Agenda Item 4.4
For Information

Council

CNL(11)8

Report of the ICES Advisory Committee

10 NORTH ATLANTIC SALMON STOCKS

10.1 Introduction

10.1.1 Main tasks

At its 2010 Statutory Meeting, ICES resolved (C. Res. 2010/2/ACOM09) that the **Working Group on North Atlantic Salmon** [WGNAS] (chaired by Gérald Chaput, Canada) will meet at ICES HQ, 22–31 March 2011 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO). In March 2011, NASCO also asked ICES to provide a more detailed evaluation of the choice of appropriate management units to be used in a risk-based framework for the provision of catch advice for the Faroese salmon fishery, taking into account relevant biological and management considerations and including, if possible, worked examples of catch advice.

The sections of the report which provide the responses to the terms of reference are identified below.

a)	With respect to Atlantic Salmon in the North Atlantic area:	Section 10.1
	1. Provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and production of farmed and ranched Atlantic salmon in 2010;[1]	10.1.5
	2. report on significant new or emerging threats to, or opportunities for, salmon conservation and management;[2]	10.1.6
	3. Report on significant advances in our understanding of associations between changes in biological characteristics of all life stages of Atlantic salmon and ecosystem changes with a view to better understanding the dynamics of salmon populations;[3]	10.1.7
	4. Further develop approaches to forecast pre-fishery abundance for North American and European stocks with measures of uncertainty;	10.1.8
	5. Provide a review of examples of successes and failures in wild salmon restoration and rehabilitation and develop a classification of activities which could be recommended under various conditions or threats to the persistence of populations;[4]	10.1.9
	6. Provide a compilation of tag releases by country in 2010 and advise on the utility of maintaining this compilation;	10.1.10
	7. Identify relevant data deficiencies, monitoring needs and research requirements.[4]	10.1.13

b)	With respect to Atlantic salmon in the North-East Atlantic Commission (NEAC) area:	10.2
	1) Describe the key events of the 2010 fisheries;[5]	

2) Review and report on the development of age-specific stock conservation limits;	
3) Describe the status of the stocks and provide annual catch options or alternative management advice for 2012–2014, with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding. • On 9 March 2011 a supplementary request was received from NASCO: "Provide a more detailed evaluation of the choice of appropriate management units to be used in a risk based framework for the provision of catch advice for the Faroese salmon fishery, taking into account relevant biological and management considerations and including, if possible, worked examples of catch advice."[6,7]	10.1.12
4) Further investigate opportunities to develop a framework of indicators or alternative methods that could be used to identify any significant change in previously provided multi-annual management advice.	10.1.11

c) With respect to Atlantic salmon in the North American Commission (NAC) area:	10.3
1) Describe the key events of the 2010 fisheries (including the fishery at St Pierre and Miquelon);[5]	
2) Update age-specific stock conservation limits based on new information as available;	
3) Describe the status of the stocks;[7]	
In the event NASCO informs ICES that the framework of indicators (FWI) indicates that reassessment is required[8]:	
4) Provide annual catch options or alternative management advice for 2011–2014 with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding.[6]	

d) With respect to Atlantic salmon in the West Greenland Commission (WGC) area:	10.4
1) Describe the key events of the 2010 fisheries;[5]	
2) Describe the status of the stocks;	
• *In the event NASCO informs ICES that the framework of indicators (FWI) indicates that reassessment is required[8]:*	

3) Provide annual catch options or alternative management advice for 2011–2013 with an assessment of risk relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding.[6]

Notes:

1. With regard to question a.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.
2. With regard to question a.2, ICES is requested to include information on any new research into the migration and distribution of salmon at sea and on the potential impacts of the development of alternative/renewable energy on Atlantic salmon.
3. With regard to question a.3, there is particular interest in determining if declines in salmon abundance coincide with changes in the biological characteristics of juveniles in fresh water or are modifying characteristics of adult fish (size-at-age, age-at-maturity, condition, sex ratio, growth rates, etc.), and whether these declines can be related to environmental changes, including climate change.
4. With regard to question a.5, ICES is requested to include information on best solutions for fish passage and associated mitigation efforts with examples of practices in member countries.
5. In the responses to questions b.1, c.1, and d.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. Any new information on non-catch fishing mortality, of the salmon gear used, and on the bycatch of other species in salmon gear, and on the bycatch of salmon in any existing and new fisheries for other species is also requested.
6. In response to questions b.3, c.4, and d.3, provide a detailed explanation and critical examination of any changes to the models used to provide catch advice.
7. In response to question d.2, ICES is requested to provide a brief summary of the status of North American and North-East Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions b.3 and c.3.
8. The aim should be for NASCO to inform ICES by 31 January of the outcome of utilizing the FWI.

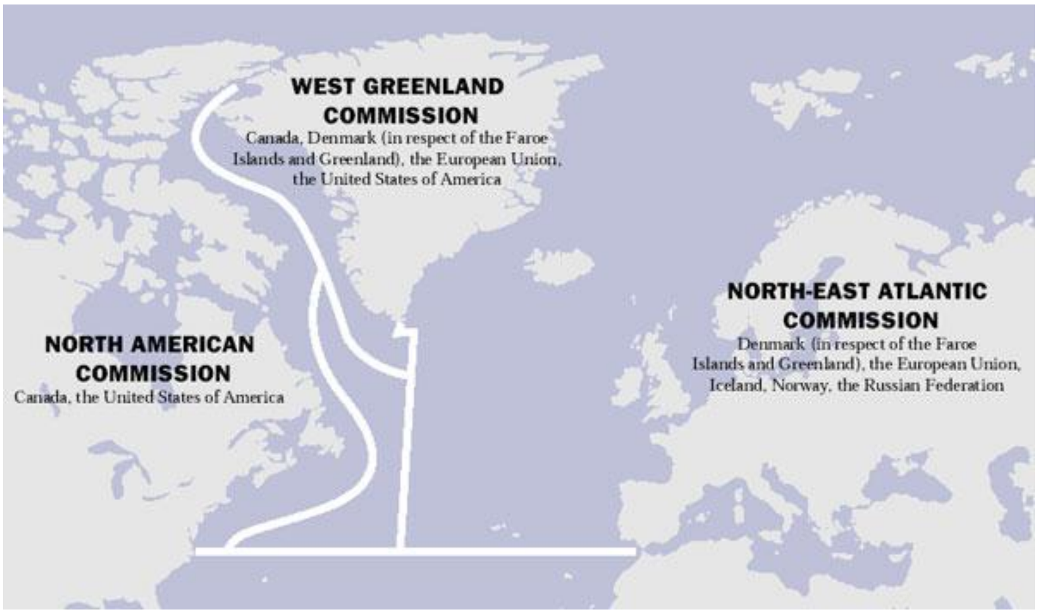
At the 2009 Annual Meeting of NASCO, conditional multi-annual regulatory measures were agreed to in the West Greenland Commission (2009–2011) and for the Faroe Islands (2009–2011) in the Northeast Atlantic Commission. The measures were conditional on a Framework of Indicators (FWI) being provided by ICES, and the acceptance of the FWI by the various parties of each commission. At the 2009 annual meeting of NASCO, Denmark (in respect of the Faroe Islands) opted out of the multi-annual regulatory measures as a FWI was not provided by ICES for the fishery in the Faroes (ICES, 2010a). In January 2011, NASCO indicated that no change to the management advice previously provided by ICES was required for the fishery at West Greenland.

In response to the remaining terms of reference, the Working Group considered 33 Working Documents. A complete list of acronyms is provided in Annex 10.1. References cited are given in Annex 10.2.

10.1.2 Management framework for salmon in the North Atlantic

The advice generated by ICES is in response to 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 seven Parties that are signatories to the Convention, including the EU which represents its Member States.

NASCO discharges these responsibilities via three Commission areas shown below:



10.1.3 Management objectives

NASCO has identified the organization's primary management objective:

"To contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice 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, 1999) 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".

10.1.4 Reference points and application of precaution

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because there are only a few age groups in the adult spawning stock. 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 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, similar to the basis for estimating B_{pa} in the precautionary approach. In short-lived stocks, where most of the annual surplus production is from recruitment (not growth), MSY $B_{escapement}$ and B_{pa} might be expected to be similar and B_{pa} is considered a reasonable initial estimate of MSY $B_{escapement}$.

To be consistent with the MSY and the precautionary approach, ICES considers that fisheries should only take place on maturing one-sea-winter (1SW) salmon and non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status.

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average MSY. In many regions of North America, the CLs are calculated as the number of spawners required to fully seed the wetted area of the river. In some regions of Europe, pseudo-stock–recruitment observations are used to calculate a hockey stick relationship, with the inflection point defining the CLs. In the remaining regions, the CLs are calculated as the number of spawners that will achieve long-term average MSY, as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted the region-specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

Management targets have not yet been defined for all North Atlantic salmon stocks. When these have been defined they will play an important role in ICES advice.

For the assessment of the status of stocks and advice on management of national components and geographical groupings of the stock complexes in the NEAC area, where there are no specific management objectives:

- ICES requires that the lower boundary of the 95% confidence interval of the current estimate of spawners is above the CL for the stock to be considered at full reproductive capacity.
- When the lower boundary of the confidence limit 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.

Therefore, stocks are regarded by ICES as being at full reproductive capacity only if they are above the MSY $B_{escapement}$ (or CLs).

For catch advice on fish exploited at West Greenland (non-maturing 1SW fish from North America and non-maturing 1SW fish from Southern NEAC), ICES has adopted a risk level of 75% (ICES, 2003) as part of an agreed management plan. ICES applies the same level of risk aversion for catch advice for homewater fisheries on the North American stock complex.

10.1.5 Catches of North Atlantic salmon

10.1.5.1 Nominal catches of salmon

Nominal catches of salmon reported for countries in the North Atlantic for 1960–2010 are given in Table 10.1.5.1. Catch statistics in the North Atlantic include fish farm escapees and in some northeast Atlantic countries also include ranched fish.

Icelandic catches have traditionally been split into two separate categories, wild and ranched, reflecting the fact that Iceland has been the only North Atlantic country where large-scale ranching has been undertaken with the specific intention of harvesting all returns at the release site. The release of smolts for commercial ranching purposes ceased in Iceland in 1998, but ranching for rod fisheries in two Icelandic rivers continued into 2010 (Table 10.1.5.1). While ranching does occur in some other countries, this is on a much smaller scale. Some of these operations are experimental and at others harvesting does not occur solely at the release site. The ranched component in these countries has therefore been included in the nominal catch.

Reported catches in tonnes for the three NASCO Commission Areas for 2001–2010 are provided below.

AREA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NEAC	2876	2495	2304	1978	1998	1867	1407	1532	1158	1400
NAC	150	150	144	164	142	140	114	162	129	149
WGC	43	9	9	15	15	22	25	26	26	40
Total	3069	2654	2457	2157	2155	2029	1546	1720	1313	1589

The provisional total nominal catch for 2010 was 1589 tonnes, 276 t above the updated catch for 2009 (1313 t). The 2010 catch was 164 t below the average of the last five years (1753 t), and over 600 t below the average of the last 10 years (2201 t) (Figure 10.1.5.1).

ICES recognises that mixed-stock fisheries present particular threats to stock status. These fisheries predominantly operate in coastal areas and NASCO specifically requests that the nominal catches in homewater fisheries be partitioned according to whether the catch is taken in coastal, estuarine, or riverine areas. The 2010 nominal catch (in tonnes) was partitioned accordingly and is shown below for the NEAC and NAC Commission Areas. Figure 10.1.5.2 presents these data on a country-by-country basis. There is considerable variability in the distribution of the catch among individual countries. In most countries the majority of the catch is now taken in freshwater; the coastal catch has declined markedly.

AREA	COAST		ESTUARY		RIVER		TOTAL
	Weight	%	Weight	%	Weight	%	Weight
NEAC	419	30	87	6	894	64	1400
NAC	10	6	40	27	100	67	149

Coastal, estuarine, and riverine catch data aggregated by region are presented in Figure 10.1.5.3. In northern Europe, about half the catch has typically been taken in rivers and half in coastal waters (although there are no coastal fisheries in Iceland and Finland), with estuarine catches representing a negligible component of the catch in this area. There has been a reduction in the proportion of the catch taken in coastal waters over the last five years. In southern Europe, catches in all fishery areas have declined dramatically over the period. 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. In the last four years, the majority of the catch in this area has been taken in freshwater.

In North America, the total catch over the period 2000–2010 has been relatively constant. The majority of the catch in this area has been taken in riverine fisheries; the catch in coastal fisheries has been relatively small in any year (13 t or less), but has increased as a proportion of the total catch over the period.

10.1.5.2 Catch and release

The practice of catch and release (C&R) in rod 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 has been practiced since 1984, and in more recent years it has also been widely used in many European countries, both as a result of statutory regulation and through voluntary practice.

The nominal catches presented in Section 10.1.5.1 do not include salmon that have been caught and released. Table 10.1.5.2 presents C&R information from 1991 to 2010 for countries that have records; C&R may also be practiced in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released: in 2010 this ranged from 12% in Norway (this is a minimum figure) to 70% in UK (Scotland) reflecting varying management practices and angler attitudes among these countries. Catch and release rates have typically been highest in Russia (average of 84% in the 5 years 2004 to 2008) and are believed to have remained at this level. However, there were no obligations to report C&R fish in Russia in 2009 and records for 2010 are incomplete. Within countries, the percentage of fish released has tended to increase over time. There is also evidence from some countries that larger multi-sea-winter (MSW) fish are released in higher proportions than smaller fish. Overall, over 222 000 salmon were reported to have been released around the North Atlantic in 2010, the highest in the time-series.

10.1.5.3 Unreported catches

The total unreported catch in NASCO areas in 2010 was estimated to be 382 t; however, there was no estimate for Russia and the estimate for Canada is incomplete. The unreported catch in the NEAC area in 2010 was estimated at 357 t, and that for the WGC and NAC areas at 10 t and 15 t, respectively. The 2010 unreported catch by country is provided in Table 10.1.5.3. It has not been possible to separate the unreported catch into that taken in coastal, estuarine, and riverine areas. Over recent years efforts have been made to reduce the level of unreported catch in a number of countries (e.g. through improved reporting procedures and the introduction of carcass tagging and logbook schemes).

Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NEAC	1089	946	719	575	605	604	465	433	317	357
NAC	81	83	118	101	85	56	-	-	16	15
WGC	10	10	10	10	10	10	10	10	10	10

10.1.5.4 Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2010 is 1174 kt, the second year in which production in this area has been in excess of one million tonnes. The 2010 total represents a 5% increase on 2009 and a 26% increase on the previous 5-year mean. Norway and UK (Scotland) continue to produce the majority of the farmed salmon in the North Atlantic (78% and 13%, respectively). Farmed salmon production in 2010 was below the previous five-year average in Canada, Ireland, and Iceland.

World-wide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002. It is difficult to source reliable production figures for all countries outside the North Atlantic area and it has been necessary to use 2009 estimates for some countries in deriving a world-wide estimate for 2010. Noting this caveat, total production in 2010 is provisionally estimated at around 1369 kt (Figure 10.1.5.4), a 4% decrease on 2009, continuing the small decrease in production first noted in 2009 and reflecting a fall in production outside the North Atlantic in 2010. Production in this area is estimated to have accounted for 14% of the total in 2010 (down from 22% in 2009 and 34% in 2008). Production outside the North Atlantic is still dominated by Chile despite a further decrease in farmed salmon production in this country compared with 2009 (60%) due to an outbreak of infectious salmon anaemia (ISA) virus. The ISA outbreak is reported to have had a catastrophic impact on the Chilean salmon industry, where a further reduction in production is expected. There has been a recent sharp rise in farmed salmon prices as a result of these production problems.

The world-wide production of farmed Atlantic salmon in 2010 was over 850 times the reported nominal catch of Atlantic salmon in the North Atlantic.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic in 2010 was 39 t, the majority of which (36 t) was taken by the Icelandic ranched rod fisheries (Figure 10.1.5.5). Small catches of ranched fish from experimental projects were also recorded in Ireland.

10.1.6 NASCO has asked ICES to report on significant, new or emerging threats to, or opportunities for, salmon conservation and management

10.1.6.1 Update on Workshop on Age Determination of Salmon (WKADS)

ICES noted that a Workshop on Age Determination of Salmon (WKADS) had recently taken place in Galway, Ireland (January 2011) with the objectives of reviewing, assessing, documenting, and making recommendations on current methods of ageing Atlantic salmon. The Workshop had primarily focused on digital scale reading to measure age and growth, with a view to standardization.

On the basis of the draft Workshop output, ICES recommended that:

1) Further work be undertaken to address the issues raised at the Workshop regarding protocols, inter-laboratory calibration and quality control as they relate to the interpretation of age and calculation of growth and other features from scales;
2) A second Workshop should be convened to facilitate the work and reporting.

10.1.6.2 Overview of the potential impacts of the development of alternative/renewable energy on Atlantic salmon

Globally, there has been increasing interest in the development of renewable energy sources over recent years. Renewable (naturally replenished) energy is that which comes from sources such as sunlight, wind, water, geothermal heat, and biofuels. The growth of clean renewable energy has been seen as an important part of addressing climate change concerns. Together with high oil prices and an increasing awareness of the need for energy security, these concerns have led to increased levels of government support, renewable energy legislation, incentives, and commercialization. Thus, governments have been keen to support the development of renewable energy technologies and to see the establishment of new renewable energy schemes. Where such technologies rely on water power (river flow, tidal currents) or are located in aquatic environments, they have the potential to affect Atlantic salmon and other fish species.

The development of renewable energy is expected to assist in the effort to reduce carbon emissions worldwide. However, this development raises particular concerns given that the impacts of past hydroelectric power developments on the natural environment and biodiversity have frequently not been adequately addressed or mitigated. Further, many new developments have not been properly evaluated, in part because many of the devices have yet to be deployed and tested (Boehlert and Gill, 2010).

ICES recognised that the potential impacts of in-river and estuarine structures on Atlantic salmon are relatively well known given the long history of hydropower development and barrage construction in rivers supporting salmonid and other migratory species. However, reports from several countries indicated a marked increase in the number of hydropower schemes in recent years, and this was anticipated to increase further in coming years in response to government targets on renewable energy and the introduction of financial incentives to support this growth.

ICES noted apparent contradictions between the objectives of different EU Directives: Renewable Energy Directive (2009/28) seeks to promote the development of hydroelectric schemes, while the Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora (1992/43) and the Water Framework Directive (2000/60) seek to protect the functionality and resiliency of rivers and require habitats to achieve good ecological status. ICES further noted that some countries, for example UK (England and Wales), are taking action to define standards (e.g. good practice guides) that must be adopted by developers at each proposed hydropower scheme to ensure appropriate environmental protection. Nonetheless, ICES considered that the difficulties posed by current salmon restoration programmes highlighted the importance of establishing robust standards at the outset and not relying on inadequate mitigation/compensation provisions.

ICES also acknowledged the recent marked increase in offshore wind farms. Wind turbines are particularly effective in areas where winds are stronger and more constant and, since offshore areas experience mean wind speeds far in excess of that on land, there is particular interest in establishing wind farms in coastal areas. Wind farms and other offshore renewable energy developments can impact on the environment during construction, operation, and decommissioning (Gill, 2005). Commonly, construction and decommissioning are likely to cause some physical disturbance (e.g. noise and sediment load) with potential implications for local biological communities. However, once operational, underwater noise and the emission of electromagnetic fields from such developments may represent longer term and more serious threats for coastal and migratory species. The likelihood of any such impacts on Atlantic salmon will depend on interactions between the migratory routes of salmon, the behaviour of the fish in the proximity of the development, the location and distribution of proposed offshore developments, and the technologies deployed.

In recognition of the potential impact of wind and tidal offshore developments on migratory species, scientists in UK (Scotland) have recently reviewed the available information on the migratory routes and behaviour of Atlantic salmon (and other diadromous species) in Scotland's coastal environment (Malcolm *et al.*, 2010). The Scottish Government has set targets to generate 80% of national power capacity from renewable sources by 2020. However, it is recognised that the development of marine renewables will need to incorporate processes to assess, manage, and minimize environmental impacts through appropriate planning and licensing processes for such schemes. This study identified broadscale migration patterns for adult salmon, but recognised these were unlikely to be sufficient to inform site-specific risk assessments. The report concluded that significant knowledge gaps remain and that these should be considered as part of an overall assessment of research needs in relation to offshore renewable developments and diadromous fish.

ICES concluded that great care must be taken to minimize the impact of renewable energy schemes on salmon (and other species) through careful development, device design, and site selection. ICES highlighted that the pressures to expand renewable energy raised additional concerns, particularly given unresolved difficulties in establishing and maintaining appropriate safeguards for aquatic biodiversity in previous hydropower developments, and the risks posed by individual and cumulative developments within a catchment.

10.1.6.3 Overview of best solutions for fish passage with examples of practices in member countries

NASCO asked ICES to provide information on best solutions for fish passage and associated mitigation efforts with examples of practices in member countries.

ICES noted that river connectivity was vital in maintaining biodiversity and that maximizing the production of juvenile salmon in freshwater was particularly important at a time when the levels of salmon survival at sea were low. It is thus essential that all potential nursery habitat can be reached by salmon, and that smolts can freely reach the sea. Restricted fish passage can have significant ecological impacts. For example, salmon may be excluded from important nursery habitats, increasing levels of predation (by fish, birds, and anglers), or disease/parasite incidence, can occur where salmon aggregate at obstacles and move through impoundments, and smolts and kelts can be injured or killed on spillways, sills, or in turbines, as they migrate downstream. ICES recognised that in the face of increasing pressures on freshwater ecosystems, for example as a result of the growing threat from small-scale hydropower plants as identified in the previous section, effective fish passage solutions were essential.

ICES noted that there are several national and international manuals and comprehensive guides on both upstream (e.g. Evans and Johnston, 1980; Powers *et al*., 1985; Struthers, 1993; Clay, 1995; Larinier, 2002; FAO/DVWK, 2002; Kroes *et al*., 2006; Jungwirth *et al*., 1998; NMFS, 2008; Degerman, 2008; Grande, 2010; Environment Agency, 2010) and downstream fish passage (e.g. Poe *et al*., 1993; Washington Department of Fish and Wildlife, 2000; Larinier and Travade, 2002; Deutsche Vereinigung für Wasserwirtschaft, 2005; NMFS, 2008).

Fish passage consists of both upstream and downstream passage. Upstream passage can be achieved in a number of different ways. Removal of the obstacle (often dams) is the best solution. Opening of a dam or sluice gates can be used in some situations, but this is rarely applicable and a simple fish pass may be still required if water velocity or the head of water is too high for fish to swim upstream. Other options are to construct fishways; these can be 'natural' or 'technical'. 'Natural' fish passes include rocky ramps or the creation of channels either within or outside the watercourse. Technical fishways come in many types; these include: (a) pool and weir fishways (traditional fish ladders); (b) vertical slot fishways; and (c) Denil and Larinier fishways (roughened channels). Other, less frequently used options include: fish elevators, fish locks, fish pumps, and the trapping and transport of ascending spawners.

The technology available for upstream fish passage is more advanced than that available for downstream passage. There are particular concerns with downstream passage in relation to hydropower generation (Section 10.1.6.2). The key requirement to achieving effective downstream passage past obstructions is to lead the fish to a spillway or by-pass. Fish tend to go with the flow, which can present a particular problem when most of the water is led through turbines. Ensuring suitable bypass flows and adequate attraction flows (relative to generating flow) are considered critical variables regulating the effectiveness of downstream fish passage (Rivinoja, 2005).

Examples of practices in member countries

River Rhine, Germany

The stocks of Atlantic salmon in the River Rhine were lost at the end of the 1950s, and a reintroduction programme started in 1978 with the aim of re-establishing self-sustaining runs. One of the main obstacles that needs to be addressed is the upstream and downstream passage of fish. There are particular concerns about the movement of fish into and through the Rhine delta, with the Haringvliet Sluice in the Netherlands considered a major obstacle. However, free passage of fish is also a problem in most of the Rhine tributaries, both with regard to fish reaching their spawning grounds and in relation to losses of smolts at hydropower plants.

River Ätran, Sweden

The River Ätran is the most important salmon river on the Swedish west coast. In 1903 a power plant was established close to the mouth and salmon and sea trout had great difficulties passing this and a previous fish ladder. In 1946, the dam was equipped with a Denil fishway and this immediately improved upstream access for salmon. The salmon population in the River Ätran is currently assessed as of good status; 3000–5000 Atlantic salmon and sea trout have been counted passing the power plant annually over the period 2000 to 2010. However, upstream migration remains a problem for weaker swimmers such as eel and sea lamprey and further changes to the dam are proposed. Further downstream passage of fish in the river has been an ongoing problem.

River Monnow, UK (England and Wales)

In 2009, a fish pass was installed on Osbaston Weir on the River Monnow, one of the largest tributaries of the River Wye in Wales. The rock ramp by-pass channel opened up 200 km on the river to a wide range of species, and salmon have since been seen spawning upstream of the weir, with juvenile salmon found in subsequent fishery surveys.

River Taff, UK (England and Wales)

The River Taff is a recovering river in south Wales. Three fish passes have recently been installed (2003, 2005, and 2009) on the river to help with the re-establishment of salmon. Prior to the installation of the passes, there were no salmon upstream. However, there has been progressive recolonization of the newly accessible areas since this time, with over 70% of the sites surveyed for juvenile salmon containing salmon fry in 2010.

River Himleån, Sweden

The River Himleån is a small catchment in Sweden. In the 1980s, salmon were absent from the river due to migration barriers, acidification in the upper parts, eutrophication in the lower parts, and canalization for drainage of agricultural areas. Today, 38 km of the river is accessible to salmon after removal of three dams and other habitat improvement measures. There has been a steady improvement in the densities of salmon parr in the river and the stock is currently assessed as being above conservation limits, i.e. from a lost salmon population to a healthy river in 23 years.

Summary

ICES noted that there was extensive information available on fish pass design and that improving fish passage had contributed to sustaining and recovering wild salmon populations. In addition, the technology available for upstream fish passage is often more advanced than that available for downstream passage. However, scientific evaluation was often absent or inadequate. It was recognised that fishways are never 100% effective, so a proportion of the migrating population is typically lost at each such structure. In rivers with multiple passes/barriers this can have substantial negative cumulative effects resulting in few spawners reaching the nursery areas and/or few smolts reaching the sea.

ICES recognised that careful design, adequate water supply, and proper maintenance were crucial to well functioning fishways. Where this was possible, the removal of dams had provided some positive examples of restoration, and complete removal of obstructions offered the best solutions for upstream and downstream movements of aquatic species without delays or mortality. However, there were many more examples of poorly designed and inefficient technical fishways where problems persisted and insufficient studies on the effectiveness of such structures.

10.1.6.4 Recent results from acoustic tracking investigations in Canada

ICES reviewed the results from the Atlantic Salmon Federation (ASF) who continued to assess estuarine and coastal survival of tagged Atlantic salmon released in rivers of the Gulf of St. Lawrence.

Assumed survivals for smolt in 2010 from freshwater release points to the head of tide, and from the head of tide to estuary exits, were similar for each of the rivers to those that have been observed in previous years. By contrast, there was an improvement in marine survivals across the Gulf of St. Lawrence to the Strait of Belle Isle. This was especially true of the Cascapedia River, where very few of the fish that successfully exited from Chaleur Bay into the Gulf of St. Lawrence failed to be detected in the Strait of Belle Isle.

10.1.6.5 Assessing the impact of common assessment procedures on smolt physiology, behaviour, and adult return rates

Marine survival estimates for various Atlantic salmon stocks are reported annually to ICES as part of the Working Group's assessment activities. It has previously been noted, however, that the assessment methodologies used in deriving these estimates may have a negative effect on fish behaviour and survival (Hansen, 1988; Hansen and Jonsson, 1988; Moffett *et al*., 1997; Crozier and Kennedy, 2002; Riley *et al*., 2007). Indeed, Crozier and Kennedy (2002) reported that over a 13-year period wild salmon smolts tagged with Coded Wire Tags (CWT) on the River Bush, Northern Ireland had return rates 56.4% lower than untagged fish.

ICES noted recent investigations conducted in UK (England and Wales) to assess the impact of trapping, handling, anaesthesia, and tagging (CWT) of Atlantic salmon on smolt physiology, smolt migratory behaviour, and subsequent adult return rates.

Physiology of wild migrating smolts – River Frome

Cortisol levels determined from blood plasma of actively migrating smolts caught on the River Frome indicated a highly significant ($p < 0.01$) increase in plasma cortisol concentrations following capture, consistent with an acute ('fight or flight') stress response.

Physiology of hatchery-reared smolts – laboratory study

Hatchery-reared smolts were randomly assigned to one of five experimental treatments (n=6 per treatment): control; handled/ no anaesthetic; anaesthetised/ handled; anaesthetised/ adipose fin clip only; anaesthetised/ adipose fin clip and CWT. Cortisol release rates remained at around 4 ng g^{-1} h^{-1} in the control fish throughout the experiment. However, all fish subjected to a handling or tagging procedure responded with an acute stress response with an increase in cortisol release rates for 3 to 12 hours after the procedure. After this time period, cortisol release rates rapidly returned to baseline levels indicating that there was no chronic stress response in any of the groups.

Wild smolt migratory behaviour – River Ceiriog

Each September, in the years 2004 to 2006, wild salmon parr were captured, PIT (Passive Integrated Transponder) tagged and released back into the River Ceiriog, a tributary of the Welsh Dee in North Wales, at their site of capture. A proportion of these tagged salmon were subsequently monitored as they migrated downstream using a PIT tag detection system installed in the water intake of a trout farm. In April and early May 2006 to 2007, a proportion of the PIT-tagged smolts migrating downstream were intercepted using a rotary screw trap (RST), 1.1 km upstream from the water intake. All PIT-tagged smolts caught were anaesthetised and tagged with a CWT, before being returned to the river immediately downstream of the RST. The previously PIT-tagged smolts that migrated past the RST without being caught and that were subsequently detected at the water intake were used as the control group.

In both 2006 and 2007, the downstream migration timing of the control group of smolts was significantly correlated with the time of sunset. However, the downstream migration timing of the smolts intercepted and tagged with CWTs was statistically random with respect to sunset (Riley *et al*., 2007).

Adult return rates – River Frome

Each September, in the years 2005 to 2008, around 10 000 wild salmon parr have been captured, PIT tagged, and released back into the River Frome in Dorset, at their site of capture. During the following springs (2006–2009), PIT-tagged salmon smolts have been intercepted using a RST in the lower reaches of the Frome. All PIT-tagged smolts caught were anaesthetised, tagged with a CWT and returned to the river. PIT-tagged smolts that successfully migrated past the RST during the spring without being caught, but that were detected using PIT antenna systems deployed in the lower Frome, were used as the control group. Differences in the survival between the CWT tagged fish and the control population were determined based on the adult return detection rate of the two groups recorded by a cross-river PIT antenna array (Ibbotson *et al*., 2004) located 4.1 km upstream of the tidal influence.

Adult return rates have varied year on year. In two years, there has been no difference between the return rates of the control and tagged groups, while in the other two years, the return rate of the tagged group has been lower. Until November 2010 there was a 34.5% reduction ($p < 0.05$) in returns from RST intercepted/ CWT smolts compared with the control group. However, the results are strongly influenced by the returns of one smolt cohort (2007) and data are required from more years. The smolt run in 2007 was atypical, with >72% of the smolts caught and released during the daylight, possibly making them more vulnerable to visual predators, although environmental variation and run timing are also likely to play a key role in smolt survival. The River Frome study is planned to continue until 2014 and based on current adult salmon return rates it is anticipated that this will enable a more robust assessment of the effects of handling/tagging on adult return rates.

Summary

Ongoing concerns about trends in the marine mortality of salmon, together with reliance on marine survival data as inputs for stock assessment and modelling, emphasize the vital importance of obtaining accurate marine survival data. The results of this and earlier studies suggest that the additional mortality associated with the handling and tagging of wild smolts should be taken into account when assessing marine survival. However, further work is needed to assess the extent to which such handling and tagging effects might vary year on year in response to factors such as environmental effects and smolt run timing.

10.1.6.6 Red vent syndrome

Over recent years, there have been reports from a number of countries in the NEAC and NAC areas of salmon returning to rivers with swollen and/or bleeding vents. The condition, known as red vent syndrome (RVS), has been noted since 2005, and has been linked to the presence of a nematode worm, *Anisakis simplex* (Beck *et al*., 2008). A number of regions within the NEAC stock complex observed a notable increase in the incidence of salmon with RVS during 2007 (ICES, 2008), but levels have been lower in some NEAC countries since 2008 (ICES, 2009; ICES, 2010a). However, levels of RVS on monitored rivers in UK (England and Wales) and in France have typically remained high (20–60%) and have changed relatively little over recent years. A survey conducted in Ireland also showed a high incidence of the condition in returning fish. Within the NAC stock complex, RVS has previously been detected in the Scotia-Fundy (2008 and 2009) and Quebec regions, but is currently thought to be at low levels.

There is no clear indication that RVS affects either the survival of the fish or their spawning success. Affected fish have been taken for use as broodstock in a number of countries, successfully stripped of their eggs, and these have developed normally in hatcheries. Recent results have also demonstrated that affected vents showed signs of progressive healing in freshwater, suggesting that the time when a fish is examined for RVS, relative to its period of in-river residence, is likely to influence perceptions about the prevalence of the condition.

10.1.6.7 Reduced sensitivity and development of resistance towards treatment in the salmon louse (*Lepeophtheirus salmonis*)

ICES previously highlighted concerns arising from Norway regarding the development of reduced sensitivity of the salmon louse (*Lepeophtheirus salmonis*) to oral treatment (ICES, 2009, 2010a). The monthly reports of lice numbers on aquaculture salmon, as reported by fish farmers, show that the average number of adult lice on salmon in January and February 2011, for Norway as a whole, was at the same high level as seen in the previous year (www.lusedata.no). Throughout 2010, levels were on average higher than the previous year in the periods January to March and August to November. This, together with the increase in geographic spread of incidences of treatment failure and resistance, gives ongoing cause for concern.

10.1.6.8 Atlantic salmon genetics – new initiatives in relation to management of mixed-stock coastal fisheries in northern Norway

SALSEA–Merge, and other current and previous projects, have contributed to the establishment of a comprehensive genetic baseline for salmon populations in northern Europe. Work continues to develop this baseline for the salmon populations of northernmost Europe into a practical and useful tool for the management of mixed-stock coastal fisheries in Norway and Russia. Power analysis of the genetic baseline indicated that with the present coverage, and number of genetic markers used, around 50% of the samples from coastal fisheries can be reliably assigned to river (probability >90%). However, it was recognized that the spatial coverage of the baseline should be expanded, and additional sampling should be conducted in a number of rivers to improve the precision of the assignment of individuals.

A further initiative to facilitate management of these mixed-stock fisheries has been taken by Norway, Russia, and Finland. Under this project, a model for coastal migration of returning spawners to these northern salmon rivers will be developed. Up to 100 northern rivers will be added to the genetic baseline, and up to 18 000 samples from coastal fisheries in Norway and Russia will be analysed. It is anticipated that the activities in this project will provide a foundation on which a river-specific management regime for coastal and riverine fisheries for these northern populations can be implemented.

10.1.6.9 SALSEA West Greenland

SALSEA West Greenland is designed to enhance the current Baseline Sampling Program (Section 10.4) and integrate with the coordinated marine surveys in other oceanic areas to provide data for investigating hypotheses on the causal mechanisms driving stock-specific performance in the ocean (i.e. marine survival).

In 2010, the SALSEA West Greenland Enhanced Sampling Program resulted in detailed examination of 358 fresh whole salmon, which were purchased directly from individual fishers. Fresh whole fish are needed, as the protocols for many of the samples require the collection of fresh internal tissues. The following provides the samples collected in 2010 and their purpose:

- adipose tissue samples preserved in RNALater for origin determination;
- scale samples for age and growth studies;
- stomach samples preserved in formalin for diet studies;
- sea lice collections preserved in both RNALater and EtOH for Slice® resistance and population genetics studies;
- muscle fillet sections frozen for lipid analysis;
- otolith and water samples for oxygen isotope analysis;
- heart and kidney samples preserved in both RNALater and formalin for parasite (*Ichthyophonus*) investigations;
- pyloric caeca, gill arch, liver, spleen, kidney, and heart samples preserved in formalin for miscellaneous parasite investigations;
- intestines preserved in formalin for parasite analysis;
- kidney samples preserved in RNALater and frozen for ISAv analysis;
- adipose and caudal fin clip, dorsal muscle and liver frozen samples and scale samples for stable isotopes analysis;
- gill rakers, pyloric caeca, spleen, and kidney frozen samples for miscellaneous disease investigations.

ICES recommends that SALSEA West Greenland be conducted in 2011 and that efforts continue to integrate the results from this sampling program with results obtained from both SALSEA–Merge and SALSEA North America.

10.1.6.10 Salmon bycatch in the Icelandic mackerel fishery

In 2010, the Icelandic Directorate of Fisheries launched a programme to investigate the incidence of salmon bycatch in a new mackerel fishery, which started in late May of that year. The programme was limited to 1000–3000 tonne multi-gear vessels fishing with a mid-water trawl. The monitoring of these landings for salmon bycatch was primarily carried out in land-based sorting facilities prior to processing and freezing of the mackerel catch. The sampling rate was 40 kg per 100 t of landed catch. However, a few salmon were also recovered in factory trawlers. The total bycatch recorded during the 2010 fishing season was 170 salmon, most of which were less than 60 cm in fork length and thus in their first sea-year. Four of the salmon were tagged, three with CWTs and one with a Carlin tag. Three of the tags originated in Norway and one from Ireland. Most of the bycatch occurred in areas off eastern and northeastern Iceland during the early summer months.

ICES welcomed this opportunistic assessment of the incidence of salmon bycatch in this pelagic fishery and also the opportunity to collect samples from the salmon caught.

10.1.6.11 Reintroduction of salmon – developments on the River Rhine

The programme of reintroducing Atlantic salmon to the River Rhine started 20 years ago and the first adult salmon was recorded in the River Sieg, a tributary of the Rhine, in 1990, more than 30 years after the extirpation of salmon from the Rhine catchment. Naturally produced juvenile salmon were first observed in 1994 and since the start of the programme more than 6200 adult salmon have now been recorded in the Rhine and its tributaries. Stocking of juveniles is planned to continue.

After a successful pilot project in 2006, the downstream migration of Atlantic salmon smolts has been monitored in the River Rhine each year since 2007. The study aims to investigate the success of downstream migration through Germany and the Netherlands and to assess the migration routes in relation to the obstructions within the partly dammed Rhine Delta, particularly the Haringvliet sluices. The number of fish reaching the sea after passage through the delta has typically been relatively low; the highest proportion (when 46% of the smolts were recorded reaching the sea) occurred in 2007 and may reflect higher discharge in this year. In 2010, in common with previous years, the most important migration route from all rivers to the sea was the passage through the Haringvliet sluices in the Netherlands.

ICES noted that proposed changes to the way in which the Haringvliet sluices will be operated had potential implications for the success of the programme. Previously, the Dutch government had agreed to the implementation of progressive measures to partially open the sluices. However, following a change in the government in 2010 these measures were dropped and alternative ecologically meaningful alternatives are to be examined. This has raised serious concerns among the different organizations involved in the migratory fish programmes on the River Rhine, since this will affect the main migration route for these fish.

10.1.7 NASCO has asked ICES to report on significant advances in our understanding of associations between changes in biological characteristics of all life stages of Atlantic salmon and ecosystem changes with a view to better understanding the dynamics of salmon populations

ICES had previously considered a preliminary report from the second meeting of the Study Group on the Identification of Biological Characteristics for Use as Predictors of Salmon Abundance [SGBICEPS] (ICES, 2010a) and noted that the final Study Group report had since been published (ICES, 2010b). No other new information was presented to ICES.

10.1.8 NASCO has asked ICES to further develop approaches to forecast pre-fishery abundance for North American and European stocks with measures of uncertainty

The Study Group on Salmon Stock Assessment and Forecasting (SGSAFE) was set up to further develop Atlantic salmon stock assessment and forecast models and to assist ICES in providing catch advice to NASCO for management of the North Atlantic high seas salmon fisheries. There were originally four terms of reference for the Study Group:

a) Update and further develop stock and/or catch forecast models for salmon stocks in the NAC and NEAC areas;

b) Evaluate options for developing forecast models which include all sea-age classes;

c) Evaluate methods for incorporating uncertainty in the assessments;

d) Develop risk analyses for the provision of salmon catch advice.

At the first meeting of the Study Group in March 2009, new forecast models for the NAC and NEAC areas were developed. For NAC, the input data used in the run-reconstruction were updated, and some of the regional spawner and return inputs were revised. A regional disaggregated model for the single 1SW non-maturing component was developed using a first order random walk production parameter. The inference portion of the model included uncertainties in the lagged spawner values (as priors) and in the 2SW returns to regions as pseudo-observations. Uncertainties in catches and biological characteristics of the West Greenland fishery were included in the forecast and the full risk analysis for West Greenland was provided. The inference and forecast portions of the model were run in a Bayesian hierarchical framework. Details of the work completed during the first Study Group are provided in ICES (2010a).

For the NEAC area, efforts were made to translate the run reconstruction of returns and spawners from Excel Crystal Ball© to R© to facilitate the development of the assessment and forecast model in a Bayesian hierarchical framework. Models for the southern NEAC and northern NEAC stock complexes, which combined maturing and non-maturing 1SW return streams from common lagged eggs, were developed. The forecast portion of the model was developed for the stock complex level and included a risk assessment of the probability of meeting or exceeding stock complex conservation limits in the absence of any fisheries. The models for NEAC were presented in 2009 and were accepted and used in 2009 and 2010 for the provision of catch advice (ICES, 2010a). Details of the NEAC model were presented in ICES (2009). The work of the Study Group was incomplete in 2009 and the group agreed to continue working on the model development in subsequent years.

Further to the work conducted by ICES in 2009, the ACOM Review Group of the Working Group report was critical of some aspects of the models and added an additional term of reference for consideration by the Study Group:

e) Explore the possibility of incorporating physical and biological variables into the models that may explain variation in salmon survival.

The second meeting of the Study Group was held in March 2011 in Moncton (NB), Canada. As in the first Study Group, experts in Bayesian modelling and Atlantic salmon assessments from France, who were not national delegates from their country to ICES, participated. The following progress was made.

10.1.8.1 Update and further develop stock and/or catch forecast models for salmon stocks in the NASCO North American and North East Atlantic Commission areas

The model for NAC originally developed during the first Study Group meeting was refined to account for covariance in the productivity parameters among the regions. Pre-Fishery Abundance (PFA) of 1SW non-maturing salmon is modelled for each region proportionally to lagged spawners using a first order autocorrelated function. The inter-regional variance in the productivity parameter was modelled as a multinormal distribution which ascribes correlation in productivity between regions among years. The justification for using the inter-region covariance matrix for the productivity parameter is that the fish share a common marine environment during part of their life cycle, but there can be regional specificities in the evolution of the freshwater and/or the marine coastal environment and subsequent variation in productivities.

Unresolved issues with the NEAC model developed in 2009 were resolved at the 2011 meeting. These included: the incorporation of the uncertainty in the regional returns for the Bayesian formulation which had not been completed during the previous meeting, an interest in exploring further alternate productivity functions such as the shifting level dynamic, consideration for the disaggregation of the returns and spawners at a sub-complex scale and the development of the full catch advice scenario.

The revised NEAC model developed by the Study Group is a combined sea-age group model with uncertainty in the returns and lagged eggs structured in a hierarchical Bayesian framework. The differences from the 2009 model structure include: a single productivity parameter is estimated for the lagged eggs to PFA association and the proportion maturing is uncoupled from the productivity parameter estimation. The productivity parameter remains a first order autocorrelated function and in addition the proportion maturing is also modelled as a first order autocorrelated function. The revised model is applied to develop catch advice for the Southern NEAC and Northern NEAC stock complexes.

10.1.8.2 Evaluate options for developing forecast models which include all sea-age classes

The combined sea-age class models have been developed for the NEAC stocks but not for the NAC stock. At present, the spawning stock variable for NEAC is lagged eggs from both sea-age groups and both maturing and non-maturing recruitments are modelled simultaneously with a common productivity parameter. For NAC, only 2SW spawners are used and ICES has only considered the recruitment of the non-maturing 1SW salmon, which is the sea-age group exploited at West Greenland. The maturing 1SW salmon are not exploited in that fishery.

Some points of discussion were raised regarding the assumptions on heritability of age-at-maturity in the two differing assumptions for NAC and NEAC. For the NEAC model, the assumption is that an egg is an egg regardless of its sea-age origin. However, there is an interest in conserving the sea-age structure of the spawning stock which is why the conservation limits are defined by sea-age group. A preliminary examination of this assumption could be done by comparing the variation in the proportion maturing parameter with the corresponding proportions of the lagged eggs contributed by one of the sea-age groups of the spawners. For the NAC model, the assumption is that there is perfect heritability in that 2SW salmon spawners are the only contributor to 1SW non-maturing salmon and that no other sea-age groups (including 3SW and repeat-spawning MSW salmon) produce recruitment of 1SW non-maturing salmon. The Study Group did not have time to consider a combined sea-age group model for NAC, but a model structure similar to that developed for NEAC could be considered.

10.1.8.3 Evaluate methods for incorporating uncertainty in the assessments

From the very first Study Group meeting, the development of inference and forecast models in a hierarchical Bayesian framework was considered the most appropriate approach to use. Both the NAC and NEAC models incorporate the uncertainty in the input data (or pseudo-observations) to the models. Further developments which would consider physical or biological variables to characterize the functional relationship between spawners and recruitment must also consider how to incorporate the uncertainty in those variables and in the forecasts.

10.1.8.4 Develop risk analyses for the provision of salmon catch advice

The development of the catch advice in a risk analysis framework within the Bayesian structure is complete for the NAC model. A similar approach for NEAC was proposed by ICES in 2010, further developed at the Study Group and is being completed by ICES (see Section 3.10 in ICES, 2010b).

10.1.8.5 Explore the possibility of incorporating physical and biological variables into the models that may explain variation in salmon survival

A very good scientific literature review of environmental and biological factors associated with biological characteristics and survival of Atlantic salmon is available in the SGBICEPS Study Group report (ICES, 2010b). The factors vary between NAC and NEAC and even within areas of NEAC. Progress on this term of reference would require the development of models at scales below the stock complex level. No specific work (exploration of forecast models and environmental variables) on this term of reference was done during the Study Group. The group began breaking out the spawning and recruitment dynamic into the specific salmon life stages associated with freshwater and marine environments.

10.1.8.6 Next steps

The Study Group report is to be finalized by July 2011. The models developed by the Study Group have been presented to ICES and are being used to develop catch advice for both NAC and NEAC. The Study Group tasks are considered complete and no further meetings are planned. Further work on the question of incorporating environmental variables in assessment and forecast models is expected by collaborators in a new EU-funded project – Effective Use of Ecosystem and Biological Knowledge in Fisheries (ECOKNOWS) – and one of their deliverables is reporting to ICES.

10.1.9 NASCO has asked ICES to provide a review of examples of successes and failures in wild salmon restoration and rehabilitation and develop a classification of activities which could be recommended under various conditions or threats to the persistence of populations

ICES noted that a Study Group had been established to address this question. The Study Group on Effectiveness of Recovery Actions for Atlantic Salmon [SGERAAS] was set up and had intended to work by correspondence to make progress on this issue. The Study Group has not been able to address this question and there was no progress to report. ICES recognised that the issue of the restoration and rehabilitation of salmon stocks remained a concern, but that the issue could not be appropriately addressed by the Working Group during its annual meeting. ICES remains of the view that a Study Group is the best way to provide this review.

10.1.10 NASCO has asked ICES to provide a compilation of tag releases by country in 2010 and advise on the utility of maintaining this compilation

10.1.10.1 Compilation of tag releases and fin clip data by ICES member countries in 2010

Data on releases of tagged, fin-clipped, and otherwise marked salmon in 2010 were provided by ICES and are compiled as a separate report (ICES, 2011). A summary of tag releases is provided in Table 10.1.10.1.

10.1.10.2 Utility of maintaining the tag compilation

In addition to providing a compilation of tag releases by country in 2010, NASCO asked ICES for advice on the utility of maintaining this compilation. ICES felt there was still some value and usefulness of maintaining the tag compilation, in particular while such large numbers of salmon are being tagged annually and while the return of tags can add to the knowledge about salmon at sea. With the preparation and assistance from the ICES Secretariat the tag compilation can be carried out during the annual meeting of the Working Group. ICES therefore recommends continuing with the annual compilation of salmon tags and encourages further use of the scientific information gathered from tagging programmes.

10.1.11 NASCO has requested ICES to further investigate opportunities to develop a framework of indicators that could be used to identify any significant change in previously provided multi-annual management advice.

ICES (2007) adopted a FWI for the Greenland fishery based on the seven contributing regions/stock complexes with direct links to the three management objectives established by NASCO for that fishery. At the time, ICES was unable to develop a FWI for the Faroese fishery because none of the available indicator data sets met the criteria for inclusion in the FWI. In 2009, ICES (2009) updated the NEAC data sets previously examined in the FWI but these still did not satisfy the criteria for inclusion in the FWI as being informative of a significant change, since over the time-series the PFA estimates have predominately remained above the spawning escapement reserve (SER). As a result, a different set of decision rules for this FWI has been proposed. For the NEAC stocks, the status of stocks should be re-evaluated if the FWI suggests that the PFA estimates are deviating substantially from the median values from the forecast. Several criteria for when the PFA deviates substantially from the forecast were explored and the 95 % confidence interval range of the indicator prediction relative to the median forecast value was chosen to define the thresholds. The limits should be computed at the median values of the PFA forecasts in each of the years in a multi-year advice. In the event of a closed fishery, the indicators should be compared to the upper 95% confidence limit, and in the event of an open fishery they should be compared to both the upper and lower 95 % confidence limits (Figure 10.1.11.1).

To be included in the FWIs an indicator must fulfil two criteria: it must be a reliable predictor of the relevant PFA (r^2 from the regression larger than 0.20), and the value of the indicator (or a preliminary value) must be available for the inclusion in the FWI evaluation by mid-January. Of the retained indicators eight were from Northern NEAC and 20 from Southern NEAC (Table 10.1.11.1). A spreadsheet for FWIs for each of the stock complexes was developed.

Based on the proposed FWI framework for NEAC, for a fishery to be opened or to remain open, there should be a high probability that all four stock complexes would meet their CLs, and any indication that there has been a change in PFA from the forecast median value would trigger an assessment. If very few indicators are available to run the FWI by the agreed time, this would automatically trigger an assessment for the coming year.

Until alternative management units are agreed the indicators should be regressed against the stock complexes to which they belong. For example MSW indicators from Norway should be regressed against PFA MSW for Northern NEAC. ICES recommends that this procedure should be developed further and presented for the next assessment in 2012.

10.1.12 NASCO has asked ICES to provide a more detailed evaluation of the choice of appropriate management units to be used in a risk-based framework for the provision of catch advice for the Faroese salmon fishery, taking into account relevant biological and management considerations and including, if possible, worked examples of catch advice

ICES has previously developed a risk framework for the provision of catch advice for the West Greenland fishery (WGF) which involves estimating the uncertainty in meeting defined management objectives at different levels of catch (catch options) (ICES, 2009). The procedure has been accepted by NASCO and employed by ICES in providing catch advice. In 2010, ICES (2010b) outlined a risk framework that could be used to provide and evaluate catch options for the Faroes fishery based on the method currently used to provide catch advice for the West Greenland fishery. ICES (2010b) described the procedure for conducting such an assessment and noted that the following three issues required decisions by managers before full catch advice could be provided:

- the choice of management units for NEAC stocks;
- the specification of management objectives;
- the share arrangement for the Faroes fishery.

The NEA Commission discussed the above questions at the 2010 NASCO annual meeting and during inter-sessional discussions but did not reach any conclusion. In this section, the proposed risk framework is explored in more detail, a number of issues including the choice of management units are discussed, and a worked example of catch advice is provided in Section 3.10.8.

10.1.12.1 Faroes fishing season

The Faroes fishery has historically operated between October/November and May/June, but the historical TACs applied to a calendar year. This means that two different cohorts of salmon of each age class (e.g. two cohorts of 1SW salmon, etc.) were exploited under each TAC. Uncertainty would be reduced if the data analysis and development of catch options was provided by fishing season, October to June, rather than the calendar year. This approach has been assumed in the examples provided in this report.

10.1.12.2 Choice of management units

ICES (2010b) noted that basing an assessment of stock status on the large stock complex units presently used greatly increases the risks to individual river stocks. The choice of management units may be influenced by both biological and political considerations as well as by practical issues such as the availability of data. Management which requires meeting CLs for individual stocks would require basing the management of a mixed-stock fishery on the status of each individual river stock (or population) that it exploits, possibly split by sea-age group. Applying such an approach to the management of the Faroes fishery would result in >3000 management units in the NEAC area (i.e. at least two age groups in each of ~1500 rivers).

Larger management units might be defined on biological grounds, such as commonalities in migratory patterns of stocks or other biological characteristics, but insufficient data are available to determine such groupings at present. From a jurisdictional perspective, there is likely to be a strong preference for splitting the management units to at least the national level because of the different management regimes adopted by jurisdictions.

The development of catch advice is also constrained by the availability of data. The run–reconstruction (RR) model, which is used to estimate PFA and national CLs can, in theory, be run for individual rivers, but estimates of exploitation rates and unreported catches required for the model are not normally available at this level and there is no benefit in sub-dividing the assessment between areas for which the same parameter values would be used. The assessment of TAC options also requires data on the size and age composition and origin of the catch. Some data are available from historic sampling in the Faroes fishery when it operated in the 1980s to 1990s, but data on the origin of the catch are limited. While the overall pattern appears reasonable, the results are relatively imprecise and some gaps (which arise from lack of tags) appear inconsistent with our general understanding of the stocks. The approximate nature of these estimates is not critical in the RR analysis, particularly since there has been little or no catch at Faroes for more than a decade, but it has a much more significant impact on the evaluation of catch options going forward. More precise estimates of stock composition could be obtained using genetic stock identification techniques on either historical (e.g. scales) or future samples collected in the fishery.

There is a conflict between the desire to define the NEAC management units at the jurisdiction level or below and the restrictions of the data which probably limit the definition of management units between the levels of jurisdictions and the currently used stock complexes. These management units would also be split into age groups (1SW and MSW).

The main problem with allocating catch to management units relates to the difficulty of estimating the contribution of the management units for which there are limited tag recoveries (e.g. UK (Northern Ireland), France, Finland). A compromise that would partly resolve this problem could be to amalgamate geographically neighbouring units.

10.1.12.3 Management objectives

The management objectives provide the basis for determining the risks to stocks in each management unit associated with different catch options. However, NASCO has not provided management objectives for the Faroes fishery. The NASCO agreement on the adoption of a Precautionary Approach (NASCO, 1998) indicates that salmon fisheries should be managed by means of CLs and management targets and also calls for the 'formulation of pre-agreed management actions in the form of procedures to be applied over a range of stock conditions'. This suggests that the management objectives (e.g. the required probability of exceeding the CL) should be agreed in advance of specific management proposals being considered. Nevertheless, the proposed presentation of the catch options would permit managers to review the risk that different TAC options would pose to individual management units and choose a risk level that they consider appropriate.

ICES also considered the implications of basing the risk framework on overall abundance objectives for management units comprising large numbers of river stocks. Even setting management units at the jurisdiction level would mean that (at least) four management units (i.e. Ireland, Norway, Russia, and UK (Scotland)) would each comprise over one hundred river stocks. Thus it would still be possible for large numbers of river stocks to be below CL while the management unit as a whole was meeting its management objective. If the management unit is set at the stock complex level, the problem would be greater, and it would be possible, for example, for the status of river stocks in a jurisdiction with many salmon rivers to completely mask the status of the stocks in a jurisdiction with fewer rivers.

An additional management objective could be applied to all management units based on the status of individual stocks. For example, this objective might state that for each of the management units an agreed percentage of the assessed river stocks must meet specified management objectives before a TAC is allocated to the mixed-stock fishery at Faroes. The criteria for judging satisfactory compliance with these requirements would need to be agreed by managers.

10.1.12.4 Sharing agreement

The 'sharing agreement' will establish the proportion of any harvestable surplus within the NEAC area that could be made available to the Faroes fishery through the TAC. In effect this means that for any TAC option being evaluated for the Faroes, it is assumed that the total harvest would be the TAC divided by the Faroes share.

The management framework for the West Greenland fishery provides a precedent for setting a share allocation based on the historic split of declared catches at West Greenland and in North America using a baseline period of 1986–1990 (catches in West Greenland are lagged one year back). ICES (2010b) indicated that the same method could be used to establish the share arrangement for the Faroes fishery, and since some stocks are exploited at both Faroes and West Greenland, suggested that it might be appropriate to use the same baseline period. On this basis, the share allocations would be 7.5% to Faroes, 7.1% to West Greenland, and 85.4% to all NEAC homewater fisheries.

NASCO has not provided a share allocation, but one Party had proposed an alternative baseline period of 1984–1988. The share allocations based on this period would be 8.4% Faroes, 5.2% West Greenland, and 86.4% all NEAC homewater fisheries (Table 10.1.12.1). In the absence of an agreed share allocation, a value of 8% for the Faroes fishery has been used in this example.

10.1.12.5 Evaluation of catch options

The process for assessing each catch option within the risk framework would be as follows. Parameters marked with an '*' in the equations have uncertainty around them and so contribute to the estimation of the probability density function around the potential total harvest arising from each TAC option.

The TAC option (T) is first divided by the mean weight (W) of salmon caught in the Faroes fishery to give the number of fish (N) that would be caught; thus:

$$N = T / W^*$$

This value is converted to numbers of wild fish (Nw) by multiplying by one minus the proportion of farm escapees in the Faroes catch (pE) observed in historic sampling programmes:

$$Nw = N \times (1 - pE^*)$$

This value is split into numbers by sea-age classes (1SW and MSW) according to the proportion of each age group (pAi) observed in historic catch sampling programmes at Faroes, and the discards that die (i.e. 80% of fish less than 60 cm TL) are added to the 1SW catch. Thus:

$$Nw1SW = Nwtotal \times pA1SW^* + (Nwtotal \times pD^* \times 0.8)$$

and

$$NwMSW = Nwtotal \times pAMSW^*$$

where 'pD' is the proportion of the total catch that is discarded (i.e. <60 cm TL).

Further corrections are made to the 1SW and MSW numbers to reduce the 1SW total to take account of the proportion that will not mature as grilse and to add the survivors from this group to the MSW fish in the following year. For the first catch advice year the number added to the MSW total is adjusted to the TAC applying in the current year (i.e. zero in 2011). Thus:

$$Nw1SW = Nw1SW \times pM^*$$

and

$$NwMSW = NwMSW + Nw1SW \times (1 - pM^*) \times e^{-12m}$$

where 'pM' is the proportion of 1SW salmon that are expected to mature in the same year (0.78) and 'm' is the instantaneous monthly rate of mortality.

The numbers in each age group are then divided among the management units by multiplying by the appropriate proportions (pUj), where 'i' denotes the age groups and 'j' denotes the management units:

$$Nwij = Nwi \times pUj$$

Finally, each of these values is raised by the Faroes share allocation (S) to give the total potential harvest (Hij) of fish from each management unit and sea-age group.

$$Hij = Nwij / S$$

These harvests are then subtracted from the stock forecasts (PFAij) for the management units and sea-age groups and compared with the Spawner Escapement Reserves (SER) to evaluate attainment of the management objective. In practice the attainment of the management objective is assessed by determining the probability that

$$PFAij - Hij - SERij > 0.$$

The SER is the number of fish that need to be alive at the time of the Faroes fishery to meet the CL when the fish return to homewaters; this equals the CL raised by the mortality over the intervening time. CLs and SERs are currently estimated without uncertainty.

10.1.12.6 Input data for the risk framework

NASCO has asked ICES to provide worked examples of catch advice. On the basis of the above evaluation, the following example of the risk framework is based on the stock complexes previously used for the provision of catch advice. The assessment requires input data as described in Section 10.1.12.5. Some of these parameters (e.g. mean ages and weights, discard rates, etc.) apply to the catch that might occur at the Faroes if a TAC was allocated. In most cases the only data available to estimate these parameters come from sampling programmes conducted in commercial and research fisheries in Faroese waters in the 1980s and 1990s.

<u>Mean weights:</u> Mean weights of salmon caught in the commercial and research fisheries operating in Faroese waters between 1983/84 and 1995/96 varied between 3.06 and 5.23 kg (Table 10.1.12.2) (ICES, 1997). However, high values were observed at the beginning of the time-series when part of the catch was taken to the north of the Faroes EEZ, and the values for the latter part of the series are based on relatively small catches in a research fishery which may not be as representative of a full commercial fishery.

<u>Proportion by sea age:</u> The age composition of catches in the Faroes fishery has been estimated from samples collected in the 1983/84 to 1994/95 fishing seasons (Table 10.1.12.3) (ICES, 1996). The samples taken between 1991/92 and 1994/95 were from the research fishery and included potential discards but excluded farm escapees. As a result, values have been drawn from the observations between 1985/86 and 1990/91 to provide a probability distribution for this parameter. However, the age composition of the catches may be expected to be related to the mean weight (Figure 10.1.12.2). To take account of this relationship, the values of mean weight and age composition used in each sample run have been drawn from the same years.

<u>Discard rates:</u> In the past, there was a requirement to discard any fish less than 60 cm total length caught in the Faroes fishery and discard rates have been estimated from the proportions of fish less than 60 cm in catch samples between the 1982/83 and 1994/95 seasons (ICES, 1996); 80% of these fish were expected to die (ICES, 1986).

<u>Proportions of fish farm escapees:</u> The proportion of fish farm escapees in the catches at Faroes has also been estimated from samples taken in the 1980/81 to 1994/95 fishing season (ICES, 1996). However, there have been substantial changes in the production of farmed fish and in the incidence of escape events. Data were available on the proportion of farm escapees in Norwegian coastal waters between 1989 and 2008; the

proportion in recent years (2002–2008) was 63% of the proportion during the period 1989/90 to 1994/95 when the sample time-series overlap. The proportion of farm escapees used in the risk framework has therefore been generated by multiplying the rates observed in the Faroes fishery between 1988/89 to 1994/95 by 0.63.

Proportions of catches by management unit: The origin of the stocks exploited at Faroes has been estimated from smolt and adult tagging studies and an approximate split between jurisdictions has been employed in the NEAC RR model (e.g. ICES, 2010a). These same proportions have been used to develop the risk framework, but because of the uncertainties described in Section 10.1.12.2, they have been grouped at the stock complex level. Thus 1SW salmon are assigned 50% to Northern NEAC and 50% to Southern NEAC area. MSW salmon are assigned 60.5% to Northern NEAC and 27.5% to Southern NEAC; the remaining 12% of MSW salmon were estimated to derive from other jurisdictions not currently included in the assessment (e.g. including Spanish and North American stocks).

Other input parameters include the Faroes sharing arrangement set at 0.08, the proportion 1SW non-maturing in the 1SW catch set at 0.22, mortality rate on discard fish set at 80%, and natural mortality in the second year at sea set at 0.03 per month.

10.1.12.7 Worked example of the risk framework

The methods and data described above have been used to provide an example of the risk framework for the Northern and Southern NEAC stock complexes using the PFA forecasts derived from the Bayesian model. The results are presented as an example of how future catch advice might be provided, and do not constitute formal catch advice at this stage.

In the example, the probability of the stock complexes in Northern and Southern NEAC areas achieving their SERs (the overall abundance objective) for different catch options in the Faroes fishery (from 0 to 500 t) in 2012 to 2014 are shown in Table 10.1.12.4 and Figure 10.1.12.1. This assumes that the same TAC is applied and is taken in each of the three years. This indicates that there are no TAC options that will permit all stock complexes to have a greater than 75% probability of achieving their SERs in any year from 2012 to 2014. The flatness of the curves in the catch options figures is a characterization of the uncertainty in the estimates and the level of exploitation on the stocks in the Faroes fishery (Table 10.1.12.5 and Figure 10.1.12.2); more uncertain data and lower exploitation rates generate flatter curves.

Section 10.1.12.2 discusses the problem of basing this form of risk analysis on management units comprising large numbers of river stocks and proposes that an additional management objective should also be applied at a smaller geographical scale if the management units are defined at the jurisdiction or stock complex level. This objective might state that an agreed percentage of the assessed river stocks within each of the smaller geographic units must meet specified management objectives before a TAC is allocated to the mixed-stock fishery at Faroes. Table 10.1.12.6 provides examples of the type of data that might be used in such an assessment, noting that stock status indicators should be based on the attainment of CLs before exploitation.

ICES recommends that further work be undertaken to check the appropriateness of the various data inputs, including seeking original data sets from the sampling programmes in the Faroes, and to define the management objectives based on individual river stocks.

10.1.13 NASCO has requested ICES to identify relevant data deficiencies, monitoring needs, and research requirements

ICES recommends that the Working Group on North Atlantic Salmon (WGNAS) should meet in 2012 to address questions posed by ICES, including those posed by NASCO. The Working Group intends to convene at ICES headquarters from 20 to 29 March 2012.

List of recommendations

ICES recommends that further work be undertaken to address the issues raised by the Workshop on Age Determination of Salmon regarding protocols, inter-laboratory calibration, and quality control as they relate to the interpretation of age and calculation of growth and other features from scales, and a second Workshop should be convened to facilitate this work and reporting (Section 10.1.6.1).

ICES recommends a continuation of the annual compilation of salmon tag releases and encourages further use of the scientific information gathered from tagging programmes (Section 10.1.10).

ICES recommends that further work be undertaken to check the appropriateness of the various data inputs used in the catch advice framework for the Faroes fishery, including seeking original data sets from the sampling programmes of the fishery in the historical time period (Section 10.1.12.7).

A preliminary proposal for a Framework of Indicators for the NEAC stock complexes was developed in 2011. ICES recommends that until alternative management units are agreed by NASCO, this procedure be developed further and that new possible indicators be brought forward for the next assessment in 2012 (Section 10.1.11).

ICES recommends that sampling of the Labrador food fisheries and at St. Pierre & Miquelon be continued and expanded if possible in 2011 and future years (Section 10.3).

ICES supports the proposal from the Greenlandic authorities for the introduction of a logbook as a condition of the licensing system for the salmon fishery at West Greenland (Section 10.4).

ICES recommends a continuation and expansion of the broad geographic sampling programme (multiple NAFO divisions) to more accurately estimate continent of origin and biological characteristics of the salmon in the West Greenland mixed-stock fishery (Section 10.4).

ICES recommends that SALSEA West Greenland be conducted in 2011 for a third year and that efforts continue to integrate the results from this sampling programme with results obtained from both SALSEA–Merge and SALSEA North America (Section 10.1.6.9).

In support of the management objective from NASCO to ensure that individual river stocks meet their conservation limits, ICES recommends that additional monitoring data or analyses of existing monitoring data (catches, juvenile surveys, short-term count data), be considered to augment the river-specific data used to develop the stock status and to improve management advice in both NAC and NEAC areas (Sections 10.2 and 10.3).

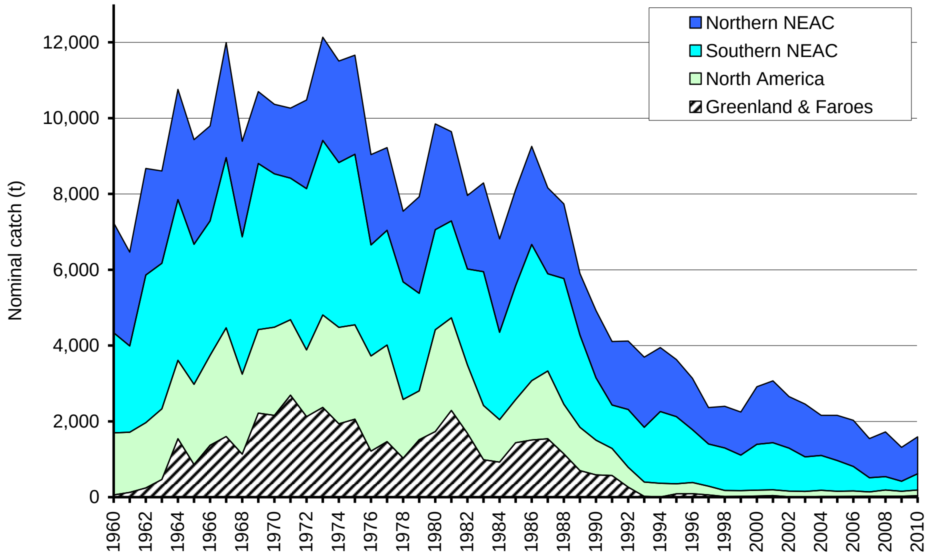


Figure 10.1.5.1. Reported total nominal catch of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960 to 2010.

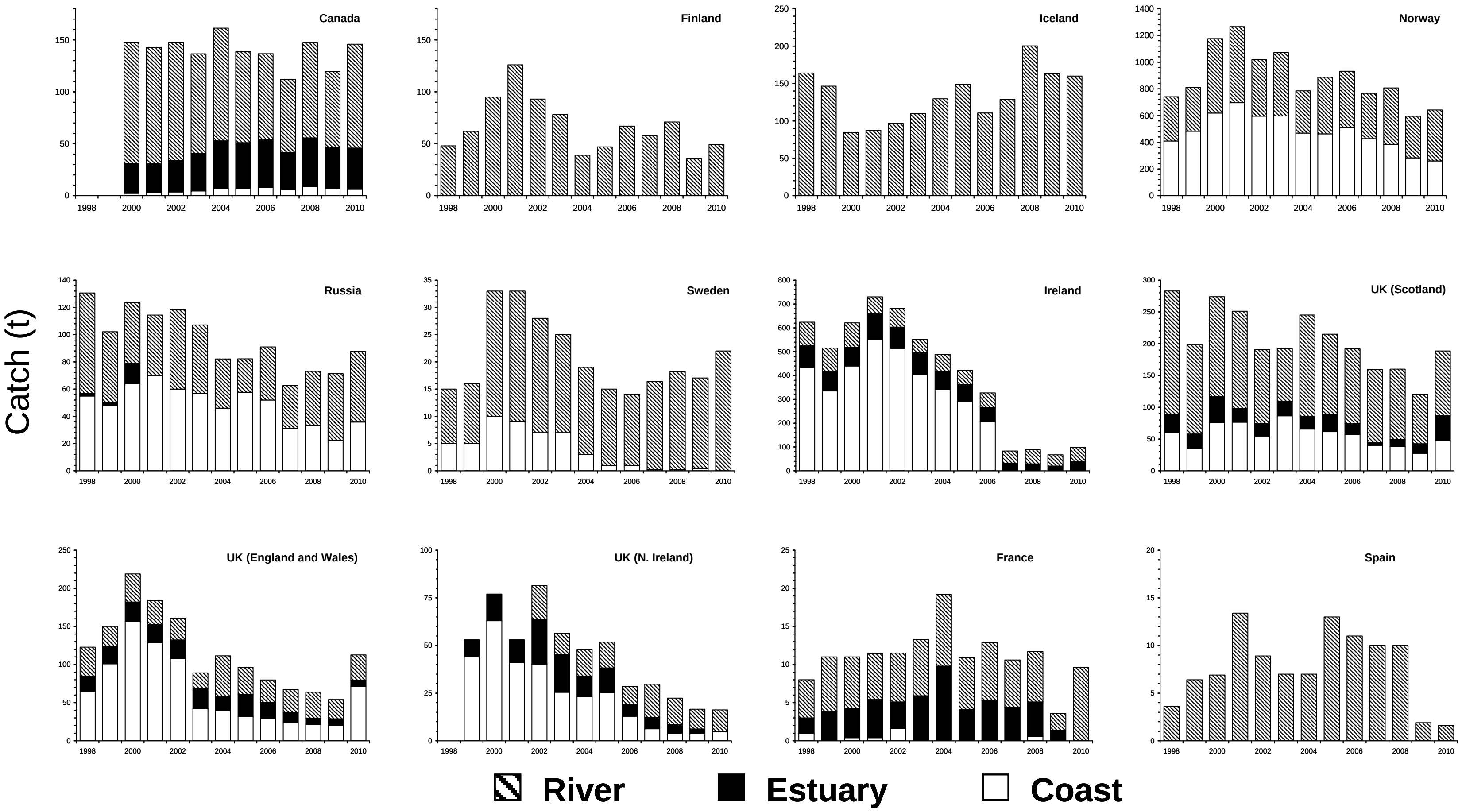


Figure 10.1.5.2. Nominal catch (t) by country taken in coastal, estuarine, and riverine fisheries.

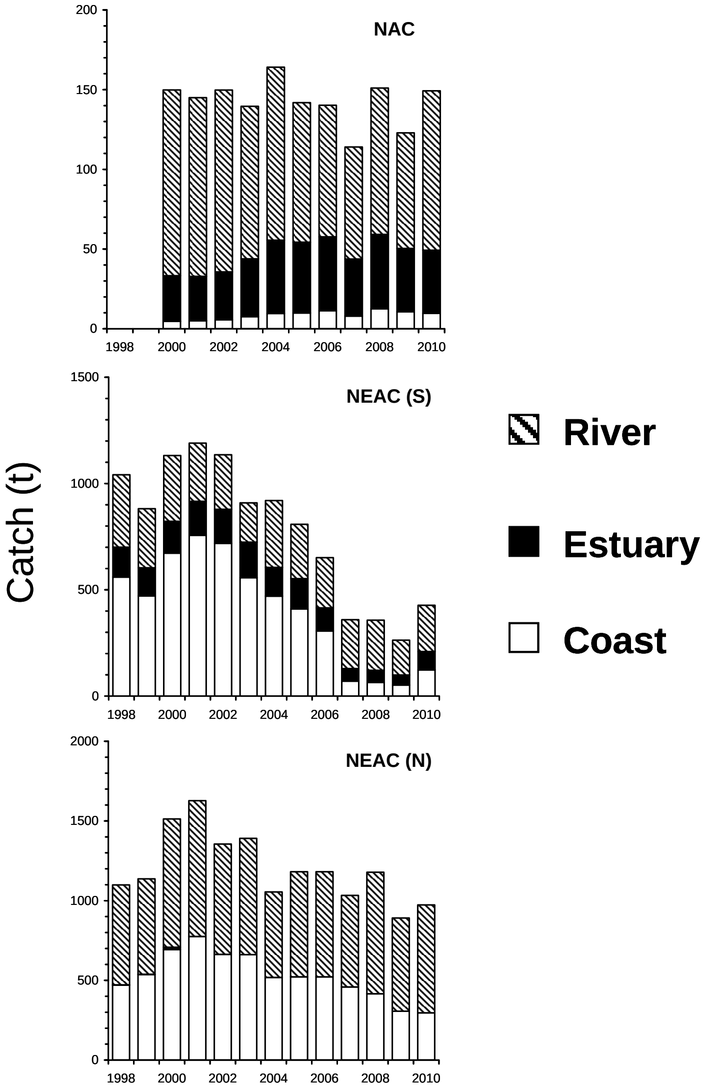


Figure 10.1.5.3. Nominal catch (t) taken in coastal, estuarine, and riverine fisheries for the NAC area, and for the northern and southern NEAC areas. Note that y-axes scales vary.

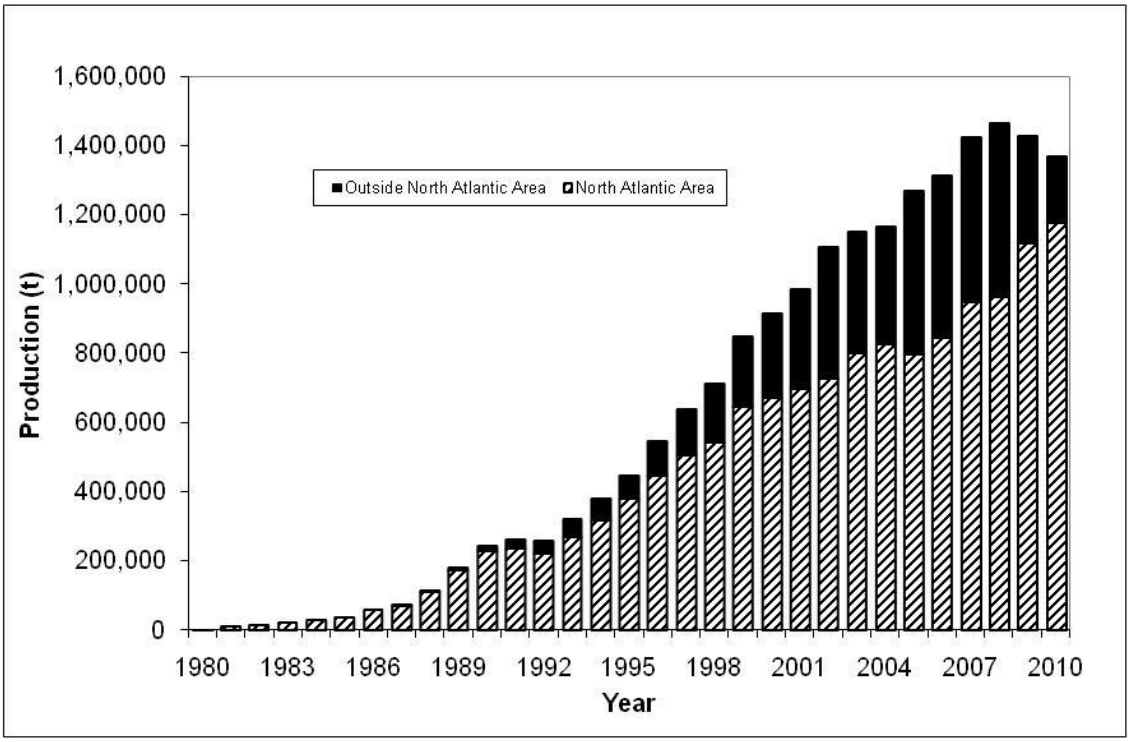


Figure 10.1.5.4. World-wide production of farmed Atlantic salmon, 1980 to 2010.

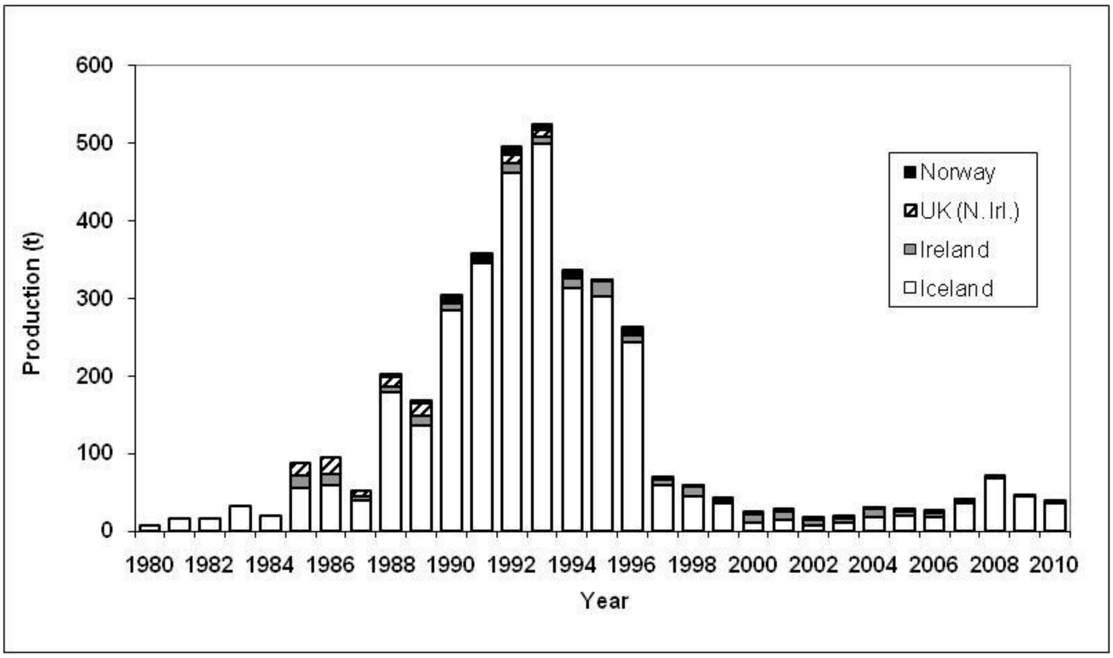


Figure 10.1.5.5. Production of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2010.

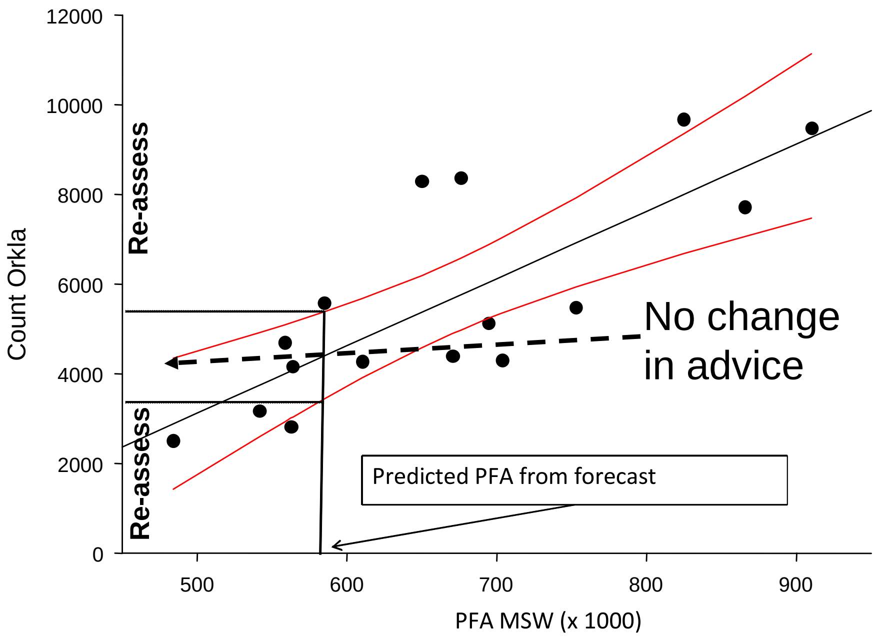


Figure 10.1.11.1. Example of an indicator for the proposed Framework of Indicators (FWI) for NEAC and how the reassessment intervals for the indicators are computed. The values of an indicator (counts) are plotted against the PFA. Regression line and 95% confidence limits are shown. From the forecasted PFA in the year in question the values of the indicator corresponding to the upper and lower 95% confidence interval are estimated. Reassessment is suggested when an indicator value falls outside of these limits .

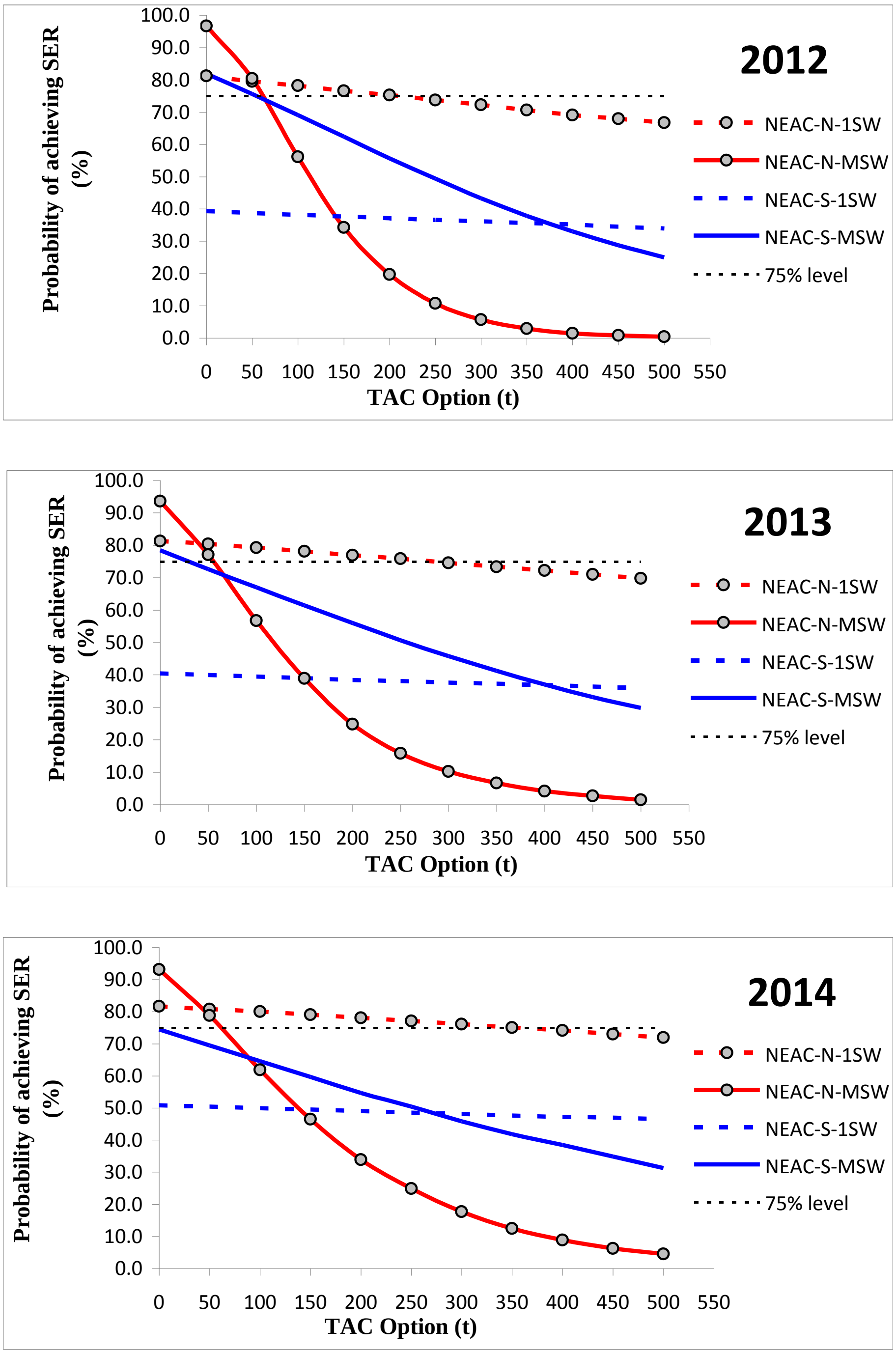
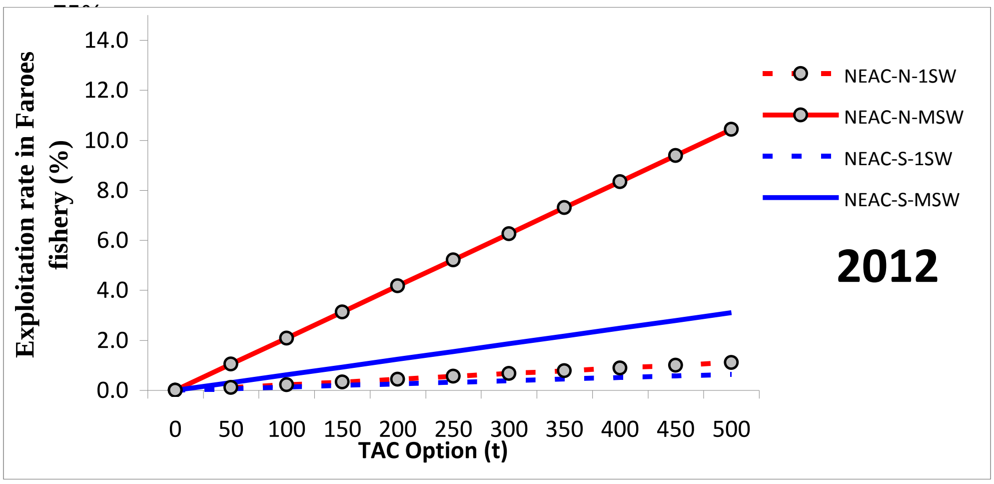
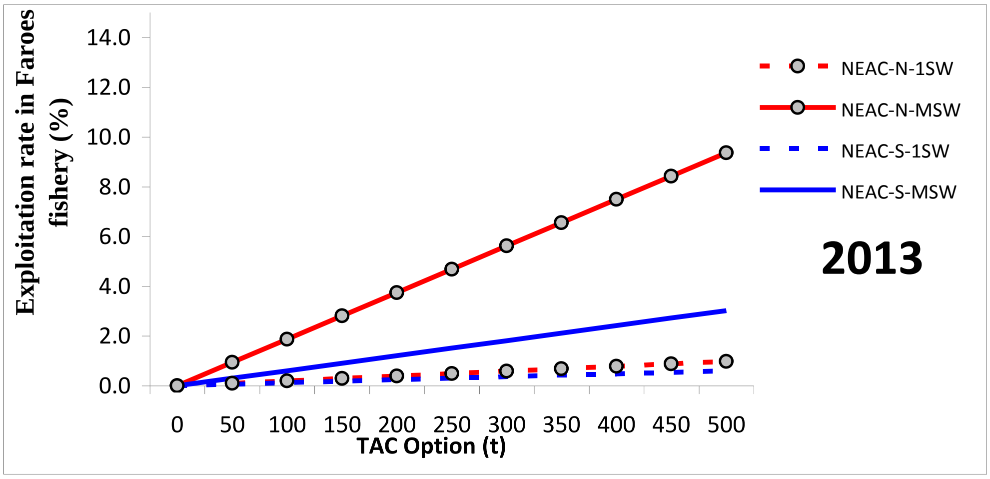


Figure 10.1.12.1. Probability (%) of 1SW and MSW salmon in Northern and Southern NEAC areas achieving their SERs for different catch options in Faroes for the years 2012 to 2014.





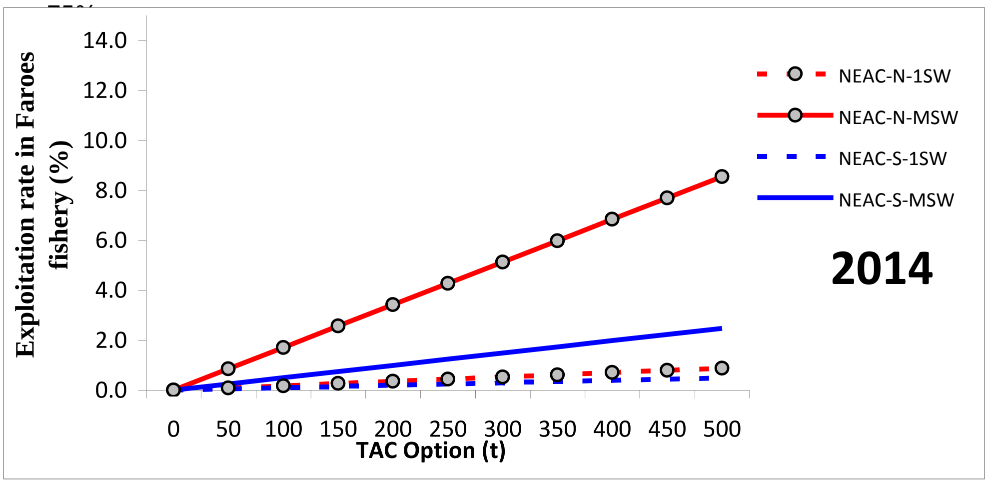


Figure 10.1.12.2. Forecast exploitation rate (%) of 1SW and MSW salmon from Northern and Southern NEAC areas in the Faroes fishery for different catch options in the years 2012 to 2014.

Table 10.1.5.1 Reported total nominal catch of salmon by country (in tonnes round fresh weight), 1960 to 2010. (2010 figures include provisional data).

	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
								Sweden				UK	UK	UK				East	West		Reported		
Year	Canada	USA	St. P&M	Norway	Russia	Iceland		(West)	Denmark	Finland	Ireland	(E & W)	(N.Irl.)	(Scotl.)	France	Spain	Faroes	Grld.	Grld.	Other	Nominal	NASCO	International
	(1)			(2)	(3)	Wild	Ranch (4)				(5,6)		(6,7)		(8)	(9)	(10)		(11)	(12)	Catch	Areas (13)	waters (14)
1960	1,636	1	-	1,659	1,100	100	-	40	-	-	743	283	139	1,443	-	33	-	-	60	-	7,237	-	-
1961	1,583	1	-	1,533	790	127	-	27	-	-	707	232	132	1,185	-	20	-	-	127	-	6,464	-	-
1962	1,719	1	-	1,935	710	125	-	45	-	-	1,459	318	356	1,738	-	23	-	-	244	-	8,673	-	-
1963	1,861	1	-	1,786	480	145	-	23	-	-	1,458	325	306	1,725	-	28	-	-	466	-	8,604	-	-
1964	2,069	1	-	2,147	590	135	-	36	-	-	1,617	307	377	1,907	-	34	-	-	1,539	-	10,759	-	-
1965	2,116	1	-	2,000	590	133	-	40	-	-	1,457	320	281	1,593	-	42	-	-	861	-	9,434	-	-
1966	2,369	1	-	1,791	570	104	2	36	-	-	1,238	387	287	1,595	-	42	-	-	1,370	-	9,792	-	-
1967	2,863	1	-	1,980	883	144	2	25	-	-	1,463	420	449	2,117	-	43	-	-	1,601	-	11,991	-	-
1968	2,111	1	-	1,514	827	161	1	20	-	-	1,413	282	312	1,578	-	38	5	-	1,127	403	9,793	-	-
1969	2,202	1	-	1,383	360	131	2	22	-	-	1,730	377	267	1,955	-	54	7	-	2,210	893	11,594	-	-
1970	2,323	1	-	1,171	448	182	13	20	-	-	1,787	527	297	1,392	-	45	12	-	2,146	922	11,286	-	-
1971	1,992	1	-	1,207	417	196	8	18	-	-	1,639	426	234	1,421	-	16	-	-	2,689	471	10,735	-	-
1972	1,759	1	-	1,578	462	245	5	18	-	32	1,804	442	210	1,727	34	40	9	-	2,113	486	10,965	-	-
1973	2,434	3	-	1,726	772	148	8	23	-	50	1,930	450	182	2,006	12	24	28	-	2,341	533	12,670	-	-
1974	2,539	1	-	1,633	709	215	10	32	-	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	-	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	-	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	10	-	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	-	37	1,230	349	148	1,323	20	32	37	8	984	138	7,682	-	-
1979	1,287	3	-	1,831	455	219	6	12	-	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	17	-	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	26	-	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	25	-	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	28	-	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	40	-	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	45	-	49	1,595	361	98	913	22	13	566	7	864	-	8,108	-	-
1986	1,559	2	3	1,598	608	232	59	54	-	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	47	-	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	40	-	36	1,874	395	114	882	32	18	243	4	893	-	7,737	3,248	-
1989	1,139	2	2	905	364	141	136	29	-	52	1,079	296	142	895	14	7	364	-	337	-	5,904	2,277	-
1990	911	2	2	930	313	141	285	33	13	60	567	338	94	624	15	7	315	-	274	-	4,925	1,890	180-350

Table 10.1.5.1 continued.

Year	NAC Area: Canada (1)	NAC Area: USA	NAC Area: St. P&M	NEAC (N. Area): Norway (2)	NEAC (N. Area): Russia (3)	NEAC (N. Area): Iceland Wild	NEAC (N. Area): Iceland Ranch (4)	NEAC (N. Area): Sweden (West)	NEAC (N. Area): Denmark	NEAC (N. Area): Finland	NEAC (S. Area): Ireland (5,6)	NEAC (S. Area): UK (E & W)	NEAC (S. Area): UK (N.Irl.) (6,7)	NEAC (S. Area): UK (Scotl.)	NEAC (S. Area): France (8)	NEAC (S. Area): Spain (9)	Faroes & Greenland: Faroes (10)	Faroes & Greenland: East Grld.	Faroes & Greenland: West Grld. (11)	Faroes & Greenland: Other (12)	Total Reported Nominal Catch	Unreported catches: NASCO Areas (13)	Unreported catches: International waters (14)
1991	711	1	1	876	215	129	346	38	3	70	404	200	55	462	13	11	95	4	472	-	4,106	1,682	25-100
1992	522	1	2	867	167	174	462	49	10	77	630	171	91	600	20	11	23	5	237	-	4,119	1,962	25-100
1993	373	1	3	923	139	157	499	56	9	70	541	248	83	547	16	8	23	-	-	-	3,696	1,644	25-100
1994	355	0	3	996	141	136	313	44	6	49	804	324	91	649	18	10	6	-	-	-	3,945	1,276	25-100
1995	260	0	1	839	128	146	303	37	3	48	790	295	83	588	10	9	5	2	83	-	3,629	1,060	-
1996	292	0	2	787	131	118	243	33	2	44	685	183	77	427	13	7	-	0	92	-	3,136	1,123	-
1997	229	0	2	630	111	97	59	19	1	45	570	142	93	296	8	4	-	1	58	-	2,364	827	-
1998	157	0	2	740	131	119	46	15	1	48	624	123	78	283	8	4	6	0	11	-	2,395	1,210	-
1999	152	0	2	811	103	111	35	16	1	62	515	150	53	199	11	6	0	0	19	-	2,247	1,032	-
2000	153	0	2	1,176	124	73	11	33	5	95	621	219	78	274	11	7	8	0	21	-	2,912	1,269	-
2001	148	0	2	1,267	114	74	14	33	6	126	730	184	53	251	11	13	0	0	43	-	3,069	1,180	-
2002	148	0	2	1,019	118	90	7	28	5	93	682	161	81	191	11	9	0	0	9	-	2,654	1,039	-
2003	141	0	3	1,071	107	99	11	25	4	78	551	89	56	192	13	9	0	0	9	-	2,457	847	-
2004	161	0	3	784	82	111	18	20	4	39	489	111	48	245	19	7	0	0	15	-	2,157	686	-
2005	139	0	3	888	82	129	21	15	8	47	422	97	52	215	11	13	0	0	15	-	2,156	700	-
2006	137	0	3	932	91	93	17	14	2	67	326	80	29	192	13	11	0	0	22	-	2,029	670	-
2007	112	0	2	767	63	93	36	16	3	58	85	67	30	169	11	9	0	0	25	-	1,546	475	-
2008	158	0	4	807	73	132	69	18	9	71	89	64	21	160	12	9	0	0	26	-	1,720	443	-
2009	126	0	3	595	71	122	44	17	8	36	68	54	17	120	4	2	0	0	26	-	1,313	327	-
2010	146	0	3	642	88	124	36	22	13	49	99	113	16	189	10	2	0	0	40	-	1,589	367	-
Average																							
2005-2009	134	0	3	798	76	114	37	16	6	56	198	72	30	171	10	9	0	0	23	-	1,753	523	-
2000-2009	142	0	3	931	92	102	25	22	5	71	406	113	46	201	12	9	1	0	21	-	2,201	764	-

Key:

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
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. Improved reporting of rod catches in 1994 and data derived from carcase tagging and log books from 2002.
6. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
7. Angling catch (derived from carcase tagging and log books) first included in 2002.
8. Data for France include some unreported catches.
9. Weights estimated from mean weight of fish caught in Asturias (80-90% of Spanish catch).
10. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place; the commercial fishery resumed in 2000, but has not operated since 2001.
11. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
12. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
13. No unreported catch estimate for Canada since 2007 and for Russia since 2008.
14. Estimates refer to season ending in given year.

Table 10.1.5.2. Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for countries in the North Atlantic where records are available, 1991-2010. Figures for 2010 are provisional.

Year	Canada		USA		Iceland		Russia [1]		UK (E&W)		UK (Scotland)		Ireland		UK (N Ireland) [2]		Denmark		Norway [3]	
	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch
1991	28,497	33	239	50			3,211	51												
1992	46,450	34	407	67			10,120	73												
1993	53,849	41	507	77			11,246	82	1,448	10										
1994	61,830	39	249	95			12,056	83	3,227	13	6,595	8								
1995	47,679	36	370	100			11,904	84	3,189	20	12,151	14								
1996	52,166	33	542	100	669	2	10,745	73	3,428	20	10,413	15								
1997	57,252	49	333	100	1,558	5	14,823	87	3,132	24	10,965	18								
1998	62,895	53	273	100	2,826	7	12,776	81	5,365	31	13,464	18								
1999	55,331	50	211	100	3,055	10	11,450	77	5,447	44	14,846	28								
2000	64,482	55	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	55	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	44,423	60	3	100	9,691	18	44,341	90	10,917	55	55,660	61	13,125	40	470	16	959	57		
2008	58,004	54	61	100	17,178	20	41,881	86	13,035	55	53,347	62	13,312	37	648	20	2,033	71	5,512	5
2009	55,178	60	0	-	17,514	24	-	-	9,096	58	48,371	67	10,265	37	847	21	1,709	53	6,696	6
2010	58,297	57	0	-	20,345	28	14,585	56	14,103	59	81,497	70	15,136	40	1024	21	2,512	60	15,041	12
5-yr mean 2005-2009	56,219	60			12,468	20			11,198	56	50,242	60	9,967	31			1,220	55		
% change on 5-year mean	+4	-+4			+63	+43			+26	+5	+62	+18	+52	+28			+106	+10		

Key:

[1] No data were provided by the authorities for 2009 and data for 2010 were incomplete, however catch-and-release is understood to have remained at similar high levels.

[2] Data for 2006-2009 is for the DCAL area only; the figure for 2010 is a total for N.Ireland.

[3] The statistics were collected on a voluntary basis, the numbers reported must be viewed as a minimum.

Table 10.1.5.3. Estimates of unreported catches by various methods in tonnes by country within national EEZs in the North East Atlantic, North American, and West Greenland Commissions of NASCO, 2010.

Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Denmark	4	0.2	25
NEAC	Finland	8	0.4	14
NEAC	Iceland	12	0.6	7
NEAC	Ireland	10	0.5	9
NEAC	Norway	275	13.9	30
NEAC	Sweden	2	0.1	8
NEAC	France	1	0.0	5
NEAC	UK (E & W)	20	1.0	15
NEAC	UK (N.Ireland)	0	0.0	0
NEAC	UK (Scotland)	25	1.3	12
NAC	USA	0	0.0	0
NAC	Canada	15	0.8	9
WGC	West Greenland	10	0.5	20
	Total Unreported Catch *	382	19.4	
	Total Reported Catch of North Atlantic salmon	1,591		

* No unreported catch estimate available for Russia in 2010. Data for Canada are incomplete.
Unreported catch estimates not provided for Spain & St. Pierre et Miquelon

Table 10.1.10.1. Summary of Atlantic salmon tagged and marked in 2010 – 'Hatchery' and 'Wild' refer to smolts and parr; 'Adults' relates to both wild and hatchery-origin fish.

Country	Origin	Microtag	External mark	Adipose clip	Other Internal[1]	Total
Canada	Hatchery Adult	0	0	21	301	322
	Hatchery Juvenile	0	3,877	716,904	0	720,781
	Wild Adult[2]	0	4,847	2,020	874	7,741
	Wild Juvenile[2]	0	18,512	35,615	266	54,393
	Total	0	27,236	754,560	1,441	783,237
Denmark	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	77,000	0	240,995	0	317,995
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	77,000	0	240,995	0	317,995
France	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile[3]	0	178,200	266,174	0	444,374
	Wild Adult[3]	0	241	0	0	241
	Wild Juvenile	2,394	2,582	0	0	4,976
	Total	2,394	181,023	266,174	0	449,591
Germany	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	18,694	0	30,950	0	49,644
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	18,694	0	30,950	0	49,644
Iceland	Hatchery Adult	0	6	0	0	6
	Hatchery Juvenile	44,064	0	0	0	44,064
	Wild Adult	0	188	0	0	188
	Wild Juvenile	3,503	0	0	0	3,503
	Total	47,567	194	0	0	47,761
Ireland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	197,852	0	368,950	0	566,802
	Wild Adult	0	0	0	0	0
	Wild Juvenile	5,020	0	5,020	0	10,040
	Total	202,872	0	373,970	0	576,842
Norway	Hatchery Adult	0	6,000	0	0	6,000
	Hatchery Juvenile	72,491	24,626	0	0	97,117
	Wild Adult	0	1,087	0	6,877	7,964
	Wild Juvenile	3,072	2,781	0	0	5,853
	Total	75,563	34,494	0	6,877	116,934
Russia	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	1,344,059	0	1,344,059
	Wild Adult	0	2,861	0	0	2,861
	Wild Juvenile	0	0	0	0	0
	Total	0	2,861	1,344,059	0	1,346,920
Sweden	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	3000	174,017	0	177,017
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	500	0	0	500
	Total	0	3,500	174,017	0	177,517
UK (England & Wales)	Hatchery Adult	0	1,224	0	0	1,224
	Hatchery Juvenile	13,800	0	109,610	0	123,410
	Wild Adult	0	0	0	0	0
	Wild Juvenile	9,963	0	11,405	0	21,368
	Total	23,763	1,224	121,015	0	146,002
UK (N. Ireland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	21,091	0	53,499	0	74,590
	Wild Adult	0	0	0	0	0
	Wild Juvenile	1315	0	0	0	1,315
	Total	22,406	0	53,499	0	75,905
UK (Scotland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	0	3,020	3,020
	Wild Adult	0	1,361	0	3	1,364
	Wild Juvenile	1919	0	0	3,082	5,001
	Total	1,919	1,361	0	6,105	9,385
USA	Hatchery Adult	1,771	1,180	227	0	3,178
	Hatchery Juvenile	40,558	0	592,274	0	632,832
	Wild Adult	788	0	0	0	788
	Wild Juvenile	252	0	162,124	0	162,376
	Total	43,369	1,180	754,625	0	799,174
All Countries	Hatchery Adult	1,771	8,410	248	301	10,730
	Hatchery Juvenile	485,550	209,703	3,897,432	3,020	4,595,705
	Wild Adult	788	10,585	2,020	7,754	21,147
	Wild Juvenile	27,438	24,375	214,164	3,348	269,325
	Total	515,547	253,073	4,113,864	14,423	4,896,907

[1] Includes other internal tags (PIT, ultrasonic, radio, DST, etc.)
[2] May include hatchery fish.
[3] Includes external dye mark.

Table 10.1.11.1. Performance of the various candidate indicators that were explored for the NEAC framework of indicators.

Southern NEAC 1SW			
Candidate indicator data set	**N**	**R^2**	**Retained?**
Ret. to coast 1SW UK(NI) Bush M	18	0.64	Yes
Catch MSW Ice Ellidaar M	39	0.63	Yes
Ret. W 1SW UK(E&W) Itchen M	21	0.48	Yes
Ret. W MSW UK(E&W) Itchen M	23	0.46	Yes
Ret. W 1SW UK(Sc) North Esk M	30	0.45	Yes
Ret. MSW UK(E&W) Frome M	38	0.37	Yes
Ret. W 2SW UK(Scot.) Baddoch M	23	0.32	Yes
Ret. 1SW UK(E&W) Frome M	36	0.29	Yes
Ret. W 2SW UK(Scot.) Girnock M	39	0.24	Yes
Ret. W 1SW UK(E&W) Test M	21	0.21	Yes
Ret. W MSW UK(E&W) Test M	23	0.08	No
Ret. W 2SW UK(Sc) North Esk M	30	0.02	No
Ret. 1SW UK(E&W) Dee M	17	0.01	No
Ret. MSW UK(E&W) Dee M	19	0.01	No
Southern NEAC MSW			
Candidate indicator data set	**N**	**R^2**	**Retained?**
Ret. W MSW UK(E&W) Itchen NM	23	0.73	Yes
Ret. to coast 1SW UK(N.Irl) Bush NM	18	0.69	Yes
Ret. W 2SW UK(Scot) Baddoch NM	23	0.47	Yes
Catch MSW Iceland Ellidaar NM	39	0.55	Yes
Ret. 1SW UK(Sc) North Esk NM	30	0.35	Yes
Ret. MSW UK(E&W) Frome NM	38	0.45	Yes
Ret. 1SW UK(E&W) Frome NM	36	0.37	Yes
Ret. W 2SW UK(Sc) North Esk NM	30	0.30	Yes
Ret. W 2SW UK(Scot) Girnock NM	39	0.22	Yes
Ret. W 1SW UK(E&W) Itchen NM	21	0.28	Yes
Ret. W 1SW UK(E&W) Test NM	21	0.15	No
Ret. W MSW UK(E&W) Test NM	23	0.11	No
Ret. 1SW UK(E&W) Dee NM	17	0.08	No
Ret. MSW (UK(E&W) Dee NM	19	0.02	No
Northern NEAC 1SW			
Candidate indicator data set	**N**	**R^2**	**Retained?**
Ret. all 1SW Nor PFA est	22	0.91	Yes
Surv W 1SW Nor Imsa	28	0.40	Yes
Surv H 1SW Nor Imsa	27	0.26	Yes
Catch All 1SW Fin	28	0.12	No
Northern NEAC MSW			
Candidate indicator data set	**N**	**R^2**	**Retained?**
PFA-MSW-CoastNorway	22	0.70	Yes
Orkla counts	16	0.62	Yes
Surv H 2SW Nor Drammen	25	0.59	Yes
R*et al*l 2SW Nor PFA est	18	0.54	Yes
Målselv counts	20	0.24	Yes
Catch W 2SW Fin	25	0.04	No

Table 10.1.12.1. Historic sharing of catches of NAC (2SW) and NEAC (all ages) salmon between West Greenland, Faroes, and homewater fisheries. Proportions are estimated from means of catches in the previous 5 years.

	West Greenland catch	WG prop. NAC	WG catch of NAC salmon	WG catch of NEAC salmon	Canada catch - large salmon	Faroes catch	NEAC Hm'water catch	Proportions of catch of NAC 2SW salmon taken in:		Proportions of catch of Southern NEAC salmon taken in:		
	(t)		(t)	(t)	(t)	(t)	(t)	WG	NAC (yr +1)	NEAC-home	Faroes	WG
1971	2,689	0.34	914	1,775	1,482	0	-	-	-	-	-	-
1972	2,113	0.36	761	1,352	1,201	9	6,558	-	-	-	-	-
1973	2,341	0.49	1147	1,194	1,651	28	7,311	-	-	-	-	-
1974	1,917	0.43	824	1,093	1,589	20	7,004	-	-	-	-	-
1975	2,030	0.44	893	1,137	1,573	28	7,070	37.0	63.0			
1976	1,175	0.43	505	670	1,721	40	5,296	32.9	67.1	83.3	0.3	16.4
1977	1,420	0.45	639	781	1,883	40	5,183	33.4	66.6	85.0	0.4	14.5
1978	984	0.43	423	561	1,225	37	4,939	31.6	68.4	85.4	0.5	14.1
1979	1,395	0.50	698	698	705	119	5,035	30.2	69.8	85.9	0.8	13.2
1980	1,194	0.52	621	573	1,763	536	5,396	28.6	71.4	84.8	2.5	12.6
1981	1,264	0.59	746	518	1,619	1,025	4,873	32.8	67.2	83.5	5.8	10.8
1982	1,077	0.57	614	463	1,082	606	4,434	33.8	66.2	81.9	7.7	10.4
1983	310	0.40	124	186	911	678	5,825	31.8	68.2	81.6	9.5	9.0
1984	297	0.54	160	137	645	628	4,724	32.1	67.9	81.0	11.1	7.8
1985	864	0.47	406	458	540	566	5,456	34.1	65.9	82.5	11.4	6.1
1986	960	0.59	566	394	779	530	6,096	32.8	67.2	84.8	9.6	5.6
1987	966	0.59	570	396	951	576	4,763	34.0	66.0	85.3	9.5	5.2
1988	893	0.43	384	509	633	243	5,072	37.4	62.6	86.4	8.4	5.2
1989	337	0.55	185	152	590	364	3,910	38.0	62.0	85.8	7.7	6.4
1990	274	0.74	203	71	486	315	3,112	38.6	61.4	85.4	7.5	7.1
1991	472	0.63	297	175	370	95	2,460	40.6	59.4	86.1	7.1	6.8
1992	237	0.45	107	130	323	23	2,836	37.2	62.8	88.1	5.3	6.6
1993	-	-	0	0	214	23	2,772	33.0	67.0	89.0	4.8	6.1
1994	-	-	0	0	216	6	3,243	32.2	67.8	93.6	3.0	3.4
1995	83	0.67	56	27	153	5	2,963	30.2	69.8	96.4	1.0	2.5
1996	92	0.70	64	28	154	0	2,492	20.8	79.2	97.4	0.4	2.3
1997	58	0.85	49	9	126	0	2,006	19.1	80.9	98.4	0.2	1.4
1998	11	0.79	9	2	70	6	2,165	23.9	76.1	99.4	0.1	0.5
1999	19	0.91	17	2	64	0	2,026	29.3	70.7	99.3	0.1	0.6
2000	21	0.65	14	7	58	8	2,700	28.8	71.2	99.3	0.1	0.6
2001	43	0.67	29	14	61	0	2,845	28.1	71.9	99.5	0.1	0.4
2002	9	0.72	6	3	49	0	2,472	20.4	79.6	99.6	0.1	0.3
2003	9	0.65	6	3	60	0	2,275	19.6	80.4	99.7	0.1	0.2
2004	15	0.72	11	4	68	0	1,936	18.3	81.7	99.7	0.1	0.2
2005	15	0.76	11	4	56	0	1,959	18.1	81.9	99.7	0.0	0.3
2006	22	0.69	15	7	55	0	1,838	14.8	85.2	99.7	0.0	0.3
2007	25	0.76	19	6	48	0	1,359	21.6	78.4	99.8	0.0	0.2

Table 10.1.12.2. Catch in weight (t) and numbers, mean weight, and mean age of catch in the 1983/1984 to 1995/1996 fishing seasons.

	Season	Catch (t)	Catch (No)	Mean wt (kg)	Mean sea age
Commercial fishery	**1983/84**	651	124,509	5.23	2.07
	1984/85	598	135,777	4.40	2.07
	1985/86	545	154,554	3.53	2.02
	1986/87	539	140,304	3.84	2.05
	1987/88	208	65,011	3.20	1.96
	1988/89	309	93,496	3.30	2.04
	1989/90	364	111,515	3.26	2.04
	1990/91	202	57,441	3.52	2.07
Research fishery	**1991/92**	31	8,464	3.66	2.09
	1992/93	22	5,415	4.06	2.14
	1993/94	7	2,072	3.38	2.03
	1994/95	6	1,963	3.06	1.98
	1995/96	1	282	3.55	

Table 10.1.12.3. Catch in numbers and percentages by sea age and mean age in the Faroes salmon fishery in the 1983/1984 to 1994/1995 fishing seasons.

Fishery	Season	1SW	2SW	3SW	MSW	%1SW	%2SW	%3SW	Mean Age
Comm'	1983/84	5,142	135,718	16,401	152,178	3.3%	86.3%	10.4%	2.07
	1984/85	381	138,375	11,358	149,733	0.3%	92.2%	7.6%	2.07
	1985/86	2,021	169,461	5,671	175,219	1.1%	95.7%	3.2%	2.02
	1986/87	71	124,628	6,621	131,324	0.1%	94.9%	5.0%	2.05
	1987/88	5,833	55,726	3,450	59,176	9.0%	85.7%	5.3%	1.96
	1988/89	1,351	110,717	5,728	116,445	1.1%	94.0%	4.9%	2.04
	1989/90	2,155	102,800	6,473	109,273	1.9%	92.3%	5.8%	2.04
	1990/91	632	52,419	4,390	56,809	1.1%	91.3%	7.6%	2.07
Research	1991/92	248	4,686	743	5,429	4.4%	82.5%	13.1%	2.09
	1992/93	521	2,646	1,120	3,766	12.2%	61.7%	26.1%	2.14
	1993/94	320	1,288	376	1,664	16.1%	64.9%	19.0%	2.03
	1994/95	206	1,585	166	1,751	10.5%	81.0%	8.5%	1.98
	Totals	18,881	900,049	62,497	962,767	1.9%	91.7%	6.4%	2.04

1991/92 to 1994/95 include discards and exclude reared fish.

Table 10.1.12.4. Probability (%) of 1SW and MSW salmon in Northern and Southern NEAC areas achieving their SERs for different catch options (t) in Faroes for the years 2012 to 2014.

Catch options for 2012:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	81.2	96.6	39.3	81.8
	50	79.5	80.4	38.8	75.6
	100	78.2	56.1	38.2	69.1
	150	76.6	34.2	37.7	62.4
	200	75.2	19.7	37.1	55.7
	250	73.7	10.7	36.6	49.4
	300	72.2	5.7	36.1	43.3
	350	70.6	2.9	35.6	37.9
	400	69.1	1.5	35.1	33.0
	450	67.9	0.8	34.5	28.8
	500	66.7	0.4	33.9	25.0

Catch options for 2013:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	81.3	93.6	40.4	78.4
	50	80.4	77.0	40.0	72.6
	100	79.3	56.7	39.4	67.0
	150	78.2	38.9	39.0	61.4
	200	76.9	24.8	38.4	56.0
	250	75.9	15.8	38.1	50.7
	300	74.5	10.2	37.6	45.8
	350	73.3	6.7	37.3	41.3
	400	72.2	4.1	36.8	37.0
	450	71.0	2.7	36.4	33.2
	500	69.8	1.5	36.0	29.8

Catch options for 2014:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	81.7	93.1	50.8	74.4
	50	80.8	78.8	50.4	69.4
	100	80.0	61.8	49.9	64.6
	150	79.0	46.5	49.5	59.6
	200	78.1	33.9	49.0	54.7
	250	77.1	24.9	48.5	50.4
	300	76.1	17.7	48.1	45.8
	350	75.0	12.4	47.6	41.8
	400	74.1	8.9	47.2	38.4
	450	73.0	6.2	46.9	34.8
	500	71.9	4.5	46.5	31.3

Table 10.1.12.5. Forecast exploitation rate (%) of 1SW and MSW salmon from Northern and Southern NEAC areas in the Faroes fishery for different catch options in the years 2012 to 2014.

Catch options for 2012:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	0.0	0.0	0.0	0.0
	50	0.1	1.0	0.1	0.3
	100	0.2	2.1	0.1	0.6
	150	0.3	3.1	0.2	0.9
	200	0.4	4.2	0.3	1.2
	250	0.6	5.2	0.3	1.6
	300	0.7	6.3	0.4	1.9
	350	0.8	7.3	0.4	2.2
	400	0.9	8.3	0.5	2.5
	450	1.0	9.4	0.6	2.8
	500	1.1	10.4	0.6	3.1

Catch options for 2013:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	0.0	0.0	0.0	0.0
	50	0.1	0.9	0.1	0.3
	100	0.2	1.9	0.1	0.6
	150	0.3	2.8	0.2	0.9
	200	0.4	3.7	0.2	1.2
	250	0.5	4.7	0.3	1.5
	300	0.6	5.6	0.4	1.8
	350	0.7	6.6	0.4	2.1
	400	0.8	7.5	0.5	2.4
	450	0.9	8.4	0.5	2.7
	500	1.0	9.4	0.6	3.0

Catch options for 2014:	TAC option	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
	0	0.0	0.0	0.0	0.0
	50	0.1	0.9	0.0	0.2
	100	0.2	1.7	0.1	0.5
	150	0.3	2.6	0.1	0.7
	200	0.4	3.4	0.2	1.0
	250	0.4	4.3	0.2	1.2
	300	0.5	5.1	0.3	1.5
	350	0.6	6.0	0.3	1.7
	400	0.7	6.8	0.4	2.0
	450	0.8	7.7	0.4	2.2
	500	0.9	8.5	0.5	2.5

Table 10.1.12.6. Information on the status of national stocks and individual river stocks within each jurisdiction in the NEAC area.

Country	Meeting National CL 1SW	Meeting National CL MSW	No. rivers	No. with CL Total	No. asessed for compliance	No. meeting CL Total	%meeting CL Total
Iceland	Yes	Yes	100	0		NA	NA
Russia	Yes	Yes	112	80	8	7	87.5
Norway	Yes	Yes	450	439	211	74	35
Sweden	No	No	23	17	0	NA	NA
Finland/Norway (Tana/Teno)	No	No	1	1	1	0	0
UK Scotland	Yes	Yes	383	0	0	NA	NA
UK England/Wales	No	Yes	68	68	64	38	59.0
UK N. Ireland	Yes	Yes	15	7	7	2	28.6
Ireland	Yes	No	141	141	141	60	42.6
France	No	No	25	25	17	3	17.6
Germany	Not assessed						
Spain	Not assessed						
Portugal	Not assessed						

Annex 10.1 Glossary of acronyms

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.

ASF (*Atlantic Salmon Federation*)

BCI *(Bayesian Credible Interval)* The Bayesian equivalent of a confidence interval. If the 90% BCI for a parameter A is 10 to 20, there is a 90% probability that A falls between 10 and 20.

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).

CL, i.e. S_{lim} *(Conservation Limit)* Demarcation of undesirable stock levels or levels of fishing activity. The ultimate objective when managing stocks and regulating fisheries will be to ensure that there is a high probability that undesirable levels are avoided.

CPUE *(Catch Per Unit Effort)* A derived quantity obtained from the independent values of catch and effort.

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.

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.

EU DCR *(The EU Data Collection Regulation)* DCR established a community framework for the collection, management, and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy.

FV *(Fishing Vessel)* A vessel that undertakes cruise for commercial fishing purposes.

FWI (*Framework of Indicators*)

GIS *(Geographic Information Systems)* A computer technology that uses a geographic information system as an analytic framework for managing and integrating data.

GSI *(Genetic Stock Identification)* Methods used to 'genetically type' salmon from particular regions and rivers across Atlantic.

ICPR *(The International Commission for the Protection of the River Rhine)* ICPR coordinates the ecological rehabilitation programme involving all countries bordering the river Rhine. This programme was initiated in response to catastrophic river pollution in Switzerland in 1986 which killed hundreds of thousands of fish. The programme aims to bring about significant ecological improvement of the Rhine and its tributaries, allowing the re-establishment of migratory fish species such as salmon.

ISAV *(Infectious Salmon Anemia Virus)* ISA is a highly infectious disease of Atlantic salmon caused by an enveloped virus.

MSW *(Multi-Sea-Winter)* An adult salmon which has spent two or more winters at sea, or a repeat spawner.

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.

NAC (*North American Commission*)

NASCO (*North Atlantic Salmon Conservation Organization*)

NEAC (*North-East Atlantic Commission*)

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

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.

Q Areas for which the Ministère des Ressources naturelles et de la Faune manages the salmon fisheries in Québec.

RR (*Run–Reconstruction Model*)

RST (R*otary Screw Trap*)

RV *(Research Vessel)* A vessel that undertakes cruises to conduct scientific research.

RVS *(Red Vent Syndrome)* The condition, known as RVS, 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.

RW *(The Random Walk)* In the RW hypothesis, the recruitment rates are modelled as a first order time varying parameter following a simple random walk with a flat prior on the first value of the time-series. The model can be used both for retrospective analysis and forecasts.

SAC *(Special Areas of Conservation)* To comply with the EU Habitats Directive (92/43/EEC) on Conservation of Natural Habitat and of Wild Fauna and Flora, which stipulates that member states maintain or restore habitats and species to favourable conservation status, a number of rivers in the NEAC area that support important populations of vulnerable qualifying species have been designated SACs. Where salmon is a "qualifying species", additional protection measures specifically for salmon are required.

SER *(Spawning Escapement Reserve)* The CL increased to take account of natural mortality between the recruitment date (1st January) and return to home waters.

SFA *(Salmon Fishing Areas)* Areas for which the Department of Fisheries and Oceans (DFO) Canada manages the salmon fisheries.

SGBICEPS *(Study Group on the Identification of Biological Characteristics for Use as Predictors of Salmon Abundance)* The ICES Study Group established to complete a review of the available information on the life-history strategies of salmon and changes in the biological characteristics of the fish in relation to key environmental variables.

SGEFISSA (*Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance*) A Study Group established by ICES which met in November 2006.

SGSSAFE (*Study Group on Salmon Stock Assessment and Forecasting*). The Study Group established to work on the development of new and alternative models for forecasting Atlantic salmon abundance and for the provision of catch advice.

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

TAC *(Total Allowable Catch)* The quantity of fish that can be taken from each stock each year.

VIE *(Visual Implant Elastomer)* The VIE tags consist of fluorescent elastomer material which is subcutaneously injected as a liquid into transparent or translucent tissue via a hand-held injector.

WFD *(Water Framework Directive)* Directive 2000/60/EC (WFD) aims to protect and enhance the water environment, updates all existing relevant European legislation, and promotes a new approach to water management through river-based planning. The Directive requires the development of River Basin Management Plans (RBMP) and Programmes of Measures (PoM) with the aim of achieving Good Ecological Status or, for artificial or more modified waters, Good Ecological Potential.

WGC (*West Greenland Commission*)

WKDUHSTI (*Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas*) The first of three workshops established by ICES to record and analyse data from old tagging experiments. WKDUHSTI was held in February 2007.

WKSHINI (*Workshop on Salmon Historical Information – New Investigations from Old Tagging Data*) The second of three workshops established by ICES to record and analyse data from old tagging experiments. WKSHINI was held 18–20 September 2008 in Halifax, Canada.

WKLUSTRE *(Workshop on Learning from Salmon Tagging Records)* The third of three workshops established by ICES to record and analyse data from old tagging experiments. WKLUSTRE was tasked with completing the compilation of available data and analyses of the resulting distributions of salmon at sea and was held in London from 16 to 18 September 2009.

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10.2 Stock Summaries

10.2.1 Advice April 2011

ECOREGION **North Atlantic**
STOCK **Atlantic Salmon from the Northeast Atlantic**

Advice for 2011

On the basis of the MSY approach, ICES advises that fishing should only take place on maturing 1SW salmon and non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status. The management of a fishery should ideally be based on the status of all stocks exploited in the fishery.

Given the current abundance levels from the NEAC run–reconstruction model and associated Bayesian abundance forecasts, the following advice on management is provided for the two age groups in the Northern and Southern NEAC stock complexes (Figures 10.2.1, 10.2.2; Table 10.2.1).

- **Northern European 1SW stocks:** For 2011 to 2014, this stock is forecasted to be at risk of suffering reduced reproductive capacity prior to the commencement of distant-water fisheries. This stock complex therefore offers no mixed-stock fishing opportunities.
- **Northern European MSW stocks:** For 2011 and 2012, this stock is forecasted to be at full reproductive capacity prior to the commencement of distant-water fisheries. For 2013 and 2014, the stock is at risk of suffering reduced reproductive capacity prior to the commencement of distant-water fisheries. There are mixed-stock fishing opportunities on this stock complex only in 2011 and 2012.
- **Southern European 1SW stocks:** For 2011 to 2014, the stock is forecasted to be at risk of suffering reduced reproductive capacity prior to the commencement of distant-water fisheries. This stock complex therefore offers no mixed-stock fishing opportunities..
- **Southern European MSW stocks:** For 2010 to 2014, the stock is forecasted to be at risk of suffering reduced reproductive capacity prior to the commencement of distant-water fisheries. This stock complex therefore offers no mixed-stock fishing opportunities..

Stock status

National stocks within the NEAC area are combined into two stock groupings for the provision of management advice for the distant-water fisheries at West Greenland and Faroes. The Northern group consists of: Russia, Finland, Norway, Sweden, and the northeast regions of Iceland. The Southern group consists of: UK (Scotland), UK (England and Wales), UK (N. Ireland), Ireland, France, and the southwest regions of Iceland.

The status of stock complexes is presented relative to the abundance prior to the commencement of distant-water fisheries with respect to the spawner escapement reserve (SER) (Figure 10.2.3). Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Northern NEAC show broadly similar patterns of a general decline over the time period 1983 to 2010, interrupted by a short period of increased recruitment from 1998 to 2003. Both stock complexes have been at full reproductive capacity prior to the commencement of distant-water fisheries throughout the time-series. Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Southern NEAC show broadly similar declining trends over the time period. The maturing 1SW stock complex has been at full reproductive capacity over most of the time period. The non-maturing 1SW stock has been at full reproductive capacity over most of the time period but has been at risk of suffering reduced reproductive capacity before any fisheries took place in two (2006 and 2008) of the last four PFA years. This is broadly consistent with the general pattern of decline in marine survival in most monitored stocks in the area.

Estimated exploitation rates have generally been decreasing over the time period for both 1SW and MSW stocks in Northern and Southern NEAC areas (Fig. 10.2.4). Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks over time. This is mainly as a consequence of continuing poor survival in the marine environment attributed to climate effects.

Management plans

The North Atlantic Salmon Conservation Organization (NASCO) has adopted an Action Plan for Application of the Precautionary Approach which stipulates that management measures should be aimed at maintaining all stocks above their conservation limits by the use of management targets. Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average maximum sustainable yield (MSY). NASCO has adopted the region-specific CLs as limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability. Advice for the Faroes fishery (both 1SW and MSW) is based on all NEAC area stocks. The advice for the West Greenland fishery is based on Southern NEAC non-maturing 1SW stock.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northeast Atlantic area their current distribution extends from northern Portugal to the Pechora River in Northwest Russia and to Iceland. Juveniles emigrate to the ocean at ages one to eight years (dependent on latitude) and generally return after one or two years at sea. Long-distance migrations to ocean feeding grounds are known to take place with adult salmon from the Northeast Atlantic stocks being exploited at both West Greenland and the Faroes.

Environmental influence on the stock

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

The fisheries

No fishery for salmon has been prosecuted at Faroes since 2000. No significant changes in gear type used were reported in 2010; however, changes in effort were recorded. The NEAC area has seen a general reduction in catches since the 1980s (Figure 10.2.5; Table 10.2.2). This reflects the decline in fishing effort as a consequence of management measures as well as a reduction in the size of stocks. The provisional total nominal catch in Northern NEAC for 2010 was 973 t, and 427 t from Southern NEAC. The catch in the Southern area, which comprised around two-thirds of the total NEAC catch in the early 1970s, has been lower than that in the Northern area since 1999 (Figure 10.2.5).

1SW salmon comprised 61% of the total catch in the Northern area in 2010, similar to the previous year (59%) and the previous 5- and 10-year means (Figure 10.2.6). For the Southern European countries, the overall percentage of 1SW fish in the catch in 2010 (60%) was equal to the previous 5- and 10-year means (59%) and has remained reasonably consistent over the time-series (range 49 to 65%), although there is considerable variability among individual countries (Figure 10.2.6).

The contribution of farmed and ranched salmon to national catches in the NEAC area was generally low in most countries, as in previous years. In Norway farmed salmon continue to form a large proportion of the catch in those fisheries which have been sampled.

Effects of the fisheries on the ecosystem

The current salmon fishery probably has no or only minor influence on the marine ecosystem. However, the exploitation rate on salmon may affect the riverine ecosystem through changes in species composition. There is limited knowledge concerning the magnitude of these effects.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. Provisional catch data for 2009 were updated where appropriate and the assessment extended to include data for 2010. Revised estimates of national exploitation rates for UK (England and Wales) were provided. The number of regions used in respect of the Norway assessment were expanded from three to four by splitting the South region into Southeast and Southwest regions, in order to better reflect differences in stock status in the two regions in the overall assessment and to reflect domestic management arrangements.

Scientific basis

Assessments are carried out using common input variables across stock complexes. Run–reconstruction models and Bayesian forecasts are performed taking into account uncertainties in the data and in process error, and the results are presented in a risk analysis framework.

10.2.1 Supporting information April 2011

ECOREGION North Atlantic
STOCK Atlantic Salmon from the Northeast Atlantic

Reference points

National run–reconstruction models have been run for all countries that do not have river-specific CLs (i.e. all countries except France, Ireland, UK (England & Wales), and Norway). To provide catch options to NASCO, CLs are required for stock complexes. These have been derived either by summing the individual river CLs to national level, or by taking overall national CLs, as provided by the national model and then summing to the level of the four NEAC stock complexes. For the NEAC area, the CLs have been calculated by ICES as:

- Northern NEAC 1SW spawners – 207 231
- Northern NEAC MSW spawners – 131 456
- Southern NEAC 1SW spawners – 624 504
- Southern NEAC MSW spawners – 258 720

Outlook for 2011 to 2014

The total PFA (maturing and non-maturing 1SW salmon at January 1st of the first winter at sea) for the Southern NEAC complex ranged from 3 to 4 million fish between 1978 and 1989, declined rapidly to just over 2 million fish in 1990, and fell to its lowest level of just over 1.5 million fish in 2008 (Figure 10.2.2; Tables 10.2.3, 10.2.4). For the Northern NEAC complex, peak PFA abundance was estimated at about 2 million fish in year 2000 with the lowest value of the series in 2008 at over 1 million fish (Figure 10.2.1; Tables 10.2.3, 10.2.4).

Forecasts from these models into 2010 to 2014 for the non-maturing and maturing age group were developed within the Bayesian model framework. Probabilities that the PFAs will be above or equal to the spawner escapement reserve (SER; CL adjusted for natural mortality to Jan. 1 of the PFA year) in 2010 to 2014 from the Bayesian model are given in Table 10.2.1. Probabilities of meeting SERs are higher in the Northern complex than in the Southern complex (Table 10.2.1).

MSY approach

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because there are only a few age groups in the adult spawning stock. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, the ICES MSY approach is aimed at achieving a target escapement (MSY $B_{escapement}$, the 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, similar to the basis for estimating B_{pa} in the precautionary approach. In short-lived stocks, where most of the annual surplus production is from recruitment (not growth), MSY $B_{escapement}$ and B_{pa} might be expected to be similar.

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average maximum sustainable yield (MSY $B_{escapement}$). In some regions of NEAC, pseudo stock–recruitment observations are used to calculate a hockey stick relationship, with the inflection point defining the CLs. In the remaining regions, the CLs are calculated as the number of spawners that will achieve long-term average maximum sustainable yield (MSY), as derived from the adult-to-adult stock and recruitment relationship.

For the assessment of the status of stocks and advice on management of national components and geographical groupings of the stock complexes in the NEAC area, where there are no specific management objectives:

- ICES requires that the lower boundary of the 95% confidence interval of the current estimate of spawners be above the CL for the stock to be considered at full reproductive capacity.
- When the lower boundary of the confidence limit 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.

ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on maturing 1SW salmon and non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status.

Management objectives

NASCO has identified the organization's primary management objective:

"To contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice 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 NASCOs 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, 1999) 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".

NASCO has adopted the region-specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

Advice for the Faroes fishery (for 1SW and MSW stocks) is based on both Northern and Southern NEAC area stocks. The advice for the West Greenland fishery is based on Southern NEAC non-maturing 1SW (MSW) stock at a risk level of 75% (ICES, 2003).

Additional considerations

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

Fisheries on mixed-stocks pose particular difficulties for management, when they cannot target only stocks that are at full reproductive capacity. The management of a fishery should ideally be based on the status of all stocks exploited in the fishery. Conservation would be best achieved if fisheries target stocks that have been shown to be at full reproductive capacity. Fisheries in estuaries and especially rivers are more likely to meet this requirement.

There has been an overall declining trend in marine survival rates of hatchery smolts in Northern and Southern NEAC areas. Most of the survival indices for wild and reared smolts are below the previous 5- and 10-year averages. For the wild smolts the decline is also apparent for the Northern NEAC areas; however, for the Southern NEAC areas the trends are more variable (Figure 10.2.7). Comparison of survival indices for the 2008 and 2009 smolt years show a general increase for 2009 compared to 2008 for wild smolts in Northern and Southern NEAC areas. Results from these analyses are consistent with the information on estimated returns and spawners as derived from the PFA model, and suggest that returns are strongly influenced by factors in the marine environment.

For the Southern NEAC stock complex, the total PFA (maturing and non-maturing 1SW salmon at January 1st of the first winter at sea) ranged from 3 to 4 million fish between 1978 and 1989, declined rapidly to just over 2 million fish in 1990, and fell to its lowest level of just over 1.5 million fish in 2008 (Figure 10.2.2; Tables 10.2.3, 10.2.4). The productivity parameter for the maturing and non-maturing components peaked in 1985 and 1986, and there was a sharp drop in the productivity parameter during 1989 to 1991 and the median values post-1991 are all lower than during the previous time period (Figure 10.2.2). Over the entire time-series, the maturing proportions averaged about 0.6 with the lowest proportion in 1980 and the highest proportion in 1998 (Figure 10.2.2).

For the Northern NEAC complex, peak PFA abundance was estimated at about 2 million fish in year 2000 with the lowest value of the series in 2008 at over 1 million fish (Figure 10.2.1; Tables 10.2.3, 10.2.4). The proportion maturing has varied around 0.55 over the time-series but in 2007 there was an abrupt drop in the proportion maturing to below 0.37. This showed some recovery in 2008 to around 0.43. However, the level in 2009 was consistent with the previous two years, around 0.38, notably below the 1991 to 2006 level (Figure 10.2.1). The productivity increased in 2009 in the Northern NEAC complex, though remaining below pre-2004 values (Figure 10.2.1).

For the Southern NEAC stock complex, the 25th percentiles of the posterior distributions of the forecasts are below the SER for the maturing age component, with the median points just above for years 2009 to 2014, with 2011 to 2014 being forecasts (Fig. 10.2.2). For the non-maturing component the 25th percentile is just above the SER for the first forecast year (2010) and falls below it by the fifth forecast year (2014). For the Northern NEAC maturing component, the lower limit of the confidence interval has fallen below the age-specific SERs for 2010 to 2014 and the 25 percentile has remained just above (Fig. 10.2.2). For the non-maturing component of the stock, forecasts are generally above the SER but with the lower limit of the confidence interval of forecast abundances falling below the SER in 2013 and 2014.

Scientific basis

Data and methods

PFA in the NEAC area is defined as the number of 1SW recruits on January 1st in the first sea winter. Input data to estimate the PFA are the catch in numbers of 1SW and MSW salmon in each country, unreported catch levels (minimum and maximum), and exploitation rates (minimum and maximum). Data for most countries are available beginning in 1971. In addition, catches at the Faroes and catches of NEAC origin salmon at West Greenland are incorporated. Modifications are reported in the year in which they are first implemented. The Bayesian inference and forecast models for the Southern NEAC and Northern NEAC complexes have the same structure and are run independently. For both Southern and Northern NEAC complexes, forecasts for maturing stocks were derived for 4 years of lagged spawners starting from 2011 to 2014, and for non-maturing stocks for 5 years, from 2010 to 2014.

Uncertainties in assessments and forecasts

The model estimates the PFA from the catch in numbers of 1SW and MSW salmon in each country. Uncertainties are accounted for using min and max ranges for unreported catches and exploitation rates. A natural mortality value of 0.03 (range 0.02 to 0.04) per month is applied during the second year at sea. Monte Carlo simulation is used to generate confidence limits of the eggs from spawners and the returns to each country.

Risks were defined each year as the posterior probability that the PFA would be below the age- and stock-specific SER levels. For illustrative purposes, risk analyses were derived based on the probability that the PFA abundance would be greater than or equal to the SER under the scenario of no exploitation. The results are presented as percentile summaries of the posterior distributions of the model parameters of interest.

Comparison with previous assessment and catch options

The models contained minor improvements in structure and calculation processes relative to the models used in previous years. Changes were made to the models to incorporate uncertainty around the estimates of lagged eggs and returns by sea age. Changes in model structure were also introduced: the proportion maturing parameter is modelled as a first order autocorrelated random walk and a single productivity parameter is estimated from which total PFA conditional on lagged eggs is derived. The previous version of the model was run in parallel with the revised 2011 recommended version. Differences in results were minimal. The largest differences are in the forecast values for PFA and proportion maturing, and particularly for the Northern NEAC complex (Figure 10.2.8).

Assessment and management area

National stocks are combined into Southern NEAC and Northern NEAC groups. The groups fulfilled an agreed set of criteria for defining stock groups for the provision of management advice that were considered in detail by ICES (2002) and re-evaluated by ICES (2005). Consideration of the level of exploitation of national stocks resulted in the advice for the Faroes fishery (both 1SW and MSW) being based on all NEAC area stocks, and the advice for the West Greenland fishery being based on the Southern NEAC non-maturing 1SW stock only.

Sources of information

ICES. 2001. Report of the Working Group on North Atlantic Salmon. Aberdeen, 2–11 April 2001. ICES Document CM 2001/ACFM:15. 290 pp.

ICES. 2002. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 3–13 April 2002. ICES Document CM 2002/ACFM:14. 299 pp.

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ICES. 2011. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 22–31 March 2011. ICES Document CM 2011/ACOM:06. 283 pp.

NASCO. 1998. North Atlantic Salmon Conservation Organization. Agreement on the adoption of a precautionary approach. Report of the 15th annual meeting of the Council. CNL(98)46. 4 pp.

NASCO. 1999. North Atlantic Salmon Conservation Organization. Action plan for the application of the precautionary approach. CNL(99)48. 14 pp.

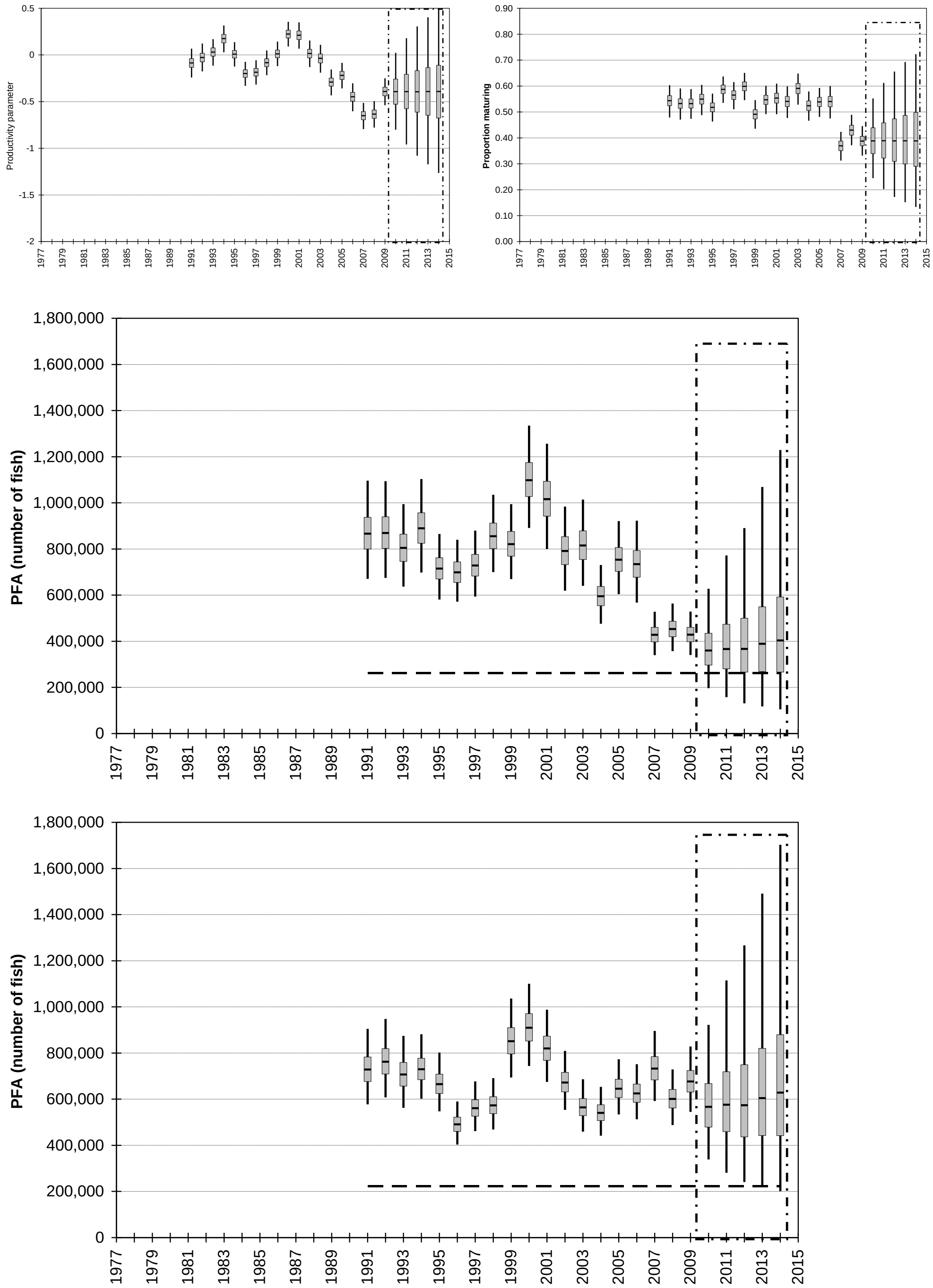


Figure 10.2.1. Estimated and forecast productivity parameters (upper left panel), proportion maturing (upper right panel), and PFA for the maturing (middle panel) and non-maturing (lower panel) stock complexes in the Northern NEAC area. The model forecast years are enclosed within the dashed boxed areas. Upper and lower bounds represent the 2.5 and 97.5 Bayesian Credibility Interval (BCI.) ranges and the boxes the 25th and 75th BCI. The horizontal dash in each rectangle is the median. The dashed horizontal line is the SER value.

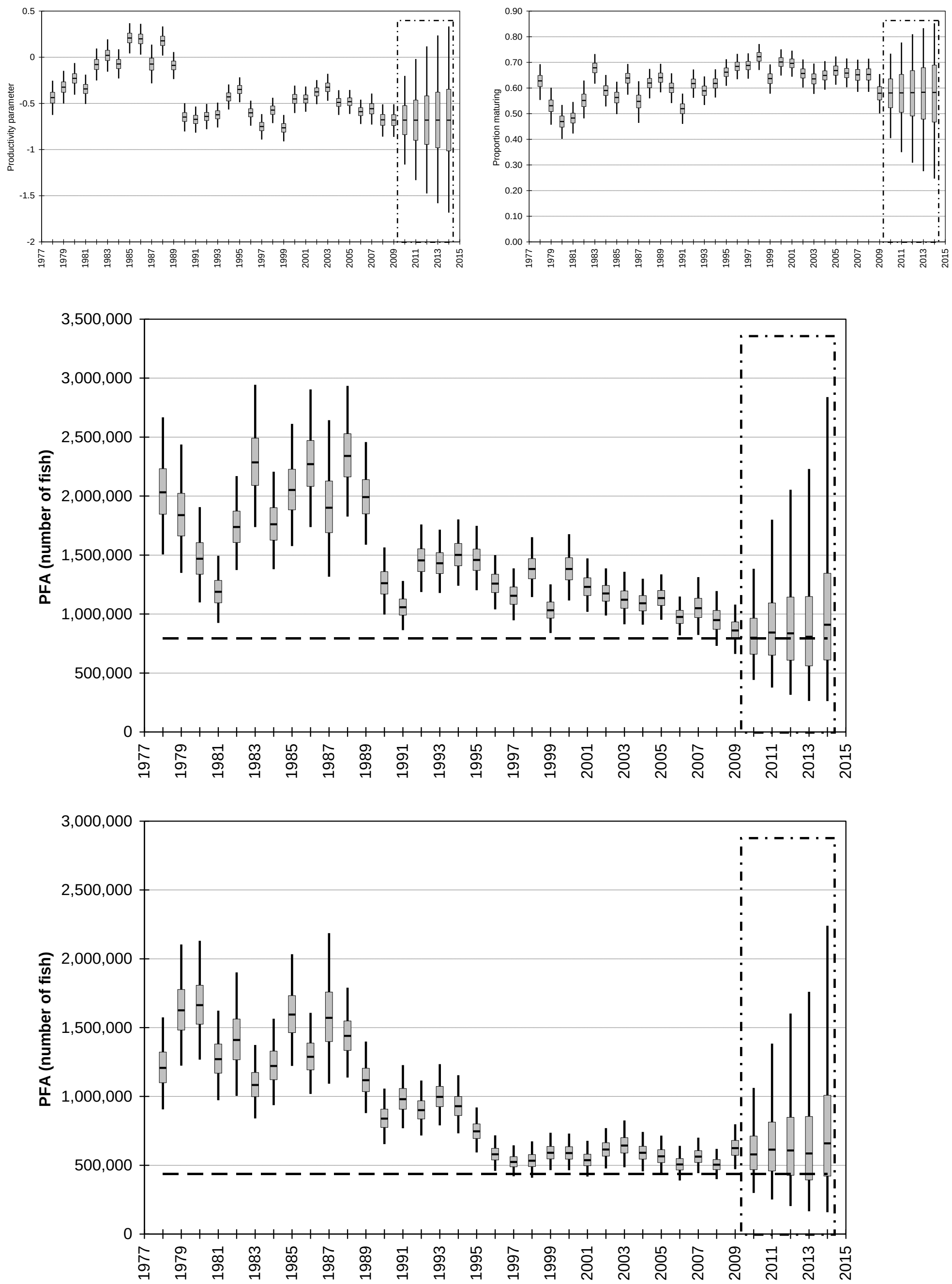


Figure 10.2.2. Estimated and forecast productivity parameters (upper left panel), proportion maturing (upper right panel), and PFA for the maturing (middle panel) and non-maturing (lower panel) stock complexes in the Southern NEAC area. The model forecast years are enclosed within the dashed boxed areas. Box plots are interpreted as in Figure 10.2.1. The dashed horizontal line is the SER value.

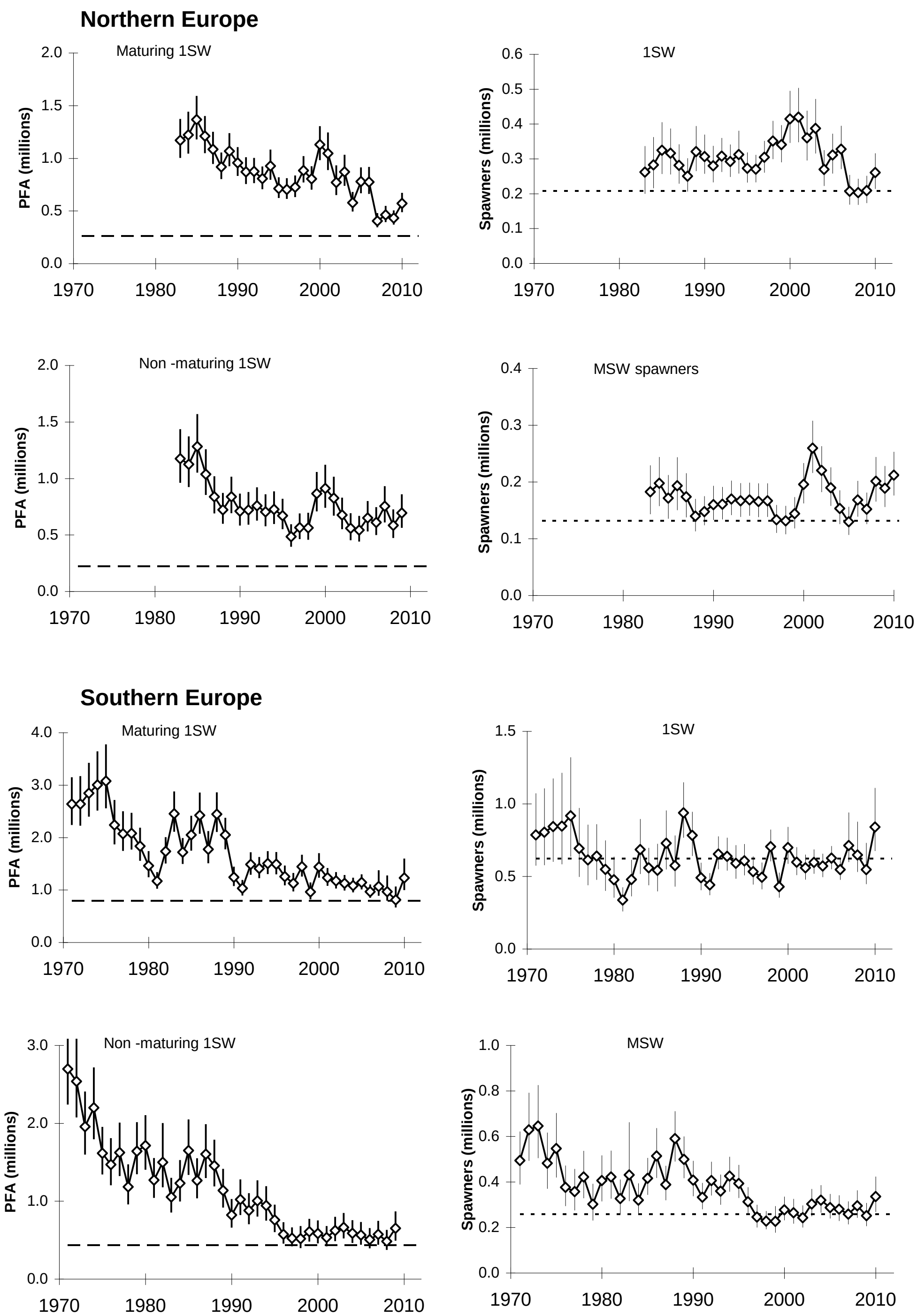
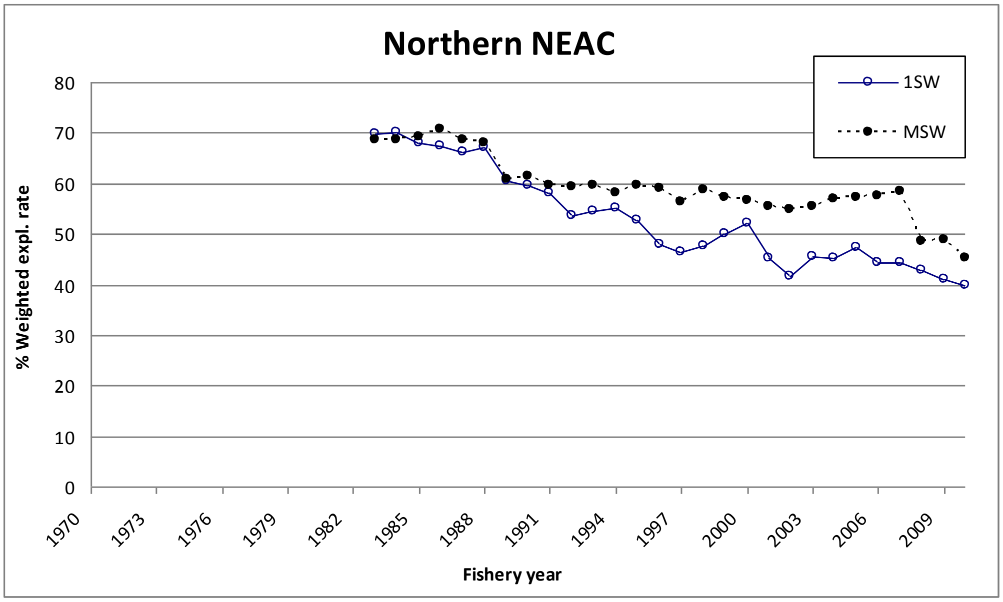


Figure 10.2.3. Estimated PFA (recruits) (left panels) and spawning escapement (right panels), with 95% confidence limits, for maturing 1SW and non-maturing 1SW salmon in Northern and Southern Europe (NEAC). The horizontal line is the spawner escapement reserve (SER, left panels) or the Conservation Limit (right panels) for the age and stock complex.



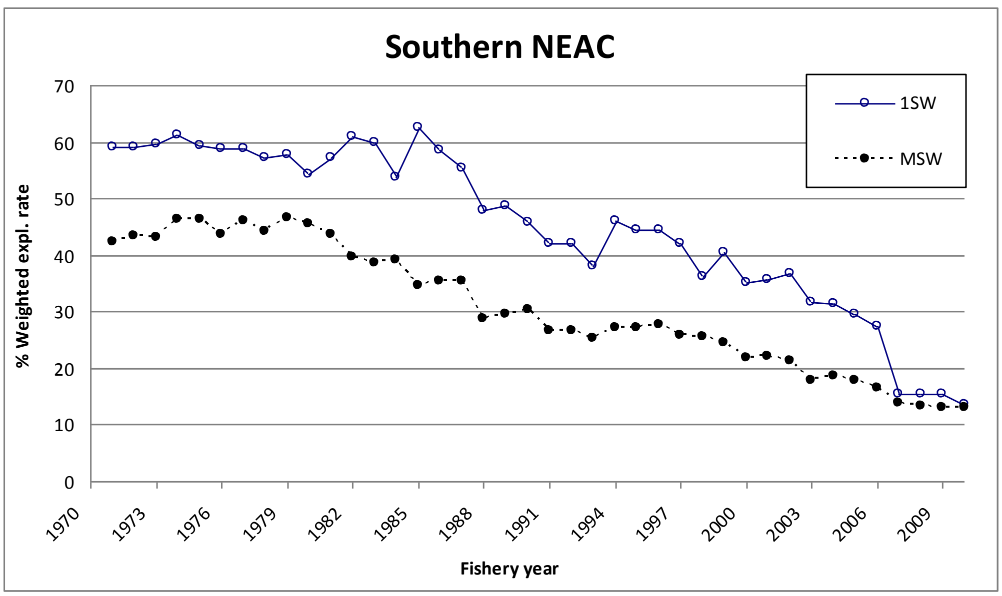


Figure 10.2.4. Exploitation rates of wild 1SW and MSW salmon by commercial and recreational fisheries in the Northern NEAC and the Southern NEAC areas from 1971 to 2010.

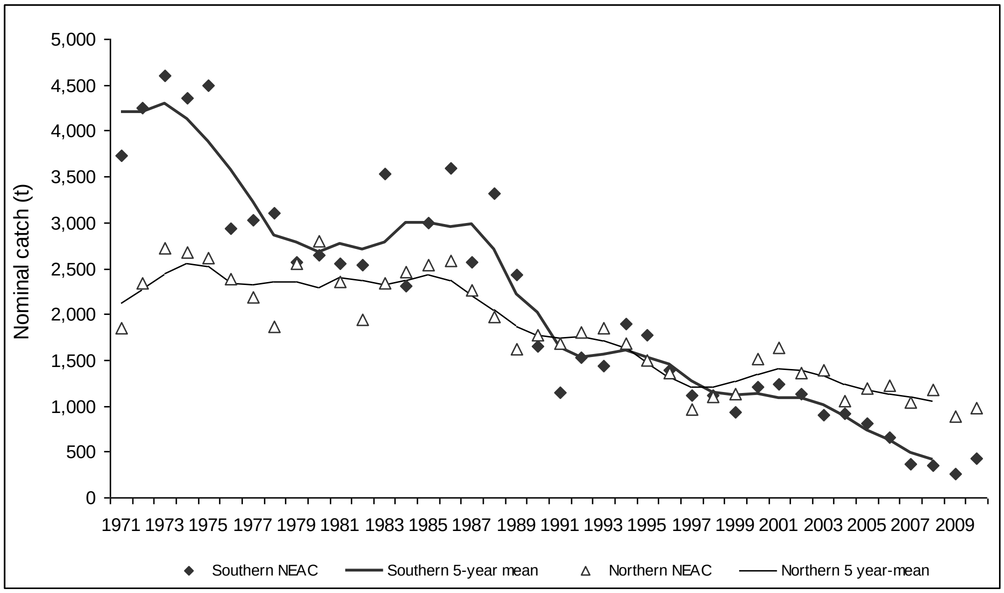


Figure 10.2.5. Nominal catch of salmon and 5-year running means in the Southern NEAC and Northern NEAC areas, 1971 to 2010.

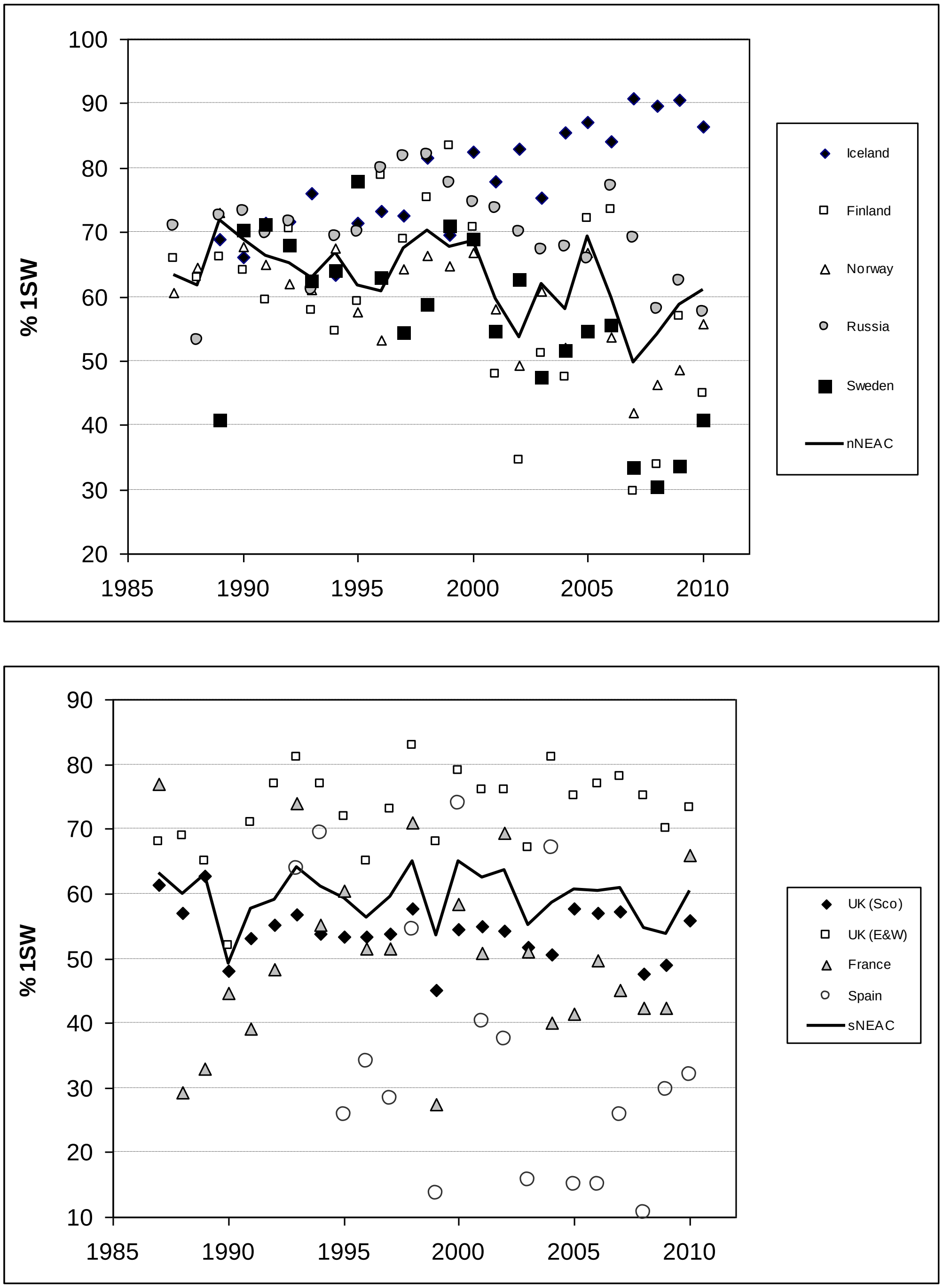


Figure 10.2.6. Percentage of 1SW salmon in the reported catch for Northern NEAC countries (upper panel) and Southern NEAC countries (lower panel), 1987 to 2010. The solid line denotes the mean value from catches in all countries within the complex.

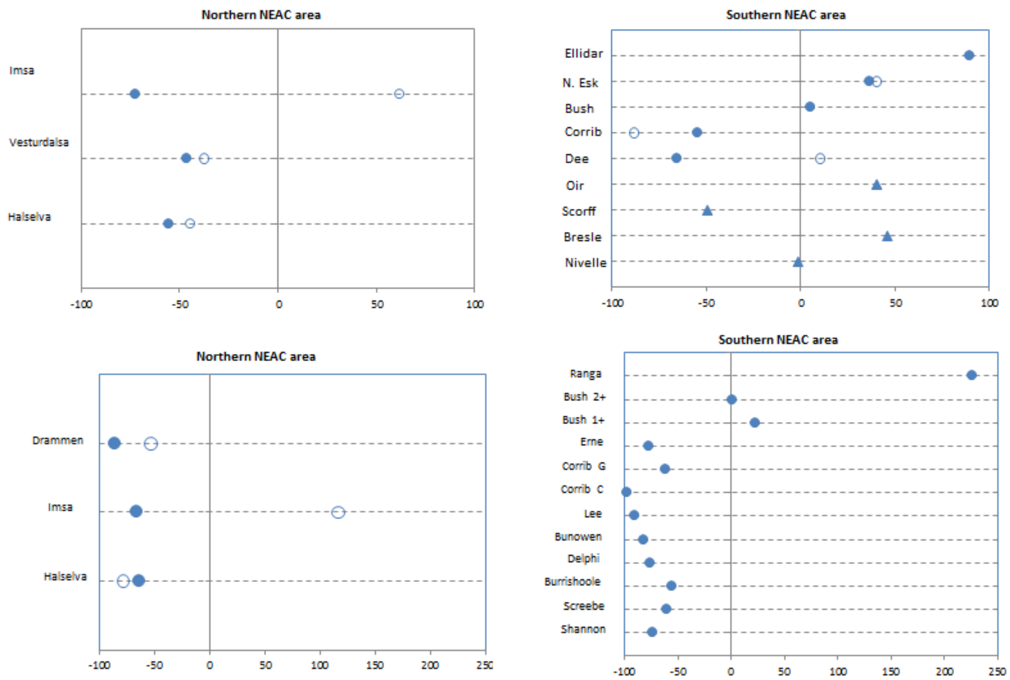


Figure 10.2.7. Comparison of the percent change in the five-year mean return rates for 1SW and 2SW salmon by wild (top) and hatchery (lower) salmon smolts to rivers of Northern and Southern NEAC areas for the 2000 to 2004 and 2005 to 2009 smolt years (1999 to 2003 and 2004 to 2008 for 2SW salmon). Filled circles are for 1SW and open circles are for 2SW data series. Triangles indicate all ages without separation into 1SW and 2SW salmon. Populations with at least 3 data points in each of the two time periods are included in the analysis. The scale of change in some rivers is influenced by low return numbers, where a few fish more or less returning may have a significant impact on the percent change.

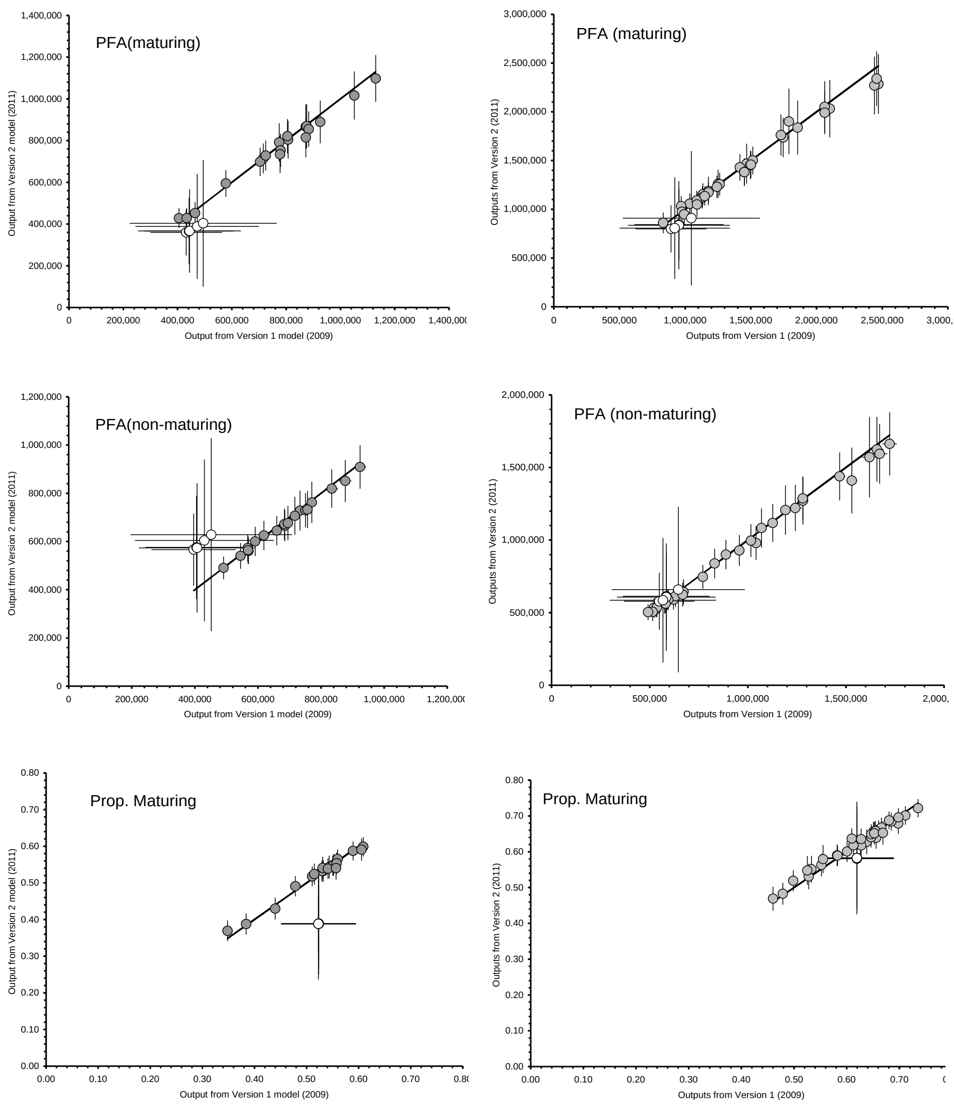


Figure 10.2.8. Comparison of outputs of revised Bayesian PFA model (y-axis) and the previous model (x-axis) for northern (left) and southern (right) NEAC stock complexes. (PFA maturing, top; PFA non-maturing, middle; proportion PFA maturing, bottom). Median and one standard deviation are shown. Grey symbols are inferences from the models, white symbols are forecasts.

Table 10.2.1. Probability (p) that the forecast PFA for Southern NEAC and Northern NEAC stock complexes will meet or exceed the spawner escapement reserve (SER) by age group in 2010 to 2014.

Probability that PFAs will be greater than or equal to the complex and age specific SERs			
Southern NEAC		Maturing	Non-maturing
	SER	793 900	437 525
Year		p	p
2010		0.508	0.810
2011		0.562	0.782
2012		0.543	0.734
2013		0.512	0.688
2014		0.589	0.732
Northern NEAC		Maturing	Non-maturing
	SER	261 359	222 225
Year		p	p
2010		0.862	0.999
2011		0.800	0.994
2012		0.761	0.982
2013		0.765	0.974
2014		0.760	0.965

Table 10.2.2. Nominal catch of salmon in NEAC Area (in tonnes round fresh weight), 1960 to 2010 (2010 figures are provisional).

Year	Southern countries	Northern countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches	
						NEAC Area (3)	International waters (2)
1960	2,641	2,899	-	-	5,540	-	-
1961	2,276	2,477	-	-	4,753	-	-
1962	3,894	2,815	-	-	6,709	-	-
1963	3,842	2,434	-	-	6,276	-	-
1964	4,242	2,908	-	-	7,150	-	-
1965	3,693	2,763	-	-	6,456	-	-
1966	3,549	2,503	-	-	6,052	-	-
1967	4,492	3,034	-	-	7,526	-	-
1968	3,623	2,523	5	403	6,554	-	-
1969	4,383	1,898	7	893	7,181	-	-
1970	4,048	1,834	12	922	6,816	-	-
1971	3,736	1,846	-	471	6,053	-	-
1972	4,257	2,340	9	486	7,092	-	-
1973	4,604	2,727	28	533	7,892	-	-
1974	4,352	2,675	20	373	7,420	-	-
1975	4,500	2,616	28	475	7,619	-	-
1976	2,931	2,383	40	289	5,643	-	-
1977	3,025	2,184	40	192	5,441	-	-
1978	3,102	1,864	37	138	5,141	-	-
1979	2,572	2,549	119	193	5,433	-	-
1980	2,640	2,794	536	277	6,247	-	-
1981	2,557	2,352	1,025	313	6,247	-	-
1982	2,533	1,938	606	437	5,514	-	-
1983	3,532	2,341	678	466	7,017	-	-
1984	2,308	2,461	628	101	5,498	-	-
1985	3,002	2,531	566	-	6,099	-	-
1986	3,595	2,588	530	-	6,713	-	-
1987	2,564	2,266	576	-	5,406	2,554	-
1988	3,315	1,969	243	-	5,527	3,087	-
1989	2,433	1,627	364	-	4,424	2,103	-
1990	1,645	1,775	315	-	3,735	1,779	180-350
1991	1,145	1,677	95	-	2,917	1,555	25-100
1992	1,523	1,806	23	-	3,352	1,825	25-100
1993	1,443	1,853	23	-	3,319	1,471	25-100
1994	1,896	1,684	6	-	3,586	1,157	25-100
1995	1,775	1,503	5	-	3,283	942	-
1996	1,392	1,358	-	-	2,750	947	-
1997	1,112	962	-	-	2,074	732	-
1998	1,120	1,099	6	`	2,225	1,108	-
1999	934	1,139	0	-	2,073	887	-
2000	1,210	1,518	8	-	2,736	1,135	-
2001	1,242	1,634	0	-	2,876	1,089	-
2002	1,135	1,360	0	-	2,495	946	-
2003	908	1,394	0	-	2,302	719	-
2004	919	1,058	0	-	1,977	575	-
2005	810	1,189	0	-	1,999	605	-
2006	651	1,217	0	-	1,868	604	-
2007	372	1,036	0	-	1,407	465	-
2008	354	1,179	0	-	1,533	433	-
2009	264	893	0	-	1,158	317	-
2010	427	973	0	-	1,401	357	-
Means							
2005-2010	490	1103	0	-	1593	485	-
2000-2009	786	1248	1	-	2035	689	-

1. Since 1991, fishing carried out at the Faroes has only been for research purposes.
2. Estimates refer to season ending in given year.
3. No unreported catch estimate available for Russia since 2008.

Table 10.2.3. Estimated pre-fishery abundance (median values) of maturing 1SW salmon (potential 1SW returns) by NEAC country or region and year.

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N&E	Norway	Russia	Sweden	Total 2.5%	Total median	Total 97.5%	France	Iceland S&W	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total 2.5%	Total median	Total 97.5%	Total 2.5%	Total median	Total 97.5%
1971	33,568	11,990		199,595	22,699				63,833	79,633	1,344,339	127,406	231,501	777,447	2,240,138	**2,639,297**	3,148,796			
1972	52,207	10,960		151,360	18,109				127,173	64,444	1,433,859	110,606	202,472	680,614	2,224,101	**2,639,313**	3,169,791			
1973	47,523	13,171		223,076	22,366				78,114	69,303	1,558,964	128,794	177,052	814,766	2,399,179	**2,845,967**	3,423,107			
1974	93,523	13,106		221,434	31,784				36,458	49,276	1,776,290	158,909	193,498	774,199	2,513,192	**3,001,129**	3,643,616			
1975	65,334	15,985		340,405	34,273				72,551	76,465	1,959,189	161,101	158,846	631,892	2,555,423	**3,076,889**	3,775,086			
1976	44,746	16,071		237,283	19,355				66,452	60,377	1,332,796	107,769	110,492	547,187	1,869,738	**2,236,679**	2,715,715			
1977	23,031	22,362		151,204	9,224				51,198	61,911	1,152,663	120,357	108,754	566,364	1,745,416	**2,071,851**	2,499,186			
1978	31,278	22,709		152,607	10,451				52,547	81,073	1,010,460	135,365	141,544	648,862	1,768,030	**2,079,506**	2,470,075			
1979	36,623	21,707		212,003	11,138				60,158	74,726	926,499	127,773	99,572	534,709	1,555,787	**1,835,530**	2,188,289			
1980	17,112	3,293		151,635	14,587				125,412	33,947	704,939	119,530	126,453	334,652	1,240,976	**1,462,635**	1,740,335			
1981	26,471	16,923		127,019	26,262				100,473	43,786	373,259	125,422	99,747	413,511	1,020,920	**1,168,286**	1,339,711			
1982	8,614	7,814		111,513	23,120				62,344	45,035	769,902	106,911	143,759	594,458	1,503,108	**1,734,105**	2,006,309			
1983	37,710	11,508	897,350	184,644	30,503	1,002,679	**1,170,966**	1,373,397	66,858	56,860	1,356,966	153,394	201,378	604,539	2,107,459	**2,453,350**	2,878,939			
1984	41,230	4,187	931,549	197,034	41,645	1,043,917	**1,222,316**	1,440,943	108,123	35,022	712,159	132,480	79,273	637,642	1,493,652	**1,720,485**	1,990,353	2,609,960	**2,946,155**	3,332,671
1985	61,803	28,882	947,216	270,247	49,202	1,178,743	**1,366,475**	1,591,819	40,418	56,698	1,179,505	132,188	102,399	527,582	1,750,738	**2,049,822**	2,414,921	3,011,983	**3,421,135**	3,893,889
1986	56,405	35,873	826,380	231,029	52,042	1,048,172	**1,210,224**	1,400,892	62,481	93,115	1,320,942	150,570	115,147	655,263	2,070,988	**2,422,680**	2,858,495	3,198,159	**3,639,142**	4,152,583
1987	71,795	21,157	694,835	246,463	42,202	945,389	**1,085,202**	1,251,353	109,849	57,931	850,497	156,498	63,111	506,309	1,506,505	**1,775,495**	2,122,440	2,515,957	**2,865,877**	3,287,225
1988	34,697	30,622	638,336	170,029	35,486	801,734	**916,682**	1,055,232	38,205	104,095	1,154,609	213,200	147,956	768,014	2,104,454	**2,444,158**	2,862,351	2,961,192	**3,363,662**	3,842,438
1989	79,945	16,482	701,514	251,252	11,566	923,930	**1,067,271**	1,239,437	20,803	58,155	828,190	140,437	142,187	842,276	1,772,795	**2,047,503**	2,374,446	2,762,468	**3,118,260**	3,526,013
1990	75,892	12,346	627,849	208,711	25,170	831,198	**955,201**	1,106,571	34,658	53,478	518,651	101,523	117,614	401,893	1,074,899	**1,240,666**	1,442,422	1,954,930	**2,199,225**	2,484,217
1991	92,012	17,935	547,492	177,729	30,235	755,972	**871,076**	1,008,831	25,001	59,032	370,073	98,508	65,695	400,367	895,499	**1,029,655**	1,189,741	1,693,578	**1,902,914**	2,142,179
1992	121,726	33,749	460,576	218,958	33,027	763,768	**874,122**	1,002,346	45,375	67,535	536,231	101,365	132,835	584,913	1,290,615	**1,485,983**	1,718,803	2,101,737	**2,363,095**	2,659,812
1993	85,543	27,792	462,449	188,065	35,254	705,228	**805,436**	921,363	65,058	66,248	436,571	139,509	155,532	523,080	1,226,165	**1,407,357**	1,628,164	1,972,757	**2,214,882**	2,496,026
1994	34,119	8,870	625,549	222,573	26,928	796,783	**926,532**	1,081,371	51,223	54,519	559,089	154,197	106,732	557,687	1,303,725	**1,502,456**	1,740,259	2,154,406	**2,431,805**	2,747,084
1995	33,479	25,538	408,487	199,867	39,171	622,585	**713,118**	819,560	17,036	73,828	623,820	118,382	99,147	547,368	1,296,024	**1,489,803**	1,724,228	1,958,406	**2,205,316**	2,491,976
1996	77,626	13,620	311,743	272,063	24,199	614,488	**704,009**	810,194	21,145	63,760	580,743	85,590	102,519	394,508	1,086,097	**1,256,659**	1,462,976	1,740,243	**1,963,454**	2,222,804
1997	66,324	18,642	359,308	267,501	11,031	631,191	**725,802**	836,868	10,817	46,581	580,993	77,620	121,569	283,425	969,215	**1,127,563**	1,323,574	1,640,332	**1,855,490**	2,105,311
1998	76,291	31,754	468,759	293,381	9,720	769,087	**884,079**	1,021,287	20,979	63,770	608,340	87,466	264,468	386,403	1,254,846	**1,443,778**	1,670,346	2,070,961	**2,330,473**	2,628,994
1999	109,507	16,148	434,962	225,837	14,317	702,384	**804,265**	923,766	7,008	51,821	565,825	71,161	68,943	190,817	819,639	**962,348**	1,142,440	1,562,956	**1,769,578**	2,011,153
2000	115,172	16,962	716,685	247,696	28,494	980,839	**1,130,186**	1,305,769	18,242	46,039	787,822	106,987	100,049	371,755	1,233,565	**1,440,355**	1,700,029	2,276,086	**2,575,079**	2,923,944
2001	52,066	15,425	618,530	334,925	18,631	888,614	**1,046,625**	1,244,453	15,797	41,239	627,614	96,027	79,131	364,957	1,078,911	**1,234,783**	1,416,534	2,023,240	**2,285,301**	2,589,323
2002	36,558	26,687	378,126	304,119	18,989	650,427	**770,858**	932,532	22,202	51,390	548,221	88,992	156,725	293,848	1,028,958	**1,172,181**	1,340,861	1,722,969	**1,946,422**	2,209,233
2003	43,064	14,154	524,914	269,744	11,564	738,186	**869,709**	1,032,727	14,588	61,401	536,393	63,881	102,406	335,434	986,794	**1,124,848**	1,286,680	1,772,199	**1,997,307**	2,256,811
2004	16,698	38,266	318,010	189,594	9,988	493,684	**576,612**	680,897	17,612	61,653	395,489	107,016	91,392	398,459	952,048	**1,082,342**	1,233,828	1,479,635	**1,660,943**	1,867,852
2005	42,469	34,053	471,657	216,182	8,502	667,376	**777,963**	913,852	11,472	90,826	393,908	87,982	116,307	432,710	1,009,475	**1,143,276**	1,297,047	1,716,958	**1,923,461**	2,158,454
2006	80,628	35,875	381,436	261,357	10,371	661,923	**774,766**	917,218	16,167	64,197	301,595	82,532	74,097	418,997	849,530	**968,800**	1,105,458	1,551,104	**1,745,817**	1,968,679
2007	14,977	26,605	213,532	140,615	4,926	344,220	**403,646**	478,653	12,602	73,443	344,066	79,166	120,452	411,375	889,437	**1,063,690**	1,373,950	1,265,449	**1,473,697**	1,799,822
2008	15,429	24,293	267,519	146,470	6,354	394,393	**462,835**	547,829	12,507	88,972	339,032	75,813	71,763	354,498	794,722	**967,620**	1,277,818	1,226,338	**1,437,466**	1,766,794
2009	31,489	39,270	214,284	137,802	6,747	370,302	**431,399**	504,804	4,467	100,745	283,065	48,025	54,670	302,944	666,561	**813,528**	1,064,376	1,069,031	**1,249,930**	1,521,078
2010	29,356	32,155	317,456	178,614	11,222	487,079	**570,981**	670,867	15,232	92,655	365,327	86,359	50,325	583,483	996,637	**1,229,576**	1,596,214	1,530,372	**1,805,369**	2,197,053
10yr Av.	36,274	28,678	370,547	217,942	10,729	569,620	**668,539**	792,383	14,265	72,652	413,471	81,579	91,727	389,671	925,307	**1,080,064**	1,299,277	1,535,729	**1,752,571**	2,033,510

Table 10.2.4. Estimated pre-fishery abundance (median values) of non-maturing 1SW salmon (potential MSW returns) by NEAC country or region and year.

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland N&E	Norway	Russia	Sweden	Total 2.5%	Total median	Total 97.5%	France	Iceland S&W	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total 2.5%	Total median	Total 97.5%	Total 2.5%	Total median	Total 97.5%
1971	63,447	26,037		270,747	7,389				56,394	63,499	401,682	394,450	31,956	1,737,264	2,238,000	**2,697,076**	3,278,712			
1972	75,289	24,377		430,928	10,289				36,185	57,263	392,656	292,373	27,945	1,720,197	2,074,687	**2,537,468**	3,129,722			
1973	111,305	22,953		398,134	7,024				20,431	49,367	407,073	212,105	30,530	1,223,221	1,597,801	**1,955,357**	2,408,376			
1974	124,416	25,382		432,411	5,851				31,557	52,473	455,991	272,140	25,087	1,347,815	1,792,981	**2,197,213**	2,717,409			
1975	102,073	20,942		368,072	6,076				27,989	45,390	344,259	182,660	17,431	989,912	1,343,482	**1,614,414**	1,951,649			
1976	62,266	28,703		254,136	4,228				19,426	44,013	280,445	180,878	17,170	920,180	1,202,108	**1,470,711**	1,808,046			
1977	39,993	36,873		217,594	3,462				20,145	56,812	250,528	158,909	22,386	1,104,584	1,321,546	**1,621,549**	2,007,060			
1978	42,514	24,532		201,287	6,357				18,623	36,579	214,993	84,500	15,697	804,645	956,389	**1,183,229**	1,473,940			
1979	44,613	34,566		351,769	13,067				35,824	51,805	256,921	223,718	19,874	1,043,026	1,345,801	**1,641,382**	2,014,102			
1980	49,010	13,261		255,209	12,978				26,310	35,413	210,785	294,099	15,568	1,120,329	1,402,163	**1,713,882**	2,104,575			
1981	63,906	14,837		228,299	16,367				17,792	25,267	140,994	136,191	22,516	921,661	1,041,062	**1,268,735**	1,554,930			
1982	69,411	11,350		280,314	12,209				17,515	41,082	297,856	139,504	31,592	931,262	1,177,728	**1,499,560**	2,001,072			
1983	65,888	13,949	819,634	258,462	11,019	961,670	**1,173,892**	1,435,324	23,380	34,605	150,913	102,392	12,430	725,766	854,352	**1,052,587**	1,300,186	1,852,501	**2,227,111**	2,681,342
1984	51,404	9,281	770,430	282,836	8,025	923,376	**1,123,813**	1,371,091	17,633	25,327	161,658	140,662	16,106	864,131	994,111	**1,228,681**	1,527,864	1,954,062	**2,356,010**	2,842,832
1985	45,047	24,182	916,753	284,288	8,843	1,050,147	**1,282,834**	1,570,128	21,661	21,389	201,943	203,971	18,110	1,175,117	1,337,677	**1,647,698**	2,047,058	2,437,365	**2,934,412**	3,543,522
1986	56,333	24,963	714,321	221,398	13,277	853,195	**1,036,102**	1,257,318	13,481	19,050	235,533	167,032	9,260	814,668	1,035,809	**1,263,337**	1,550,632	1,922,113	**2,301,197**	2,758,477
1987	36,090	16,038	568,426	202,550	10,423	689,488	**837,972**	1,019,179	28,258	21,263	172,835	201,843	26,060	1,145,106	1,295,518	**1,602,263**	1,987,717	2,018,206	**2,441,807**	2,962,013
1988	40,867	13,819	440,349	205,194	23,914	598,043	**721,085**	872,122	16,529	19,166	169,757	172,491	20,765	1,051,805	1,188,221	**1,454,780**	1,788,531	1,810,915	**2,177,409**	2,622,184
1989	51,140	14,462	505,427	253,321	16,639	691,075	**836,565**	1,014,942	12,973	18,940	81,865	184,474	18,887	813,673	916,305	**1,136,047**	1,413,802	1,635,174	**1,974,891**	2,385,648
1990	61,425	9,875	396,712	229,510	16,011	582,571	**709,642**	866,146	11,070	18,520	102,130	79,885	9,705	595,943	659,527	**820,521**	1,026,010	1,265,907	**1,530,647**	1,854,763
1991	65,555	14,505	413,816	210,460	19,298	590,169	**719,506**	879,265	14,949	20,778	85,460	68,204	22,226	808,269	821,547	**1,020,837**	1,278,176	1,437,625	**1,741,908**	2,117,635
1992	76,037	16,357	396,204	248,301	26,006	625,138	**757,768**	920,378	7,380	10,227	79,476	68,962	52,437	654,345	703,756	**879,165**	1,101,549	1,353,048	**1,638,351**	1,984,324
1993	63,065	13,879	388,222	223,091	19,190	577,165	**703,688**	859,160	12,833	16,510	114,750	86,115	18,418	752,150	800,967	**1,005,218**	1,267,692	1,404,924	**1,711,432**	2,087,870
1994	39,082	9,694	417,203	253,350	13,743	596,514	**726,396**	885,257	6,155	18,605	111,235	87,133	15,597	697,970	747,970	**941,856**	1,190,880	1,370,766	**1,669,531**	2,037,655
1995	34,537	12,680	417,311	192,771	17,330	549,841	**670,675**	818,606	11,272	12,022	77,207	89,265	17,105	545,225	602,478	**756,800**	953,711	1,175,699	**1,429,094**	1,737,052
1996	50,170	7,086	266,762	151,783	10,805	395,754	**483,867**	593,710	5,953	13,406	96,491	56,493	21,361	372,426	453,397	**573,887**	728,343	868,925	**1,058,516**	1,295,364
1997	42,196	10,325	320,487	187,736	7,969	461,929	**563,737**	689,457	4,891	8,297	55,640	34,983	29,366	389,174	418,783	**524,666**	661,513	899,161	**1,089,284**	1,322,934
1998	39,468	11,855	341,166	166,102	6,786	456,922	**562,598**	695,406	10,260	16,181	85,640	78,027	13,311	297,953	396,163	**517,113**	680,050	877,246	**1,082,289**	1,337,155
1999	87,916	6,949	473,482	289,171	14,913	707,283	**865,633**	1,056,320	7,160	4,406	107,059	82,735	17,774	380,048	480,581	**607,701**	772,504	1,214,699	**1,474,241**	1,789,584
2000	126,433	7,967	556,908	204,234	17,920	740,548	**910,342**	1,119,821	8,439	7,711	95,995	87,069	13,060	363,648	458,399	**584,594**	751,166	1,229,196	**1,497,470**	1,824,682
2001	101,296	7,538	483,326	222,969	13,143	670,161	**824,885**	1,015,620	6,319	8,360	110,681	81,070	15,512	299,839	419,029	**531,821**	678,757	1,114,241	**1,358,440**	1,655,711
2002	71,877	7,921	427,028	155,807	14,985	550,711	**676,114**	830,048	9,013	13,349	116,198	93,541	10,145	369,366	485,399	**622,286**	799,444	1,062,093	**1,300,022**	1,592,159
2003	34,476	7,793	387,090	120,194	10,859	452,206	**558,426**	691,341	16,729	10,791	64,038	75,908	9,073	478,161	519,681	**663,030**	848,011	997,063	**1,223,113**	1,502,530
2004	26,655	9,657	356,320	144,014	8,239	441,256	**541,469**	667,795	10,296	9,527	82,737	88,501	11,514	377,096	463,246	**588,150**	753,760	926,420	**1,131,615**	1,389,071
2005	46,693	9,264	451,774	137,669	8,235	530,529	**649,881**	799,222	10,336	7,908	59,937	75,766	7,345	392,072	439,575	**565,187**	730,821	996,516	**1,216,600**	1,491,198
2006	66,447	8,910	384,673	142,612	11,380	499,332	**610,195**	745,369	9,856	4,867	27,374	69,734	10,089	377,021	392,415	**505,593**	654,948	914,377	**1,117,142**	1,365,634
2007	63,200	11,472	443,385	225,283	16,225	609,498	**752,882**	932,070	10,825	5,573	40,666	77,539	6,115	422,474	441,004	**573,062**	747,179	1,081,739	**1,327,677**	1,633,110
2008	29,441	9,235	346,929	190,698	14,691	473,237	**584,885**	725,085	5,680	8,339	45,512	56,693	7,982	352,762	373,212	**484,500**	631,205	871,942	**1,070,784**	1,319,194
2009	46,597	14,616	382,467	243,537	18,074	562,345	**694,437**	859,538	4,775	10,715	31,084	99,018	7,335	486,579	492,763	**651,522**	867,649	1,087,326	**1,349,104**	1,676,653
10yr Av.	61,311	9,437	421,990	178,702	13,375	552,982	**680,351**	838,591	9,227	8,714	67,422	80,484	9,817	391,902	448,472	**576,975**	746,294	1,028,091	**1,259,197**	1,544,994

10.2.2 **Advice April 2011**

ECOREGION **North Atlantic**
STOCK **Atlantic Salmon from North America**

Advice for 2011

Because the NASCO Framework of Indicators of North American stocks for 2010 did not indicate the need for a revised analysis of catch options, no new management advice for 2011 is provided. The most recent multi-year advice for the North America Commission was provided by ICES (2009). In that assessment, no catch options for 2009 to 2012 in North America were consistent with the management objectives defined for this stock unit.

Stock status

Estimates of pre-fishery abundance suggest continued low abundance of North American adult salmon (Figure 10.3.1). In 2010, the estimated PFA of 1SW maturing salmon ranks 28th out of the 40-year time-series and the estimated PFA of 1SW non-maturing salmon ranks 37th out of the 39-year time-series. Egg depositions by all sea-ages combined in 2010 exceeded or equalled the river-specific CLs in 31 of the 71 assessed rivers (44%) and were less than 50% of CLs in 19 other rivers (37%) (Figure 10.3.2). In 2010, 2SW spawner estimates for the six geographic areas indicated that all areas were below their conservation limit and are suffering reduced reproductive capacity (Figures 10.3.3, 10.3.4). Particularly large deficits are noted in the Bay of Fundy, Atlantic coast, and USA. Despite major changes in fisheries management 18 to 25 years ago and increasingly more restrictive fisheries measures since, returns in these regions have remained near historical lows and many populations are currently threatened with extirpation. The continued low abundance of salmon stocks across North America, despite significant fishery reductions, further strengthens the conclusions that factors other than fisheries are constraining production.

Management plans

The North Atlantic Salmon Conservation Organization (NASCO) has adopted an Action Plan for Application of the Precautionary Approach which stipulates that management measures should be aimed at maintaining all stocks above their conservation limits by the use of management targets. NASCO has adopted the region-specific CLs as limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability. Within the agreed management plan, a risk level of 75% has been agreed for the provision of catch advice on 2SW salmon exploited at West Greenland (as non-maturing 1SW fish) and in North America as non-maturing 1SW and 2SW salmon.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northwest Atlantic they range from the Connecticut River (USA, 41.6°N) northward to 58.8°N (Quebec, Canada). Juveniles emigrate to the ocean at ages one to eight years (dependent on latitude) and generally return after one or two years at sea. Long-distance migrations to ocean feeding grounds are known to take place with adult salmon from both the North American and Northeast Atlantic stocks migrating to West Greenland to feed in their second summer and fall at sea.

Environmental influence on the stock

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

The fisheries

Three groups exploited salmon in Canada; Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. The provisional harvest of salmon by all users was 146 (Table 10.3.1). The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort; the closure of the insular Newfoundland commercial fishery in 1992, the closure of the Labrador commercial fishery in 1998, and the closure of the Québec commercial fishery in 2000 (Figure 10.3.5). All commercial fisheries for Atlantic salmon remained closed in Canada in 2010 and the catch therefore was zero. The total reported harvests for the Aboriginal peoples' food fisheries was 59.3 t, 2.3 t for residents fishing for food in Labrador, and 84 t (about 44 100 small and large salmon) were harvested in the recreational fisheries. In 2010, approximately 58 300 salmon (about 35 600 small and 22 700 large) were caught and released by recreational fishers, representing about 62% of the total number caught (including retained fish). France (Islands of Saint-Pierre and Miquelon) reported a total harvest of 2.8 t in the professional and recreational fisheries in 2010 (Table 10.3.1). There are no commercial or recreational fisheries for Atlantic salmon in USA (Table 10.3.1).

Effects of the fisheries on the ecosystem

The current salmon fishery probably has no or only minor influence on the marine ecosystem. However, the exploitation rate on salmon may affect the riverine ecosystem through changes in species composition. There is limited knowledge concerning the magnitude of these effects.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. Because of absence of catch data from some regions in Canada, the values were estimated based on historical exploitation rates. Estimates of abundance of adult salmon in some areas, in particular Labrador, are based on a small number of counting facilities raised to a large production area.

Scientific basis

Assessments are carried out using common input variables across stock complexes. Run–reconstruction models and Bayesian forecasts are performed taking into account uncertainties in the data.

10.3.1 Supporting information April 2011

ECOREGION North Atlantic
STOCK Atlantic Salmon from North America

Reference points

Conservation limits for 2SW salmon to North America total 152 548 fish.

COUNTRY AND COMISSION AREA	STOCK AREA	2SW SPAWNER REQUIREMENT
	Labrador	34 746
	Newfoundland	4022
	Gulf of St. Lawrence	30 430
	Québec	29 446
	Scotia-Fundy	24 705
Canada Total		123 349
USA		29 199
North American Total		152 548

Outlook for 2011

No outlook is provided relative to the North American stock because the Framework of Indicators of North American stocks for 2010 did not indicate the need for a re-assessment for 2011.

MSY approach

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because there are only a few age groups in the adult spawning stock. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, the ICES MSY approach is aimed at achieving a target escapement (MSY $B_{escapement}$, the 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, similar to the basis for estimating B_{pa} in the precautionary approach. In short-lived stocks, where most of the annual surplus production is from recruitment (not growth), MSY $B_{escapement}$ and B_{pa} might be expected to be similar.

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average maximum sustainable yield (MSY $B_{escapement}$). It should be noted that this is equivalent to the ICES B_{MSY} and B_{pa} as applied to short-lived stocks. Therefore, stocks are regarded by ICES as being at full reproductive capacity only if they are above MSY $B_{escapement}$, or above CLs.

ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on maturing 1SW salmon and non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status.

Management objectives

NASCO has identified the organization's primary management objective:

"To contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice 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 NASCOs 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, 1999) 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".

NASCO has adopted the region-specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

The advice for the fisheries on 2SW salmon in North America is based on achieving management objectives at a risk level of 75% (ICES, 2003). For the North American Commission, the management objective is to simultaneously meet or exceed, at a risk level of 75%, the 2SW CLs in the four northern areas (Labrador, Newfoundland, Quebec, Gulf) and to achieve a 25% increase in regional returns relative to a baseline period for the two southern regions (Scotia-Fundy, USA) (ICES, 2003).

Additional considerations

Fisheries on mixed stocks pose particular difficulties for management, when they cannot target only stocks that are at full reproductive capacity. The management of a fishery should ideally be based on the status of all stocks exploited in the fishery. Conservation would be best achieved if fisheries target stocks that have been shown to be at full reproductive capacity. Fisheries in estuaries and especially rivers are more likely to meet this requirement.

Most catches (95%) in North America now take place in rivers or in estuaries. Fisheries are principally managed on a river-by-river basis and, in areas where retention of large salmon is allowed, it is closely controlled. The commercial fisheries are now closed and the remaining coastal food fisheries in Labrador are mainly located close to river mouths and likely harvest few salmon from other than local rivers. The coastal fishery in St Pierre & Miquelon (SPM) is a mixed-stock fishery which catches salmon from stocks in Canada and USA. There are no salmon-producing rivers in SPM.

Recreational catch statistics for Atlantic salmon are not collected regularly in Canada and there is no mechanism in place that requires anglers to report their catch statistics, except in Québec. The reliability of recreational catch statistics could be improved in all areas of Canada.

It would be desirable to resolve the outstanding issues regarding stock origin of the salmon caught in the estuarine and coastal fisheries at Labrador and in St Pierre & Miquelon. Genetic analysis techniques offer the opportunity to identify the origin of harvested individuals at varying levels of origin and can provide the information necessary to evaluate the effect that these mixed-stock fisheries have on the contributing populations. Appropriate baselines that represent all populations subjected to the fishery are required to support these analyses.

Exploitation rates of both small and large salmon fluctuated annually but remained relatively steady until 1984 when exploitation of large salmon declined sharply with the introduction of the non-retention of large salmon in angling fisheries and reductions in commercial fisheries (Figure 10.3.6). Exploitation of small salmon declined steeply in North America with the closure of the Newfoundland commercial fishery in 1992. Declines continued in the 1990s with continuing management controls in all fisheries to reduce exploitation. In the last few years, exploitation rates on small salmon and large salmon have remained at the lowest in the time-series, an average of 15% for both small salmon and large salmon over the past ten years. However, exploitation rates across regions within North America are highly variable.

The returns of 2SW fish in 2010 decreased from 2009 in Labrador (65%), Newfoundland (51%), Gulf (14%), Scotia-Fundy (11%), and USA (21%), and increased in Québec (7%). Returns in 2010 of 1SW salmon relative to 2009 increased in all areas with a range of 3% in Labrador and Newfoundland to 251% in Scotia-Fundy. Returns of 1SW salmon (3 to 65%) were also above the previous 5-year mean (2005 to 2009) in all regions except for Labrador (50% decrease).

The rank of the estimated returns in the 1971 to 2010 time-series and the proportions of the 2SW CL achieved in 2010 for six regions in North America are shown below:

	Rank of 2010 returns in 1971 to 2010, (40=lowest)		Rank of 2010 returns in 2001 to 2010 (10=lowest)		Median estimate of 2SW spawners as percentage of Conservation Limit
Region	1SW	2SW	1SW	2SW	(%)
Labrador	15	29	8	10	25
Newfoundland	5	37	3	10	53
Québec	22	31	5	3	77
Gulf	16	34	2	8	61
Scotia-Fundy	28	37	2	7	8
USA	12	33	2	5	5

Scientific basis

Data and methods

The returns for individual river systems and management areas for both sea-age groups were derived from a variety of methods. These methods included counts of salmon at monitoring facilities, population estimates from mark–recapture studies, and applying angling and commercial catch statistics, angling exploitation rates, and measurements of freshwater habitat. The 2SW component of the large returns was determined using the sea-age composition of one or more indicator stocks. Returns of small (1SW), large, and 2SW salmon (a subset of large) to each region were originally estimated by the methods and variables developed by Rago *et al*. (1993) and reported by ICES (1993).

Returns are the number of salmon that returned to the geographic region, including fish caught by homewater commercial fisheries, except in the case of the Newfound-land and Labrador regions where returns do not include landings in commercial and food fisheries. This avoided double counting fish because commercial catches in Newfoundland and Labrador and food fisheries in Labrador were added to the sum of regional returns to create the PFA of North American salmon.

Total returns of salmon to USA rivers are the sum of trap catches and redd-based es-timates.

Uncertainties in assessments and forecasts

To date, 1082 Atlantic salmon rivers have been identified in eastern Canada and 21 rivers in eastern USA, where salmon are or were present within the last half century. Conservation requirements in terms of eggs have been defined for 45% (485) of the 1082 rivers in Canada. For rivers with conservation requirements, over 59% of them have conservation requirements less than 1 million eggs, which translates to roughly 200 to 300 spawners depending on life-history type. Collectively, 91% of the rivers have conservation requirements less than five million eggs. Assessments were reported for 71 of these rivers in 2010.

Recreational catch statistics for Atlantic salmon are not collected regularly in Canada and there is no mechanism in place that requires anglers to report their catch statis-tics, except in Québec. The reliability of recreational catch statistics could be improved in all areas of Canada.

The unreported catch estimate for Canada is incomplete. The reports received from three of the four administrative regions totals 15 t in 2010. A large part of this unre-ported catch is illegal fisheries directed at salmon.

Comparison with previous assessment and catch options

The NASCO Framework of Indicators of North American stocks for 2010 did not indicate the need for a revised analysis of catch options and no new management advice for 2011 is provided. The assessment was updated to 2010 and the stock status was consistent with the previous year’s assessment.

Assessment and management area

The advice for the North America Commission is based on the objectives defined by management in six geographic areas of North America (Figure 10.3.4).

Sources of information

ICES. 1993. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 5–12 March 1993. ICES Document CM 1993/Assess: 10.

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ICES. 2011. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 22–31 March 2011. ICES Document CM 2011/ACOM:06. 283 pp.

NASCO. 1998. North Atlantic Salmon Conservation Organization. Agreement on the adoption of a precautionary approach. Report of the 15th annual meeting of the Council. CNL(98)46. 4 pp.

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Rago, P. J., Reddin, D. G., Porter, T. R., Meerburg, D. J., Friedland, K. D., and Potter, E. C. E. 1993. A continental run reconstruction model for the non-maturing component of North American Atlantic salmon: analysis of fisheries in Greenland and Newfoundland Labrador, 1974–1991. ICES Document CM 1993/M:25.

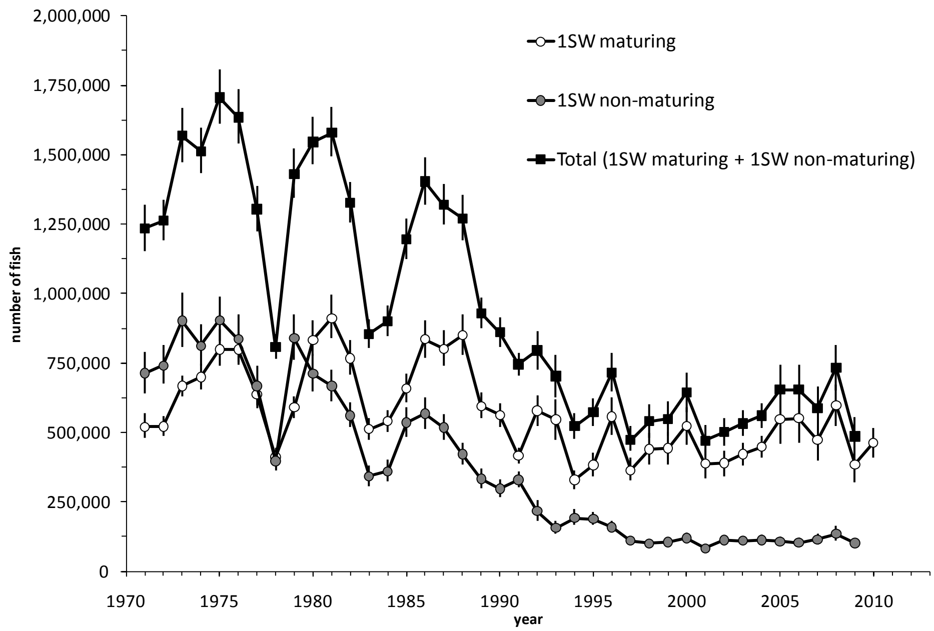

Figure 10.3.1. Estimates of PFA for 1SW maturing, 1SW non-maturing salmon, and the total cohort of 1SW salmon based on the Monte Carlo simulations of the run–reconstruction model for NAC. Median and 95% CI interval ranges derived from Monte Carlo simulations are shown.

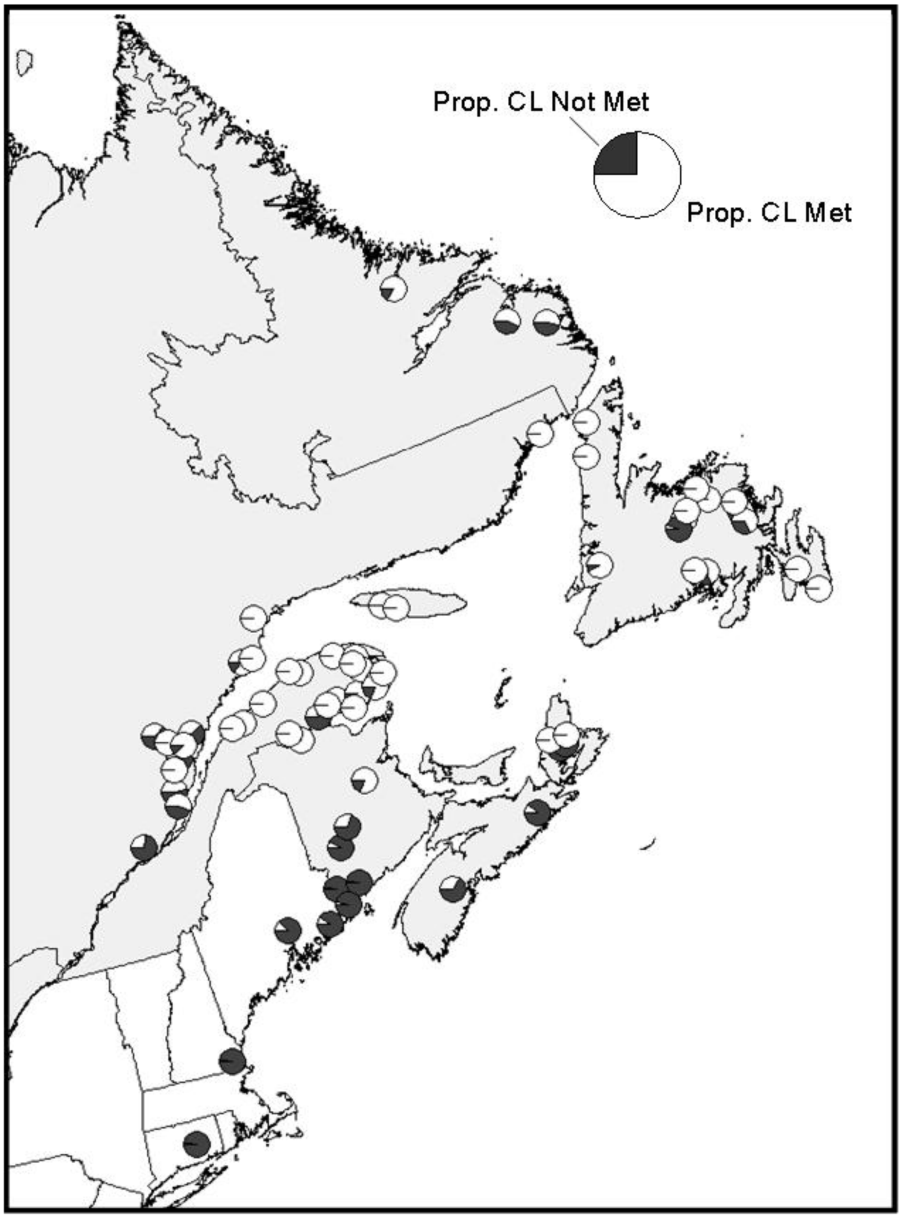

Figure 10.3.2. Proportion of the conservation requirement attained in assessed rivers of the North American Commission area in 2010.

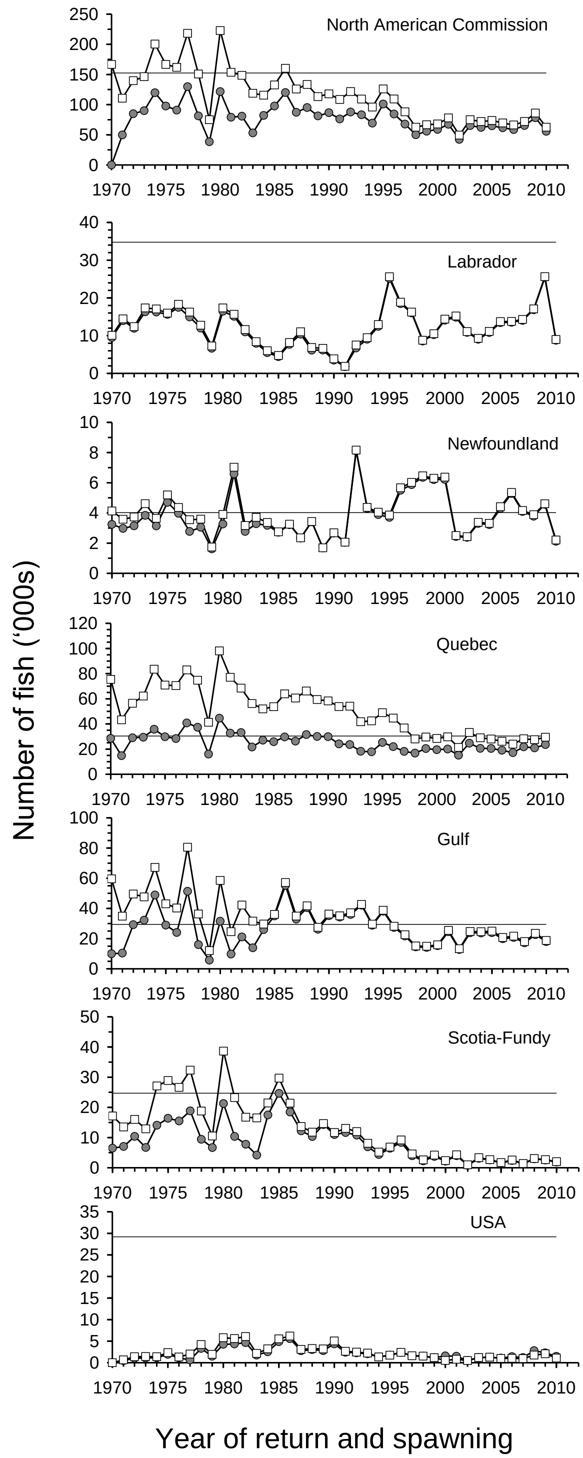

Figure 10.3.3. Comparison of the 2SW conservation limits (horizontal line), estimates (medians) of 2SW returns (squares), and 2SW spawners (circles) in six geographic areas of North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23. For USA, estimated spawners exceed the estimated returns due to adult stocking restoration efforts.

Figure 10.3.4. Regional groupings of Atlantic salmon in the North American Commission.

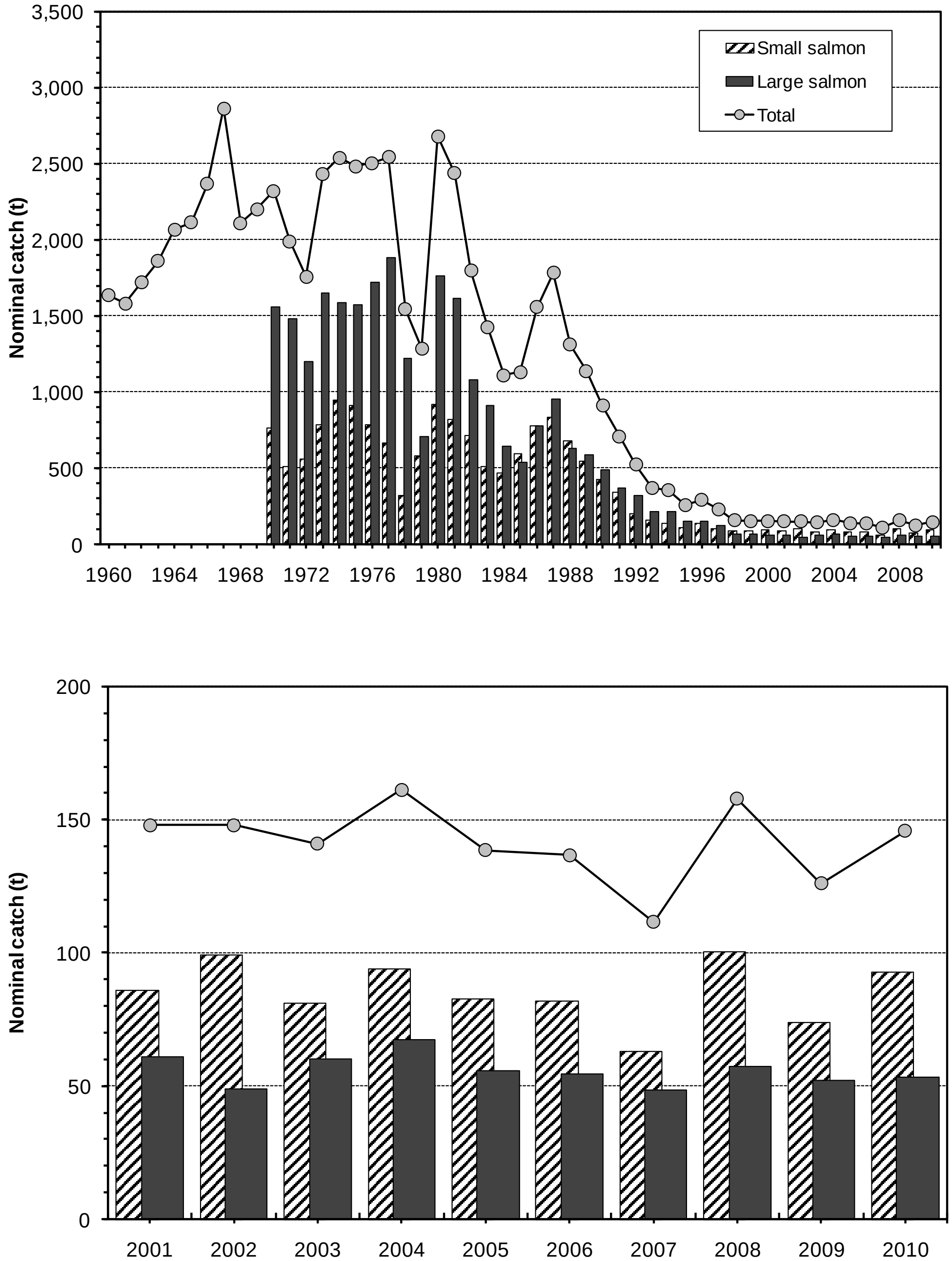

Figure 10.3.5. Harvest (t) of small salmon, large salmon and combined for Canada, 1960 to 2010 (top panel) and 2001 to 2010 (bottom panel) by all users.

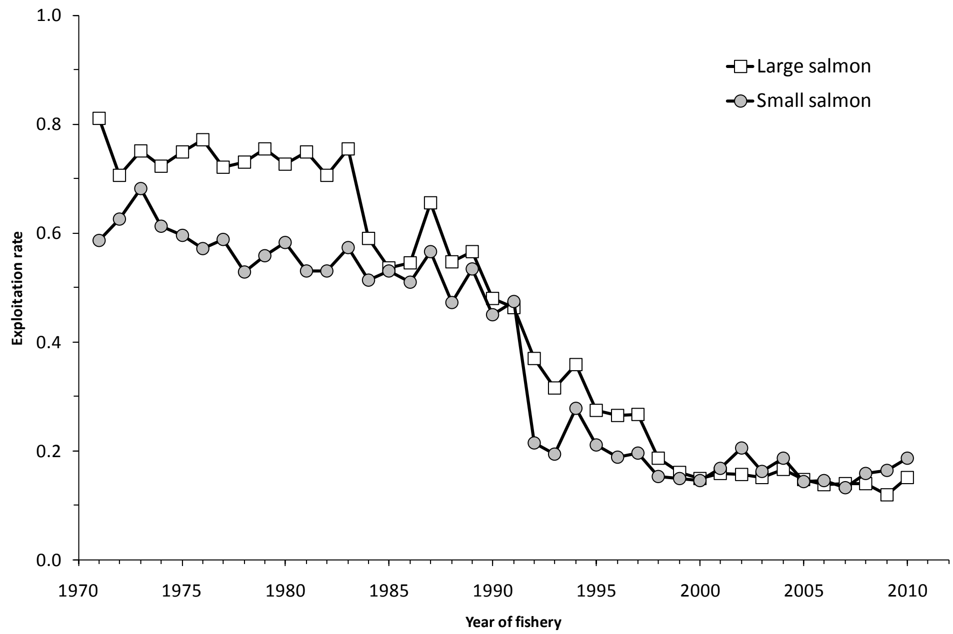

Figure 10.3.6. Exploitation rates in North America on the North American stock complex of small salmon (mostly 1SW) and large salmon (2SW, 3SW, and repeat spawners).

Table 10.3.1. Total reported nominal catch of salmon in homewaters by country (in tonnes round fresh weight), 1960–2010. (2010 figures include provisional data).

	Canada			USA	St. P&M
Year	Total	Large	Small	Total	Total
1970	2,323	1,562	761	1	-
1971	1,992	1,482	510	1	-
1972	1,759	1,201	558	1	-
1973	2,434	1,651	783	3	-
1974	2,539	1,589	950	1	-
1975	2,485	1,573	912	2	-
1976	2,506	1,721	785	1	3
1977	2,545	1,883	662	2	-
1978	1,545	1,225	320	4	-
1979	1,287	705	582	3	-
1980	2,680	1,763	917	6	-
1981	2,437	1,619	818	6	-
1982	1,798	1,082	716	6	-
1983	1,424	911	513	1	3
1984	1,112	645	467	2	3
1985	1,133	540	593	2	3
1986	1,559	779	780	2	3
1987	1,784	951	833	1	2
1988	1,310	633	677	1	2
1989	1,139	590	549	2	2
1990	911	486	425	2	2
1991	711	370	341	1	1
1992	522	323	199	1	2
1993	373	214	159	1	3
1994	355	216	139	0	3
1995	260	153	107	0	1
1996	292	154	138	0	2
1997	229	126	103	0	2
1998	157	70	87	0	2
1999	152	64	88	0	2
2000	153	58	95	0	2
2001	148	61	86	0	2
2002	148	49	99	0	2
2003	141	60	81	0	3
2004	161	68	94	0	3
2005	139	56	83	0	3
2006	137	55	82	0	3
2007	112	49	63	0	2
2008	158	58	100	0	4
2009	126	52	67	0	3
2010	146	53	93	0	3

10.2.3 **Advice April 2011**

ECOREGION North Atlantic
STOCK Atlantic Salmon at West Greenland

Advice for 2011

Because the NASCO Framework of Indicators of North American stocks for 2010 did not indicate the need for a revised analysis of catch options, no new management advice for 2011 is provided. The most recent multi-year advice for the West Greenland fishery was provided by ICES (2009). In that assessment, none of catch options for 2009, 2010, and 2011 were consistent with the management objectives defined for this stock unit.

Stock status

For West Greenland, stock status for North America and the Northeast Atlantic are relevant. The stock complex at West Greenland is below conservation limits and thus suffering reduced reproductive capacity. In European and North American areas, the overall status of stocks contributing to the West Greenland fishery is among the lowest recorded, and as a result, the abundance of salmon within the West Greenland area is thought to be extremely low compared to historical levels. Estimates of pre-fishery abundance suggest continued low abundance of North American adult salmon. Recruitment patterns of non-maturing 1SW recruits for Southern NEAC show a declining trend over the time period. The non-maturing 1SW stock has been at full reproductive capacity for most of the time-series until 1997. Thereafter the stock was either at risk of reduced reproductive capacity or suffering reduced reproductive capacity with the exception of 2004 and 2010, when the stock was at full reproductive capacity. This is broadly consistent with the general pattern of decline in marine survival in most monitored stocks in the area.

Despite major changes in fisheries management 18 to 25 years ago and increasingly more restrictive fisheries measures since, returns in these regions have remained near historical lows and many populations are currently threatened with extirpation. The continued low abundance of salmon stocks across North America and in the Northeast Atlantic, despite significant fishery reductions, further strengthens the conclusions that factors other than fisheries are constraining production.

Management plans

The North Atlantic Salmon Conservation Organization (NASCO) has adopted an Action Plan for Application of the Precautionary Approach which stipulates that management measures should be aimed at maintaining all stocks above their conservation limits by the use of management targets. NASCO has adopted the region-specific CLs as limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability. Within the agreed management plan, a risk level of 75% has been agreed for the provision of catch advice on fish exploited at West Greenland (non-maturing 1SW fish from North America and non-maturing 1SW fish from Southern NEAC).

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northeast Atlantic area their current distribution extends from northern Portugal to the Pechora River in Northwest Russia and on to Iceland. In the Northwest Atlantic they range from the Connecticut River (USA, 41.6°N) northward to the Leaf River, Quebec, Canada (58.8°N). Juveniles emigrate to the ocean at ages one to eight years (dependent on latitude) and generally return after one or two years at sea. Long distance migrations to ocean feeding grounds are known to take place with adult salmon from both the North American and Northeast Atlantic stocks migrating to West Greenland to feed on abundant fish and invertebrate prey during their second summer and fall at sea.

Environmental influence on the stock

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

The fisheries

Catches of Atlantic salmon at West Greenland (Figure 10.4.1) decreased until the closure of the commercial fishery for export in 1998, but the subsistence fishery has been increasing in recent years (Table 10.4.1). A total catch of 40 t of salmon was reported for the 2010 fishery compared to 26 t of salmon in the 2009 fishery, an increase of 53%. The increase in 2010 occurred in NAFO Division 1A, the total catch reported in this Division was the highest reported since 1989 at 17 t (Table 10.4.2). In total, 80% of the salmon sampled were of North American origin and 20% were determined to be of European origin. The 1SW age group dominated the catch at 98% (Table 10.4.3). Approximately 10 000 (34 t) North American origin fish and approximately 2600 (9 t) European origin fish were harvested in 2010. These totals remain among the lowest in the time-series, although they are the highest of the more recent years since 2001 (Figure 10.4.2).

Effects of the fisheries on the ecosystem

The current salmon fishery is practiced with nearshore surface gillnets. There is no information on bycatch of other species with this gear.

Quality considerations

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

Scientific basis

Assessments are carried out using common input variables across stock complexes in NEAC and NAC. Run–reconstruction models and Bayesian forecasts are performed taking into account uncertainties in the data.

10.4.1 Supporting information April 2011

ECOREGION North Atlantic
STOCK Atlantic Salmon at West Greenland

Reference points

For the Southern NEAC non-maturing stock complex, the conservation limit (CL) is 258 720 salmon. For NAC, the conservation limit expressed in 2SW salmon spawners totals 152 548 fish.

Outlook for 2011

The total PFA of the non-maturing 1SW salmon of the Southern NEAC complex ranged from 1.7 million to 1 million fish between 1978 and 1993, declining rapidly to under 500 thousand fish in 2008 (Table 10.4.4). Forecasts into 2012 to 2014 for the non-maturing Southern NEAC complex indicate that there are no catch options at West Greenland that would allow the management objectives for this stock to be met.

No outlook is provided relative to the North American stock because the Framework of Indicators of North American stocks for 2010 did not indicate the need for an updated forecast for 2011.

MSY approach

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because there are only a few age groups in the adult spawning stock. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, the ICES MSY approach is aimed at achieving a target escapement (MSY $B_{escapement}$, the 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, similar to the basis for estimating B_{pa} in the precautionary approach. In short-lived stocks, where most of the annual surplus production is from recruitment (not growth), MSY $B_{escapement}$ and B_{pa} might be expected to be similar.

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average maximum sustainable yield (MSY $B_{escapement}$). It should be noted that this is equivalent to the ICES B_{MSY} and B_{pa} as applied to short-lived stocks. Therefore, stocks are regarded by ICES as being at full reproductive capacity only if they are above MSY $B_{escapement}$, or above CLs.

ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on maturing 1SW salmon and non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status.

Management objectives

NASCO has identified the organization's primary management objective:

"To contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice 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 NASCOs 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, 1999) 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".

NASCO has adopted the region-specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

The advice for the West Greenland fishery is based on achieving management objectives at a probability level of 75% (ICES, 2003). For the Southern NEAC non-maturing 1SW (MSW) stock, the objective is to meet the Spawner Escapement Reserve (SER) for the complex. For the North American Commission, the management objectives are to simultaneously meet, or exceed, the 2SW CLs in the four northern areas (Labrador, Newfoundland, Quebec, Gulf), and to achieve a 25% increase in regional returns relative to a baseline period for the two southern regions (Scotia-Fundy, USA) (ICES, 2003).

Additional considerations

Fisheries on mixed stocks pose particular difficulties for management, when they cannot target only stocks that are at full reproductive capacity. The management of a fishery should ideally be based on the status of all stocks exploited in the fishery. Conservation would be best achieved if fisheries target stocks that have been shown to be at full reproductive capacity. Fisheries in estuaries and especially rivers are more likely to meet this requirement.

Sampling the fishery at West Greenland has made information available to examine the changing weights and condition factors of 1SW non-maturing salmon. Over the period of sampling (1969 to 2010) the mean weight of these fish appeared to decline from high values in the 1970s to the lowest mean weights of the time-series in 1990 to 1995, before increasing subsequently to 2010 (Figure 10.4.3). These mean weight trends are unadjusted for the period of sampling and it is known that salmon grow quickly during the period of sampling in the fishery from August to October. For the standardized sampling week 36 (Sept. 3 to 9; from which most of the samples were obtained over 2002 to 2010) and for a standardized fork length of 64 cm, there was a significant year effect in the predicted whole weight of salmon for 2002 to 2010 (Figure 10.4.3). The heaviest fish at length for NAC were sampled in 2009 and the lightest fish at length in 2005. For NEAC origin salmon, the lightest fish at length were also sampled in 2005 and the heaviest fish at length were sampled in 2002 (Figure 10.4.3). The analysis of condition of salmon over the period 2002 to 2010 contrasts with the interpretation of salmon size at West Greenland based entirely on weights or lengths unadjusted for the period of sampling or for the length of the fish. With the exception of the 2005 sampling year for NAC and 2005 as well as 2002 for NEAC, there is no apparent change in condition of 1SW non-maturing salmon at West Greenland.

Scientific basis

Data and methods

The international sampling programme for the fishery at West Greenland agreed by the parties at NASCO continued in 2010. The sampling was undertaken in three different communities representing three different NAFO Divisions. As in previous years no sampling occurred in the fishery in East Greenland in 2010. The decentralized landings and broad geographic distribution of the fishery causes practical problems for the sampling program. In total, 1265 individual salmon were inspected in 2010 representing 10% by weight of the reported landings.

Non-reporting of harvest becomes evident upon comparison of the reported landings to the sample data. When there is this type of weight discrepancy, the reported landings are adjusted according to the total weight of the fish identified as being landed during the sampling effort and these adjusted landings are carried forward for all future assessments (Table 10.4.5). In 2010 this occurred in all three sampled communities. The total discrepancy equalled 5.1 t and the catch for assessment purposes was 43 t (Table 10.4.5).

Uncertainties in assessments and forecasts

The fluctuations in the numbers of people reporting catches and the catches themselves in each of the NAFO Divisions suggest that there are inconsistencies in the catch data and highlights the need for better data. Since 2002, in at least one of the divisions where international samplers were present, the sampling team observed more fish than were reported as being landed. There is presently no quantitative approach for estimating the unreported catch, but the 2010 value is likely to have been at the same level proposed in recent years (10 t).

Comparison with previous assessment and catch options

The NASCO Framework of Indicators of North American stocks for 2010 did not indicate the need for a revised analysis of catch options and no new management advice for 2011 is provided. The assessment was updated to 2010 and the stock status was consistent with the previous year's assessment.

Assessment and management area

The advice for the West Greenland fishery is based on the Southern NEAC non-maturing 1SW stock complex and the North American 2SW complex.

Sources of information

ICES. 2003. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 31 March–10 April 2003. ICES Document CM 2003/ACFM:19. 297 pp.

ICES. 2009. Report of the Working Group on North Atlantic Salmon. ICES Headquarters, Copenhagen, 30 March–8 April 2009. ICES Document CM 2009/ACFM:06. 283 pp.

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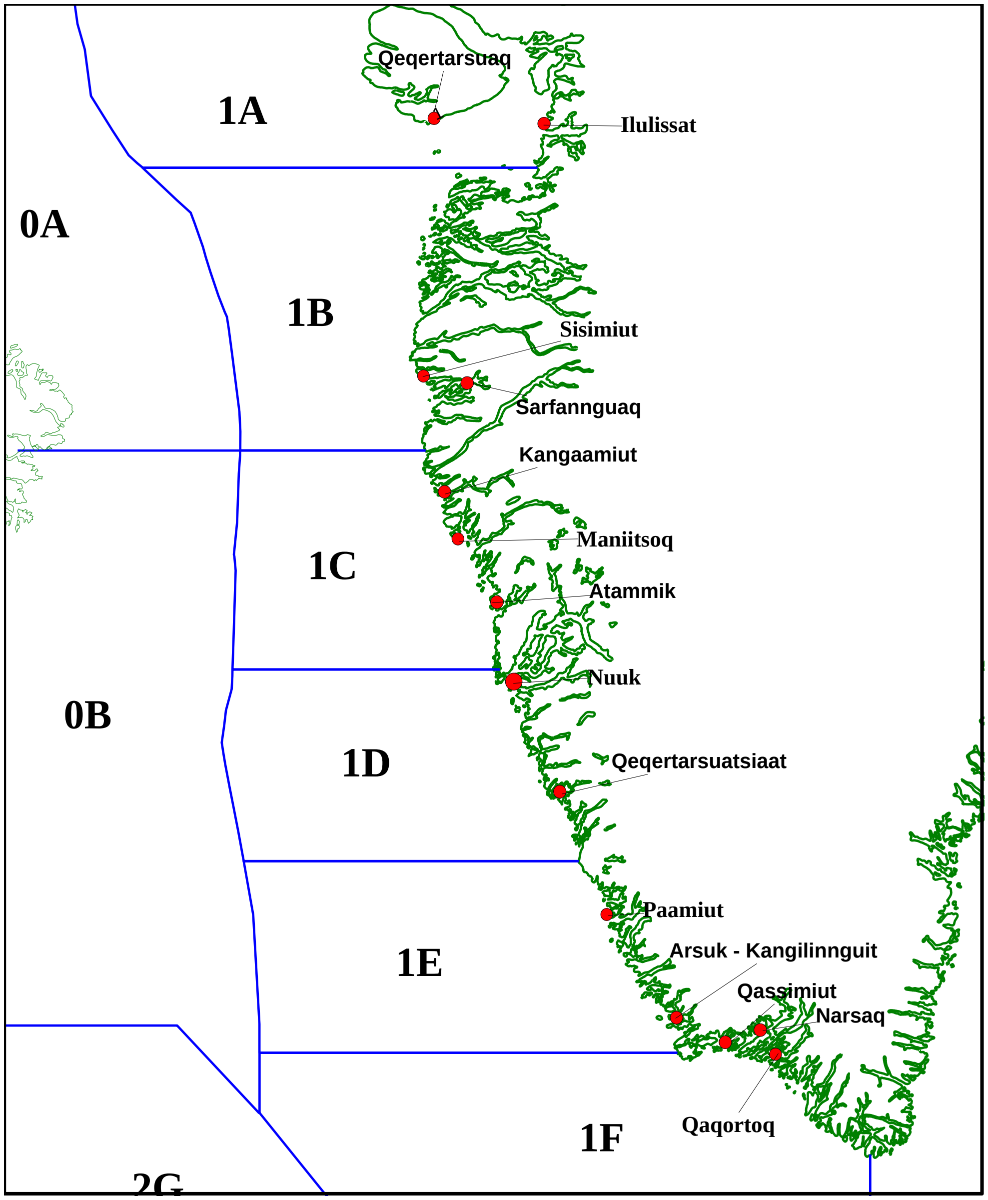

Figure 10.4.1. Location of NAFO divisions along the coast of West Greenland.

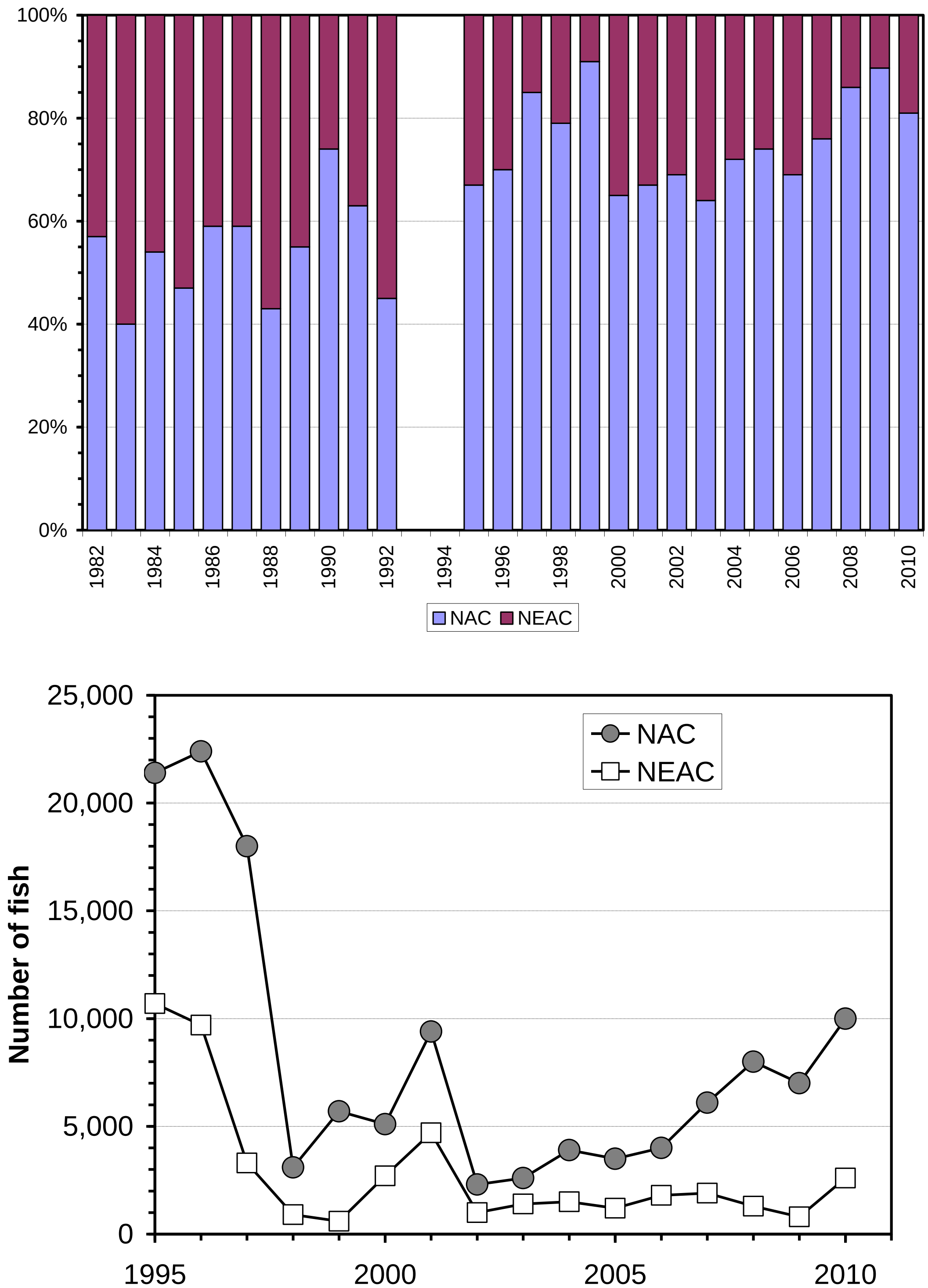

Figure 10.4.2. Upper panel: Percent by continent of origin during 1982 to 2010. Lower panel: Estimated number of salmon by continent of origin in the catches at West Greenland for fishery years 1995 to 2010.

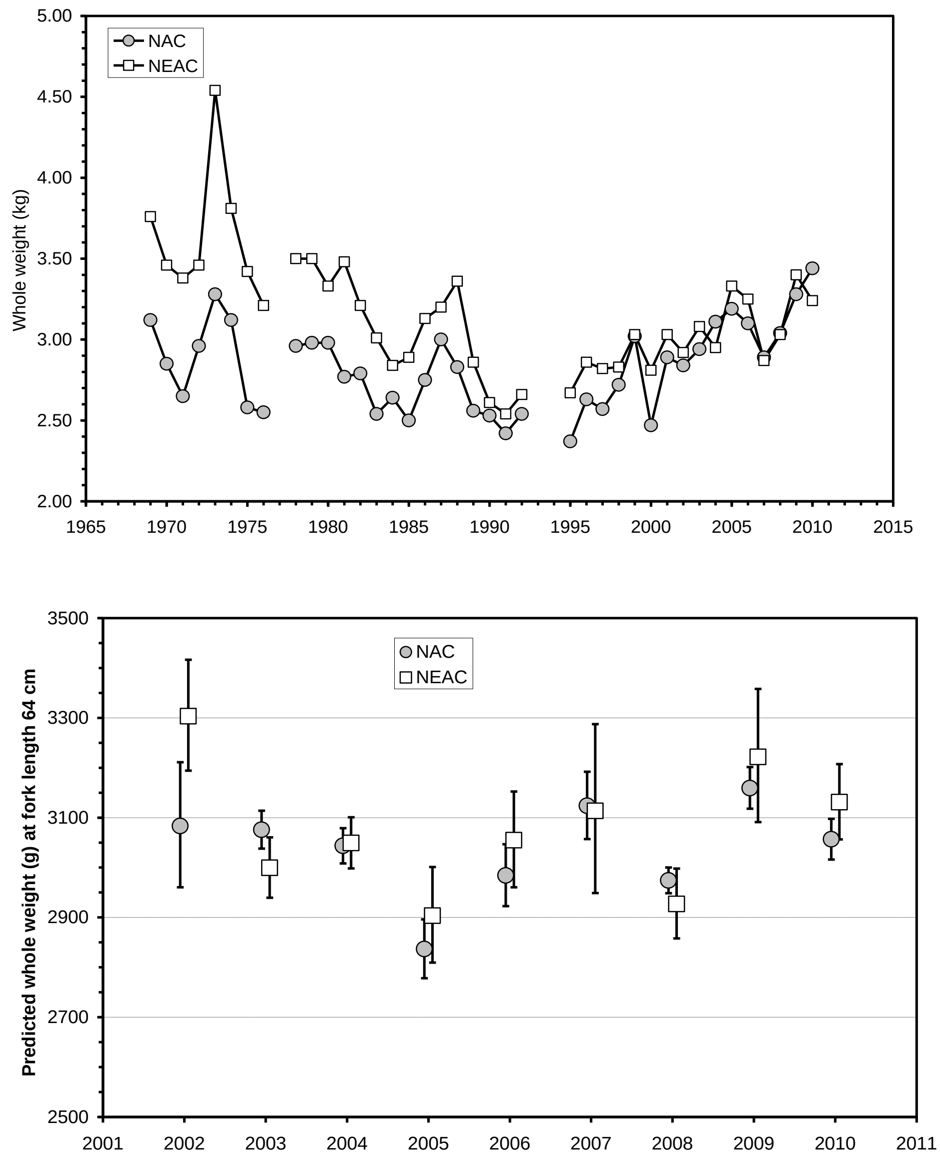

Figure 10.4.3. Upper panel: Sampled mean whole weight (kg) of 1SW non-maturing salmon by continent of origin over the period 1969 to 2010. Lower panel: The predicted whole weight (g) (mean, +/- 2 std errors) of 1SW non-maturing salmon, by continent of origin, sampled at West Greenland and adjusted for standard sampling week 36 and a standardized fork length of 64 cm.

Table 10.4.1. Nominal catches and management of Atlantic salmon at West Greenland since 1971.

Year	Total (t)	Quota (t)	Comments
1971	2689	-	
1972	2113	1100	
1973	2341	1100	
1974	1917	1191	
1975	2030	1191	
1976	1175	1191	
1977	1420	1191	
1978	984	1191	
1979	1395	1191	
1980	1194	1191	
1981	1264	1265	Quota set to a specific opening date for the fishery
1982	1077	1253	Quota set to a specific opening date for the fishery
1983	310	1191	
1984	297	870	
1985	864	852	
1986	960	909	
1987	966	935	
1988	893	840	Quota for 1988-90 was 2520 t with an opening date of August 1.
1989	337	900	Annual catches were not to exceed an annual average (840 t) by
1990	274	924	more than 10%. Quota adjusted to 900 t in 1989 and 924 t in 1990
1991	472	840	
1992	237	258	Quota set by Greenland authorities
1993		89	The fishery was suspended. NASCO adopt a new quota
1994		137	The fishery was suspended and the quotas were bought out.
1995	83	77	Quota advised by NASCO
1996	92	174	Quota set by Greenland authorities
1997	58	57	Private (non-commercial) catches to be reported from now
1998	11	20	Fishery restricted to catches used for internal consumption in
1999	19	20	Greenland
2000	21	20	
2001	43	114	Final quota calculated according to the ad hoc management
2002	9	55	Quota bought out, quota represented the maximum allowable
2003	9		Quota set to nil (no factory landing allowed), fishery restricted
2004	15		same as previous year
2005	15		same as previous year
2006	22		Quota set to nil (no factory landing allowed) and fishery
2007	25		Quota set to nil (no factory landing allowed), fishery restricted
2008	26		same as previous year
2009	26		same as previous year
2010	40		same as previous year

Table 10.4.2. Distribution of nominal catches (metric tonnes) by Greenland vessels since 1977.

Year	NAFO Division							West Greenland	East Greenland	Total
	1A	1B	1C	1D	1E	1F	NK			
1977	201	393	336	207	237	46	-	1 420	6	1 426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1 395	+	1 395
1980	52	275	404	231	158	74	-	1 194	+	1 194
1981	105	403	348	203	153	32	20	1 264	+	1 264
1982	111	330	239	136	167	76	18	1 077	+	1 077
1983	14	77	93	41	55	30	-	310	+	310
1984	33	116	64	4	43	32	5	297	+	297
1985	85	124	198	207	147	103	-	864	7	871
1986	46	73	128	203	233	277	-	960	19	979
1987	48	114	229	205	261	109	-	966	+	966
1988	24	100	213	191	198	167	-	893	4	897
1989	9	28	81	73	75	71	-	337	-	337
1990	4	20	132	54	16	48	-	274	-	274
1991	12	36	120	38	108	158	-	472	4	476
1992	-	4	23	5	75	130	-	237	5	242
1993 [1]	-	-	-	-	-	-	-	-	-	-
1994 [1]	-	-	-	-	-	-	-	-	-	-
1995	+	10	28	17	22	5	-	83	2	85
1996	+	+	50	8	23	10	-	92	+	92
1997	1	5	15	4	16	17	-	58	1	59
1998	1	2	2	4	1	2	-	11	-	11
1999	+	2	3	9	2	2	-	19	+	19
2000	+	+	1	7	+	13	-	21	-	21
2001	+	1	4	5	3	28	-	43	-	43
2002	+	+	2	4	1	2	-	9	-	9
2003	1	+	2	1	1	5	-	9	-	9
2004	3	1	4	2	3	2	-	15	-	15
2005 *	1	3	2	1	3	5	-	15	-	15
2006 *	6	2	3	4	2	4	-	22	-	22
2007 *	2	5	6	4	5	2	-	25	-	25
2008 *	5	2	10	2	3	5	0	26	-	26
2009 *	0.2	6	7	3	4	5	0	26	1	26
2010 *	17	5	2	3	7	4	0	38	2	40

[1] The fishery was suspended
+ Small catches <0.5t
- No catch
* Corrected from gutted weight to total weight (factor 1.11).

Table 10.4.3. Summary biological characteristics of catches at West Greenland in 2010.

Distribution of 2010 nominal catch (metric tons)

Total	NAFO Division					
	1A	1B	1C	1D	1E	1F
38	17	5	2	3	7	4

River age distribution (%) by origin (NA – North America, E – Europe)

	1	2	3	4	5	6	7	8
NA	1.6	21.7	47.9	21.7	6.3	0.8	0	0
E	11.3	57.1	27.3	3.4	0.8	0	0	0

Length and weight by origin and sea age

	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)
NA	66.7	3.44	80.0	6.45	72.4	4.17	66.9	3.28
E	65.2	3.24	75.0	5.45	70.0	3.92	65.4	3.42

Continent of Origin (%)

North America	Europe
79.9	20.1

Sea age composition (%) by continent of origin:
North America (NA) and Europe (E)

	1SW	2SW	Previous Spawners
NA	98.2	0.4	1.4
E	97.5	1.7	0.8

Table 10.4.4. Estimated pre-fishery abundance (median values) of non-maturing 1SW salmon (potential MSW returns) by NEAC country or region and year.

Year	Northern NEAC								Southern NEAC									NEAC Area		
	Finland	Iceland	Norway	Russia	Sweden	Total			France	Iceland	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total			Total		
		N&E				2.5%	median	97.5%		S&W					2.5%	median	97.5%	2.5%	median	97.5%
1971	63,447	26,037		270,747	7,389				56,394	63,499	401,682	394,450	31,956	1,737,264	2,238,000	**2,697,076**	3,278,712			
1972	75,289	24,377		430,928	10,289				36,185	57,263	392,656	292,373	27,945	1,720,197	2,074,687	**2,537,468**	3,129,722			
1973	111,305	22,953		398,134	7,024				20,431	49,367	407,073	212,105	30,530	1,223,221	1,597,801	**1,955,357**	2,408,376			
1974	124,416	25,382		432,411	5,851				31,557	52,473	455,991	272,140	25,087	1,347,815	1,792,981	**2,197,213**	2,717,409			
1975	102,073	20,942		368,072	6,076				27,989	45,390	344,259	182,660	17,431	989,912	1,343,482	**1,614,414**	1,951,649			
1976	62,266	28,703		254,136	4,228				19,426	44,013	280,445	180,878	17,170	920,180	1,202,108	**1,470,711**	1,808,046			
1977	39,993	36,873		217,594	3,462				20,145	56,812	250,528	158,909	22,386	1,104,584	1,321,546	**1,621,549**	2,007,060			
1978	42,514	24,532		201,287	6,357				18,623	36,579	214,993	84,500	15,697	804,645	956,389	**1,183,229**	1,473,940			
1979	44,613	34,566		351,769	13,067				35,824	51,805	256,921	223,718	19,874	1,043,026	1,345,801	**1,641,382**	2,014,102			
1980	49,010	13,261		255,209	12,978				26,310	35,413	210,785	294,099	15,568	1,120,329	1,402,163	**1,713,882**	2,104,575			
1981	63,906	14,837		228,299	16,367				17,792	25,267	140,994	136,191	22,516	921,661	1,041,062	**1,268,735**	1,554,930			
1982	69,411	11,350		280,314	12,209				17,515	41,082	297,856	139,504	31,592	931,262	1,177,728	**1,499,560**	2,001,072			
1983	65,888	13,949	819,634	258,462	11,019	961,670	**1,173,892**	1,435,324	23,380	34,605	150,913	102,392	12,430	725,766	854,352	**1,052,587**	1,300,186	1,852,501	**2,227,111**	2,681,342
1984	51,404	9,281	770,430	282,836	8,025	923,376	**1,123,813**	1,371,091	17,633	25,327	161,658	140,662	16,106	864,131	994,111	**1,228,681**	1,527,864	1,954,062	**2,356,010**	2,842,832
1985	45,047	24,182	916,753	284,288	8,843	1,050,147	**1,282,834**	1,570,128	21,661	21,389	201,943	203,971	18,110	1,175,117	1,337,677	**1,647,698**	2,047,058	2,437,365	**2,934,412**	3,543,522
1986	56,333	24,963	714,321	221,398	13,277	853,195	**1,036,102**	1,257,318	13,481	19,050	235,533	167,032	9,260	814,668	1,035,809	**1,263,337**	1,550,632	1,922,113	**2,301,197**	2,758,477
1987	36,090	16,038	568,426	202,550	10,423	689,488	**837,972**	1,019,179	28,258	21,263	172,835	201,843	26,060	1,145,106	1,295,518	**1,602,263**	1,987,717	2,018,206	**2,441,807**	2,962,013
1988	40,867	13,819	440,349	205,194	23,914	598,043	**721,085**	872,122	16,529	19,166	169,757	172,491	20,765	1,051,805	1,188,221	**1,454,780**	1,788,531	1,810,915	**2,177,409**	2,622,184
1989	51,140	14,462	505,427	253,321	16,639	691,075	**836,565**	1,014,942	12,973	18,940	81,865	184,474	18,887	813,673	916,305	**1,136,047**	1,413,802	1,635,174	**1,974,891**	2,385,648
1990	61,425	9,875	396,712	229,510	16,011	582,571	**709,642**	866,146	11,070	18,520	102,130	79,885	9,705	595,943	659,527	**820,521**	1,026,010	1,265,907	**1,530,647**	1,854,763
1991	65,555	14,505	413,816	210,460	19,298	590,169	**719,506**	879,265	14,949	20,778	85,460	68,204	22,226	808,269	821,547	**1,020,837**	1,278,176	1,437,625	**1,741,908**	2,117,635
1992	76,037	16,357	396,204	248,301	26,006	625,138	**757,768**	920,378	7,380	10,227	79,476	68,962	52,437	654,345	703,756	**879,165**	1,101,549	1,353,048	**1,638,351**	1,984,324
1993	63,065	13,879	388,222	223,091	19,190	577,165	**703,688**	859,160	12,833	16,510	114,750	86,115	18,418	752,150	800,967	**1,005,218**	1,267,692	1,404,924	**1,711,432**	2,087,870
1994	39,082	9,694	417,203	253,350	13,743	596,514	**726,396**	885,257	6,155	18,605	111,235	87,133	15,597	697,970	747,970	**941,856**	1,190,880	1,370,766	**1,669,531**	2,037,655
1995	34,537	12,680	417,311	192,771	17,330	549,841	**670,675**	818,606	11,272	12,022	77,207	89,265	17,105	545,225	602,478	**756,800**	953,711	1,175,699	**1,429,094**	1,737,052
1996	50,170	7,086	266,762	151,783	10,805	395,754	**483,867**	593,710	5,953	13,406	96,491	56,493	21,361	372,426	453,397	**573,887**	728,343	868,925	**1,058,516**	1,295,364
1997	42,196	10,325	320,487	187,736	7,969	461,929	**563,737**	689,457	4,891	8,297	55,640	34,983	29,366	389,174	418,783	**524,666**	661,513	899,161	**1,089,284**	1,322,934
1998	39,468	11,855	341,166	166,102	6,786	456,922	**562,598**	695,406	10,260	16,181	85,640	78,027	13,311	297,953	396,163	**517,113**	680,050	877,246	**1,082,289**	1,337,155
1999	87,916	6,949	473,482	289,171	14,913	707,283	**865,633**	1,056,320	7,160	4,406	107,059	82,735	17,774	380,048	480,581	**607,701**	772,504	1,214,699	**1,474,241**	1,789,584
2000	126,433	7,967	556,908	204,234	17,920	740,548	**910,342**	1,119,821	8,439	7,711	95,995	87,069	13,060	363,648	458,399	**584,594**	751,166	1,229,196	**1,497,470**	1,824,682
2001	101,296	7,538	483,326	222,969	13,143	670,161	**824,885**	1,015,620	6,319	8,360	110,681	81,070	15,512	299,839	419,029	**531,821**	678,757	1,114,241	**1,358,440**	1,655,711
2002	71,877	7,921	427,028	155,807	14,985	550,711	**676,114**	830,048	9,013	13,349	116,198	93,541	10,145	369,366	485,399	**622,286**	799,444	1,062,093	**1,300,022**	1,592,159
2003	34,476	7,793	387,090	120,194	10,859	452,206	**558,426**	691,341	16,729	10,791	64,038	75,908	9,073	478,161	519,681	**663,030**	848,011	997,063	**1,223,113**	1,502,530
2004	26,655	9,657	356,320	144,014	8,239	441,256	**541,469**	667,795	10,296	9,527	82,737	88,501	11,514	377,096	463,246	**588,150**	753,760	926,420	**1,131,615**	1,389,071
2005	46,693	9,264	451,774	137,669	8,235	530,529	**649,881**	799,222	10,336	7,908	59,937	75,766	7,345	392,072	439,575	**565,187**	730,821	996,516	**1,216,600**	1,491,198
2006	66,447	8,910	384,673	142,612	11,380	499,332	**610,195**	745,369	9,856	4,867	27,374	69,734	10,089	377,021	392,415	**505,593**	654,948	914,377	**1,117,142**	1,365,634
2007	63,200	11,472	443,385	225,283	16,225	609,498	**752,882**	932,070	10,825	5,573	40,666	77,539	6,115	422,474	441,004	**573,062**	747,179	1,081,739	**1,327,677**	1,633,110
2008	29,441	9,235	346,929	190,698	14,691	473,237	**584,885**	725,085	5,680	8,339	45,512	56,693	7,982	352,762	373,212	**484,500**	631,205	871,942	**1,070,784**	1,319,194
2009	46,597	14,616	382,467	243,537	18,074	562,345	**694,437**	859,538	4,775	10,715	31,084	99,018	7,335	486,579	492,763	**651,522**	867,649	1,087,326	**1,349,104**	1,676,653
10yr Av.	61,311	9,437	421,990	178,702	13,375	552,982	**680,351**	838,591	9,227	8,714	67,422	80,484	9,817	391,902	448,472	**576,975**	746,294	1,028,091	**1,259,197**	1,544,994

Table 10.4.5. Reported landings (kg) for the West Greenland Atlantic salmon fishery from 2002 by NAFO Division as reported by the Home Rule Government and the division-specific adjusted landings where the sampling teams observed more fish landed than were reported.

		NAFO Division						
Year		1A	1B	1C	1D	1E	1F	Total
2002	Reported	14	78	2100	3752	1417	1661	9022
	Adjusted						2408	9769
2003	Reported	619	17	1621	648	1274	4516	8694
	Adjusted			1782	2709		5912	12 312
2004	Reported	3476	611	3516	2433	2609	2068	14 712
	Adjusted				4929			17 209
2005	Reported	1294	3120	2240	756	2937	4956	15303
	Adjusted				2730			17276
2006	Reported	5427	2611	3424	4731	2636	4192	23021
	Adjusted							
2007	Reported	2019	5089	6148	4470	4828	2093	24647
	Adjusted						2252	24806
2008	Reported	4882	2210	10024	1595	2457	4979	26147
	Adjusted				3577		5478	28627
2009	Reported	195	6151	7090	2988	4296	4777	25497
	Adjusted				5466			27975
2010	Reported	17263	4558	2363	2747	6766	4252	37949
	Adjusted		4824		6566		5274	43056