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

Introduction

Main tasks

At its 2022 Statutory Meeting (2022/2/FRSG18), ICES resolved that the Working Group on North Atlantic Salmon (WGNAS, chaired by Dennis Ensing, UK) would meet in Copenhagen, Denmark from 27 March to 6 April 2023 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO). Dennis Ensing was not able to continue as chair of the working group and was replaced, prior to the meeting, by Alan Walker (UK) and Martha Robertson (Canada). The working group met online 14–15 February 2023 to initiate work for terms of reference (ToR) 2.4, then met from 27 March to 6 April 2023 in hybrid format (i.e. with members in Copenhagen and via web conference) to address these questions. As the WGNAS was not able to meet in 2022, several of the questions from NASCO refer to both 2021 and 2022.

The table below identifies the sections of the report (ICES, 2023) that provide response to the questions posed by NASCO in the ToR.

ToR	Question	Section
1	With respect to Atlantic salmon in the North Atlantic area:	sal.oth.all
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 2021 and 2022[1].	
1.2	report on significant new or emerging threats to, or opportunities for, salmon conservation and management[2];	
1.3	provide information on causes of variability in return rates between rivers within regions in the North Atlantic;	
1.4	provide a summary of the most recent findings of ongoing research projects investigating the marine phase of Atlantic salmon (e.g. SeaSalar, SeaMonitor, SAMARCH, satellite tagging at Greenland);	
1.5	provide a summary of the current state of knowledge on freshwater and marine predation by cormorants and impact on stocks;	
1.6	provide a compilation of tag releases by country in 2021 and 2022; and,	
1.7	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 2021 and 2022 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	advise on the risks of salmon bycatch occurring in pelagic and coastal fisheries, and report on effectiveness and adequacy of current bycatch monitoring programs.	
3	With respect to Atlantic salmon in the North American Commission area:	sal.nac.all
3.1	describe the key events of the 2021 and 2022 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; and,	
3.3	describe the status of the stocks, including updating the time-series of trends in the number of river stocks meeting CLs by jurisdiction;	
4	With respect to Atlantic salmon in the West Greenland Commission area:	sal.wgc.all
4.1	describe the key events of the 2021 and 2022 fisheries[3];	
4.2	describe the status of the stocks[4];	

[1] *With regard to ToR 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 ToR 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.*

[3] *In the responses to ToRs 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 ToR 4.1, if any new surveys are conducted and reported to ICES, ICES should review the results and advise on the appropriateness of incorporating resulting estimates into the assessment process.*

[4] *In response to ToR 4.2, ICES is requested to provide a brief summary of the status of North American and North-East Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to ToRs 2.3 and 3.3.*

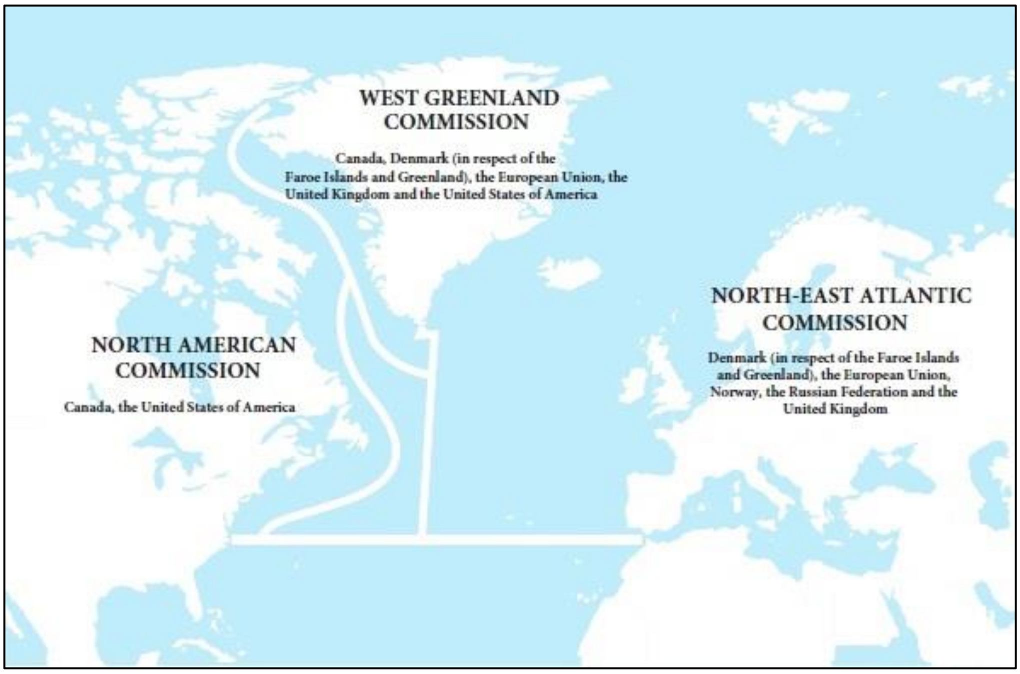
In response to the ToR, the WGNAS considered 32 working documents. A complete list of acronyms and abbreviations used in this report is provided in Annex 1.

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

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 have 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 countries/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, nominal catches (landings) are equivalent to harvest. The reported catches do not include salmon that have been caught and released (these are reported separately) nor do they include post-release mortalities, although the latter are included in the spawner estimates by some countries/jurisdictions. For clarity, detailed Tables 5–8 are provided at the end of the report. Following the ToRs, an overview of catches are reported for 2021 and 2022.

Reported total catches of salmon in four North Atlantic regions from 1960 to 2022 are shown in Figure 1. Catches reported by country or jurisdiction are given in Table 5. Catch statistics in the North Atlantic include fish-farm escapees and, in some Northeast Atlantic countries, ranched fish. The data for 2022 are provisional.

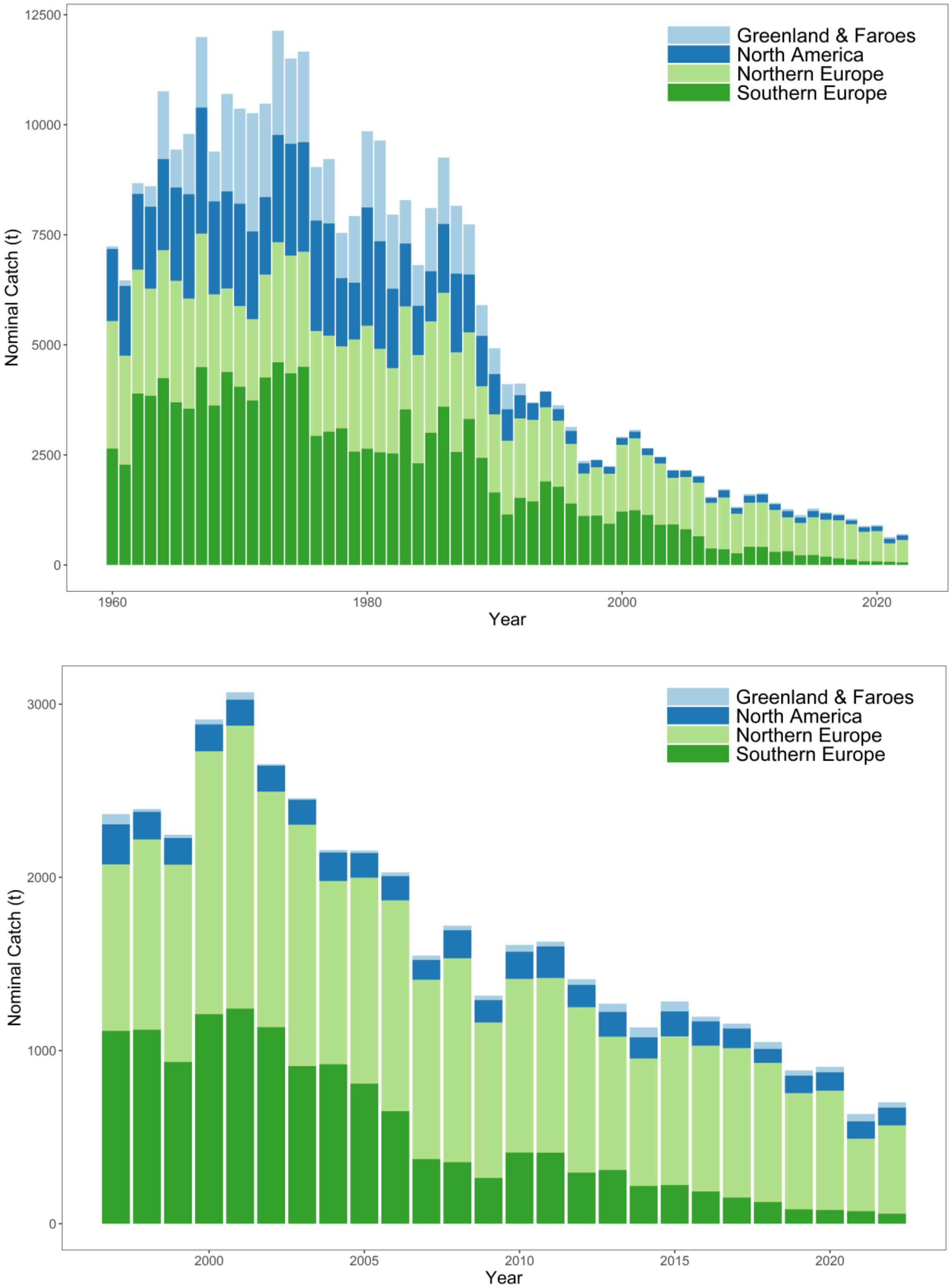


Figure 1 Total reported catch of salmon (tonnes, round fresh weight) in four North Atlantic regions, 1960–2022 (top) and 1998–2022 (bottom).

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 2022 (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 2013–2022.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NEAC	1081	955	1081	1028	1015	928	756	761	487	568
NAC	142	122	144	140	113	80	101	105	100	101
WGC	47	58	57	28	28	40	29	32	43	31
Total	1270	1135	1282	1196	1156	1048	886	898	630	700

The provisional total reported catch was 630 tonnes in 2021 and 700 tonnes in 2022, the two lowest in the time-series since 1960. 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 2021 and 2022 reported catches (in tonnes) for the NEAC and NAC commission areas.

Area	Coastal		Estuarine		In-river		Total
	Weight	%	Weight	%	Weight	%	Weight
NEAC 2021	115	24	22	4	349	72	487
NEAC 2022	153	27	16	3	398	70	568
NAC 2021	7	7	41	41	52	52	100
NAC 2022	7	7	42	42	52	51	101

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 115 t in in 2021 and 153 t in 2022, and in-river catches have declined from 594 t in 2009 to 300 t in 2021 and 357 t in 2022. 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 2021. Estuarine fisheries have also declined, from 72 t in 2007 to 22 t in 2021 and 16 t in 2022. 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, since 2018, it has been about half; the catch in coastal fisheries has been relatively small throughout the time-series (13 t or less).

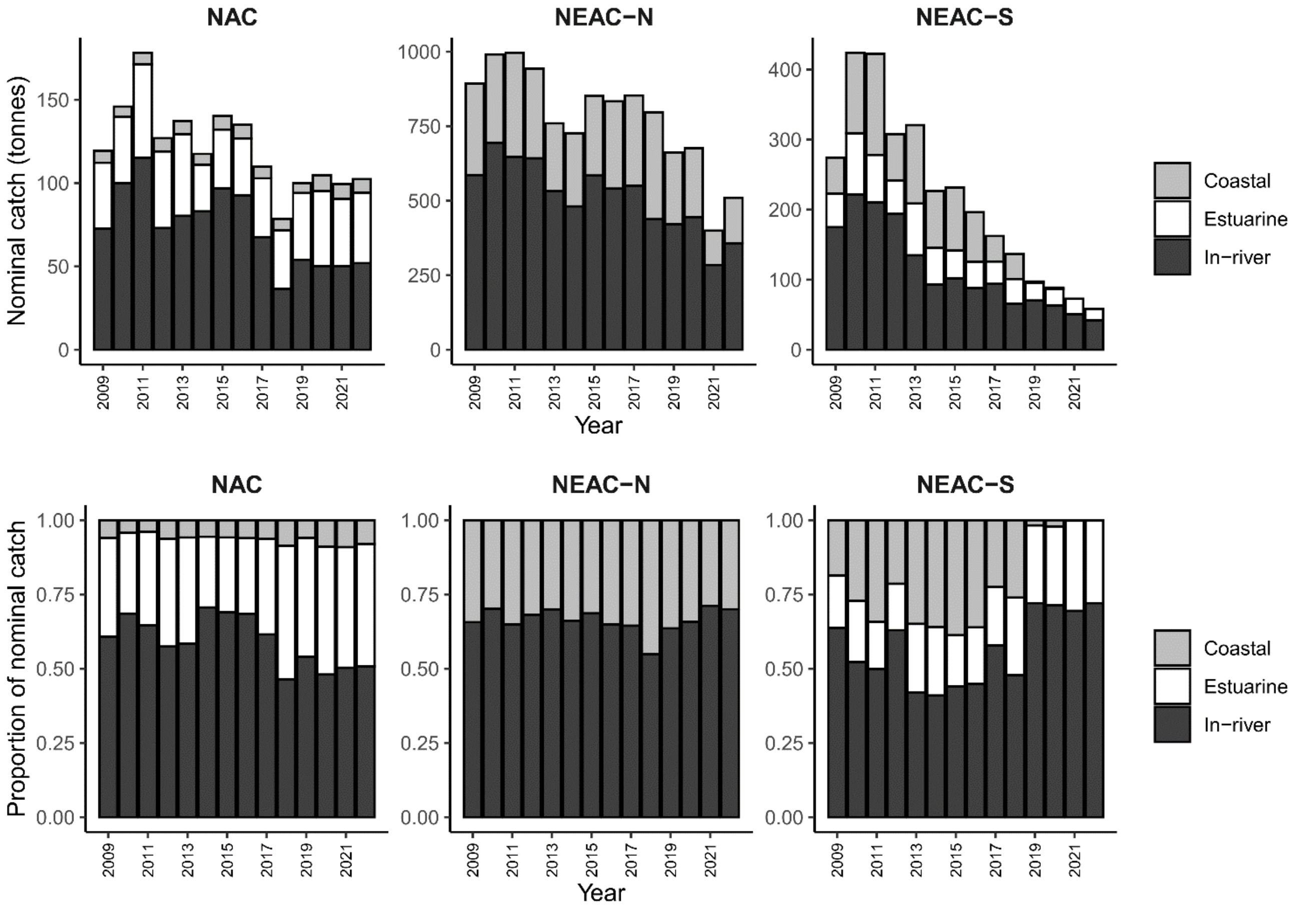


Figure 2 Reported catches (tonnes; top panels) and percentages of the reported catches (bottom panels) from coastal, estuarine, and in-river fisheries for the NAC area, and for the Northern (NEAC–N) and Southern (NEAC–S) NEAC areas in 2009–2022. Note that scales of vertical axes in the top panels vary.

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. Nominal catches (harvests) from rivers have also declined in many countries as more of the fish caught are returned through catch and release schemes in angling fisheries and a few net fisheries.

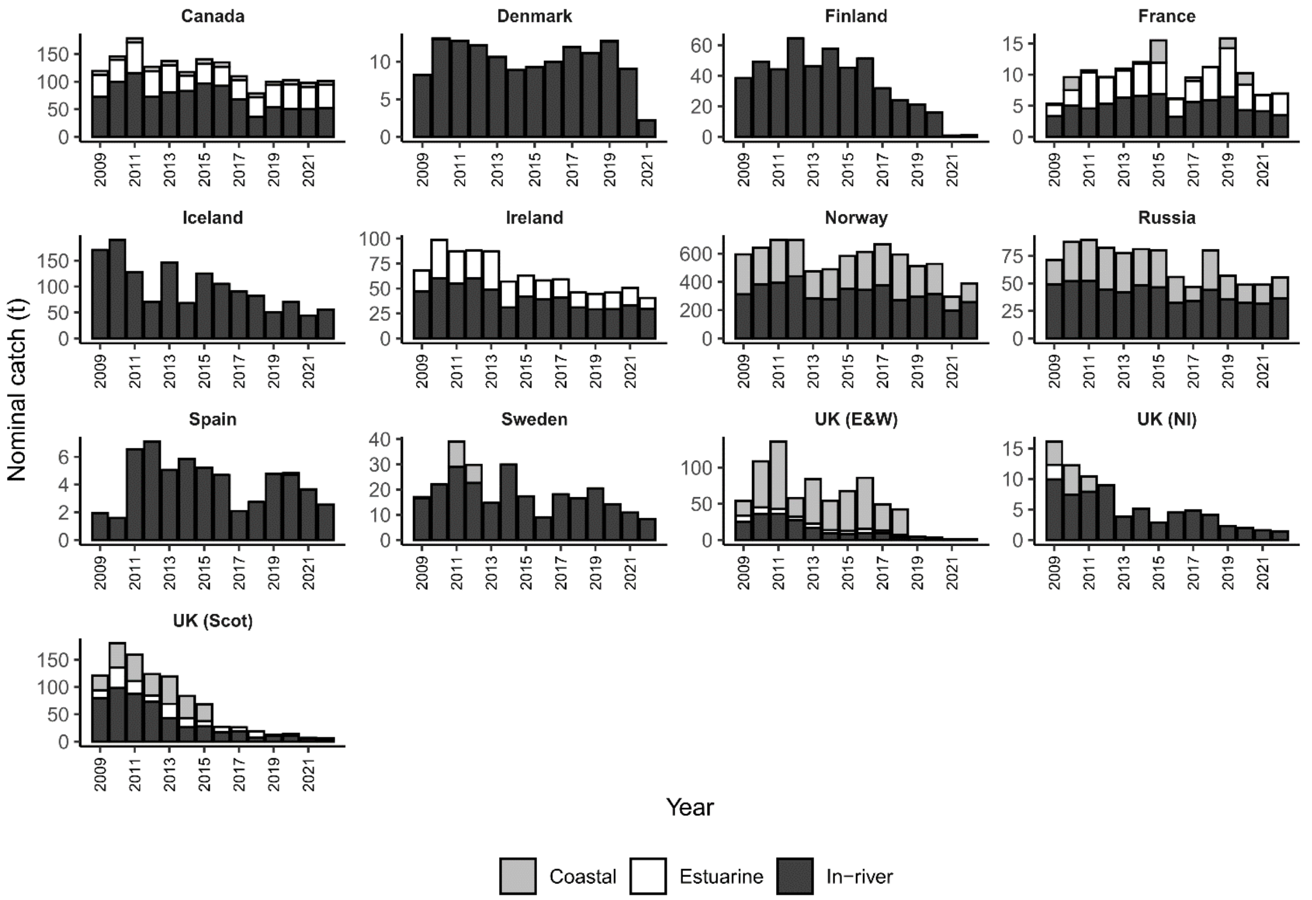


Figure 3 Reported catch (tonnes) by country taken in coastal, estuarine, and riverine fisheries, 2009–2022. Note that scales on the *y*-axes vary. US is not included because there has been no catch. 100% of the fishery at St Pierre and Miquelon and at West Greenland occurs in coastal areas. These catches are not shown.

Unreported catches

The total unreported catch in NASCO areas was estimated at 164 t in 2021 (NEAC 134 t, NAC 19 t and WGC 10 t) and 202 t in 2022 (NEAC 174 t, NAC 18 t and WGC 10 t). No estimates were provided for Russia, France, Spain, or St Pierre and Miquelon in 2021 or 2022.

Table 3 Unreported catch (in tonnes) by NASCO commission area in the last 10 years.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NEAC	272	256	299	297	318	278	238	238	134	174
NAC	24	21	17	27	25	24	12	27	19	18
WGC	10	10	10	10	10	10	10	10	10	10
Total	306	287	326	335	353	312	259	275	163	202

The 2021 and 2022 unreported catches by country are provided in Table 7. Unreported catch estimates 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 US, mandatory C&R became widely applied as a management measure in 1984, and many European countries have introduced this in recent years, 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 2022 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 2021, it ranged from 4% in France to 93% in UK (England & Wales), and in 2022, it ranged from 5% (France) to 96% (UK: England & Wales; UK: Scotland), reflecting varying management practices and angler attitudes among countries. Within countries, the percentage of released fish has increased over time. There is also evidence from some countries that larger MSW fish are released in higher proportions than smaller fish. Overall, more than 172 000 salmon were reported to have been caught and released in the North Atlantic area in 2021 and 2022.

Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2021 and 2022 were 2 003 000 t and 1 951 000 t (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 10%, respectively). Farmed salmon production in 2021 and 2022 were 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 US 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 2021 was provisionally estimated at 2 978 000 t and provisionally estimated for 2022 at 2 926 000 t (Figure 4), which are higher than 2020 and the previous five-year mean (2 643 000 t). Production outside the North Atlantic is estimated to have accounted for one-third of the total worldwide production in 2021 and 2022, dominated by Chile (80%).

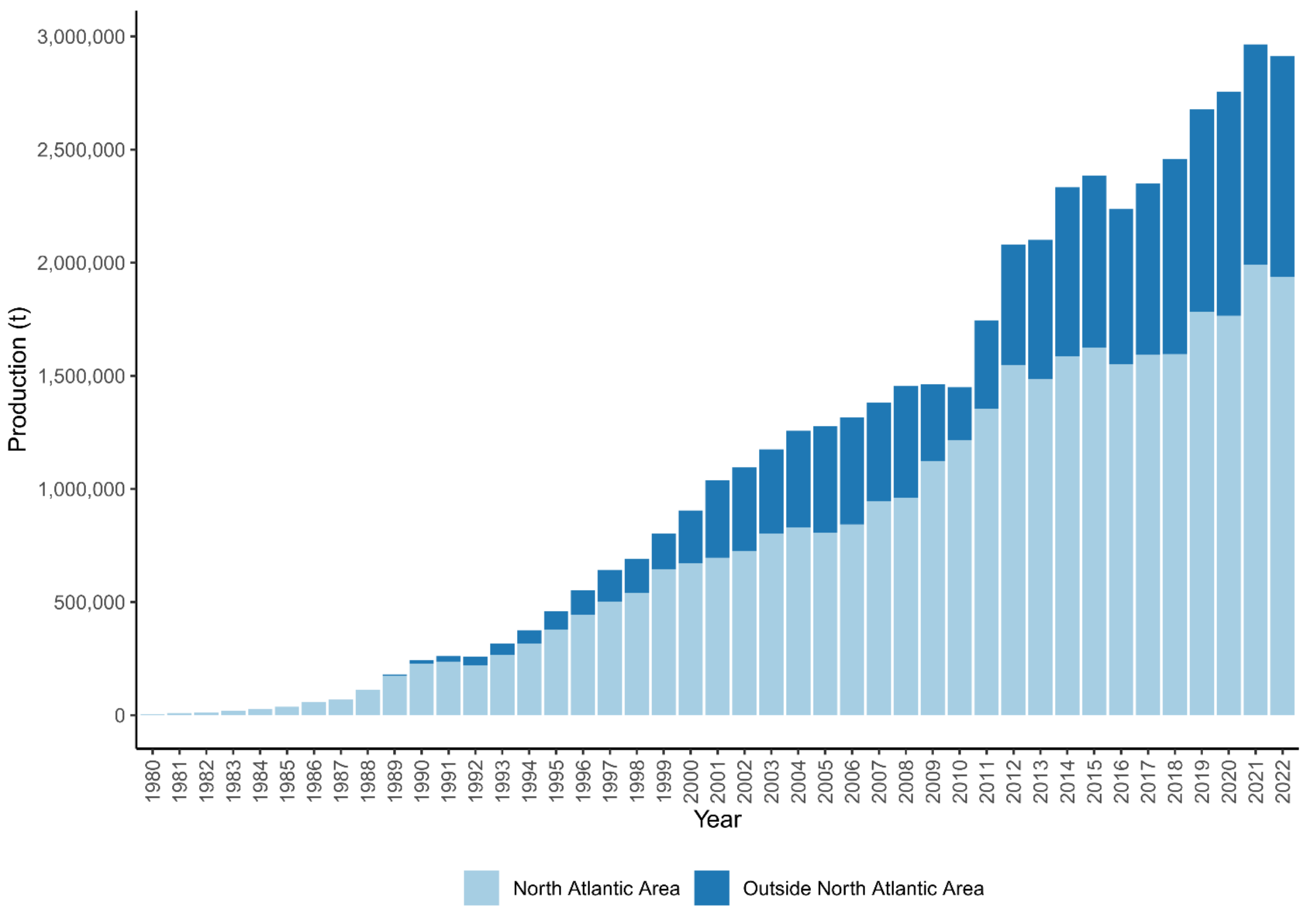


Figure 4 Worldwide production of farmed Atlantic salmon, 1980–2022.

The reported catch of Atlantic salmon in the North Atlantic was in the order of 0.02% of the worldwide production of farmed Atlantic salmon in 2021 and 2022.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic was 20 t in 2021 and 23 t in 2022, all taken in Iceland and Sweden (Figure 5), with the majority of the catch taken in Iceland (80% in 2021 and 93% in 2022). No estimate was made of the ranched salmon production in Norway in 2021 or 2022, where such catches have been very low in recent years (< 1 t); nor in UK (Northern Ireland), where the proportion of ranched fish has not been assessed since 2008; nor in Ireland, where ranching is carried out in a small number of rivers.

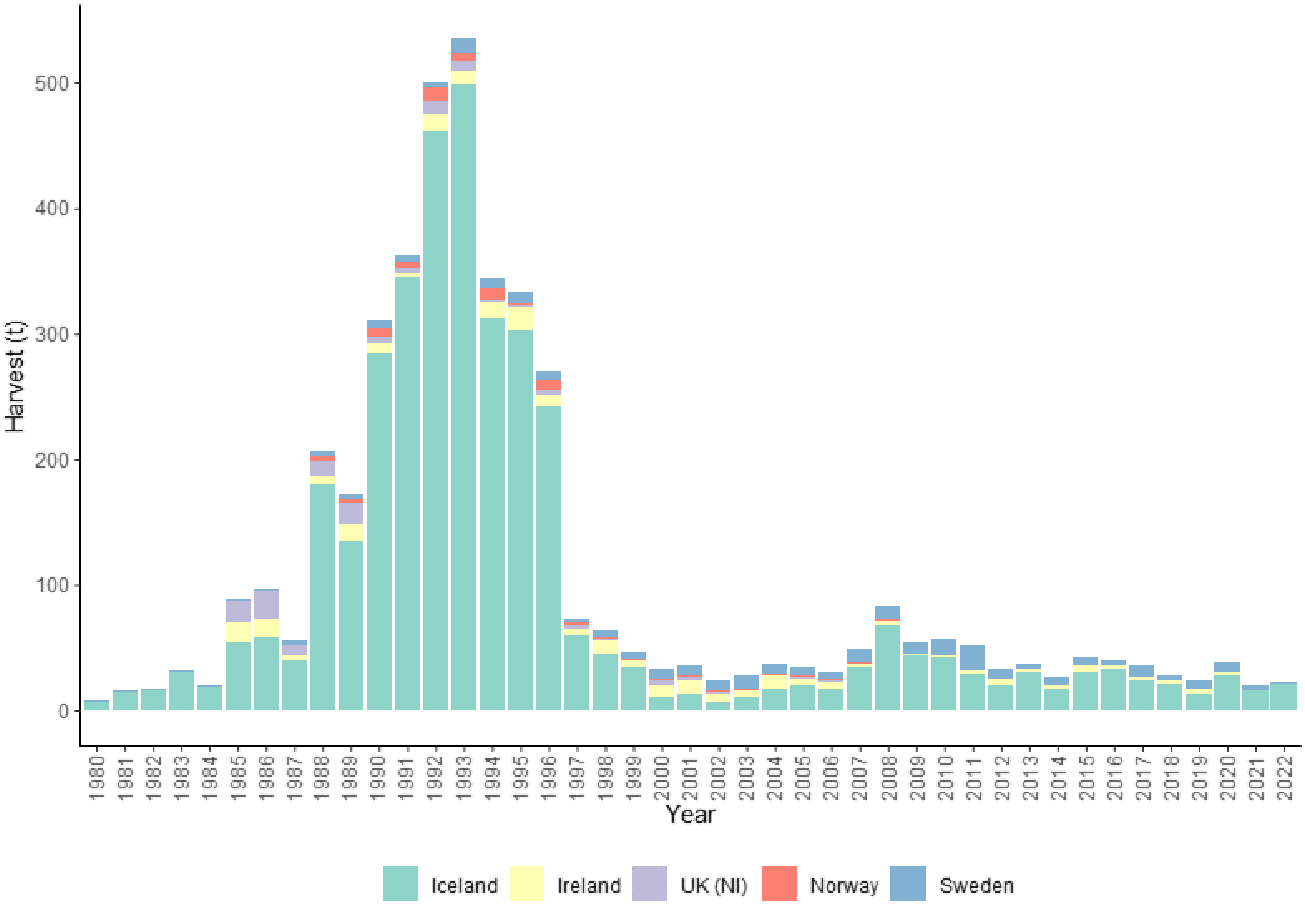


Figure 5 Harvest of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980–2022.

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, and a summary of these is presented below. Details for these are available in the working group report (ICES, 2023a).

Coronavirus (COVID-19)

- In Ireland, exploitation rates, along with their error terms, were revised for MSW salmon in 2020 and 2021 to account for reduced recreational angling due to COVID-related restricted movement orders in spring of each year.
- In UK (Scotland), in order to use the 2020 and 2021 catch data to undertake stock estimation, the catches were first adjusted to account for the reduction in fishing effort due to COVID-19 restrictions. Statistical models were updated in 2022 to include water flow in the relationships, which improved model fits.

Threats

- Infectious Salmon Anaemia (ISA) was noted in farmed salmon in sea-pens in Iceland for the first time. In November 2021, a farmed salmon in a sea pen in Reyðarfjörður was detected with an ISA viral infection (ISA-HPR-del). The virus was also detected in spring of 2022 in a sea pen in Berufjörður, which is about 40 km from Reyðarfjörður and most likely carried between the fjords with equipment that was moved between these two areas prior to the first ISA identification. The decision was made to remove and slaughter all salmon in both areas and rest all operation for 90 days. Following the detection, a screening of ISA was carried out in 4 660 samples from 14 different sea pens in the East fjords, along with 517 samples from three smolt facilities in 2022, all of which came out negative. ISA has caused problems in aquaculture in several countries since it was first discovered in Norway in 1984, but this is the first time the virus has been detected in Iceland.
- Red Skin Disease (RSD) update. Various surveillance programmes and awareness-raising campaigns for reporting of RSD have been established or continued in 2021 and 2022. As they had in 2019 and 2020, several European countries reported Atlantic salmon returning to rivers with RSD in 2021 and 2022 during late spring into summer. While the majority of recorded cases in Ireland are observed in 1SW salmon, this is not the case elsewhere in Europe (notably in UK: Scotland and northern European countries), where RSD is principally observed in MSW stocks. This may be a consequence of the Irish stocks being predominantly 1SW. RSD was not reported in Greenland, Canada, or the US.
- Update on sea lice investigations in Norway. The surveillance programme for sea lice infections on wild salmon postsmolts and sea trout at specific localities along the Norwegian coast continued in 2021 and 2022 (Nilsen *et al.*, 2021, 2022). Activities in the field included trawling for salmon postsmolts in fjords and coastal areas, near-shore traps and nets catching sea trout/arctic char, and sentinel cages with smolts placed at various locations. The field examinations were conducted in two periods: an early period covering the migration period of salmon postmolts; and a period one week later, focused on sea trout infection. As in previous years, the field activities in the surveillance programme were partly based on predictions from the hydrodynamic model for spreading and geographic distribution of salmon louse larvae. Field sampling was directed to areas where the model predicted high densities of infective salmon louse copepodites in the smolt migration period. In 2021 and 2022, in general, the surveillance programme demonstrated varying infection pressure along the coast during the postsmolt migration period.
- Gyrodactilus in Norway. In November 2022, one of the previously infected clusters of rivers ("the Skibotn region") was declared free of the parasite *Gyrodactylus salaris*. This declaration was made because no parasites had been found in salmon samples taken yearly in the rivers since 2016, when they were last treated with rotenone. In 2022, the Driva river was treated with cloramine against *G. salaris*. The chemical monochloramine (brand name 'Monokloramin') is a new treatment that will kill the parasite but not the fish if administered in the correct dosage, eliminating the problems created by rotenone killing all the fish in the river. This treatment will continue in 2023. The smaller rivers in this region were treated with rotenone in 2022, and a new treatment is planned in 2023. At present, only the Drammen region has not been treated against the parasite because of the complexity of the water basins, and the number of infected rivers in Norway is decreasing.

- Offshore Fish Farming in Norway. In Norway, plans are under development for opening offshore areas for aquaculture. A number of suggested areas along the coast have been evaluated for suitability for farming of salmon and also for potential conflict with other natural resources, such as deep-sea coral reefs and spawning areas for marine species, as well as with other activities that may use these areas, such as fishing. Through a formal consultation process with a number of institutions and agencies, many of the initially proposed areas were excluded, and three areas were selected for further evaluation: one off southwest Norway, one area in Mid-Norway, and one in northern Norway[1]. Depending on the technology being developed for the offshore fish farms, the level of production in the areas, and their proximity to migration routes of wild postsmolts, aquaculture in these areas may have an impact on outmigrating postsmolts from the rivers.

Opportunities

- Estimating homewater catches and returns in France. In the context of the WGNAS benchmarking process, France has identified the need to review the models used to provide time-series (1971 onwards) of homewater catches and adult returns at the national level. A new integrated hierarchical Bayesian model is currently under development that makes the best use of the available data and expertise, while accounting for regional specificities of fisheries and population dynamics. This model integrates various sources of data, e.g. catches of estuarine net fisheries and freshwater angling fisheries; estimates of abundances at regional and river scales; and surface area of production. Regional expertise was used to make assumptions on time-trends of harvest rates, depending on the fishery and the sea age class considered. The results provide new insights on the abundance of adults returning to homewaters and on associated harvest rates, both on a regional basis and aggregated at the national level. The decrease of 1SW adults is estimated to be less severe than that which the run-reconstruction model has estimated so far, whereas no major changes were observed between the estimates for MSW returns from the two models. The new approach still needs to be validated, and the new estimates are expected to be used for the ICES assessment in 2024.
- Effect of Catch and Release and temperature on reproductive success on a Quebec river. A new project investigating the effect of catch and release and temperature at release on reproductive success of Atlantic salmon has been conducted in Quebec, Canada (Bouchard *et al.*, 2022). This project was motivated by the fact that, while this conservation practice is increasingly common and usually causes low mortality rates, its effects on the reproductive success of caught-and-released fish are poorly understood. In this project, the reproductive success of caught-and-released relative to non-caught salmon was compared, and the effect of temperature at release was tested. Molecular parentage analysis to link parents with their young-of-the-year progeny shows that at least 83% of caught-and-released salmon successfully reproduced, including fish that had been released in water warmer than 20°C. However, the reproductive success of caught-and-released female salmon was only 73% of the reproductive success of non-caught salmon. Moreover, the increasing temperature did not affect the reproductive success of released fish. These findings should be useful for evaluating the risks and benefits of catch and release and for optimising conservation practices used for the preservation of Atlantic salmon populations.

NASCO 1.3 Provide information on causes of variability in return rates between rivers within regions in the North Atlantic

Annual estimates of marine return rates of Atlantic salmon in the North Atlantic have been compiled and updated annually by ICES (2023a). There are 35 rivers in the Northwest and Northeast Atlantic with monitoring data that provide estimates of return rates of wild outmigrating salmon smolts to adult returns. This is supplemented by data from 28 rivers with hatchery smolt to adult return rates. The data sets cover the period from the 1969 to 2019 smolt migration years. Temporal coverage is sparse for a number of the rivers; but 37 data sets, including wild and hatchery origin smolts, have a temporal coverage of 20 or more years.

Return rates are expressed as the ratio of returning first-time spawning salmon to outmigrating salmon smolts for the smolt migration year. Estimates of return rates are provided for 1SW, for two-sea-winter (2SW or MSW), and for some series for the sum of first-time spawning salmon. The return rates are estimated from the point where smolt and returning

[1] http://www.fiskeridirektoratet.no/Akvakultur/Dokumenter/Rapporter/anbefaling-av-tre-omrader-for-havbruk-til-havs

adult abundances are assessed and, therefore, represent the outcome of marine and estuarine fishing and non-fishing–related mortality.

Smolt and adult return monitoring programs most often occur at freshwater monitoring sites. There may be important losses of smolts in the freshwater portion of the river during the downstream migration of smolts, and the mortality in the freshwater phase may be important in some rivers and regions, with factors dependent upon the geography of the river systems, predator communities, and anthropogenic stressors. Losses of adult salmon returning to rivers may also occur in proximity to their natal rivers or in the river itself, downstream of the assessment facility; this will have consequences on the calculation of return rates. Standardizing the return rate reporting as returns of adults to freshwater is much easier than attempting to correct for the freshwater location of the smolt monitoring site. Survival rates of smolts through freshwater below the monitoring sites cannot be easily corrected, as the rates can be highly variable among rivers and years, and estimates from acoustic tagged smolts may not be representative of survival rates of untagged and unmanipulated animals.

It is not possible to address marine return rates for Atlantic salmon without considering the interaction of marine survival and sea age at maturity processes. Return rates are the product of sea survival rates and the probability of maturing at a given sea age.

Return rates of wild salmon smolts in the Southern NEAC regions are generally higher than those of the Northern NEAC regions, and both are higher than return rates of regions in NAC. The differences between continental complexes are also noted in the hatchery origin smolt return rates. In both continent complexes and smolt origin type, the return rates to first-time spawners are higher in populations dominated by 1SW salmon compared to the return rates of the MSW-dominated rivers of those regions. River-specific return rates are highly variable among monitored rivers, with general characteristics consistent with the sea age at maturity characteristics of the stocks and the continent of origin patterns.

The temporal trends in return rates in regions are variable. In NAC, there is a general declining trende over the 1980s to the 2000s in the return rates to the Quebec region, contrasted with increased return rates to rivers for 1SW salmon in the Newfoundland region. In NEAC, there is an obvious decline in returns rates for Ireland and UK (Northern Ireland); in UK (England & Wales), there is a recent trend of decline in the 1SW and an increasing trend in the MSW return rates. The declining trend in return rates for 1SW salmon in Norway occurred from the 1980s through to the year 2000 and has levelled off since. However, the trends in regions are not representative of all rivers within those regions. Increased return rates to freshwater in some monitored rivers in the Newfoundland region after 1992 are attributed to the closure of the homewater marine commercial fisheries, whereas, in other rivers, return rates declined further after the commercial fishery closure. In the NEAC areas, river-specific return rates for wild salmon are equally variable among rivers and regions. With few exceptions, the general pattern is a decline in return rates for 1SW salmon and for the overall smolt cohort across all rivers from Iceland to Norway, with the exception of the rivers in UK (England & Wales) and UK (Scotland). The strongest decline occurred for the 1SW salmon return rate; the decline was much less for the MSW return rate.

A number of studies and reviews over the past two decades have considered the potential factors and mechanisms that modify marine survival of Atlantic salmon. Overall, these studies point to the interactions and interdependence of the different ecosystems that anadromous salmon occupy and that shape their life histories. Marine survival in Atlantic salmon can be influenced by a range of factors associated with individual outmigrating smolt characteristics (e.g. size, condition, genetics); the rearing environment of the juveniles (natural versus captive rearing); and local and broad-scale ecosystem conditions, including physical attributes of the receiving environment and the prey and predator communities. Additional to these are the diverse anthropogenic stressors to salmon, which differ across the species distribution range.

The inter-river variation in return rates within the same year are (most likely) largely attributable to local and regional variations in factors that affect the early phase of the marine migration and survival, whereas the long-term temporal patterns of return rates are most likely determined by the combination of local, regional, and North Atlantic factors acting throughout the time of salmon at sea. It is probably a given that predation is the final cause of the death of an individual fish, but the factors that lead to its being predated upon may be associated with stresses at an earlier time and location in its life history. These carryover effects can originate in freshwater, in the early phase of the marine migration, and up to the point of return to rivers as potential spawners.

Thus, a number of factors at local, regional, and continental scales – all of which potentially fluctuate over time – can result in variations in return rates from monitored rivers within and among regions assessed by ICES. Variations among return rates of 1SW, MSW, and the smolt cohort observed in monitored rivers, and among regions and continental groups, suggest that factors at river-specific, regional, and North Atlantic scales interact to affect marine survival rates and maturation schedules. With the exception of very specific identifiable factors, such as exploitation of returning spawners in rivers or mortality of downstream migrating smolts through turbines, it is very unlikely that any single factor can account for the temporal variations and, in several areas, the declines of wild Atlantic salmon in the North Atlantic.

NASCO 1.4 Provide a summary of the most recent findings of ongoing research projects investigating the marine phase of Atlantic salmon (e.g. SeaSalar, SeaMonitor, SAMARCH, satellite tagging at Greenland)

ICES is aware of a number of large-scale collaborative projects investigating the marine phase of Atlantic salmon across the North Atlantic. These projects are ongoing, and section 2.5 in ICES (2023a) introduces these projects and provides updates on status and preliminary results. Information was provided directly by Working Group members involved in the following projects:

- Atlantic Salmon Federation's Acoustic Tracking
- Environmental Studies Research Fund
- ATLANTIC SALMON AT SEA - factors affecting their growth and survival (SeaSalar)
- SAlmonid MAngement Round the CHannel (SAMARCH)
- Pop-off satellite tagging at Greenland
- SeaMonitor
- SMOLTRACK

NASCO 1.5 Provide a summary of the current state of knowledge on freshwater and marine predation by cormorants and impact on stocks

In the North Atlantic region, the great cormorant (*Phalacrocorax carbo*) and the double-crested cormorant (*Nannopterum auritum*) can be found, while only the latter is present in North America. The great cormorant consists of two subspecies: *Phalacrocorax carbo carbo* and *P. c. sinensis*. They exhibit a predominantly piscivorous diet, and *P. c. sinensis* is likely to pose the greater threat with respect to the predation of salmon.

In Europe, cormorants (principally *P. c. sinensis*) have increased extensively since the 1980s, mainly in the North Sea and Baltic Sea regions. Numbers of this subspecies have increased substantially in Europe (excluding Russia, Belarus, Moldova, and Ukraine) from approximately 10 000 breeding pairs in 1970 to approximately 233 000 in 2006, though estimates vary depending on subspecies, geographical region, and year[2]. This great population increase has led to widespread conflicts throughout Europe, where even mitigation measures and cormorant regulation (i.e. Article 9 of the EU Birds Directive[3]) have not been effective in resolving these (EIFAAC, 2022).

In Denmark, there was a rapid increase of breeding pairs of cormorants in the 1990s, from very few to 40 000 pairs. The main food was coastal fish, and main conflicts were on the coast with pound net fishers. Anecdotely, common prey species of cormorants, such as cod (*Gadus morhua*), flounder (*Platichthys flesus*), dab (*Limanda limanda*), and eelpout (*Zoarces viviparus*), have decreased substantially in coastal waters. It is hypothesized that, as a result, the abundance of cormorant breeding pairs has decreased to around 30 000 (Jepsen *et al.*, 2019).

Many studies have been conducted focusing on the impact of cormorants on fish populations in Denmark. For example, Jepsen *et al.* (2019) found that, from results of 23 individual studies, a mean of 47% of smolts (both salmon and trout) are consumed by cormorants over multiple rivers and years. In Denmark, cormorant/smolt studies have been carried out for

[2] https://ec.europa.eu/environment/nature/cormorants/faq.htm

[3] https://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm

20 years, and it is noteworthy that the rapid rebuilding of the Danish salmon populations took place when the cormorant breeding population was at its highest, with more than 40 000 breeding pairs (Jepsen [pers. comm.]). However, after a steep decrease in available prey on the coasts, the cormorants started to forage in Danish rivers, consuming a high proportion of salmon parr. It is hypothesized that this reduction in traditional marine prey for cormorants decreased cormorant abundance but increased predation on salmon in freshwater, likely contributing to the stagnation of the recovery of Danish salmon stocks, despite increased and improved spawning and rearing habitats.

A series of predator exclusion experiments were conducted in several Danish rivers, and the results showed that winter survival of 0+ and 1+ salmon parr increased from 17% to 50% when cormorants were excluded (other predators had access) by installing cover nets over river stretches (ICES, 2023a). Results from these studies suggest that cormorant predation will lower smolt production and could result in as much as a 75% decrease in adult salmon runs, a substantial impact on EU-listed salmon in Danish rivers (Habitats Directive, Annex V[4]). In Europe, the cormorant diet can vary significantly over time and space, particularly in relation to prey availability in freshwater or marine environments; this has led to the conclusion that the impacts of cormorant predation on salmon in some areas may be more limited (Lyach and Čech, 2017).

In Sweden and Finland, a similar increase in breeding cormorants has been observed during the last decades. Similarly to Denmark, coastal fish populations have decreased and, therefore, shifts in cormorant diet may be expected. In Sweden, results from PIT-tagging in the river Dalälven show that, as in Denmark, trout are more commonly preyed upon by cormorants than are salmon, particularly in the Baltic Sea (ICES, 2023a). On the Swedish west coast, only a few studies have been conducted focusing on cormorant-prey dynamics. However, it has been suggested that, in the marine environment, the predation pressure on cod is of greater concern than that on salmon. Some accounts also propose that in west coast rivers, cormorants may be feeding upon salmon (ICES, 2023a). Reports from Ireland conclude that predation from cormorants (*carbo* subspecies) can also be a problem for salmon stocks in some areas (Kennedy *et al.*, 1988; Flavio *et al.*, 2020). Cormorant predation has also been identified as an issue for grayling populations in some areas of Europe, even leading to local extinctions (Jepsen *et al.*, 2018; Carss and Russell, 2022).

Very few salmonid studies met the criteria for inclusion in a global meta-analysis of the effect of predation by cormorants (multiple *Phalacrocorax* species) on fish in general (Ovegård *et al.*, 2021). No Atlantic salmon studies were included in this analyses because they did not meet the criteria; therefore, the range-wide effect of cormorant predation on Atlantic salmon populations remains unclear. More studies are required, and these must be statistically robust, with clear treatment-control setups so that confident conclusions can be drawn.

In North America, Cairns (1998) reported that double-crested cormorants (*Phalacrocorax auritus*) breed along coasts and estuaries in the Atlantic New England states, the Maritimes Provinces, and Eastern Quebec. A few inland colonies are also found in the Gulf region. They forage primarily along the coast, but they may intrude on freshwater habitats during spring runs of anadromous fish. At these times, a substantial fraction of the diet may include Atlantic salmon during smolt outmigration in rivers whose runs are supplemented by stocking. At other times, this species feeds on a variety of marine and estuarine species. Double-crested cormorants leave the region in the autumn to winter in the southeastern United States.

Great cormorants (*P. carbo carbo*) mainly breed in Nova Scotia, with a few colonies found in Quebec and Newfoundland. They forage almost exclusively in saltwater. Information on their diet is only available for populations on the coasts of Nova Scotia and the Magdalen Islands (Quebec). No salmonids were found in the stomach, vomit, or pellet samples from this species.

In 2004 and 2005, Hawkes *et al.* (2013) conducted experiments to evaluate the effectiveness of non-lethal harassment of double-crested cormorants to improve smolt survival in the Narraguagus River (US). Their study highlighted the lack of overlap between the peak migration of smolts (mainly at night) and cormorant presence in the estuary (mainly in the morning). Most mortalities observed (30/127 smolt marked) during the study occurred in the estuary in the morning hours, with reduced mortality rate when harassment occurred. A study (Carrier *et al.*, 2016) on a colony of about a thousand breeding pairs of double-crested cormorants located at the mouth of the Restigouche river (New Brunswick, Canada) found

[4] https://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

two salmon otoliths out of 441 regurgitated pellets during the 2014 smolt run, suggesting that Atlantic salmon smolts did not comprise a large part of the diet of these cormorants.

In conclusion, in areas where cormorants have increased and/or declines have occurred in other cormorant prey species abundances, there is a higher likelihood that salmon will be predated upon. Cormorant predation can have substantial impacts on salmon populations, particularly in areas where salmon populations are already threatened or endangered; but further and more robust studies are required to determine local and widespread impacts on salmon populations. When considering predation as a threat to salmon, ICES notes that there are many other fish, bird, and mammalian predators.

NASCO 1.6 Provision of a compilation of tag releases by country in 2021 and 2022

Data on releases of tagged, finclipped, and other marked salmon in 2021 and 2022 are compiled as a separate report (ICES, 2023a). In summary (Tables 4a, 4b) and noting that no recent data were available from the Russian Federation (where large tagging programmes have taken place in recent years):

- Approximately 1.5 and 1.12 million salmon were marked in 2021 and 2022, reduced from the 1.96 million salmon marked in 2020.
- The adipose clip was the most commonly used primary marker (1.11 million), with coded wire microtags (CWT) (0.196 million) being the next-most common.
- Most marks were applied to hatchery-origin juveniles (1.42 million in 2021, 1.03 million in 2022), while 67 169 and 70 603 wild juveniles and 13 212 and 14 656 wild adults were tagged in 2021 and 2022 (respectively), and 4 213 and 5 198 hatchery adults were marked in these years.
- The use of Passive Integrated Transponder (PIT) tags, data storage tags (DSTs), radio and/or sonic transmitting tags (pingers) has increased in recent years. Nevertheless, in 2021 and 2022, 50 000 and 128 000 salmon (respectively) were tagged with these tag types (Table 4): a marked decrease from 2020 (161 705).

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. A PIT-tagged salmon database that lists individual PIT tag numbers or codes identifying the origin, source, or programme of the tags has been designed by Missing Salmon Alliance UK (MSA) and IMR in Norway and is hosted and maintained by MSA.[5] The database provides a central, searchable tag data repository against which unknown PIT detections can be searched. It also holds information on tag detections from pelagic marine fish species in the eastern Atlantic region, with a network of over 20 PIT detector stations operated at fish processing plants in several countries.

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 US, genetic identification procedures have been adopted wherein 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, 20 out of 24 farmed escapees could be traced to the pens from which they had escaped by matching their genotypes to known parental genotypes, and a further three could be traced to foreign broodstocks.

[5] https://shiny.missingsalmonalliance.org/tag-database/

Table 4a Summary of Atlantic salmon tagged and marked in 2021. 'Hatchery' and 'Wild' juvenile refer to smolts and parr.

Country	Origin	Primary Tag or Mark				
		Microtag	External mark *	Adipose clip	Other Internal †	Total
Canada	Hatchery Adult	0	1813	23	453	2289
	Hatchery Juvenile	0	24	24 741	50	24 815
	Wild Adult	0	2474	13	1243	3730
	Wild Juvenile	0	13 511	13 545	1762	28 818
	Total	**0**	**17 822**	**38 322**	**3508**	**59 652**
Denmark	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	90 000	0	90 000
	Wild Adult	0	0	0	241	241
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**90 000**	**241**	**90 241**
France	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	87 957	0	87 957
	Wild Adult	0	0	0	524	524
	Wild Juvenile	0	0	0	5030	5030
	Total	**0**	**0**	**87 957**	**5554**	**93 511**
Iceland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	29 585	0	0	0	29 585
	Wild Adult	0	415	0	0	415
	Wild Juvenile	4947	0	0	1095	6042
	Total	**34 532**	**415**	**0**	**1095**	**36 042**
Ireland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	152 486	0	0	0	152 486
	Wild Adult	0	0	0	0	0
	Wild Juvenile	114	0	0	3387	3501
	Total	**152 600**	**0**	**0**	**3387**	**155 987**
Norway	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	2986	0	7925	10 911
	Wild Adult	0	0	0	6467	6467
	Wild Juvenile	0	415	0	0	415
	Total	**0**	**3401**	**0**	**14 392**	**17 793**
Russia	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	464 740	0	464 740
	Wild Adult	0	784	0	0	784
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**784**	**464 740**	**0**	**465 524**
Spain	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	121 902	0	121 902
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**121 902**	**0**	**121 902**
Sweden	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	183 285	0	183 285
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	123	123
	Total	**0**	**0**	**183 285**	**123**	**183 408**

Country	Origin	Primary Tag or Mark				
		Microtag	External mark *	Adipose clip	Other Internal †	Total
UK (England & Wales)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	19	26	45
	Wild Adult	0	465	0	40	505
	Wild Juvenile	2824	0	0	10 393	13 217
	Total	**2824**	**465**	**19**	**10 459**	**13 767**
UK (N. Ireland)	Hatchery Adult	0	0	0	22	22
	Hatchery Juvenile	7018	0	100 487	30	107 535
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	418	418
	Total	**7018**	**0**	**100 487**	**470**	**107 975**
UK (Scotland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	33 251	0	33 251
	Wild Adult	0	472	0	4	476
	Wild Juvenile	0	0	806	8799	9605
	Total	**0**	**472**	**34 057**	**8803**	**43 332**
Germany	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	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**
Greenland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	0	0
	Wild Adult	0	70	0	0	70
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**70**	**0**	**0**	**70**
US	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	4	0	1898	1902
	Wild Adult	0	0	112 835	72	112 907
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**4**	**112 835**	**1970**	**114 809**
All Countries	Hatchery Adult	0	1817	23	2373	4213
	Hatchery Juvenile	189 089	124 912	1 097 315	8103	1 419 419
	Wild Adult	0	4680	13	8519	13 212
	Wild Juvenile	7885	13 926	14 351	31 007	67 169
	Total	**196 974**	**145 335**	**1 111 702**	**50 002**	**1 504 013**

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

Table 4b Summary of Atlantic salmon tagged and marked in 2022. 'Hatchery' and 'Wild' juvenile refer to smolts and parr.

Country	Origin	Primary Tag or Mark				
		Microtag	External mark ‡	Adipose clip	Other Internal §	Total
Canada	Hatchery Adult	0	1195	128	581	1904
	Hatchery Juvenile	0	0	202	0	202
	Wild Adult	0	1731	0	378	2109
	Wild Juvenile	0	13 171	10 369	1551	25 091
	Total	**0**	**16 097**	**10 699**	**2510**	**29 306**
Denmark	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	230 000	0	230 000
	Wild Adult	0	0	0	668	668
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**230 000**	**668**	**230 668**
France	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	0	0
	Wild Adult	0	0	0	277	277
	Wild Juvenile	0	0	0	5326	5326
	Total	**0**	**0**	**0**	**5603**	**5603**
Iceland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	38 150	0	0	0	38 150
	Wild Adult	0	355	0	0	355
	Wild Juvenile	1975	0	0	1891	3866
	Total	**40 125**	**355**	**0**	**1891**	**42 371**
Ireland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	133 075	0	0	0	133 075
	Wild Adult	0	0	0	0	0
	Wild Juvenile	5190	0	0	3442	8632
	Total	**138 265**	**0**	**0**	**3442**	**141 707**
Norway	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	2995	2995
	Wild Adult	0	0	0	8776	8776
	Wild Juvenile	0	376	0	0	376
	Total	**0**	**376**	**0**	**11 771**	**12 147**
Russia	Hatchery Adult					na
	Hatchery Juvenile					na
	Wild Adult					na
	Wild Juvenile					na
	Total	**na**	**na**	**na**	**na**	**na**
Spain	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	179 895	0	179 895
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**179 895**	**0**	**179 895**
Sweden	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	202 733	0	202 733
	Wild Adult	0	0	0	482	482
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**0**	**202 733**	**482**	**203 215**

Country	Origin	Primary Tag or Mark				
		Microtag	External mark ‡	Adipose clip	Other Internal §	Total
UK (England & Wales)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	0	0
	Wild Adult	0	638	0	25	663
	Wild Juvenile	6216	0	0	9054	15 270
	Total	**6216**	**638**	**0**	**9079**	**15 933**
UK (N. Ireland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	11 202	0	0	76 499	87 701
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	491	491
	Total	**11 202**	**0**	**0**	**76 990**	**88 192**
UK (Scotland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	27 320	0	27 320
	Wild Adult	0	215	0	7	222
	Wild Juvenile	0	0	0	11 551	11 551
	Total	**0**	**215**	**27 320**	**11 558**	**39 093**
Germany	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	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**
Greenland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	0	0
	Wild Adult	0	100	0	109	209
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**100**	**0**	**109**	**209**
USA	Hatchery Adult	0	0	0	3294	3294
	Hatchery Juvenile	0	0	126 252	148	126 400
	Wild Adult	0	13	327	555	895
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**13**	**126 579**	**3997**	**130 589**
All Countries	Hatchery Adult	0	1195	128	3875	5198
	Hatchery Juvenile	182 427	0	766 402	79 642	1 028 471
	Wild Adult	0	3052	327	11 277	14 656
	Wild Juvenile	13 381	13 547	10 369	33 306	70 603
	Total	**195 808**	**17 794**	**777 226**	**128 100**	**1 118 928**

‡ Includes other internal tags (e.g. PIT, ultrasonic, radio, DST).
§ Includes Carlin, spaghetti, streamers, VIE, etc.

NASCO 1.7 Identify relevant data deficiencies, monitoring needs, and research requirements

ICES recommends that WGNAS should meet in 2024 (chaired by Alan Walker, 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. A tentative date for the meeting was set from 11 March to 21 April 2024.

Recommendations

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

North Atlantic (Other)

Overview of predation by cormorants: No Atlantic salmon studies met the criteria for inclusion in a global meta-analysis of the effect of predation from cormorants (multiple *Phalacrocorax* species) on fish in general (Ovegård *et al.*, 2021). Therefore, the range-wide effect of cormorant predation on Atlantic salmon populations remains unclear. More studies are required, and these must be statistically robust, with clear treatment-control setups so that confident conclusions can be made.

A database has been designed by MSA in UK and IMR in Norway and hosted and maintained by MSA[6]. The database provides a central, searchable tag data repository against which unknown PIT detections can be searched. It also holds information on tag detections from pelagic marine fish species in the eastern Atlantic region, with a network of over 20 PIT detector stations operated at fish processing plants in several countries. Tag users from across the North Atlantic Basin 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.

North American Commission

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. A sampling rate of at least 10% of catches across the fishery season 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

Data call submissions were not received for the following NEAC jurisdictions with known/historic salmon fisheries or farmed salmon production: Ireland, Russian Federation, Faroe Islands, Portugal, and Germany. Equivalent data from Ireland and Faroe Islands were received via national reports to ICES. ICES understands that there was no commercial catch in Germany in 2022; there may have been a small amount of recreational catch, but the amount has not been reported. ICES recommends that all countries submit salmon data through the data call process, as this is the most effective and efficient way for ICES to automate the data collation, quality assurance, analyses, and reporting.

Data on catch numbers, exploitation rates, and unreported catch rates were not available to ICES for the years 2021 and 2022 for any of the four Russian Federation stock units. In the absence of data, exploitation rates and unreported catch rates, together with their associated errors, were assumed unchanged from previous years. With respect to catches, the total catch for Russian Federation in wet mass for all stock units and sea ages combined was available for both 2021 (55.38 t) and 2022 (48.82 t) (NASCO, 2023a). The ratios of the total catch for Russian Federation in 2021 and 2022 to the mean total catch for the last five years of available stock unit data (2016 to 2020) were used to scale the mean catches by sea age and stock unit for the same five-year period to derive estimated catches for 2021 and 2022. The method developed to fill these data gaps might improve with time; but if the true data cannot be used in future years, the levels of uncertainty in the derived data will increase and, at some point, will reach a level at which the process should no longer be applied.

[6] https://shiny.missingsalmonalliance.org/tag-database/

No river-specific CLs have been established for Denmark, Germany and Spain. Iceland has set provisional CLs for all salmon-producing rivers and continues to work towards finalizing an assessment process for determining CL attainment.
The review of risk of bycatch conducted by ICES identified that, although it was clear that salmon are currently caught as bycatch in coastal areas when they migrate to and from their natal rivers, the information that exists on coastal fisheries is insufficient to evaluate coastal bycatch risk.

From this review of literature on salmon bycatch, ICES has identified the following data deficiencies, monitoring needs and research requirements:

1) Improve understanding of post-smolt and adult salmon migration route in time.
2) Move to a quantitative analysis of the risk of exposure and bycatch risk to stocks, which requires access to gear- and fisheries-specific fishing effort data (both inshore and offshore data) at an ICES rectangle by month.
3) Include salmon as a species in offical bycatch data calls.
4) Standardise salmon bycatch monitoring programmes across countries, including minimum effort per fishery and standards for data recording and reporting.
5) Improve at-sea and onshore observer screening, including better salmon identification guidance. Minimum data to be collected are: date, fishery, catch location, number of salmon bycatch, fork length (preferably) and/or weight. The screening of discards from factories should also be explored (recommendation from ICES Study Group on Bycatches of Salmon in Pelagic Fisheries [SGBYSAL], 2004) via close collaboration with factories operators.
6) As bycatch data collection is difficult to access at present, eDNA data collection from scientific and commercial pelagic trawls may help improve detection of salmon and improve knowledge of their migratory pathways. Uncertainty estimates from these analyses are required.

West Greenland Commission
No recommendations specific to WGC are provided.

Table 5 Total reported catch of salmon by country@ (in tonnes, round fresh weight), 1960–2022 (2022 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

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 ^^														
2000	153	0	2	1176	124	73	11	24	9	5	95	621	219	78	274	11	7	8	0	21	-	2912	1269
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	103	0	2	527	49	42	28	7	7	9	16	46	3		14	8	5	0	1	31		898	275
2021	98	0	2	295	49[%]	41	16	6	5	2	1	51	1	2	7	7	4	0	1	42		630	164
2022	100	0	1	389	55[%]	35	21	7	2		1	40	1	1	6	7	3	0	1	30		700	202
2017–2021	98	0	2	519	56	49	21	7	7	11	19	49	20	4	16	10	4	0	1	34		923	272
2012–2021	115	0	3	545	66	63	24	11	6	11	36	60	45	5	50	10	5	0	1	39		1091	302

[@] Country/Jurisdiction codes: CA (Canada), US (United States of America), SPM (Saint Pierre and Miquelon), NO (Norway), RU (Russian Federation), IS (Iceland), SE (Sweden), DK (Denmark), FI (Finland), IE (Ireland), UK E/W (United Kingdom England & 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 2001 do not include catches taken in the recreational (rod) fishery; 2021 and 2022 data extracted from NASCO website at https://nasco.int/conservation/third-reporting-cycle-2/

^ 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 Northern 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 Russian Federation since 2008.
[%] Russian Federation data extracted from NASCO website at https://nasco.int/conservation/third-reporting-cycle-2/

Table 6 Reported catches (tonnes, round fresh weight) and % of the reported catches by country taken in coastal, estuarine, and in river fisheries, 2000–2022. Data for 2022 include provisional data.

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
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	8	7	45	44	50	49	103
	2021	7	8	40	41	50	51	98
	2022	7	7	42	42	51	51	100
Denmark	2008	0	1	0	0	9	99	9
	2009	0	0	0	0	8	100	8
	2010	0	1	0	0	13	99	13
	2011	0	0	0	0	13	100	13
	2012	0	0	0	0	12	100	12
	2013	0	0	0	0	11	100	11
	2014	0	0	0	0	9	100	9
	2015	0	0	0	0	9	100	9
	2016	0	0	0	0	10	100	10
	2017	0	1	0	0	12	99	12

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
	2018	0	1	0	0	11	99	11
	2019	0	1	0	0	13	99	13
	2020	0	0	0	0	9	100	9
	2021					2	100	2
Finland	1996	0	0	0	0	44	100	44
	1997	0	0	0	0	45	100	45
	1998	0	0	0	0	48	100	48
	1999	0	0	0	0	63	100	63
	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
	2021					1	100	1
	2022					1	100	1
France*^	1996			4	31	9	69	13
	1997			3	38	5	62	8
	1998	1	12	2	25	5	62	8
	1999	0	0	4	35	7	65	11
	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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
	2008	1	5	5	39	7	57	12
	2009	0	4	2	34	3	62	5
	2010	2	22	2	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	0	5	3	36	6	59	10
	2018	0	0	5	47	6	53	11
	2019	0	2	8	54	6	44	15
	2020	0	2	4	48	4	50	8
	2021	0	1	3	38	4	61	7
	2022	0	0	3	50	3	50	7
Iceland^^^	1996	10	9	0	0	111	91	122
	1997	0	0	0	0	156	100	156
	1998	0	0	0	0	164	100	164
	1999	0	0	0	0	146	100	146
	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	146	100	146
	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	90
	2018	0	0	0	0	82	100	82
	2019	0	0	0	0	51	100	51
	2020	0	0	0	0	70	100	70
	2021					44	100	44
	2022					56	100	56

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
Ireland	1996	440	64	134	20	110	16	684
	1997	380	67	100	18	91	16	571
	1998	433	69	92	15	99	16	624
	1999	335	65	83	16	97	19	515
	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	21	31	47	69	68
	2010	0	0	38	39	60	61	98
	2011	0	0	32	37	55	63	87
	2012	0	0	28	32	60	68	88
	2013	0	0	38	44	49	56	87
	2014	0	0	26	46	31	54	57
	2015	0	0	21	33	42	67	63
	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	36	29	64	46
	2021			17	35	33	65	51
	2022			11	27	29	73	40
Norway	1996	520	66	0	0	267	34	787
	1997	394	63	0	0	235	37	629
	1998	410	55	0	0	331	45	741
	1999	483	60	0	0	327	40	810
	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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
	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
	2021	98	33			197	67	295
	2022	134	34			256	66	389
Russian Federation$	1996	64	49	21	16	46	35	130
	1997	63	57	17	15	32	28	111
	1998	55	42	2	2	74	56	131
	1999	48	47	2	2	52	51	102
	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	24	30	82
	2006	52	57	0	0	39	43	91
	2007	31	50	0	0	31	50	62
	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	44	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	38	0	0	35	62	57
	2020	16	34	0	0	32	66	49
	2021	17	35			32	65	49
	2022	19	35			36	65	55

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
Spain^^	1996	0	0	0	0	7	100	7
	1997	0	0	0	0	4	100	4
	1998	0	0	0	0	4	100	4
	1999	0	0	0	0	6	100	6
	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	10	100	10
	2007	0	0	0	0	9	100	9
	2008	0	0	0	0	9	100	9
	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	7	100	7
	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	3	5	97	5
	2021			0	1	4	99	4
	2022					3	100	3
Sweden***	1996	19	58	0	0	14	42	33
	1997	10	56	0	0	8	44	18
	1998	5	33	0	0	10	67	15
	1999	5	31	0	0	11	69	16
	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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
	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	17	100	17
	2016	0	0	0	0	9	100	9
	2017	0	0	0	0	18	100	18
	2018	0	0	0	0	17	100	17
	2019	0	0	0	0	20	100	20
	2020	0	0	0	0	14	100	14
	2021	0	0	0	0	11	100	11
	2022	0	0	0	0	8	100	8
UK (England & Wales)	1996	83	45	42	23	58	31	183
	1997	81	57	27	19	35	24	142
	1998	65	53	19	16	38	31	123
	1999	101	67	23	15	26	17	150
	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
	2021			0	0	1	100	1
	2022			0	0	1	100	1

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
UK (Northern Ireland)**	1999	44	83	9	17			53
	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	28
	2007	6	21	6	20	17	59	30
	2008	4	19	4	22	12	59	21
	2009	4	24	2	15	10	62	16
	2010	5	39	0	0	7	61	12
	2011	2	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	4	100	4
	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	2	100	2
	2021	0	0			2	100	2
	2022					1	100	1
UK (Scotland)	1996	129	30	80	19	218	51	427
	1997	79	27	33	11	184	62	296
	1998	60	21	28	10	195	69	283
	1999	35	18	23	11	141	71	199
	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	86	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

Country	Year	Coastal		Estuarine		In-river		Total
		Weight (t)	% of total	Weight (t)	% of total	Weight (t)	% of total	Weight (t)
	2015	31	45	9	14	28	41	68
	2016	0	0	10	37	17	63	27
	2017	0	0	7	27	19	73	26
	2018	0	0	12	63	7	37	19
	2019	0	0	2	13	11	87	13
	2020	0	0	3	19	11	81	14
	2021	0	0	2	30	5	70	7
	2022	0	0	2	31	4	69	6

* 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 (N. 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.
$ 2021 and 2022 data extracted from NASCO website at https://nasco.int/conservation/third-reporting-cycle-2/

Table 7a Estimates for 2021 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 country/jurisdiction catch (unreported + reported)
NEAC	Denmark	0		
NEAC	Finland	0.08	0.01	7
NEAC	Iceland	0		
NEAC	Ireland	5.052	0.6	9
NEAC	Norway	126.369	15.9	30
NEAC	Sweden	1.306	0.2	11
NEAC	UK (England & Wales) **	0		
NEAC	UK (N. Ireland)	0.3	0.04	13
NEAC	UK (Scotland)	0.688	0.1	9
NAC	US	0		
NAC	Canada	19	2.4	16
WGC	Greenland	10	1.3	19
Total unreported catch *		163	20.6	
Total reported catch of North Atlantic salmon		630		

* No unreported catch estimates are available for France, Spain, St. Pierre and Miquelon, or the Russian Federation in 2021.

Table 7b Estimates for 2022 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 country/jurisdiction catch (unreported + reported)
NEAC	Denmark	0		
NEAC	Finland	0		
NEAC	Iceland	1	0.1	18
NEAC	Ireland	4	0.4	9
NEAC	Norway	167	18.5	30
NEAC	Sweden	1	0.1	10
NEAC	UK (England & Wales)	0		
NEAC	UK (N. Ireland)	0		
NEAC	UK (Scotland)	1	0.1	14
NAC	US	0		
NAC	Canada	18	2.0	15
WGC	Greenland	10	1.1	24
Total unreported catch *		202	22.4	
Total reported catch of North Atlantic salmon		700		

* No unreported catch estimates are available for France, Spain, St. Pierre and Miquelon, or the Russian Federation in 2022.

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, 1991–2022. Data for 2022 are provisional.

Year	Canada $		US		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	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	5			3211	51														
1992	37803	29	407	6			1012	73														
1993	44803	36	507	7			1124	82	1448	10												
1994	52887	43	249	9			1205	83	3227	13	6595	8										
1995	46029	46	370	1			1190	84	3189	20	12151	14										
1996	52166	41	542	1	669	2	1074	73	3428	20	10413	15										
1997	50009	50	333	1	1558	5	1482	87	3132	24	10965	18										
1998	56289	53	273	1	2826	7	1277	81	4378	30	13464	18										
1999	48720	50	211	1	3055	10	1145	77	4382	42	14846	28										
2000	64482	56	0	-	2918	11	1291	74	7470	42	21072	32										
2001	59387	55	0	-	3611	12	1694	76	6143	43	27724	38										
2002	50924	52	0	-	5985	18	2524	80	7658	50	24058	42										
2003	53645	55	0	-	5361	16	3386	81	6425	56	29170	55										
2004	62316	57	0	-	7362	16	2467	76	13211	48	46279	50					255	19				
2005	63005	62	0	-	9224	17	2359	87	11983	56	46165	55	255	12			606	27				
2006	60486	62	1	1	8735	19	3338	82	10959	56	47669	55	540	22	302	18	794	65				
2007	41192	58	3	1	9691	18	4434	90	10917	55	55660	61	151	44	470	16	959	57				
2008	54887	53	61	1	17178	20	4188	86	13035	55	53347	62	135	38	648	20	2033	71			5512	5
2009	52151	59	0	-	17514	24			9096	58	48436	67	114	39	847	21	1709	53			6696	6
2010	55895	53	0	-	21476	29	1458	56	15012	60	78041	70	151	40	823	25	2512	60			1504	12
2011	71358	57	0	-	18593	32			14406	62	64870	73	126	38	1197	36	2153	55	424	5	1430	12
2012	43287	57	0	-	9752	28	4743	43	11952	65	63628	74	118	35	5014	59	2153	55	404	6	1861	14
2013	50630	59	0	-	23133	34	3732	39	10458	70	54002	80	106	37	1507	64	1932	57	274	9	1595	15
2014	41613	54	0	-	13616	41	8479	52	7992	78	37355	82	653	37	1065	50	1918	61	982	15	2028	19
2015	65440	64	0	-	21914	31	7028	50	8113	79	46836	84	938	37	111	100	2989	70	690	14	2543	19
2016	68925	65	0	-	22751	43	1079	76	9700	80	50186	90	109	43	280	100	3801	72	362	17	2519	21
2017	57357	66	0	-	19667	42	1011	77	11255	83	45652	90	125	45	126	100	4435	69	680	14	2592	21
2018	56011	82	0	-	19409	43	1079	73	6857	88	35066	93	924	43	3247	49	4613	79	806	16	2202	22
2019	60636	72	0	-	15185	52	1276	74	8171	89	43825	91	979	48	5000	85	3913	70	747	14	2117	20
2020	56618	72	0	-	21277	51	9508	65	11893	93	42854	92	121	51	7333	89	4375	69	587	16	2875	23
2021	67056	75	0	-	19108	54	1072	71	6087	95	34853	95	142	51	5132	89	4016	66	680	19	2135	27
2022	53001	70	0	-	23609	53	1032	64	6635	96	40753	96	136	53	3570	86	4344	73	730	28	2718	28
Avg. 2017–2021	59535	73	0	-	18929	48	1078	72	8852	89	40450	92	116	47	4167	82	4270	70	700	15	2384	22
% change from Avg. 2017–2021	−12	4	-	-	19	8	−4	−12	−33	6	0	3	14	10	−16	4	1	3	4	43	12	19

* Since 2009, data have been either unavailable or incomplete; however, catch and release is understood to have remained at similar high levels as before. 2021 and 2022 data extracted from NASCO website at https://nasco.int/conservation/third-reporting-cycle-2/

** 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.

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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 season 2023/2024

The advice provided in 2021 remains valid for the 2023/2024 fishing season (see ICES, 2021a).

ICES was advised by the NASCO NEAC Framework of Indicators (FWI) Working Group that, when the FWI was applied in January 2023, it did not indicate that the pre-fishery abundance (PFA) forecast for 2022 had been underestimated. This meant that no re-assessment of the existing management advice for the Faroes fishery was required from ICES in 2023 and that the 2021 ICES advice remains valid. That advice states that when the MSY approach is applied, there are no mixed-stock fisheries options on the four constituent NEAC complexes at the Faroes for the 2023/2024 fishing seasons.

ICES advice on conservation aspects

ICES advises that: all non-fisheries related anthropogenic mortalities should be minimized (direct effects on salmon survival); and the quantity and quality of salmon habitats should be restored; connectivity should be restored, as well as the physical, chemical, and biological properties of those habitats (indirect effects).

NASCO 2.1 Describe the key events of the 2021 and 2022 fisheries

Information on significant key events in the fisheries is presented below.

Norway

The total number of marine fishers actively fishing was 431 in 2021 and 351 in 2022; this was a significant reduction from 2020 (956 marine fishers). There were significant changes of the rules for marine fishing of Atlantic salmon from 2021 onwards, which is the reason for the reduction. In 2021, bag-net fishing was banned in coastal areas south of Finnmark, and this led to bag-net fishing being permitted only in selected fjords from Troms to Rogaland (the part of Norway facing westwards) and not permitted at all in the southeastern part of Norway (from Agder to the border with Sweden). In Finnmark (the northernmost part of Norway), bag-net and bend-net fishing were banned in the Tanafjord and adjacent coastal areas because of the state of the Tana salmon stock. Bend-net fishing was also banned in Finnmark in 2022, resulting in this gear no longer being legal to use in Norway. The bag-net regulations from 2021 were continued into 2022, with only minor exceptions.

River Teno/Tana (Finland/Norway)

Because of the poor status of salmon populations in the River Teno/Tana in recent years, a total moratorium on salmon fishing was implemented for both 2021 and 2022. The salmon fishing ban was also extended to the Tanafjord and adjacent coastal areas in Norway.

No significant changes in gear type used were reported in the NEAC area in 2021 and 2022, with the exception of the 2022 cessation of bend-net fisheries in Finnmark mentioned above.

Faroe Islands

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

NEAC overall

The reported (i.e nominal) catch in the NEAC area in 2021 and 2022 are 487 tonnes (t) and 568 t, respectively. There were 72 t (2021) and 58 t (2022) reported in the Southern NEAC area and 415 t (2021) and 510 t (2022) in the Northern NEAC area. Estimates of unreported catches in the NEAC area were 134 t in 2021 and 174 t in 2022. The location of the reported catches differed between the Southern and Northern NEAC areas (Table 1a and 1b), just as in previous years. In 2021, the catches in the Southern NEAC area came from both in-river (69%) and estuarine (31%) fisheries; in the Northern NEAC area, catches came from coastal (27.7%) and in-river (72.3%) fisheries. In 2022, in-river and estuarine fisheries accounted for 71.9% and 28.1% (respectively) of the catches in the Southern NEAC area. In the Northern NEAC area, coastal fisheries accounted for 30% of the catches, with the remaining 70% of the catches coming from in-river fisheries.

Table 1a Salmon catch by area and location in the NEAC area in 2021. 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
2021 reported catch (tonnes)	72	415	0	487
Catch as % of NEAC total	15	85	0	
Unreported catch (tonnes)	134		0	134
Location of catches	Southern NEAC	Northern NEAC	Faroes	Total NEAC
% in-river	69	72	0	72
% in estuaries	31	0	0	4
% coastal	0	28	0	24

Table 1b Salmon catch by area and location in the NEAC area in 2022. 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
2022 reported catch (tonnes)	58	510	0	568
Catch as % of NEAC total	10	90	0	
Unreported catch (tonnes)	174		0	174
Location of catches	Southern NEAC	Northern NEAC	Faroes	Total NEAC
% in-river	72	70	0	70
% in estuaries	28	0	0	3
% coastal	0	30	0	27

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 2021 (487 t) and 2022 (568 t) were both notably lower than preceding years and below the previous five-year (897 t, 2016–2020) and 10-year (1027 t, 2011–2020) means. The 2021 total catch in the NEAC area was the lowest in the time-series. The catch in Southern NEAC, which constituted around two-thirds of the total NEAC catch in the early 1970s, has been lower than that of the Northern NEAC area since 1999 (Figure 1). In this document, nominal catches (landings) are equivalent to harvest. The reported catches do not include salmon that have been caught and released (these are reported separately) nor do they include post-release mortalities, although the latter are included in the spawner estimates by some countries/jurisdictions.

1SW salmon constituted 60% and 61% (respectively) of the total catch in the Northern NEAC area in 2021 and 2022 (Figure 2). For Southern NEAC countries, the overall percentage of 1SW fish in the catch in 2021 and 2022 were estimated at 48% and 45%, respectively (Figure 2), and is trending downward in this area.

The contribution of escaped farmed salmon to national catches in the NEAC area in 2021 and 2022 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 2021 and 2022 were the lowest in the time-series (1% in both years); the proportion in samples taken from Norwegian rivers in autumn in both 2021 and 2022 (4%) were also among the lowest values 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 was also reported from catches in Icelandic rivers in 2021 (five individuals) and 2022 (32 individuals). A small proportion of the catch in UK (Scotland) in 2022 were reported to be of farmed origin (0.23% of retained, 0.02% of all catch including catch-and-released salmon).

Estimated exploitation rates have decreased since the early 1980s in both the Northern and Southern NEAC areas (Figure 3). The weighted exploitation rate on 1SW salmon in the Northern NEAC area was 31% in 2021 and 34% in 2022, which was lower than the most recent five-year (38%) and 10-year (40%) means. Exploitation on 1SW fish in the Southern NEAC complex was 7% in 2021 and 2022, which was at the same level as the most recent five-year mean (7%) but lower than the most recent 10-year mean (9%). Exploitation on MSW salmon in the Northern NEAC area was 35% in 2021 and 2022, which was lower than the most recent five-year (40%) and 10-year (42%) means. Exploitation on MSW fish in Southern NEAC was 3% in 2021 and 2022, which was lower than the most recent five-year (4%) and 10-year (5%) means.

Estimates of the number of salmon caught and released in angling fisheries are available for all NEAC countries. There are large differences between countries in the percentage of the total angling catch that is released. In 2021, this ranged from

4% in France to 95% in both UK (England and Wales) and UK (Scotland); for 2022, it ranged from 5% in France to 96% in both UK (England and Wales) and UK (Scotland). These reflect differences in both management practices and angler attitudes between these countries. Catch and release mortality is also estimated for some countries, but these data are not included in the reported catch.

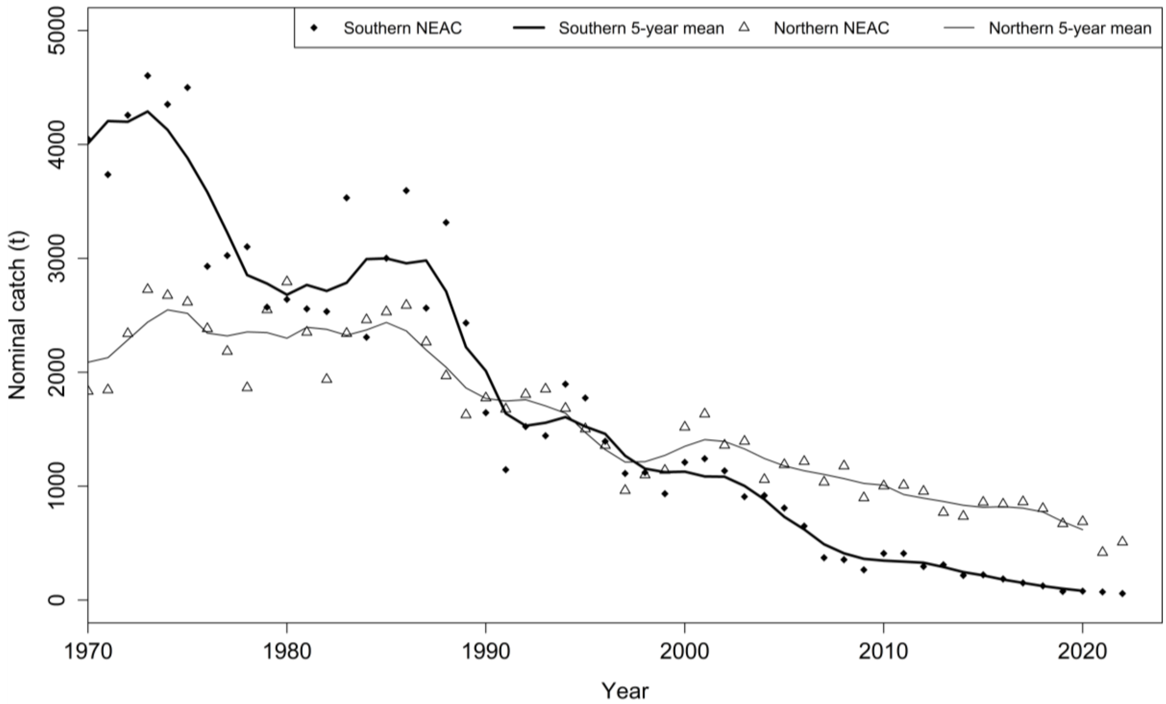

Figure 1 Nominal catches of salmon and five-year running means in the Southern and Northern NEAC areas, 1971–2022.

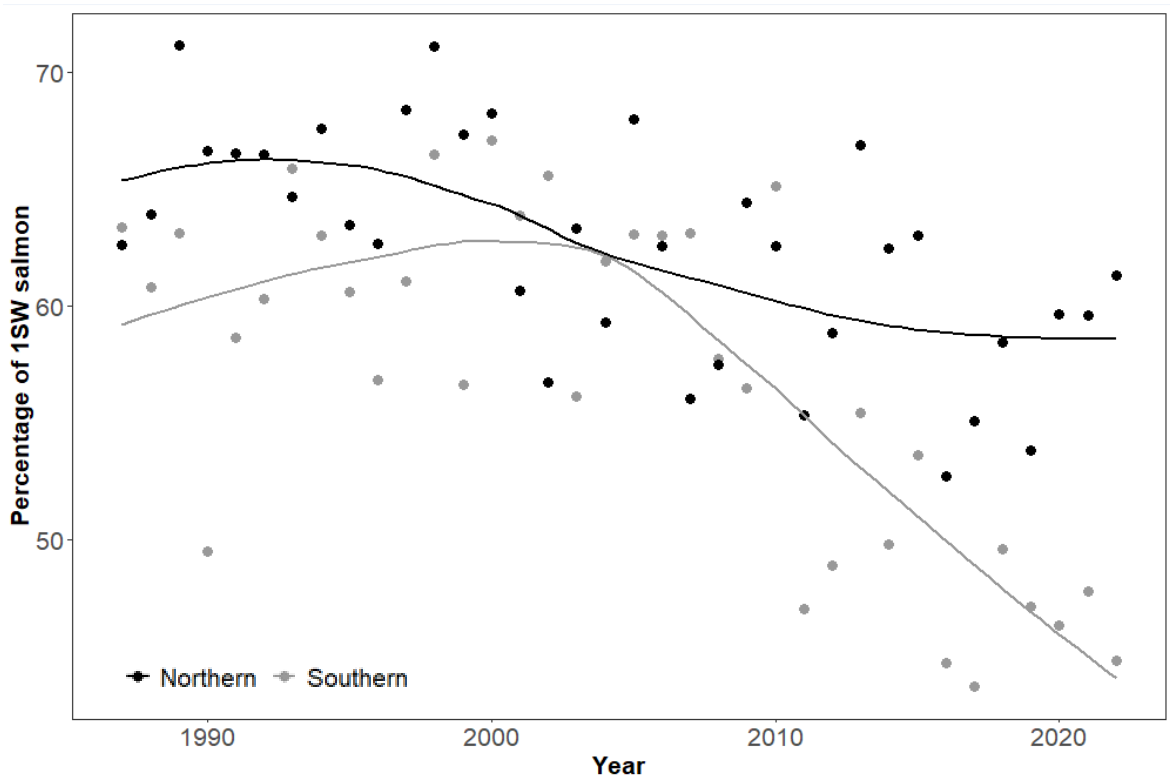

Figure 2 Percentage of 1SW salmon in the reported catch for the Northern (black dots) and Southern (grey dots) stock complexes, 1987–2022. Curves represent Northern (black line) and Southern (grey line) stock complexes with a Loess

smoother (span = 85%) applied to the data. For 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023)

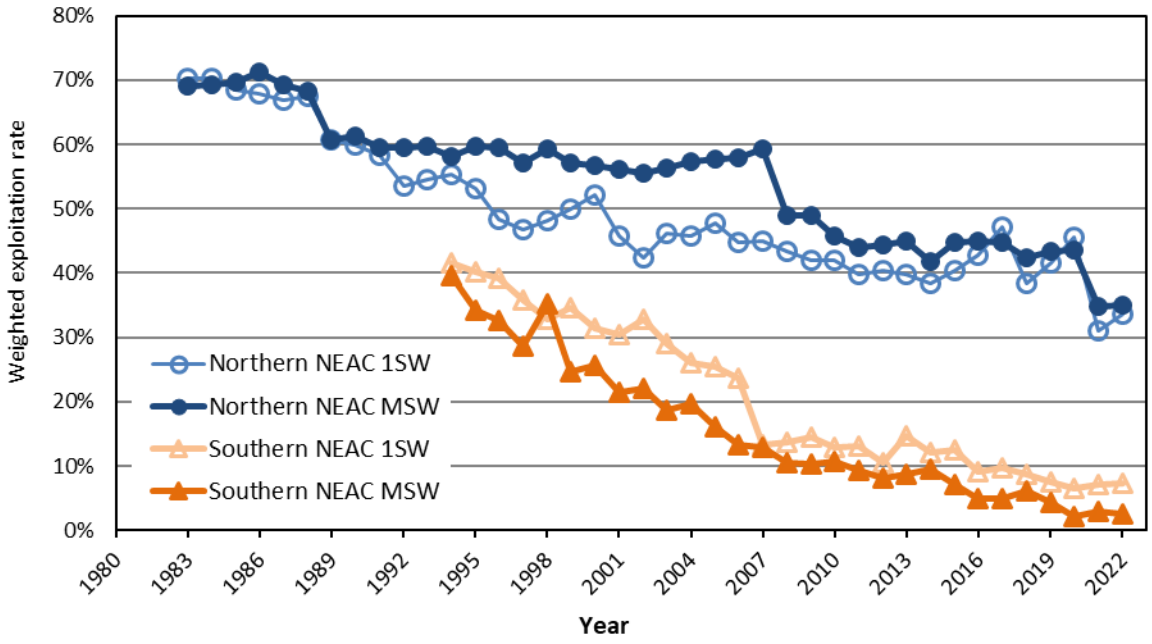

Figure 3 Mean annual exploitation rate of wild 1SW and MSW salmon by fisheries in Northern and Southern NEAC countries. For 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

Table 2 Reported catch of salmon in the NEAC Area (in tonnes round fresh weight), 1960–2022 (2022 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	-	-

Year	Southern NEAC countries	Northern NEAC countries *	Faroes **	Other catches in international waters	Total reported catch	Unreported catches	
						NEAC Area ***	International waters ^
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	-
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	76	671	0	-	747	237	-
2020	79	689	0	-	768	238	-
2021	72	415	0	-	487	134	-
2022	58	510	0	-	568	174	-
Mean							
2017–2021	101	688	0	-	790	241	-
2012–2021	173	760	0	-	934	269	-

* 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 the Russian Federation since 2008.
^ Estimates refer to season ending in the 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, the Russian Federation, 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, Finland, Ireland, Norway, Sweden, UK [England and Wales], UK [Northern Ireland] and UK [Scotland]), 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 the Russian Federation 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 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) that are adjusted to take into account natural mortality (0.03 per month) between 1 January of the first winter at sea and the time of their return to homewaters. The homewaters are defined as the river of origin, including estuaries 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 2022. Values are in numbers of fish.

Geographic group	Age group	CL	SER
Northern NEAC	1SW	139681	176623
	MSW	119766	203899
Southern NEAC	1SW	438 096	554282
	MSW	176261	297005

For the nine countries/jurisdictions where river-specific CLs are available, the following are provided in Figure 4:

- the 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, except for France).

For France, the number of rivers that met the CL actually corresponds to the number of rivers for which the TAC has been reached. France will review this methodology for 2024 by assessing the compliance to CL in terms of egg deposition. Iceland has set provisional CLs for all salmon-producing rivers and continues to work towards finalizing an assessment process for determining CL attainment. In Finland/Norway, a CL has been set for the northern transboundary river River Näätämöjoki/Neidenelva, which is counted amongst the Norwegian rivers for the CL development and compliance. Data compilation and preparations to undertake a CL compliance assessment for this stock are underway.

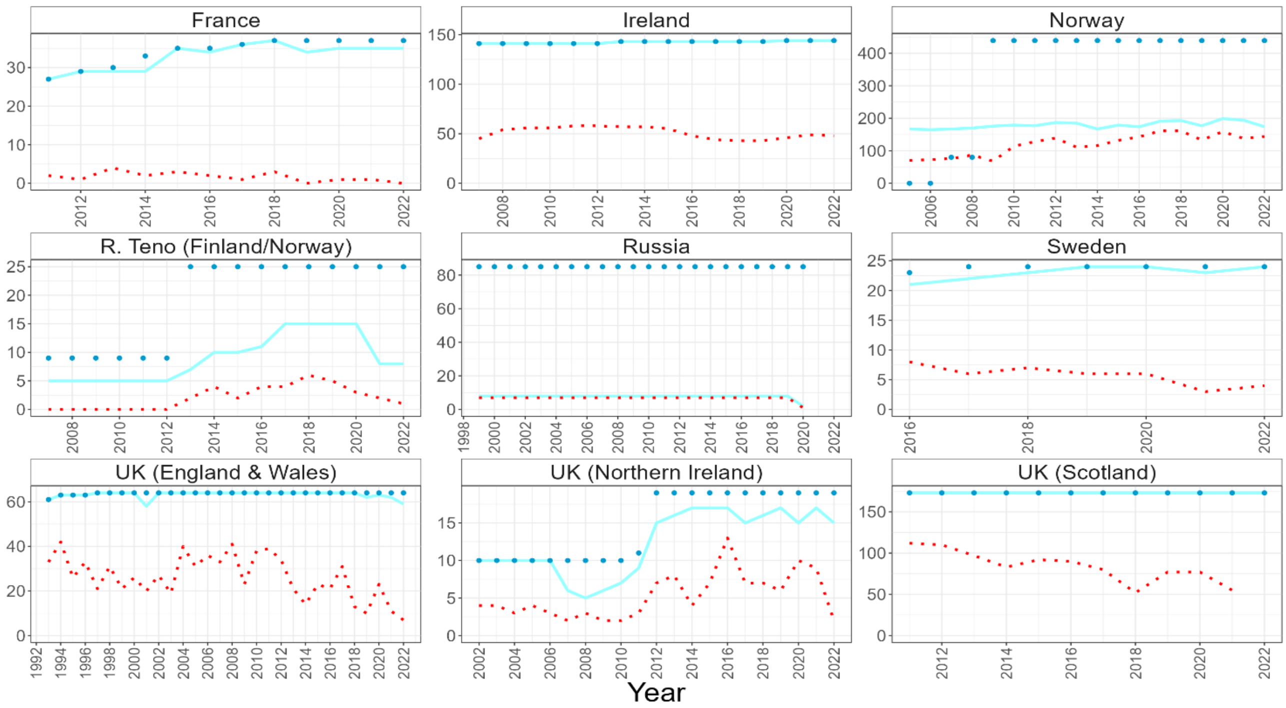

Figure 4 Time-series showing the number of rivers with established CLs (blue dots), the number of rivers assessed annually (light blue solid lines), and the number of rivers meeting CLs annually (red dotted lines) for countries/jurisdictions in the NEAC area. UK (Scotland) 2022 data are not available for by country/jurisdiction analysis at time of publication.

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; it is assessed relative to the 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 two most recent years in Figure 6a and 6b. 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 by individual countries/jurisdictions in 2021 and 2022 for 1SW (Figure 7a and 7b) and MSW (Figure 8a and 8b) salmon.

PFA relative to SER and spawners relative to CLs
The status of the two age groups of the Northern NEAC stock complex, prior to the commencement of distant-water fisheries in the latest available PFA year, were considered to be at full reproductive capacity (i.e. above the SER; Figure 5). The abundances of both maturing 1SW and non-maturing 1SW recruits (PFA) for Northern NEAC (Figure 5) show a general decline over the time period, with that decline more marked in the maturing 1SW stock. In 2021, the numbers of maturing 1SW and non-maturing 1SW recruits (PFA) are at their lowest point since the start of the time-series. The 1SW spawners in the Northern NEAC stock complex have been at full reproductive capacity throughout the time-series, with the exception of 2021. MSW spawners, on the other hand, have periodically been at risk of suffering reduced reproductive capacity, though not in the last 10 years (Figure 5).

Similarly, in the Southern NEAC complex, the abundances of both maturing 1SW and non-maturing 1SW recruits (PFA) show a general decline over the time period (Figure 5). The decline was more marked in the maturing 1SW stock with five of the most recent 10 years being at risk of suffering or suffering reduced reproductive capacity (i.e., below or overlapping the SER). MSW stocks (non-maturing 1SW PFA) were considered to be at full reproductive capacity prior to the commencement of distant-water fisheries in the latest available PFA year (Figure 5). The 1SW spawners in the Southern NEAC stock complex have been at full reproductive capacity throughout the time-series, but in eight of the ten last years have been at risk of suffering or suffering reduced reproductive capacity. In contrast, MSW spawners have been at risk of suffering reduced reproductive capacity or suffering reduced reproductive capacity for most of the time-series, although they have been at full reproductive capacity for all of the most recent ten years (Figure 5).

For all countries in Northern NEAC, 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 years, except for maturing and non-maturing 1SW stocks in the Tana/Teno (Finland & Norway) and 1SW maturing stocks in the Russian Federation, which were at risk of suffering or suffering reduced reproductive capacity (Figures 6a and 6b). Note that for 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023) and should be taken with caution. Returning and spawning 1SW and MSW stocks in Sweden and Norway, as well as 1SW returning stocks in Iceland, were at full reproductive capacity in 2021 and 2022. However, both 1SW and MSW returns and spawner stocks in the River Teno/Tana (Finland & Norway) and in the Russian Federation were at risk or suffering reduced reproductive capacity, except for MSW returns in the Russian Federation (based on data derived from reported catches in NASCO, 2023), which were at full reproductive capacity (Figures 7a–8b). Note that for 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023). In addition, 1SW and MSW spawners in Iceland were at risk of suffering or suffering reduced reproductive capacity in 2021 and 2022 (Figures 7a and 7b; Figures 8a and 8b).

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 (Figures 6a and 6b). 1SW returns and spawners were all suffering reduced reproductive capacity in 2021 and 2022 (Figures 7a and 7b), apart from in UK (Scotland): here, maturing and non-maturing stocks were at full reproductive capacity both prior to the commencement of distant-water fisheries (Figures 6a and 6b) and for returns and spawners (Figures 7a and 7b), with the sole exception of MSW spawners in 2021, which were at risk of suffering reduced reproductive capacity (Figure 8a). In addition, in UK (England and Wales), the 1SW maturing stock was suffering reduced reproductive capacity both prior to the commencement of distant-water fisheries (Figures 6a and 6b) and at spawning in 2021 and 2022 (Figures 7a and 7b), whereas the non-maturing 1SW stock and MSW returns and spawners were at full reproductive capacity for both years (Figures 6a and 6b; Figures 8a and 8b).

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, except for France, as outlined previously.

Table 4a Summary of the attainment of CLs in 2021 and trends based on all available data in the NEAC area. Further details can be found in ICES (2023a).

Country /Jurisdiction	Number of rivers with CLs	Number of rivers assessed for compliance	Number of rivers attaining CL	% of assessed rivers attaining CL	Trend over each time series
Northern NEAC					
Russian Federation	No data available				
Norway/Finland (Tana/Teno)	25	8	2	25	Decreasing
Norway	439	194	138	71	Decreasing
Sweden	24	23	3	13	Decreasing
Southern NEAC					
UK (Scotland)	173	173	55	32	Decreasing
UK (Northern Ireland)	19	17	9	53	Minor decrease
UK (England and Wales)	64	62	11	18	Decreasing
Ireland	144	144	49	34	Minor increase
France	37	35	1	3	Variable

Table 4b Summary of the attainment of CLs in 2022 and trends based on all available data in the NEAC area. Further details can be found in ICES (2023a).

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					
Russian Federation	No data available				
Norway/Finland (Tana/Teno)	25	8	1	12	Decreasing
Norway	439	174	144	83	Increasing
Sweden	24	24	4	17	Minor increase
Southern NEAC					
UK (Scotland)	173	2022 compliance data not yet available			
UK (Northern Ireland)	19	15	2	13	Decreasing
UK (England and Wales)	64	59	7	12	Decreasing
Ireland	144	144	48	33	Minor decrease
France	37	35	0	0	Decreasing

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 the most recent years, especially for wild smolts. Mean return rates of wild and hatchery smolts to Southern NEAC are less variable, primarily because they are estimated from more rivers. They have also generally decreased since 1980 but appear to have stabilized since 2010, with an upward trend in rates of 2SW returns from wild smolts apparent since 2005 (Figure 9).

The overall 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.

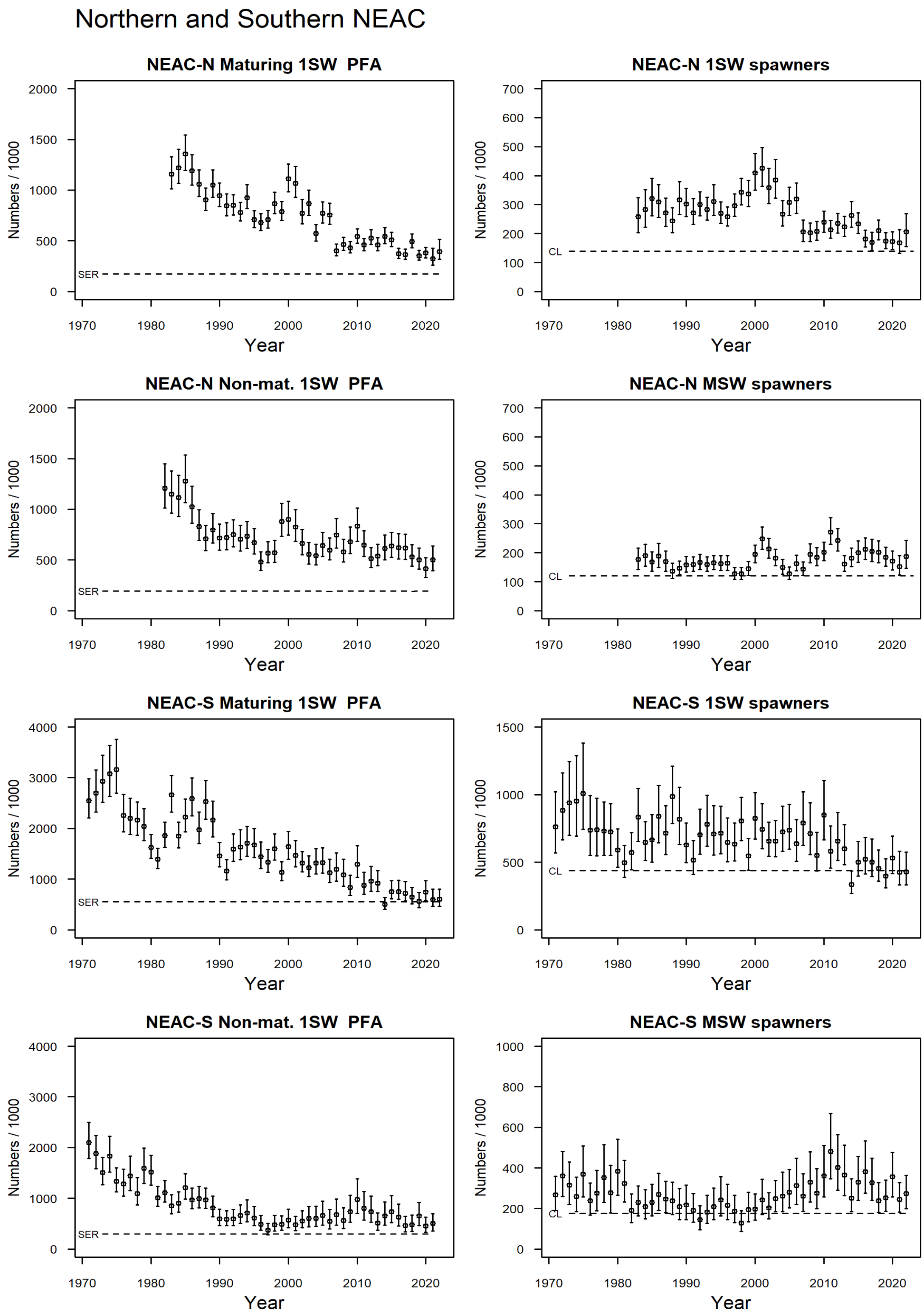

Figure 5 Estimated pre-fishery abundance (PFA – recruits; left panels) and spawner escapement (right panels), with 90% confidence limits, for maturing 1SW (1SW spawners) and non-maturing 1SW (MSW spawners) salmon in Northern (NEAC-N) and Southern (NEAC-S) NEAC stock complexes. The dashed horizontal lines are the respective 2022 SER values (left panels) and CL values (right panels).

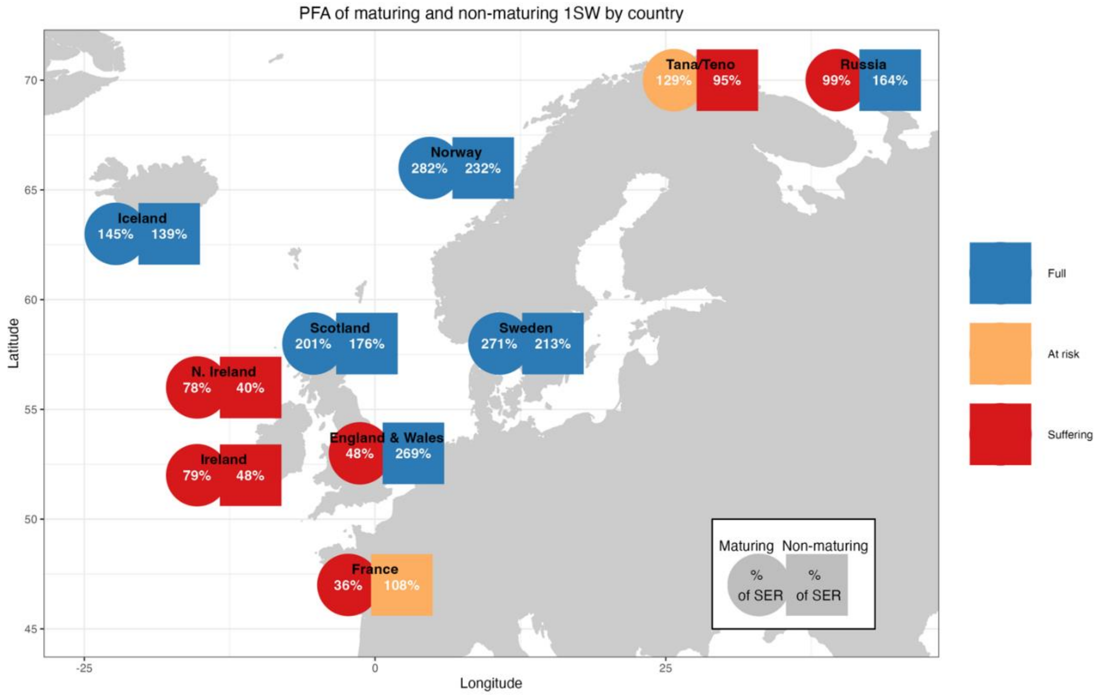

Figure 6a PFA of maturing (2021) and non-maturing (2020) in percent of spawner escapement reserve (% of SER). The percent of SER is based on the median of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the SER), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the SER, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the SER). For 2021, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

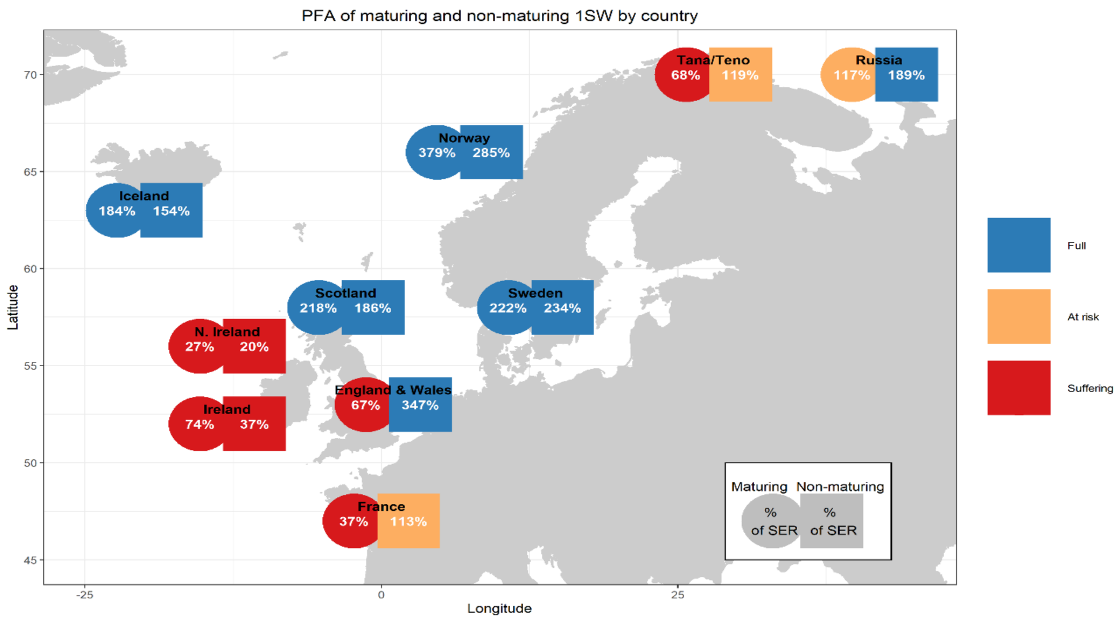

Figure 6b PFA of maturing (2022) and non-maturing (2021) in percent of spawner escapement reserve (% of SER). The percent of SER is based on the median of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the SER), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the SER, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the SER). For 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

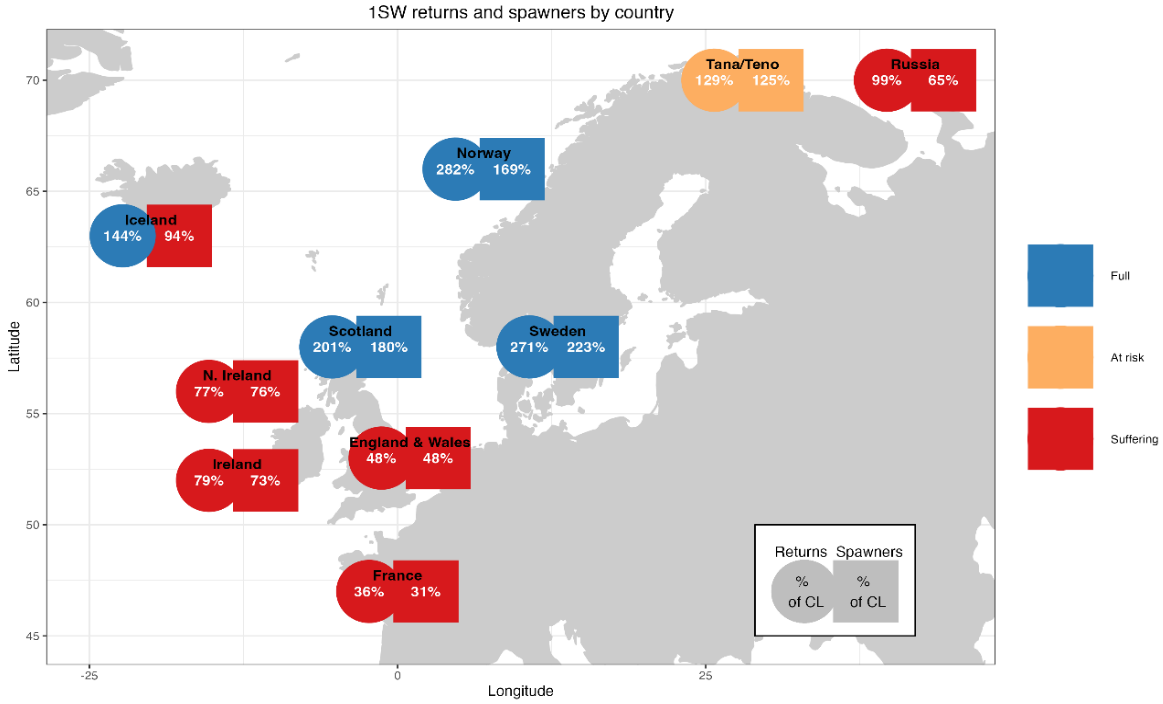

Figure 7a 1SW returns and spawners in percent of conservation limit (% of CL) for 2021. The percent of CL is based on the median of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL). For 2021, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

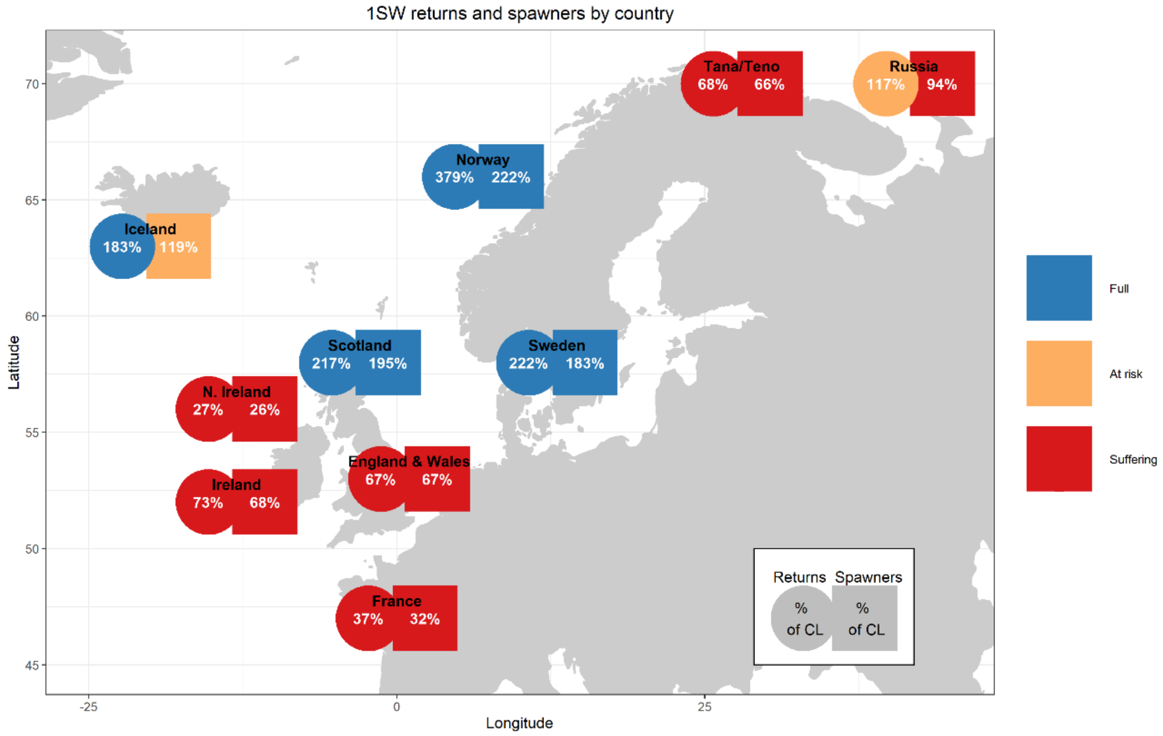

Figure 7b 1SW returns and spawners in percent of conservation limit (% of CL) for 2022. The percent of CL is based on the medi-an of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL). For 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

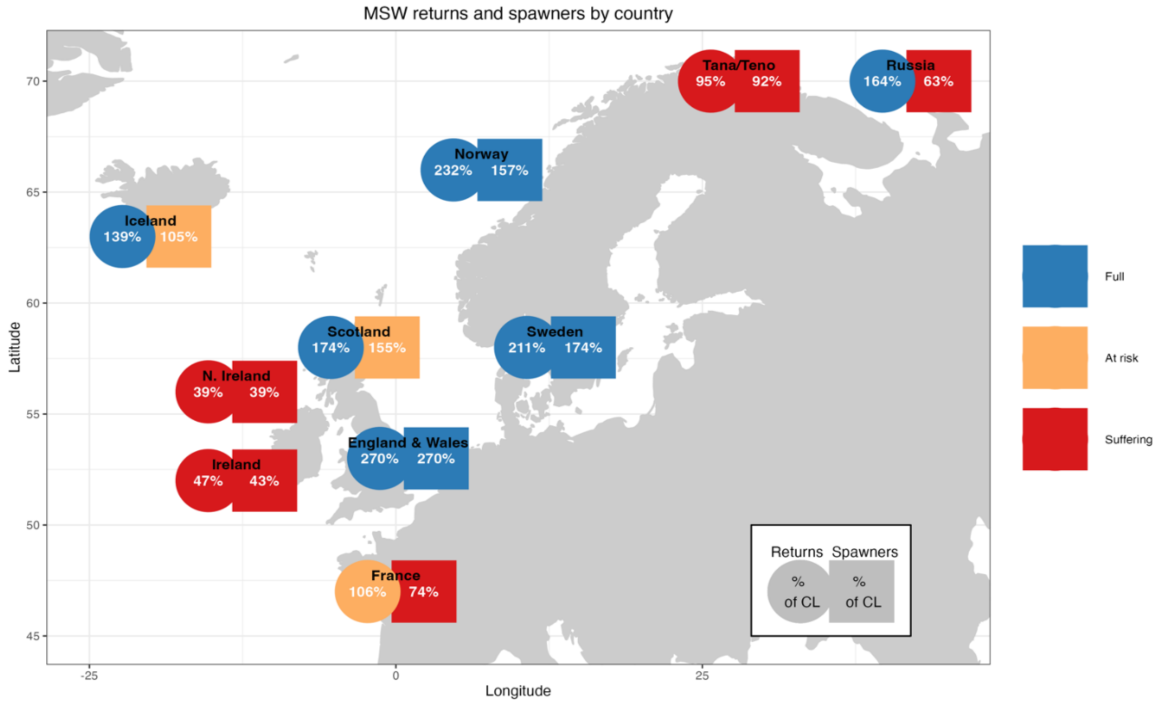

Figure 8a MSW returns and spawners in percent of conservation limit (% of CL) for 2021. The percent of CL is based on the median of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL). For 2021, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

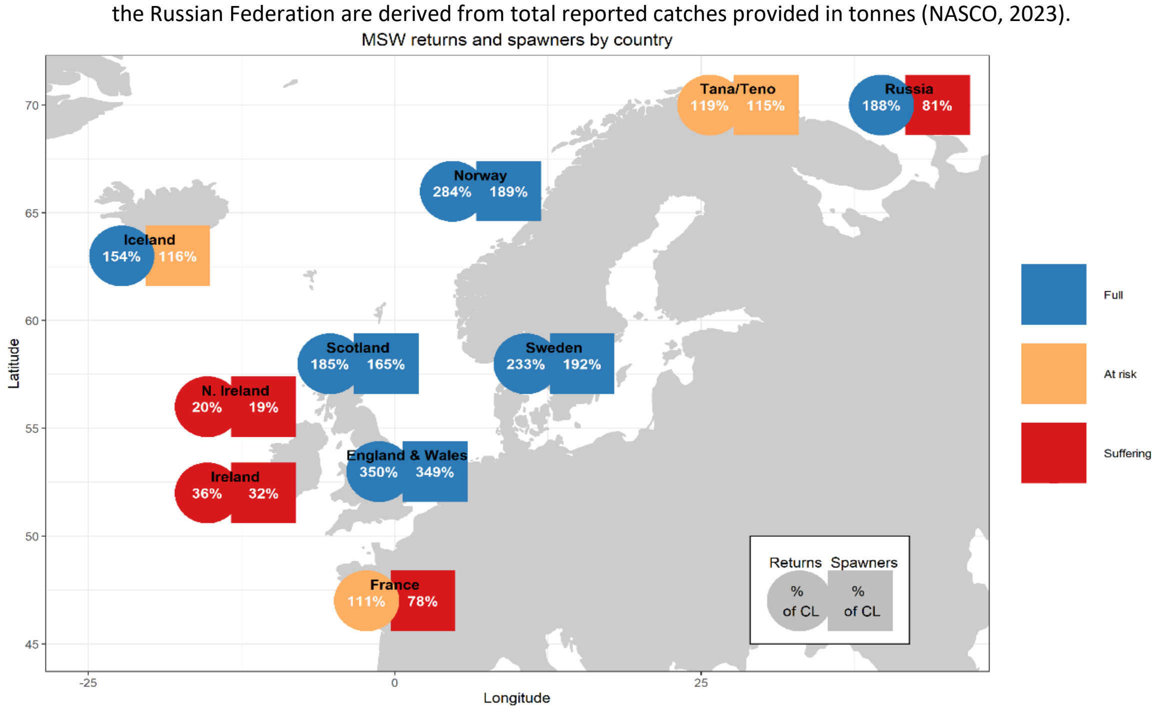

Figure 8b MSW returns and spawners in percent of conservation limit (% of CL) for 2022. The percent of CL is based on the median of the Monte Carlo distribution. The colour shading represents the three ICES stock status designations: Full (at full reproductive capacity: the 5th percentile of the spawner estimate is above the CL), At Risk (at risk of suffering reduced reproductive capacity: median spawner estimate is above the CL, but the 5th percentile is below), and Suffering (suffering reduced reproductive capacity: median spawner estimate is below the CL). For 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

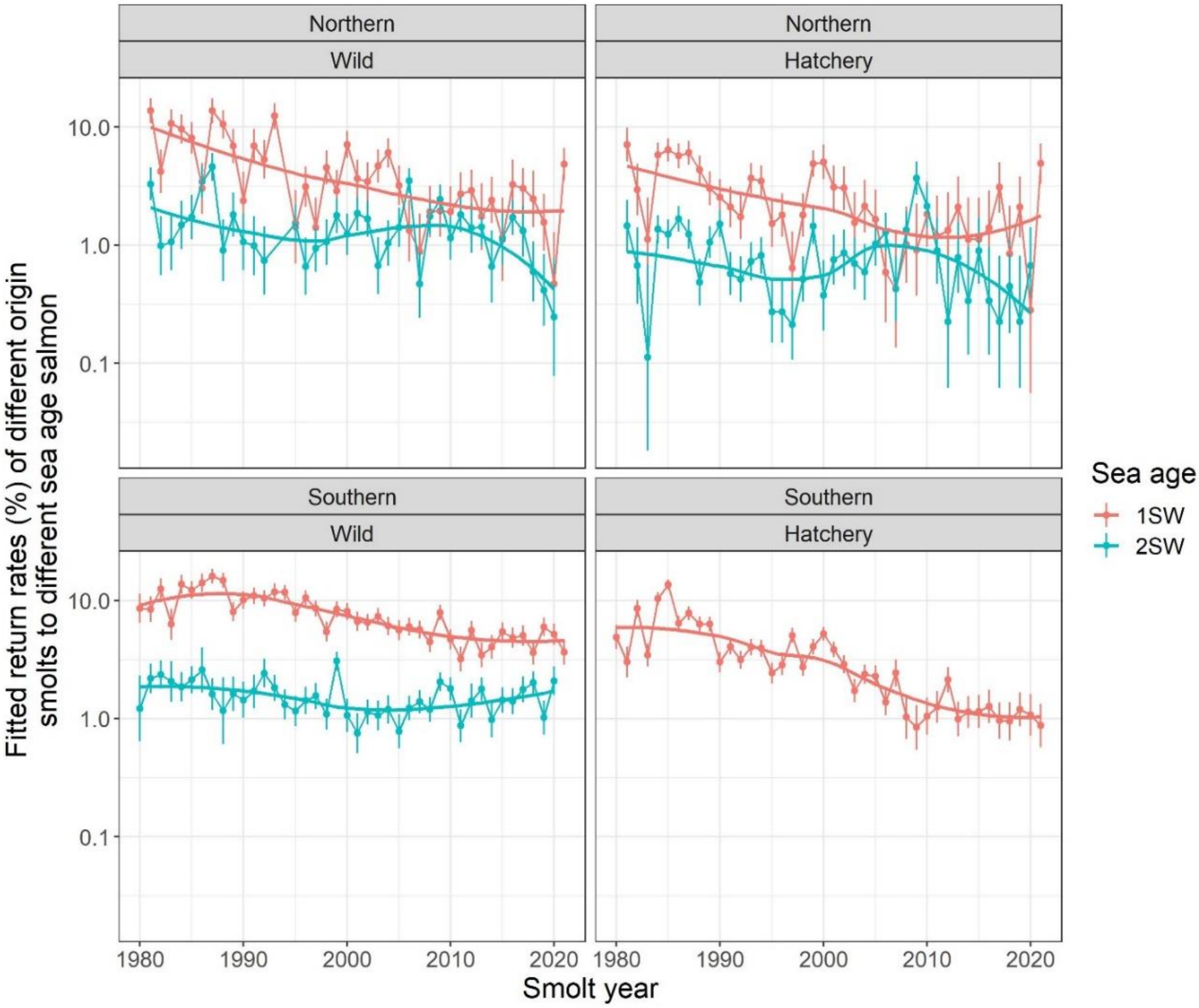

Figure 9 Least squared (marginal mean) average annual return rates (in %) of wild (left panels) and hatchery-origin (right panels) smolts of 1SW and 2SW salmon to Northern (top panels) and Southern (bottom panels) NEAC areas. For most rivers in Southern NEAC, the values represent returns to the coast 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 (2023a; Tables 3.3.6.1 and 3.3.6.2), the analyses include estimated return rates (in %) for 1SW and 2SW returns by smolt year.

Table 5 Estimated PFA 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). Note: For 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

Year	Northern NEAC						Southern NEAC							NEAC Area
	Finland	Iceland (N&E)	Norway	Russian Federation	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	29700	11676			22138		63797	77055	1340550	105555	222340	724642	2547239 (2209773; 2979419)	
1972	115434	10704		151002	17619		128477	62631	1437535	102429	194815	749574	2698666 (2326890; 3153030)	
1973	53727	12867		222437	21784		78836	67393	1565737	120843	170785	907268	2927284 (2516010; 3444468)	
1974	74665	12778		221116	31659		36683	47966	1778610	149017	185653	869421	3082327 (2632600; 3632067)	
1975	88920	15561		340134	34248		72965	74474	1957900	154489	152577	725929	3158615 (2694075; 3762663)	
1976	80627	15655		237354	19291		66202	58841	1334480	102428	106222	576914	2255451 (1934979; 2675026)	
1977	45568	21684		151145	8680		51698	59887	1153716	117388	104528	697865	2201487 (1883421; 2597422)	
1978	43413	22031		152695	10351		53317	78666	1009231	133593	136113	731767	2162374 (1862605; 2518482)	
1979	38856	21132		211764	10665		60816	72601	924367	127686	95677	740493	2041307 (1755856; 2388091)	
1980	31250	3352		150882	13699		127796	33431	711807	120459	121799	491092	1625082 (1406751; 1882211)	
1981	28002	16681		125233	25071		100554	43125	377092	126977	95880	633942	1392784 (1210637; 1609433)	
1982	16667	7689		109332	22078		62163	43921	773143	107870	137472	720561	1858490 (1626150; 2120049)	
1983	40626	11393	890791	183221	29245	1158942 (1011093; 1328229)	67354	55965	1362454	157969	193657	807212	2664184 (2324171; 3048481)	3829210 (3409498; 4283621)
1984	44102	4167	930274	196255	41251	1219172 (1064391; 1401391)	109548	34244	715691	137946	76405	759975	1853821 (1617682; 2124632)	3075276 (2752277; 3433705)
1985	58472	28147	946298	269729	49181	1355544 (1193524; 1543316)	40855	55044	1183513	137753	98485	696827	2225333 (1937150; 2577728)	3587936 (3208904; 4026412)
1986	46277	35135	820721	230464	51456	1189130 (1051167; 1350607)	63306	90576	1325869	158637	110918	811268	2588090 (2246610; 2993915)	3779936 (3363846; 4250591)
1987	55795	20613	691129	244981	40746	1057777 (935785; 1200003)	112371	56415	851179	164376	60508	693445	1974887 (1698070; 2319778)	3036336 (2702654; 3436643)
1988	32793	29781	634092	169305	34219	902556 (800163; 1022695)	38141	100807	1156800	224822	142325	846084	2534057 (2185125; 2942678)	3443851 (3045918; 3895462)
1989	71718	16072	698058	251267	9978	1050014 (928848; 1199094)	20913	56739	828865	151932	136380	942276	2161841 (1837552; 2538849)	3218659 (2833573; 3649771)
1990	71526	12034	626862	208498	23315	945343 (836339; 1071942)	34744	51961	518910	108652	112721	613054	1461385 (1242528; 1722769)	2409343 (2138780; 2730739)
1991	70407	17411	546478	177907	29001	845171 (747985; 960841)	25284	57231	370288	107044	63046	525049	1160177 (990238; 1384432)	2009348 (1787201; 2279119)
1992	98952	32816	460131	218735	32484	848748 (753789; 955246)	46024	65723	537208	112350	127420	683858	1595877 (1355722; 1894027)	2450105 (2160848; 2788751)
1993	66949	27039	461894	187946	32308	780385 (695727; 877914)	66138	64357	438020	155537	149179	736221	1635797 (1386381; 1977939)	2420111 (2130084; 2793197)
1994	37233	8641	624814	223201	24829	923592 (815518; 1052713)	51803	53140	558920	173195	102392	745513	1709994 (1454973; 2044338)	2637952 (2326807; 3026432)
1995	37105	22569	408267	200013	36171	707821 (629705; 796596)	17439	65243	624547	131672	95242	730272	1678741 (1426829; 1995891)	2388970 (2098995; 2736507)
1996	57071	12053	311291	272706	21729	678825 (602567; 766135)	21395	56476	582088	97633	98602	569699	1441142 (1214358; 1730542)	2121082 (1858787; 2443108)
1997	51960	16510	359481	267359	9840	708238 (628475; 800793)	10972	41186	578581	87706	117014	487495	1338970 (1132596; 1588212)	2051188 (1802161; 2337143)
1998	65232	28032	468379	293017	7998	866734 (767545; 978935)	21335	56263	609810	96772	253746	545062	1601103 (1373290; 1889517)	2471800 (2192630; 2801646)
1999	95593	14202	435354	225986	12496	787959 (700119; 886424)	7123	45856	566543	76474	66114	364899	1138129 (965980; 1344578)	1928360 (1711384; 2178835)
2000	103929	14945	716106	246868	23055	1110950 (984079; 1257392)	18737	40591	787113	117103	97010	560495	1640111 (1389597; 1939527)	2755886 (2437969; 3121973)
2001	75115	13625	618397	333381	14321	1064811 (927437; 1232217)	15996	36526	627645	101709	77252	592215	1465153 (1243192; 1755706)	2536739 (2242120; 2887997)
2002	46639	23592	377872	302572	13713	771749 (667588; 908493)	35632	45453	549234	96000	136833	440558	1320221 (1145237; 1541883)	2096529 (1864959; 2377023)
2003	46044	12531	524764	269744	7468	866881 (752440; 1001986)	23762	54308	537803	73720	85875	435165	1229221 (1050646; 1461459)	2103445 (1861837; 2391233)
2004	19484	33708	318015	189976	6259	571249 (499531; 659618)	28862	54445	395772	133009	82404	604346	1319988 (1105942; 1602525)	1895627 (1650525; 2203684)
2005	42788	30144	471431	215930	6088	772196 (677277; 885740)	18704	80387	394345	108458	103347	604923	1329334 (1117743; 1616867)	2106207 (1851226; 2425908)

Year	Northern NEAC						Southern NEAC							NEAC Area
	Finland	Iceland (N&E)	Norway	Russian Federation	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%)
2006	70166	31766	381365	261989	6830	756666 (662247; 872431)	26341	56653	302350	106781	70013	546436	1125747 (934262; 1389409)	1889202 (1648304; 2188444)
2007	20562	23500	213518	140708	2127	403204 (351408; 467019)	20607	64904	304273	102366	103849	559557	1197333 (961938; 1519920)	1604110 (1354047; 1941735)
2008	22226	21504	267272	146361	3307	464877 (405163; 536517)	20273	78593	322656	100031	65206	454311	1083332 (862307; 1391971)	1552949 (1309623; 1878147)
2009	39315	34643	214174	137283	3514	431615 (379804; 491938)	5819	88940	262525	62732	40527	350641	841333 (677673; 1076826)	1275738 (1089843; 1521919)
2010	31619	27735	317816	156338	6027	542816 (475163; 619531)	19550	91539	350205	124838	40397	622799	1294605 (1037186; 1660460)	1840644 (1560279; 2222663)
2011	35846	22815	223625	167224	6569	458607 (403350; 522814)	13309	64324	302246	84192	29156	354347	878633 (703966; 1135708)	1340733 (1143533; 1612349)
2012	62201	11857	248690	195107	7173	528794 (463930; 610726)	14474	36462	308872	48235	66766	448311	962232 (758770; 1252003)	1494146 (1265861; 1802549)
2013	35919	28411	234742	152314	4199	459556 (400782; 530752)	20414	108517	259956	67788	73943	351870	921697 (751518; 1165613)	1385066 (1192022; 1646429)
2014	51164	13350	320117	143215	11558	544988 (472246; 632104)	17987	26684	159302	40058	33504	204275	502391 (409689; 637200)	1052872 (917114; 1216540)
2015	31701	37653	282200	149734	3313	509305 (445049; 585639)	16761	74306	227052	49074	36065	322343	755674 (610109; 966525)	1268998 (1092373; 1499650)
2016	24833	15962	219085	106708	2985	372399 (326330; 426130)	15099	43624	230086	52411	68039	314531	755318 (601434; 974708)	1131757 (958888; 1359546)
2017	15838	15570	288545	38361	3817	363985 (317391; 420604)	19129	45483	249994	37983	57281	279383	718529 (571795; 949419)	1087877 (920180; 1325943)
2018	39948	16618	294595	127977	10213	495129 (432088; 570254)	15910	39299	197711	49122	50213	268734	649252 (514748; 837450)	1148073 (983871; 1357475)
2019	13189	10046	230493	91713	4955	353959 (309472; 406709)	16411	26130	168346	32696	28017	273320	564389 (442452; 741401)	921129 (779549; 1111422)
2020	11311	12120	282730	66054	5445	379580 (332571; 435177)	13276	32628	205267	61307	44833	364353	746050 (579552; 970283)	1127878 (944133; 1365137)
2021	23934	9976	196458	79609	6400	324978 (260270; 425972)	8043	26425	212324	32761	33989	265353	599488 (464691; 804760)	932870 (770567; 1161949)
2022	12536	11486	263883	93902	5237	394707 (318794; 515485)	8367	34297	197469	46115	11965	286618	605737 (466327; 801604)	1009918 (833837; 1237251)
Mean 2013-2022	26037	17119	261285	104959	5812	419858 (361499; 494883)	15140	45739	210751	46932	43785	293078	681853 (541231; 884896)	1106644 (939253; 1328134)

Table 6 Estimated PFA 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%; 95%) quantiles of the Monte Carlo distribution). Estimates for 2022 will only be available in 2023 for this component. Note: For 2021 and 2022, values for the Russian Federation are derived from total reported catches provided in tonnes (NASCO, 2023).

Year	Northern NEAC						Southern NEAC							NEAC area
	Finland	Iceland (N&E)	Norway	Russian Federation	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	47342	27036		264705	4733		59221	65579	384328	363956	32690	1181439	2100629 (1782655; 2493454)	
1972	72820	25396		427371	7566		39573	59175	384650	281731	28709	1076675	1879781 (1586314; 2242292)	
1973	117095	23884		396160	5095		22259	51026	402574	208401	31197	782311	1507211 (1267331; 1805579)	
1974	148210	26414		428330	3799		34986	54242	452346	264841	25753	985761	1832116 (1521082; 2225266)	
1975	116550	21665		366089	4752		29992	46758	338763	180334	17932	710539	1334393 (1125003; 1598276)	
1976	81133	29723		252437	2606		20826	45473	275283	176116	17569	735041	1282726 (1047640; 1573701)	
1977	41937	38046		218527	2602		21065	58531	243036	153957	22707	929670	1439333 (1152284; 1831734)	
1978	43198	25398		198502	4582		20403	37718	209783	85448	16176	719638	1096904 (868453; 1407671)	
1979	48691	36010		343923	9472		40348	53657	245170	232788	21018	988942	1591217 (1290849; 1988237)	
1980	62146	14328		235065	6905		31000	37106	193215	309620	17412	921286	1520511 (1260186; 1847201)	
1981	75840	15956		209804	11249		21418	26556	125406	148398	24236	661242	1013688 (842103;1235227)	
1982	79213	12151	839227	265512	7974	1206925 (1012882; 1446225)	20626	42708	208146	151782	32966	652242	1114694 (924681; 1353963)	2325253 (1969557; 2757126)
1983	64147	14678	810291	249721	8069	1151202 (960703; 1378499)	26778	35927	143113	109672	13268	519540	854357 (694084; 1071562)	2013039 (1688417; 2399629)
1984	62587	9858	760628	274091	4683	1115755 (928502; 1337898)	20606	26390	152600	149994	16986	527624	900194 (726020; 1128032)	2017083 (1693125; 2411861)
1985	54731	25347	915851	277415	4502	1279645 (1067772; 1536332)	24512	22405	190399	218590	19178	723619	1208734 (988509; 1485256)	2492052 (2098246; 2969407)
1986	68041	26122	707669	212654	7870	1024699 (860856; 1226627)	14695	19908	220668	175019	10277	523119	972728 (791938; 1201470)	2000160 (1685429; 2384355)
1987	46308	16660	561212	196276	6920	829476 (694619; 994091)	31586	22010	167964	217384	26634	521167	997299 (814923; 1236040)	1827148 (1540374; 2188047)
1988	46494	14404	429120	195745	20063	708584 (593697; 842833)	18620	19871	162929	188619	21390	554971	973456 (799918; 1203454)	1683789 (1418262; 2009068)
1989	49380	14936	478728	240802	10774	796569 (665742; 956305)	14886	19472	73810	198887	19418	474581	809630 (635591; 1042678)	1610110 (1335039; 1948438)
1990	63310	10346	396309	230686	13527	717766 (596061; 854123)	12681	19286	100002	89374	10049	358784	595979 (462372; 787936)	1319994 (1088949; 1594910)
1991	59812	15018	413516	213651	17936	722026 (601212; 865057)	16488	21448	83649	75512	22419	363488	586668 (466677; 754337)	1312769 (1095574; 1578093)
1992	62237	16973	395852	252298	20211	751361 (629421; 897152)	8291	10593	79016	77718	52682	355841	594178 (465045; 780875)	1349730 (1121079; 1628935)
1993	58905	14371	387172	225110	15404	705062 (587700; 843623)	14505	17081	113729	97730	18633	390229	659272 (505893; 866426)	1367148 (1120986; 1665024)
1994	39688	9223	417560	257601	7937	733277 (611957; 879242)	7104	17562	110251	98922	15791	452645	708507 (535355; 966512)	1448347 (1181449; 1790373)
1995	36461	11946	414364	194435	12588	671377 (559499; 807322)	12714	11304	75790	103314	17339	384491	611805 (459752; 838530)	1290617 (1051224; 1594157)
1996	42581	6643	266486	154810	8870	480741 (398502; 579688)	6565	12596	96245	63559	21461	278877	489857 (368857; 664657)	977672 (794057; 1206469)
1997	40613	9678	319758	192015	4921	569342 (473386; 680513)	5422	7788	55536	41128	29310	226998	370661 (279351; 503621)	943359 (775632; 1148514)
1998	48023	11143	340231	168671	3471	573197 (476153; 690743)	11487	15164	85534	80600	13387	255568	481150 (354151; 661107)	1058721 (860666; 1308593)
1999	91477	6530	471599	295451	12429	879683 (733579; 1058067)	7946	4149	106897	83793	16347	260051	490041 (369220; 655133)	1374955 (1134986; 1662452)
2000	110574	7484	554264	207302	14704	898538 (744669; 1080014)	9358	7251	96163	90362	11104	347087	573591 (422340; 790384)	1478171 (1206096; 1805931)
2001	96817	7056	482115	226355	10127	825841 (684091; 994844)	8777	7836	111256	81117	13918	246921	481714 (364437; 646936)	1307925 (1082062; 1593266)
2002	69887	7431	425179	158139	2423	664766 (553275; 801938)	12444	12506	116057	103636	8515	288236	555323 (418594; 751129)	1225039 (1003927; 1505866)
2003	31733	7330	386594	121857	7473	555570 (460574; 671121)	23207	10158	64011	88947	9012	392949	600530 (435670; 839980)	1164646 (928581; 1461304)
2004	26301	9075	354670	146196	5004	541767 (450747; 654926)	14307	8969	82759	97237	11315	381368	607924 (443259; 842858)	1155912 (925493; 1450202)
2005	38819	8716	449140	139450	5196	642901 (536771; 773136)	14436	7402	60329	87092	8920	467698	659957 (471399; 945563)	1310240(1050827; 1662774)
2006	56432	8323	382441	145195	4891	598171 (501213; 719262)	13732	4554	42356	84562	9250	381312	548206 (393104; 779495)	1151202 (929850; 1449181)
2007	56764	10775	440987	229037	6870	746949 (619141; 909978)	15083	5219	31692	92884	7184	512546	677297 (475702; 983345)	1431244(1140934; 1817349)
2008	24364	8684	346768	194296	6070	581605 (480013; 704971)	6964	8076	39689	70997	7321	423225	565167 (407005; 811184)	1155809 (923525; 1459365)
2009	39112	12305	379791	240466	7072	679916 (563427; 826263)	5707	16721	37058	104920	10692	555525	741554 (527192; 1059197)	1429414 (1133378; 1819008)
2010	30024	13724	531293	240181	16486	834299 (684961; 1011891)	16188	8519	40202	173851	13686	704084	980555 (704235; 1382910)	1820335 (1446391; 2313057)
2011	36360	7712	465710	117520	18763	648254 (534010; 787605)	12768	4849	35178	139772	31819	556513	800933 (569387; 1134154)	1456691 (1147409; 1853565)

Year	Northern NEAC						Southern NEAC							NEAC area
	Finland	Iceland (N&E)	Norway	Russian Federation	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%)
2012	35107	8883	328081	134055	7925	515411 (427493; 623403)	13229	13385	40287	135211	10324	505547	733455 (527878; 1041935)	1253912 (990535; 1609241)
2013	38102	10690	337263	133233	16074	537419 (441964; 653818)	16478	8204	34162	91335	5542	344602	510873 (370664; 716574)	1054073 (846501; 1319280)
2014	36554	10142	427318	125616	10368	611796 (501146; 747781)	18621	7454	36131	149682	7201	420035	656383 (472812; 926842)	1273289 (1013481; 1615375)
2015	39072	14303	468007	107419	7100	637243 (524648; 772282)	7975	10697	35214	194192	13307	454733	737967 (525689; 1056233)	1382182 (1094003; 1764014)
2016	28393	8083	474731	99201	9453	621687 (508623; 758797)	9085	9051	32382	155934	10753	396650	630868 (453360; 888018)	1257616 (1005688; 1592133)
2017	17422	8775	446833	130734	11813	619015 (505732; 754291)	13493	9668	32959	154516	10159	227321	463737 (339039; 644708)	1087883 (878079; 1350103)
2018	24552	6759	375921	101502	18623	529338 (437595; 649935)	21564	7886	30008	120892	6402	285461	477909 (346928; 667406)	1010008 (815499; 1268896)
2019	14663	6006	381500	87774	11421	503216 (411635; 616722)	10603	11082	32410	219850	3848	371564	656918 (460043; 917897)	1164137 (914333; 1479824)
2020	15479	4436	285363	94678	9971	413660 (328110; 521576)	10208	4691	37799	138575	3820	256652	456623 (328127; 632850)	874369 (690390; 1104024)
2021	19437	4713	351021	108988	10949	500536 (394622; 637919)	10675	5347	28768	178672	1969	271757	502149 (357964; 694277)	1006915 (797504; 1271114)
Mean 2012-2021	25964	8212	394217	109905	11752	552657 (450453; 679236)	13189	8231	33315	155961	7000	336531	565937 (406069; 793867)	1123386 (895053; 1418307)

NASCO 2.4 Advice on the risks of salmon bycatch occurring in pelagic and coastal fisheries and effectiveness and adequacy of current bycatch monitoring programmes

The following presents a summary in response to ToR Question 2.4. The corresponding report can be found in ICES (2023a). There are two main methods of analysing the risk of bycatch for salmon.

First, through the **risk of exposure.** This is defined as the risk of salmon being in the same place as commercial vessels that either have a specific gear type or are targeting a particular species that is likely to intercept (catch or kill) salmon, at a depth where the salmon would be. This approach to analysing risk requires the identification of fisheries that will have a higher risk of overlap in space and time with known salmon migration (ICES, 2019). Using the matrix of fisheries with higher overlap, an exposure analysis of fishing effort from at-risk fisheries needs to be modelled with information on the at-sea salmon probability of presence (e.g. Queiroz *et al.*, 2019).

Second, salmon bycatch **risk to stock** can be analysed. ICES Working Group on Bycatch (WGBYC) developed a Bycatch Evaluation and Assessment Matrix (BEAM) that considers species abundance estimates, species variability in space, gear capture variability, and species density (ICES, 2022). This method could be applied to salmon, taking into consideration spatial-temporal variability at a finer resolution given their migration routes. However, it has been reported that for species with very low detectability, such as salmon, the BEAM process may not be sufficiently robust.

ICES (2004) recommended that knowledge of the migration routes of salmon needed improvement. Much progress has been made in this area (e.g. Gilbey *et al.*, 2021; Rikardsen *et al.*, 2021), but gaps in describing their precise migration still exist. For example, the migration routes and time spent in areas such as the North Sea and the Barents Sea are unknown. Furthermore, even though the Norwegian Sea is an important migratory pathway for post-smolt originating from Southern NEAC areas, it is not known whether other important migration pathways may be used by a proportion of the post-smolts. Information on adult migration is also scarce.

Equally, since the ICES Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries (SGBYSAL) undertook an analysis of pelagic fisheries bycatch of Atlantic salmon (ICES, 2004), the Working Group has reviewed pelagic and coastal fisheries bycatch risk. It should be noted that because gear- and métier-specific fisheries data (including targeted fisheries) were not available at the time of writing this text, certain fisheries may have been missed. At present, salmon is considered to be caught as bycatch in coastal areas when they migrate to and from their natal rivers, but insufficient information exists on coastal fisheries to be able to evaluate coastal bycatch risk (Sumner, 2015; Elliott *et al.*, 2023).

To understand how bycatch is being monitored and the effectiveness of that monitoring, existing national programmes and whether these programmes were efficient in detecting and reporting salmon bycatch were reviewed. Although nation-specific onboard and onshore fisheries observer programs exist, salmon bycatch monitoring appears to be more complex than that for larger marine mammals, birds, and reptiles (ICES, 2019). For example:

- For pelagic fisheries, few catches are monitored for bycatch, and normally this monitoring only screens a small proportion of the total catch. This is due in part to the nature of those fisheries (catching hundreds of tonnes of a specific species) and in part to the difficulties of detecting salmon among other pelagic fish in the catch (ICES, 2023b).
- At present, monitoring programmes focus more on demersal fisheries, which are known to have high overall bycatch levels, albeit are less likely to capture pelagic salmon.
- It is difficult to obtain sufficient information on the country and fishery-specific observer effort (e.g. number of observed vessel-days/total days fished per fishery/year). In addition, this information is variable between countries but seldom exceeds 5% of a nation's total annual fishing effort[1].
- There appears to be underreporting of bycatch. It has been noted, for example, that salmon and diadromous fish in general may not be reported at present through national sampling programs (Charbonnel *et al.*, 2022, 2023; ICES, 2023a).
- It should also be noted that access to bycatch records and precise monitoring methods can be difficult to obtain; in numerous cases, these were not available to ICES.

[1] https://datacollection.jrc.ec.europa.eu/wp/2020-2021

From the information collated on pelagic fisheries, a qualitative bycatch risk of exposure matrix was initiated, taking into consideration certainty. Too little information was available to include coastal fisheries' risk of exposure to the matrix. It should also be noted that since spatial and temporal gear and métier-specific data were not available at the time of writing this report, certain fisheries may have been missed in the matrix. From the exposure matrix, it was found that the mackerel fishery during summer in the Norwegian Sea and south of Iceland is a high-risk fishery; this is due to multiple levels of bycatch recorded and its overlap in space, depth, and time with migration routes and feeding areas for salmon. Furthermore, the total landings of mackerel caught in the Norwegian Sea have increased in the last 10–15 years. There is also a medium risk of bycatch in the fishery for herring and blue whiting in the Norwegian Sea; for herring and sandeel in the North Sea; and for capelin in the Barents Sea, as well as for horse mackerel west of the British Isles and sardine and anchovy in the Bay of Biscay.

From this review of literature on salmon bycatch, ICES has identified the following data deficiencies, monitoring needs, and research requirements:

1) Improving understanding of post-smolt and adult salmon migration route in time.
2) Moving to a quantitative analysis of the risk of exposure and bycatch risk to stocks, which requires access to gear- and fisheries-specific fishing effort data (both inshore and offshore data) at an ICES rectangle by month.
3) Including salmon on ICES data calls for bycatch would facilitate the analysis presented in 2).
4) Standardizing salmon bycatch monitoring programmes across countries, including minimum effort per fishery and standards for data recording and reporting.
5) Improving at-sea and onshore observer screening, including better salmon identification guidance. Minimum data to be collected are: date, fishery, catch location, number of salmon bycatch, fork length (preferably), and/or weight. The screening of discards from factories should also be explored (recommendation from ICES, 2004) by having close collaborations with factories operators.
6) Since bycatch data collection is currently difficult to access, eDNA data collection from scientific and commercial pelagic trawls may help improve detection of salmon and improve knowledge of their migratory pathways. Uncertainty estimates from these analyses are required.

Scientific basis

Table 11 The basis of the assessment.

ICES stock data category	1 (ICES, 2023c)
Assessment type	Run-reconstruction models and Bayesian forecasts, taking into account uncertainties in the data (ICES, 2021b, 2023a)
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. Risks of bycatch uncertain due to data-limited situation.
Indicators	Framework of Indicators (FWI) is used to indicate whether a significant change has occurred in the status of stocks in intermediate years where multi-annual management advice applies.
Other information	None
Working group	Working Group on North Atlantic Salmon (WGNAS)

Issues relevant for conservation advice

Abundance of salmon is affected by similar non fishing influences throughout the North Atlantic. Despite major changes in fisheries management two to three decades ago and increasingly restrictive fisheries measures since then, returns of most salmon stocks are at near historic lows. The continued low and declining abundance of many salmon stocks, despite significant fishery reductions, strengthens the conclusion 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 are also contributing to lower adult abundance.

Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. There are a range of problems in the freshwater environment across the North Atlantic that play a significant role in explaining the poor status of stocks. In many cases, river damming and habitat deterioration have had a negative 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.

Conservation status

Atlantic Salmon (*Salmo salar*) has most recently been assessed for the IUCN Red List of Threatened Species in 1996 and for Europe in 2014. *Salmo salar* is listed for Europe as Vulnerable under criteria A2ace (Freyhof, 2014).

A new assessment is underway. In addition, there are regional and national Red List assessments.

Identify relevant data deficiencies, monitoring needs, and research requirements

Data call submissions were not received for the following NEAC jurisdictions with known/historic salmon fisheries or farmed salmon production: Ireland, the Russian Federation, Faroe Islands, Portugal, and Germany. Equivalent data from Ireland and Faroe Islands were received via national reports to ICES. ICES understands that there was no commercial catch in Germany in 2022; although there may have been a small amount of recreational catch, the amount was not reported. ICES recommends that all countries submit salmon data through the data call process, as this is the most effective and efficient way for data collation, quality assurance, analyses, and reporting to be automated.

Data on catch numbers, exploitation rates, and unreported catch rates were not available to ICES for the years 2021 and 2022 for any of the four Russian Federation stock units. In the absence of data, exploitation rates and unreported catch rates, together with their associated errors, were assumed unchanged from previous years. With respect to catches, the total catch for the Russian Federation in wet mass for all stock units and sea ages combined was available for both 2021 (55.38 t) and 2022 (48.82 t) (NASCO, 2023). The ratios of the total catch for the Russian Federation in 2021 and 2022 to the mean total catch for the last five years of available stock unit data (2016–2020) were used to scale the mean catches by sea age and stock unit for the same five-year period to derive estimated catches for 2021 and 2022. The method developed to fill these data gaps might improve with time; however, if the true data cannot be used in future years, the levels of uncertainty in the derived data will increase and, at some point, reach a level that means the process should not be applied.

No river-specific CLs have been established for Denmark, Germany, and Spain. Iceland has set provisional CLs for all salmon-producing rivers and continues to work towards finalizing an assessment process for determining CL attainment.

ICES has identified specific data deficiencies, monitoring needs, and research requirements in regard to *Advice on the risks of salmon bycatch occurring in pelagic and coastal fisheries and effectiveness and adequacy of current bycatch monitoring programmes*, which are outlined above in Section NASCO 2.4.

The creation of a database listing individual PIT tag numbers or codes identifying the origin, source, or programme of the tags should be implemented on a North Atlantic basin–wide scale. This is needed to facilitate identification of individual tagged fish, taken in marine fisheries or surveys, back to the source. A database has been designed by Missing Salmon Alliance UK (MSA) and IMR in Norway; it is hosted and maintained by MSA[2]. The database provides a central, searchable tag data repository, against which unknown PIT detections can be searched. It also holds information on tag detections from pelagic marine fish species in the eastern Atlantic region, with a network of over 20 PIT detector stations operated at fish processing plants in several countries. 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.

[2] https://shiny.missingsalmonalliance.org/tag-database/

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.all advice (ICES, 2023e).

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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, 2023f) 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 the northwest of the Russian Federation 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 Greenland and formerly 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. Data on catch numbers, exploitation rates and unreported catch rates were not available to the Working Group for the years 2021 and 2022 for any of the four Russian Federation stock units. In the absence of data, exploitation rates and unreported catch rates together with their associated errors were assumed unchanged from previous years. With respect to catches, the total catch for the Russian Federation in wet mass for all stock units and sea ages combined was available for both 2021 (55.38 t) and 2022 (48.82 t) (NASCO, 2023). The ratios of the total catch for the Russian Federation in 2021 and 2022 to the mean total catch for the last five years of available stock unit data (2016 to 2020) were used to scale the mean catches by sea age and stock unit for the same five-year period to derive estimated catches for 2021 and 2022.

A variance adjustment parameter was added to the data for each Russian Federation stock unit and sea age. This parameter captures the necessary increase in the variance in return estimates to ensure that they reflect the expected uncertainty arising from the method of estimating catches as described above. The scaling parameters were derived numerically by considering the error between the returns derived from observed catches and the returns derived from catches estimated using the above method applied to the period 2016 to 2020. Additional details on the estimation of catches in 2021 and 2022 and the adjustment to the uncertainty in the returns can be found in ICES (2023a).

Atlantic salmon from North America

Summary of the advice for 2023

The advice provided in 2021 remains valid for 2023 (see ICES, 2021a).

ICES advice on conservation aspects

ICES advises that: i) all non-fisheries related anthropogenic mortalities should be minimized (direct effects on salmon survival); and ii) the quantity and quality of salmon habitats should be restored, including restoring connectivity and the physical, chemical, and biological properties of the habitats (indirect effects).

NASCO 3.1 Describe the key events of the 2021 and 2022 fisheries (including the fishery at Saint Pierre and Miquelon (SPM))

The reported (i.e. nominal) catch of Atlantic salmon in eastern North America, including Canada, France[1] (Islands of Saint Pierre and Miquelon [SPM], located off the southern coast of Newfoundland) and the United States of America (US), was estimated at 99.5 tonnes (t) in 2021 (Canada 97.9 t, SPM 1.6 t, and US 0 t) and provisionally at 101.1 t in 2022 (Canada 99.9 t, SPM 1.2 t, and US 0 t). This is shown in Tables 1 and 2, and in Figure 1. Commercial fisheries in Canada have remained closed since 2000. There have been no commercial or recreational fisheries for anadromous Atlantic salmon in the US since 1999.

Unreported catch for Canada was estimated to be 19.3 t in 2021 and 18.4 t in 2022; the US reported 0 t in both years. SPM did not provide an unreported catch value (ICES, 2023c).

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

Three groups of fishers exploited salmon in Canada in 2021 and 2022: Indigenous, Labrador resident subsistence, and recreational. The fishery in SPM included professional and recreational fishers.

For Canada, 8% of the catch in 2021 and 7% in 2022 were taken in coastal areas; these were entirely from Labrador. The catches from SPM were entirely from coastal areas. For eastern North America overall, 52% of the 2021 catch was in-river, 41% was estuarine, and 7% was coastal. In 2022, 51% was in-river, 42% was estuarine, and 7% was coastal.

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

The estimated numbers of salmon caught and released in the recreational fisheries of Canada was 67 056 in 2021 and 53 002 in 2022 representing about 62% and 56% of the total catch by number in each year. Of these caught and released individuals, 47 969 were small and 19 087 large in 2021, compared to 29 650 small and 23 351 large in 2021.

[1] Saint Pierre and Miquelon (SPM), islands located off the southern coast of Newfoundland.

Table 1 Salmon catch (in tonnes [t], round fresh weight) and catch location in the North American Commission (NAC) area in 2021 and 2022. 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 and Miquelon	USA	North America
	Commercial	Indigenous	Labrador resident	Recreational	Total			
2021								
Reported catches (t)	0	56.6	1.8	39.5	97.9	1.6	0	99.5
% of NAC total	0	57.8	1.8	40.4	98.4	1.6	0	
Unreported catch (t)	na	na	na	na	19.3	na	0	19.3
Location of catches								
% in-river					51.1	0	-	51.9
% estuarine					41.3	0	-	40.6
% coastal					7.6	100	-	7.5
2022								
Reported catches (t)	0	58.1	1.4	40.3	99.9	1.2	0	101.1
% of NAC total	0	58.1	1.4	40.3	98.8	1.2	0	
Unreported catch (t)	na	na	na	na	18.4	na	0	18.4
Location of catches								
% in-river					50.8	0	-	51.4
% estuarine					42.3	0	-	41.8
% coastal					6.9	100	-	6.8

Table 2 Total reported catch (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 2022. The 2022 figures include provisional data.

Year	Canada			USA	St Pierre and 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
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	52	51	103	0	2
2021	58	40	98	0	2
2022	57	43	100	0	1

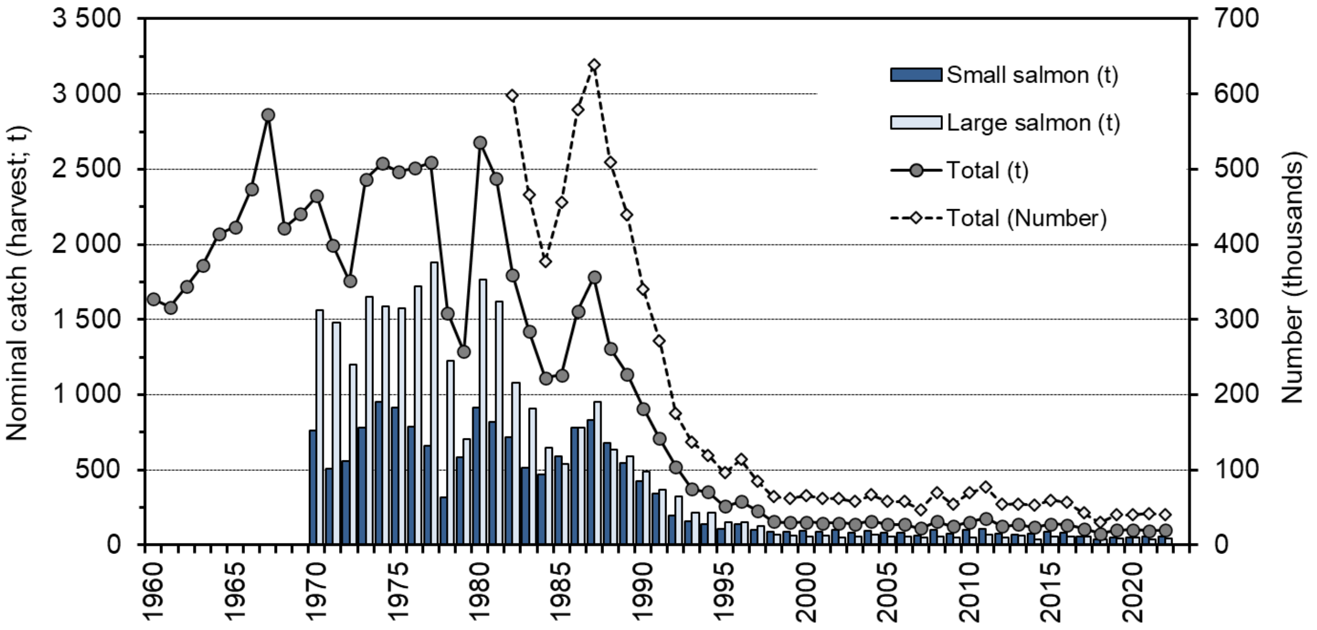

Figure 1 Reported catch (harvest; tonnes and number in thousands) of small (< 63 cm) and large (≥ 63 cm) salmon in Canada (combined catches in US and Saint Pierre and Miquelon are ≤ 6 tonnes in any year) from 1960 to 2022.

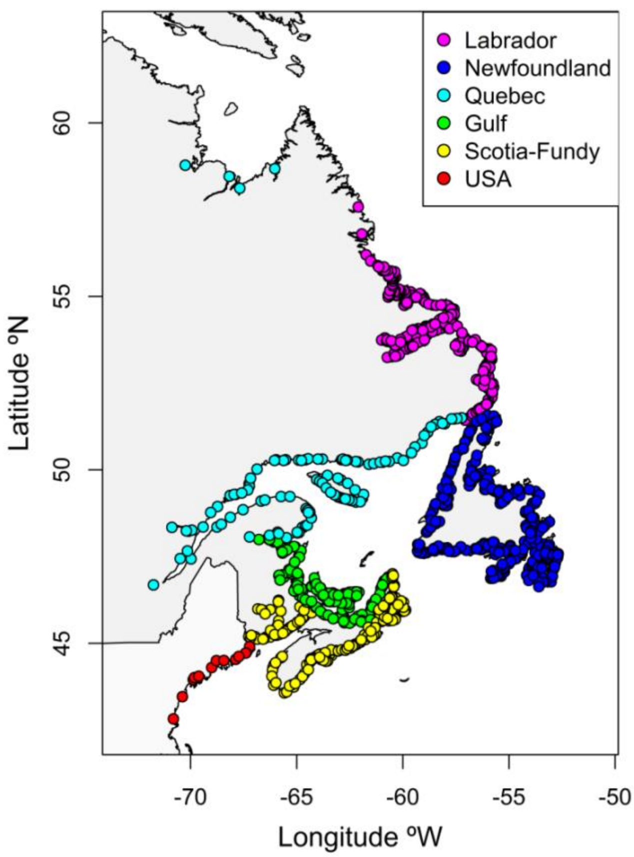

Figure 2 Assessment regions for salmon in the NAC area. Dots indicate locations of all salmon rivers.

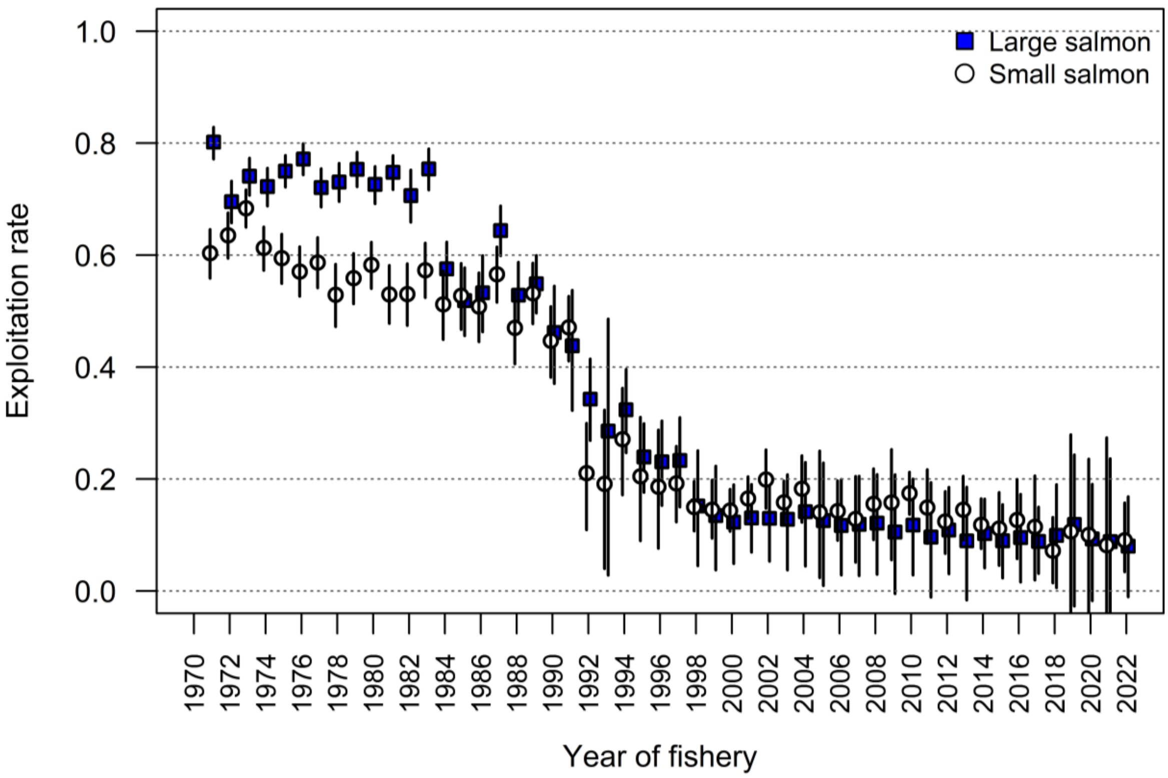

Figure 3 Exploitation rates in North America on small (one-sea-winter [1SW]) and large (multi-sea-winter [MSW] and repeat spawners) salmon from 1971 to 2022.

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, as well as Saint Pierre and Miquelon) are used to monitor the stock composition of these mixed-stock fisheries.

A single nucleotide polymorphism (SNP) panel range-wide baseline 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). This assignment has 90% accuracy. 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, 2021b) and for the SPM fishery (Bradbury et al., 2016; ICES, 2015, 2020;).

The reporting groups from the genetic assignments do not correspond directly to the regions used by ICES to characterize stock status and provide catch advice. Assessment of stock status and provision of catch advice is not possible at the scale of the genetic groups, as historical catch reporting is available at a jurisdictional scale that is broader than these groups. The genetic reporting groups can, however, be aligned to the assessment regions (Table 3).

Table 3 Correspondence between ICES regions used for the assessment of North American salmon stock status and the genetic reporting groups defined using the SNP range-wide baseline (Jeffery *et al.*, 2018). See Figure 4 for a map of genetic reporting groups.

ICES 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 Shore Lower	QLS
	Anticosti	ANT
	Gaspe Peninsula	GAS
	Quebec City Region	QUE
Gulf	Gulf of St Lawrence	GUL
Scotia–Fundy	Inner Bay of Fundy	IBF
	Eastern Nova Scotia	ENS
	Western Nova Scotia	WNS
	Saint John River & Aquaculture	SJR
Newfoundland	Northern Newfoundland	NNF
	Western Newfoundland	WNF
	Newfoundland 1	NF1
	Newfoundland 2	NF2
	Fortune Bay	FTB
	Burin Peninsula	BPN
	Avalon Peninsula	AVA
USA	Maine, United States	USA
Europe	Spain	SPN
	France	FRN
	European Broodstock	EUB
	United Kingdom and Ireland	BRI
	Barents-White Seas	BAR
	Baltic Sea	BAL
	Southern Norway	SNO
	Northern Norway	NNO
	Iceland	ICE
	Greenland	GL

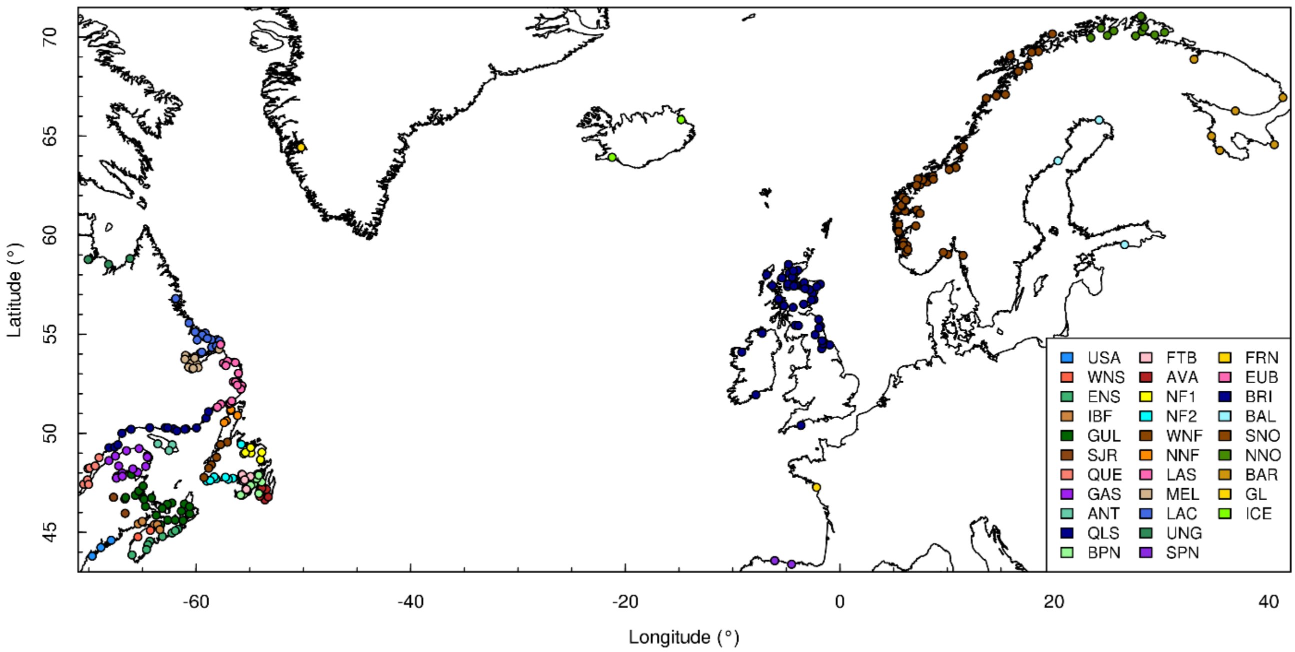

Figure 4 Map of sample locations used in the range-wide genetic baseline (single nucleotide polymorphisms [SNPs]) for Atlantic salmon. The SNP provided assignment of individual salmon to 21 North America and 10 European genetic reporting groups (labelled and identified by colour). The full names of the genetic reporting groups and the corresponding ICES assessment regions are provided in Table 3. The European Broodstock (EUB) reporting group is not represented on the map.

Labrador fishery origin and composition of the catches

Tissue samples from the Labrador subsistence salmon fisheries were collected in 2021 and 2022; with a sampling rate of 7.9% and 6.4% of the catch, respectively. The SNP panel was used to analyse 1 079 samples in 2021 and 872 in 2022. As in previous years, the estimated origin of the samples was dominated (> 95%) by the Labrador reporting groups. The dominance of these groups is consistent with previous analyses conducted for the period 2006–2020, which estimated that > 95% of the catch was attributable to Labrador stocks (ICES, 2019, 2020, 2021b). Furthermore, assignment of catches within the Labrador genetic reporting groups suggests a largely local catch within salmon fishing areas (Figures 5 and 6).

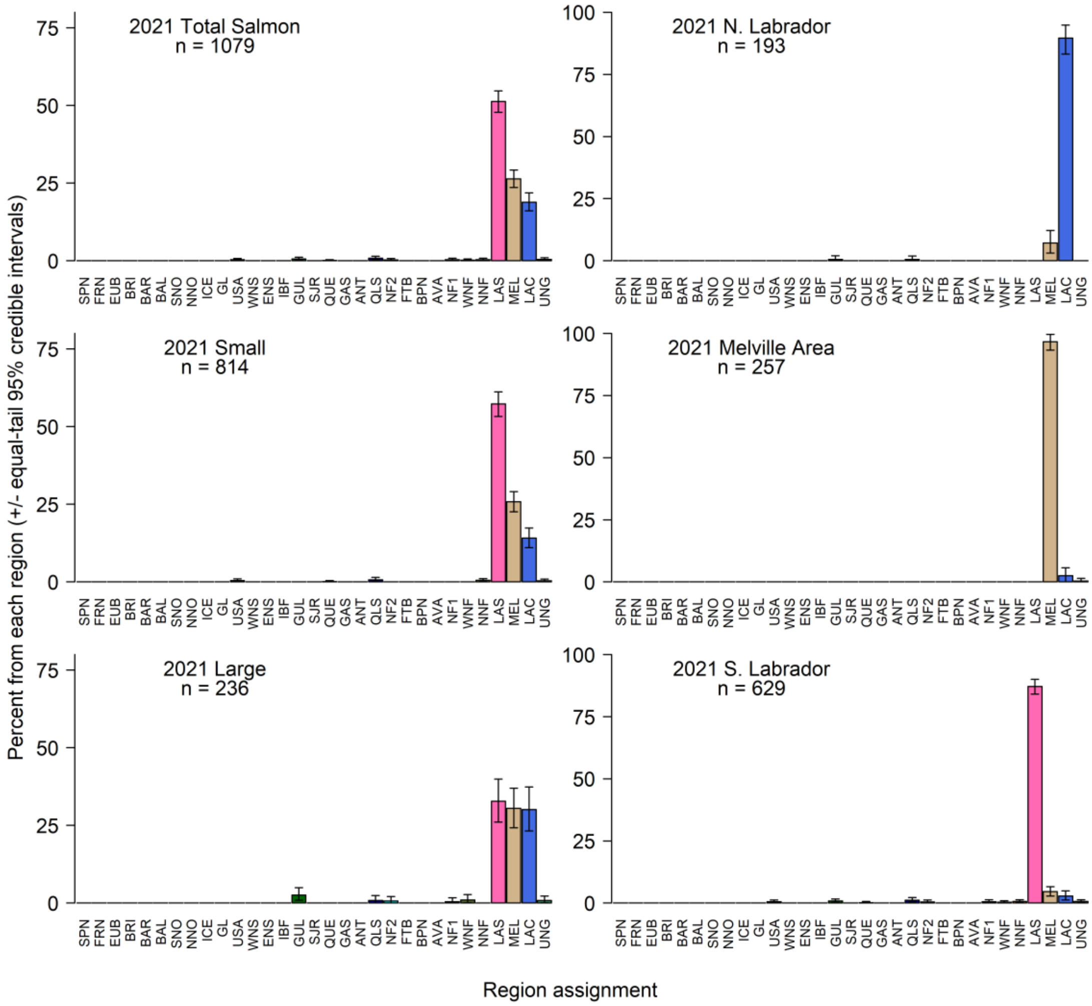

Figure 5 Percentages of Labrador subsistence fishery samples by size group and by Labrador SFA (Northern Labrador = SFA 1A; Southern Labrador = SFA 2), assigned using SNPs to regional reporting groups of the North Atlantic for the 2021 fishery year. The colours used for the bars and match those used in Figure 4. Reporting groups with zero support have been excluded from the figure.

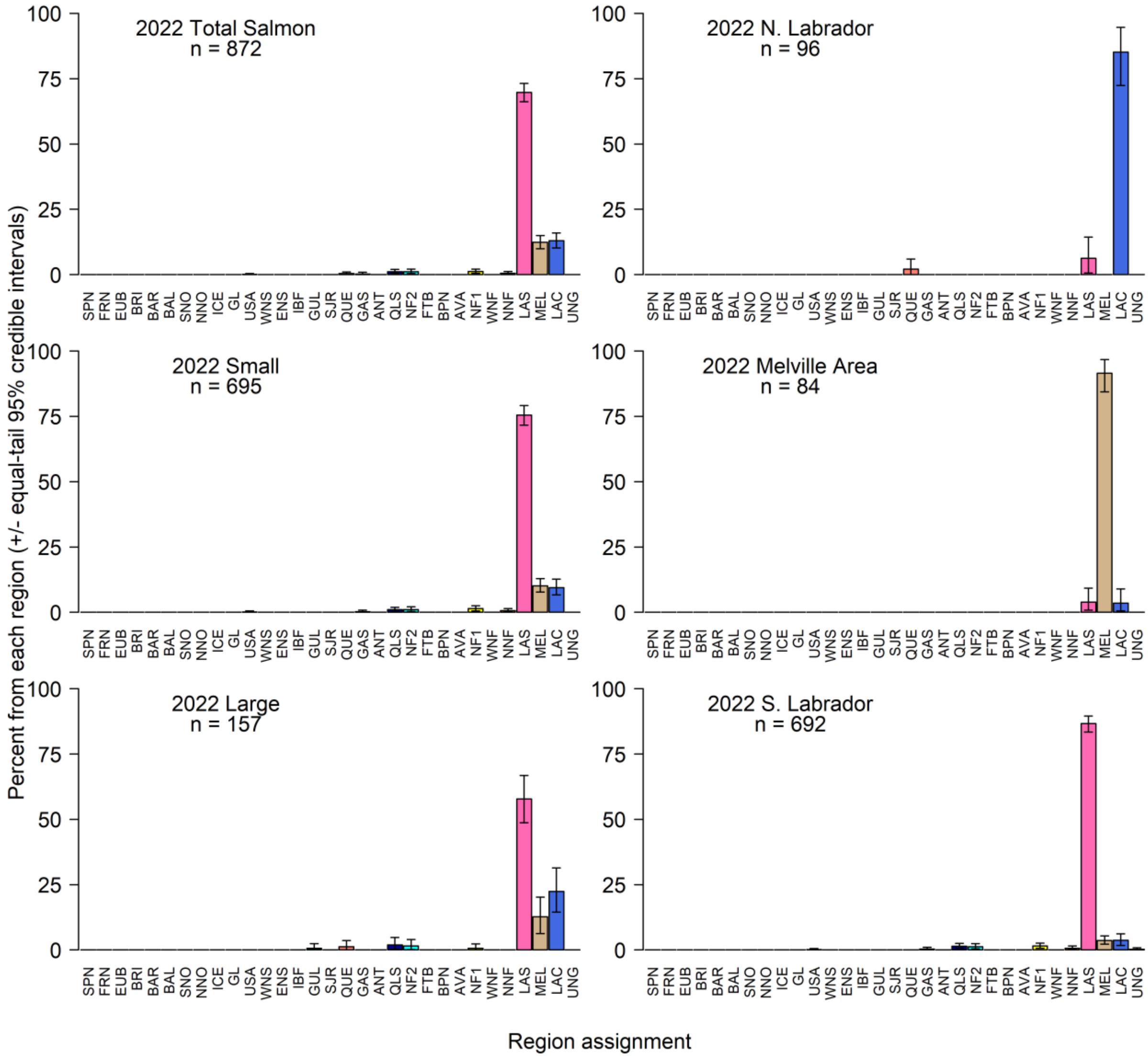

Figure 6 Percentages of Labrador subsistence fishery samples by size group and by Labrador SFA (Northern Labrador = SFA 1A; Southern Labrador = SFA 2), assigned using SNPs to regional reporting groups of the North Atlantic for the 2022 fishery year. The colours used for the bars and match those used in Figure 4. Reporting groups with zero support have been excluded from the figure.

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

The SNP panel was used to analyse tissue samples collected in the SPM fishery from 2020 to 2022 (116 in 2020, 51 in 2021, and 29 in 2022). Samples collected represented 18%, 7%, and 6% (respectively) of the catch in each year from 2020 to 2022. Samples were dominated (> 94%) by the genetic reporting groups in Quebec, Gulf, and Newfoundland. Large salmon were mainly (> 77%) from the Quebec and Gulf groups, and the largest portion (> 48%) of the small salmon were from the Newfoundland groups.

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 Conservation Limits (CLs) by jurisdiction

Limit reference points in terms of two-sea-winter (2SW) CLs have been defined for all six areas in North America (MFFP, 2016; DFO, 2018; ICES, 2021a). No changes to the 2SW CLs or to the management objectives were made from those identified previously (ICES, 2021b).

Rebuilding management objectives have been defined for Scotia–Fundy and US. 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 1992–1996. For US, the management objective is to achieve 2SW adult returns of 4 549 or greater (Table 4). The methods used to determine conservation limits differ between regions (ICES, 2021b).

Table 4 The 2SW CLs and management objectives for the regional groups in North America.

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 7). CLs have been established for 33 river stocks in US since 1995 (Figure 7).

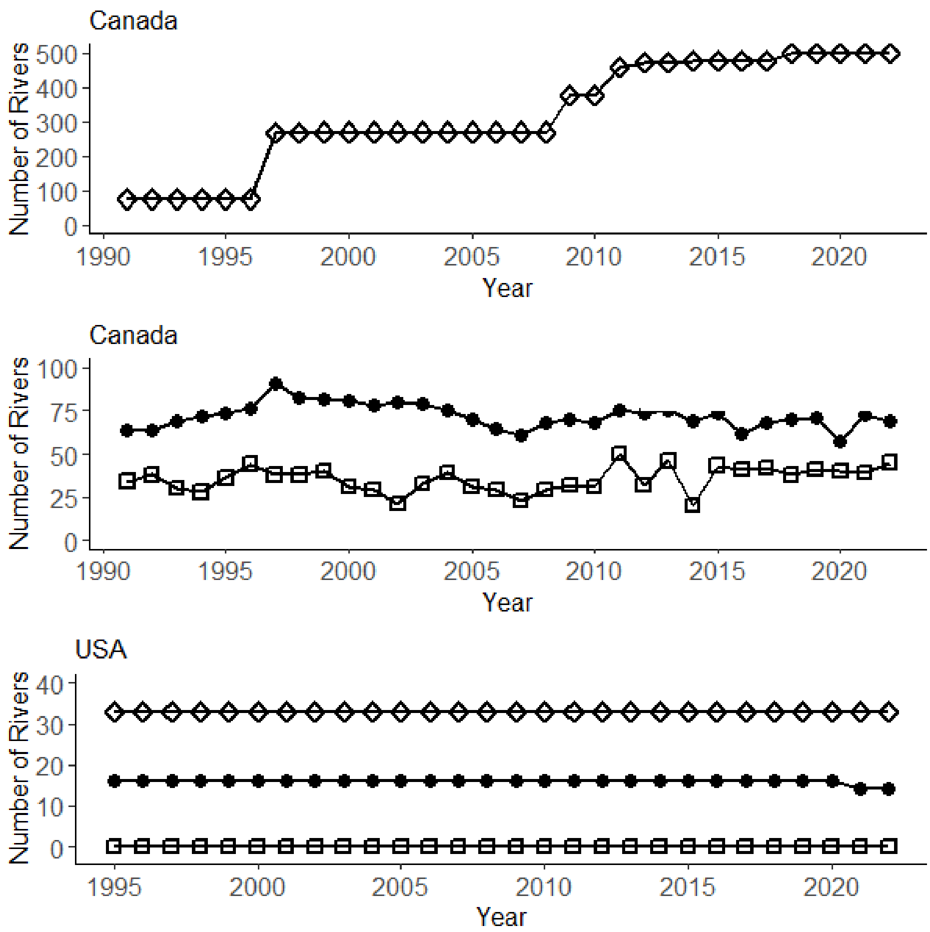

Figure 7 Time-series for Canada and US showing the number of rivers with established CLs (diamonds), the number of rivers assessed (circles), and the number of assessed rivers meeting CLs (squares) for the period 1991–2022. Further details can be found in ICES (2021b).

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 the six assessment regions identified in Figure 2 and overall for North America.

Returns of small (1SW), large (MSW and repeat spawners), and 2SW (a subset of large) salmon 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 2021. 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 2022 was 540 700 (Figure 8). Small salmon returns in 2022 were the highest in the time-series for Labrador and among the lowest for Gulf and Scotia–Fundy (both fourth-lowest). For 2022 and similarly to the previous five years, small salmon returns to Labrador (335 500) and Newfoundland (160 400) combined represented the majority (92%) of the total small salmon returns to North America.

The total estimate of returns of large salmon to North America in 2022 was 188 800 (Figure 9). Large salmon returns in 2022 increased from the previous year in the assessed regions of Labrador (72%), Quebec (10%), Gulf (69%), Scotia–Fundy (179%), and US (159%). Large salmon returns for Labrador in 2022 were the second highest (84 700) of the 52-year time-series. On average (2018–2022), large salmon returns to the US and Scotia–Fundy regions combined represented less than 2% of the total large salmon returns to North America.

The total estimate of 2SW salmon returns (subset of returns of large salmon) to North America in 2022 was 114 000 (Figure 10). Returns of 2SW salmon in 2022 increased from the previous year in the assessed regions of Labrador (71%), Quebec (10%), Gulf (61%), Scotia–Fundy (169%), and US (163%). On average (2018–2022) 92% of all 2SW salmon returns to North America were from the three regions of Labrador, Quebec, and Gulf which generated 36% 28% and 28% of 2SW returns respectively. There are few 2SW salmon returns to Newfoundland (5%), as the majority of the large salmon returns to the region are those that have spawned previously. Scotia–Fundy and US each represent less than 1% of the 2SW returns to North America.

In 2021, the median estimates of 2SW returns and spawners to rivers were below the respective 2SW CLs in five of the six assessment regions of NAC and, therefore, are suffering reduced reproductive capacity. The remaining assessment region of Newfoundland was above the 2SW CL and at full reproductive capacity (Figures 11). In 2022, four of the six assessment regions of NAC were suffering reduced reproductive capacity, whereas Labrador was at risk of suffering reduced reproductive capacity and the Gulf was at full reproductive capacity (Figure 11). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the Scotia–Fundy and US regions.

River-specific assessments were provided for 87 rivers in 2021 and 83 rivers in 2022. Egg depositions by all sea ages combined in 2021 exceeded or equaled the river-specific CLs (the solid blue line in Figure 12) in 39 of the 87 assessed rivers (45%) and were less than half of CLs in 37 rivers (43% [Figure 12]). In 2022, 45 of the 83 assessed rivers (54%) exceeded or equaled the river-specific CLs and were less than half of CLs in 25 rivers (30% [Figure 12]). 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 70% with no temporal trend (Figure 7). Sixteen rivers in USA are assessed against CL attainment annually No rivers in the USA meet the CL in any year assessed (Figure 7).

Estimates of PFA (defined as the number of maturing and non-maturing 1SW salmon) suggest continued low abundance of North American salmon (Figure 13). The PFA in the Northwest Atlantic shows a period of general decline (albeit with large fluctuations) between 1971 and ~1995 after which there has been a sustained period of low abundance. During the period 1992 to 2021, the average PFA was 622 700 fish, less than half of the average abundance (1 252 000 fish) during the period 1971 to 1991. PFA of maturing and non-maturing 1SW salmon in 2021, the most recent available value, was estimated at 886 900 fish. Abundance declined by 48% over the time-series, from a peak of 1 706 300 fish in 1975 (Figure 13).

Despite major changes in fisheries management two to three decades ago and increasingly 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 the US and 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 conclusion 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.

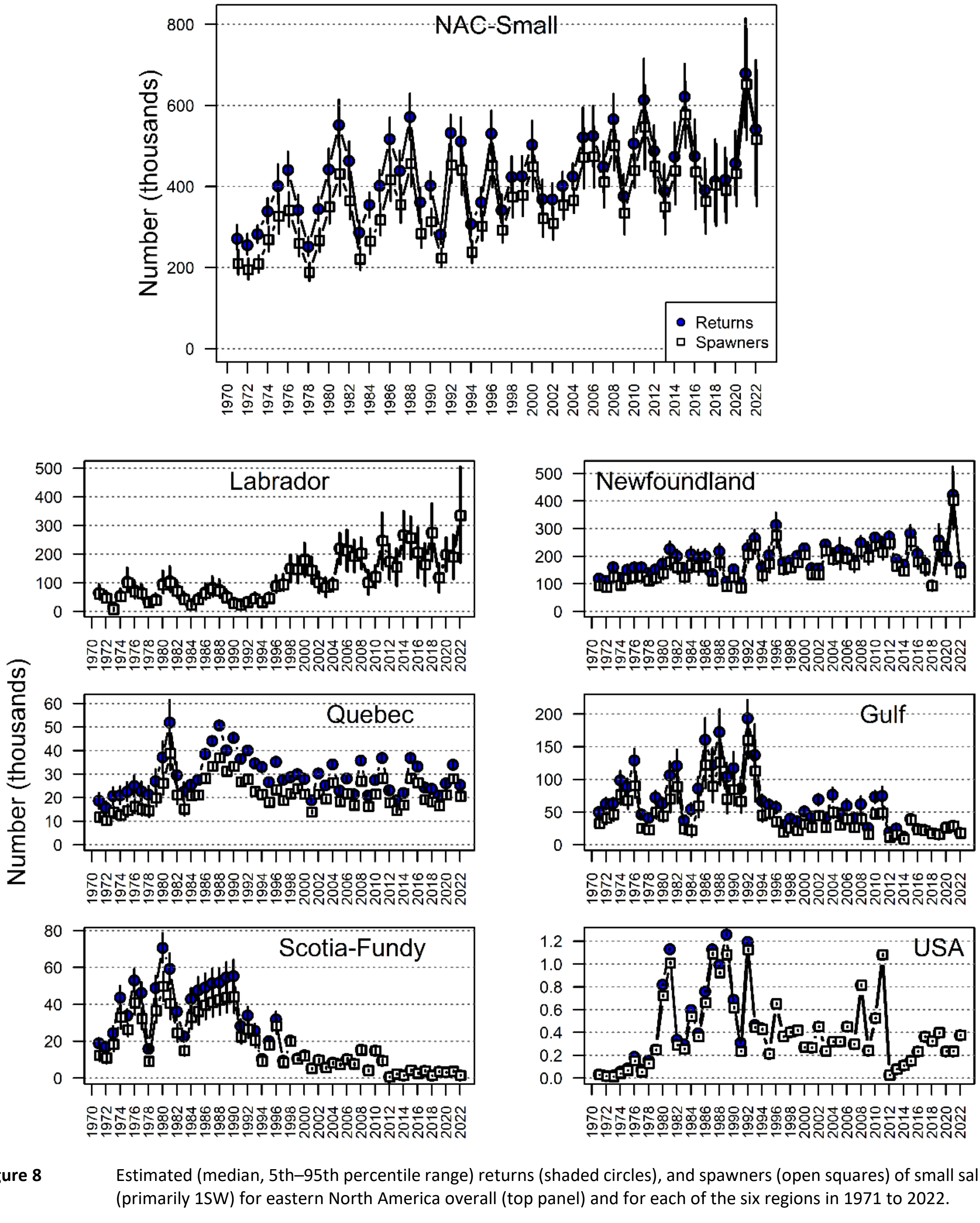

Figure 8 Estimated (median, 5th–95th percentile range) returns (shaded circles), and spawners (open squares) of small salmon (primarily 1SW) for eastern North America overall (top panel) and for each of the six regions in 1971 to 2022.

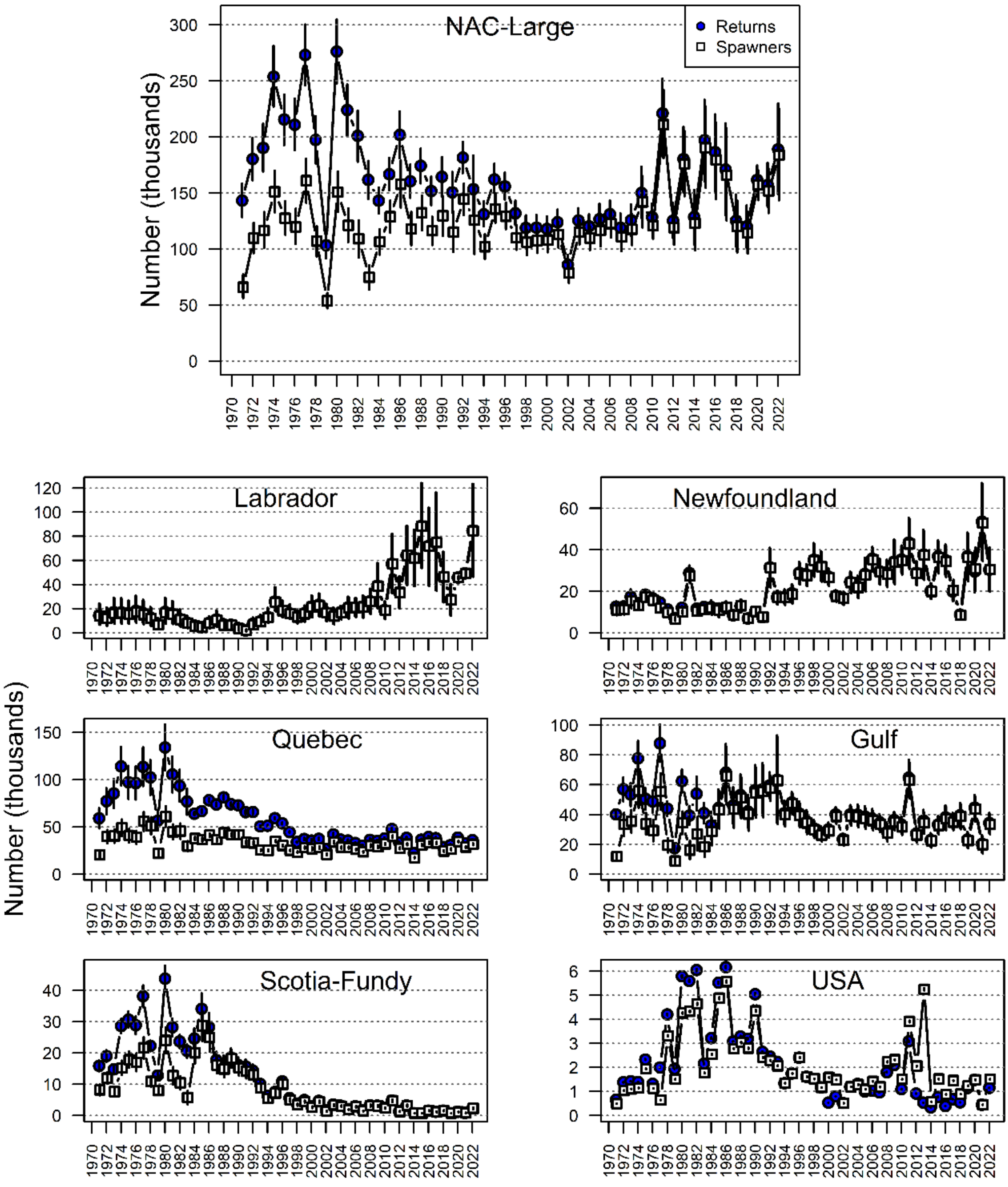

Figure 9 Estimated (median, 5th–95th percentile range) returns (shaded circles), and spawners (open squares) of large salmon (primarily MSW and repeat spawners) for eastern North America overall (top panel) and for each of the six regions in 1971 to 2022.

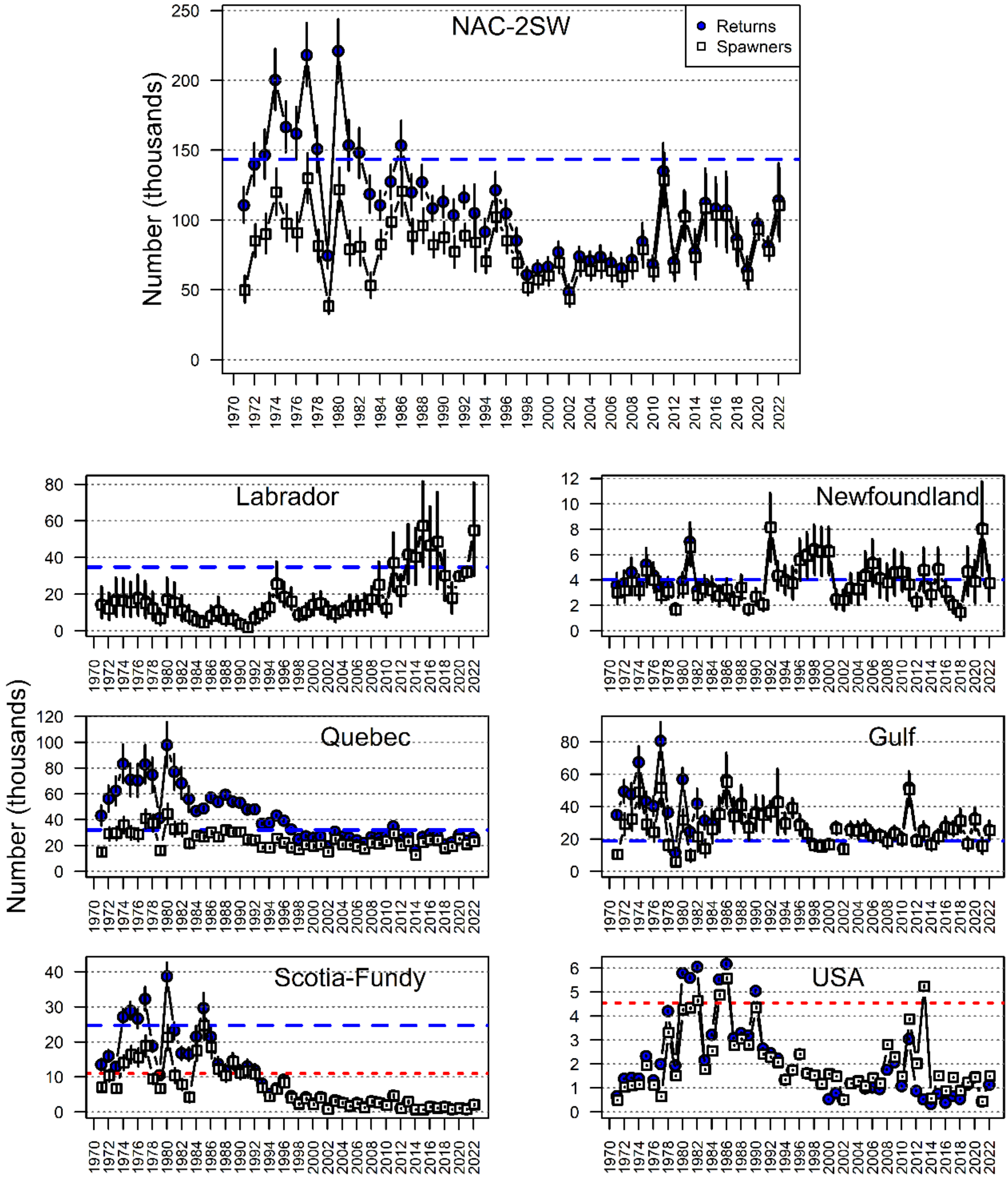

Figure 10 Estimated (median, 5th–95th percentile range) returns (shaded circles), and spawners (open squares) of 2SW salmon for eastern North America overall (top panel) and for each of the six regions in 1971 to 2022. The blue dashed lines are the corresponding 2SW CLs; the 2SW CL (29 199 fish) is off scale in the plot for US. The red dotted lines in the Scotia–Fundy and US panels are the region-specific management objectives. For US, estimated spawners exceed the estimated returns in some years as a result of adult stocking restoration efforts.

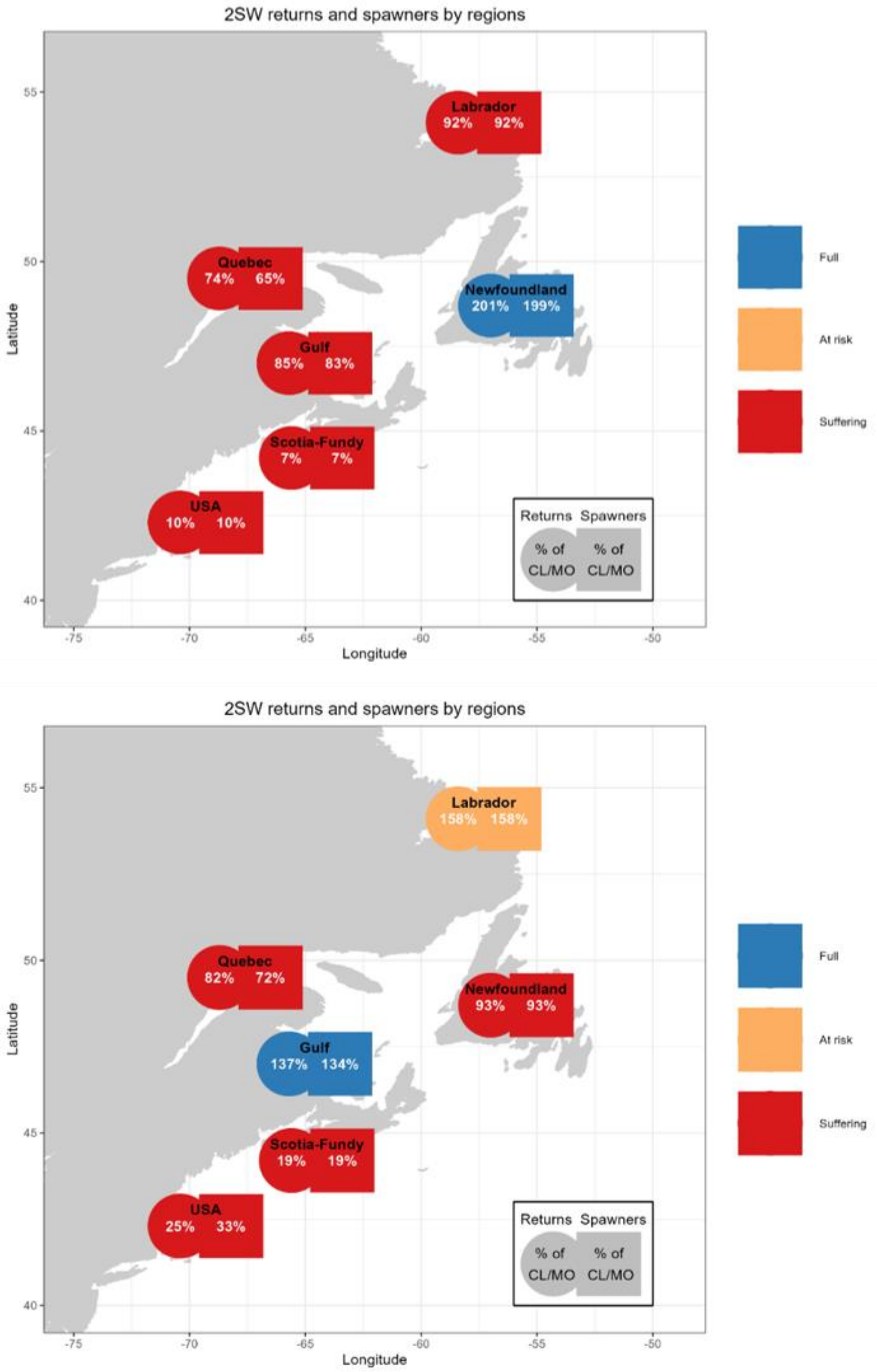

Figure 11 Estimated returns (circle symbol) and spawners (square symbol) of 2SW salmon in 2021 and 2022 to six regions of North America relative to the stock status categories. The percentage of the 2SW CLs for the four northern regions and to the rebuilding management objectives (MO) for the two southern areas are shown based on the median of the Monte Carlo distribution. For Quebec, 2SW CL correspond to the Upper Stock Reference point. 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).

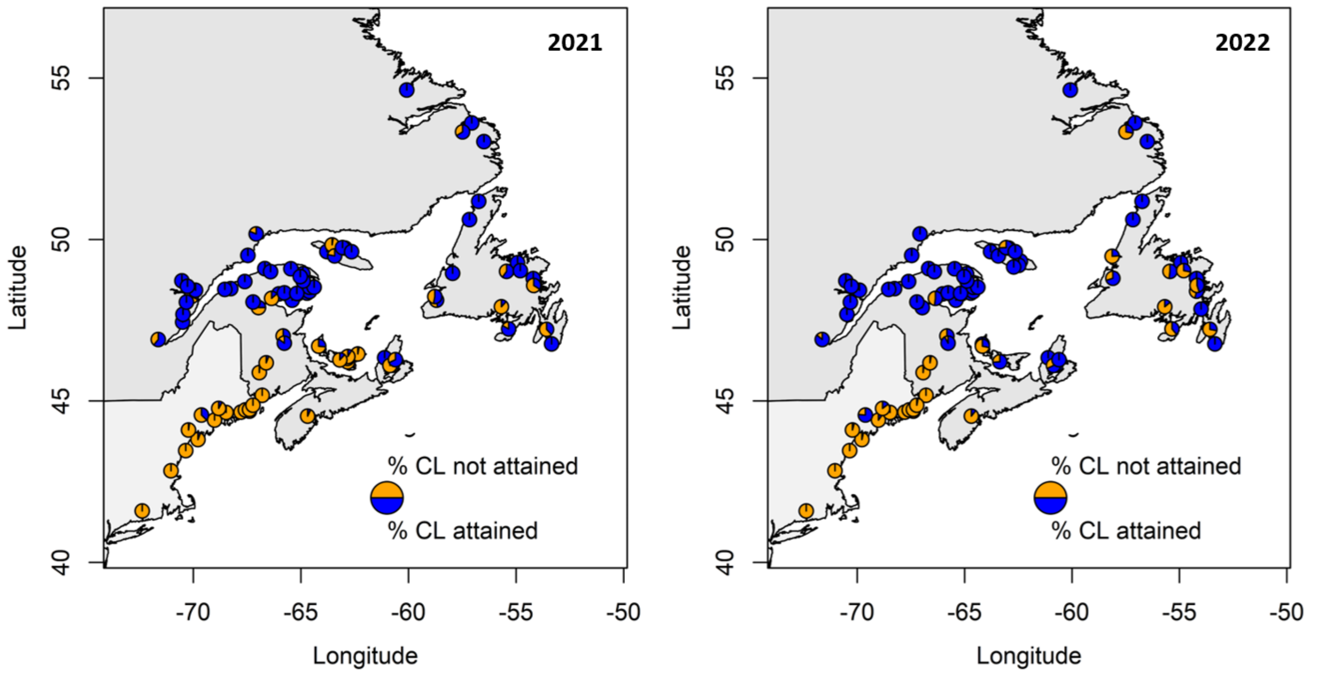

Figure 12 Degree of attainment for the river-specific conservation limit (CL) egg requirement assessed in 87 rivers in 2021 and 83 rivers in 2022.

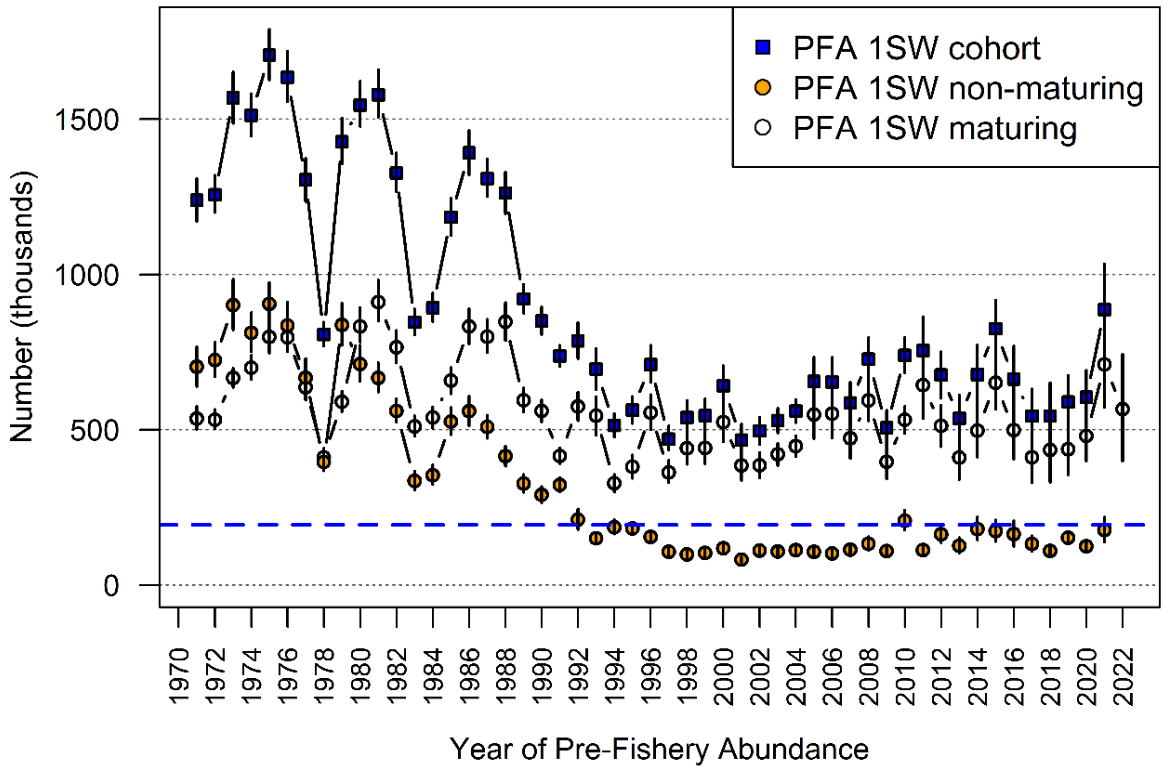

Figure 13 Estimated (median, 5th–95th percentile range) PFA for 1SW maturing, 1SW non-maturing, and total cohort of 1SW salmon for North America for the 1971–2022 PFA years. The horizontal dashed blue line is the corresponding sum of the 2SW CLs for North America, corrected for 11 months of natural mortality and against which 1SW non-maturing abundance is assessed.

Issues relevant for conservation advice

Abundance of salmon is affected by similar non fishing influences throughout the North Atlantic. Despite major changes in fisheries management two to three decades ago and increasingly restrictive fisheries measures since then, returns of most salmon stocks are at near-historical lows. The continued low and declining abundance of many salmon stocks, despite significant fishery reductions, strengthens the conclusion 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 are also contributing to lower adult abundance.

Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. There are a range of problems in the freshwater environment across the North Atlantic that play a significant role in explaining the poor status of stocks. In many cases, river damming and habitat deterioration have had a negative 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 the 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.

Conservation status

Atlantic Salmon (*Salmo salar*) has most recently been assessed for the IUCN Red List of Threatened Species in 1996 and for Europe in 2014. *Salmo salar* is listed for Europe as Vulnerable under criteria A2ace (Freyhof, 2014).

All salmon populations within the US and Scotia–Fundy regions have either been listed or are being considered for listing under country-specific species at risk legislation.

Identify relevant data deficiencies, monitoring needs, and research requirements

The following data deficiencies, monitoring needs, and research requirements were identified as 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. A sampling rate of at least 10% of catches across the fishery season 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.
- The creation of a database listing individual PIT tag numbers or codes identifying the origin, source, or programme of the tags should be implemented on a North Atlantic basin–wide scale. This is needed to facilitate identification of individual tagged fish, taken in marine fisheries or surveys, back to the source. A database has been designed by Missing Salmon Alliance UK (MSA) and IMR in Norway and is hosted and maintained by MSA[2]. The database provides a central, searchable tag data repository against which unknown PIT detections can be searched. It also holds information on tag detections from pelagic marine fish species in the eastern Atlantic region, with a network of over 20 PIT detector stations operated at fish processing plants in several countries. 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 1.7 of the sal.oth.all advice (ICES, 2023a).

[2] https://shiny.missingsalmonalliance.org/tag-database/

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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 the 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. The exploitation rate on salmon, however, 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, Labrador in particular, 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 either had to 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 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. The larger overestimate for Labrador relative to the other regions, however, 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, 2023b)
Assessment type	Run–reconstruction models and Bayesian forecasts, taking into account uncertainties in the data (ICES, 2021b, 2023c).
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	None
Other information	None
Working group	Working Group on North Atlantic Salmon (WGNAS)

Atlantic salmon at West Greenland

Summary of the advice for 2023

The advice provided in 2021 remains valid for 2023 (see ICES, 2021).

ICES advice on conservation aspects

ICES advises that i) all non-fisheries-related anthropogenic mortalities should be minimized (direct effects on salmon survival); ii) the quantity and quality of salmon habitats should be restored, including restoring connectivity and the physical, chemical, and biological properties of the habitats (indirect effects).

NASCO 4.1 Describe the key events of the 2021 and 2022 fisheries

Fishing for salmon using hooks and fixed gillnets is currently allowed along the entire coast of Greenland. Commercial fishers are allowed to use up to 20 gillnets at a time, either as single gillnets fixed to the shore or up to 20 nets connected and used as a driftnet. Recreational licensed fishers can only use one gillnet fixed to the shore or rod and reel. 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.

Commercial fishery for export has been closed since 1998, with the exception of 2001; fishery for internal use, however, continues to this day. There are two landing categories reported for the fishery: commercial landings, where professional fishers can sell salmon to hotels, institutions, and local markets; and recreational landings, where both professionals and non-professionals fish for private consumption. Since 2002, only licensed commercial fishers have been permitted to sell salmon to hotels, institutions, and local markets, as well as to 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 2021, the Government of Greenland published a “Management Plan for Atlantic Salmon in Greenland” (GoG, 2021), which is to remain in force from 1 July 2021 through 31 December 2025. The management plan identifies two different user groups and three separate management areas (Figure 1), specifying fishing seasons for each; and it sets how the established total allowable catches (TAC) are to be distributed among regions/user groups.

In 2021, a single year regulatory measure was agreed at NASCO (NASCO, 2021), which stipulated a TAC of 27 t for the fishery at West Greenland. The regulatory measure maintained many of the provisions from the preceding measures, such as a continuation of the ban on the export of wild Atlantic salmon; restricting the fishery to August through November; requiring all fishers to have a license; requiring fishers to allow samplers access to their catch; and requiring fishers to report their catch, even zero harvest. As outlined within the management plan, the Government of Greenland also allocated an additional 3 t TAC for the fishery at East Greenland.

In 2022, a multiyear regulatory measure was agreed at NASCO (NASCO, 2022) that stipulated a TAC of 27 t for the fishery at West Greenland for the years 2022–2025. The agreement outlined a new measure to minimize the likelihood of overharvest. At least for the first year of the agreement, it was agreed that the fishery would be closed when the registered catch had reached no more than 49% of the overall TAC to help ensure that the TAC would not be exceeded. In subsequent years, the percentage could be adjusted, in consultation with NASCO, based on previous experiences and the expected effect of new management measures. As outlined within the management plan, the Government of Greenland also allocated an additional 3 t TAC for the fishery at East Greenland.

Reported (i.e. nominal) catches of Atlantic salmon at Greenland (Table 1; Figure 2) increased through the 1960s, reached a peak of approximately 2 700 t in 1971, then decreased until the closure of the commercial fishery for export in 1998. Catches are reported from all six NAFO divisions and ICES Statistical Area 14, and proportions vary annually (Table 2). A total salmon catch of 43.2 t was reported for the 2021 fishery and 29.8 t for the 2022 fishery. This represents a 13.2 t overharvest for the 2021 fishery, whereas the 2022 fishery did not exceed the TAC. Unreported catch is assumed to have been at the same level (10 t) as historically reported by the Greenlandic authorities. In 2021, commercial landings represented the majority of the harvest at 32.2 t (74.5%), and the remaining 11.0 t (25.4%) was for recreational use (Table 3). In 2022, commercial landings represented the majority of the harvest at 20.6 t (69.3%), and the remaining 9.2 t (30.7%) was for recreational use. 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 requirements both for all fishers to obtain a licence and for mandatory reporting (Figure 3).

The reported landings in West Greenland were adjusted for the assessment in some years using port sampling and/or telephone surveys (Table 4).

The sampling programme for 2020 was modified from past efforts due to travel restrictions associated with the COVID-19 pandemic. The programme was marginally successful, as a total of 197 samples were collected, this is a sampling rate of 1% of harvested individuals. Shipping delays prevented these samples from being processed in 2021, but all samples have been processed and results are reported here.

The sampling programme continued in 2021. Six international samplers were scheduled, but only three were able to participate, given continued travel restrictions associated with the pandemic. To increase the sampling coverage, a local resident from Qaqortoq, Greenland was hired to provide sampling in that community throughout the fishing season. Samples were collected from the city of Nuuk (NAFO Division 1D) by the Greenland Institute of Natural Resources (GINR).

A Citizen Science programme was also initiated by the GINR. This involved sending a mailing to all license holders who had reported catches of five or more salmon in 2020. The mailing contained a letter requesting the fishers' participation, an instruction sheet, and five scale envelopes. It was requested that any collected samples and data be returned to the GINR at the conclusion of the fishing season. In total, 1 548 salmon were observed in 2021 (Citizen Science [252], GINR [393] and International Samplers [903]), this is a sampling rate of 17% of reported landings.

The sampling programme continued in 2022 with four international samplers and the local resident of Qaqortoq. There was no Citizen Science programme initiated in 2022. In total, 672 salmon were observed in 2022 (all from the International Samplers), this is a sampling rate of 7% of reported landings.

A summary of the biological characteristics and continental contribution for the 2020–2022 fisheries are presented in Table 5. In 2020, 2021, and 2022 (Figure 4 and 5), North American contributions to the fisheries were 59%, 83%, and 91%, while European contributions were 41%, 17% and 9%, respectively. Approximately 8 800 (5 200 North American and 3 600 European), 12 300 (10 300 North American and 2 000 European) and 10 100 (9 200 North American and 900 European) salmon were harvested in the 2020, 2021 and 2022 fisheries, respectively. The origin of salmon harvested at West Greenland in the 2020–2022 fisheries has been estimated based on an updated genetic range-wide baseline using Single Nucleotide Polymorphisms (SNPs). This baseline, based on samples from 189 rivers from across the North Atlantic (Jeffery *et al.*, 2018), was updated in 2018 (ICES, 2018) and can discriminate salmon from 21 North American and 10 European genetic reporting groups (Table 6 and Figure 6).

The North American contributions to the West Greenland fishery are dominated by the Gaspe Peninsula, the Gulf of St Lawrence, and the Labrador South reporting group (Tables 7, 8, and 9). These three groups accounted for 78% of the North American contributions in 2020, 88% in 2021, and 60% in 2022. The Northeast Atlantic contributions were dominated by the United Kingdom and Ireland reporting group (93%, 92%, and 88% of the European contributions in 2020, 2021, and 2022, respectively). From North America, there are smaller but consistent contributions to the harvest for a number of other reporting groups (e.g. Lake Melville, St Lawrence North Shore-Lower, Maine, United States, Labrador Central). These results are similar to those reported previously. A single sample in 2022 was identified as originating from the Greenland reporting group (i.e. Kapisillit River). This is the second time a sample has been assigned the Greenland reporting group. The first time was in 2018, and the sample also originated from Nuuk. The SNP baseline, which includes the Greenland reporting group, has only been used since 2017.

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 apply 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 2 520 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
2001	-	-	-	-	43	43	114	Final quota calculated according to the *ad hoc* management system

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
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
2021	-	-	-	-	43	43	30	Overall quota segregated across 3 management areas and 2 user groups with 27 t allocated for the fishery at West Greenland
2022	-	-	-	-	30	30	30	Same as previous year

Table 2 Annual distribution of reported catches (in tonnes) at Greenland by NAFO division (where known). NAFO divisions and ICES Area 14 (East Greenland) 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
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

Year	NAFO Division						Unknown	West Greenland	East Greenland	Total
	1A	1B	1C	1D	1E	1F				
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
2021	1.3	5.1	13.8	10.5	3.4	7.4	0.3	41.8	1.4	43.2
2022	1.4	3.0	5.3	8.2	4.1	7.0	0.8	29.0	0.8	29.8

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

Table 3 Reported landings (in tonnes and percentage) from West Greenland and East Greenland and by landings type (commercial and recreational fishers) from 2020 to 2022.

Year	Reported Landings (%)			Landings Type (%)	
	West Greenland	East Greenland	Total	Commercial	Recreational
2020	30.9 (97.5%)	0.8 (2.5%)	31.7	22.0 (69.5%)	9.7 (30.5%)
2021	41.8 (96.8%)	1.4 (3.2%)	43.2	32.2 (74.6%)	11.0 (25.4%)
2022	29.0 (97.3%)	0.8 (2.7%)	29.8	20.6 (69.3%)	9.2 (30.7%)

Table 4 Reported 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 (10 tonnes per year since 2000).

Year	Reported landings (West Greenland)	Total adjusted landings
2002	9.0	9.8
2003	8.7	12.3
2004	14.7	17.2
2005	15.3	17.3
2006	23.0	23.0
2007	24.6	24.8
2008	26.1	28.6
2009	25.5	28.0
2010	37.9	43.1
2011	27.4	27.4
2012	32.6	34.6
2013	46.9	47.7
2014	57.7	70.5
2015	55.9	60.9
2016	25.7	30.2
2017	27.8	28.0
2018	39.0	39.0
2019	28.3	28.3
2020	30.9	30.9
2021	41.8	41.8
2022	29.0	29.0

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Table 5 Summary of biological characteristics of catches of Atlantic salmon at West Greenland in 2020–2022.

2020

River age distribution (%) by origin

Continent of origin	1	2	3	4	5	6	7	8
North America	2.6	28.2	23.1	28.2	17.9	0	0	0
Europe	9.7	74.2	9.7	3.2	3.2	0	0	0

Length and weight by origin and sea age

Continent of origin	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)
North America	66.6	3.20	-	-	85.0	7.90	68.3	3.59
Europe	65.6	3.38	-	-	-	-	65.6	3.38

Continent of origin (%)

North America	Europe
59%	41%

Sea age composition (%) by continent of origin

Continent of origin	1SW	2SW	Previous spawners
North America	92.3	0.0	7.7
Europe	97.1	0.0	2.9

2021

River age distribution (%) by origin

Continent of origin	1	2	3	4	5	6	7	8
North America	0.4	27.3	38.3	21.7	10.1	2.0	0.1	0
Europe	15.6	58.2	19.1	5.7	1.4	0	0	0

Length and weight by origin and sea age

Continent of origin	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)
North America	66.2	3.34	86.9	7.92	74.7	4.72	66.7	3.44
Europe	65.9	3.34	70.1	4.02	-	-	66.0	3.35

Continent of origin (%)

North America	Europe
83%	17%

Sea-age composition (%) by continent of origin

Continent of origin	1SW	2SW	Previous spawners
North America	95.5	1.2	3.3
Europe	97.9	2.1	0.0

2022

River age distribution (%) by origin

Continent of origin	1	2	3	4	5	6	7	8
North America	0.4	24.9	38.7	24.1	10.3	1.6	0	0
Europe	17.9	53.8	17.9	5.1	5.1	0	0	0

Length and weight by origin and sea age

Continent of origin	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)
North America	63.9	2.79	80.9	6.51	69.0	3.25	64.3	2.83
Europe	62.4	2.73	81.5	6.05	-	-	64.3	3.05

Continent of origin (%)

North America	Europe
91%	9%

Sea age composition (%) by continent of origin

Continent of origin	1SW	2SW	Previous spawners
North America	94.7	0.7	4.6
Europe	90.0	10.0	0.0

Table 6 Correspondence between ICES regions used for the assessment of North American salmon stock status and the genetic reporting groups defined using the SNP range wide baseline (Jeffery *et al.*, 2018). See Figure 6 for map of genetic reporting groups.

ICES 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 Shore Lower	QLS
	Anticosti	ANT
	Gaspe Peninsula	GAS
	Quebec City Region	QUE
Gulf	Gulf of St Lawrence	GUL
Scotia–Fundy	Inner Bay of Fundy	IBF
	Eastern Nova Scotia	ENS
	Western Nova Scotia	WNS
	Saint John River & Aquaculture	SJR
Newfoundland	Northern Newfoundland	NNF
	Western Newfoundland	WNF
	Newfoundland 1	NF1
	Newfoundland 2	NF2
	Fortune Bay	FTB
	Burin Peninsula	BPN
	Avalon Peninsula	AVA
US	Maine, United States	US
Europe	Spain	SPN
	France	FRN
	European Broodstock	EUB
	United Kingdom and Ireland	BRI
	Barents-White Seas	BAR
	Baltic Sea	BAL
	Southern Norway	SNO
	Northern Norway	NNO
	Iceland	ICE
	Greenland	GL

Table 7 Bayesian estimates of mixture composition for the West Greenland Atlantic salmon fishery, by region and overall, for 2020. Baseline locations refer to regional reporting groups identified in Table 6 and Figure 6. Sample locations are identified by NAFO divisions. Mean estimates provided with 95% credible interval in parentheses. Estimates of mixture contributions not supported by significant individual assignments (P > 0.8) are represented as zero and, therefore, all columns may not add up to 100. Credible intervals with a lower bound of zero or close to zero may indicate little support for the mean assignment value. COO = continent of origin, EUR = Europe, NA = North America.

Reporting Group	COO	NAFO 1D	NAFO 1E	NAFO 1F	Overall
Baltic Sea	EUR	0.0	0.0	0.0	0.0
Barents-White Seas	EUR	0.0	0.0	0.0	0.0
European Broodstock	EUR	0.0	0.0	0.0	0.0
UK and Ireland	EUR	39.9 (32.4, 47.5)	77.3 (55.6, 93.4)	14.9 (1.9, 37.4)	41.7 (34.9, 48.8)
France	EUR	0.0	0.0	0.0	0.0
Greenland	EUR	0.0	0.0	0.0	0.0
Iceland	EUR	0.0	0.0	0.0	0.0
Northern Norway	EUR	0.0	0.0	0.0	0.0
Southern Norway	EUR	4 (1.4, 7.7)	0.0	0.0	3.3 (1.1, 6.4)
Spain	EUR	0.0	0.0	0.0	0.0
Anticosti	NA	0.0	0.0	0.0	0.0
Avalon Peninsula	NA	0.0	0.0	0.0	0.0
Burin Peninsula	NA	0.0	0.0	0.0	0.0
Eastern Nova Scotia	NA	0.0	0.0	0.0	0.0
Fortune Bay	NA	0.0	0.0	0.0	0.0
Gaspé Peninsula	NA	21 (14.7, 27.8)	12.1 (1.7, 30.7)	25 (6.3, 51.1)	20.4 (14.8, 26.7)
Gulf of St Lawrence	NA	7.8 (3.7, 13)	0.0	0.0	7.3 (3.7, 11.8)
Inner Bay of Fundy	NA	0.0	0.0	0.0	0.0
Labrador Central	NA	1.1 (0, 3.5)	0.0	0.0	0.7 (0.0, 2.7)
Labrador South	NA	14.6 (9.5, 20.7)	0.0	16.7 (0, 42.5)	13.5 (8.9, 18.8)
Lake Melville	NA	1.5 (0.1, 4.1)	0.0	17.9 (0.9, 46)	2.9 (0.9, 6)
Newfoundland 1	NA	0.0	0.0	0.0	0.0
Newfoundland 2	NA	0.0	0.0	0.0	0.0
Northern Newfoundland	NA	0.0	0.0	6.5 (0, 24)	0.0
St. Lawrence North Shore-Lower	NA	3.6 (1.2, 7.1)	0.0	7.5 (0.2, 25.2)	3.6 (1.4, 6.8)
Québec City Region	NA	0.0	0.0	0.0	0.0
Saint John River & Aquaculture	NA	0.0	0.0	0.0	0.0
Ungava Bay	NA	3.7 (1.3, 7)	5.9 (0.2, 20.6)	0.0	3.6 (1.5, 6.7)
Maine, United States	NA	0.6 (0, 2.2)	0.0	0.6 (0, 2.2)	0.5 (0.0, 1.9)
Western Newfoundland	NA	0.0	0.0	0.0	0.0
Western Nova Scotia	NA	0.0	0.0	0.0	0.0

Table 8 Bayesian estimates of mixture composition for the West Greenland Atlantic salmon fishery, by region and overall for 2021. Baseline locations refer to regional reporting groups identified in Table 6 and Figure 6. Sample locations are identified by NAFO divisions. Mean estimates provided with 95% credible interval in parentheses. Estimates of mixture contributions not supported by significant individual assignments (P > 0.8) are represented as zero and, therefore, all columns may not add up to 100. Credible intervals with a lower bound of zero or close to zero may indicate little support for the mean assignment value. COO = continent of origin.

Reporting Group	COO	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	ICES 14	Overall
Baltic Sea	EUR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barents-White Seas	EUR	0.0	0.0	0.0	0.2 (0, 0.9)	0.0	0.0	0.0	0.1 (0, 0.2)
European Broodstock	EUR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK and Ireland	EUR	58.9 (23.6, 89.5)	14.9 (10.2, 20.4)	14.8 (12.2, 17.5)	18.3 (14.6,	17.8 (6.8, 32.2)	16.9 (11.8,	28.7 (9.3, 54)	16.3 (14.5, 18.2)
France	EUR	0.0	0.0	0.3 (0, 0.8)	0.0	0.0	0.0	0.0	0.1 (0, 0.4)
Greenland	EUR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Iceland	EUR	0.0	0.0	0.1 (0, 0.5)	0.2 (0, 0.9)	0.0	0.0	0.0	0.1 (0.0, 0.4)
Northern Norway	EUR	0.0	0.0	0.3 (0, 0.9)	0.0	0.0	0.0	0.0	0.0
Southern Norway	EUR	0.0	0.6 (0, 2.2)	0.0	3.1 (1.6, 5.1)	0.0	0.0	0.0	1 (0.5, 1.5)
Spain	EUR	0.0	0.0	0.1 (0, 0.5)	0.0	0.0	0.0	0.0	0.2 (0.0, 0.4)
Anticosti	NA	0.0	1 (0, 2.9)	0.9 (0.3, 1.8)	1.9 (0.7, 3.5)	0.0	1.1 (0.1, 3.2)	0.0	1.1 (0.6, 1.8)
Avalon Peninsula	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burin Peninsula	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 (0.0, 0.2)
Eastern Nova Scotia	NA	0.0	0.0	1 (0.3, 1.8)	0.6 (0.1, 1.6)	0.0	0.0	0.0	0.7 (0.3, 1.2)
Fortune Bay	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 (0.0, 0.2)
Gaspé Peninsula	NA	0.0	19.9 (13.6, 26.7)	23.2 (19.9, 26.7)	18.3 (14.3,	18.2 (7.1, 32.9)	13 (7.8, 18.9)	28 (0.7, 56.4)	20.3 (18, 22.6)
Gulf of St Lawrence	NA	12.7 (0, 45.7)	18.8 (12.9, 25.7)	17.6 (14.5, 20.7)	11.4 (8.2, 15.1)	14.6 (4.7, 28.7)	23 (16.6, 30.1)	0.0	15.9 (13.8, 18)
Inner Bay of Fundy	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Labrador Central	NA	0.0	1.5 (0, 4.5)	3.3 (1.8, 5.1)	7.3 (4.4, 10.7)	6.6 (0.6, 17.7)	0.0	0.0	3.8 (2.6, 5.2)
Labrador South	NA	0.0	16.7 (11.6, 22.6)	10.9 (8.5, 13.4)	15.4 (11.7,	25.6 (12.3,	22.9 (16.9,	15.7 (0, 41)	14.5 (12.7, 16.5)
Lake Melville	NA	0.0	6 (2.8, 10.2)	3.8 (2.3, 5.4)	3.8 (1.9, 6.2)	0.0	4.5 (1.7, 8.5)	0.0	3.9 (2.9, 5.1)
Newfoundland 1	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2 (0.0, 0.6)
Newfoundland 2	NA	0.0	0.0	0.0	1.1 (0, 2.7)	0.0	0.0	0.0	0.5 (0.1, 1.1)
Northern Newfoundland	NA	0.0	0.5 (0, 1.9)	0.0	0.6 (0.1, 1.7)	0.0	0.6 (0, 2.1)	0.0	0.5 (0.2, 0.9)
St. Lawrence North	NA	15 (0.5, 47.5)	4.5 (1.8, 8.1)	8.4 (6.4, 10.6)	4.8 (2.8, 7.3)	6 (0.7, 16.2)	4.1 (1.5, 7.7)	0.0	6.6 (5.4, 8)
Québec City Region	NA	0.0	0.0	2.6 (1.3, 4.2)	2.3 (0.8, 4.5)	0.0	0.0	0.0	2.7 (1.7, 3.8)
Saint John River & Aquaculture	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 (0.0, 0.4)
Ungava Bay	NA	0.0	8 (4.6, 12.2)	7.5 (5.7, 9.6)	6.6 (4.3, 9.2)	8.8 (2, 20.4)	7.6 (4.3, 11.8)	6.7 (0.2, 23.3)	7.4 (6.1, 8.7)
Maine, United States	NA	0.0	4.4 (1.9, 7.9)	2.1 (1.2, 3.4)	1.8 (0.7, 3.3)	0.0	1.7 (0.4, 4.1)	0.0	2.1 (1.4, 3)
Western Newfoundland	NA	0.0	2 (0.4, 4.5)	2.1 (1, 3.4)	2 (0.8, 3.7)	0.0	2.3 (0.4, 5.1)	0.0	2 .0 (1.3, 2.8)
Western Nova Scotia	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9 Bayesian estimates of mixture composition for the West Greenland Atlantic salmon fishery, by region and overall for 2022. Baseline locations refer to regional reporting groups identified in Table 6 and Figure 6. Sample locations are identified by NAFO divisions. Mean estimates provided with 95% credible interval in parentheses. Estimates of mixture contributions not supported by significant individual assignments (P > 0.8) are represented as zero and, therefore, all columns may not add up to 100. Credible intervals with a lower bound of zero or close to zero may indicate little support for the mean assignment value. COO= continent of origin.

Reporting Group	ROO	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Overall
Baltic Sea	EUR	0.0	0.0	0.0	0.0	0.0	0.0
Barents-White Seas	EUR	0.0	0.0	0.0	0.0	0.0	0.0
European Broodstock	EUR	0.0	0.0	0.0	0.0	0.0	0.0
UK and Ireland	EUR	0.0	7.8 (5.1, 11.1)	2.5 (1.1, 4.7)	9.7 (2.2, 21.7)	13.5 (3.1, 29.8)	5.6 (4, 7.5)
France	EUR	0.0	0.0	0.0	0.0	0.0	0.0
Greenland	EUR	0.0	0.0	0.4 (0, 1.3)	0.0	0.0	0.2 (0.0, 0.6)
Iceland	EUR	0.0	0.3 (0, 1.2)	0.0	0.0	4.3 (0.1, 15.2)	0.3 (0.0, 0.8)
Northern Norway	EUR	0.0	0.0	0.0	0.0	0.0	0.0
Southern Norway	EUR	3.8 (0.1, 12.8)	0.0	0.0	0.0	0.0	0.2 (0.0, 0.8)
Spain	EUR	3.4 (0.1, 12.2)	0.0	0.0	0.0	0.0	0.0
Anticosti	NA	0.0	0.0	0.0	0.0	0.0	0.0
Avalon Peninsula	NA	0.0	0.0	0.0	0.0	0.0	0.0
Burin Peninsula	NA	3.2 (0, 12.2)	0.4 (0, 1.6)	0.0	0.0	0.0	0.3 (0.0, 1)
Eastern Nova Scotia	NA	0.0	0.8 (0.1, 2.2)	0.0	0.0	0.0	0.6 (0.1, 1.5)
Fortune Bay	NA	0.0	1.2 (0.2, 2.7)	0.0	0.0	0.0	0.4 (0, 1.2)
Gaspé Peninsula	NA	15.9 (4.1, 32.5)	22.2 (17.3, 27.5)	32 (25.9, 38.5)	20.4 (7.5, 36.6)	22.9 (6.9, 45.2)	26.9 (23.2, 30.7)
Gulf of St Lawrence	NA	24.2 (9.9, 42)	12.7 (8.6, 17.2)	13.5 (9.3, 18.1)	26.4 (12.5, 44.2)	22.1 (5.7, 42.7)	14.5 (11.7, 17.6)
Inner Bay of Fundy	NA	0.0	0.0	0.0	0.0	0.0	0.0
Labrador Central	NA	0.0	5.3 (2.5, 8.8)	7 (3.8, 10.8)	0.0	0.0	5.3 (3.3, 7.7)
Labrador South	NA	15.5 (4.3, 30.9)	17.2 (12.8, 22.1)	12.3 (8.3, 16.9)	18.6 (6.7, 33.9)	4.6 (0.1, 15.9)	14.2 (11.3, 17.4)
Lake Melville	NA	3.9 (0.1, 13.4)	1.2 (0.2, 3)	7.5 (4.5, 11.1)	3.5 (0, 13.5)	0.0	4.5 (2.9, 6.4)
Newfoundland 1	NA	0.0	0.0	1.5 (0.4, 3.3)	0.0	0.0	0.7 (0.1, 1.6)
Newfoundland 2	NA	3 (0, 11.9)	0.4 (0, 1.3)	0.0	0.0	0.0	0.2 (0.0, 0.9)
Northern Newfoundland	NA	3.5 (0.1, 12.3)	3.8 (1.9, 6.3)	0.0	0.0	0.0	2.4 (1.3, 3.7)
St. Lawrence North Shore-Lower	NA	0.0	4.8 (2.6, 7.6)	3.9 (1.9, 6.6)	2.8 (0, 11.1)	0.0	4.2 (2.7, 5.9)
Québec City Region	NA	19.4 (6.6, 36.3)	3.2 (1.3, 5.8)	6 (2.5, 10)	0.0	0.0	3.9 (2.3, 6)
Saint John River & Aquaculture	NA	0.0	0.0	0.0	0.0	0.0	0.0
Ungava Bay	NA	0.0	11.7 (8.4, 15.6)	2.5 (1, 4.6)	9.4 (2.1, 21.3)	8.8 (1.2, 22.7)	7.2 (5.4, 9.3)
Maine, United States	NA	0.0	1.3 (0.3, 2.9)	4.4 (2.3, 7.1)	3.3 (0.1, 12.1)	8.7 (1.1, 22.7)	3 (1.8, 4.5)
Western Newfoundland	NA	0.0	5.4 (3, 8.3)	5.6 (3.1, 8.7)	0.0	5.3 (0, 18.7)	5.1 (3.5, 7.1)
Western Nova Scotia	NA	0.0	0.0	0.0	0.0	0.0	0.0

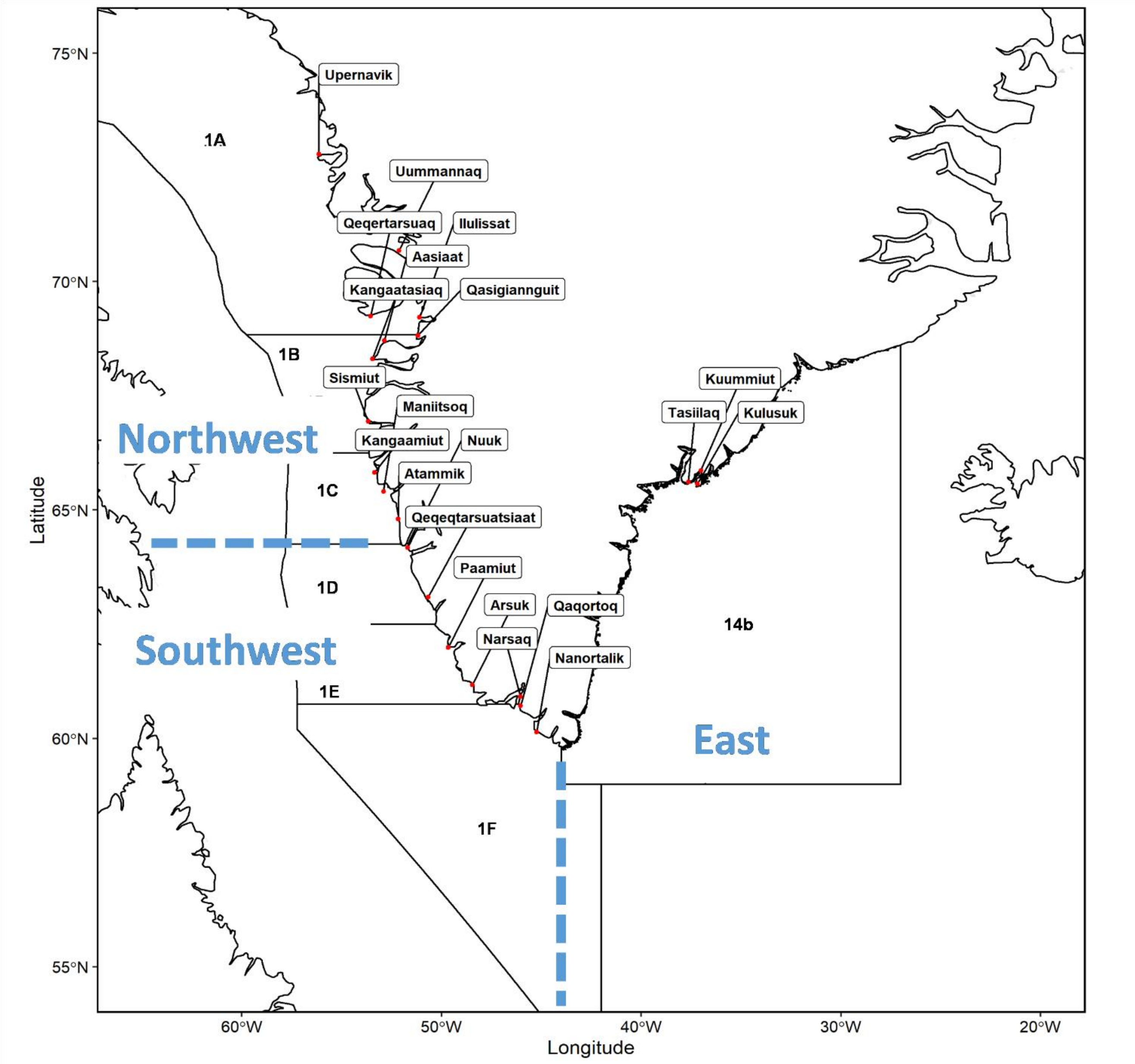

Figure 1 Map of communities in south Greenland where Atlantic salmon have historically been landed and the corresponding NAFO divisions (1A–1F) and ICES Statistical Areas.

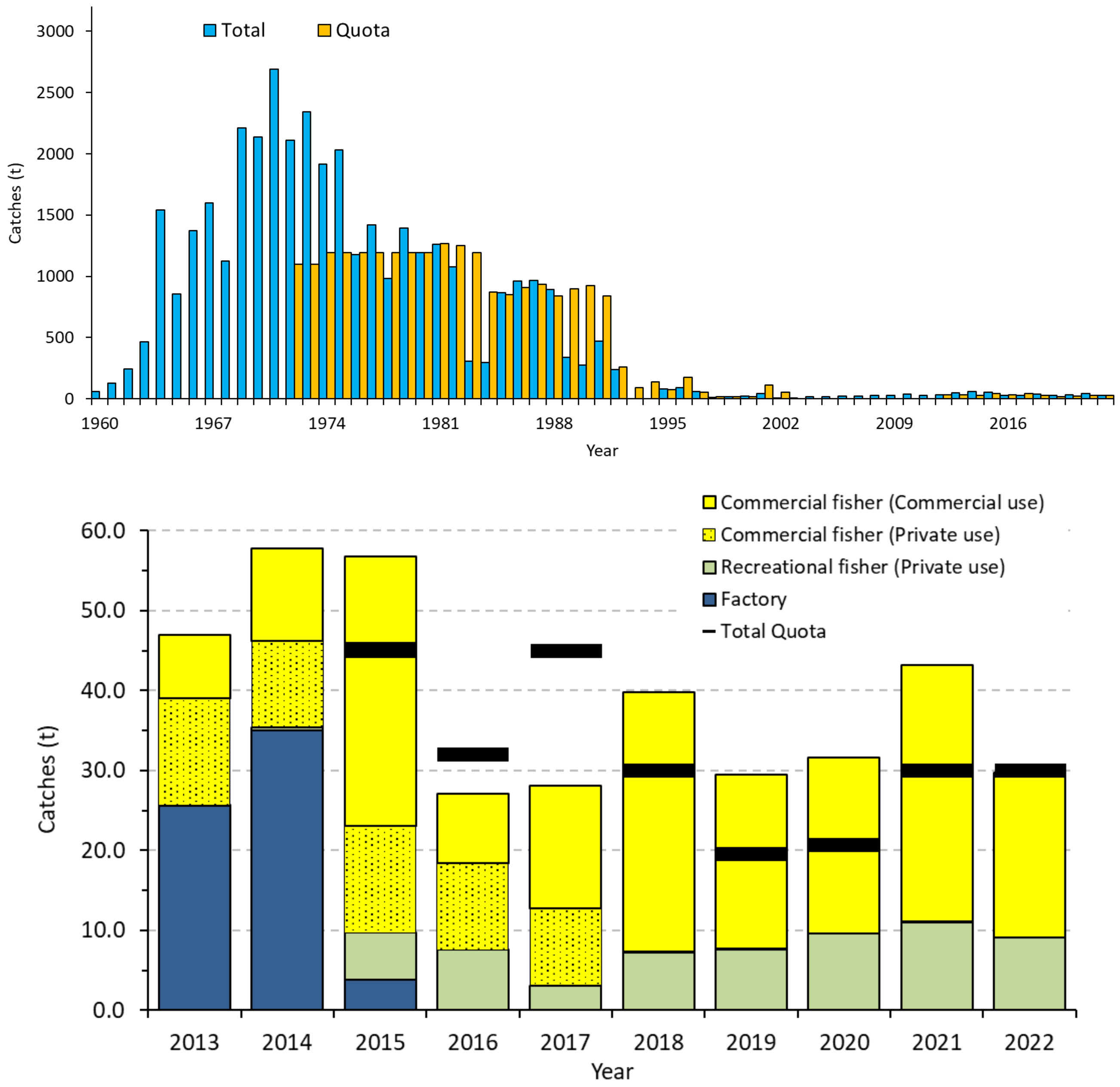

Figure 2 Reported catches and quotas (tonnes, round fresh weight) of salmon at West Greenland from 1960 to 2022 (upper panel). Landings from 2013 to 2022 are also displayed by landing type (lower panel). Quotas for 2013–2014 were for factory landings only.

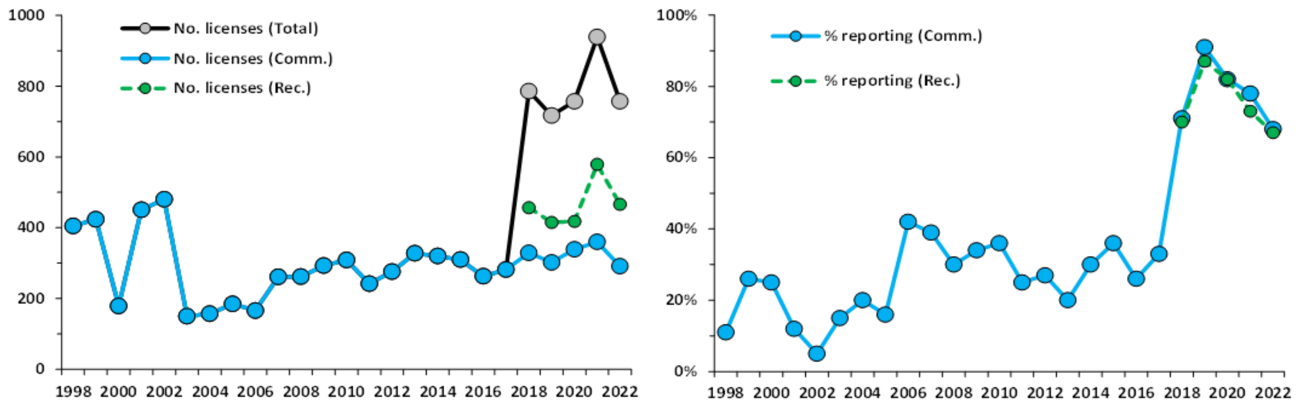

Figure 3 Number of licences issued by licence type (left panel) and percent of licensed fishers reporting by licence type (right panel). Starting in 2018, all fishers were required to have a licence.

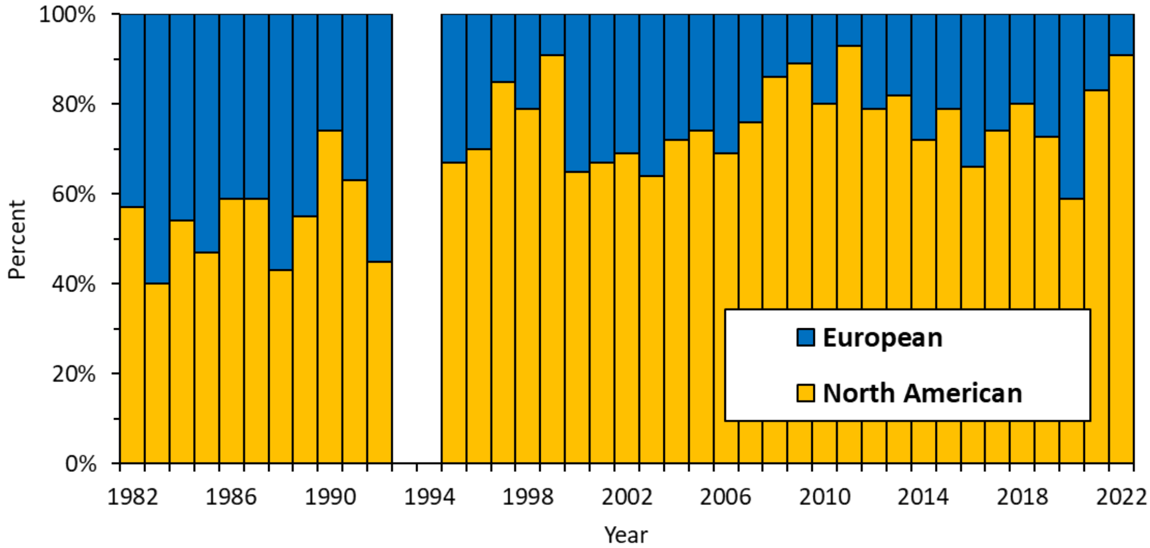

Figure 4 Estimated percent of continental origin of Atlantic salmon harvested at West Greenland from 1982 to 2022. There was no fishery in 1993 and 1994.

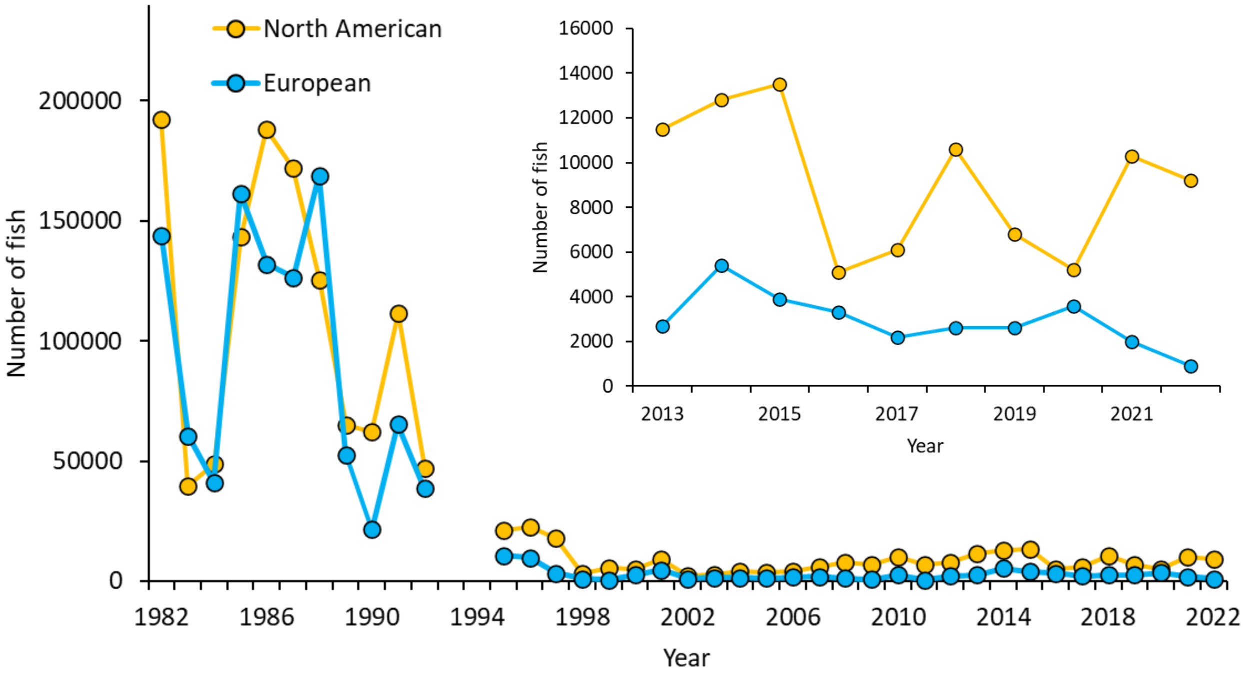

Figure 5 Number of North American and European Atlantic salmon caught at West Greenland in 1982–2022 and 2013–2022 (inset). Estimates are based on continent of origin by NAFO division, weighted by catch (weight) in each division. Unreported catch is not included. There was no fishery in 1993 and 1994.

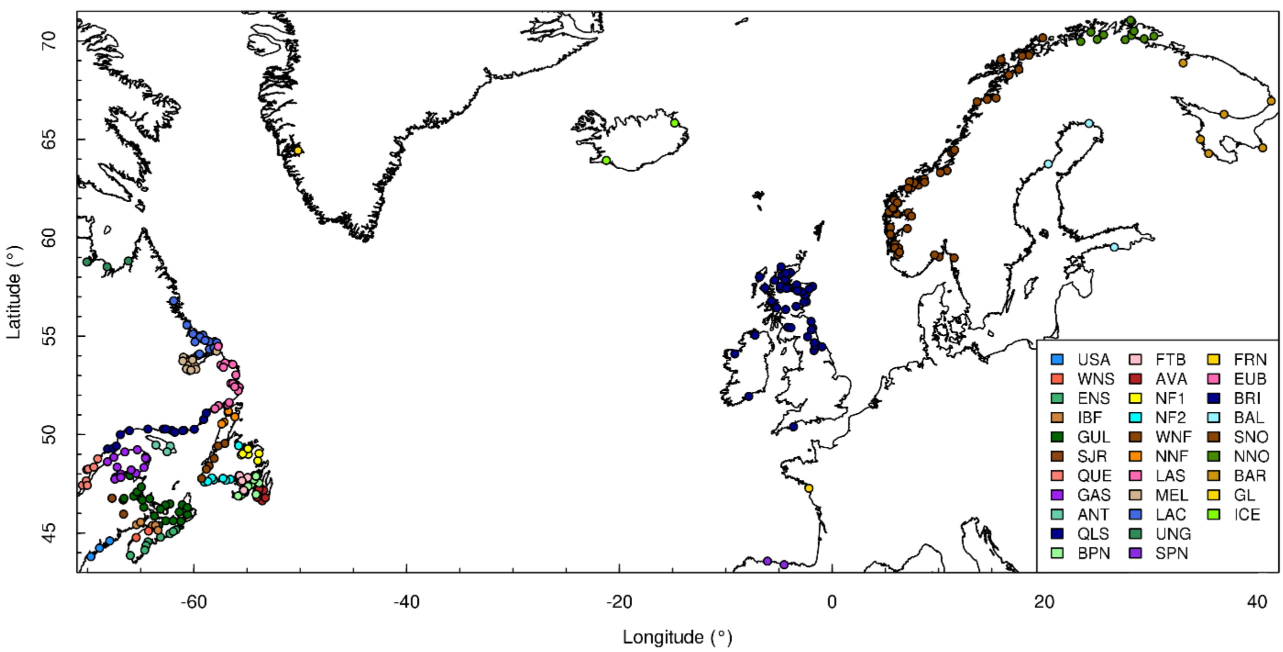

Figure 6 Map of sample locations used in the range-wide genetic baseline (single nucleotide polymorphisms [SNPs]) for Atlantic salmon. The SNP provided assignment of individual salmon to 21 North America and 10 European genetic reporting groups (labelled and identified by colour). The full names of the genetic reporting groups and the corresponding ICES assessment regions are provided in Table 6. The European Broodstock (EUB) reporting group is not represented on the map.

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 CL for the NAC stock complex (Figure 7), but are above the spawner escapement reserves (SER) for southern NEAC stock complex (Figure 8).

In 2022, the estimates (median) of 2SW salmon returns to rivers and spawners were below CLs for the Quebec and Newfoundland regions and below the management objective (MO) for the Scotia–Fundy and US regions, therefore suffering reduced reproductive capacity for all 4 regions. The Labrador region was at risk of suffering reduced reproductive capacity, and the Gulf region was considered at full reproductive capacity. The percentage of the CL/MO attained ranged from 19% in Scotia–Fundy to 158% in Labrador (Figure 9). Particularly large deficits are noted in the Scotia–Fundy and US regions.

The exploitation rate (catch in Greenland divided by PFA) in 2021 and 2022 was, respectively, 4.8% and 6.7% for NAC fish and 1.4% and 0.6% for European fish (Figure 10). Despite major changes in fisheries management in the past few decades and increasingly restrictive fisheries measures, returns have remained low compared to historical levels. It is likely, therefore, that other factors besides fisheries are constraining production.

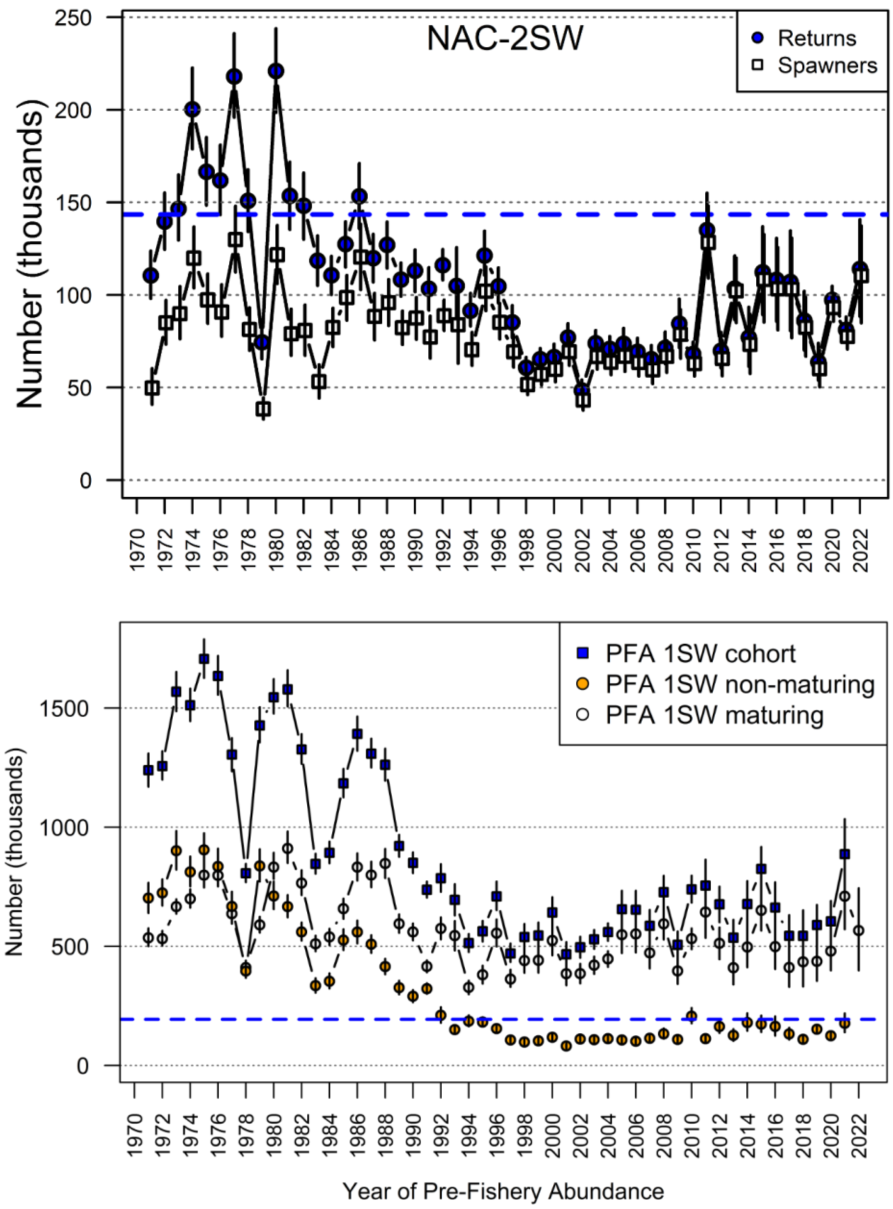

Figure 7 Upper panel: estimated (median, 5th–95th percentile range; in thousands) returns (blue circles) and spawners (white squares) of 2SW salmon for the NAC area in 1971–2022. The dashed blue line is the corresponding 2SW CL for NAC. Bottom panel: estimated (median, 5th–95th percentile range; in thousands) PFA for 1SW maturing, 1SW non-maturing, and the total cohort of 1SW salmon for the NAC area in PFA years 1971–2022. 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.

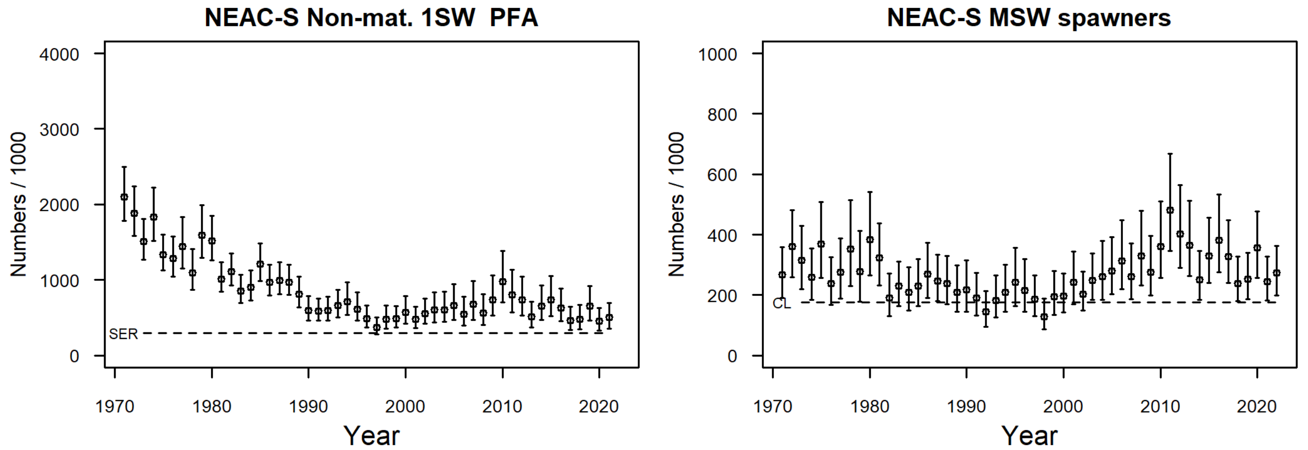

Figure 8 Estimated Southern NEAC non-maturing 1SW PFA (left) and MSW spawners (right) with 90% confidence limits. The dashed line is the corresponding MSW spawner escapement reserve (left) or the corresponding conservation limit (right).

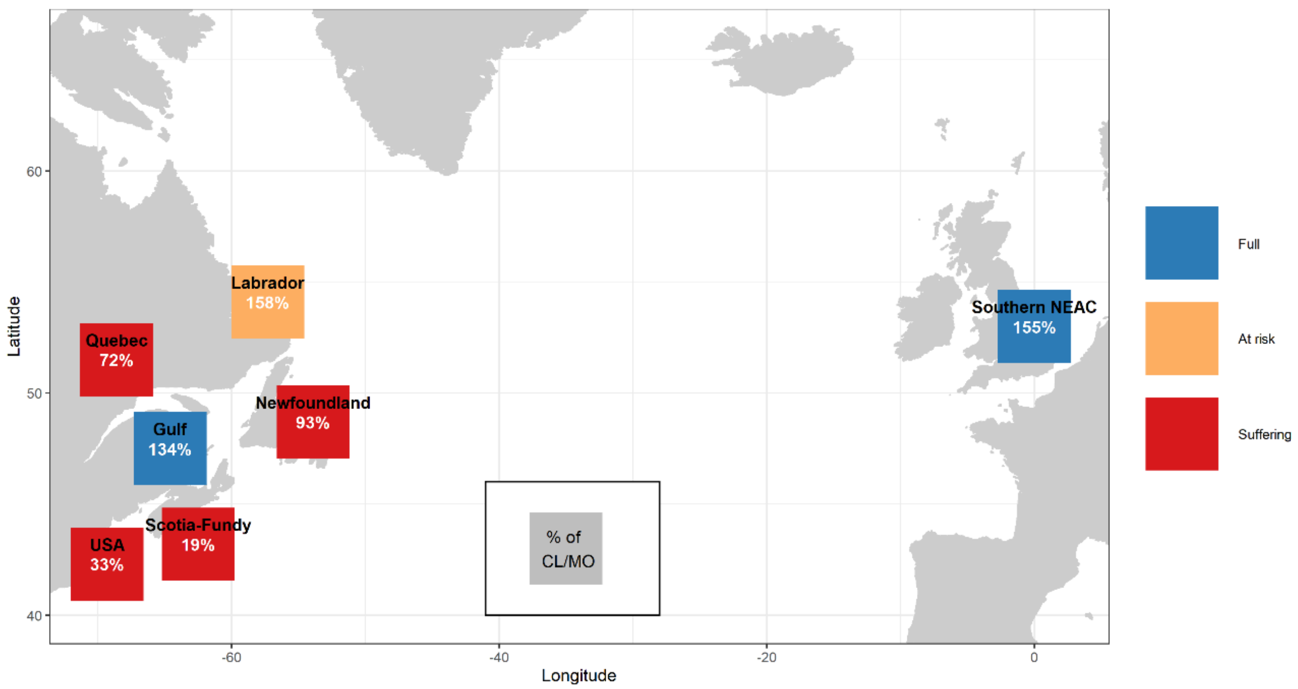

Figure 9 Summary of 2SW (NAC regions) and MSW (southern NEAC) 2022 median (from the Monte Carlo posterior distributions) spawner estimates in relation to CLs or management objectives (only for US and Scotia–Fundy). The colours used as shading represent the three ICES stock status designations: blue = 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); red = Suffering (suffering reduced reproductive capacity; the median spawner estimate is below the CL).

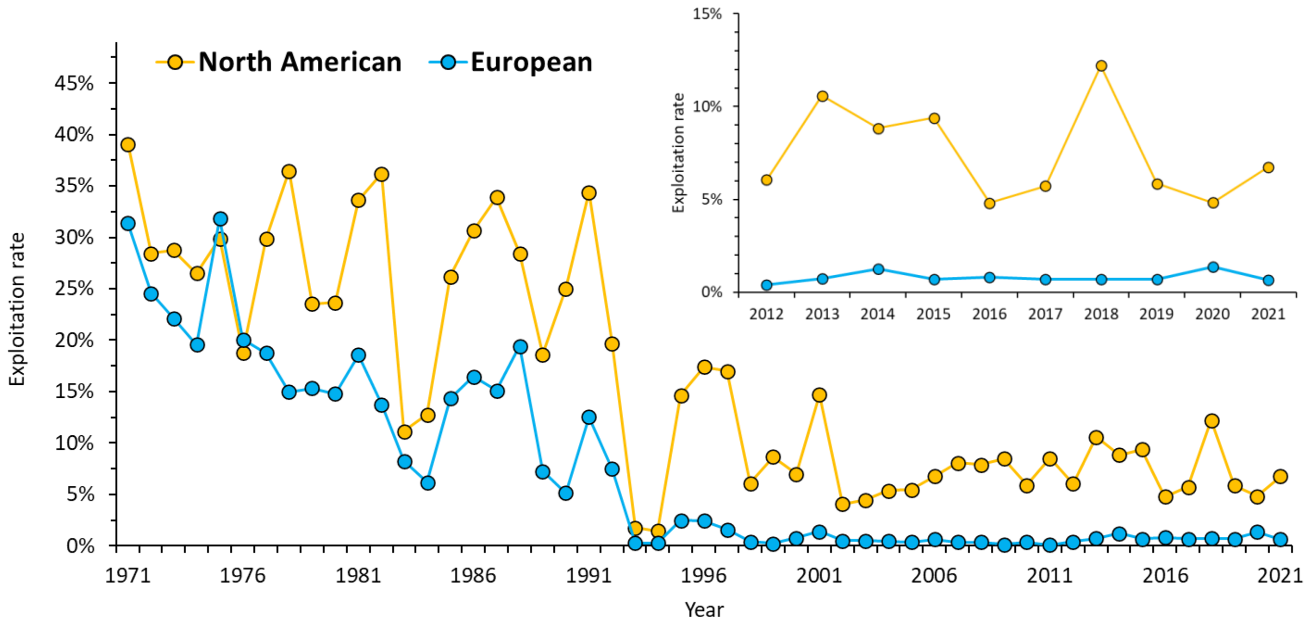

Figure 10 Exploitation rate (%) for NAC 1SW non-maturing and European non-maturing Atlantic salmon at West Greenland in 1971–2022 and 2012–2022 (insert). Exploitation rate estimates are only available up to 2021, as 2022 exploitation rates are dependent on 2023 returns.

Issues relevant for conservation advice

Abundance of salmon is affected by similar non fishing influences throughout the North Atlantic. Despite major changes in fisheries management two to three decades ago and increasingly more restrictive fisheries measures since then, returns of most salmon stocks are at near-historical lows. The continued low and declining abundance of many salmon stocks, despite significant fishery reductions, strengthens the conclusion 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 are also contributing to lower adult abundance.

Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. There are a range of problems in the freshwater environment across the North Atlantic that play a significant role in explaining the poor status of stocks. In many cases, river damming and habitat deterioration have had a negative 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.

Conservation status

Atlantic Salmon (*Salmo salar*) has most recently been assessed for the IUCN Red List of Threatened Species in 1996 and for Europe in 2014. *Salmo salar* is listed for Europe as Vulnerable under criteria A2ace (Freyhof, 2014).

All salmon populations within the US and Scotia–Fundy regions have either been listed or are being considered for listing under country-specific species at risk legislation.

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 1.7 of the sal.oth.all advice (ICES, 2023a).

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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.

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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 US 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 (US, 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 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, 2023b)
Assessment type	Run–reconstruction models and Bayesian forecasts, taking into account uncertainties in the data (ICES, 2021b, 2023c)
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. Salmon bycatch is known to occur, but it is not included in the assessment.
Indicators	None
Other information	None
Working group	Working Group on North Atlantic Salmon (WGNAS)