NORTH ATLANTIC SALMON STOCKS

Introduction

Main tasks

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

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

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

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

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

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

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

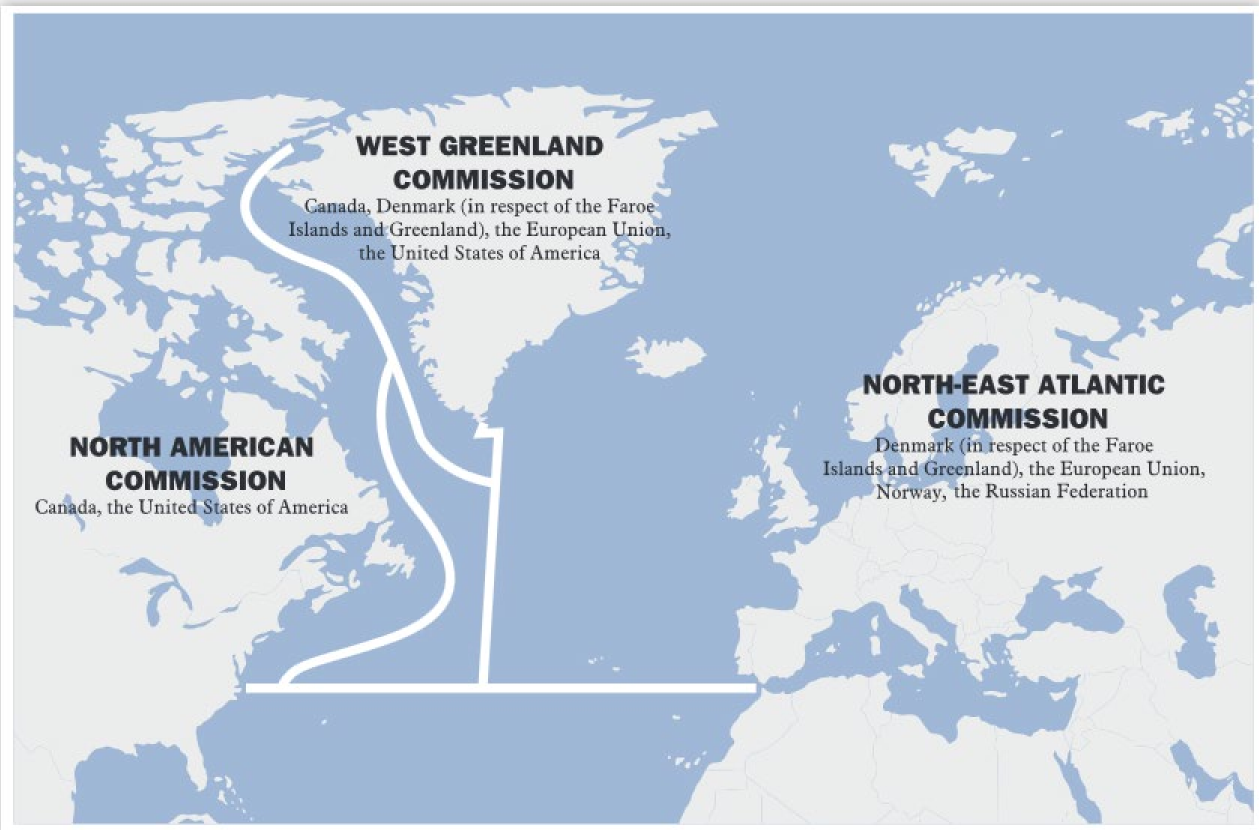
In response to the terms of reference, the WGNAS considered 35 working documents. A complete list of acronyms and abbreviations used in this report is provided in Annex 1. References cited are given in Annex 2.

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

Management framework for salmon in the North Atlantic

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

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



Management objectives

NASCO's objective is:

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

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

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

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

Reference points and application of precaution

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

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

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

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

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

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

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

NASCO 1.1 Catches of North Atlantic salmon

Nominal catches of salmon

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

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

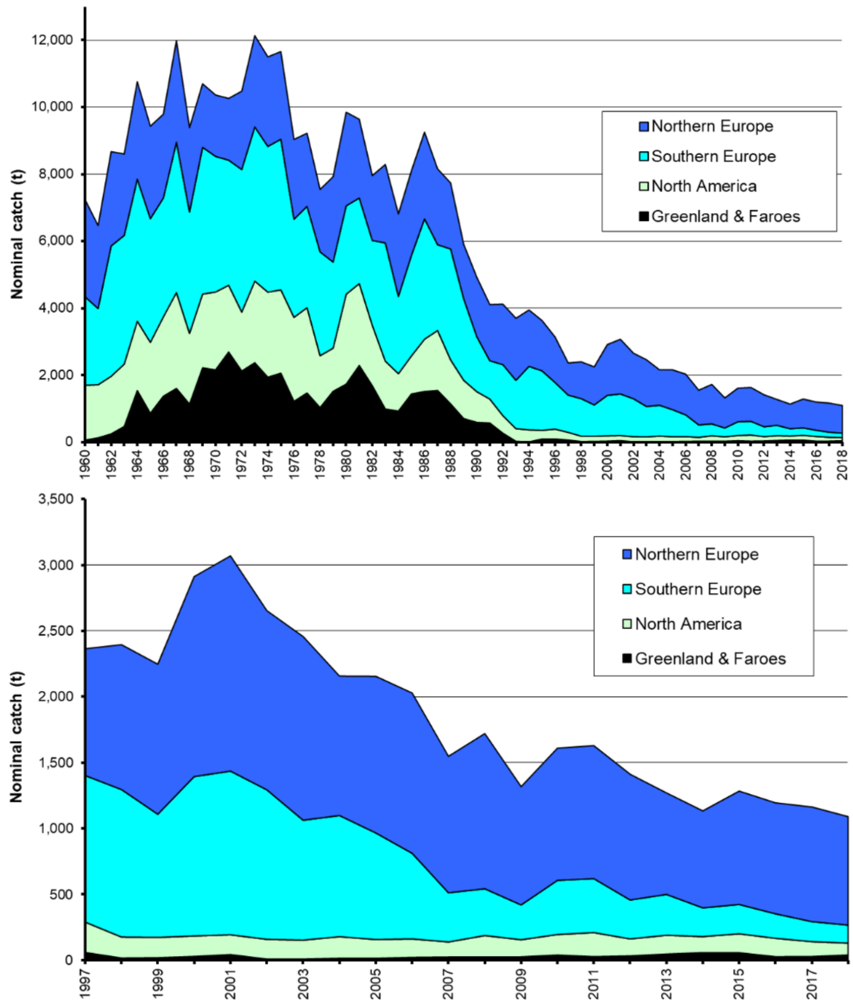


Figure 1 Total reported nominal catch of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960–2018 (top) and 1997–2018 (bottom).

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

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

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

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

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

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

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

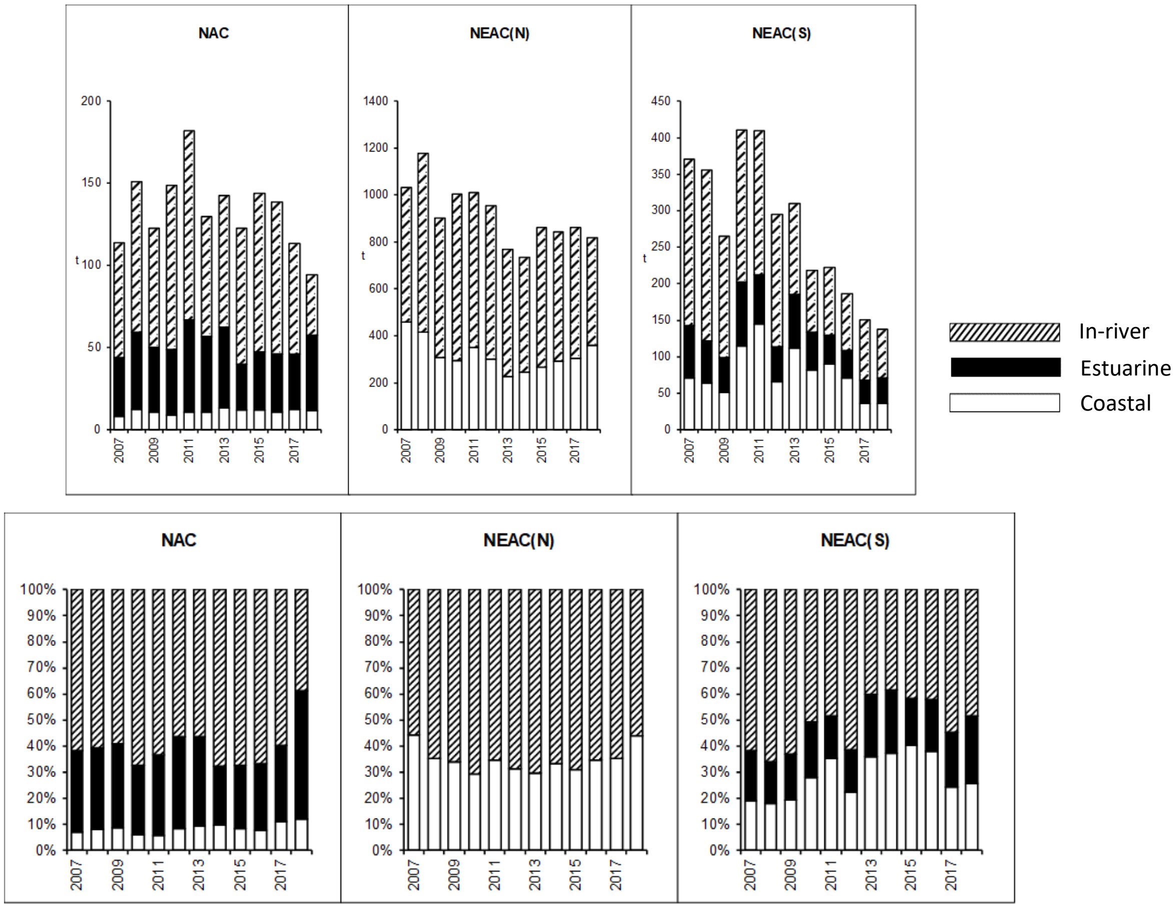


Figure 2 Nominal catches (tonnes; top panels) and percentages of the nominal catches (bottom panels) reported from coastal, estuarine, and in-river fisheries for the NAC area, and for the northern (NEAC–N) and southern (NEAC–S) NEAC areas, 2006–2018. Note that scales of vertical axes in the top panels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

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

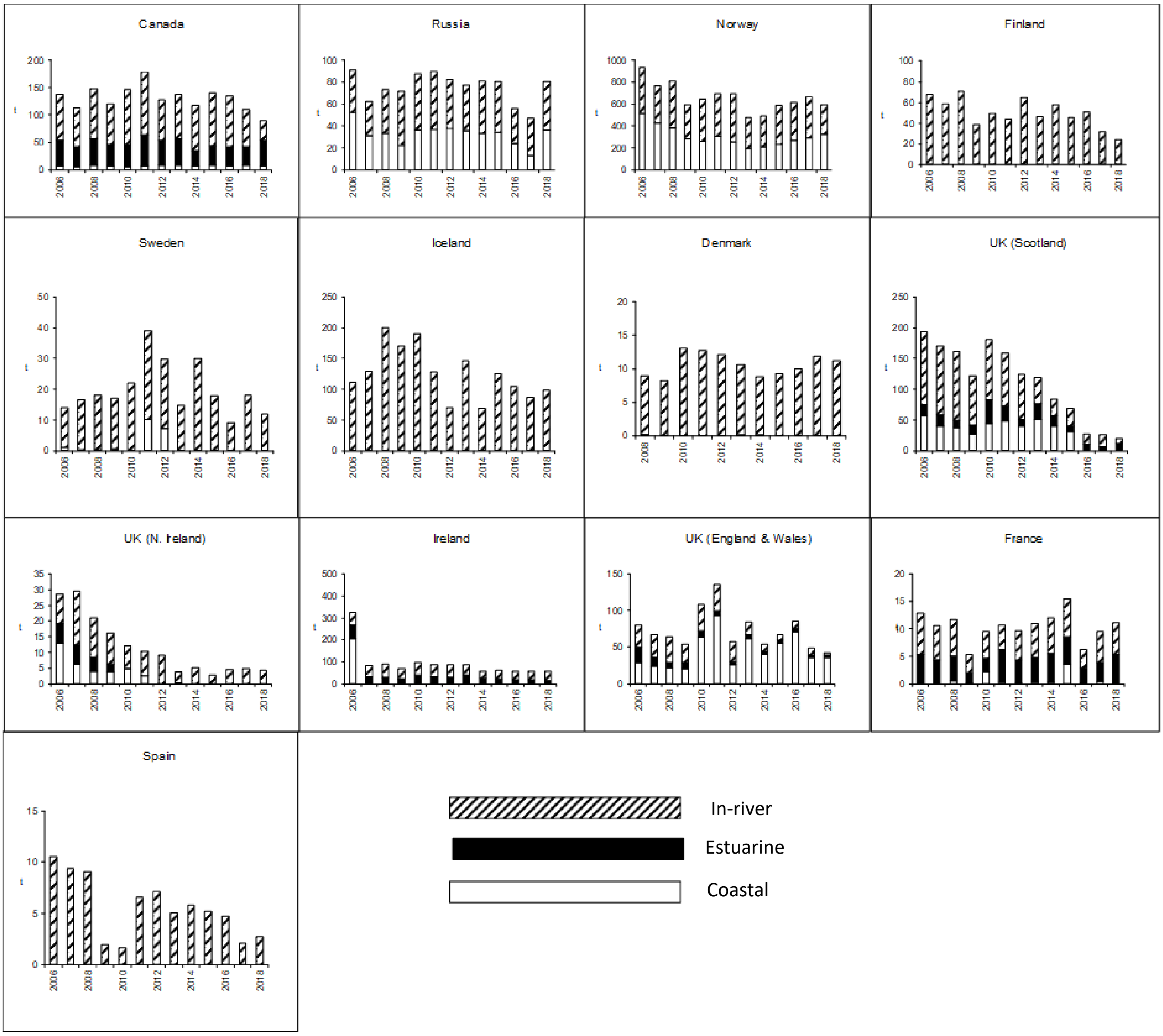


Figure 3 Nominal catch (tonnes) by country taken in coastal, estuarine, and riverine fisheries, 2006–2018 (except Denmark: 2008–2018). Note that scales on the *y*-axes vary. USA is not included because there has been no catch. 100% of the fishery at St Pierre and Miquelon and at West Greenland occurs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

Unreported catches

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

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

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

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

Catch-and-release

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

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

Farming and sea ranching of Atlantic salmon

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

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

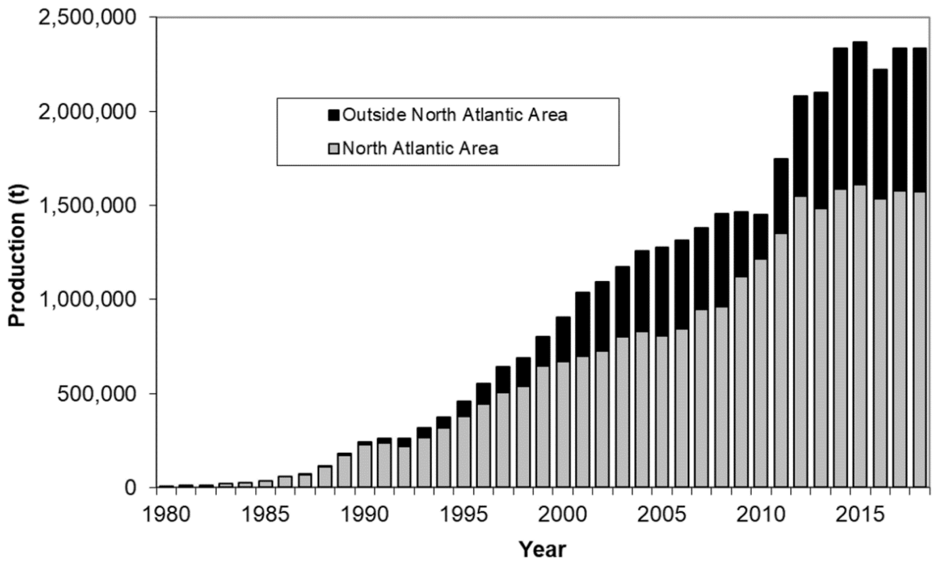


Figure 4 Worldwide production of farmed Atlantic salmon, 1980 to 2018.

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

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

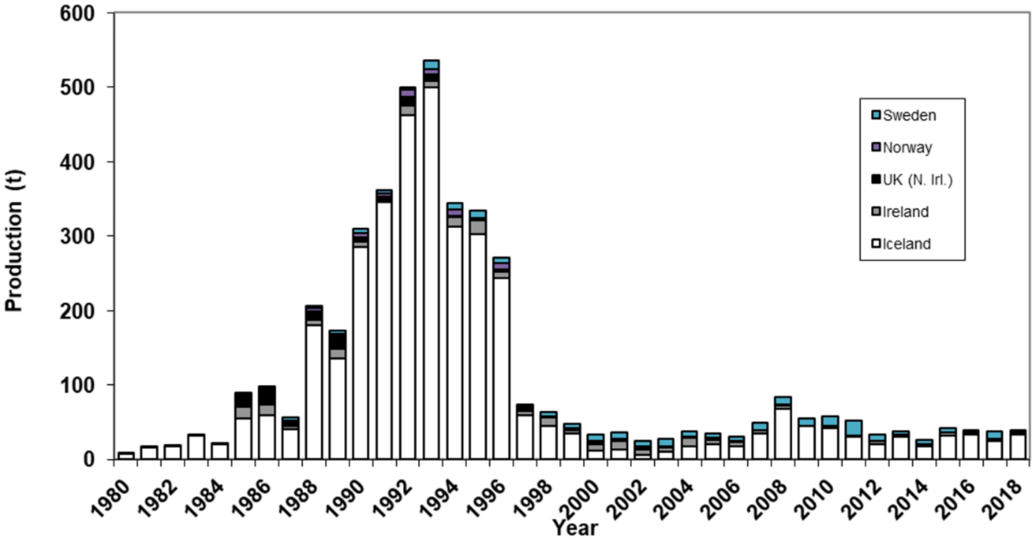


Figure 5 Harvest of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2018.

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

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

Diseases and parasites

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

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

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

Environmental and ecosystem interactions with Atlantic salmon

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

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

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

Opportunities for salmon conservation and management

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

Update on the Atlantic salmon stock situation in Germany

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

Smolt size and marine survival

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

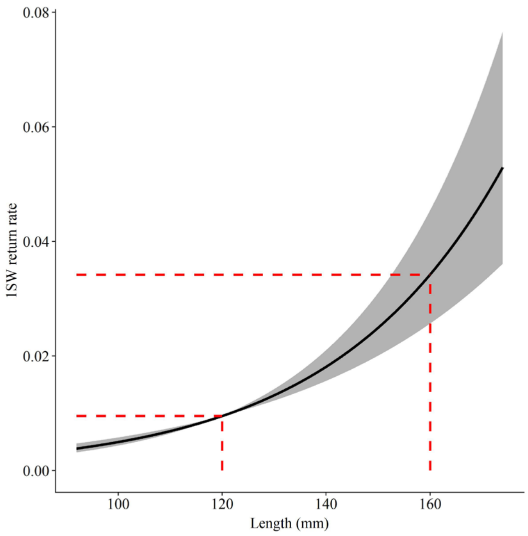


Figure 6 Estimated marine return rate after one winter at sea (1SW) as a function of fork length of individual Atlantic salmon (*Salmo salar*) smolt emigrating from the River Frome (Dorset, UK). The solid black line shows the estimated effect while the grey bands delimit the estimated 25 to 75% Bayesian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

Update on opportunities for investigating salmon at sea

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

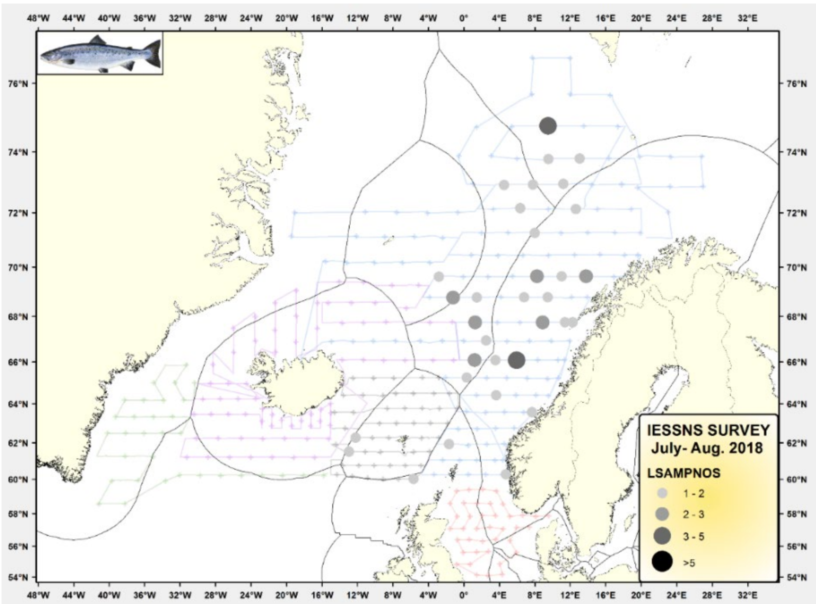


Figure 7 Catches in number of Atlantic salmon taken by the IESSNS survey in the Northeast Atlantic in July 2018. The catches are dominated by post-smolts. This is the main survey where salmon would be expected to be taken by the survey nets.

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

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

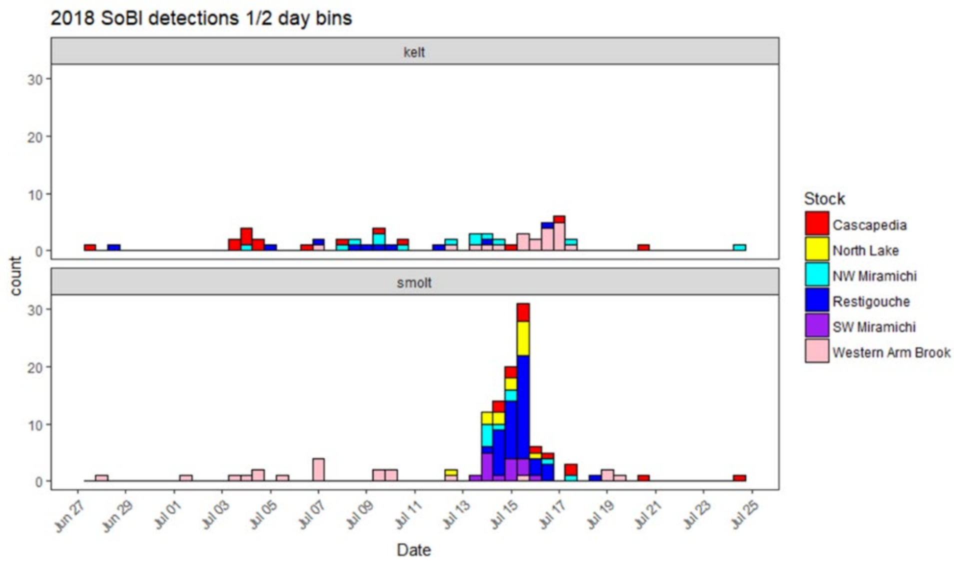


Figure 8 Counts and dates of acoustically tagged Atlantic salmon kelts (upper panel) and smolts (lower panel) from various Gulf of St Lawrence rivers crossing the Strait of Belle Isle receiver array in 2018.

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

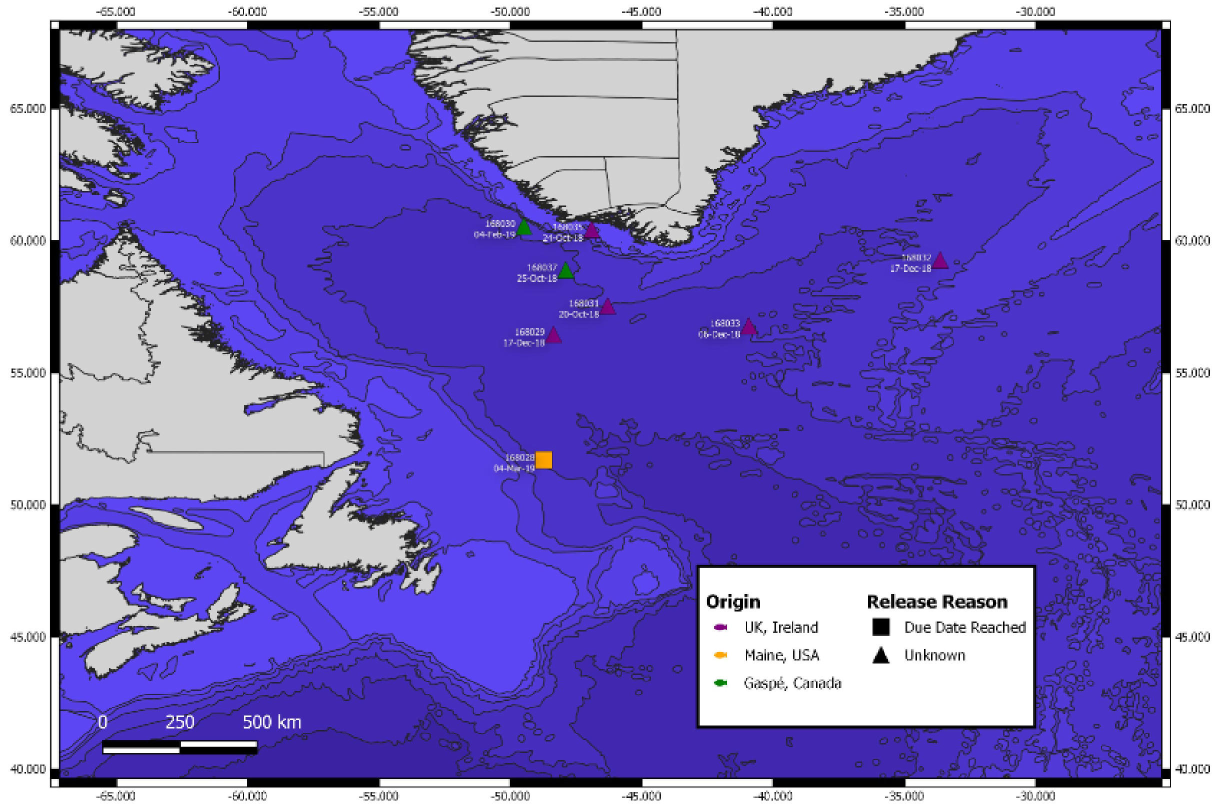


Figure 9 Pop-up location of Atlantic salmon tagged at Greenland in October 2018, identifying fish origin and pop-up mechanism as of 17 March 2019.

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

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

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

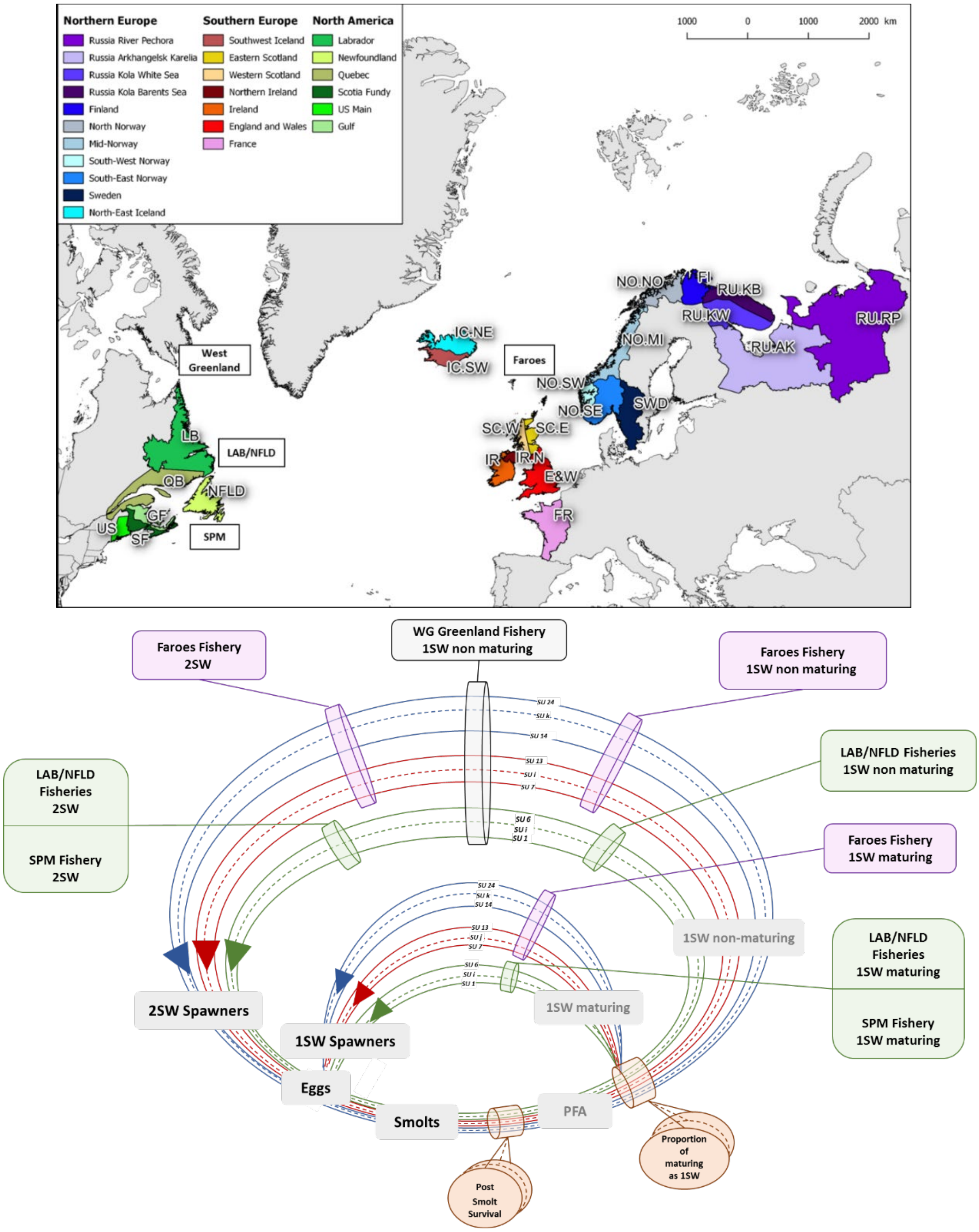


Figure 10 Schematic of the life cycle model applied to the 24 stock units of NEAC–N, NEAC–S, and North America. Variables in light blue are the main stages considered in the stage-structured model. The smolt-to-PFA survival (post-smolt survival) and the proportion of maturing PFA are estimated for the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

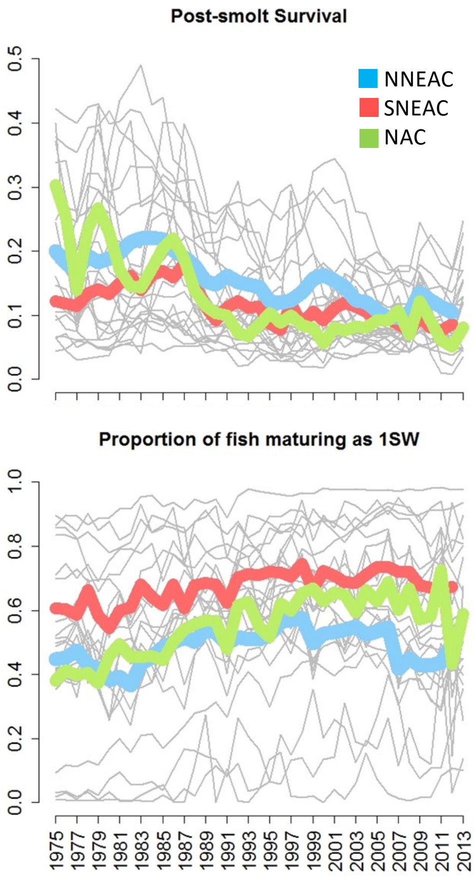


Figure 11 Time-series of (top panel) smolt-PFA survival (plotted in the natural scale) and (bottom panel) proportion of fish maturing as 1SW for the 24 stock units (thin grey lines) and averaged over the three continental stock groups (thick coloured lines). NAC = green, NEAC–N = blue, NEAC–S = red.

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

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

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

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

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

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

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

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

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

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

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

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

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

North Atlantic

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

Northeast Atlantic Commission

No recommendations specific to NEAC are provided.

North American Commission

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

West Greenland Commission

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Footnotes:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Annex 1 Glossary of acronyms and abbreviations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ROO *(region of origin)*

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

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

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

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

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

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

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

S–R (*stock–recruitment*).

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

ToR (*terms of reference*).

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

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

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

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

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

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