	2106104 (1863817; 2390961)
2004	19612	33830	317984	189595	6218	571000 (499835; 658117)	28633	54439	396060	132449	82459	601582	1317884 (1102630; 1601939)	1892648 (1646329; 2205554)
2005	42813	30032	471723	216142	6138	772726 (677128; 884834)	18856	80084	393423	108484	103397	607123	1329420 (1116814; 1610722)	2108646 (1850975; 2429667)
2006	70218	31749	381051	261599	6810	756685 (659432; 876172)	26258	56805	301876	106765	70358	544846	1124984 (933369; 1382608)	1887962 (1645579; 2188571)
2007	20528	23509	213473	140819	2120	403026 (351838; 466432)	20609	64912	304380	101986	103740	561348	1201913 (964936; 1511586)	1606346 (1352578; 1941107)

Year	Northern NEAC						Southern NEAC							NEAC Area
	Finland	Iceland (N&E)	Norway	Russia	Sweden	Northern NEAC 50% (5%; 95%)	France	Iceland (S & W)	Ireland	UK (E & W)	UK (NI)	UK (Scot)	Southern NEAC 50% (5%; 95%)	NEAC 50% (5%; 95%)
2008	22192	21413	267133	146763	3305	464182 (406843; 533616)	20469	78747	320901	101054	65339	451138	1081604 (862866; 1390360)	1548962 (1308900; 1870761)
2009	39310	34652	214516	138074	3511	431866 (379646; 492590)	5774	88700	261739	63493	40536	350028	840840 (678105; 1075921)	1275467 (1091743; 1526198)
2010	31522	27780	317132	156964	5964	542641 (476736; 620147)	19325	91174	349689	125738	40313	626374	1301112 (1038713; 1663217)	1846383 (1558652; 2229191)
2011	35891	22848	223115	166622	6566	457864 (401964; 524167)	13460	64266	299835	83565	29196	352355	875492 (703183; 1138486)	1338423 (1141384; 1614828)
2012	62096	11887	248715	194812	7240	529113 (462885; 610589)	14422	36444	309756	47861	67304	448035	959923 (760546; 1253608)	1492583 (1269427; 1808097)
2013	35715	28337	234391	152266	4203	459914 (401220; 530986)	20284	108431	261211	68259	74043	354402	923723 (753037; 1166556)	1387930 (1189545; 1647576)
2014	50725	13315	319552	143435	12389	545660 (472872; 631208)	18127	26814	160933	40185	33456	205420	506023 (408946; 644413)	1055567 (918677; 1227887)
2015	31678	37627	281921	149469	4011	510489 (445614; 586614)	16603	74576	226818	49121	35928	323817	757567 (610412; 971286)	1272414 (1092070; 1505339)
2016	24728	16037	218706	106027	2151	370665 (325167; 425625)	15121	43889	227763	52387	68023	313948	753969 (601599; 968201)	1127043 (957891; 1355330)
2017	15916	15598	288410	38343	5762	365788 (318646; 421315)	19108	45442	248545	37705	57299	275058	714175 (565970; 937068)	1083458 (918099; 1319872)
2018	39964	16596	295086	128057	9405	494596 (431287; 570165)	16037	39196	180246	49303	50236	259476	621950 (497348; 791831)	1121456 (966574; 1314335)
2019	13143	9964	230409	91821	5441	354395 (309762; 406622)	16486	26174	172970	33057	27875	268949	565484 (443498; 744088)	922213 (782635; 1113570)
2020	11389	10612	282647	65763	8041	380768 (333212; 435908)	13264	34492	243607	63201	44868	370434	796463 (616157; 1051103)	1179197 (983857; 1443812)
Mean 10-year	32124	18282	262295	123661	6521	446925 (390263; 514320)	16291	49972	233168	52464	48823	317189	747477 (596070; 966664)	1198029 (1022016; 1435065)

Table 6 Estimated pre-fishery abundance of non-maturing 1SW salmon (potential MSW returns) by year for NEAC countries (50% quantile of the Monte Carlo distribution only) and region (50% 5%, and 95% quantiles of the Monte Carlo distribution). Estimates for 2020 will only be available in 2021 for this component.

Year	Northern NEAC						Southern NEAC							NEAC area
	Finland	Iceland (N&E)	Norway	Russia	Sweden	Northern NEAC 50% (5%; 95%)	France	Iceland (S & W)	Ireland	UK (E & W)	UK (NI)	UK (Scot)	Southern NEAC 50% (5%; 95%)	NEAC 50% (5%; 95%)
1971	47317	27022		265414	4704		59281	65478	381580	363532	32712	1172472	2089205 (1776962 ;2480546)	
1972	72571	25376		427818	7574		39600	59257	384173	282376	28741	1077158	1883748 (1590079 ;2247874)	
1973	117047	23832		395323	4882		20527	50954	393763	199254	31201	739585	1444737 (1208560 ;1735522)	
1974	149119	26452		428729	3793		34795	54176	448124	264750	25795	985693	1829217 (1510427 ;2215123)	
1975	115827	21679		366109	4748		30110	46830	337949	180263	17883	709943	1328269 (1123056 ;1593368)	
1976	80916	29727		253372	2678		21468	45484	280139	179330	17534	749008	1303279 (1071460 ;1597006)	
1977	42011	38016		218480	2687		21847	58607	248265	158551	22748	947042	1467948 (1174689 ;1866293)	
1978	43499	25426		197866	4596		20463	37803	209702	86421	16166	720180	1097973 (865145 ;1422249)	
1979	48555	36021		343278	9419		40099	53759	244014	231591	21006	982034	1585524 (1283292 ;1989719)	
1980	61915	14322		235429	6854		30671	37064	192822	307394	17413	912831	1513387 (1248965 ;1833149)	
1981	76120	15969		209941	11248		21242	26668	124691	147564	24205	658556	1009087 (836195 ;1228395)	
1982	79323	12172	839919	266375	8038	1208952 (1013662; 1444975)	20764	42750	207880	152409	32915	653174	1117846 (928943 ;1356825)	2331235 (1978013; 2758444)
1983	64086	14677	811223	249804	8050	1149995 (960236; 1380119)	26931	35883	142996	109897	13265	521607	857709 (689733 ;1070197)	2013417 (1690147; 2392326)
1984	62790	9881	758239	274182	4656	1112540 (929944; 1336787)	20373	26277	152155	150016	17016	526415	899015 (722888 ;1133907)	2016884 (1689810; 2419030)
1985	54724	25325	918016	278159	4525	1284581 (1066726; 1537767)	24691	22390	191739	220382	19237	729894	1218947 (996569 ;1495664)	2507235 (2107450; 2969248)
1986	67949	26166	710208	212980	8007	1029329 (862989; 1235473)	15730	19958	225988	181112	10268	548200	1009517 (826643 ;1240521)	2041610 (1725178; 2425088)
1987	46433	16714	562374	196252	6942	829930 (695859; 995763)	31527	22026	166943	213946	26668	517601	988233 (804341 ;1226473)	1820208 (1529195; 2176648)
1988	46332	14383	428045	195937	19912	705770 (593480; 844460)	17955	19894	159208	185331	21418	536852	947944 (773741 ;1178129)	1658428 (1391852; 1984051)
1989	49257	14934	480416	240855	10832	798187 (666888; 954127)	14869	19555	74142	199399	19387	474599	810808 (641096 ;1041242)	1612283 (1337008; 1951170)
1990	63275	10338	395976	230885	13536	717590 (596743; 857273)	12713	19219	100070	89814	10050	360071	596616 (464008 ;787041)	1320181 (1086834; 1595883)
1991	59830	14976	412273	213644	17903	720508 (603184; 865654)	16427	21446	83343	74794	22409	360040	583208 (462088 ;750742)	1309551 (1089986; 1575663)
1992	62444	16958	396602	252511	20267	750857 (628607; 897059)	8240	10569	78308	77197	52618	355204	591811 (457040 ;772784)	1346840 (1115332; 1629206)
1993	59028	14399	387486	225622	15455	704370 (585982; 845612)	14429	17069	113833	98249	18596	388397	657069 (507000 ;869716)	1365695 (1123135; 1667842)
1994	39570	9191	417058	257666	7884	733096 (610914; 880187)	7089	17535	110230	99038	15832	452892	709071 (536935 ;951389)	1447941 (1182423; 1776250)
1995	36367	11961	414995	193911	12650	671996 (561076; 808020)	12700	11310	75942	102819	17315	385104	612421 (458509 ;837721)	1289080 (1050442; 1591721)
1996	42563	6639	265845	154731	8907	480919 (399123; 578028)	6558	12591	96204	63891	21515	281904	494033 (372417 ;665661)	979476 (794422; 1212523)
1997	40670	9702	319102	192068	4917	568101 (473435; 684295)	5443	7776	55705	41612	29416	227539	372929 (279631 ;505806)	944165 (776876; 1150861)

Year	Northern NEAC						Southern NEAC							NEAC area
	Finland	Iceland (N&E)	Norway	Russia	Sweden	Northern NEAC 50% (5%; 95%)	France	Iceland (S & W)	Ireland	UK (E & W)	UK (NI)	UK (Scot)	Southern NEAC 50% (5%; 95%)	NEAC 50% (5%; 95%)
1998	48124	11141	340753	169407	3485	574255 (476180; 692421)	11451	15172	86766	80785	13371	255975	482201 (355445 ;654194)	1061839 (862784; 1302533)
1999	91475	6509	471852	294837	12418	879718 (735824; 1058215)	7961	4135	107114	82765	16381	258151	487535 (369977 ;653475)	1374341 (1134402; 1663152)
2000	110724	7455	554317	207146	14745	897548 (746385; 1081067)	9377	7253	95944	89462	11076	347808	572296 (422207 ;795083)	1475953 (1207065; 1815143)
2001	97100	7071	481346	225564	10132	823194 (685454; 991091)	8753	7855	110976	81406	13896	246440	480586 (364154 ;638223)	1309751 (1083128; 1586140)
2002	69556	7439	425616	158271	2410	664748 (551697; 802413)	12440	12520	116269	104694	8497	288772	557385 (418585 ;754795)	1225911 (998269; 1512312)
2003	31810	7316	386999	121535	7483	556551 (459969; 671312)	23139	10127	64174	89178	9011	393716	600438 (434620 ;848061)	1160609 (930360; 1467230)
2004	26307	9074	354733	145820	5004	542374 (450611; 653141)	14352	8932	82850	96818	11290	382329	609315 (445723 ;846100)	1156366 (928989; 1448610)
2005	38999	8674	449903	139471	5226	643363 (536254; 776516)	14410	7395	59594	86919	8913	468280	658883 (467740 ;945254)	1308739 (1044880; 1665291)
2006	56402	8373	382726	145555	4868	598341 (502232; 719133)	13597	4567	42432	84462	9220	382838	548554 (395356 ;776284)	1153869 (932717; 1447446)
2007	56843	10742	442265	228627	6892	747696 (619228; 906381)	15110	5228	31688	92392	7190	514112	678225 (480319 ;978532)	1433584 (1143169; 1818097)
2008	24351	8673	347971	194598	6059	582970 (480597; 703664)	6994	8082	39737	71466	7290	424979	567612 (403844 ;819022)	1155901 (921816; 1465846)
2009	39044	12330	381388	239485	7063	682300 (563296; 823614)	5736	16717	36994	104517	10698	554227	742176 (523065 ;1059078)	1431349 (1131328; 1821612)
2010	30096	13716	531721	239945	16447	835497 (688148; 1010644)	16084	8479	40406	175750	13712	703407	981269 (698846 ;1384653)	1822928 (1442991; 2321822)
2011	36343	7732	465615	117537	18673	648368 (534839; 787670)	12857	4853	35306	137904	31926	555105	797199 (566741 ;1133112)	1450815 (1147292; 1849837)
2012	35092	8838	328292	134222	7973	516569 (427084; 625722)	13238	13396	40403	134813	10285	507459	737100 (529528 ;1042874)	1260198 (991999; 1614819)
2013	37896	10677	337988	133538	17060	540506 (442625; 655349)	16415	8240	33996	91605	5594	342702	510960 (373134 ;714765)	1052930 (847916; 1323455)
2014	36659	10168	427872	125685	11711	614777 (502771; 750812)	18557	7451	36038	147492	7180	419621	654559 (473789 ;922575)	1273701 (1015980; 1610589)
2015	39226	14234	469406	107098	4561	636909 (521914; 771549)	7972	10681	35446	193878	13298	456380	739414 (523810 ;1045933)	1381255 (1090213; 1760808)
2016	28303	8011	473854	99187	19273	630637 (516697; 771059)	9053	9069	32540	155157	10727	403016	637820 (457812 ;904803)	1274801 (1017364; 1605705)
2017	17409	8805	445323	130346	12747	617138 (506762; 755886)	13502	9694	32846	156437	10149	228518	468208 (338600 ;651671)	1089862 (879156; 1356314)
2018	24448	6704	376527	101423	25451	537611 (442165; 657288)	21436	7875	25881	120498	6394	285664	473053 (340842 ;661174)	1016217 (817601; 1268609)
2019	14733	5165	382780	87988	21468	514204 (420717; 627706)	10683	7648	37663	214878	3852	351709	636018 (446530 ;888260)	1153181 (908755; 1464141)
2020														
Mean 10-year	30012	8926	411962	115225	15435	584080 (479508; 711449)	13746	8768	34458	150296	11045	394464	628259 (450087 ;885019)	1216996 (968475; 1539364)

NASCO 2.4. Provide catch options or alternative management advice for the 2021/22–2023/24 fishing seasons, with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding

PFA forecasts until 2024 for the Southern and Northern NEAC complexes were developed within a Bayesian model framework (Figures 10 and 11). The probabilities of meeting SERs under different catch scenarios in the Faroes in seasons 2021/2022 to 2023/2024, assuming that the agreed catch allocation is fully taken in homewaters, are provided in Table 7 for the stock complexes. The corresponding forecast exploitation rates, for fish taken at the Faroes, are presented in Table 8. The probabilities of meeting SERs in the individual NEAC countries are presented in Tables 9 and 10. The probabilities of meeting SERs are higher in the Northern than in the Southern complex and are generally higher for the Northern countries than the Southern countries.

MSY approach

ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on salmon from stocks that can be shown to be at full reproductive capacity. Due to the different status of individual stocks, mixed-stock fisheries present particular threats.

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 SERs, 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). In the absence of any fisheries in the Faroes in 2021/2022 to 2023/2024, there is a less than 95% probability of meeting the SERs for the two Southern NEAC complexes (potential 1SW and MSW spawners) and for the Northern NEAC potential 1SW spawners (Table 7). There is also a less than 95% probability of most individual countries meeting their SERs for MSW fish in the absence of any fisheries (Table 10); only Norway meets its SER for 1SW fish for 2021/2022 and for 2022/2023 up to its 60 t TAC option (Table 9). Therefore, in the absence of specific management objectives, ICES advises that there are no mixed-stock fisheries options for the NEAC complexes/countries at the Faroes in 2021/2022 to 2023/2024.

Additional considerations

ICES emphasizes that the national stock SERs discussed above are not appropriate for the management of homewater fisheries, particularly where these exploit separate river stocks. This is because the SERs will not take account of differences in the status of different river stocks or sub-river populations. Management at finer scales should take account of individual river stock status. Nevertheless, given that not all stocks are currently at full reproductive capacity, the combined SERs for the main stock groups (national stocks) exploited by the distant-water fisheries can be used to provide general management advice to the distant-water fisheries.

Fisheries on mixed-stocks pose particular difficulties for management when they cannot only target stocks that are at full reproductive capacity. The management of a fishery should ideally be based on the status of all stocks exploited in the fishery. Conservation would be best achieved if fisheries target stocks that have been shown to be at full reproductive capacity. Fisheries in estuaries and especially rivers are more likely to meet this requirement. While the abundance of stocks remains low, even in the absence of a fishery at the Faroes, particular care should be taken to ensure that fisheries in home waters are managed to protect river stocks that are below their CLs.

The probabilities of meeting SERs for the 1SW salmon are hardly affected by the catch options at the Faroes (within the range considered in Table7), principally because the exploitation rates on the 1SW stock components in the fishery are expected to be very low (Table 8).

Data and methods

The input data used to estimate the historical PFAs are the catch in numbers of 1SW and MSW salmon in each country, unreported catch levels, and exploitation rates; error values are included to account for uncertainties. A natural mortality value of 0.03 (range 0.02 to 0.04) per month is applied during the second year at sea. Data beginning in 1971 are available for most countries. In addition, catches at the Faroes (equal to 0 since 2000) and catches of NEAC-origin salmon at West Greenland are included.

The Bayesian inference and forecast models for the Southern NEAC and Northern NEAC complexes have the same structure and are run independently through R. For both Southern and Northern NEAC complexes, PFA forecasts were derived based on lagged spawners and productivity (Figures 10 and 11).

The risk framework was used to evaluate TAC options for the Faroes fishery in the 2021/2022, 2022/2023, and 2023/2024 fishing seasons, based on the NEAC stock complex and countries/jurisdictions. For any TAC option being evaluated, the number of fish that would be caught at the Faroes from each management unit is estimated. These values are divided by the Faroes share allocation to estimate the total harvest that can be taken by each participating country at Faroes and in homewater fisheries combined (ICES, 2016). The risk analysis then estimates the probability of each management unit achieving its management objectives for each TAC option, assuming that the total estimated harvest is taken.

The large uncertainty in the PFA forecasts (Figures 10 and 11) results in increased risk of not achieving the CLs in the forecasts. As a result, the advice is more cautious regarding fishing opportunities.

Comparison with previous assessment and catch options

The most recent catch advice in 2018 concluded that there were no catch options at the Faroes for 2018/2019 to 2020/2021 (ICES, 2018). The current assessment and forecast results in similar advice.

The advice this year is based on the risk assessment framework, as in 2018. This framework directly evaluates the risk (probability) of meeting SERs in the 1SW and MSW Southern and Northern NEAC complexes, as well as at country level, under different catch scenarios. Managers can choose the risk level which they consider appropriate. ICES considers, however, that to be consistent with the MSY and precautionary approach, and given that the SERs (as CLs increased to take account of natural mortality between the recruitment date and the date of return to homewaters) are considered to be limit reference points to be avoided with high probability, managers should choose a risk level that results in a low chance of failing to meet the SERs. ICES still considers that management decisions be based principally on a 95% probability of attainment of SERs in each stock complex or country individually (ICES, 2013).

Assessment and management area

National stocks are combined into Southern NEAC and Northern NEAC groups. The groups fulfilled an agreed set of criteria for defining stock groups for the provision of management advice (ICES, 2005). At that time, consideration of the level of exploitation of national stocks resulted in the advice for the Faroes fishery (both 1SW and MSW) being based on all NEAC area stocks and the advice for the West Greenland fishery being based on the Southern NEAC non-maturing 1SW stock only.

ICES (2012) previously emphasized the problem of basing a risk assessment and catch advice for the Faroes fishery on management units comprising large numbers of river stocks. In providing catch advice at age and stock complex or country levels for the Northern and Southern NEAC areas, consideration needs to be given to the recent performance of the stocks within individual countries. At present, insufficient monitoring occurs to assess the performance of individual stocks in all countries or jurisdictions in the NEAC area, and in some instances river-specific CLs are in the process of being developed. Nonetheless, Figure 4 indciates that there are many rivers in the NEAC area that are not meeting their CLs.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. Provisional catch data for 2019 were updated where appropriate, and the assessment was extended to include data for 2020. Further development of the Faroes risk framework would benefit from new data on the biological characteristics and origin of the catch (ICES, 2016).

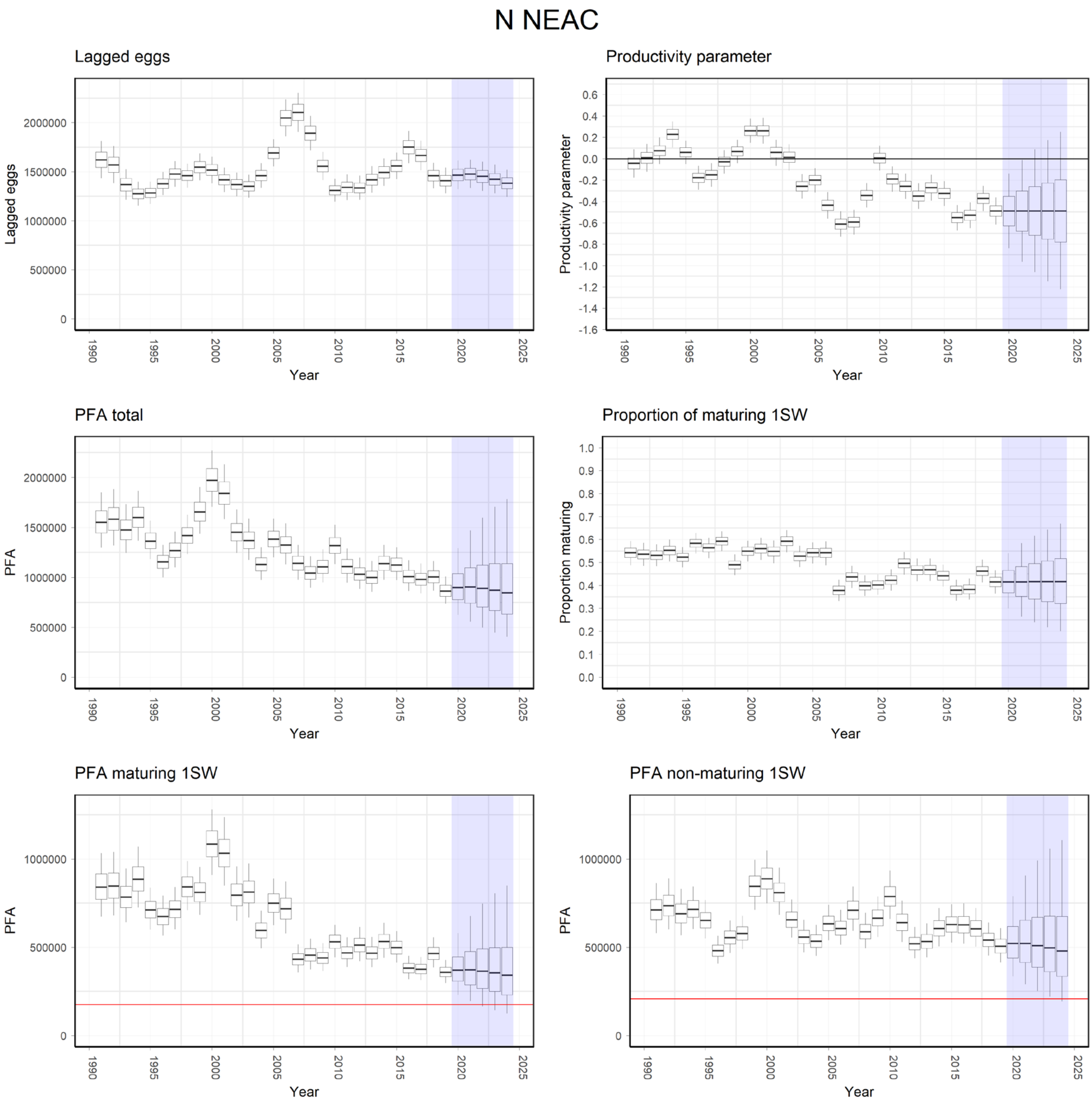

Figure 10 Northern NEAC: lagged eggs (in thousands) from 1SW and MSW spawners combined, productivity parameter from eggs to PFA, total PFA, proportion of maturing 1SW spawners, and PFA of maturing and non-maturing stocks for PFA years 1978 to 2024. For PFAs, the proportion of maturing fish and productivity parameter for the last five years (2020 to 2024) are forecasts (as indicated by the blue shaded region). The red horizontal lines in the bottom panels are the age-specific SER values. Box and whiskers plots show the 5th, 25th, 50th, 75th, and 95th Bayesian credible intervals (BCIs).

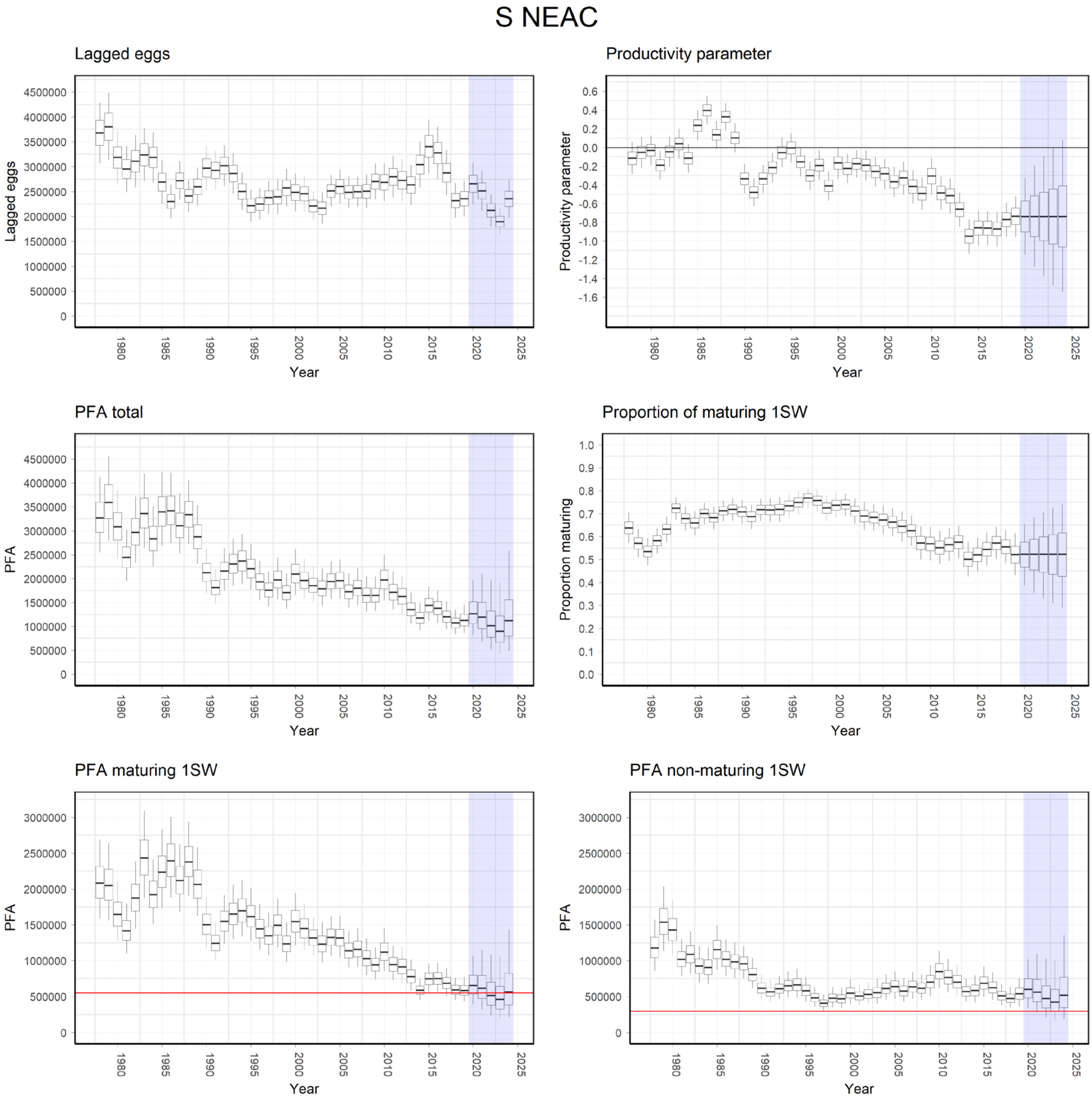

Figure 11 Southern NEAC: lagged eggs (in thousands) from 1SW and MSW spawners combined, productivity parameter from eggs to PFA, total PFA, proportion of maturing 1SW spawners, and PFA of maturing and non-maturing stocks for PFA years 1978 to 2024. For PFAs, the proportion of maturing fish and productivity parameter for the last five years (2020 to 2024) are forecasts (as indi-cated by the blue shaded region). The horizontal lines in the bottom panels are the age-specific SER values. Box and whiskers plots show the 5th, 25th, 50th, 75th, and 95th Bayesian credible intervals (BCIs).

Table 7 Probabilities (in %) of Northern and Southern NEAC 1SW and MSW stock complexes achieving their SERs both independently and simultaneously for different catch options for the Faroes fishery in the 2021/2022 to 2023/2024 fishing seasons (assuming full catch allocations are taken). Cells shaded yellow denote attainment of SERs with ≥ 95% probability.

Catch options season	TAC option (t)	NEAC-N-1SW (%)	NEAC-N-MSW (%)	NEAC-S-1SW (%)	NEAC-S-MSW (%)	All complexes simultaneously (%)
2021/22	0	94	99	45	94	40
	20	94	98	44	92	38
	40	94	94	43	89	36
	60	94	87	42	87	32
	80	94	78	42	84	28
	100	94	67	41	81	23
	120	93	56	40	78	19
	140	93	46	40	75	15
	160	93	37	39	71	11
	180	93	29	38	68	9
	200	93	23	38	64	7
2022/23	0	91	98	36	84	30
	20	91	94	35	80	28
	40	90	89	35	77	25
	60	90	81	34	73	22
	80	90	72	34	69	19
	100	90	63	33	66	15
	120	90	53	32	62	13
	140	90	45	32	58	10
	160	90	37	31	55	8
	180	90	31	31	51	6
	200	90	25	30	48	5
2023/24	0	87	96	52	75	37
	20	87	91	52	71	34
	40	87	85	51	67	30
	60	87	77	51	63	26
	80	87	67	50	59	22
	100	86	59	50	56	18
	120	86	51	49	52	15
	140	86	43	49	49	12
	160	86	36	48	45	10
	180	86	30	47	42	8
	200	86	26	47	39	6

Table 8 Forecast exploitation rates (in %) for 1SW and MSW salmon from Northern and Southern NEAC areas in all fisheries for different TAC options in the Faroes fishery in the 2021/2022 to 2023/2024 fishing seasons (assuming catch allocations are fully taken).

Catch options season	TAC option(t)	NEAC-N-1SW (%)	NEAC-N-MSW (%)	NEAC-S-1SW (%)	NEAC-S-MSW (%)	All complexes simultaneously (%)
2021/22	0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.8	0.1	0.3	0.0
	40	0.0	1.6	0.1	0.6	0.0
	60	0.0	2.4	0.2	0.9	0.0
	80	0.1	3.1	0.3	1.2	0.1
	100	0.1	3.9	0.3	1.5	0.1
	120	0.1	4.7	0.4	1.7	0.1
	140	0.1	5.5	0.5	2.0	0.1
	160	0.1	6.3	0.6	2.3	0.1
	180	0.1	7.1	0.6	2.6	0.1
	200	0.1	7.9	0.7	2.9	0.1
2022/23	0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.8	0.1	0.4	0.0
	40	0.0	1.6	0.2	0.7	0.0
	60	0.0	2.4	0.2	1.0	0.0
	80	0.1	3.2	0.3	1.4	0.1
	100	0.1	4.0	0.4	1.7	0.1
	120	0.1	4.8	0.5	2.1	0.1
	140	0.1	5.6	0.5	2.4	0.1
	160	0.1	6.4	0.6	2.8	0.1
	180	0.1	7.2	0.7	3.1	0.1
	200	0.1	8.0	0.8	3.5	0.1
2023/24	0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.8	0.1	0.4	0.0
	40	0.0	1.7	0.1	0.8	0.0
	60	0.0	2.5	0.2	1.2	0.0
	80	0.1	3.3	0.3	1.6	0.1
	100	0.1	4.1	0.3	2.0	0.1
	120	0.1	5.0	0.4	2.3	0.1
	140	0.1	5.8	0.4	2.7	0.1
	160	0.1	6.6	0.5	3.1	0.1
	180	0.1	7.4	0.6	3.5	0.1
	200	0.2	8.3	0.6	3.9	0.2

Table 9 Probability (in %) of national NEAC 1SW stock complexes achieving their SERs (in numbers) both individually and simultaneously for different catch options (in tonnes) for the Faroes fishery in the 2021/2022 to 2023/2024 fishing seasons. Cells shaded yellow denote attainment of SERs with ≥ 95% probability. MUs are management units.

Catch options season	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	UK (Scotland)	UK (N. Ireland)	Ireland	UK (England & Wales)	France	All 1SW MUs simultan-eously
SER		79291	18174	68831	2235	26761	130514	42587	269026	68682	22471	
2021/22	0	28%	38%	97%	82%	74%	70%	30%	25%	22%	40%	0.0%
	20	28%	38%	97%	82%	74%	69%	30%	25%	22%	40%	0.0%
	40	28%	38%	97%	82%	73%	69%	30%	24%	22%	40%	0.0%
	60	28%	38%	97%	82%	73%	68%	29%	24%	21%	40%	0.0%
	80	28%	38%	97%	82%	73%	67%	29%	24%	21%	40%	0.0%
	100	28%	37%	97%	81%	73%	67%	29%	24%	21%	40%	0.0%
	120	28%	37%	97%	81%	72%	66%	29%	24%	21%	39%	0.0%
	140	27%	37%	97%	81%	72%	65%	29%	23%	21%	39%	0.0%
	160	27%	37%	97%	81%	72%	65%	28%	23%	21%	39%	0.0%
	180	27%	37%	97%	81%	72%	64%	28%	23%	21%	39%	0.0%
	200	27%	37%	97%	81%	71%	63%	28%	23%	20%	39%	0.0%
2022/23	0	27%	33%	95%	84%	66%	63%	25%	24%	23%	28%	0.0%
	20	27%	33%	95%	84%	65%	63%	25%	24%	23%	28%	0.0%
	40	27%	33%	95%	84%	65%	62%	24%	24%	23%	28%	0.0%
	60	27%	33%	95%	84%	65%	61%	24%	23%	22%	28%	0.0%
	80	27%	33%	94%	84%	65%	61%	24%	23%	22%	28%	0.0%
	100	27%	33%	94%	84%	64%	60%	24%	23%	22%	28%	0.0%
	120	26%	33%	94%	84%	64%	60%	24%	23%	22%	28%	0.0%
	140	26%	33%	94%	84%	64%	59%	23%	23%	22%	28%	0.0%
	160	26%	32%	94%	84%	64%	58%	23%	22%	22%	27%	0.0%
	180	26%	32%	94%	84%	63%	58%	23%	22%	21%	27%	0.0%
	200	26%	32%	94%	84%	63%	57%	23%	22%	21%	27%	0.0%
2023/24	0	37%	29%	92%	83%	55%	68%	34%	32%	34%	32%	0.1%
	20	37%	28%	92%	83%	54%	67%	33%	32%	34%	32%	0.0%
	40	36%	28%	92%	83%	54%	67%	33%	32%	34%	32%	0.0%
	60	36%	28%	92%	83%	54%	66%	33%	32%	33%	32%	0.0%
	80	36%	28%	92%	83%	54%	66%	33%	31%	33%	32%	0.0%
	100	36%	28%	92%	83%	54%	65%	32%	31%	33%	31%	0.0%
	120	36%	28%	91%	83%	53%	65%	32%	31%	33%	31%	0.0%
	140	36%	28%	91%	83%	53%	64%	32%	31%	33%	31%	0.0%
	160	36%	28%	91%	83%	53%	64%	32%	31%	33%	31%	0.0%
	180	36%	28%	91%	83%	53%	63%	31%	31%	32%	31%	0.0%
	200	35%	28%	91%	82%	52%	63%	31%	30%	32%	31%	0.0%

Table 10 Probability (%) of national NEAC MSW stock complexes achieving their SERs (in numbers) both individually and simultaneously for different catch options (in tonnes) for the Faroes fishery in the 2021/2022 to 2023/2024 fishing seasons. Cells shaded yellow denote attainment of SERs with ≥ 95% probability. MUs are management units.

Catch options season	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	UK (Scotland)	UK (N. Ireland)	Ireland	UK (England & Wales)	France	All MSW MUs simultaneously
SER		61918	16365	123036	4735	5988	143293	10316	78294	51423	9451	
2021/22	0	62%	40%	99%	96%	93%	89%	20%	24%	97%	57%	0.5%
	20	47%	32%	98%	94%	90%	87%	19%	23%	96%	56%	0.3%
	40	34%	26%	95%	92%	87%	85%	18%	22%	95%	54%	0.1%
	60	24%	21%	92%	89%	83%	82%	18%	22%	94%	52%	0.0%
	80	17%	17%	87%	87%	80%	79%	17%	21%	93%	51%	0.0%
	100	12%	14%	81%	84%	76%	76%	16%	20%	91%	49%	0.0%
	120	8%	11%	75%	81%	73%	73%	16%	20%	90%	48%	0.0%
	140	6%	9%	68%	79%	69%	70%	15%	19%	89%	46%	0.0%
	160	4%	8%	61%	76%	66%	67%	15%	19%	87%	45%	0.0%
	180	3%	7%	55%	74%	62%	64%	14%	18%	86%	44%	0.0%
	200	2%	6%	48%	71%	59%	61%	14%	18%	84%	43%	0.0%
2022/23	0	43%	41%	98%	95%	87%	78%	18%	22%	94%	64%	0.2%
	20	31%	34%	96%	93%	83%	74%	18%	21%	92%	63%	0.1%
	40	21%	28%	93%	91%	80%	71%	17%	21%	91%	62%	0.0%
	60	15%	24%	89%	89%	76%	67%	16%	20%	90%	60%	0.0%
	80	10%	20%	85%	87%	72%	64%	16%	20%	89%	59%	0.0%
	100	7%	17%	80%	84%	69%	60%	15%	19%	87%	58%	0.0%
	120	5%	15%	74%	82%	65%	57%	15%	19%	86%	57%	0.0%
	140	4%	13%	68%	80%	62%	53%	15%	18%	84%	55%	0.0%
	160	3%	11%	63%	78%	59%	50%	14%	18%	83%	54%	0.0%
	180	2%	10%	57%	76%	56%	47%	14%	18%	81%	53%	0.0%
	200	1%	8%	52%	73%	53%	43%	13%	17%	80%	52%	0.0%
2023/24	0	40%	36%	97%	95%	81%	70%	17%	22%	90%	49%	0.1%
	20	29%	30%	94%	94%	77%	66%	16%	22%	89%	48%	0.0%
	40	21%	25%	90%	92%	73%	63%	16%	21%	87%	47%	0.0%
	60	15%	21%	85%	90%	70%	59%	15%	21%	86%	46%	0.0%
	80	11%	18%	80%	89%	66%	56%	15%	20%	84%	45%	0.0%
	100	8%	16%	75%	87%	63%	52%	14%	20%	82%	43%	0.0%
	120	6%	14%	70%	85%	60%	49%	14%	19%	81%	42%	0.0%
	140	4%	12%	65%	84%	57%	46%	13%	19%	79%	41%	0.0%
	160	3%	11%	59%	82%	54%	43%	13%	19%	77%	40%	0.0%
	180	3%	10%	54%	81%	51%	40%	13%	18%	76%	39%	0.0%
	200	2%	8%	49%	79%	48%	37%	13%	18%	74%	38%	0.0%

NASCO 2.5 Update the Framework of Indicators used to identify any significant change in the previously provided multiannual management advice

The Framework of Indicators (FWI) previously used in support of multiannual catch options was updated in 2021. In 2018, the FWI was revised such that only stock complexes that would be appropriate to changing the multiyear advice were included; i.e. those stock complexes which had predicated the zero catch option for the Faroes when catch advice was last provided (ICES, 2016). As future catch advice could be determined by the status of stocks in any of the four stock complexes, indicators for each of these have been retained in the FWI in 2020. All existing indicators were updated and examined to see if they still met the criteria for inclusion in the framework (ICES, 2012).

Assuming a new multiannual agreement is confirmed, the updated FWI has been structured such that it could be applied for the next two years, in January 2022 and 2023, based on new indicator values for 2021 and 2022, respectively. The updated FWI will be made available to NASCO to enable the organization to facilitate intermediate assessments in 2022 and 2023 in order to determine whether new catch advice might be required. The FWI will then need to be updated and a new three-year cycle started in 2024 (Figure 12).

FWI NEAC	2022	Indicators suggest:	REASSESS

Indicators for Northern NEAC 1SW PFA

	Insert data from 2021 here	N reg	Slope	Intercept	r^2	Median PFA in 2021	12.5%ile	87.5%ile	Reassess in year 2022? Outside 75% conf.lim. below	above	Outside 75% confidence limits below	above
1 Returns all 1SW NO PFA est		37	0.514780	-27673.84	0.92	371561	111272.56	215924.28	0	0	Uninformative	Uninformative
2 Survivals W 1SW NO Imsa		37	0.000011	-2.55	0.47	371561	-2.48	5.45	0	0	Uninformative	Uninformative
3 Survivals H 1SW NO Imsa		38	0.000005	-0.43	0.31	371561	-1.17	4.31	0	0	Uninformative	Uninformative
4 Counts all Akujoki (1SW)		18	0.000151	-16.38	0.38	371561	2.77	76.58	0	0	Uninformative	Uninformative
5 Counts all NO Nausta (1SW)		23	0.001608	302.93	0.22	371561	49.48	1751.08	0	0	Uninformative	Uninformative
6 Catch rT&N 1SW FI		22	0.0168897	-672.3621	0.51	371561	-2565.78	13772.15	0	0	Uninformative	Uninformative
							Sum of scores		0	0	Indicators suggest that the PFA forecast is an overestimation.	Indicators suggest that the PFA forecast is an underestimation. REASSESS

Indicators for Northern NEAC MSW PFA

	Insert data from 2021 here	N reg	Slope	Intercept	r^2	Median PFA in 2021	12.5%ile	87.5%ile	Reassess in year 2022? Outside 75% conf.lim. below	above	Outside 75% conf.lim. below	above
1 PFA-MSW-CoastNorway		37	0.328645	17743.77	0.79	521052	148154.03	229815.63	0	0	Uninformative	Uninformative
2 Orkla counts		17	0.013480	-3420.75	0.55	521052	1593.48	5612.91	0	0	Uninformative	Uninformative
3 Counts all NO Nausta		23	0.003829	-1199.20	0.33	521052	5.92	1585.55	0	0	Uninformative	Uninformative
4 Returns all 2SW NO PFA est		27	0.2051312	37948.148	0.31	521052	69947.74	219716.58	0	0	Uninformative	Uninformative
5 Catch W rT&N 2SW FI		22	0.0080952	-2358.398	0.36	521052	-571.96	4291.25	0	0	Uninformative	Uninformative
							Sum of scores		0	0	Indicators suggest that the PFA forecast is an overestimation.	Indicators suggest that the PFA forecast is an underestimation. REASSESS

Indicators for Southern NEAC 1SW PFA

	Insert data from 2021 here	N reg	Slope	Intercept	r^2	Median PFA in 2021	12.5%ile	87.5%ile	Reassess in year 2022? Outside 75% conf.lim. below	above	Outside 75% conf.lim. below	above
1 Ret. 1SW UK(E&W) Tamar M		27	0.001914	1101.95	0.31	616416	998.67	3564.69	0	0	Uninformative	Uninformative
2 Ret. W 1SW UK(E&W) Frome M		48	0.000534	-78.84	0.43	616416	-251.66	752.60	0	0	Uninformative	Uninformative
3 Ret. W 1SW UK(Sc.) North Esk M		40	0.006883	2807.30	0.68	616416	3877.19	10223.23	0	0	Uninformative	Uninformative
4 Surv. W 1SW UK(NI) Bush M		32	1.945E-05	-9.699526	0.64	616416	-6.22	10.80	0	0	Uninformative	Uninformative
5 Ret. Freshw 1SW UK(NI) Bush		46	0.000649	433.07	0.29	616416	73.98	1592.24	0	0	Uninformative	Uninformative
6 Ret. W 1SW UK(E&W) Dee M		29	0.0036297	-1008.336	0.58	616416	-193.60	2651.74	0	0	Uninformative	Uninformative
7 Count 1SW UK(E&W) Fowey M		26	0.0004136	171.28444	0.30	616416	155	698	0	0	Uninformative	Uninformative
8 Surv. 1SW UK(E&W) Frome		17	4.424E-06	0.2044226	0.32	616416	1	5	0	0	Uninformative	Uninformative
9 Surv coast 1SW UK(E&W) Dee M		24	2.984E-06	-0.319153	0.35	616416	-0.33	3.37	0	0	Uninformative	Uninformative
							Sum of scores		0	0	Indicators suggest that the PFA forecast is an overestimation.	Indicators suggest that the PFA forecast is an underestimation. REASSESS

Indicators for Southern NEAC MSW PFA

	Insert data from 2021 here	N reg	Slope	Intercept	r^2	Median PFA in 2021	12.5%ile	87.5%ile	Reassess in year 2022? Outside 75% conf.lim. below	above	Outside 75% conf.lim. below	above	
1 Ret. W 2SW UK(Sc.) Baddoch NM		33	0.000060	-12.15	0.37	565441	7.76	36.00	0	0	Uninformative	Uninformative	
2 Ret. W 2SW UK(Sc.) Girnoch NM		49	0.000049	2.19	0.40	565441	0.39	59.17	0	0	Uninformative	Uninformative	
3 Ret. W MSW UK(E&W) Itchen NM		33	0.000307	-63.78	0.26	565441	16.49	202.63	0	0	Uninformative	Uninformative	
4 Ret. W 1SW UK(E&W) Itchen NM		32	0.001016	-289.72	0.41	565441	83.41	485.80	0	0	Uninformative	Uninformative	NB use 2020 data
5 Ret. W MSW UK(E&W) Frome NM		48	0.000847	74.39	0.31	565441	-12.74	1119.57	0	0	Uninformative	Uninformative	
6 Ret. W 1SW UK(E&W) Frome NM		47	0.000741	154.34	0.22	565441	-6.85	1154.04	0	0	Uninformative	Uninformative	NB use 2020 data
7 Catch W MSW Ice Ellidaar NM		49	0.000120	-33.32	0.53	565441	-21.11	90.63	0	0	Uninformative	Uninformative	
8 Ret W 1SW UK(Sc.) North Esk NM		39	0.011622	4214	0.25	565441	5949	15622	0	0	Uninformative	Uninformative	NB use 2020 data
9 Ret. W 2SW UK(Sc.) North Esk NM		40	0.0089909	948.40233	0.53	565441	3598.83	8465.63	0	0	Uninformative	Uninformative	
							Sum of scores		0	0	Indicators suggest that the PFA forecast is an overestimation.	Indicators suggest that the PFA forecast is an underestimation. REASSESS	

Figure 12 Framework of indicators (FWI) spreadsheet for the Faroes fishery. The Northern NEAC stock complexes are shaded out since only the two Southern NEAC stock complexes are currently determining the outcome of the FWI. The Northern NEAC stock complexes are still retained in the spreadsheet because they may influence the advice in future.

Scientific basis

Table 11 The basis of the assessment.

ICES stock data category	1 (ICES 2021b)
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	Reported (i.e. 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 2021 (ICES, 2021c).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2021a)

Identify relevant data deficiencies, monitoring needs, and research requirements

A database is needed that lists individual PIT tag numbers or codes identifying the origin, source, or programme of the tags on a North Atlantic basin-wide scale. This is needed to facilitate identification of individual tagged fish taken in marine fisheries or surveys. Data on individual PIT tags used in Norway have now been compiled; however, there is a need for an ICES coordinated database where the data could be stored.

PIT tag users should be encouraged to include these tags or tagging programmes as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions.

The full list of data deficiencies, monitoring needs, and research requirements for North Atlantic salmon is presented in Section 1.4 of the sal.oth.nasco advice (ICES, 2021d).

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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(s) *conservation limit(s),* **i.e. S_{lim}**. 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 multiannual 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 *spawner 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*. The 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 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, 2021e) 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 (CLs) simultaneously in four regions (Labrador, Newfoundland, Quebec, and Gulf), as well as being above the management objectives for Scotia-Fundy and USA, 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 CLs, applied at the level of the European stock complexes (two areas and two age classes) and for the ten NEAC countries and two age classes. A Framework of Indicators (FWI) has been developed in support of the multiannual 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, its current distribution extends from the Lima River (41°69’) in northern Portugal to the Pechora River (68°20’) in Northwest Russia and west to Iceland (66°44’). Juveniles migrate to the ocean at the 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 take place, with adult salmon from the Northeast Atlantic stocks being exploited in waters near both Greenland and the Faroes.

Environmental and other influences 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 since 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 return rates.

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.
In 2020, some countries were affected by the COVID-19 global pandemic and had to modify the way return and spawner estimates were produced (e.g. UK [Scotland] using ‘expected-catch estimates’ to mitigate against an underestimate of abundance as a result of reduced effort due to COVID-19) or could not provide certain data for 2020, such as juvenile densities in UK (England and Wales). In UK (Scotland) the pandemic delayed the collection of fishery statistics in 2020, although these statistics were collated in time for ICES WGNAS. These data had not yet been officially published by the Scottish Government at the start of the 2021 WGNAS meeting. As an interim measure, 2019 catch statistics were provided

* Version 2: Section header corrected.

for publication in the WGNAS report. However, the 2020 data were used for stock assessment analyses within the run-reconstruction PFA and forecast models.

Atlantic salmon from North America

Summary of the advice for 2021 to 2024

ICES advises that, in line with the management objectives agreed by the North Atlantic Salmon Organization (NASCO) and consistent with the MSY approach, the catch of one-sea-winter (1SW) non-maturing salmon and two-sea-winter (2SW) salmon in mixed-stock fisheries in North America should be zero in the period 2021 to 2023. 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.

In the absence of any fishing on 1SW non-maturing salmon and 2SW salmon in North America, there is a less than 75% probability in the period 2021 to 2023 that the numbers of 2SW salmon returning to the six regions of North America will be above the defined management objectives (conservation limits [CLs] for the four northern areas; rebuilding objectives for the two southern areas) simultaneously for the six regions.

The Framework of Indicators (FWI) was updated in support of the multiyear catch advice and the potential approval of multiyear regulatory measures. The FWI can be applied at the beginning of 2022, using the returns or return rate data for 2021 to evaluate the appropriateness of the advice for 2022, and again at the beginning of 2023, using the returns or return rate data for 2022 to evaluate the appropriateness of the advice for 2023.

NASCO 3.1 Describe the key events of the 2020 fisheries (including the fishery at Saint Pierre and Miquelon)

The provisional reported (i.e. nominal) catch of Atlantic salmon in eastern North America in 2020 was estimated at 105.6 t, of which 103.9 t was reported from Canada, 1.7 t from France (Islands of Saint Pierre and Miquelon [SPM], 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 2020. The dramatic decline in catches 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 Quebec commercial fishery in 2000. All commercial fisheries for Atlantic salmon remained closed in Canada in 2020.

Unreported catch for Canada in 2020 was 27.1 t and for USA 0 t. France (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 2020: indigenous people, residents fishing for food in Labrador, and recreational fishers. No rivers in the Gulf and Scotia–Fundy regions of Canada were opened for retention recreational fisheries. Mandatory catch-and-release measures were in effect during the period 2015–2020 in the recreational fisheries for the Gulf region. Recreational fisheries regulations in Quebec limited the retention of small (< 63 cm, fork length) and large salmon to 20 of 114 rivers and the retention of small salmon only to 52 rivers. Eight rivers were opened to catch-and-release only, and 34 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 2020, 7% of the catches were taken in coastal areas, and these were entirely from Labrador. The catches from France (Saint Pierre and Miquelon) were entirely from coastal areas. Overall for eastern North America in 2020, 50% of the catches were in-river, 42% from estuaries, and 8% 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, respectively, 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 2020 recreational fisheries of Canada, 59 627 salmon (38 012 small and 21 615 large) were estimated to have been caught and released, representing about 72% of the total catch by number.

Table 1 Salmon catches and catch locations in the North American Commission (NAC) area in 2020. Catches of NAC-origin salmon at Greenland are reported in the West Greenland Commission area. Differences in sums and percentages are due to rounded values.

	Canada					St Pierre & Miquelon	USA	North America
	Commercial	Indigenous	Labrador resident	Recreational	Total			
2020 reported catches (t)	0	59	2	44	104	2	0	106
% of NAC total	0	56	2	42	98	2	0	100
Unreported catch (t)					27	na	0	27
Location of catches								
% in-river					51	0	-	50
% in estuaries					42	0	-	42
% coastal					7	100	-	8

Table 2 Total reported catches (in tonnes, round fresh weight) of salmon in home waters in North America for Canada (small salmon, large salmon, and total), USA, and France (Saint Pierre and Miquelon) from 1980 to 2020. The 2020 figures include provisional data.

Year	Canada			USA	St Pierre & Miquelon
	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

Year	Canada			USA	St Pierre & Miquelon
	Small salmon	Large salmon	Total		
2015	86	54	140	0	4
2016	79	56	135	0	5
2017	55	55	110	0	3
2018	39	39	79	0	1
2019	53	47	100	0	1
2020	55	49	104	0	2

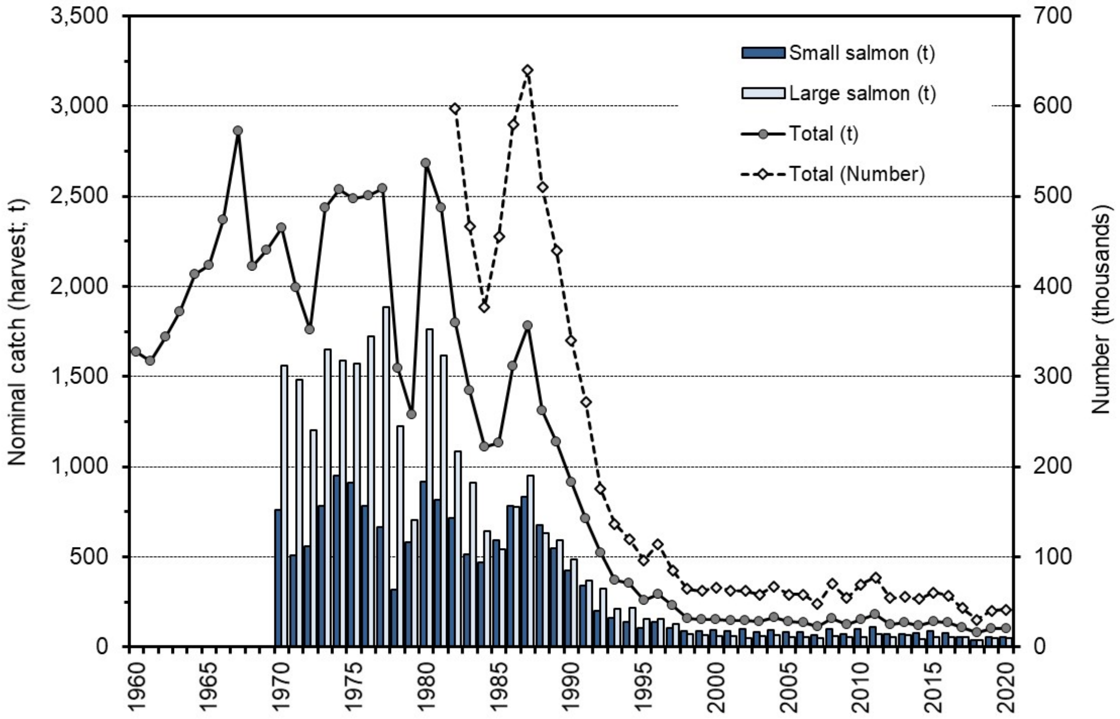

Figure 1 Reported catch (harvest; t and number in thousands) of small (< 63 cm) and large (≥ 63 cm) salmon in Canada (combined catches in USA and Saint Pierre and Miquelon are ≤ 6 t in any year) from 1960 to 2020.

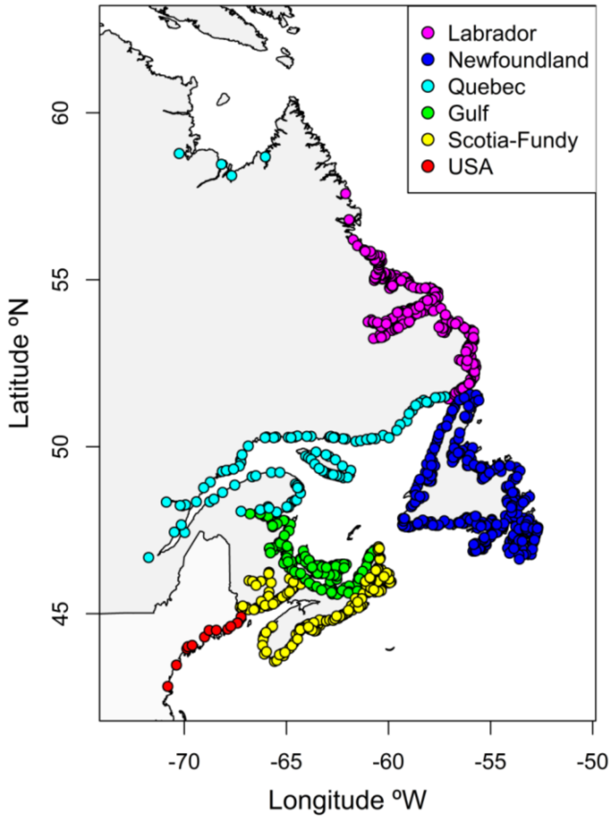

Figure 2 Assessment regions for salmon in the NAC area. Dots indicate locations of salmon rivers.

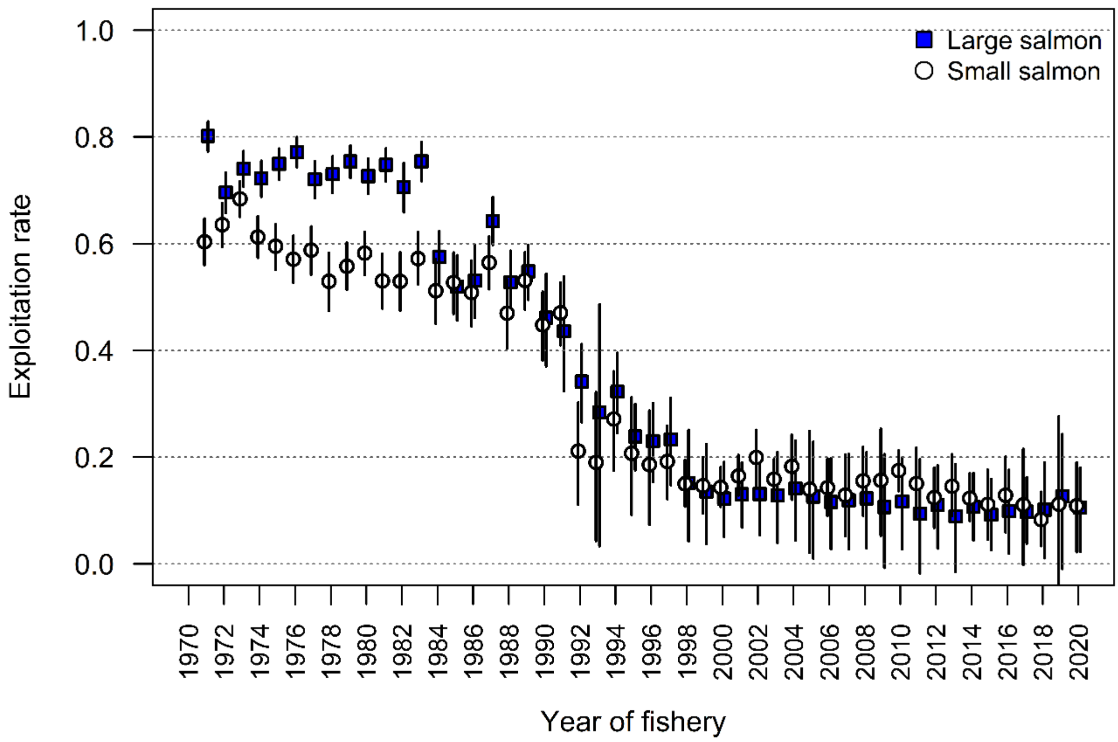

Figure 3 Exploitation rates in North America on small (1SW) and large (MSW and repeat spawners) salmon from 1971 to 2020.

Origin and composition of catches

In the past, salmon from both Canada and USA were taken in the commercial fisheries of eastern Canada. Sampling programmes of current marine fisheries (Labrador subsistence and Saint Pierre and Miquelon) 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). A single nucleotide polymorphism (SNP) panel range-wide baseline has been developed and has been used since 2018 to provide assignment of individual salmon to one of 21 North American or ten European reporting groups (Jeffery *et al.*, 2018; Figure 4). The accuracy of assignment in the SNP analyses was 90%. The origin of salmon in the mixed-stock fisheries has been previously reported for the Labrador subsistence fishery (Bradbury *et al.,* 2015; ICES, 2015, 2020) and for the SPM fishery (ICES, 2015, 2020; Bradbury *et al.,* 2016). The accuracy of assignment in these analyses was very high (94.5%). Assignment accuracy was tested using a leave-one-out cross validation method described in Anderson *et al.* (2008) which can yield essentially unbiased estimates of genetic stock identification accuracy, providing all populations in the mixture are accurately represented in the baseline.

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 these groups. However, these genetic reporting groups can be aligned to the assessment regions (Figure 4).

Assessment REGION	GENETIC REPORTING GROUP	GROUP ACRONYM
Quebec (North)	Ungava	UNG
Labrador	Labrador Central	LAC
	Lake Melville	MEL
	Labrador South	LAS
Quebec	St Lawrence North	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 &	SJR
Newfoundland	Northern	NNF
	Western	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	BRI
	Barents-White Seas	BAR
	Baltic Sea	BAL
	Southern Norway	SNO
	Northern Norway	NNO
	Iceland	ICE
	Greenland	GL

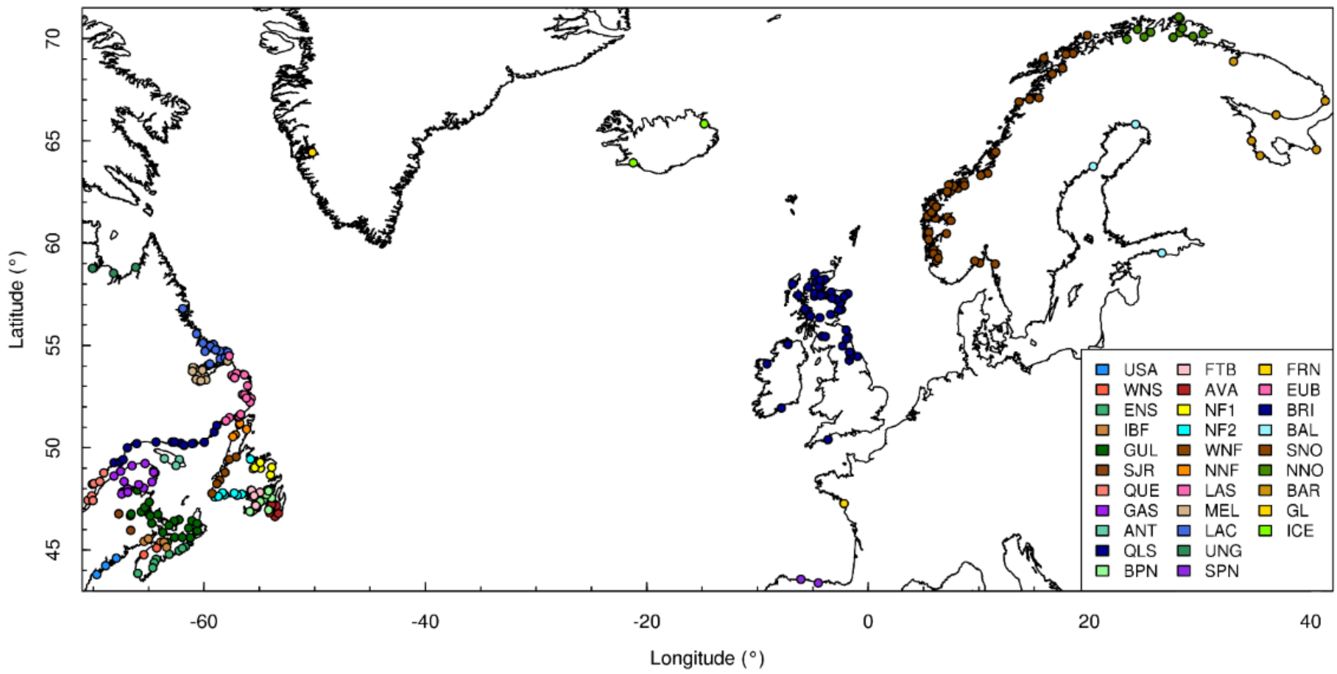

Figure 4 Map of sample locations used in the range-wide genetic baseline (single nucleotide polymorphisms [SNPs]) for Atlantic salmon. The SNP provided assignment of individual salmon to 21 North America and ten European genetic reporting groups (labelled and identified by colour) and correspondence 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 2020, 741 tissue samples from the Labrador subsistence salmon fisheries were analysed using the SNP panel (9.2% of the catch by number for the coastal area fisheries). Emphasis was placed on genotyping samples from the coastal areas (Northern Labrador Salmon Fishing Area [SFA] 1A, and Southern Labrador SFA 2). In these areas, interception of non-local stocks has been more prevalent in the past at the exclusion of samples from the estuarine portion of Labrador located in Lake Melville (SFA 1B) for which the catches were almost exclusively assigned to that area. As in previous years, the estimated origin of the samples was dominated (> 98%) by the Labrador reporting groups. The dominance of these groups is consistent with previous analyses conducted for the period 2006–2019, which estimated > 95.0% of the catch was attributable to Labrador stocks (ICES, 2019, 2020). Furthermore, assignment of catches within the two coastal Labrador genetic reporting groups (Labrador Central and Labrador South) suggests a largely local catch within salmon fishing areas (Figure 5).

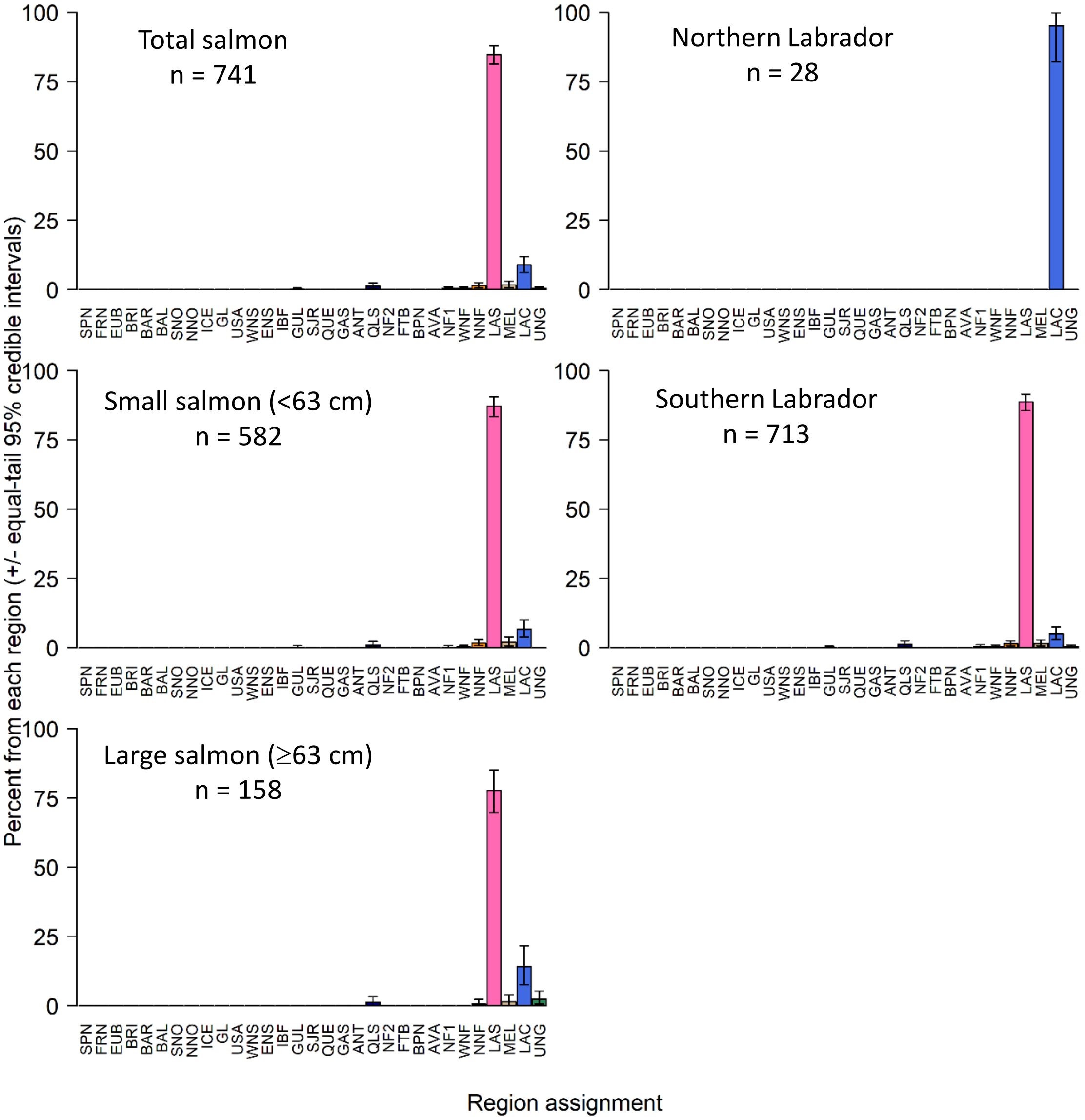

Figure 5 Percentages of Labrador subsistence fishery samples by size group and by Labrador SFA (Northern Labrador = SFA 1A; Southern Labrador = SFA 2), assigned using SNPs to regional reporting groups of the North Atlantic for the 2020 fishery year. The colours used for the bars and match those used in Figure 4.

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

Regional analysis using the SNP panel applied to tissue samples from the fishery at SPM showed the consistent dominance (83–89%) of three genetic reporting groups – southern Gulf of St Lawrence, Gaspe Peninsula, and Newfoundland – consistent with previous studies (Bradbury *et al.,* 2016; ICES, 2018, 2020). A total of 116 samples were collected from the SPM salmon fishery in 2020. The samples were representative of the reported catch by size class (60.7% small salmon and 39.3% large salmon, by weight). Due to the extraordinary circumstance in 2020 associated with COVID-19, the samples were not received in time for genetic analyses. These samples will be analysed and reported with the 2021 samples.

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 in terms of 2SW CLs have been defined for all six areas in North America (MFFP, 2016; DFO, 2018; ICES, 2020). No changes to the 2SW CLs or the management objectives were made from those identified previously (ICES, 2020).

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 2020.

Country and Commission area	Assessment regional group	2SW conservation limit (number of fish)	2SW management objective (number of fish)
Canada	Labrador	34746	
	Newfoundland	4022	
	Quebec	32085	
	Southern Gulf of St Lawrence	18737	
	Scotia–Fundy	24705	10976
	Total	114295	
USA		29199	4549
North American Commission		143494	

In Canada, 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 6). CLs have been established for 33 river stocks in USA since 1995 (Figure 6).

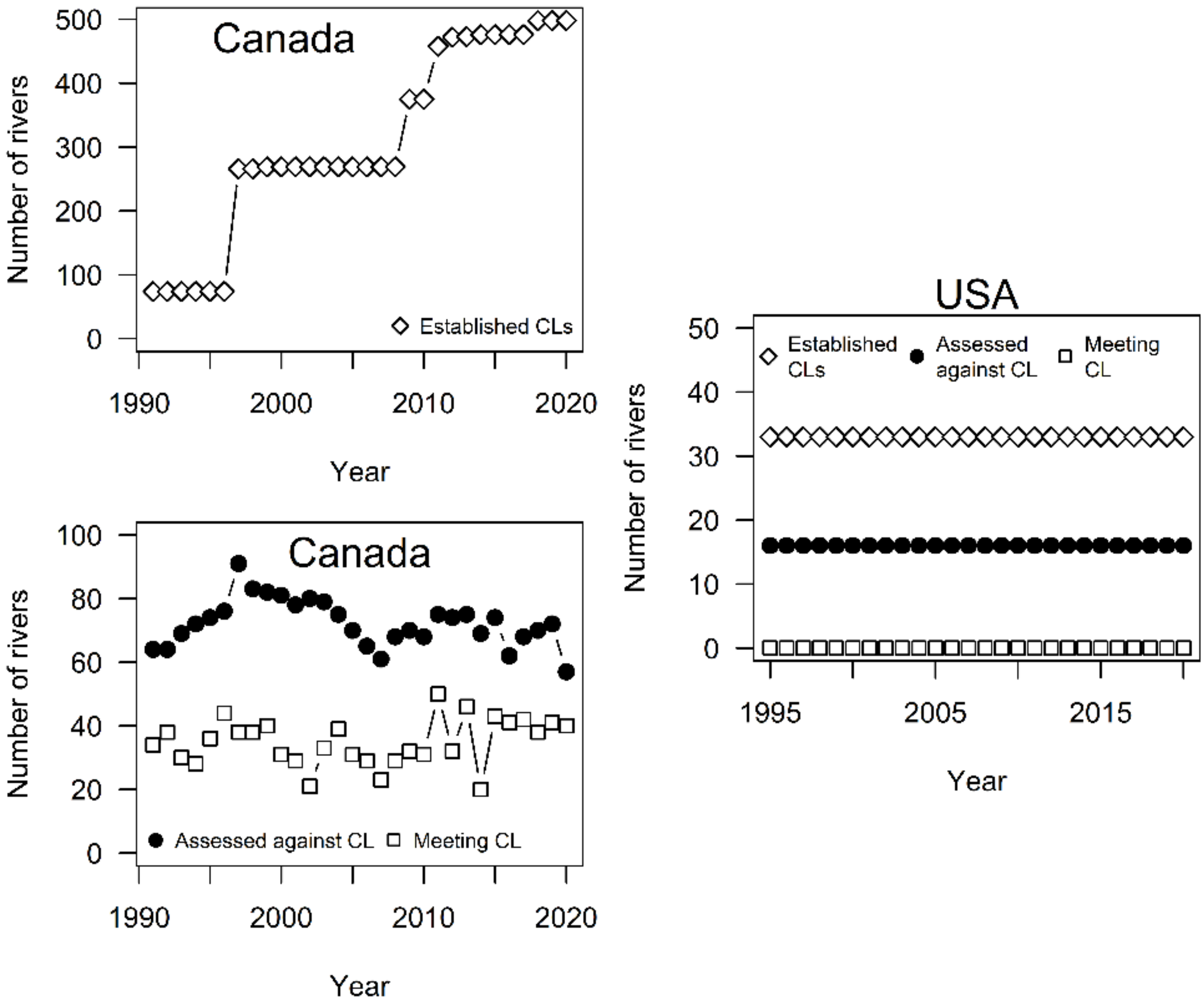

Figure 6 Time-series for Canada and USA showing the number of rivers with established CLs, the number of rivers assessed, and the number of assessed rivers meeting CLs for the period 1991 to 2020. Further details can be found in ICES (2021a).

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 in 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 each geographic region, including fish caught by home water commercial fisheries. Two exceptions are 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 three-sea-winter [3SW] and repeat spawners), is the estimated number of salmon in the North Atlantic on 1 August of the second summer at sea. Estimates of pre-fishery abundance (PFA) account for returns to rivers, fisheries at sea in North America, and fisheries at West Greenland and are corrected for natural mortality. Catches of North American-origin salmon in the fishery at the 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 2019. 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 estimated returns of small salmon to North America in 2020 was 456 100 (Figure 7). For the previous five years 2015 to 2019, small salmon returns to Labrador (197 900) and Newfoundland (202 400) combined represented 88% of the total small salmon returns to North America

The total estimate of returns of large salmon to North America in 2020 was 155 600 (Figure 7). Large salmon returns in 2020 increased from the previous year in the assessed regions of Labrador (69%), Quebec (27%), and USA (30%).

The total estimate of 2SW salmon returns (subset of returns of large salmon) to North America in 2020 was 94 700. Returns of 2SW salmon in 2020 increased from the previous year in the assessed regions of Labrador (69%), Quebec (27%), and USA (28%). For the previous five years, 2015 to 2019, 2SW salmon returns to Labrador (29 700), Quebec (28 300), and Gulf (31 200) combined represented 94% of the total estimated 2SW salmon returns to North America. There are few 2SW salmon returns to Newfoundland as the majority of the large salmon returns to that region are composed of previously spawned 1SW salmon.

In 2020, the estimates (median) of 2SW salmon returns to rivers and spawners were below CLs (suffering reduced reproductive capacity) all the assessment regions except the Gulf; for spawners ranging from 10% in Scotia-Fundy to 161% in Gulf (Figure 10). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the Scotia–Fundy and USA regions. The status of the Gulf region was assessed using the previous 5 year-mean as a proxy for the unavailable 2020 input data. It is not expected that this has caused the substantial increase in the returns and spawners to this region in 2020 compared to the previous year. The increase appears to be a true reflection of the increased escapement in the region, which was also mirrored to a degree in the adjacent areas Quebec, Labrador, and Newfoundland in 2020 relative to 2019.

River-specific assessments are provided for 73 rivers in 2020 for NAC. Egg depositions by all sea ages combined in 2020 exceeded or equalled the river-specific CLs in 40 of the 73 assessed rivers (55%) and were less than half of CLs in 23 rivers (32% [Figure 11]). The number of rivers in Canada assessed annually has ranged from 57 to 91, and the annual percentages of these rivers achieving CLs has ranged from 26% to 67% (70% in 2020) with no temporal trend (Figure 6). Sixteen rivers in USA are assessed against CL attainment annually, with none meeting CLs to date (Figure 6).

Estimates of PFA (defined as the number of maturing and non-maturing 1SW salmon) suggest continued low abundance of North American salmon (Figure 9). 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 1992 to 2019, the average PFA was 615 500 fish, less than half of the average abundance (1 252 600 fish) during the period 1971 to 1991. PFA of maturing and non-maturing 1SW salmon in 2019, the most recent available value, was estimated at 562 400 fish. Abundance declined by 66% over the time-series, from a peak of 1 704 000 fish in 1975 (Figure 12).

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 either been listed or are being considered for listing under country-specific species at risk legislation. The continued low and declining abundance of salmon stocks across North America, 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 Atlantic salmon. Declines in smolt production in some rivers of eastern North America are now being observed and are also contributing to lower adult abundance.

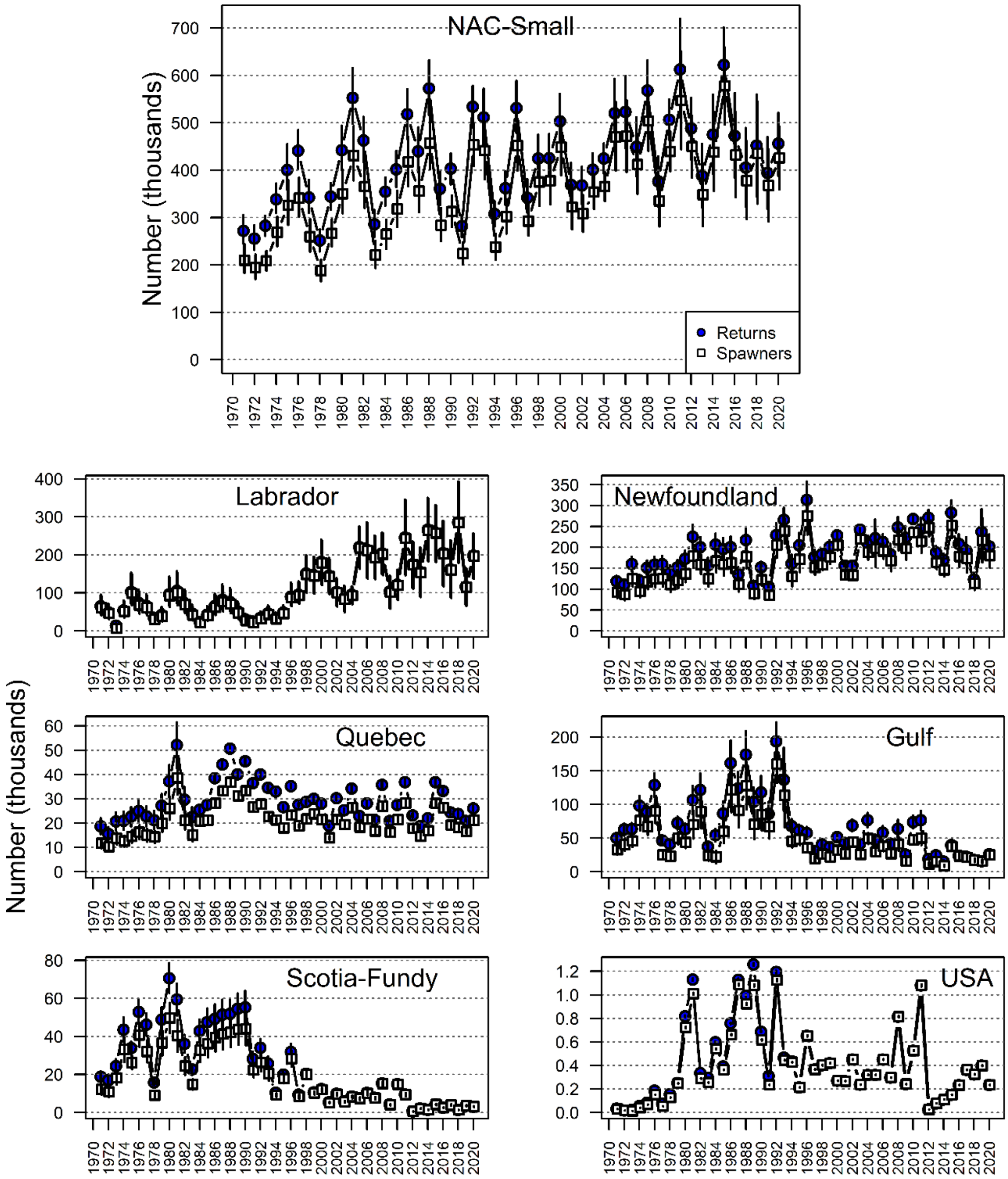

Figure 7 Estimated (median, 5th to 95th percentile range) returns (shaded circles), and spawners (open squares) of small salmon (primarily 1SW) for eastern North America overall (top panel) and for each of the six regions in 1971 to 2020.

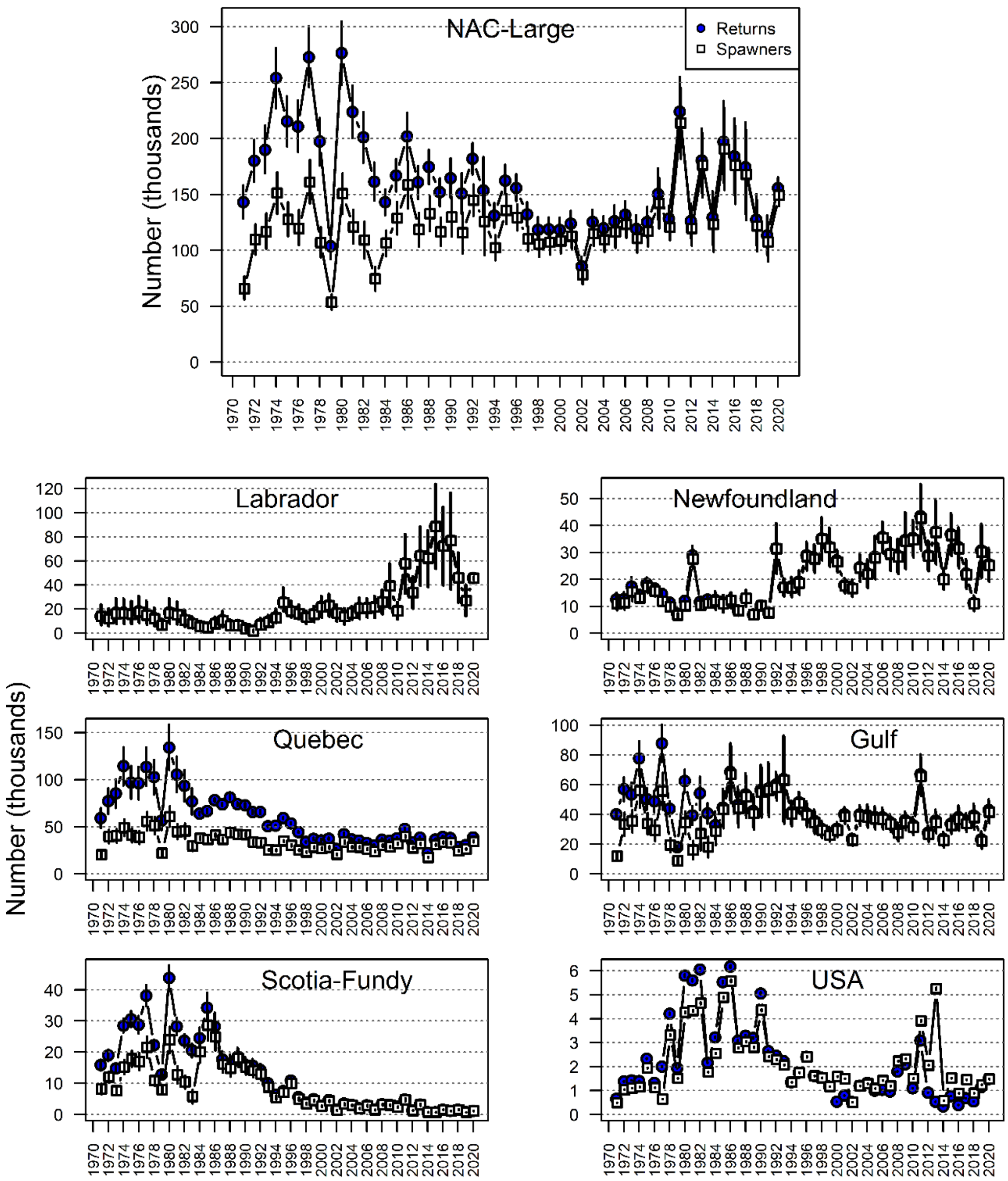

Figure 8 Estimated (median, 5th to 95th percentile range) returns (shaded circles), and spawners (open squares) of large salmon (primarily MSW and repeat spawners) for eastern North America overall (top panel) and for each of the six regions in 1971 to 2020.

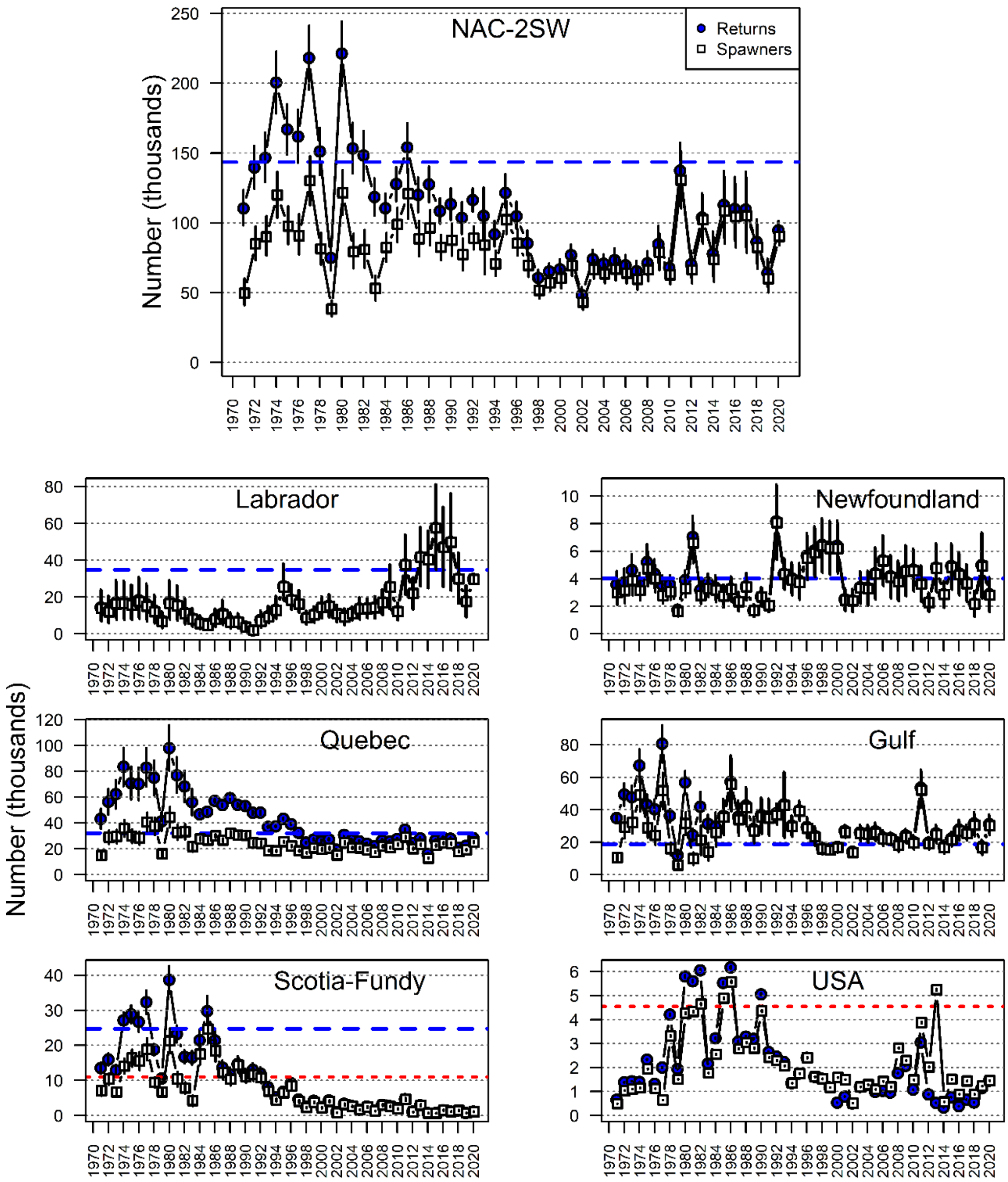

Figure 9 Estimated (median, 5th to 95th percentile range) returns (shaded circles), and spawners (open squares) of 2SW salmon for eastern North America overall (top panel) and for each of the six regions in 1971 to 2020. The blue dashed lines are the corresponding 2SW CLs; the 2SW CL (29 199 fish) is off scale in the plot for USA. The red 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.

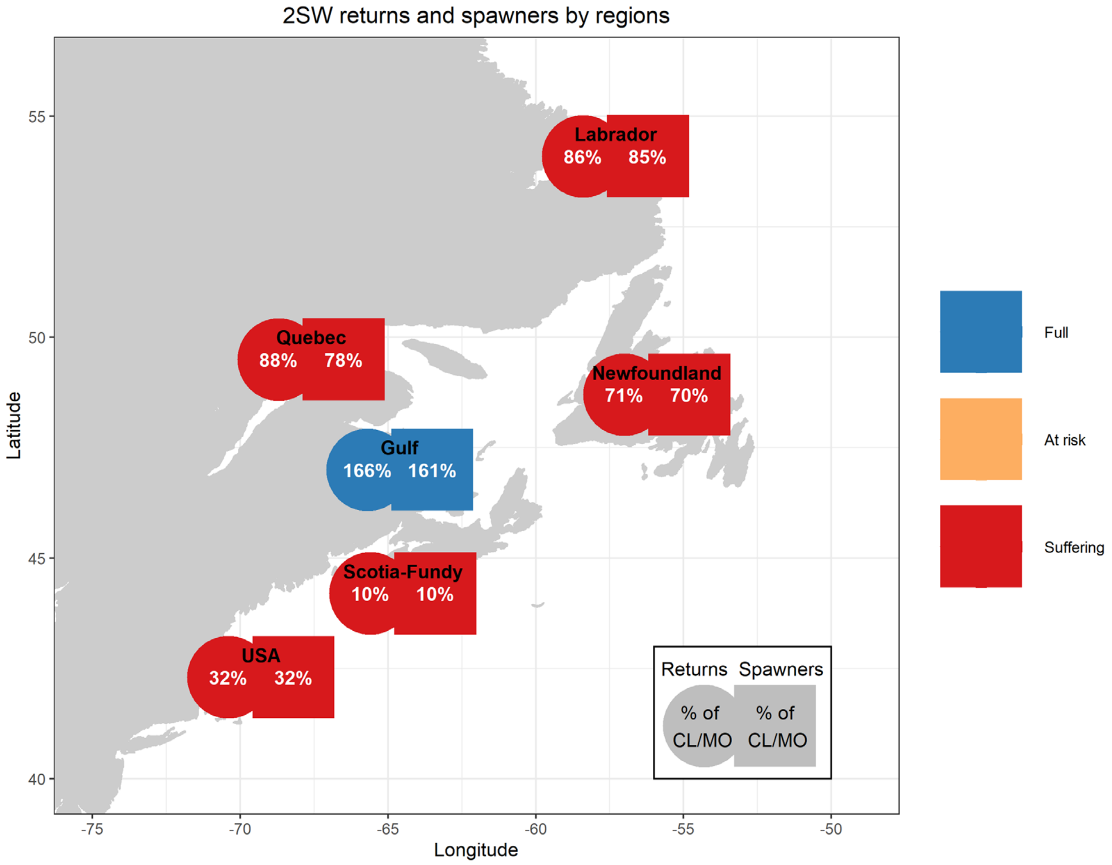

Figure 10 Estimated returns (circle symbol) and spawners (square symbol) of 2SW salmon in 2020 to six regions of North America relative to the stock status categories. The percentage of the 2SW CLs for the four northern regions and to the rebuilding management objectives (MO) for the two southern areas are shown based on the median of the Monte Carlo distribution. The blue shading refers to the stock being at full reproductive capacity (the median and 5th percentile of the Monte Carlo distributions are above the CL), the orange shading refers to the stock being at risk of suffering reduced reproductive capacity (the median is above but 5th percentile below the CL), and the red shading refers to the stock suffering reduced reproductive capacity (the median is below the CL).

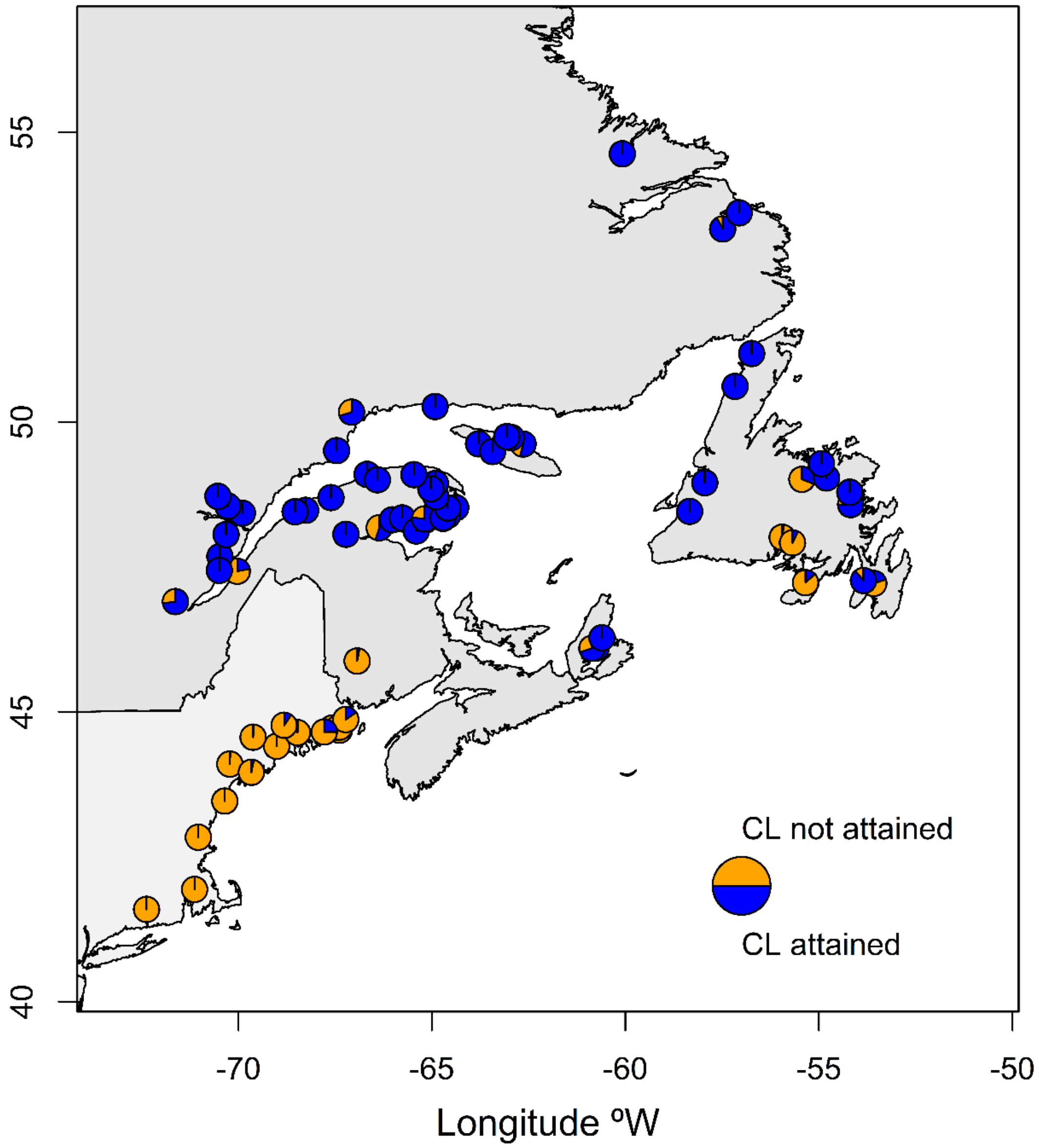

Figure 11 Degree of attainment for the river-specific conservation limit (CL) egg requirement in the 73 rivers of the North American Commission area assessed in 2020. One river in the USA is not shown because it was partially assessed, but it is considered not to have attained CL in 2020.

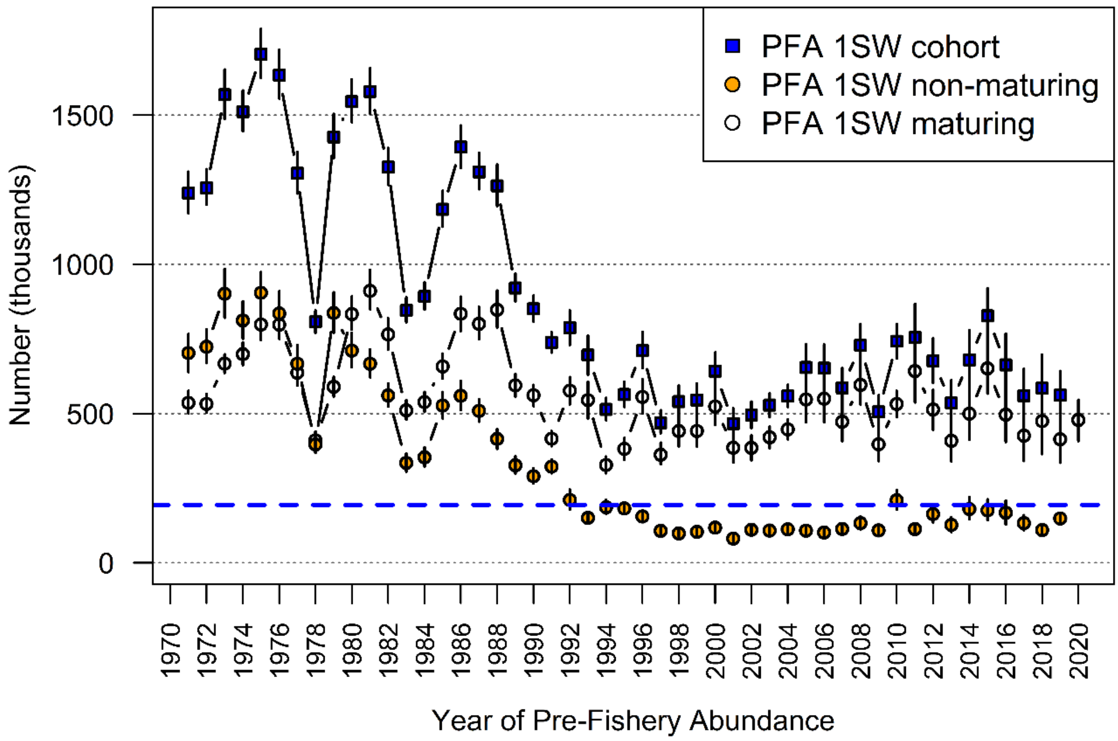

Figure 12 Estimated (median, 5th to 95th percentile range) pre-fishery abundance (PFA) for 1SW maturing, 1SW non-maturing, and total cohort of 1SW salmon for North America for the 1971 to 2020 PFA years. The horizontal dashed blue line is the corresponding sum of the 2SW CLs for North America, corrected for 11 months of natural mortality and against which 1SW non-maturing abundance is assessed.

NASCO 3.4 Provide catch options or alternative management advice for 2021–2024* with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding

Catch options for mixed-stock fisheries are only provided for the non-maturing 1SW and maturing 2SW components as the maturing 1SW component is not fished outside home waters.

As the predicted numbers of 2SW salmon returning to the six regions in North America in the period 2021 to 2024 are below the region-specific 2SW CLs of the four northern areas and of the 2SW management objectives of the two southern areas, there are no catch options for the 2SW mixed-stock fisheries in North America (Table 4).

Wild salmon populations are critically low in the southern regions (Scotia–Fundy, USA) of North America and the remaining populations require alternative conservation actions including habitat restoration, captive rearing strategies, and very restrictive fisheries regulations. This is also the case for other species in certain areas.

Relevant factors to be considered in management

Management for all fisheries should be based upon assessments of the status of individual stocks. Fisheries on mixed-stocks, particularly in coastal waters or on the high seas, pose particular difficulties for management as they may catch stocks that are not meeting their CLs. Conservation would be best achieved if fisheries target stocks that have been shown to be meeting CLs. Fisheries in estuaries and especially rivers are more likely to meet this requirement.

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* Version 2: Year corrected.

The salmon caught in the Labrador subsistence fisheries are predominantly (> 95%) from rivers in Labrador, although there is occasional attribution of very low proportions of salmon in the sampled catches from other areas, including USA. The salmon caught in the SPM mixed-stock fisheries originate in all areas of North America; all sea age groups, including previous spawners, contribute to the fisheries in varying proportions.

Updated forecast and catch options for the 2021 to 2024 fisheries on 2SW maturing fish

It is possible to provide catch options for the North American Commission area for four years.

ICES (2015, 2018) developed estimates of the PFA for the non-maturing 1SW salmon using a Bayesian framework that incorporates the estimates of 2SW lagged spawners and works through the fisheries at sea to determine the corresponding returns of 2SW salmon, conditioned by fisheries removals and natural mortality at sea. This model considered lagged spawners (Figure 12) and returns of 2SW salmon for each of the six regions of North America (Figure 8). Dataseries were finalized for 2020 and updated for past years in some regions. North American region-specific PFA and productivity value inferences are provided by the model (Figures 15 and 16).

The model forecasts productivity using a random walk with the forecast value set at the value of the most recent assessment year (2019), and it applies this value to the assessment abundance of lagged spawners to forecast PFA. The overall productivity estimate (on the log scale) for the NAC in the most recent PFA year (2019) is positive but remains below the higher levels of the late 1970s and 1980s (Figure 14). By region, the most recent year values of productivity are positive for all regions. Positive values indicate that the PFA is greater than the lagged spawner abundance that produced it, and the salmon abundances in these regions are expected to increase from current levels if the positive productivity and lagged spawner abundances are maintained (Figure 14). Negative productivity parameters (log scale) in the past indicate that the PFA was less than the lagged spawner abundance that produced it, and the salmon abundances in these regions declined to very low levels in the southern regions (Scotia–Fundy, USA) in particular. Annual productivity estimates are highly variable among years, and large changes in values have been observed over a short time period, as in 2011 to 2017 (Figure 14).

For 2021 to 2023 PFA years, the 5th percentiles of the posterior distributions of the regional PFAs are less than the management objective reserves for all six regions (Figure 15). There are, therefore, no mixed-stock fishery options on 1SW non-maturing salmon in the period 2021 to 2023 or on 2SW salmon in the period 2021 to 2024 which would provide a greater than 95% chance of meeting the individual management objectives; the probability of simultaneous attainment in any year is near zero (Table 4). The forecasts have very high uncertainty, and the uncertainties increase as the forecasts move further forward in time.

Table 4 Probabilities that returns of 2SW salmon to the six regions of the NAC area will meet or exceed the 2SW objectives both for the six regions and simultaneously for all regions in the absence of fishing on the 1SW non-maturing and 2SW age groups for the 2SW salmon return years 2021 to 2024. For the 2021 return year, catches of 1SW non-maturing salmon in 2020 in Labrador and at Greenland have already occurred and are accounted for in the estimation of the probabilities of meeting the 2SW objectives for the 2021 return year.

Region	Region specific 2SW objective	Probability of meeting the 2SW objectives in the absence of fisheries for the 2SW return year			
		2021	2022	2023	2024
Labrador	34746	0.645	0.632	0.573	0.671
Newfoundland	4022	0.465	0.401	0.268	0.300
Quebec	32085	0.534	0.413	0.419	0.464
Gulf	18737	0.890	0.870	0.799	0.831
Scotia–Fundy	10976	0.013	0.030	0.026	0.029
USA	4549	0.094	0.144	0.213	0.226
Simultaneously for all regions		0.004	0.006	0.006	0.007

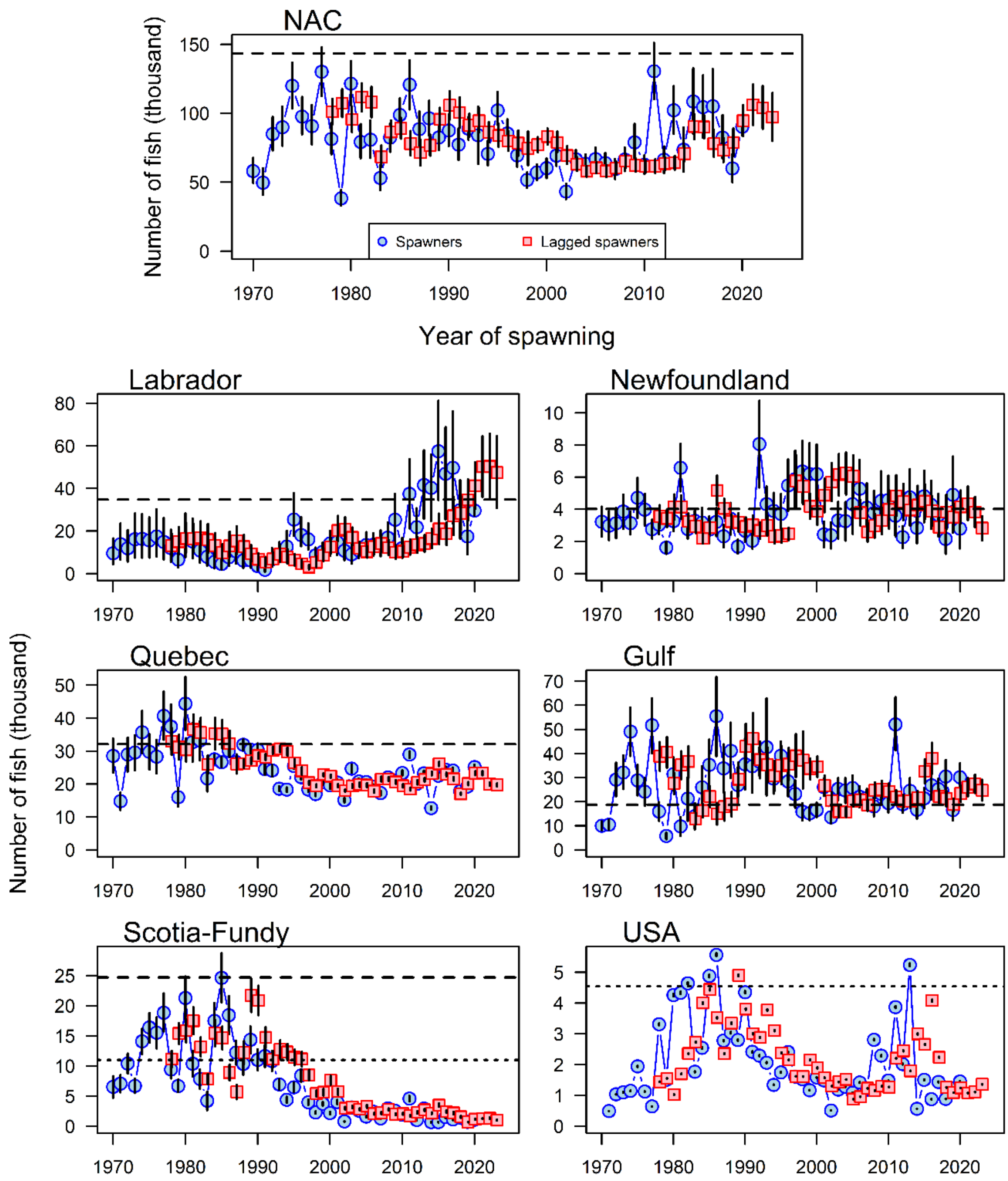

Figure 13 Median (fifth to 95th percentile range) of spawners (circles) and lagged spawners (squares) of 2SW salmon to the NAC area overall (top panel) and for each of the six assessment regions. For spawners, year corresponds to the year of spawning. For lagged spawners, year corresponds to the year of PFA. The horizontal dashed line is the corresponding 2SW CLs for the NAC area overall and for each region; the 2SW CL for USA (29 990 fish) is off scale in the plot. The dotted horizontal line in the Scotia–Fundy and USA panels are the region specific 2SW management objectives.

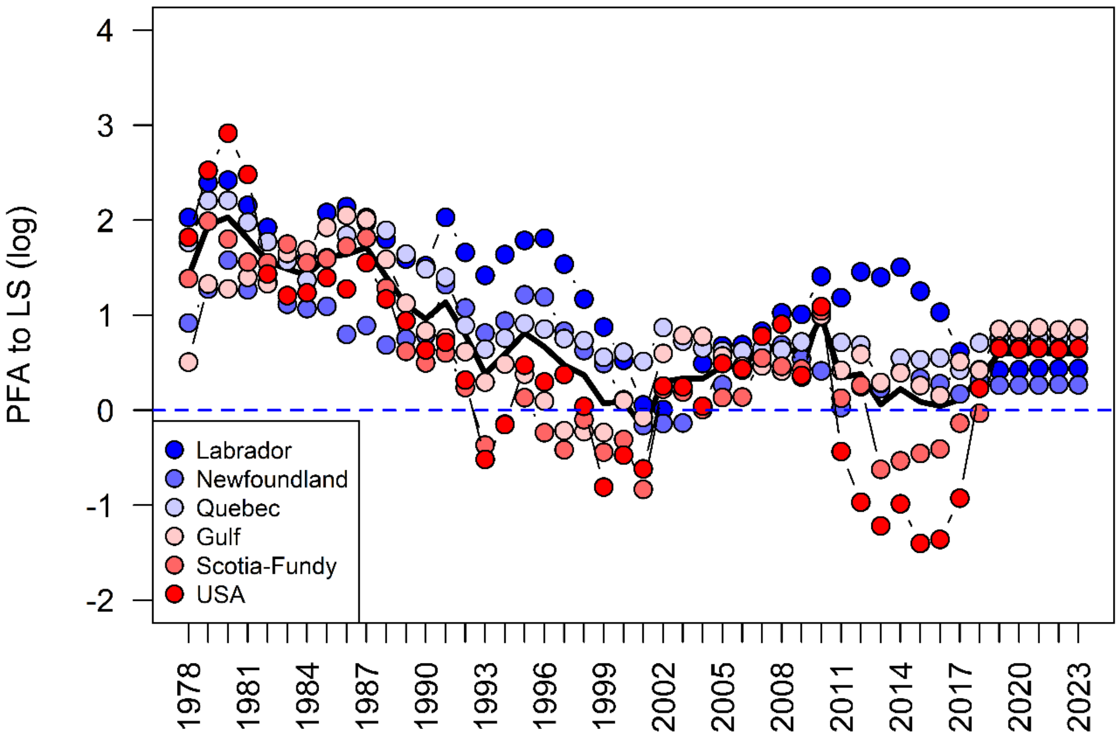

Figure 14 Region specific (median) PFA to LS ratio (log scale; productivity) and mean over all regions (solid black line) for NAC for PFA years 1978 to 2023. The horizontal dashed blue line is the PFA to LS ratio on the log scale of zero, which equates to a PFA to LS ratio of one. The values for 2020 to 2023 are forecast values.

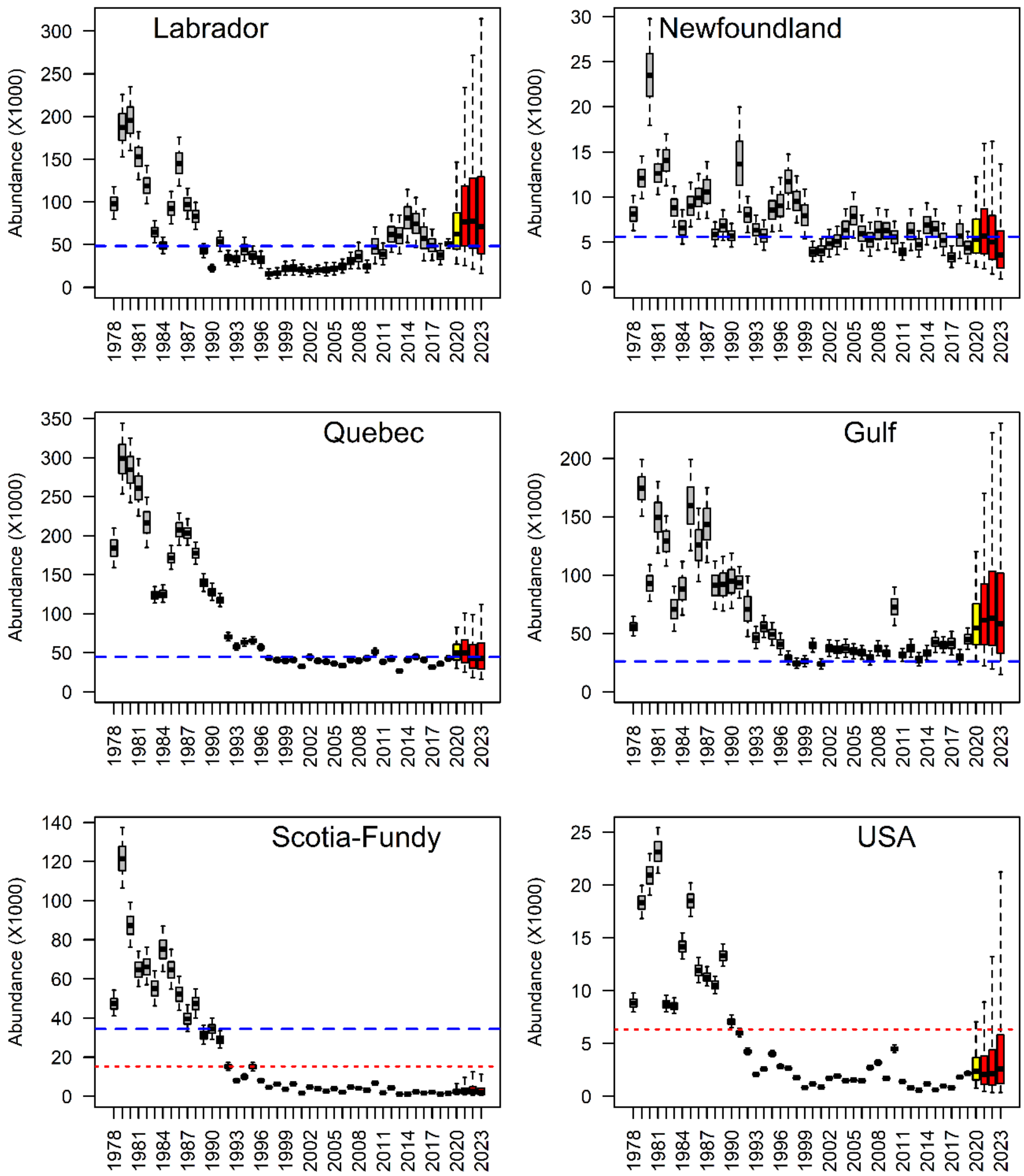

Figure 15 Region-specific PFA values for PFA years 1978 to 2023. The values for 2020 (yellow shading) and for the period 2021 to 2023 (red shading) are predicted based on lagged spawners and forecasts of the PFA to LS ratio. The dashed blue line is the corresponding 2SW CL reserve for each region. For Scotia–Fundy and USA the dotted red line corresponds to the 2SW management objectives (adjusted for eleven months of natural mortality). Boxplots are interpreted as follows: the dashed line is the median, the shaded rectangle is the inter-quartile range, and the dashed vertical line is the fifth to 95th percentile range.

NASCO 3.5 Update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice

An updated Framework of Indicators (FWI) that can be used to identify any significant change in the previously provided multiannual management advice has been provided. The same FWI is used for the North American Commission (NAC) and West Greenland Commission areas of NASCO with the exception that for the NAC area, only indicators from regions in North America apply.

The update consisted of:

- Adding the values of the indicator variables for the most recent years;
- Running the objective function spreadsheet for both each indicator variable and the variable of interest relative to the management objectives;
- Quantifying the threshold value for the indicator variables and the probabilities of a true high state and a true low state for those variables retained for the framework;
- Revising/adding the indicator variables and the functions for evaluating the indicator score to the framework spreadsheet; and
- Providing the spreadsheet for carrying out the FWI assessment.

The updated FWI contains 19 indicator variables, represented by 13 different rivers (Figure 16). Of these variables, two were survival rate indicators, while of the remainder 13 were indicators of 2SW and large salmon and four were indicators of wild 1SW and small salmon returns to rivers. No indicator variables were retained for the Labrador or Newfoundland.

The FWI can be applied at the beginning of 2022, using the returns or return rate data for 2021 to evaluate the appropriateness of the advice for 2022, and again at the beginning of 2023, using the returns or return rate data for 2022 to evaluate the appropriateness of the advice for 2023.

Catch Advice	Catch option > 0 (Yes = 1, No = 0)	0

Overall Recommendation

No Significant Change Identified by Indicators

Geographic Area	River/ Indicator	**2020 Value***	Ratio Value to Threshold	Threshold	True Low	True High	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns	998	46%	2,167	100%	100%	-1	1.00	-1.00	
	Penobscot 2SW Survival (%)	0.002	18%	0.011	100%	60%	-1	1.00	-1.00	
	possible range				*-1.00*	*0.80*				
	Average		32%						**-1.00**	**No**
Scotia-Fundy	Saint John Return Large	115	3%	3,329	97%	100%	-1	0.97	-0.97	
	Lahave Return Large	22	8%	285	82%	85%	-1	0.82	-0.82	
	North Return Large	226	36%	626	96%	75%	-1	0.96	-0.96	
	Saint John Return Small	241	11%	2,276	90%	80%	-1	0.90	-0.90	
	LaHave Return Small	278	17%	1,679	96%	67%	-1	0.96	-0.96	
	possible range				*-0.92*	*0.81*				
	Average		15%						**-0.92**	**No**
Gulf	Miramichi Return 2SW	4746	57%	8,366	100%	98%	-1	1.00	-1.00	
	Miramichi Return 1SW	8792	36%	24,287	58%	92%	-1	0.58	-0.58	
	possible range				*-0.79*	*0.95*				
	Average		46%						**-0.79**	**No**
Quebec	Bonaventure Return Large	1531	68%	2,243	73%	100%	-1	0.73	-0.73	
	Grande Rivière Return Large	426	96%	442	100%	83%	-1	1.00	-1.00	
	Saint-Jean Return Large	814	80%	1013	79%	100%	-1	0.79	-0.79	
	Dartmouth Return Large	889	118%	756	86%	75%	1	0.75	0.75	
	Madeleine Return Large	922	137%	672	94%	74%	1	0.74	0.74	
	Sainte-Anne Return Large	780	134%	584	82%	60%	1	0.60	0.60	
	Mitis Return Large	873	237%	369	89%	50%	1	0.50	0.50	
	De la Trinité Return Large	113	29%	385	88%	100%	-1	0.88	-0.88	
	De la Trinité Return Small	150	26%	578	90%	85%	-1	0.90	-0.90	
	De la Trinité 2SW Survival	0.28	57%	0.49	100%	68%	-1	1.00	-1.00	
	possible range				*-0.88*	*0.80*				
	Average		98%						**-0.27**	**No**
Newfoundland										
	possible range									
	Average								**NA**	**Unknown**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Southern NEAC										
	possible range									
	Average								**NA**	**Unknown**

* 2020 value: or if not available, the latest value of the time-series.

Figure 16 FWI spreadsheet for the NAC. For illustrative purposes, the 2020 value of returns or survival rates for the 19 retained indicators is entered in the cells corresponding to the annual indicator variable values.

Relevant data deficiencies, monitoring needs, and research requirements

The following data deficiencies, monitoring needs, and research requirements were identified as being relevant to the NAC area:

- Complete and timely reporting of catch statistics from all fisheries for all areas of eastern Canada is recommended.
- Improved catch statistics and sampling of the Labrador and SPM 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 caught in these mixed-stock fisheries. A sampling rate of at least 10% of catches in Labrador would be required to achieve a relatively unbiased estimate.
- Additional monitoring in Labrador should be considered 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.
- A database is needed that lists individual PIT tag numbers or codes identifying the origin, source, or programme of the tags on a North Atlantic basin-wide scale. This is needed to facilitate identification of individual tagged fish taken in marine fisheries or surveys. Data on individual PIT tags used in Norway have now been compiled, although an ICES-coordinated database where the data could be stored is needed and is being considered by ICES. Tag users should be encouraged to include these tags or tagging programmes as this greatly facilitates identification of the origin of tags recovered in fisheries or tag scanning programmes in other jurisdictions.

The full list of data deficiencies, monitoring needs, and research requirements for North Atlantic salmon is presented in Section 1.4 of the sal.oth.nasco advice (ICES, 2021b).

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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(s) *conservation limit(s)*, **i.e. S_{lim}.** 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 multiannual 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.

SFA *Salmon Fishing Area*. The 23 areas for which Fisheries and Oceans Canada (DFO) manages the salmon fisheries.

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 CLs through 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. Within the management plan for the NAC, 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, Quebec, 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 for the USA region of NAC. An FWI has been developed to identify any significant change in the multiannual 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 it ranges from the Connecticut River (USA, 41.6°N) northwards to the Ungava Bay rivers (58.8°N; Quebec, Canada). Juveniles emigrate to the ocean at ages of between one and 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 in the North East Atlantic Commission (NEAC) area.

Environmental and other influences 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 areas of eastern 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. In 2020, some regions were affected by the COVID-19 global pandemic and had to either modify the way return and spawner estimates were produced (e.g. SFA 15 [Gulf] using spawners snorkel counts instead of angling data) or could not

† Version 2: Section header corrected

provide return and spawner estimates (SFAs 16, 17, 18 [Gulf], and 21 and 23 [Scotia–Fundy]. When no data were available, the previous five-year average values were used, except for Newfoundland for which previous six-year averages were used.

The forecasts for PFA, based on availability of lagged spawners for three years and forecast values of productivity, have very high uncertainty, and the uncertainties increase as the forecasts move further forward in time. Annual productivity estimates are highly variable among years, and large changes in values have been observed over a short time period, as in 2011 to 2017. In the 2018 assessment, the productivity parameter used for the 2018 to 2020 PFA years was negative for three regions, positive and at low values for two regions, and high for Labrador (ICES, 2018). When assessed in 2021, the returns of 2SW salmon in 2018 to 2020 were slightly higher than expected in all regions except Labrador, and the realized productivity for the 2017 to 2019 PFA years was higher than forecast for those years. As a result, the estimated regional PFA values were lower in Labrador for the 2017 to 2019 PFA years and slightly higher in all the other regions; however, the larger overestimate for Labrador relative to the other regions resulted in a lower PFA value for the NAC area for those years than forecast in the 2018 assessment. Due to the large uncertainty associated with the forecast values, the estimated PFA values for 2017 to 2019 were within the 95% confidence intervals of the forecast values.

Basis of the assessment

Table A1 Atlantic Salmon from North America. The basis of the assessment.

ICES stock data category	1 (ICES, 2021c)
Assessment type	Run-reconstruction models and Bayesian forecasts, taking into account uncertainties in the data
Input data	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 FWI 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 2021 (ICES, 2021b).
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2021a)

Atlantic salmon at West Greenland

Summary of the advice for 2021–2023

ICES advises that, in line with the management objectives agreed by the North Atlantic Salmon Organization (NASCO) and consistent with the MSY approach, the catch at West Greenland in 2021, 2022, and 2023 should be zero.

Mixed-stock fisheries present particular threats and should be managed based on the individual status of all stocks exploited in the fishery.

The Framework of Indicators (FWI) was updated in support of the multiyear catch advice and the potential approval of multiyear regulatory measures. The FWI can be applied at the beginning of 2022, using the returns or return rate data for 2021 to evaluate the appropriateness of the advice for 2022, and again at the beginning of 2023, using with the returns or return rate data for 2022 to evaluate the appropriateness of the advice for 2023.

NASCO 4.1 Describe the key events of the 2020 fishery

Fishing for salmon using hooks and fixed gillnets is currently allowed along the entire west coast of Greenland (Figure 1). Commercial fishers are allowed to fish using single gillnets fixed to the shore, with no limit on the number of gillnets that can be used. Driftnetting has not been allowed since 2020. Private licensed fishers can only use one gillnet fixed to the shore. Gillnets are the preferred gear in Greenland, but rod and reel catches and bycatch in poundnets are also noted in small amounts within the catch reports.

The commercial fishery for export closed in 1998; the fishery for internal use, however, continues to date. Since 2002, licensed commercial fishers have only been allowed to sell salmon to hotels, institutions, local markets, and factories when factory landings were allowed. People fishing for private consumption only were not required to have a licence until 2018 and are prohibited from selling salmon.

In 2018, the Government of Greenland set a total quota for all components of the 2018–2020 fisheries to 30 t annually. Within the regulatory measure (NASCO, 2018), the government agreed to continue its ban on the export of wild Atlantic salmon or its products from Greenland and to prohibit landings and sales to fish processing factories. The government also agreed to restrict the fishery from 15 August to no later than 31 October each year, and any overharvest in a particular year would result in an equal reduction in the total allowable catch (TAC) 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 included 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 licensed fishers, and mandatory reporting requirements of all fishers. The measure also stated that as a condition of the licence, all fishers will be required to allow international samplers to take samples of their catches upon request. The measure was applied to the 2018–2020 fisheries as the FWI indicated no significant change in the catch advice provided prior to the 2019 and 2020 fisheries. Given the 2018 fishery overharvest, the 2019 quota was set to 19.5 t. Given the 2019 fishery overharvest, the 2020 fishery quota was set to 20.7 t.

Reported (i.e. nominal) catches of Atlantic salmon at West Greenland (Figure 2; Table 1) increased through the 1960s, reached a peak 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 31.7 t was reported for the 2020 fishery, an increase from the 2019 catch (29.8 t) but a harvest of 11 t over the 20.7 t quota (Table 2). In 2020, commercial landings represented the majority of the harvest at 22.0 t (79.5%) and the remaining 9.7 t (30.5%) was for private use, compared to 21.8 t and 7.6 t, respectively, in 2019 (Table 3). The mean percentage of commercial landings registered for private use was 41 from 1997 to 2017 (excluding 2000 and 2001) and 0.2 from 2018 to 2020. Reported commercial and private landings by NAFO/ICES areas in 2020 are presented in Table 4. The number of licences issued, the number of fishers that reported, and the number of reports received have all increased greatly since 2017, a result of the new regulatory measure requirements both for all fishers to obtain a licence and for mandatory reporting (Figure 3).

The 2020 fishery opened on 1 September. On 17 September, more than 15 t of landings had been registered and, given landings projections, the Government of Greenland announced the fishing season would end on 20 September. However, an approximate one-week delay from landings to registration of landings resulted in the quota being exceeded by 11 t. Unreported catch is assumed to have been at the same level (10 t) as historically reported by the Greenlandic authorities.

An adjustment for some of the unreported catch has been carried out since 2002 using two approaches: 1) comparisons of the sampling programme statistics and reported landings (adjusted landings [survey]) and 2) utilizing results from the previously implemented phone surveys (adjusted landings [sampling]). Adjusted landings (sampling) are estimated by comparing the weight of salmon observed by the sampling teams and the corresponding community-specific reported landings for the entire fishing season. Sampling is not random and only occurs during part of the fishing season; it is therefore not representative of the total unreported catch. An evaluation of non-reporting of harvest was not possible in 2020 due to international samplers not being in Greenland given travel restrictions associated with the COVID-19 pandemic. Adjusted landings (survey) are estimated from results of phone surveys, conducted after each of the fishing seasons 2014–2016 in order to gain further information on inconsistencies in the reported catch data. Adjusted landings (survey) are added to the adjusted landings (sampling) and reported landings to estimate the landings for assessment (Table 5). Landings for assessment do not replace the official reported statistics.

The sampling programme for 2020 was modified from past efforts, because travel restrictions associated with the COVID-19 pandemic meant that international samplers were not able to travel to Greenland to sample harvested Atlantic salmon. Instead, individual sampling kits were provided to three groups of potential samplers located within Greenland: wildlife officers from the Greenland Fisheries License Control Authority (GFLK), staff from the Greenland Institute of Nature Resources (GINR), and individual fishers as part of a citizen science initiative. The sampling programme was marginally successful because of the short fishing season and challenges associated with the COVID-19 pandemic. A total of 114 Atlantic salmon were sampled, but shipping delays prevented these samples from being processed. The samples will be processed in 2021 and made available to support future assessment efforts.

A summary of the biological characteristics and continent and region of contributions to the harvest is therefore not available for the 2020 catch, although the time-series of salmon sampled that were determined to be of North American and European origin is presented in Figure 4. To mitigate for the lack of biological characteristics data and continent of origin estimates for the 2020 fishery, five-year mean values were used in the North American Commission (NAC) and North-East Atlantic Commission (NEAC) pre-fishery abundance run-reconstruction models, which generated estimates of the number of North American (9600) and European (3200) fish harvested in 2020 (Figure 5). The total number of fish harvested in 2020 (12 800) is an increase from the estimated number harvested in 2019 (9400) and approximate to the previous ten-year mean (2010–2019; 11 900).

Table 1 Reported catches of salmon at West Greenland since 1960 (tonnes, round fresh weight) by participating nations. For Greenlandic vessels specifically, all catches up to 1968 were taken with set gillnets only; catches 1968–2019 were taken with both set gillnets and driftnets; and catches from 2020 to the present were taken with set gillnets only. All non-Greenlandic vessel catches 1969–1975 were taken with driftnets. The quota figures applied to Greenlandic vessels only, and entries in parentheses 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 catch 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	
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	Quota for 1988–1990 was 2520 t with an opening date of 1 August. Annual catches were not to exceed an annual average (840 t) by more than 10%.
1989	-	-	-	-	337	337	900	Quota adjusted to 900 t for later opening date
1990	-	-	-	-	274	274	924	Quota adjusted to 924 t for later opening date
1991	-	-	-	-	472	472	840	
1992	-	-	-	-	237	237	258	
1993	-	-	-	-			89	The fishery was suspended. NASCO adopt a new quota allocation model
1994	-	-	-	-			137	The fishery was suspended and the quota was bought out
1995	-	-	-	-	83	83	77	
1996	-	-	-	-	92	92	174	
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	Same as previous year
2000	-	-	-	-	21	21	20	Same as previous year

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
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).
2003	-	-	-	-	9	9		Quota set to nil (no factory landing allowed); fishery restricted to catches used for internal consumption in Greenland
2004	-	-	-	-	15	15		Same as previous year
2005	-	-	-	-	15	15		Same as previous year
2006	-	-	-	-	22	22		Same as previous year
2007	-	-	-	-	25	25		Same as previous year
2008	-	-	-	-	26	26		Same as previous year
2009	-	-	-	-	26	26		Same as previous year
2010	-	-	-	-	40	40		Same as previous year
2011	-	-	-	-	28	28		Same as previous year
2012	-	-	-	-	33	33	(35)	35 t quota for factory landings only
2013	-	-	-	-	47	47	(35)	Same as previous year
2014	-	-	-	-	58	58	(30)	Quota for factory landings only
2015	-	-	-	-	57	57	45	Quota for all sectors (private and commercial) of the fishery
2016	-	-	-	-	27	27	32	Same as previous year
2017	-	-	-	-	28	28	45	Same as previous year
2018	-	-	-	-	40	40	30	Same as previous year
2019	-	-	-	-	30	30	19.5	Same as previous year
2020	-	-	-	-	32	32	21	Same as previous year

Table 2 Annual distribution of reported catches (in tonnes) at Greenland by NAFO division (when known). NAFO divisions are shown in Figure 1. 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		1539		1539
1965	19	234	274	86	202	10	36	861		861
1966	17	223	321	207	353	130	87	1338		1338
1967	2	205	382	228	336	125	236	1514		1514
1968	1	90	241	125	70	34	272	833		833
1969	41	396	245	234	370		867	2153		2153
1970	58	239	122	123	496	207	862	2107		2107
1971	144	355	724	302	410	159	560	2654		2654
1972	117	136	190	374	385	118	703	2023		2023
1973	220	271	262	440	619	329	200	2341		2341
1974	44	175	272	298	395	88	645	1917		1917
1975	147	468	212	224	352	185	442	2030		2030
1976	166	302	262	225	182	38		1175		1175
1977	201	393	336	207	237	46	-	1420	6	1426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1395	+	1395
1980	52	275	404	231	158	74	-	1194	+	1194
1981	105	403	348	203	153	32	20	1264	+	1264
1982	111	330	239	136	167	76	18	1077	+	1077
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
2019	0.8	3.0	4.4	8.0	4.8	7.3	0	28.3	1.4	29.8
2020	0.9	3.6	6.6	9.7	3.0	7.1	0	30.9	0.8	31.7

* The fishery was suspended.
+ Small catches, < 0.5 t.
- No catch.

Table 3 Reported 2019 and 2020 catches (in tonnes) by license type and landings category. Licences for private fishers were introduced in 2018. Entries of 0.0 represent reported values of < 0.1. Note: Due to rounding, numbers presented may not add up precisely to the totals indicated.

Licence status	Landings type	Reported 2019 catch	Reported 2020 catch
Licensed	Commercial (from commercial fishers)	21.8	22.0
	Private use (from commercial fishers)	0.1	0
	Commercial use (from private fishers)	0.2	0
	Private use (from private fishers)	7.6	9.7
	Total commercial catch	22.0	22.0
	Total private use catch	7.7	9.7
	Total catch	29.8	31.7

Table 4 Reported 2020 landings in NAFO/ICES areas (in tonnes) by licence type, landing category, the number of fishers reporting, and the total number of landing reports received. Empty cells identify categories with no reported landings and 0.0 entries represent reported values of < 0.1. Note: due to rounding, numbers presented may not add up precisely to the totals indicated.

NAFO/ICES	Licence type	No. of fishers	No. of reports	Commercial	Private	Total
NAFO 1A	Private	41	58		0.2	0.2
	Commercial	59	120	0.7		0.7
	Total	100	178	0.7	0.2	0.9
NAFO 1B	Private	42	92		0.5	0.5
	Commercial	47	147	3.1		3.1
	Total	89	239	3.1	0.5	3.6
NAFO 1C	Private	28	47		0.8	0.8
	Commercial	75	181	5.8		5.8
	Total	103	228	5.8	0.8	6.6
NAFO 1D	Private	116	171		2.8	2.8
	Commercial	35	102	7.0		7.0
	Total	151	273	7.0	2.8	9.7
NAFO 1E	Private	27	47		1.1	1.1
	Commercial	20	44	1.9		1.9
	Total	47	91	1.9	1.1	3.0
NAFO 1F	Private	79	191		3.9	3.9
	Commercial	39	93	3.2		3.2
	Total	118	284	3.2	3.9	7.1
ICES Subarea 14	Private	8	23		0.5	0.5
	Commercial	2	5	0.3		0.3
	Total	10	28	0.3	0.5	0.8
ALL	Private	341	629		9.7	9.7
	Commercial	277	692	22.0		22.0
	Total	618	1321	22.0	9.7	31.7

Table 5 Reported landings and adjusted landings (in tonnes) for the assessment of Atlantic salmon at West Greenland 2002–2020. The total adjusted landings do not include the unreported catch (ten tonnes per year since 2000).

Year	Reported landings (West Greenland)	Adjustment to landings (sampling)	Adjustment to 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	0.0	-	39.0
2019	28.3	0.0	-	28.3
2020	30.9	-	-	

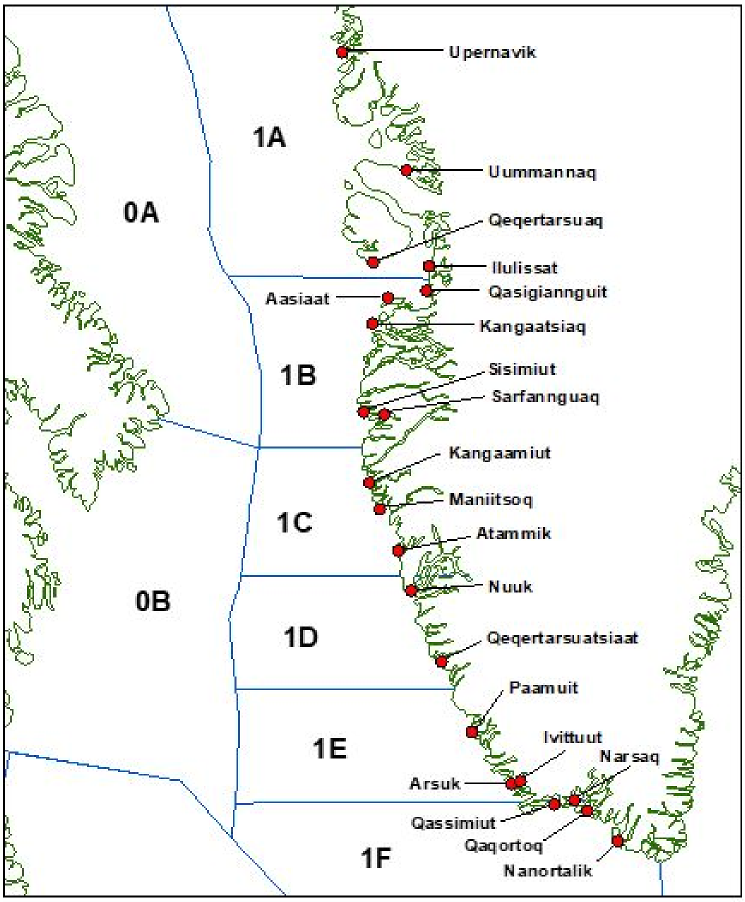

Figure 1 Map of communities in West Greenland where Atlantic salmon have historically been landed and the corresponding NAFO divisions (1A–1F).

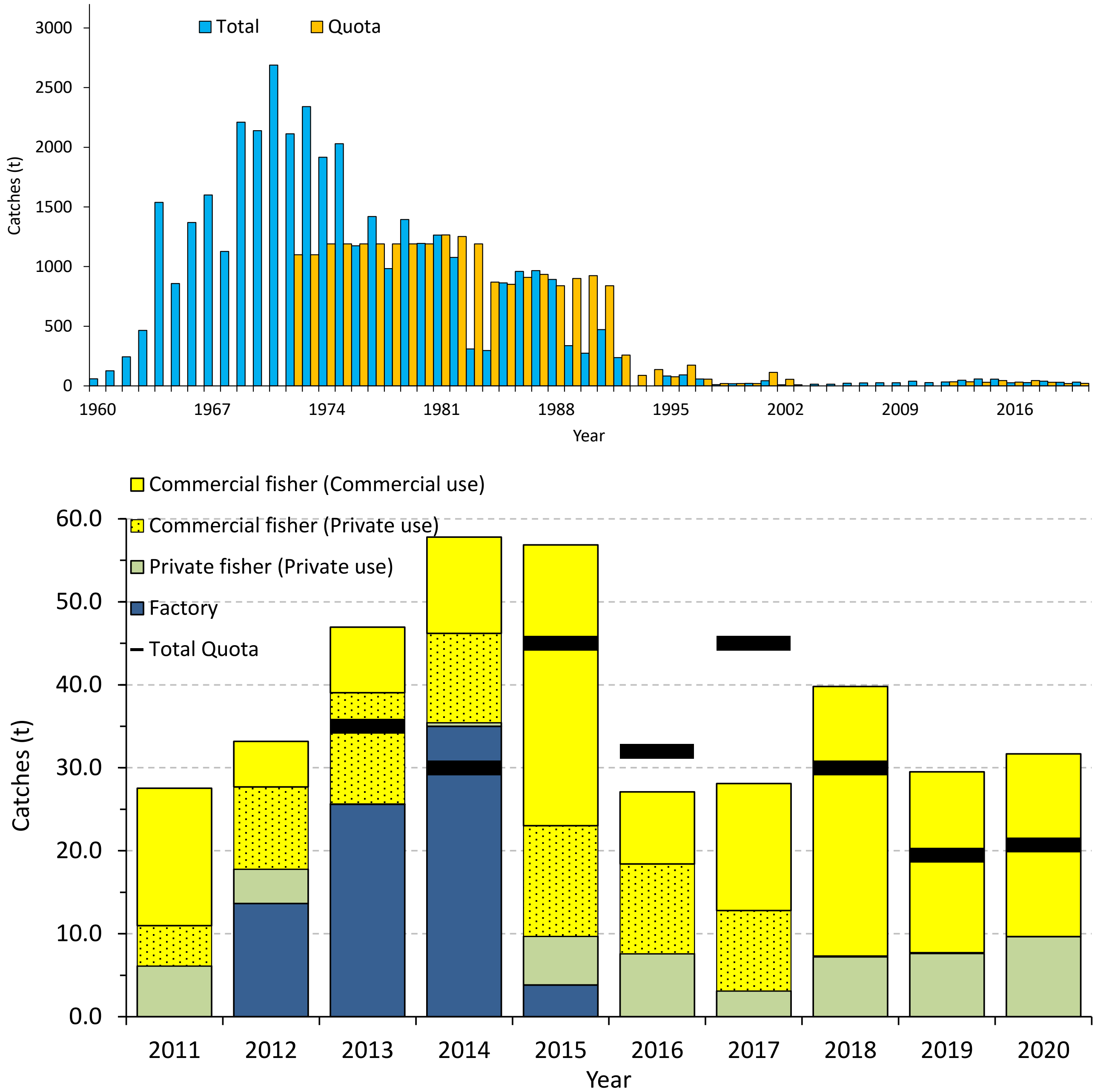

Figure 2 Reported landings and commercial quotas (tonnes, round fresh weight) of salmon at West Greenland from 1960 to 2020 (upper panel). Landings from 2011 to 2020 are also displayed by landing type (lower panel). No quotas were set for 2002–2011, and the quotas for 2012–2014 were for factory landings only.

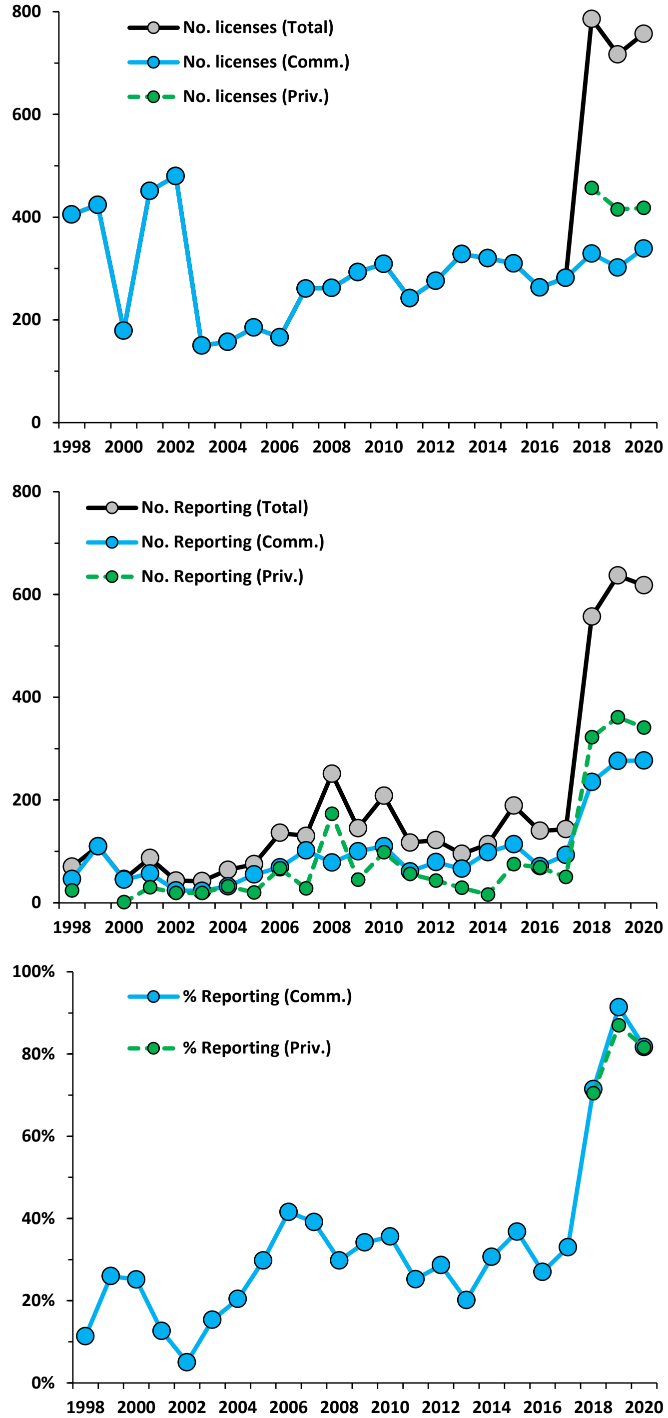

Figure 3 Number of licences issued by licence type (upper panel), number of fishers reporting by licence type (middle panel), and percent of licensed fishers reporting by licence type (lower panel). Starting in 2018 all fishers were required to have a licence.

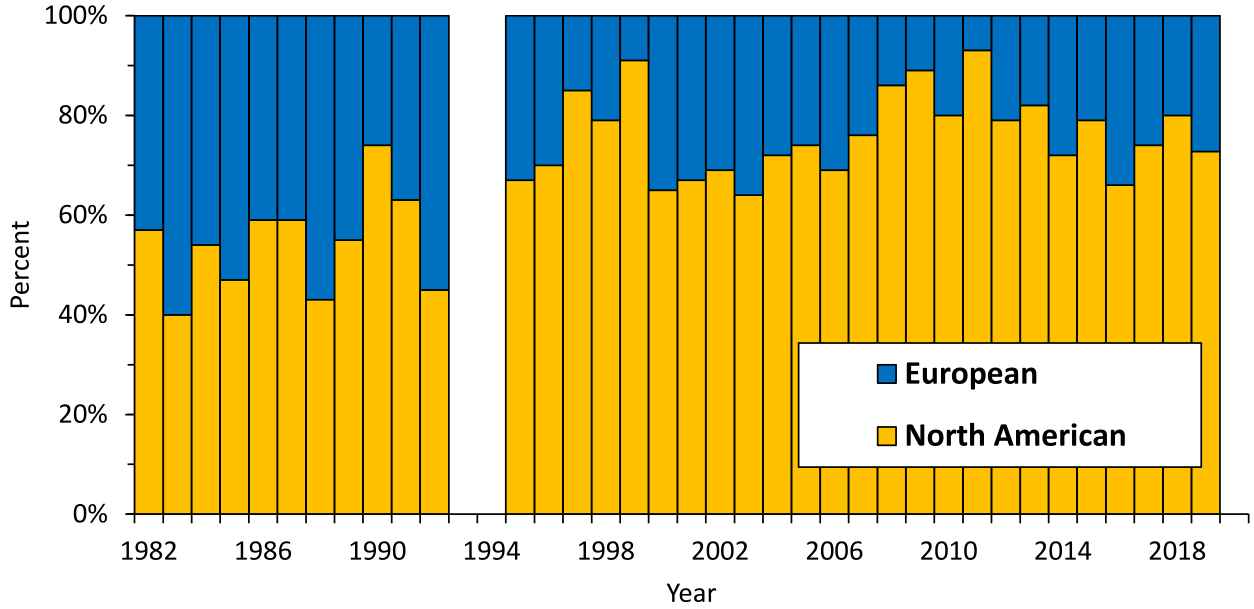

Figure 4 Estimated percent of continental origin of Atlantic salmon harvested at West Greenland from 1982 to 2019. No estimate is available for 2020 because of restrictions associated with the COVID-19 pandemic.

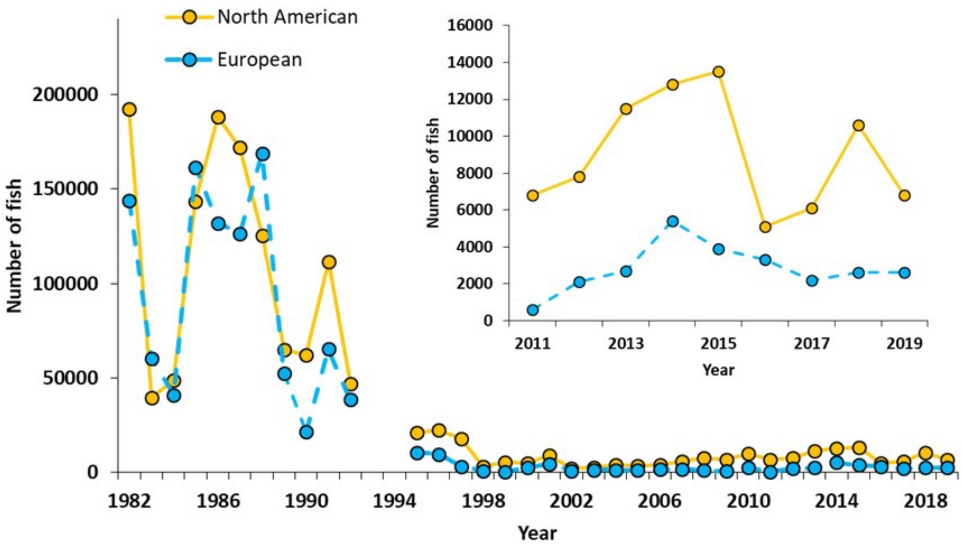

Figure 5 Number of North American and European Atlantic salmon caught at West Greenland in 1982–2019 and 2011–2019 (inset). Estimates are based on continent of origin by NAFO division, weighted by catch (weight) in each division. Unreported catch is not included. No estimate is available for 2020 because of restrictions associated with the COVID-19 pandemic.

NASCO 4.2 Describe the status of the stocks

Recruitment (pre-fishery abundance [PFA]) estimates of non-maturing 1SW salmon at Greenland show continued low abundance compared to historical levels. PFA estimates are currently below the spawner escapement reserves (SER) for the NAC stock complex (Figure 6) but above for the Southern NEAC stock complex (Figure 7). The CLs and SERs for the Southern NEAC complexes have been revised downwards substantially compared to last year due to changes in UK (Northern Ireland) and particularly UK (Scotland) estimates.

In 2020, the estimates (median) of 2SW salmon returns to rivers and spawners were below CLs (suffering reduced reproductive capacity) in the NAC assessment regions except for the Gulf region; for spawners, the percentage of the CL ranged from 10% in Scotia–Fundy to 161% in Gulf (Figure 8). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the Scotia–Fundy and USA regions. The Gulf status was assessed using the previous five-year mean as a proxy for the unavailable 2020 input data. This is not expected to have caused the substantial increase in returns and spawners to this region in 2020 compared to the previous year. The increase appears to be a true reflection of the increased escapement in the region, which was also mirrored to a degree in the adjacent areas Quebec, Labrador, and Newfoundland in 2020 relative to 2019.

The exploitation rate (catch in Greenland divided by PFA) in 2019 was 6.0% for NAC fish and 0.7% 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 low compared to historical levels. It is likely, therefore, that other factors besides fisheries are constraining production.

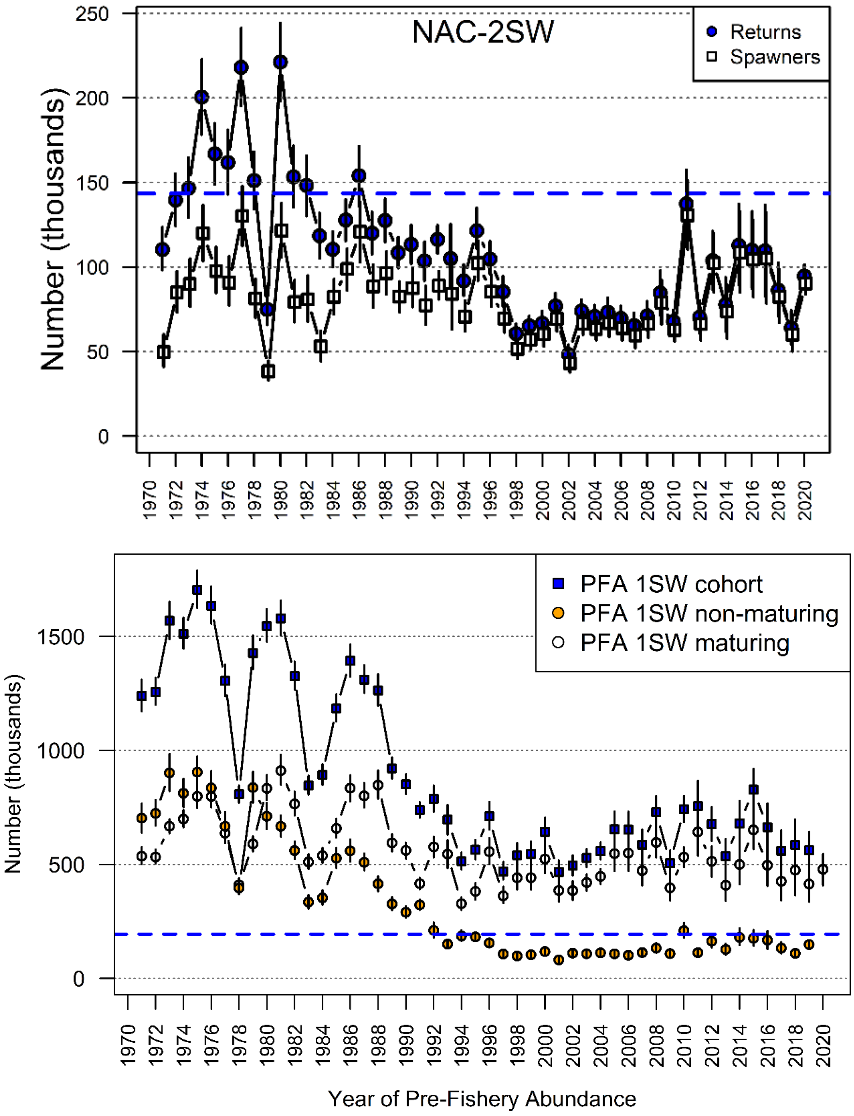

Figure 6 Upper panel: estimated (median, 5th to 95th percentile range; in thousands) returns (blue circles) and spawners (white squares) of 2SW salmon for the NAC area in 1971–2020. The dashed blue line is the corresponding 2SW CL for NAC. Bottom panel: estimated (median, 5th to 95th percentile range; in thousands) PFA for 1SW maturing, 1SW non-maturing, and the total cohort of 1SW salmon for the NAC area in PFA years 1971–2019. The dashed horizontal blue line is the corresponding sum of the 2SW CLs for NAC, corrected for 11 months of natural mortality against which 1SW non-maturing salmon are assessed.

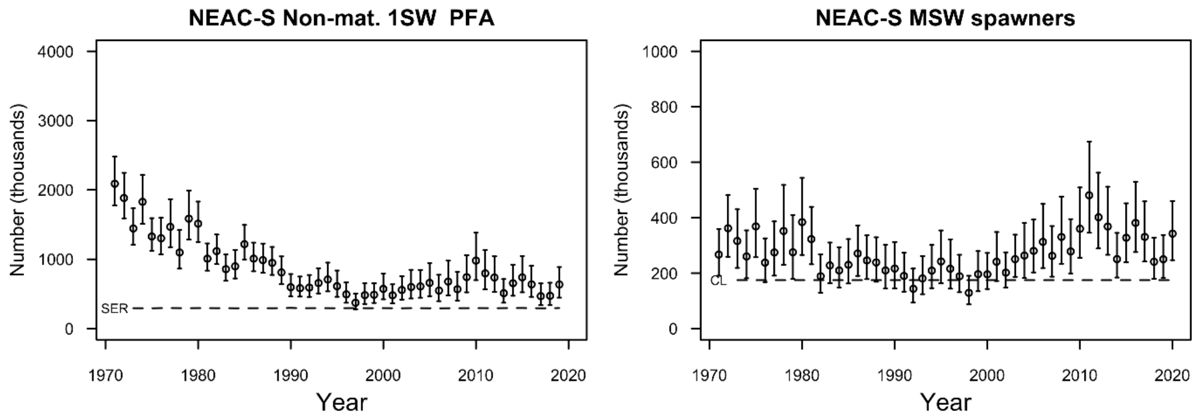

Figure 7 Estimated spawners with 90% confidence limits for MSW salmon for Southern NEAC (right panel). The dashed line is the corresponding MSW conservation limit for Southern NEAC. Estimated PFA with 90% confidence limits for non-maturing 1SW salmon for Southern NEAC (left panel). The dashed line is the corresponding SER for Southern NEAC.

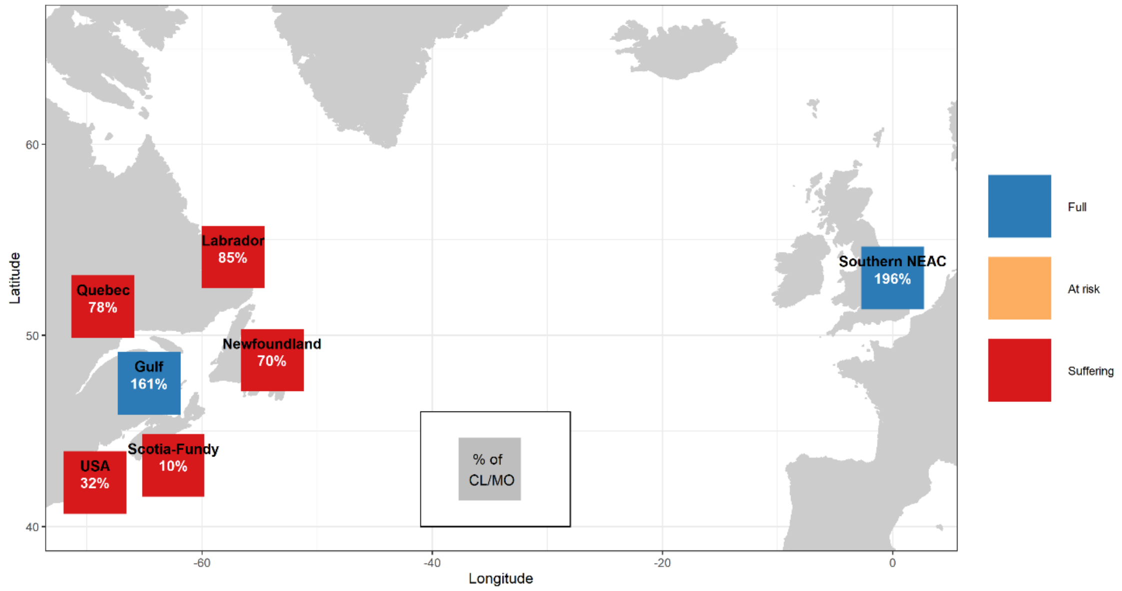

Figure 8 Summary of 2SW (NAC regions) and MSW (Southern NEAC) 2020 median (from the Monte Carlo posterior distributions) spawner estimates in relation to CLs or management objectives (only for USA and Scotia–Fundy). The colours used as shading represent the three ICES stock status designations: blue – Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL); orange – At risk (at risk of suffering reduced reproductive capacity: the median spawner estimate is above but the 5th percentile below the CL); and red – Suffering (suffering reduced reproductive capacity: the median spawner estimate is below the CL).

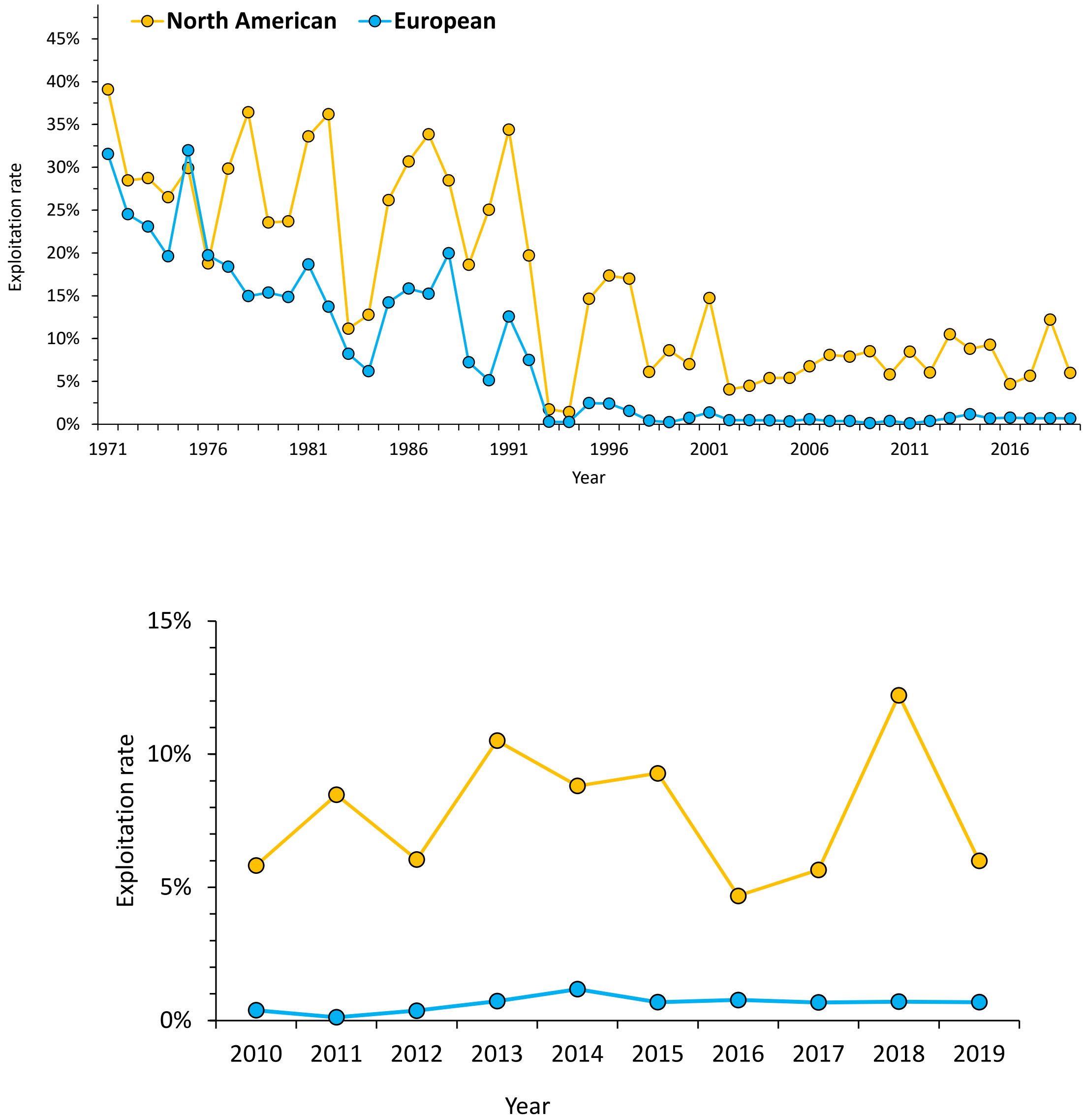

Figure 9 Exploitation rate (%) for NAC 1SW non-maturing and Southern NEAC non-maturing Atlantic salmon at West Greenland in 1971–2019 (upper panel) and 2010–2019 (lower panel). Exploitation rate estimates are only available up to 2019, as 2020 exploitation rates are dependent on 2021 returns.

NASCO 4.3 Provide catch options or alternative management advice for 2021–2023 with an assessment of risk relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding

The management advice for the West Greenland fishery for 2021 to 2023 is based on the models used by ICES since 2003 and was most recently revised in 2018 (ICES, 2018). ICES followed the processes developed in previous years for providing management advice and catch options for West Greenland using the PFA and CLs or alternate management objectives for the NAC and NEAC areas (Table 6). The risks of the Greenland fishery to NAC and NEAC stock complexes are developed in parallel and combined into a single catch options table (Table 7). In summary, none of the stated management objectives would allow a mixed-stock fishery at West Greenland to take place in 2021, 2022, or 2023. Specifically:

- Newfoundland has the lowest probabilities of any of the four northern regions of reaching the CLs; these were estimated to be 0.51, 0.44, and 0.30 for the years 2021, 2022, and 2023, respectively (Table 7).
- In the absence of any marine fishing mortality at Greenland and North America, there is a low probability (from 0.01 to 0.03) that the returns in the southern region of Scotia–Fundy will be sufficient to meet the stock

rebuilding objective during the period 2021–2023 (Table 7). The probability of meeting or exceeding the stock rebuilding objective of the USA region is estimated at 0.11–0.23 over the three years.

- In the absence of any marine fishing mortality at Greenland and in NEAC, the probabilities of meeting or exceeding the SER for the Southern NEAC MSW complex are 0.93, 0.83, and 0.75 in 2021–2023, respectively (Table 7).
- In the absence of any fishing mortality on these stocks, there is a near zero probability (0.004–0.006) of meeting or exceeding the seven management objectives simultaneously in 2021–2023 (Table 7).

Relevant factors to be considered in management

The management of all fisheries should be based upon assessments of the status of individual stocks. Fisheries on mixed-stocks, particularly in coastal waters or on the high seas, pose particular difficulties for management as they target all stocks present, whether or not they are meeting their individual CLs. Conservation would be best achieved if fisheries target stocks that have been shown to be meeting CLs. Fisheries in estuaries and especially rivers are more likely to meet this requirement.

The salmon caught in the West Greenland fishery are mostly (> 90%) non-maturing 1SW salmon, most of which are destined to return to home waters in Europe or North America as 2SW fish. European stocks contributing to the fishery in West Greenland mainly originate in the southern MSW stock complex, although small numbers may also originate in northern Europe. Most MSW stocks in North America contribute to the fishery at West Greenland. Previous spawners, including salmon that spawned first as 1SW and 2SW salmon, also contribute to the fishery although in low (< 5%) proportions.

Table 6 **Management objectives and equivalent number of fish relevant to the development of catch options at West Greenland for the six geographic areas in the NAC area and the Southern NEAC non-maturing complex.**

Area	Objective	Number of fish
USA	2SW proportion of recovery criteria	4549
Scotia–Fundy	25% increase from 2SW returns during 1992 to 1997	10976
Gulf	2SW conservation limit	18737
Québec	2SW conservation limit	32085
Newfoundland	2SW conservation limit	4022
Labrador	2SW conservation limit	34746
Southern NEAC non-maturing complex	MSW conservation limit	174735
	(Spawner escapement reserve to Jan. 1 of first winter at sea)	295582

Table 7 Catch options tables for the mixed-stock fishery at West Greenland by PFA year 2021 to 2023.

	Probability of meeting or exceeding region-specific management objectives							
	Labrador	Newfoundland	Québec	Gulf	Scotia–Fundy	USA	Southern NEAC	Simultaneous
2021 Catch options (tonnes)								
0	0.75	0.51	0.60	0.92	0.01	0.11	0.93	0.004
10	0.73	0.49	0.58	0.91	0.01	0.10	0.93	0.004
20	0.72	0.47	0.55	0.90	0.01	0.10	0.93	0.004
30	0.70	0.45	0.52	0.88	0.01	0.09	0.92	0.004
40	0.68	0.44	0.50	0.87	0.01	0.09	0.92	0.004
50	0.67	0.42	0.47	0.86	0.01	0.08	0.92	0.003
60	0.65	0.40	0.45	0.84	0.01	0.08	0.92	0.003
70	0.63	0.38	0.42	0.83	0.01	0.08	0.92	0.003
80	0.61	0.36	0.40	0.81	0.01	0.07	0.91	0.003
90	0.59	0.34	0.37	0.79	0.01	0.07	0.91	0.003
100	0.57	0.32	0.35	0.77	0.01	0.07	0.91	0.003
2022								
0	0.73	0.44	0.47	0.90	0.03	0.15	0.83	0.006
10	0.72	0.42	0.44	0.88	0.03	0.15	0.82	0.006
20	0.70	0.40	0.42	0.87	0.03	0.15	0.82	0.005
30	0.68	0.39	0.40	0.86	0.03	0.14	0.81	0.004
40	0.67	0.37	0.38	0.85	0.03	0.14	0.81	0.004
50	0.65	0.35	0.37	0.83	0.03	0.13	0.81	0.004
60	0.63	0.34	0.35	0.82	0.03	0.13	0.80	0.004
70	0.62	0.32	0.33	0.80	0.02	0.12	0.80	0.004
80	0.60	0.31	0.31	0.78	0.02	0.12	0.79	0.004
90	0.58	0.29	0.30	0.76	0.02	0.12	0.79	0.004
100	0.57	0.28	0.28	0.74	0.02	0.11	0.78	0.004
2023								
0	0.67	0.30	0.46	0.83	0.03	0.23	0.75	0.005
10	0.66	0.28	0.44	0.82	0.03	0.22	0.74	0.005
20	0.64	0.27	0.43	0.80	0.03	0.22	0.74	0.005
30	0.63	0.26	0.41	0.79	0.03	0.21	0.74	0.005
40	0.61	0.25	0.39	0.77	0.03	0.21	0.73	0.005
50	0.60	0.24	0.37	0.76	0.02	0.20	0.73	0.004
60	0.58	0.23	0.35	0.73	0.02	0.19	0.72	0.004
70	0.56	0.22	0.34	0.72	0.02	0.19	0.72	0.004
80	0.55	0.20	0.32	0.70	0.02	0.18	0.71	0.004
90	0.53	0.19	0.30	0.69	0.02	0.18	0.71	0.004
100	0.51	0.18	0.29	0.67	0.02	0.17	0.70	0.003

NASCO 4.4 Update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice

An updated Framework of Indicators (FWI) that can be used to identify any significant change in the previously provided multiannual management advice has been provided. The update consisted of:

- Adding the values of the indicator variables for the most recent years;
- Running the objective function spreadsheet for both each indicator variable and the variable of interest relative to the management objectives;
- Quantifying the threshold value for the indicator variables and the probabilities of a true high state and a true low state for those variables retained for the framework;
- Revising/adding the indicator variables and the functions for evaluating the indicator score to the framework spreadsheet;
- Providing the spreadsheet for carrying out the FWI assessment.

The updated FWI contains 19 indicator variables, represented by 13 different rivers (Figure 10). Of these variables, two were survival rate indicators, while of the remainder 13 were indicators of 2SW and large salmon and four were indicators of wild 1SW and small salmon returns to rivers. No indicator variables were retained for the Labrador, Newfoundland or Southern NEAC. Although informative for the mixed fisheries in the NEAC, the Faroe FWI is uninformative for the West Greenland fishery.

The FWI can be applied at the beginning of 2022, using the returns or return rate data for 2021 to evaluate the appropriateness of the advice for 2022, and again at the beginning of 2023, using the returns or return rate data for 2022 to evaluate the appropriateness of the advice for 2023.

Catch Advice	**Catch option > 0 (Yes = 1, No = 0)**	**0**

Overall Recommendation
No Significant Change Identified by Indicators

Geographic Area	River/ Indicator	**2020 Value***	Ratio Value to Threshold	Threshold	True Low	True High	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns	998	46%	2,167	100%	100%	-1	1.00	-1.00	
	Penobscot 2SW Survival (%)	0.002	18%	0.011	100%	60%	-1	1.00	-1.00	
	possible range				*-1.00*	*0.80*				
	Average		32%						**-1.00**	**No**
Scotia-Fundy	Saint John Return Large	115	3%	3,329	97%	100%	-1	0.97	-0.97	
	Lahave Return Large	22	8%	285	82%	85%	-1	0.82	-0.82	
	North Return Large	226	36%	626	96%	75%	-1	0.96	-0.96	
	Saint John Return Small	241	11%	2,276	90%	80%	-1	0.90	-0.90	
	LaHave Return Small	278	17%	1,679	96%	67%	-1	0.96	-0.96	
	possible range				*-0.92*	*0.81*				
	Average		15%						**-0.92**	**No**
Gulf	Miramichi Return 2SW	4746	57%	8,366	100%	98%	-1	1.00	-1.00	
	Miramichi Return 1SW	8792	36%	24,287	58%	92%	-1	0.58	-0.58	
	possible range				*-0.79*	*0.95*				
	Average		46%						**-0.79**	**No**
Quebec	Bonaventure Return Large	1531	68%	2,243	73%	100%	-1	0.73	-0.73	
	Grande Rivière Return Large	426	96%	442	100%	83%	-1	1.00	-1.00	
	Saint-Jean Return Large	814	80%	1013	79%	100%	-1	0.79	-0.79	
	Dartmouth Return Large	889	118%	756	86%	75%	1	0.75	0.75	
	Madeleine Return Large	922	137%	672	94%	74%	1	0.74	0.74	
	Sainte-Anne Return Large	780	134%	584	82%	60%	1	0.60	0.60	
	Mitis Return Large	873	237%	369	89%	50%	1	0.50	0.50	
	De la Trinité Return Large	113	29%	385	88%	100%	-1	0.88	-0.88	
	De la Trinité Return Small	150	26%	578	90%	85%	-1	0.90	-0.90	
	De la Trinité 2SW Survival	0.28	57%	0.49	100%	68%	-1	1.00	-1.00	
	possible range				*-0.88*	*0.80*				
	Average		98%						**-0.27**	**No**
Newfoundland										
	possible range									
	Average								**NA**	**Unknown**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Southern NEAC										
	possible range									
	Average								**NA**	**Unknown**

* 2020 value or if not available, the latest value of the time-series

Figure 10 FWI spreadsheet for the West Greenland fishery. For illustrative purposes, the 2020 value of returns or survival rates for the 19 retained indicators is entered in the cells corresponding to the annual indicator variable values.

Identify relevant data deficiencies, monitoring needs, and research requirements

No data deficiencies, monitoring needs, or research requirements of relevance to the West Greenland Commission were identified. The full list of data deficiencies, monitoring needs, and research requirements for North Atlantic salmon is presented in Section 1.45 of the sal.oth.nasco advice (ICES, 2021c).

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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(s) *conservation limits(s)*, **i.e. S_{lim}.** Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing stocks and regulating fisheries is 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*. An intergovernmental fisheries science and management organization that ensures the long-term conservation and sustainable use of 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 specific 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 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. Within the 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 the NAC (Labrador, Newfoundland, Quebec, 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 USA region of NAC. An FWI of indicators has been developed in support of the multiannual 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 its current distribution extends from the Lima River (41°69’) in northern Portugal to the Pechora River (68°20’) in Northwest Russia and Iceland (66°44’). In the Northwest Atlantic distribution ranges from the Connecticut River (USA, 41°.6°’N) northwards to 60°29’ N in the Ungava Bay (Quebec, Canada). Juveniles migrate to the ocean at ages of between one and 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 Greenland to feed during their second summer and autumn at sea.

Environmental and other influences 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.

The COVID-19 pandemic prevented the international sampling programme from taking place, which resulted in no data on biological characteristics, continent/region of origin, and non-reporting of harvest being available for 2020. Previous five-year mean values were used for the 2020 biological characteristics of salmon in the fishery at West Greenland. For the

* Version 2: Section header corrected.

2020 assessment year, previous five-year mean values were used in some regions of NAC because of the impact of the COVID-19 pandemic on field programmes.

Scientific basis

Table A1 Atlantic Salmon at West Greenland. The basis of the assessment.

ICES stock data category	1 (ICES, 2021a)
Assessment type	Run–reconstruction models and Bayesian forecasts, taking into account uncertainties in the data
Input data	Reported (i.e. 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	An 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 2021 (ICES, 2021b)
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2021c)