Agenda item 4.4
For information

Council

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Report of the ICES Advisory Committee on Fishery Management

Extract of the report of the Advisory Committee on Fishery Management

North Atlantic Salmon Stocks

to the North Atlantic Salmon Conservation Organization

2007

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International Council for the Exploration of the Sea
CIEM
Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

- In the North Atlantic, exploitation remains low and nominal catch of Atlantic salmon in 2006 was the lowest in the time-series.
- Marine survival indices remain low.
- The North American Commission 2SW stock complex is suffering reduced reproductive capacity. Factors other than fisheries (marine mortality, fish passage, water quality) are contributing to continued low adult abundance.
- Northern North East Atlantic Commission stock complexes (1SW and MSW) are at full reproductive capacity prior to the commencement of distant water fisheries.
- Southern North East Atlantic Commission stock complexes (1SW and MSW) are at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries.
- There are no catch options for the fishery at West Greenland (2007-2009) that would meet the management objectives.
- There are no catch options for the fishery at the Faroes (2008-2010) that would meet precautionary management objectives.
- A finalized Framework of Indicators for the West Greenland Fishery is provided.
- A model is presented that demonstrates the expected population response to recovery activities and highlights the limiting effect that low marine survival can have on recovery actions which focus only on improving freshwater habitat. It also demonstrates that freshwater habitat degradation can limit the potential for population growth even with high at-sea survival.
- A number of studies were reviewed that report on significant new or emerging threats to, or opportunities for, salmon conservation and management.

1 Introduction

1.1 Main Tasks

At its 2006 Statutory Meeting, ICES resolved (C. Res. 2006/2/ACFM14) that the Working Group on North Atlantic Salmon [WGNAS] (Chair: T Sheehan, USA) will meet in Copenhagen, Denmark, from 11 to 20 April 2007 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO). The terms of reference were met and the sections of the report which provide the answers are below:

a)	With respect to Atlantic salmon in the North Atlantic Area:	Section 2
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 2006;	2.1 and 2.2
2)	report on significant new or emerging threats to, or opportunities for salmon conservation and management;	2.3 and 2.6
3)	provide a framework of indicators which would be used to identify any significant change in the previously provided multi-annual management advice for each Commission area;	2.4
4)	examine associations between changes in biological characteristics of all life stages of Atlantic salmon and variations in marine survival[1];	2.5
5)	provide a compilation of tag releases by country in 2006;	2.6.4
6)	identify relevant data deficiencies, monitoring needs and research requirements[2].	Section 6
b)	With respect to Atlantic salmon in the North East Atlantic Commission area:	Section 3

1)	describe the key events of the 2006 fisheries and the status of the stocks[3];	3.8
2)	provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	3.9
3)	further develop the age-specific stock conservation limits, where possible based upon individual river stocks;	3.3
4)	provide annual catch options or alternative management advice for 2008–2010, if possible based on forecasts of PFA for northern and southern stocks, 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[4];	3.4 and 3.6
5)	provide estimates of bycatch and non-catch fishing mortality of salmon in pelagic fisheries with an assessment of impacts on returns to homewaters.	3.10
c)	With respect to Atlantic salmon in the North American Commission area:	Section 4
1)	describe the key events of the 2006 fisheries (including the fishery at St Pierre and Miquelon) and the status of the stocks[3];	4.9
2)	provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	4.10
3)	update age-specific stock conservation limits based on new information as available;	4.3
4)	provide annual catch options or alternative management advice for 2007–2010 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[4];	4.4 and 4.7
5)	provide a comprehensive description of coastal fisheries including timing and location of harvest, biological characteristics (size, age, origin) of the catch, and potential impacts on non-local salmon stocks.	4.11
d)	With respect to Atlantic salmon in the West Greenland Commission area:	Section 5
1)	describe the events of the 2006 fisheries and the status of the stocks[3,5];	5.8
2)	provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	5.10
3)	provide annual catch options or alternative management advice for 2007–2009 with an assessment of risk relative to the objective of exceeding stock conservation limits and advice on the implications of these options for stock rebuilding[4].	5.4

Notes:

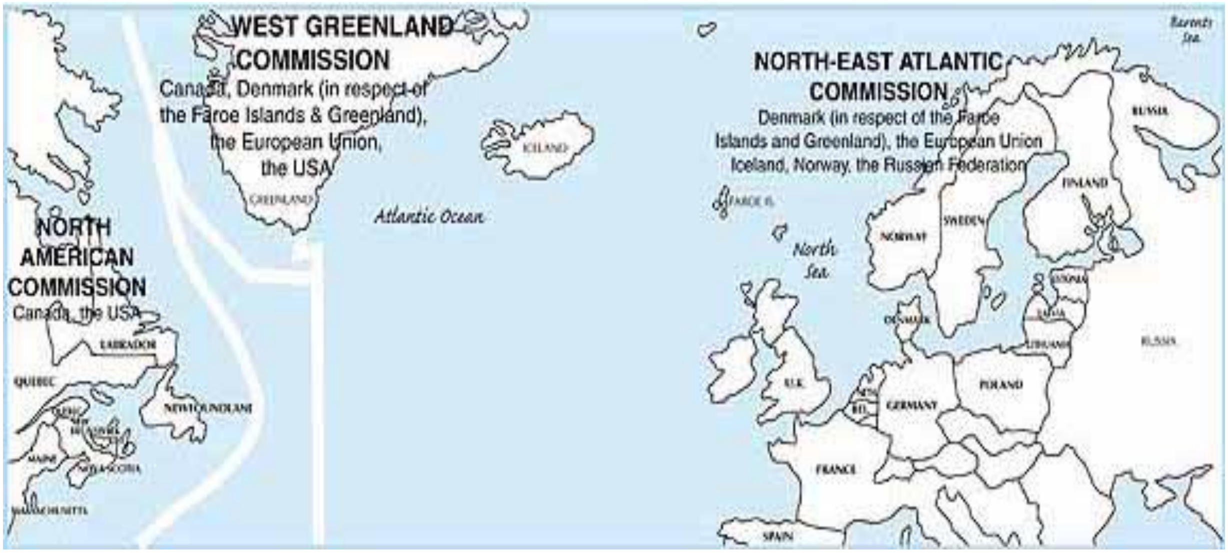
1. *There is interest in determining whether declines in marine survival coincide with changes in the biological characteristics of juveniles in fresh water or are modifying characteristics of adult fish (size-at-age, age-at-maturity, condition, sex ratio, growth rates, etc).*
2. *NASCO's International Atlantic Salmon Research Board's inventory of on-going research relating to salmon mortality in the sea will be provided to ICES to assist in this task.*
3. *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.*
4. *Provide a detailed explanation and critical examination of any changes to the models used to provide catch advice.*
5. *ICES is requested to provide a brief summary of the status of North American and Northeast Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to b1 and c1.*

A complete list of acronyms used within this document is provided in Annex 1. References cited are in Annex 2.

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. While sovereign states retain their role in the regulation of salmon fisheries for salmon originating from their own rivers, distant water salmon fisheries, such as those at Greenland and Faroes, which take salmon originating from 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:



1.3 Management objectives

NASCO has identified the primary management objective of that organisation as:

"To contribute through consultation and co-operation 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 interpretation of how this is to be achieved, as follows:

- "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".

1.4 Reference points and application of precaution

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). In many regions of North America, the conservation limits 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 conservation limits. In the remaining regions, the conservation limits 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 (Ricker, 1975; ICES, 1993). NASCO has adopted the region-specific conservation limits (NASCO, 1998). These conservation limits 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 considers a stock to be at full reproductive capacity when the lower bound of the 95% confidence interval of the current estimate of spawners is above the CL.
- ICES considers a stock to be at risk of suffering reduced reproductive capacity when the lower bound of the confidence limit is below the CL, but the midpoint is above.
- ICES considers a stock to be suffering reduced reproductive capacity when the midpoint is below the CL.

It should be noted that this is equivalent to the ICES precautionary target reference points (S_{pa}). Therefore, stocks are regarded by ICES as being at full reproductive capacity only if they are above the precautionary target reference point. This approach parallels the use of precautionary reference points used for the provision of catch advice for other fish stocks in the ICES area.

For management of the West Greenland fishery, NASCO has adopted a precautionary management plan requiring at least a 75% probability of achieving three management objectives:

- Meeting the conservation limits (S_{lim}) simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf;
- Achieving increases in returns to the Scotia–Fundy and USA regions relative to the base years 1992–1996. Improvements of greater than 25% and 10% relative to base year returns are presented although, to achieve a 25% increase, by definition the 10% increase is also achieved;
- Meeting the conservation limits (S_{lim}) for the Southern NEAC MSW complex.

ICES applies the 75% threshold in the advice for the West Greenland fishery.

2 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

2.1 Catches of North Atlantic Salmon

2.1.1 Nominal catches of salmon

Nominal catches of salmon reported for each salmon-producing country in the North Atlantic are given in Table 2.1.1.1 for the years 1960 to 2006. These catches (in tonnes) are illustrated in Figure 2.1.1.1 for four North Atlantic regions. Catch statistics in the North Atlantic also include fish farm escapees and, in some Northeast Atlantic countries, also ranched fish. Reported catches for the three NASCO Commission Areas for 1996–2006 are provided below.

Area	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NEAC	2750	2074	2225	2073	2736	2876	2495	2303	1977	1999	1844
NAC	294	231	159	154	155	150	150	144	164	142	136
WGC	92	59	11	19	21	43	9	9	15	14	21
Total	3135	2364	2396	2246	2913	3069	2654	2456	2156	2155	2001

The catch data for 2006 are provisional, but the total nominal catch of 2001 t is the lowest on record. Catches for most countries were below the recent 5- and 10-year averages, and in six countries were the lowest in the time-series.

The nominal catch (in tonnes) of wild fish in 2006 was partitioned according to whether the catch was taken in coastal, , or riverine fisheries. These are shown below for the NEAC and NAC Commission Areas. The delineations of these environments used within the NAC area were refined in 2006 to incorporate expert knowledge of these fisheries. It was not possible to apportion the small Danish catches in 2006 and these have been excluded from the calculation. The catch accounted for by each fishery varied considerably between countries. In total, however, coastal fisheries accounted for 47% of catches in Northeast Atlantic countries compared to 8% in North America, whereas in-river fisheries took 48% of catches in Northeast Atlantic countries and 59% in North America.

Area	Coast		Estuary		River		Total
	Weight	%	Weight	%	Weight	%	Weight
NEAC	859	47	103	6	884	48	1,846
NAC	11	8	45	33	80	59	135

In the NEAC Northern area, catches since 1995 have fluctuated with no apparent trend (Figure 2.1.1.2); coastal fisheries have typically comprised about half of the total catch (although there are no coastal fisheries in Iceland and Finland). In Southern Europe, catches in all fishery areas have declined over the same period. While coastal fisheries make up the largest component of the catch in this area, these fisheries have declined the most, reflecting widespread measures to reduce exploitation in a number of countries. In North America, the total catch over the period 2000–2006 has been relatively constant, with that in coastal fisheries comprising 11 t or less. Catches in coastal and estuarine areas, predominantly aboriginal food fisheries, have increased slightly over the period.

2.1.2 Catch and release

The practice of catch and release 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. These fish are not included in the nominal catches. For countries that reported such data in 2006, the percentage of the total rod catch that was released ranged from 18% in Iceland to 82% in Russia. Catch and release rates have generally increased over the last decade. Overall, more than 153 000 salmon were reported to have been released in 2006.

2.1.3 Unreported catches

The estimated unreported catch within the NASCO Commission Areas in 2006 was 670 t (Table 2.1.1.1). The unreported catch, expressed as a percentage of the total North Atlantic catch (nominal and unreported), has fluctuated since 1987 (range 23–34%), but has remained fairly constant in the last three years at about 25%. Over recent years, efforts have been made to reduce the level of unreporting in a number of countries (e.g. through improved reporting procedures, carcase tagging, and logbook schemes). After 1994 there are no available data on the extent of possible salmon catches in international waters. Limited surveillance flights, which were the bases of past estimates of catches in international waters, have not reported any such salmon fishing in recent years. Estimates (in tonnes) of unreported catches for the three Commission Areas for the period 1996–2006 are given below:

AREA	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NEAC	947	732	1108	887	1135	1089	946	719	575	605	604
NAC	156	90	91	133	124	81	83	118	101	85	56
WGC	20	5	11	13	10	10	10	10	10	10	10
Int'l. waters	Not available										

Expressed as a percentage of the total North Atlantic catch, unreported catch estimates range from 0% to 15% for individual countries. However, it should be noted that methods of estimating unreported catch vary both within and among countries. The non-reporting rates range from 1% to 50% of the total national catch in individual countries. An allowance for unreported catch is included in the assessments and catch advice for each Commission area.

2.2 Farming and Sea Ranching of Atlantic Salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2006 is 817 100 t. This represents a small increase on 2005 (804 908 t), but remains below the peak figure of 831 075 t produced in 2004. Most of the North Atlantic production took place in Norway (73%) and UK (Scotland) (17%).

World-wide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002. Total production in 2006 is provisionally estimated at around 1 264 000 tonnes (Figure 2.2.1), the highest in the time-series. Production outside the North Atlantic is currently estimated to account for 35% of total farmed production, with Chile (370 000 t) contributing the largest proportion of the production in this area. World-wide production of farmed Atlantic salmon in 2006 was over 630 times the reported nominal catch of Atlantic salmon in the North Atlantic. Farmed salmon therefore dominate world markets.

Catches of ranched salmon have declined substantially from a high of over 500 t in 1993 to around 9 t in 2006 (Figure 2.2.2). This is due to the cessation of salmon ranching in Iceland from 1999.

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

2.3.1 Recovery potential of Bay of Fundy and Southern Upland salmon populations

A model was developed to show how salmon populations are expected to respond to recovery activities in the Scotia–Fundy Region of Canada. The first part of the model gives the number of smolts produced as a function of egg deposition (Figure 2.3.1.1a), modelled using a Beverton–Holt stock–recruitment function. The second part, the egg-per-smolt relationship (Figure 2.3.1.1b), which gives the rate at which smolts were expected to produce eggs in their entire life, is calculated based on survival of juvenile salmon in the marine environment, age-at-maturity, fishing mortality, fecundity, and the number of times a fish spawns throughout its life. The population equilibrium is found by estimating the abundance at which the production of smolts by eggs equals the reciprocal of the production of eggs by smolts (Figure 2.3.1.1c). In the example provided, a decrease in smolt-to-adult survival shifts the equilibrium point to a smaller population size.

Four case studies were examined, two of which are reproduced here. For two populations, such as the LaHave River, Nova Scotia, only a single threat was examined. The population equilibrium, based on average at-sea survival rates for the period, is just over 50% the conservation requirement (Figure 2.3.1.2.). At the lowest at-sea survival rates observed during this period, the population is not viable, whereas at the highest rates observed, the population equilibrium is well above the conservation requirement for this river.

In the West River (Sheet Harbour, Nova Scotia) case study (Figure 2.3.1.3), little population-specific data exists so the model was developed using a combination of data from the LaHave River and information about habitat specific to the river. Besides low at-sea survival, West River is also impacted by acidification. The model illustrates that a small population may be achieved in this river if marine survival improves; the population would be expected to remain below its conservation requirement and may be below a size at which the population would be viable in the long term. Both an increase in at-sea survival and pH recovery is needed to increase this population to levels above its conservation requirement.

The approach is useful for evaluating the potential for recovery of salmon populations. Assuming that conditions in freshwater are not responsible for the low marine survival being experienced by Scotia–Fundy populations, the case studies illustrate the limiting effect that low marine survival can have on recovery actions focused only on improving freshwater habitat. However, at high at-sea survival rates the equilibrium population size is very sensitive to the amount of freshwater habitat. The LaHave River case study showed that in recent years, at-sea survival rates have in some years been high enough that if sustained, populations would be expected to increase to levels above the conservation spawner requirement given sufficient freshwater habitat. In these instances, recovery actions focused in freshwater may or may not be effective depending on the scope available for improvements in freshwater. The case studies also illustrated how freshwater habitat degradation such as acidification limits the potential for population growth in some rivers even if at-sea survival improves. These analyses could be extended to other populations and threats.

2.3.2 Timing and nature of density dependence in Atlantic Province salmon populations

Analyses of density dependence are an important step in model development for reference point estimation, assessment of extinction risk, and evaluating the effectiveness of proposed recovery activities. Density-dependent survival within freshwater was analysed using electrofishing data from nine populations in the Maritime Provinces. Smolt-to-adult return-rate data from 15 populations in eastern Canada were used to evaluate whether density dependence is important in the marine environment. As illustrated with data and fits for three of the populations in Figure 2.3.6.1, three spawner-recruit models, a Beverton–Holt, a Ricker, and a one-parameter density-independent model, were fit to each data series using maximum likelihood. Model fits were compared using likelihood ratio tests.

Within freshwater, no single, unequivocal pattern was evident with respect to the timing of density dependence. In the marine environment, density dependence was potentially detected in three of the 15 populations for 1SW salmon, but these three series were either short or highly variable. Density dependence was not detected in any of nine 2SW salmon populations. The variability in both the timing of density dependence and carrying capacity for parr highlights the need for population-specific data for establishing reference points or when planning recovery or enhancement activities. The three populations with the lowest estimated age-1 carrying capacity are located in the outer Bay of Fundy and Southern Upland, are in the southern half of the range of the included populations, and are populations with low at-sea survival. Assuming these estimates are correct, freshwater production has the potential to limit population growth in these populations even if at-sea survival improves.

2.3.3 Monitoring interactions between aquaculture and wild fisheries in Norway

Studies relevant to regulations and management – Ongoing studies in Norway clearly indicate that the impact from salmon lice infestations occurring in the migration areas of wild postsmolts may not only directly influence mortality rates but may also indirectly increase mortality through reducing growth rates of fish surviving the first infestations (Skilbrei and Wennevik, 2006a). These secondary effects have not been previously demonstrated and may lead to an underestimation of the potential negative effects of aquaculture on wild salmon stocks.

Experimental trawling for wild postsmolts and hatchery postsmolts placed in cages along a fjord have demonstrated that a combination of enforcement of aquaculture regulations, and a strict programme of sea lice monitoring in fish pens together with voluntary actions from the farmers appears to reduce the numbers of sea lice to stated tolerance levels (Boxaspen, 2006; Finstad *et al.*, 2007). However, the continued increase in the number of fish farms and production of aquaculture highlight the importance of continued monitoring and surveillance. The results demonstrate that the level of sea lice infestation from aquaculture fish to migrating wild smolts can be reduced significantly given effective aquaculture regulations and enforcement, and coordinated de-lousing by fish farmers.

Capture fisheries following simulated escapes of aquaculture salmon suggest a low probability of successful recapture after a major escape, unless the fisheries are operated immediately (within a few days) and with the effort spread over a large area. A study showed that escapees can be dispersed over several square kilometres in the course of just a few days (Skilbrei *et al.*, 2007). In addition, immediately after an “escape” the fish may be in the deeper water layers avoiding capture by many gear types. After the initial period, surface gears may be more effective as the fish may be present on the surface. Recoveries from acoustic tagged salmon show that most of the tagged salmon were caught within a range of 20 kilometres from the release sites, indicating that high recapture rates are possible in fjord regions if the fishing effort is high. In sparsely populated areas, the efforts and resources required to recapture escaped salmon may be large. This includes farm sites close to the open sea where the salmon are believed to spread even faster than in the fjords (Skilbrei and Wennevik, 2006b; Skilbrei *et al.*, 2007). These results suggest that recapturing escaped farm salmon can be a resource intensive effort with a low probability of success.

Identification methods – Norwegian fish farmers are required to report escapes from their farms to the authorities. In autumn 2006, substantial numbers of escaped salmon were observed in a fjord in Western Norway, although none of the fish farmers in the area had reported any escapes. Samples were collected from all net cages in fish farms in the fjord and analyzed for 15 microsatellites. The DNA and fatty acid profiles of the escaped fish were then compared to the profiles of the different fish farms. The results showed with high probability that the escapees originated from one specific net cage and the Directorate of Fisheries in Norway proposes to apply similar procedures in similar cases in the future. These results demonstrate that with the proper baseline dataset, identifying the origin of escaped farm salmon can be conducted with high precision.

2.3.4 Cessation of mixed stock fisheries in Irish coastal waters from 2007

In 2005, an Irish Government decision was taken to end the at-sea mixed stock fisheries (predominantly driftnets) in 2007 and to operate fisheries only on single river stocks, which were shown to be meeting conservation limits (CLs). This was to align with the best international practice, comply with scientific advice from ICES, meet NASCO objective, and to afford greater protection to stocks designated under the EU Habitats Directive (Council Directive 92/43/EC; http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/habitats_directive/index_en.htm). In the absence of at-sea mixed stock fisheries, the methodology used to provide status of river stocks and catch advice has been modified for 2007 and thereafter. The major differences are related to the provision of catch advice on a river-specific basis as advised by the Standing Scientific Committee of the National Salmon Commission. In so doing, the status of stocks is related specifically to individual rivers rather than to district aggregations of stocks. In the absence of a driftnet fishery (or any other net fishery) at sea, in-river measures of abundance have been used (i.e. fish counter data and rod catch data) to provide a primary measure of spawning stocks and attainment of conservation limits.

The process of estimating CLs remains unchanged, as does the assessment of whether the stock (in this case the river stocks rather than the district stock as calculated in previous years) is above or below its CL. This eliminates the uncertainty associated with the previous assessment in assigning all fish in the district catch to rivers within that district.

In this manner fisheries will now only take place on the 43 rivers shown to be meeting CLs with the catch level set to allow at least a 75% chance of meeting the CL. Two estuarine fisheries have also been identified as having a catch option providing a 75% chance that the individual rivers entering the estuary will meet their CLs.

There are 34 rivers that do not have an identifiable surplus over the CL. Therefore, there are no harvest options available to allow a fishery to take place such that these stocks will meet their conservation limit. Where these rivers are meeting 65% or more of their conservation limit a directed catch and release fishery will be permitted, provided the regional fisheries authorities are satisfied that this will comply with set criteria and that the survival of released fish is within official limits.

There are 74 small rivers with no counter or an average rod catch of less than 10 salmon per annum. Given the tenuous state of many of the smaller rivers, the Standing Scientific Committee's general advice is that there should be no directed fishery (including catch and release) until other information is made available to indicate that these rivers are exceeding their CL and that there is a catch option that meets the management objectives.

2.3.5 Development of predictive models for returning salmon in Norway

A project to develop predictive models for the return of Norwegian salmon has recently been completed. The factors examined included hydrography, plankton production, the biomass and condition of pelagic marine fish species, and salmon growth and survival indices (e.g. catches, estimated marine survival rates). Models to forecast 1SW salmon were developed from environmental variables, plankton production, condition factor, and biomass of herring. This approach is based on the assumption that the smolt production is the same every year. To forecast pre-fishery abundance (PFA) of 1SW salmon, a multivariate regression method called PLS (Projection on Latent Structures, Martens and Martens, 2001) was applied. PLS models both the predictors and the response (1SW return) simultaneously to find the latent structures in the predictor space that best explain the response. Models were developed for the whole of Norway, for the three regions (southern, mid-, and northern Norway) and for a single river (River Drammen). For all models, except southern Norway, it was found that the total stock biomass of herring was the most influential predictor as it was negatively correlated with 1SW returns. The precision of the forecasts was variable, lowest in southern Norway and highest in northern Norway. This has been the first approach to forecast salmon runs to Norway, and work is continuing to further develop the models, including standardizing data sampling so that the quality of the appropriate time-series will be less variable. It is hoped this will improve the ability to predict homewater PFA for Norway.

2.3.6 Human activities impacting on aquatic diversity

ICES was informed of the first confirmed occurrence of a presumably non-native freshwater alga in a salmon river of eastern Canada.

Didymosphenia geminata, commonly referred to as “didymo” or “rock-snot”, is a freshwater diatomous alga that attaches to rocks and grows on gelatinous stalks. It prefers waters of low nutrient levels. It can develop into large mats of yellow-brown colour, which can cover the bottom of rivers and lakes. The mats have the texture of wet wool and when dry have the appearance of toilet paper or parchment paper. Didymo is not toxic and its impacts are most important to the aesthetics of the rivers (including angling quality).

Since the late 1980s, didymo blooms have been reported in a number of northern hemisphere countries within Europe and North America. In Iceland, didymo was not identified from aquatic surveys dating back to the 1940s, but it was subsequently identified in samples from 1994 from several rivers (Jonsson *et al*., 2000). It seems that shortly after it first arrives in a river or to an area in a river it can have very dense growth, but generally retreats after a few years (although it still persists). It has now spread around the entire coast of Iceland, though not in all rivers. There have been no documented impacts on salmon or trout populations in Iceland. More detailed information and references on the characteristics of didymo can be found at the website of the Invasive Species Specialist Group (ISSG) of IUCN Species Survival Commission (http://www.issg.org/database/species/ecology.asp?si=775&fr=1&sts=).

2.3.7 Autumn downstream migration of juvenile Atlantic salmon in the UK – possible implications for the assessment and management of stocks

ICES received new information from a study undertaken in the River Frome (Pinder *et al*., in press), which sought to quantify the size of the autumn migration and determine the physiological status of both migrants and non-migrants in this catchment. Large numbers of 0+ salmon parr were tagged in the Frome during September in both 2004 and 2005 with Passive Integrated Transponder (PIT) tags; the majority of salmon leave this river as one-year-old smolts. The subsequent movements of the tagged fish were monitored at a number of trapping facilities and by means of a full river PIT antenna detector array (Ibbotson *et al*., 2004) located 4 km above the head of tide. The number of autumn migrants passing the antenna array between October 2005 and January 2006 was estimated at 2480 fish. This compares with a three-year mean smolt run estimate for the river (2004–06) of 9400. Electrofishing at low water in tidal sections of the river in February and March subsequently confirmed the presence of autumn migrating parr in the estuary.

It was concluded that the component of the population that migrated downstream in the autumn was not physiologically adapted to survive early entry into saltwater and was expected to remain in the lower river/estuary at least until the following spring. It is not clear whether the downstream migration reflects displacement from upstream areas or is a specific life history strategy. It is also not known whether marine survival varies between autumn and spring migrants. Future returns of PIT-tagged adult salmon to the Frome should provide new information in this context. The findings may have implications for stock assessment programmes, as autumn migrants are likely to be excluded from most current smolt run estimates and estimates of marine survival.

2.4 NASCO has asked ICES to provide a framework of indicators which would be used to identify any significant change in the previously provided multi-annual management advice for each Commission area

2.4.1 Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance

In 2006, ICES provided multi-annual management advice for all three NASCO Commission Areas and presented a preliminary framework (Framework of Indicators) which would indicate whether any significant changes in the previously provided multi-annual management advice had occurred in subsequent years. The advice and Framework of Indicators (FWI) formed the basis for the multi-annual (3-year) regulatory measures, which were agreed upon in the West Greenland (salmon fishery in the waters off West Greenland; NASCO, 2006a) and North East Atlantic Commissions (salmon fishery in Faroese waters; NASCO, 2006b). The second and third year of the regulatory measures for both fisheries is dependant on ICES providing, and the Parties to each Commission Area accepting, a finalized Framework of Indicators.

ICES formed the Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance (SGEFISSA, ICES, 2007a) which met in 2006. The SGEFISSA further developed the FWI that was originally presented by ICES (ICES, 2006).

2.4.2 Update of the Framework of Indicators for the 2007–2009 multi-year catch advice at West Greenland

ICES updated the FWI for the Greenland fishery. The update consisted of:

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

The management objectives for the development of the catch options for the West Greenland fishery are presented in Table 2.4.2.1.

A total of 82 indicator variables were updated and analysed using the objective function spreadsheet. These variables included returns of 1SW or small salmon, 2SW or large salmon, and return rates as 1SW and 2SW salmon of wild and hatchery-origin fish. Based on the objective function spreadsheet and the criteria established by the SGEFISSA, a total of 32 indicator variables were retained (see below). Of these, four were return rate indicators of hatchery fish, while the remainder were of wild 2SW or large salmon (N = 15) and wild 1SW or small salmon (N = 13) returns to rivers.

Summary of indicator variables retained from North America							
ORIGIN	Wild	Wild	Wild	Wild	Hatchery	Hatchery	
TYPE OF DATA	Return	Return	Survival	Survival	Survival	Survival	
SIZE/AGE GROUP	Small/1SW	Large/2SW/ MSW	Small/1SW	Large/2SW	Small/1SW	Large/2SW	**Total**
Newfoundland	1						1
Quebec	6	8					14
Gulf	1	1					2
Scotia–Fundy	4	4			1	1	10
US[1]	1	2[2]			1	1	5
Total	13	15			2	2	**32**

[1] for US, returns include both wild and hatchery-origin fish.
[2] in one river (Narraguagus), returns are of age/size groups combined.

No indicator variables were retained for the Labrador area and for the southern NEAC non-maturing complex. All the retained indicator variables had a probability of at least 80% of identifying a true low state or a true high state (Figure 2.4.2.1).

ICES modified the FWI from a one-way test to a two-way test in order to evaluate the over-estimation of stock abundance by the forecast model.

2.4.3 Application of the framework indicator spreadsheet for signalling whether a significant change in management advice may occur for the fisheries in 2008 and 2009

The FWI spreadsheet is shown in Figure 2.4.3.1. The framework provides one of two conclusions for the user:

1) no significant change identified by the indicators;
2) reassess.

If no significant change has been identified by the indicators, then the multi-year catch advice for the year of interest could be retained. If a significant change is signalled by the indicators, the suggested response is to reassess.

The framework spreadsheet is designed to capture both fishing and non-fishing scenarios:

- multi-year advice provides no catch options greater than zero, but indicators are suggesting that the management objectives may be met (conclusion: Reassess);
- multi-year advice provides catch options greater than zero, but the indicators suggest the management objectives may not be met (conclusion: Reassess).

The FWI spreadsheet will be updated with the returns or return rate data for 2007 to evaluate the appropriateness of the 2008 advice, and with the returns or return rate data for 2008 to evaluate the appropriateness of the 2009 advice. It is anticipated that the data for the indicator variables to populate the framework would be available in January of the year of interest. The framework will be updated whenever a new set of multi-year catch advice is provided. Figure 2.4.3.2 illustrates the timeline of how the FWI would operate.

Applying the framework

There are two steps required by the user to run the framework. The first step is to enter the catch advice option for the West Greenland fishery (t). This feature provides the two-way evaluation of whether a change in management advice may be expected and a reassessment would be required. The second step is to enter the values for the indicator variables in the framework for the year of interest. The spreadsheet evaluation update is automated and the conclusion is shown in the row underneath “Overall Recommendation”.

Framework features

The conclusions from the framework evaluation are based on whether there is an indication of simultaneous achievement of the management objectives in the six stock areas of North America and the southern NEAC non-maturing complex (Figure 2.4.3.1). If there are no indicator variables for a geographic area, the attainment of the management objectives is evaluated as unknown and that area or complex is not used in the decision structure of the framework.

Within the geographic areas for which indicator variables are retained, all the available indicators are used to assess the indicator score. If an update value for an indicator variable is not available for the year of interest, the indicator variable is not used to quantify the indicator score for that area.

The average indicator score for the geographic area is used to determine whether management objectives could be met. Multiple indicators within the stock complex groupings are combined by arithmetic average of the product of the indicator state (−1, +1) and the probability of a correct assignment corresponding to the true low or true high states. An average geographic area or stock complex score equal to or greater than zero would suggest there is a likelihood of meeting the management objective for that grouping, based on the historic relation between the variable of interest (adult returns to a geographic area or PFA) and the indicators evaluated.

2.5 NASCO has asked ICES to examine associations between changes in biological characteristics of all life-stages of Atlantic salmon and variations in marine survival

New information was received on changes in the size and growth of 1SW fish in the Northeast Atlantic and in biological characteristics from two index rivers in Quebec, but ICES was unable to consider this topic in depth in the time available. It is recommended that co-ordinated efforts are made to collate information on biological characteristics throughout the geographic range, to include issues such as:

- Juvenile size-at-age (freshwater growth);
- Smolt age composition;
- Smolt run timing (and autumn parr movements);
- Post-smolt growth;
- Sea-age composition;
- Size at return (marine growth);
- Adult run timing;
- Sex ratios.

2.5.1 Small grilse size and growth during the first summer at sea in Scottish and Norwegian salmon populations

Sample data from three Scottish net fisheries suggest that over a wide area of Scotland and in each month of the season where data were available, grilse returning in 2006 were both substantially shorter and lighter than previous years. Samples from river fisheries in southern Norway show a similar pattern, while in mid- and northern Norway the grilse sizes in 2006 were closer to the average in the period 1989–2005. The Scottish data show that the existence of “small grilse” was the result of a general decline in the size of returning fish as a whole.

Analysis of the back-calculated lengths of fish from scale samples from the North Esk net and coble fishery provides strong evidence for a substantial decline in the growth of the 2006 grilse either in the short period in freshwater before smolt emigration or, more likely, in the post-smolt phase of their life in 2005. Back-calculated lengths of first-year growth of grilse from rivers in the southwestern part of Norway also show that the growth of the 2005 smolt cohort had declined substantially compared to the growth of previous cohorts.

Analysis of the time-series data for all six Scottish net fisheries indicates that both median fork length and fresh round weight of returning grilse show distinct declines over a 40-year time period, albeit with shorter time-scale variations also evident within the data set. Data for 2006 show a sharp decline, particularly in July and August. In rivers in the southern parts of Norway the mean weight of grilse (fish smaller than 3 kg) had varied since 1989, with 2006 showing the lowest values in the time-series. For Norway the data prior to 1989 is likely biased because of the size-selective driftnet fishery that mainly targeted large grilse and smaller MSW salmon.

Grilse weight and grilse catches were positively correlated in rivers in southern Norway and mid-Norway, suggesting that cohorts with reduced growth suffered reduced survival. However, in rivers in the northern part of Norway a similar pattern was not observed. Furthermore, the mean weight of grilse in the River Drammen was positively correlated to survival estimates from hatchery smolts released in the same river.

Sweden also reported that the grilse in 2006 were small and lean, with a mean weight in the sport fishery 17% less than that in 2005, although MSW salmon were of normal size. Quite a few of the fish caught by anglers were reported to be extremely thin and this raised concerns among fishers about the future. There was also evidence of significantly smaller grilse from parts of UK (England & Wales) and similar *ad hoc* reports from Ireland. This information and data demonstrate that reduced grilse size was a phenomenon that affected southern European areas, including southern Norway, in 2006.

2.6 Tracking and tagging studies

2.6.1 Acoustic tracking of migrating Atlantic salmon kelts from the LaHave River, Nova Scotia, Canada

The results of an acoustic tagging experiment in the LaHave River were reviewed. Salmon kelts were captured in early April by seining, angling, and at a downstream assessment facility 25 km above tide head. Thirty kelts were implanted with acoustic tags, including 5 tags that transmit depth data. The outward migration of 30 kelts and subsequent return of one consecutive spawning salmon was successfully documented using this method. All kelts left the estuary by the middle of May. The mortality rate of kelts to migration past the outer array was 10%. Location and duration of residency was recorded and environmental variables were compared to behaviour.

The results indicated that capture by angling was the most successful method and that kelts tolerated handling and surgery well. No mortalities due to capture, holding, or surgery occurred. The data on migration rate, diving behaviour, and high survival rate were new and important information for this stock, which is experiencing increased mortality to repeat spawning. One post-spawned 2SW female salmon returned to the estuary after 79 days, spent four days in the estuary, and reached the assessment facility in one day after entering the river. This consecutive repeat spawning salmon had increased its weight by 50%. The remaining 26 salmon that successfully migrated past the outer array are expected to reach the Labrador Sea within three months and possibly farther north within five months, similar to that expected for smolts. Based on the low mortality rate of kelts migrating past the outer arrays, the expected ocean migration, and the large size of kelts, tagging experiments utilizing this stage of salmon, particularly with newly evolving advanced technology tags, could provide critical insights into the migration, behaviour, and possibly survival rates to northern geographic areas.

2.6.2 Monitoring smolt migration in the River Rhine, Germany

The downstream migration of Atlantic salmon smolts was monitored in the River Rhine in 2006 and 2007 using the NEDAP Trail system (Breukelaar *et al*., 1998). Overall, 88 tagged fish were released into two tributaries of the River Rhine about 350 km from the sea. The smolts (hatchery 2^+, weight > 150 g) were tagged with a transponder (length 3.5 cm, weight 11.5 g) by implantation into the body cavity, and allowed to recover for a period of several days in the hatchery before release to the river. The tagged fish were detected by fixed antenna arrays when leaving the tributary and during their migration through the Rhine delta to the sea. The NEDAP trail system is based on inductive coupling between an antenna loop on the river bottom and a ferrite rod antenna within the transponders. When the fish passes each detection station the unique ID-number of the transponder is recorded.

As of April 2007, 64 fish have been detected leaving the tributary of release (5 in 2006 and 59 in 2007, respectively) and 24 (1 in 2006 and 23 in 2007, respectively) have been recorded reaching the sea after passing through the Rhine delta. The study aims to investigate the success of downstream migration and the migration routes in relation to the obstructions within the partly dammed Rhine delta, and particularly the Haringvliet sluices. The study will be repeated after re-opening of the Haringvliet dam. This is scheduled to occur by the end of 2008, aimed specifically at improving conditions for migratory fish species during their passage from freshwater to the sea and vice versa.

2.6.3 Data storage tags and tagging studies in Iceland

Hatchery-reared smolts with implanted data storage tags (DST) were released in 2005 and 2006 in an Icelandic river. The first returns (5 salmon) were obtained in 2006. The DST tags recorded temperature and depth for the whole ocean cycle of these salmon. The salmon stayed in the surface layers throughout most of their ocean stay and all showed similar temperature profiles. The research provides new information on the conditions salmon experience at sea. Further analyses of these data as well as tags still to be recovered will provide considerable input to the understanding of the behaviour of salmon at sea.

2.6.4 Compilation of tag releases and fin clip data by ICES member countries in 2006

Data on releases of tagged, fin-clipped, and otherwise marked salmon in 2006 were provided by ICES and are compiled as a separate report (ICES, 2007b). A summary of tag releases is provided in Table 2.7.1.

2.6.5 Summary of the Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas (WKDUHSTI)

Results from the Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas (WKDUHSTI) were presented. A framework for analyses of data was developed, and a standard format for recording tag recoveries was agreed. Using GIS as a tool, examples of geographic distribution of recaptured salmon originating from different areas were provided, demonstrating the potential for the use of this tool. A number of hypotheses relating to oceanic migration and distribution that could be tested using tagging and recapture material, were discussed and developed. Tag recovery information could be complemented by genetic analyses of time-series of available scale or tissue samples in relation to salmon life-history information derived from scale pattern analyses of freshwater and marine growth characteristics. There is still a large amount of material available, but this has to be standardised and converted to the same format, as agreed in WKDUHSTI. The workshop recommended a framework which could be used for future contributions to the tag recovery data set. The Workshop considered that the integration of historical tagging data for NEAC and NAC provides a significant opportunity to advance the state of knowledge of the marine distribution and migration of salmon. It was recommended that a follow-up Workshop should include oceanographers to assist with describing salmon distributions and relating them to the ocean environment.

Table 2.1.1.1. Nominal catch of salmon by country (in tonnes round fresh weight), 1960–2006. (2006 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)	Den.	Finland	Ireland	(E & W)	(N.Irl.)	(Scotl.)	France	Spain	Faroes	Grld.	Grld.	Other	Nominal	NASCO	International
	(1)			(2)	(3)	Wild	Ranch				(4,5)		(5,6)		(7)	(8)	(9)		(10)	(11)	Catch	Areas	waters (13)
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	146	280	33	13	60	567	338	94	624	15	7	315	-	274	-	4,924	1,890	180-350

Table 2.1.1.1 continued

Year	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch	Sweden (West)	Den.	Finland	Ireland (4,5)	UK (E & W)	UK (N.Irl.) (5,6)	UK (Scotl.)	France (7)	Spain (8)	Faroes (9)	East Grld.	West Grld. (10)	Other (11)	Reported Nominal Catch	NASCO Areas	International waters (12)
1991	711	1	1	876	215	130	345	38	3	70	404	200	55	462	13	11	95	4	472	-	4,106	1,682	25-100
1992	522	1	2	867	167	175	461	49	10	77	630	171	91	600	20	11	23	5	237	-	4,119	1,962	25-100
1993	373	1	3	923	139	160	496	56	9	70	541	248	83	547	16	8	23	-	-	-	3,696	1,644	25-100
1994	355	0	3	996	141	141	308	44	6	49	804	324	91	649	18	10	6	-	-	-	3,945	1,276	25-100
1995	260	0	1	839	128	150	298	37	3	48	790	295	83	588	10	9	5	2	83	-	3,629	1,060	-
1996	292	0	2	787	131	122	239	33	2	44	685	183	77	427	13	7	-	0	92	-	3,135	1,123	-
1997	229	0	2	630	111	106	50	19	1	45	570	142	93	296	8	3	-	1	58	-	2,364	827	-
1998	157	0	2	740	131	130	34	15	1	48	624	123	78	283	8	4	6	0	11	-	2,396	1,210	-
1999	152	0	2	811	103	120	26	16	1	62	515	150	53	199	11	6	0	0	19	-	2,246	1,032	-
2000	153	0	2	1,176	124	83	2	33	5	95	621	219	78	274	11	7	8	0	21	-	2,913	1,269	-
2001	148	0	2	1,267	114	88	0	33	6	126	730	184	53	251	11	13	0	0	43	-	3,069	1,180	-
2002	148	0	2	1,019	118	97	0	28	5	93	682	161	81	191	11	9	0	0	9	-	2,654	1,039	-
2003	141	0	3	1,071	107	110	0	25	4	78	551	89	56	192	13	7	0	0	9	-	2,456	847	-
2004	161	0	3	784	82	130	0	19	4	39	489	111	48	245	19	7	0	0	15	-	2,156	686	-
2005	139	0	3	888	82	149	0	15	8	47	422	97	52	215	11	13	0	0	14	-	2,155	700	-
2006	132	0	4	932	91	121	0	14	3	67	326	79	25	164	11	11	0	0	21	-	2,001	670	-
Average																							
2001-2005	147	0	3	1,006	101	115	0	24	5	77	575	128	58	219	13	10	0	0	18	-	2,498	890	-
1996-2005	172	0	2	917	110	114	35	24	4	68	589	146	67	257	12	8	2	0	29	-	2,554	991	-

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 recently developed recreational (rod) fishery.
4. Improved reporting of rod catches in 1994 and data derived from carcase tagging and log books from 2002.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Angling catch (derived from carcase tagging and log books) first included in 2002.
7. Data for France include some unreported catches.
8. Weights estimated from mean weight of fish caught in Asturias (80-90% of Spanish catch).
9. 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.
10. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
11. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
12. Estimates refer to season ending in given year.

Table 2.4.2.1. Management objectives and equivalent number of fish relevant to the development of catch options at West Greenland for the six geographic areas in NAC and the southern NEAC non-maturing complex.

AREA	OBJECTIVE	NUMBER OF FISH
US	25% increase from 2SW returns during 1992 to 1996	2,548
Scotia–Fundy	25% increase from 2SW returns during 1992 to 1997	10,976
Gulf	2SW conservation limit	30,430
Quebec	2SW conservation limit	29,446
Newfoundland	2SW conservation limit	4,022
Labrador	2SW conservation limit	34,746
Southern NEAC non-maturing complex	Spawner escapement reserve	455,413

Table 2.7.1. Summary of Atlantic salmon tagged and marked in 2006 – 'Hatchery' and 'Wild' refer to smolts and parr; 'Adults' relates to both wild and hatchery-origin fish.

		Primary Tag or Mark				
Country	Origin	Microtag	External mark	Adipose clip	Pit tag/Internal tags[3]	Total
Belgium	Hatchery	2,383	0	0	0	2,383
	Wild	0	0	0	0	0
	Adult	0	0	0	0	0
	Total	2,383	0	0	0	2,383
Canada	Hatchery	0	3,223	923,607	0	926,830
	Wild	0	19,768	7,216	280	27,264
	Adult	0	5,421	1,189	47	6,657
	Total	0	28,412	932,012	327	960,751
Germany	Hatchery	82,612	5480	136816	0	224,908
	Wild	0	0	0	0	0
	Adult	0	191	0	0	191
	Total	82,612	5,671	136,816	0	225,099
Iceland [1]	Hatchery	146,653	0	0	300	146,953
	Wild	2,658	0	0	0	2,658
	Adult	0	2,344	0	0	2,344
	Total	149,311	2,344	0	300	151,955
Ireland	Hatchery	258,012	0	0	0	258,012
	Wild	7,077	0	0	0	7,077
	Adult	0	0	0	0	0
	Total	265,089	0	0	0	265,089
Norway	Hatchery	12,299	41,170	0	0	53,469
	Wild	1,416	2,103	0	0	3,519
	Adult	0	2,110	0	0	2,110
	Total	13,715	45,383	0	0	59,098
Russia	Hatchery	0	0	754,985	0	754,985
	Wild	0	0	0	0	0
	Adult	0	2,568	0	0	2,568
	Total	0	2,568	754,985	0	757,553
Spain	Hatchery	189,195	0	339,588	0	528,783
	Wild	0	0	0	0	0
	Adult	0	0	0	0	0
	Total	189,195	0	339,588	0	528,783
Sweden	Hatchery	0	3,000	170,355	0	173,355
	Wild	0	400	0	0	400
	Adult	0	0	0	0	0
	Total	0	3,400	170,355	0	173,755
UK (England & Wales)	Hatchery	54,826	0	148,535	0	203,361
	Wild	16,778	0	16,749	0	33,527
	Adult	0	2,907	0	0	2,907
	Total	71,604	2,907	165,284	0	239,795
UK (N. Ireland)	Hatchery	17,751	3,904	54,004		75,659
	Wild	1832	0	0	0	1,832
	Adult	0	0	0	0	0
	Total	19,583	3,904	54,004	0	77,491
UK (Scotland)[2]	Hatchery	30,070	0	0	0	30,070
	Wild	9,634	2,598	0	5,678	17,910
	Adult	0	1,375	0	0	1,375
	Total	39,704	3,973	0	5,678	49,355
USA	Hatchery	1,530	60	468,873	0	470,463
	Wild	526	0	0	0	526
	Adult	1,604	1,257	0	0	2,861
	Total	3,660	1,317	468,873	0	473,850
All Countries	Hatchery	795,331	56,837	2,996,763	300	3,849,231
	Wild	39,921	24,869	23,965	5,958	94,713
	Adult	1,604	18,173	1,189	47	21,013
	Total	836,856	99,879	3,021,917	6,305	3,964,957

[1] The number of microtagged hatchery fish in Iceland includes 18,326 fish reared in sea-pens.

[2] Pit tagged juvenile in Scotland also adipose finclipped.

[3] Includes all larger internal tags

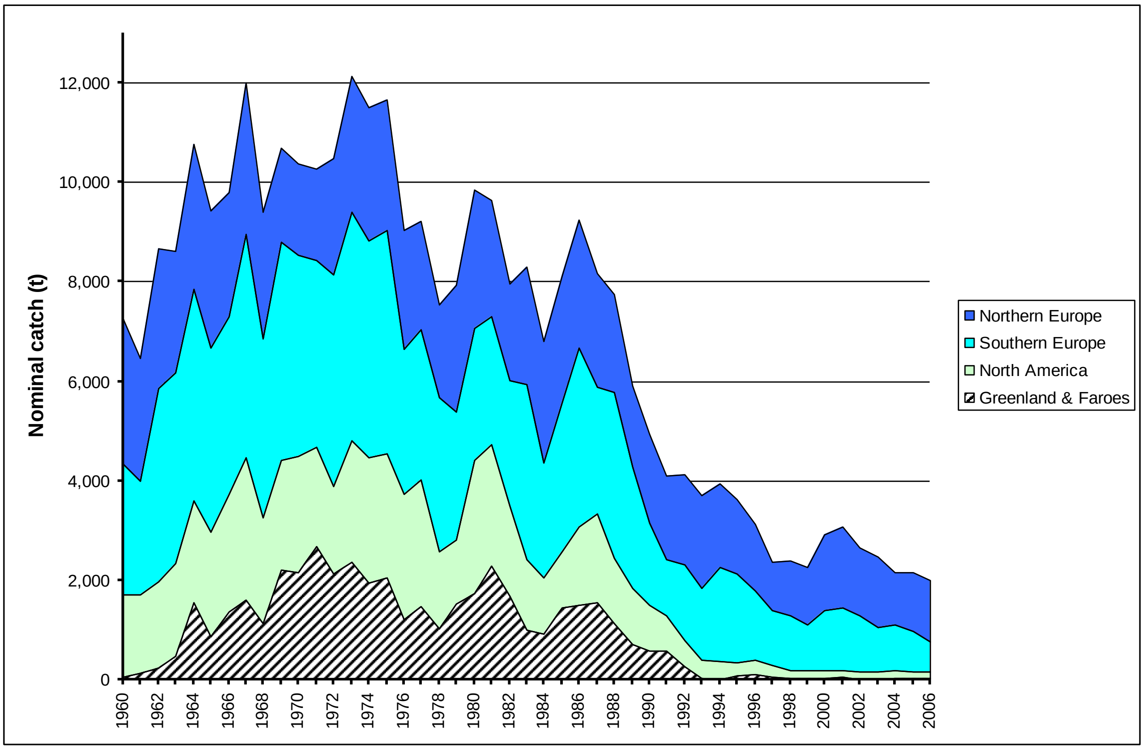


Figure 2.1.1.1. Nominal catches of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960-2006.

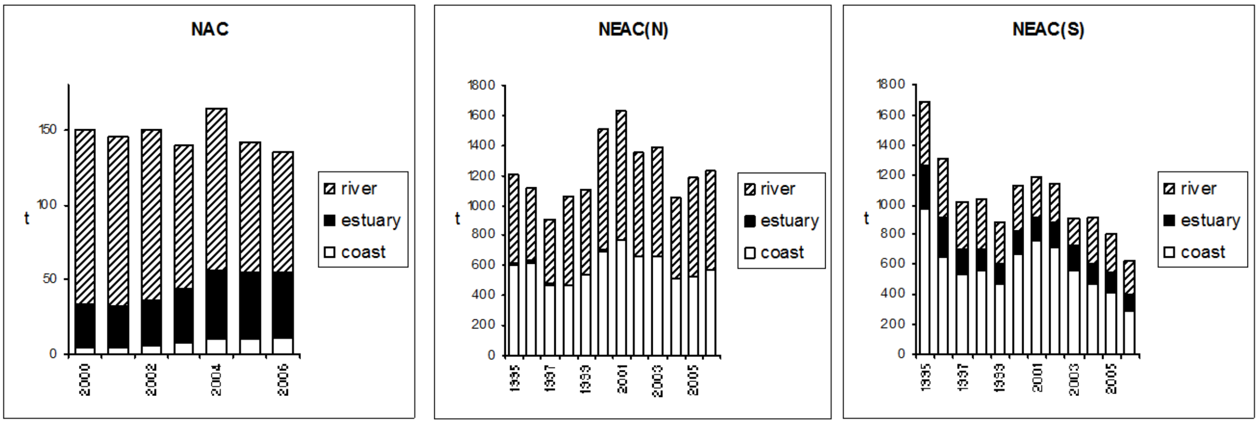


Figure 2.1.1.2. Nominal catch taken in coastal, estuarine, and riverine fisheries for the NAC area, and for the NEAC northern and southern areas. Note that time-series and y-axes vary.

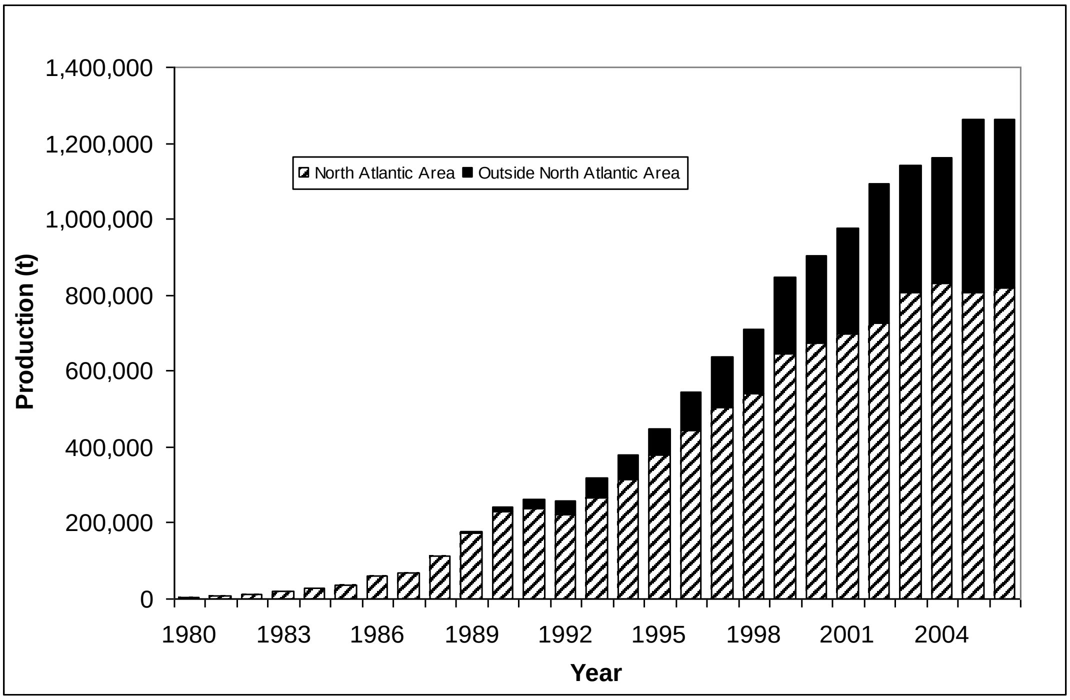


Figure 2.2.1. World-wide production of farmed Atlantic salmon, 1980–2006.

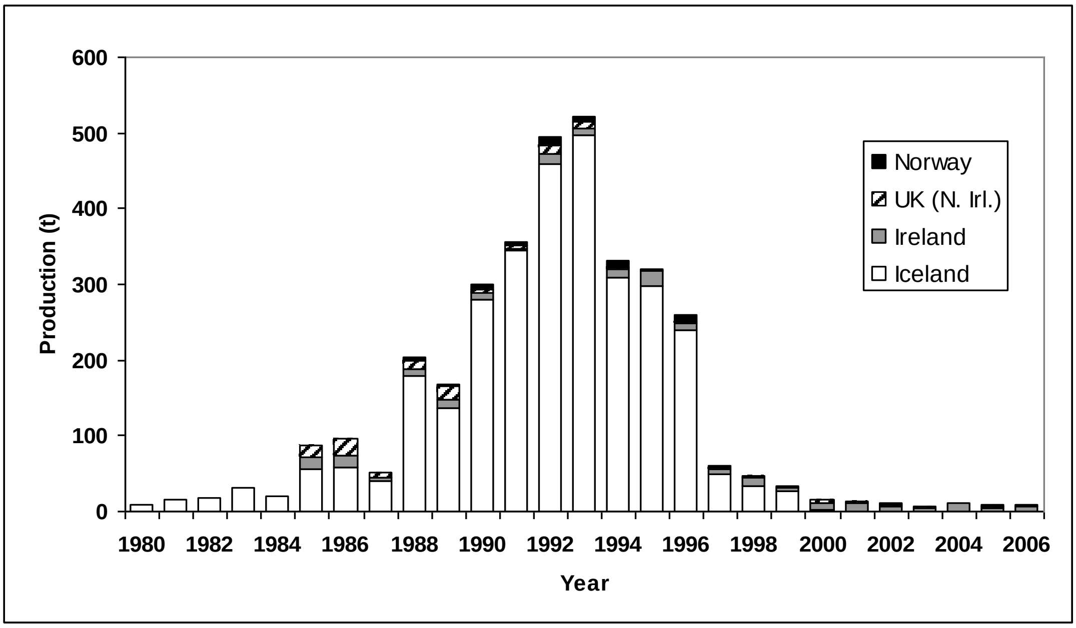


Figure 2.2.2. Production of ranched Atlantic salmon (tonnes round fresh weight) as harvested at ranching facilities in the North Atlantic, 1980–2006.

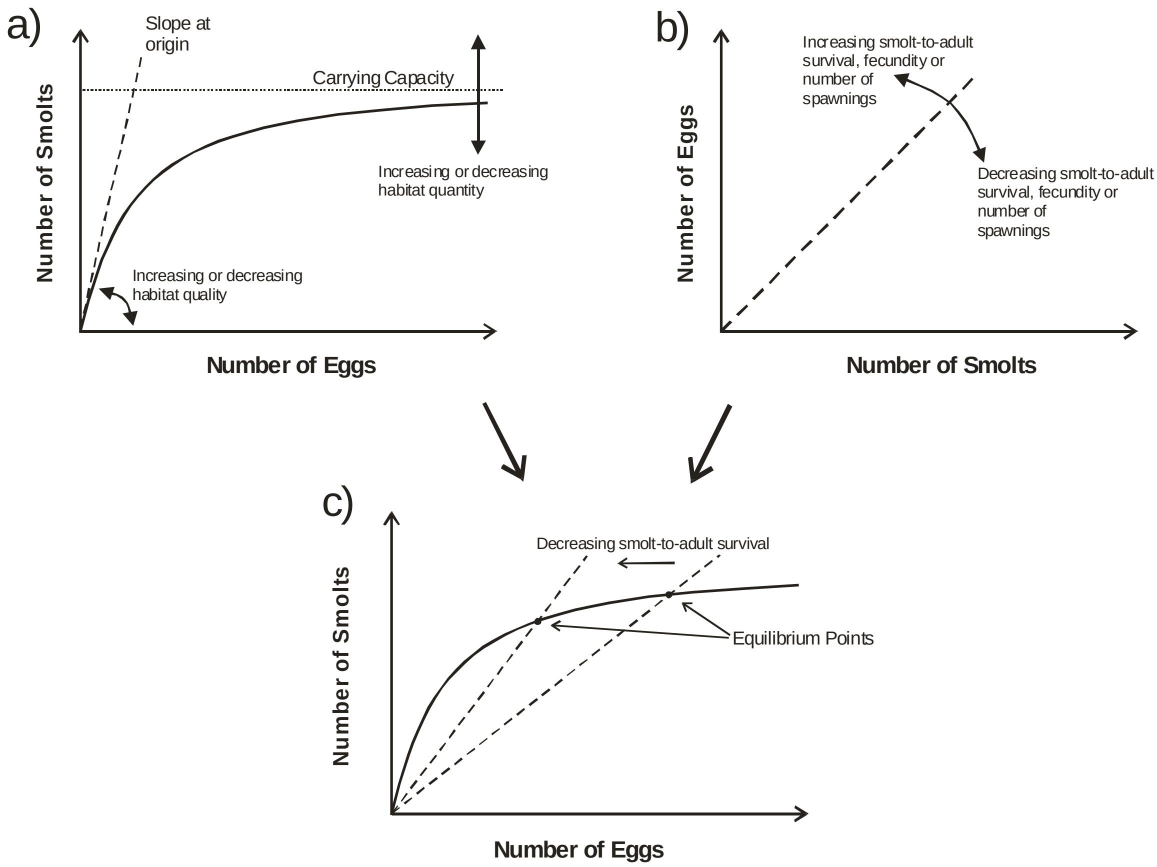


Figure 2.3.1.1. An equilibrium model linking habitat quality and quantity to fish population dynamics. A Beverton–Holt model is used to model the density-dependent relationship for survival from eggs to smolt (a). The slope at the origin of this model, which is the maximum number of smolts produced per egg in the absence of density-dependent effects, changes as habitat quality changes, whereas changes in the amount of habitat change the carrying capacity. The number of eggs produced per smolt (b) throughout its life changes with smolt-to-adult survival, fecundity, age-at-maturity, or the number of times a fish spawns throughout its life. The population equilibrium occurs at the population size where the production of smolts by eggs is in balance with the production of eggs by smolts throughout their lives, and is the size at which the population will stabilize if all rates and the carrying capacity remain unchanged (c). The population equilibrium changes as the vital rates change and can be used to assess how a population is expected to change in response to human activities.

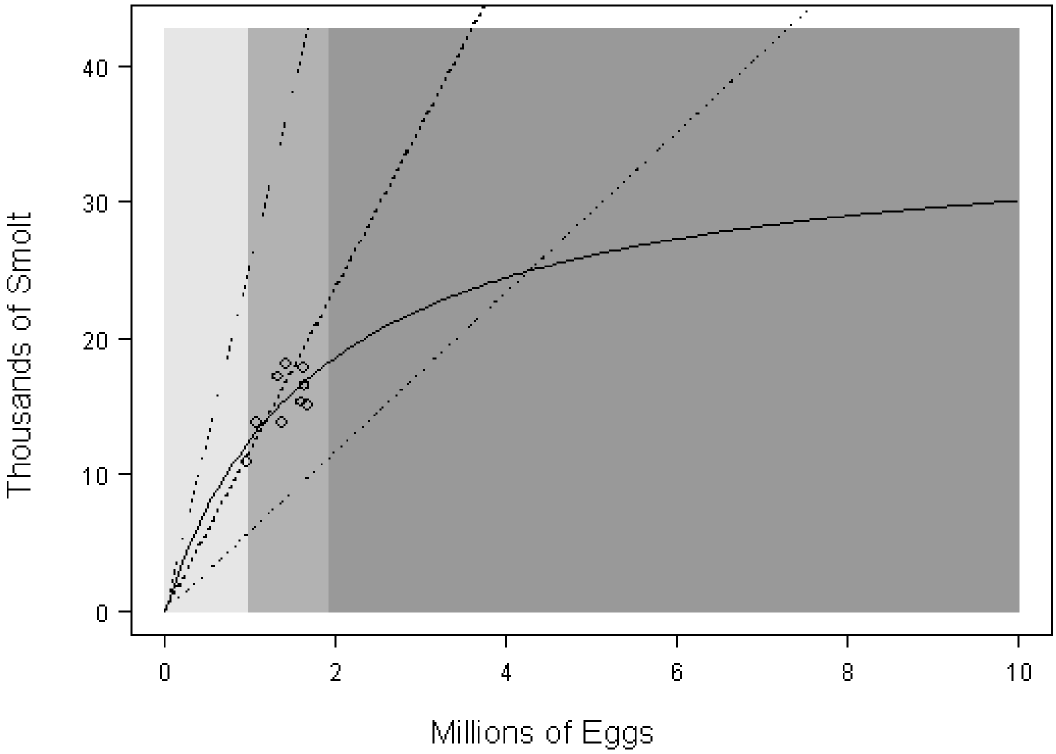


Figure 2.3.1.2. Dynamics of the LaHave River (above Morgan Falls) salmon population. The points are the observed egg depositions and smolt production for the 1994 to 2001 cohort years. The solid line is a Beverton–Holt model obtained by fitting these data to the population spawning above Morgan Falls. The dashed lines show the replacement lines calculated using the minimum, average, and maximum smolt-to-adult return rates observed for this population between 1996 and 2004. Shading indicates the status relative to the conservation egg requirement: dark shading is above the requirement, the medium shading is between 50% and 100% of the egg requirement, and the light shading is below the requirement.

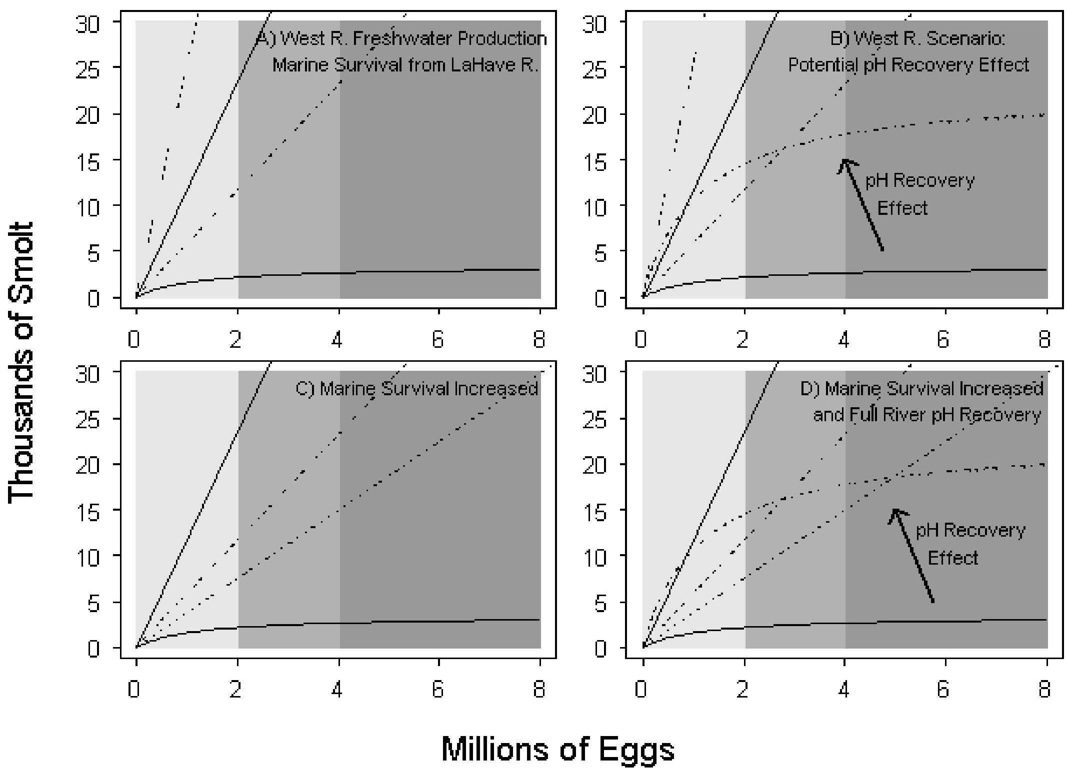


Figure 2.3.1.3. Equilibrium analysis of the recovery potential of salmon in West River (Sheet Harbour, NS). The upper left panel shows the present dynamics in which populations aren't viable as a result of low marine survival and reduced freshwater production due to acidification. The slopes of replacement lines are calculated using the mean, minimum, and maximum return rates for LaHave River salmon for the 1996 to 2004 return rates. The upper right panel shows the expected change in freshwater production if the acidification problem was addressed in the entire river. The lower left panel shows the dynamics if freshwater production remains unchanged and at-sea survival rates are the mean and maximum returns rates from the LaHave River, together with a hypothesized return rate increase to 6% for 1SW and 2% for 2SW salmon. The lower right panel shows a combined increased freshwater production and increased marine survival scenario in which the conservation egg requirement is reached. Shading indicates the status relative to the conservation egg requirement: dark shading is above the requirement, the medium shading is between 50% and 100% of the egg requirement, and the light shading is below the requirement.

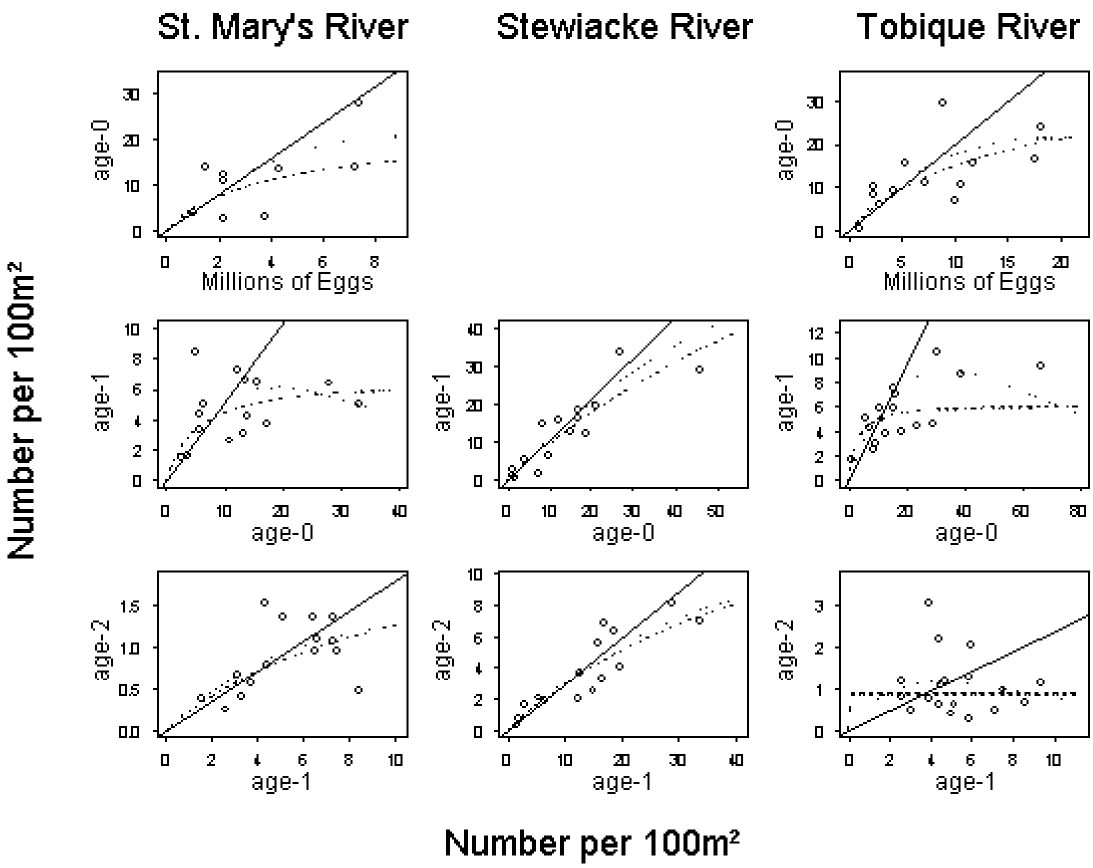


Figure 2.3.6.1. Observed (points) and predicted (lines) densities of Atlantic salmon obtained by fitting three models to the data. The data are the observed abundance or density within a cohort by age. The solid line is a one-parameter model that shows the fit obtained based on the assumption that survival is density independent. The dashed and dotted lines show the fits obtained from two-parameter Beverton–Holt and Ricker models respectively. Note: egg deposition time-series not available for the Stewiacke River.

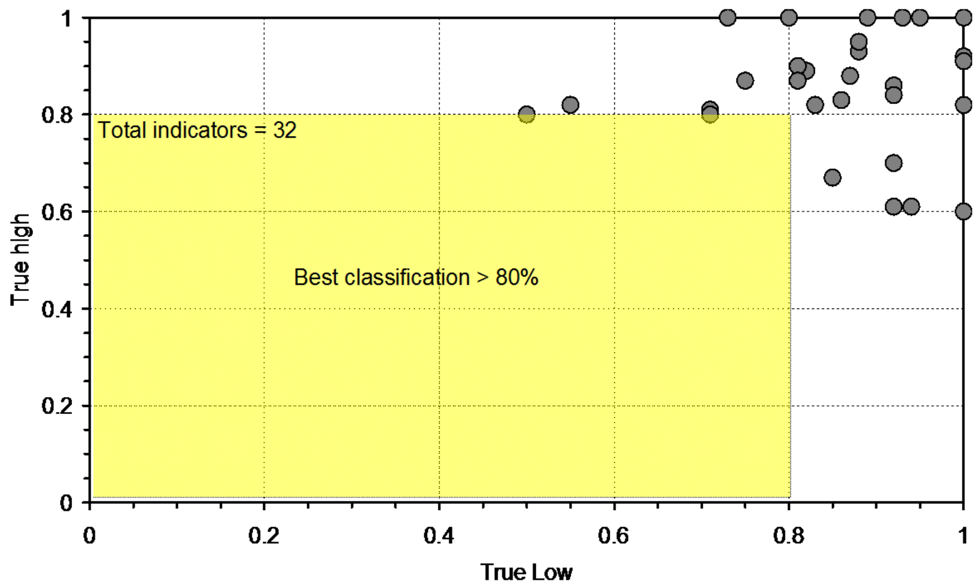


Figure 2.4.2.1. Comparative performance of the retained indicators (N = 32) at identifying a true low (i.e. management objective will not be met) and a true high (i.e. management objective will be met) for the West Greenland multi-year catch advice framework.

Derived multi-year catch advice	
Catch option (t)	0

Overall Recommendation

No Significant Change Identified by Indicators

Geographic Area	River/ Indicator	2008 Value	Ratio Value to Threshold	Threshold	True Low	True High	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns	727	51%	1415	100%	92%	-1	1	-1	
	Penobscot 2SW Rate (%)	0.12	50%	0.24	100%	60%	-1	1	-1	
	Penobscot 1SW Returns	290	59%	495	82%	89%	-1	0.82	-0.82	
	Penobscot 1SW Rate (%)	0.05	56%	0.09	85%	67%	-1	0.85	-0.85	
	Narraguagus Returns	22	22%	100	94%	61%	-1	0.94	-0.94	
	possible range				*-0.92*	*0.74*				
	Average		48%						**-0.92**	**No**
Scotia-Fundy	Saint John Return Large	458	20%	2,309	100%	91%	-1	1	-1	
	Lahave Return Large	148	49%	301	100%	100%	-1	1	-1	
	North Return Large	245	48%	509	93%	100%	-1	0.93	-0.93	
	St. Mary's Return Large	91	41%	221	100%	82%	-1	1	-1	
	Saint John Return Small	725	32%	2,276	81%	90%	-1	0.81	-0.81	
	Lahave Return Small	870	45%	1931	92%	86%	-1	0.92	-0.92	
	St. Mary's Return Small	857	54%	1583	92%	84%	-1	0.92	-0.92	
	North Return Small	137	63%	216	92%	70%	-1	0.92	-0.92	
	Saint John 2SW Rate (Hatchery %)	0.113	51%	0.222	87%	88%	-1	0.87	-0.87	
	Saint John 1SW Rate (Hatchery %)	0.514	69%	0.745	81%	87%	-1	0.81	-0.81	
	possible range				*-0.92*	*0.88*				
	Average		44%						**-0.92**	**No**
Gulf	Miramichi 2SW	9634	53%	18,119	95%	100%	-1	0.95	-0.95	
	Miramichi 1SW	30699	91%	33,610	92%	61%	-1	0.92	-0.92	
	possible range				*-0.94*	*0.81*				
	Average		72%						**-0.94**	**No**
Quebec	Bonaventure Large	1497	101%	1479	75%	87%	1	0.87	0.87	
	Grande Rivière Large	371	85%	437	100%	100%	-1	1	-1	
	Saint-Jean Large	716	97%	736	83%	82%	-1	0.83	-0.83	
	Dartmouth Large	643	85%	756	73%	100%	-1	0.73	-0.73	
	Sainte-Anne Large	356	86%	413	88%	93%	-1	0.88	-0.88	
	Mitis Large	364	99%	369	71%	81%	-1	0.71	-0.71	
	Godbout Large	469	80%	584	80%	100%	-1	0.8	-0.8	
	De la Trinite Large	286	74%	385	73%	100%	-1	0.73	-0.73	
	York Small	417	110%	380	50%	80%	1	0.8	0.8	
	Dartmouth Small	298	105%	284	55%	82%	1	0.82	0.82	
	Madeleine Small	468	108%	432	71%	80%	1	0.8	0.8	
	Sainte-Anne Small	205	129%	159	71%	80%	1	0.8	0.8	
	Godbout Small	425	84%	508	89%	100%	-1	0.89	-0.89	
	De la Trinite Small	373	93%	399	88%	95%	-1	0.88	-0.88	
	possible range				*-0.76*	*0.90*				
	Average		88%						**-0.24**	**No**
Newfoundland	Middle Brook Small	1640	94%	1,751	86%	83%	-1	0.86	-0.86	
	possible range				*-0.86*	*0.83*				
	Average		94%						**-0.86**	**No**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Southern NEAC										
	possible range									
	Average								**NA**	**Unknown**

Figure 2.4.3.1. Framework of indicators spreadsheet for the West Greenland fishery. For illustrative purposes, the average of the most recent ten years of returns or return rates for the 32 retained indicators is entered in the cells corresponding to the annual indicator variable values.

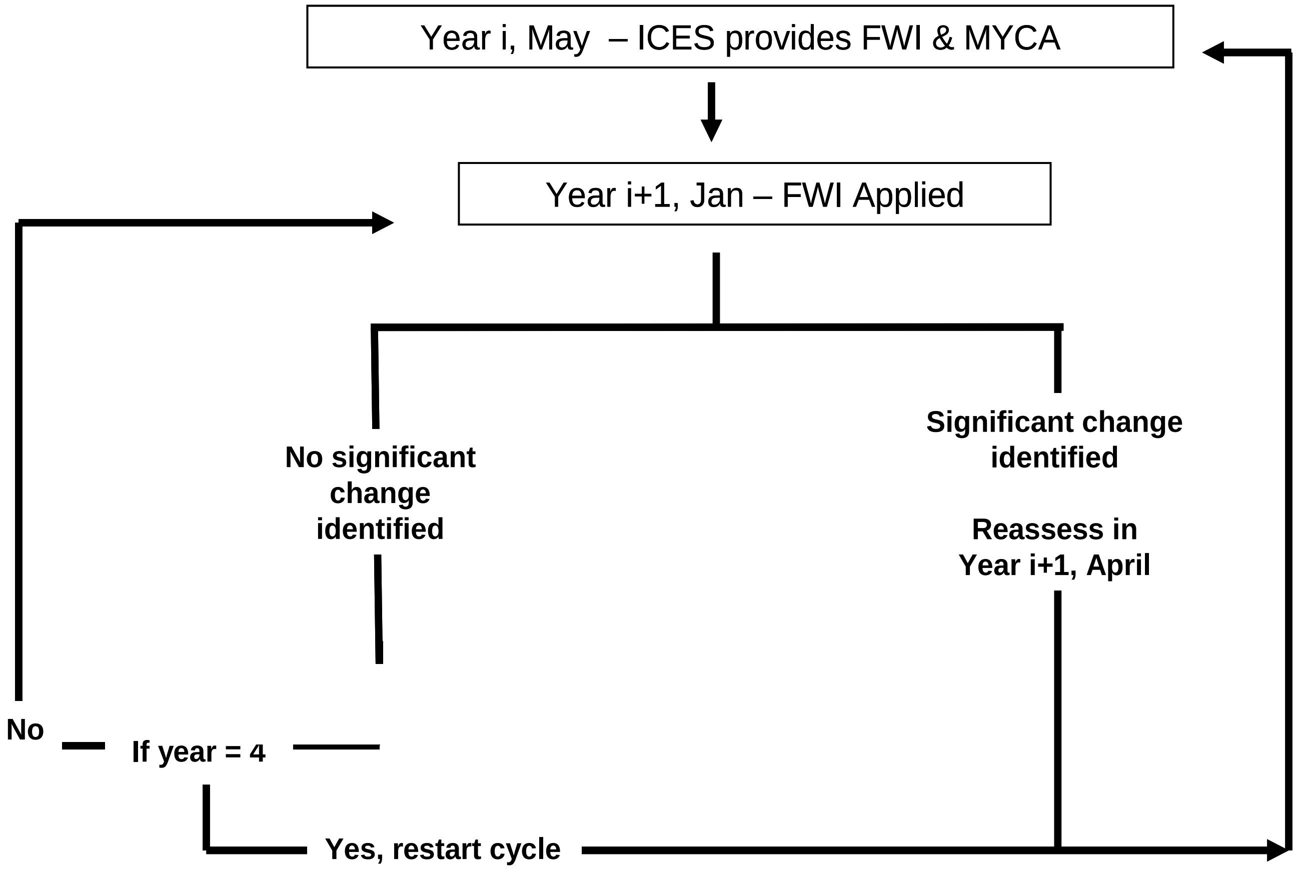


Figure 2.4.3.2. Suggested timeline for employment of the Framework of Indicators (FWI). In Year i, ICES provides multi-year catch advice (MYCA) and an updated FWI which re-evaluates the updated datasets and is summarized in an Excel worksheet. In January of Year i+1 the FWI is applied and two options are available depending on the results. If no significant change is detected, no re-assessment is necessary and the cycle continues to Year i+2. If no significant change is detected in Year i+2, the cycle continues to Year i+3. If a significant change is detected in any year, then reassessment is recommended. In that case, ICES would provide an updated FWI the following May. ICES would also provide an updated FWI if year equals 4.

3 NORTH-EAST ATLANTIC COMMISSION

Conservation limits (CLs) have been defined by ICES as the level of stock that will achieve long-term average maximum sustainable yield (MSY). NASCO has adopted this definition of CLs (NASCO, 1998). The CL is a limit reference point; having populations fall below these limits should be avoided with high probability. However, management targets have not yet been defined for all NEAC Atlantic salmon stocks. Therefore:

- ICES considers homewater stocks in the NEAC Commission to be at full reproductive capacity when the lower bound of the confidence interval of the most recent spawner estimate is above the CL. In a similar manner, the status of stocks prior to the commencement of distant water fisheries has been interpreted to be at full reproductive capacity when the lower bound of the confidence interval of the most recent PFA estimate is above the Spawner Escapement Reserve (SER).
- ICES considers a stock to be at risk of suffering reduced reproductive capacity when the lower boundary of the spawner/PFA confidence limit is below the CL/SER, but the midpoint is above.
- ICES considers a stock to be suffering reduced reproductive capacity when the spawner/PFA midpoint is below the CL/SER.

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 used the risk level of 75%, which is part of the agreed management plan (ICES, 2003).

For stock assessment purposes, the NEAC stocks are grouped into two stock groupings; northern and southern NEAC stocks. The composition of these groups is shown below:

Southern European countries:	**Northern European countries:**
Ireland	Finland
France	Norway
UK (England & Wales)	Russia
UK (Northern Ireland)	Sweden
UK (Scotland)	Iceland (north/east regions) [1]
Iceland (south/west regions)[1]	

3.1 Status of stocks/exploitation

The status of stocks is shown in Figure 3.1.1.

ICES classifies the status of stock complexes prior to the commencement of distant water fisheries with respect to the SER requirements as follows:

- Northern European 1SW stocks are considered to be at full reproductive capacity.
- Northern European MSW stocks are considered to be at full reproductive capacity.
- Southern European 1SW stocks are considered to be at risk of suffering reduced reproductive capacity.
- Southern European MSW stocks are considered to be at risk of suffering reduced reproductive capacity.

[1] The Iceland stock complex was spilt into two separate complexes for stock assessment purposes in 2005. Prior to 2005, all regions of Iceland were considered to contribute to the Northern European stock complex.

Estimated exploitation rates have generally been decreasing over the time period for both 1SW and MSW stocks in Northern and Southern NEAC areas (Figure 3.1.2 and Figure 3.1.3). Exploitation on Northern 1SW stocks is higher than on Southern 1SW and considerably higher for MSW stocks. There has been a slight increase in exploitation on 1SW and 2SW northern stocks since 2002. However, the current estimates for both stock complexes are amongst the lowest in the time-series.

3.2 Management objectives

This commission area is subject to the general NASCO management objectives as outlined in Section 1.3.

3.3 Reference points

Section 1.4 describes the derivation of reference points for these stocks and stock complexes.

3.3.1 National conservation limits

The national model has been run for all countries that do not have river-specific conservation limits (i.e. all countries except France, Ireland, and UK (England & Wales)).

Iceland, Russia, Norway, UK (Northern Ireland), and UK (Scotland) have provided regional input data for the PFA analysis (1971–2006). For these countries the lagged spawner analysis has been conducted by region. The regional results were combined to estimate conservation limits based on a pseudo stock–recruitment relationship for the country. Outputs from the national model are only designed to provide a provisional guide to the status of stocks in the NEAC area.

To provide catch options to NASCO, conservation limits 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. For the NEAC area, the conservation limits have been calculated by ICES as:

- Northern NEAC 1SW spawners – 271 111
- Northern NEAC MSW spawners – 140 230
- Southern NEAC 1SW spawners – 624 221
- Southern NEAC MSW spawners – 269 237

3.3.2 Progress with setting river-specific conservation limits

Specific progress in individual countries is summarised below:

In Iceland, work is progressing on several rivers to derive river-specific CLs. Several datasets and techniques (catch data, counter data, habitat mapping, wetted area and juvenile surveys) are being used to estimate salmon production, run size, and spawning escapement. To date, work has indicated highly variable spawning reference levels. The next stage will explore if and how CLs can be transported to recipient rivers.

In UK (Scotland), work is continuing on the development of procedures for setting river-specific CLs. GIS applications, in conjunction with field-based observation and a literature review of salmon distribution, have been used to develop a map-based useable wetted area model for salmon which can be used to transport CLs among catchments. A CL has been derived for the North Esk and this has been transported to several recipient rivers. Methods to determine spawning escapement values in these rivers are now being investigated.

In Norway, work is in progress to set conservation limits in 80 rivers. This work is based on stock–recruitment relationships in nine rivers, and further transportation to data-poor rivers based on similarities in productivity and stock age structure. Productivity is mostly based on catch statistics, and scale samples are used to access the river- and sea-age structure in a subset of the populations. To derive the CLs, wetted areas have been determined for the rivers, based on digital maps and knowledge on how far salmon can migrate in the rivers. This work is planned to be reported to the Directorate for Nature Management during the summer of 2007.

So far only France, Ireland, and UK (England & Wales) have implemented river-specific conservation limits.

3.4 Management advice

ICES has been asked to provide catch options or alternative management advice, if possible based on a forecast of PFA, with an assessment of risks relative to the objective of exceeding stock conservation limits in the NEAC area.

Given the status of the stocks ICES provides the following advice on management:

- **Northern European 1SW stocks:** In the absence of specific management objectives for this stock complex the precautionary approach is to fish only on maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity.
- **Northern European MSW stocks:** In the absence of specific management objectives for this stock complex the precautionary approach is to fish only on non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity.
- **Southern European 1SW stocks:** In the absence of specific management objectives for this stock complex the precautionary approach is to fish only on maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Reductions in exploitation are required for as many stocks as possible, to increase the probability of the complex meeting conservation limits. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status.
- **Southern European MSW stocks:** The quantitative forecast of PFA for 2007 indicates that this stock complex is expected to continue to decline from the previous year. In the absence of any fisheries on this stock complex there is a less than 64% probability that the CL will be achieved in 2008. The PFA forecast for 2007-2010 predicts values below the SER and therefore there should be no fishing on this complex at West Greenland or Faroes. In the absence of specific management objectives for this stock complex, with the exception of the West Greenland fishery, the precautionary approach is to fish only on non-maturing 1SW salmon from rivers where stocks have been shown to be at full reproductive capacity. Reductions in exploitation are required for as many stocks as possible, to increase the probability of the complex meeting conservation limits. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status.

3.5 Relevant factors to be considered in management

The national stock conservation limits discussed in Section 3.3.1 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 conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations. Nevertheless, the combined conservation limits 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.

Management for all fisheries should be based upon assessments of the status of individual stocks. Fisheries on mixed stocks, either in coastal or distant waters, pose particular difficulties for management as they cannot target stocks that are at full reproductive capacity. Conservation would be best achieved if fisheries target stocks that have been shown to be at full reproductive capacity. Fisheries in estuaries and rivers are more likely to meet this requirement.

It should be noted that the inclusion of farmed fish in the Norwegian data would result in the stock status being overestimated. Since very few of these salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea, management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks.

NEAC PFAs from the national models are combined to provide NASCO with catch advice or alternative management advice for the distant water fisheries at West Greenland and Faroes. These groups were deemed appropriate as they fulfilled an agreed set of criteria for defining stock groups for the provision of management advice that were considered in detail at the 2002 meeting (ICES, 2002) and re-evaluated at the 2005 meeting (ICES, 2005).

Consideration of the level of exploitation of national stocks at Faroes and West Greenland fisheries resulted in the proposal that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC area stocks, but that advice for the West Greenland fishery should be based upon Southern European MSW salmon stocks only (comprising UK, Ireland, France, and Iceland (south/west regions)).

3.6 Pre-Fishery Abundance for 2006–2010

To develop quantitative catch options for NEAC stock complexes, forecasts of PFA are required for each stock complex and for each sea-age component. These are currently only available for the non-maturing 1SW component of the southern European stock complex. The forecast of this PFA for 2007 has been used to provide management advice for West Greenland and Faroes for 2007. ICES has adopted a model to forecast the pre-fishery abundance (PFA) of non-maturing (potential MSW) salmon from the Southern European stock group (ICES, 2002, 2003). Model options were re-evaluated in 2007 to explore the relative contribution of several variables to predictions of PFA. As in the past three years, ICES decided to apply a model that used the *Year* and *Spawners* terms to predict the PFA of non-maturing salmon where it was fitted to data from 1978–2005 and used to update the PFA in 2006 and to forecast the PFA in 2007 (Figure 3.6.1).

Provision of 3-year management advice for the Faroese fishery requires that PFA forecasts be extended to 2010. This has been achieved by estimating the *Spawner* term for the 1-year-old smolts in 2010 for each homewater country as the average of the previous five years. The quantitative prediction for the southern NEAC non-maturing (potential MSW) stock component gives a projected PFA (at 1st January each year) for catch advice in 2008–2010 (Figure 3.6.1). No projections are available for other stock components or complexes in the NEAC area.

Predicted PFA and 95% confidence limits of non-maturing 1SW salmon for Southern NEAC are given below:

YEAR	PFA	LOWER	UPPER
2006	483,733	319,960	731,333
2007	455,415	300,621	689,913
2008	434,060	285,640	659,602
2009	413,701	271,349	630,733

2010	410,542	267,052	631,130

The lower bound of the 95% confidence intervals for all the estimates are less than the SER (455 413) and therefore there is no surplus available for exploitation.

3.7 Comparison with previous assessment

3.7.1 PFA forecast model

The midpoints of updated forecasts of the southern NEAC MSW PFA for the years 2006 to 2008 were 484 000, 455 000, and 434 000, respectively. All were between 1% and 2% lower than the forecasts (489 000, 461 000, and 440 000) provided last year.

3.7.2 National PFA model and national conservation limit model

Provisional catch data for 2005 were updated where appropriate. In addition, changes were made to the input data from Iceland. Exploitation rates were reduced in recent years to take into account the increasing practice of catch and release in the rod fishery. Changes were also made to non-reporting rates to better reflect current knowledge.

3.8 NASCO has requested ICES to describe the key events of the 2006 fisheries and the status of the stocks

3.8.1 Fishing at Faroes in 2005/2006

No fishery for salmon has been carried out since 2000. No buyout arrangement has been in force since 1999.

3.8.2 Significant events in NEAC homewater fisheries in 2006

In several countries, measures aimed at reducing exploitation were implemented or strengthened in 2006. These include: a reduction of net fisheries in UK (England and Wales), a continuing reduction of a TAC used in Ireland to limit catches, and the introduction of bag limits in some districts.

3.8.3 Gear and effort

No significant changes in the types of gear used for salmon fishing were reported in the NEAC area and the number of licensed gear units has, in most cases, continued to fall. There are no such consistent trends for the rod fishing effort in NEAC countries over this period.

3.8.4 Catches

In the NEAC area there has been a general reduction in catches since the 1980s (Table 2.1.1.1). 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 declared catch in the NEAC area in 2006 was 1846 tonnes, slightly lower than in 2005 (1995 t), but down on the previous 5-year mean. The catch in the Southern area has declined over the period from about 4500 t in 1972–1975 to below 1500 t since 1986, and is now just above 600 t. The catch declined particularly sharply in 1976 and again in 1989–91. The catch in the Northern area also shows an overall decline over the time-series, but less steep than for the Southern area. The catch in the Northern area varied between 1850 and 2700 t from 1971 to 1986, fell to a low of 962 t in 1997, and then increased to over 1500 t in 2001. The catch has shown a downward trend again since this time. Thus, the catch in the Southern area, which comprised around two-thirds of the NEAC total in the early 1970s, has been lower than that in the Northern area since 1999.

3.8.5 Catch per unit effort (cpue)

Cpue can be influenced by various factors, and it is assumed that the cpue of net fisheries is a more stable indicator of the general status of salmon stocks than rod cpue since the latter may be more affected by varying local factors.

In the Southern NEAC area, cpue show a general decrease in UK (Scotland) and UK (England & Wales) net fisheries. cpue for the net fishery showed mostly lower figures compared to 2005 and the previous 5-year averages. In the Northern NEAC area, there has been an increasing trend in the cpue figures for Norwegian net fisheries and Russian rod fisheries in Barents Sea rivers. A decreasing trend was noted for rod fisheries in Finland (River Teno) and Russian White Sea rivers. In comparison with the previous year, most cpue values went up and were higher than the previous 5-year means.

3.8.6 Age composition of catches

1SW salmon comprised 60% of the total catch in the Northern area in 2006, which was below the 5- and 10-year means (61% and 64%, respectively). In general, there has been greater variability in the proportion of 1SW fish between countries in recent years (since 1994) than prior to this time. For the Southern European countries, the overall percentage of 1SW fish in the catch (59%) was close to the 5- and 10-year mean (60% in both cases).

3.8.7 Farmed and ranched salmon in catches

The contribution of farmed and ranched salmon to national catches in the NEAC area in 2006 was again generally low (<2% in most countries) and is similar to the values that have been reported in previous reports (ICES, 2006). The occurrence of such fish is usually ignored in assessments of the status of national stocks. However, in Norway farmed salmon continue to form a large proportion of the catch in coastal (33% in 2006), fjordic (19% in 2006), and rod fisheries (7% in 2006). An assessment of the likely effect of these fish on the output data from the PFA model has been reported previously (ICES, 2001).

3.8.8 National origin of catches

Information presented by Ireland on the origin of tagged salmon recovered from their screening programme of Irish fisheries over the period 1985–2006 was reviewed. In 2006, 31 tags originating from fish released from five other countries were recovered in Irish fisheries: 15 from UK (Northern Ireland), 9 from UK (England & Wales), 2 from Spain, and 5 from Germany. The number of tagged salmon recovered is raised to the total fishery to give an indication of the relative contribution of non-Irish salmon. The analysis indicated that the highest average recapture rates for non-Irish tagged salmon are UK (N. Ireland), UK (Scotland), Denmark, France, UK (England and Wales), Spain, Germany, and Norway, respectively.

These data provide little information on exploitation rates of fish from each country which are taken in Irish fisheries and therefore say little about the potential impacts on individual stocks. River-specific models based on the run reconstruction approach were presented for a number of English and Welsh stocks, which were updated. The results demonstrated that: salmon from all parts of England and Wales are exploited in the Irish coastal fishery, exploitation levels vary among regions and years, and there has been a general decline in exploitation following the introduction of management measures in the Irish fishery since 1997. Exploitation rates varied considerably from year to year and that exploitation rates on particular stocks may still be relatively high in some years and negligible in others. For stocks below their conservation limit, even low levels of exploitation may represent an impediment to stock recovery.

3.8.9 Trends in the PFA for NEAC stocks

Northern European 1SW and MSW stocks: Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Northern Europe (Figure 3.1.1) show broadly similar patterns. The general decline over the time period is 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. Trends in spawner number for the Northern stock complexes for both 1SW and MSW are similar. Throughout most of the time-series, both 1SW and MSW spawners have been either at full reproductive capacity (as in 2006) or at risk of reduced reproductive capacity. This is broadly consistent with the general pattern of decline in marine survival of 1SW and 2SW returns in most monitored stocks in the area (Section 3.8.10).

Southern European 1SW and MSW stocks: Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Southern Europe (Figure 3.1.1) show broadly similar declining trends over the time period. The maturing 1SW stock complex has been at full reproductive capacity over the time period with the exception of 2006, when it was at risk of suffering reduced reproductive capacity after homewater fisheries had taken place. 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 after homewater fisheries have taken place in five of the nine years since 1996. Declining trends in spawner number are evident in the Southern stock complexes for both 1SW and MSW. However, the 1SW stock has been at risk of reduced reproductive capacity or suffering reduced reproductive capacity for most of the time-series. In contrast the MSW stock has been at full reproductive capacity for most of the time-series until 1997; since then this stock has been either at risk of reduced reproductive capacity or suffering reduced reproductive capacity. This is broadly consistent with the general pattern of decline in marine survival of 1SW and 2SW returns in most monitored stocks in the area (Section 3.8.10).

3.8.10 Survival Indices for NEAC stocks

An overall trend in both Northern and Southern NEAC areas, both wild and hatchery smolts, show a decline in marine survival with the annual decline varying between 1% and 13% (Figure 3.8.10.1). Most of the survival indices for wild smolts were lower than those of the previous year, but higher than or at the 5- and 10-year averages. Most of the survival indices for the hatchery-reared smolts were below the 5- and 10-year averages, although many figures were at or higher than those of the previous year. Return rates of hatchery-released fish, however, may not always be a reliable indicator of marine survival of wild fish. Results from these analyses are consistent with the information derived from the PFA model (Section 3.8.9), and suggest that returns are strongly influenced by factors in the marine environment.

3.9 NASCO has requested ICES to provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved

In 2005, ICES noted the implications for salmon stocks arising from the implementation of Council Directive 92/43/EEC (on the conservation of natural habitats and of wild flora and fauna). States are obliged to take measures to ensure that the exploitation of salmon stocks is compatible with their being maintained at a favourable conservation status. Under the terms of the Directive, every 6 years Member States are obliged to submit a report detailing the conservation status of their salmon stocks. The first such report is due to be submitted in 2007.

Salmon management in European Member States is becoming increasingly linked with the Water Framework Directive (Directive 2000/60/EC) (WFD), and its 6-year planning cycle. The 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.

Member States will need to identify River Basin Districts (RBDs), which will be 'characterized' by assessing the pressures and impacts, on the water environment, such as overuse or pollution. Once that is complete, a RBMP for each District will be prepared setting out how these impacts will be reduced through its PoM. Monitoring programmes will then chart progress towards achievement of Good Ecological Status. RBMPs and PoMs need to be agreed, finalized, and published by December 2009 for the first round of the WFD planning cycle. The second round plans are to be published in 2015. The status of migratory species and access to habitats will be important elements to take into account when assessing Good Ecological Status.

Most management measures introduced in recent years in relation to international, national, and local objectives have aimed to reduce levels of exploitation on NEAC stocks, to increase freshwater escapement, and in some countries specifically to meet river-specific CLs. Although some local measures have had notable success (Table 3.9.1), the two southern NEAC stock complexes are currently suffering reduced reproductive capacity after homewater fisheries have taken place.

3.10 NASCO has requested ICES to provide estimates of bycatch and non-catch fishing mortality of salmon in pelagic fisheries with an assessment of impacts on returns to homewaters

3.10.1 SGBYSAL

Disaggregated pelagic fisheries data (e.g. by weeks, gear types, etc.) are generally available from most countries who have important fisheries in the Nordic Seas. In contrast, there have not been any dedicated investigations on distribution of postsmolts and salmon in this area since 2005. Therefore, without data on salmon distribution or regularly occurring reliable reports on bycatches, it is not possible to provide updated estimates of bycatch. Consequently, the Study Group on Bycatch of Salmon in Pelagic Fisheries (SGBYSAL) was dissolved by ICES in 2006 and will be reconvened when new and relevant information becomes available. However, ICES continues to collate reports on salmon taken in commercial or research fisheries to document any increases in the frequencies of such reports.

3.10.2 Bycatch of salmon in non-targeted catches in 2006

Norwegian research vessels registered a bycatch of 46 post-smolts from one single haul and 7 larger salmon from three separate cruises (Figure 3.10.2).

Norwegian bycatch observers have not reported any salmon bycatches during routine screening of commercial catches.

Records were obtained of a bycatch of 12 larger salmon (from 1 to 12 kg) from a commercial trawl fishery for cod northeast of Bear Island during August and September 2006.

Russian commercial catches screening reported a total of 9 salmon as follows:

In 2006 the screening program was carried out in the Norwegian Sea by FV M-0011 "Boris Syromyatnikov" while pelagic fishing for mackerel, blue whiting, and herring from June 19 to September 16.

Four post-smolts (wt – 127–170 g) were found in a single catch of 40 tonnes of mackerel taken in international waters on 27 June. On 2 July, one post-smolt (wt – 120 g) was found in a catch of 35 tonnes of mackerel. All post-smolts were caught when surface trawling at a depth of 0–50 meters. One adult salmon (female, fl – 54 cm, wt – 3.5 kg) was caught while fishing for herring.

Two other commercial vessels reported Atlantic salmon bycatch while fishing for mackerel. One post-smolt (wt – 130 g) was found on 7 July. One adult salmon (male, fl – 52 cm, wt – 2.0 kg) was reported in the catch of another ship the same day. A third commercial vessel registered a Norwegian Carlin tagged postsmolt (fl – 286 mm) in a herring catch on 15 August (Figure 3.10.2).

The above records do not supply enough information to allow an assessment of the effect of non-targeted fisheries on salmon abundance.

Table 3.9.1. Summary of national objectives, recent management measures and attainment of management objectives.

Country	Objective	Measure	Assessment	Outcome/extent achieved	Further consideration
Russia	Reduce commercial fishing effort and enhance recreational catch and release fisheries	Various management measures including prohibition of some important commercial in-river fisheries and allocation quotas for fisheries	Examination of catch statistics	Mean total commercial catch reduced by 38% and mean in-river commercial catch reduced by 67% (2002-2006 compared to 1997-2001). Catch and release increased twice in past 5 years	Further reductions likely to be introduced
Ireland	Reduce exploitation rates and increase freshwater returns leading to simultaneous attainment of CLs in all rivers	TAC imposed in 2002 which has been reduced by 17%, 11%, 14% and 35% annually or 58% in total. Restrictions in angling catch including bag limits and mandatory catch and release operated from the 1st of September in 8 fishery districts which were assessed as being below their Conservation Limits	Examination of coded wire tagging returns to Irish and UK rivers pre and post imposition of TACs	Exploitation rate reduced from 61% (pre-2002) to 46% (post 2002) for wild salmon, 82% to 69% for hatchery salmon Exploitation rate on UK stocks reduced by up to 50% following management measures in 1997 and imposition of TACs	Mixed stock marine fisheries will not operate in 2007 and hereafter.
	Maintain salmon stocks in SAC rivers at favourable conservation status	As above	Examination of counter (14 rivers) or rod catch (16 rivers)data to assess CL compliance for 30 SAC rivers	Following re-apraisal in 2007 and with the closure of the irish mixed stock fishery at sea, 19 of 30 SAC rivers will probably meet CLs	Under the EU Water Framework Directive water quality and fish passage are expected to improve
UK (England & Wales)	Safeguard MSW stock component	National spring salmon measures introduced in 1999 (restricted net fishing before June and required compulsory catch & release by anglers up to June 16)	Estimated 1,000 salmon saved from net fisheries and 1,600 saved from rod fisheries in 2006 due to these measures	Spawning escapement of spring salmon may have increased by up to one third on some rivers due to measures	Measures will remain in place until at least 2008.
	Stocks to meet or exceed CLs in at least 4 years of 5	Mixed stock fishery measures imposed including phase outs, closures, buy outs and reductions in fisheries	Examination of catch statistics and annual compliance	Coastal fishery catch reduced from average of 41,000 (88-92) to under 32,000 (98-02) and to about 9,500 (03-06) Declared rod catch in 5 north east rivers 61% higher on average in the 4 years since net buy out in 2003, relative to average of 5 years before buy out.	Continuing to phase out remaining mixed stock fisheries and focus on other limiting factors. Annual application of decision structure to assess need for effort controls.
			Examination of counters	Recorded runs (salmon + sea trout) into the Tyne 97% higher since 2003 compared with mean of previous 5 years.	Continue monitoring
		Promote catch and release, including 100% catch and release in some catchments.	Examination of catch statistics, release rates and annual compliance	Catch and release increased to over 50% of rod caught fish in recent years & 100% C&R on some catchments. Estimated to have contributed an extra 34 million eggs in 2006.	Continuing promotion of C&R at national and local levels.

Table 3.9.1. Cont'd. Summary of national objectives, recent management measures and attainment of management objectives.

Country	Objective	Measure	Assessment	Outcome/extent achieved	Further consideration
UK (England & Wales)	To meet a management target on the River Lune of 14.4 million eggs or about 5,000 adults	Regulations on River Lune introduced in 2000 to reduce exploitation in net and rod fisheries by 50% and 25% respectively.	Assessment of counter data, catch statistics and juvenile monitoring data	Increase in salmon spawning and management target exceeded in all years since the regulation. Increases in juvenile production and net catch.	Contine to meet management objectives
	Maintain salmon stocks in SAC rivers at favourable conservation status	Fishing controls, catch and release and addressing issues identified in Salmon Action Plans as appropriate.	Examination of counter/rod data to assess CL compliance for 18 rivers designated as SACs	2 are currently considered to be complying with the management objective of passing the CL 4 years out of 5.	Continue with management plan to meet management objectives. Targeted actions as identified in Salmon Action Plans.
UK (Northern Ireland)	To conserve, enhance, restore and manage salmon stocks in catchments throughout Northern Ireland through two Salmon Management Plans (FCB and Loughs Agency areas).	Voluntary net buyout scheme initiated in FCB area in 2001/2.	Examination of fish counter & rod catch data to assess spawning escapement on index rivers with defined CLs	Homewater exploitation in FCB area reduced from around 10,542 fish per year (1992-2001) to about 2,852 salmon per year (2002-06).	Continue monitoring and management protocols under the salmon management plans.
		Introduction of conservation policies in angling byelaws including mandatory catch & release before 1st June and bag limit of 2 salmon per day thereafter in the FCB area.	Examination of juvenile electric fishing assessments in-river habitat surveys		Continue to develop salmon management plans on other major catchments to define CLs and compliance monitoring mechanisms.
		Rational management of fishery in Loughs Agency area based on compliance against temporal management targets with statutory instruments to increase/decrease in-season effort accordingly.	Assessment of commercial and recreational exploitation through a carcass tagging scheme in both FCB and Loughs Agency areas.		Monitor effect of habitat enhancement schemes.
		Introduction of salmon management plan in FCB area to facilitate monitoring against CL's.	Examination of CWT data to assess exploitation/survival rates.		

Table 3.9.1. Cont'd. Summary of national objectives, recent management measures and attainment of management objectives.

Country	Objective	Measure	Assessment	Outcome/extent achieved	Further consideration
UK (Scotland)	Improve status of early running MSW salmon	Agreement by Salmon Net Fishing Association to delay fishing to beginning of April from 2000	Examination of catch statistics	80% reduction in MSW net fishery catch in February to March relative to previous 5 yr mean	Further reduction in exploitation
		Bervie, N.and S. Esk salmon district net fishery delayed til May with catch and release only until June	Examination of catch statistics	Believed to have increased escapement	Measure in place for 5 years. Re-evaluation after this period
France	Reduce exploitation on MSW in particular and increase escapement and compliance with river specific CLs	Closure since 1994 of Loire-Allier sport and commercial fisheries	Measured against compliance objectives for the area	This did not seem to enhance salmon numbers	Physical obstructions (noticeably Poutès-Monistrol Hydropower Dam) and other environmental factors, including higher temperatures, also being considered
		TACs introduced in 1996 in Brittany and Lower Normandy MSW TACs have lead to temporary closures on some rivers	Examination of catch statistics	Reduced catch and probably increased in spawning numbers. Reduced catch in MSW catch in Brittany since 2000 and Lower Normandy since 2003	Monitored river (Scorff) has failed to meet CL consistently since 1994. However, the Scorff is non typical of exploitation pattern in the area (small fishery)
		Management measures in the Adour-Gaves basin in 1999 and '2003	Examinaton of catch statistics	Some reduction in rod catch but current regulations have been unable to reduce the exploitation rate on MSW stocks as expected	Rod catch increased in 2004 and 2005 when measures lapsed with steady increase in effort and catch of estuary drift net fishery for 1999 to 2004
Germany	Reintroduction of Atlantic salmon Salmon stocks extinct since the middle of 20th century but improvements in conditions and water quality were thought to be sufficient to support salmon	Restocking of rivers running into North Sea (Rhine, Ems, Weser and Elbe). 2 million juveniles (mainly fry) released annually	Trap and counter data (Sieg, upper Rhine)	200-500 adults recorded annually. Return rates of less than 1%	Low return rates thought to reflect obstructions to migration in the Rhine delta as well as spawning tributaries and probably due to bye-catch in non-target fisheries
	Establish free migration routes for salmon and other migratory fishes and rehabilitation of habitat in rivers basins	Collaborative programme has started e.g. Rheinprogramm 2020 (ICPR) International Commision for the Protection of the River Rhine	Assessment in progress	Assessment in progress	

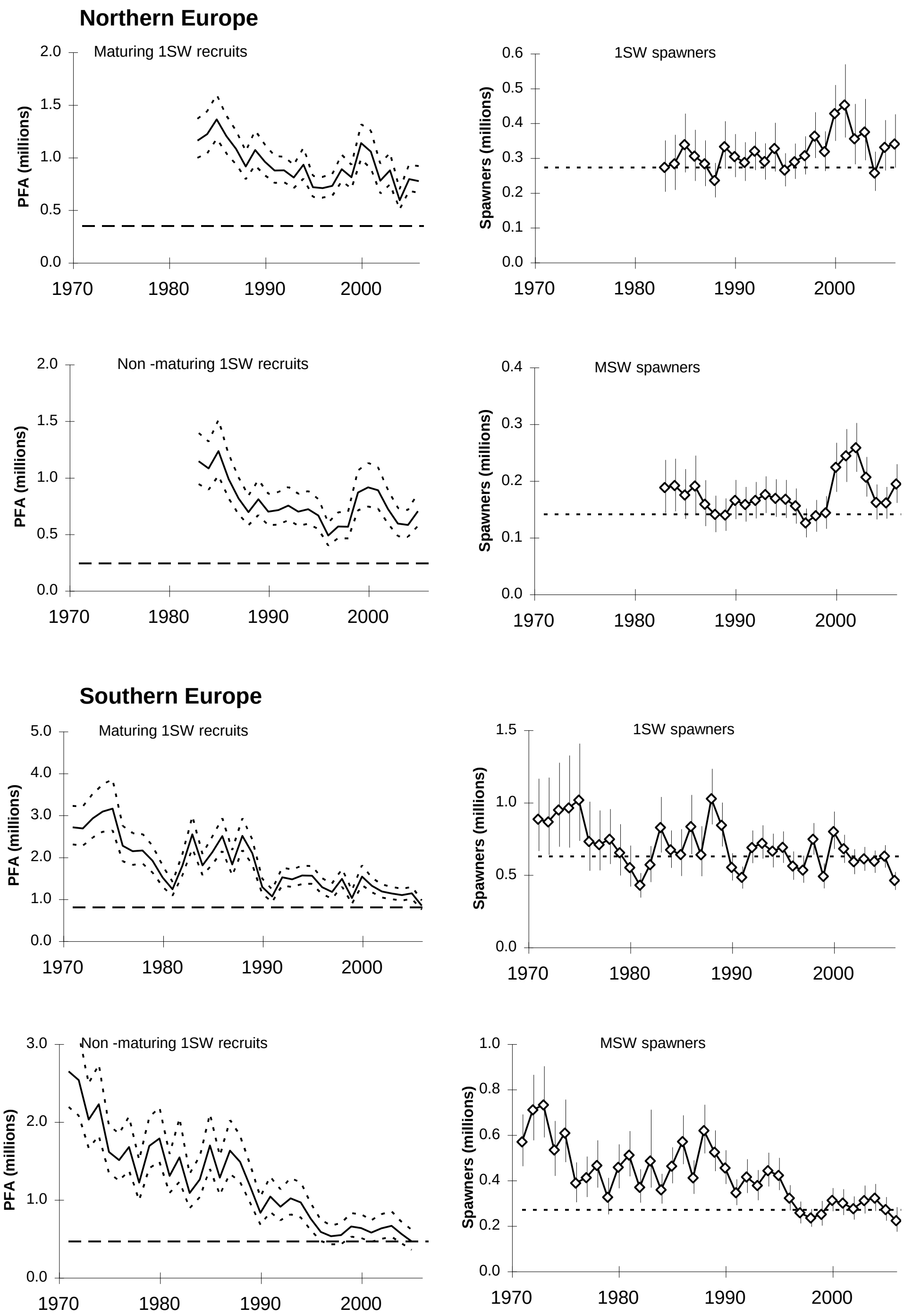


Figure 3.1.1. **Estimated PFA (recruits), with 95% confidence limits, Spawning Escapement Reserve for maturing and non-maturing salmon in Northern & Southern Europe.**

Estimated spawning escapement with 95% confidence limits, and conservation limits for 1SW and MSW salmon in Northern & Southern Europe.

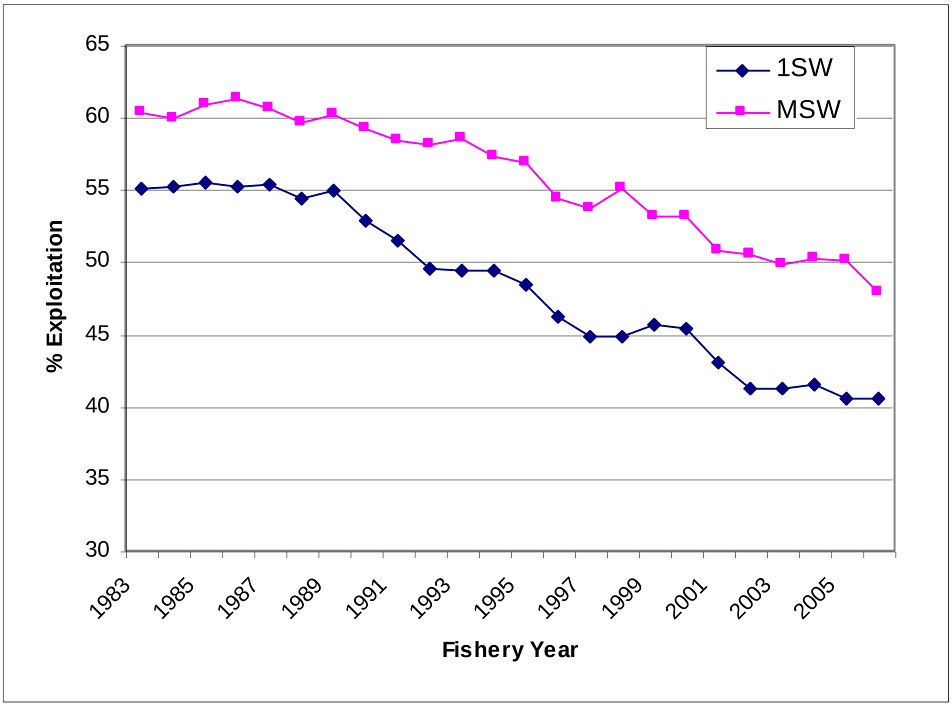


Figure 3.1.2. Exploitation rates of wild 1SW and MSW salmon by commercial and recreational fisheries in the Northern NEAC area from 1971–2006.

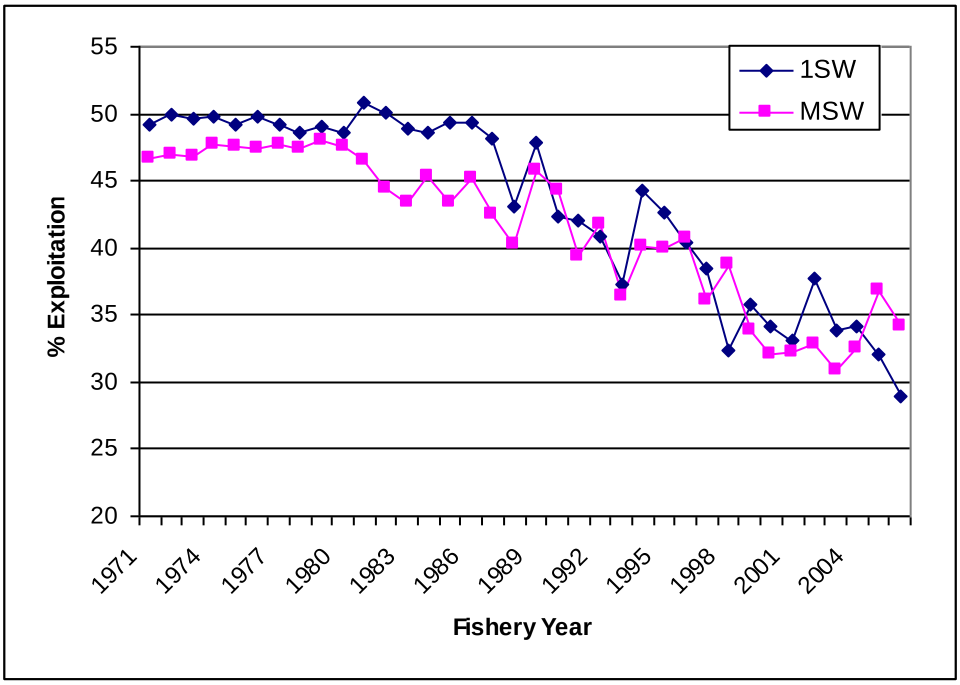


Figure 3.1.3. Exploitation rates of wild 1SW and MSW salmon by commercial and recreational fisheries in the Southern NEAC area from 1971–2006.

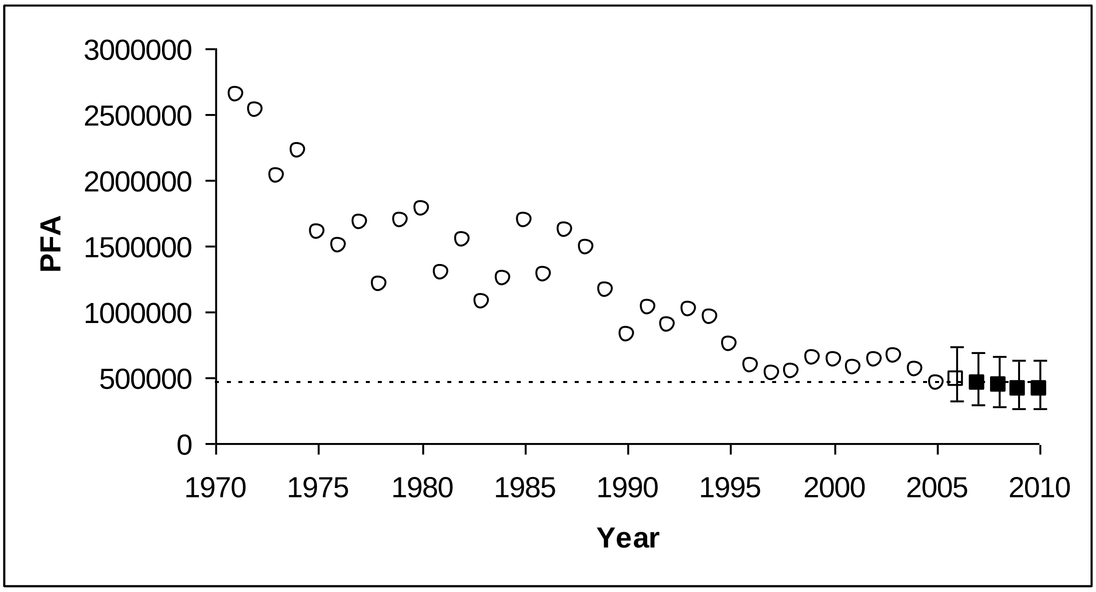


Figure 3.6.1. PFA trends and predictions (95% confidence limits) for non-maturing 1SW European stock. Note: open square is 2006 update and blocked squares are 2007 to 2010 forecasts.

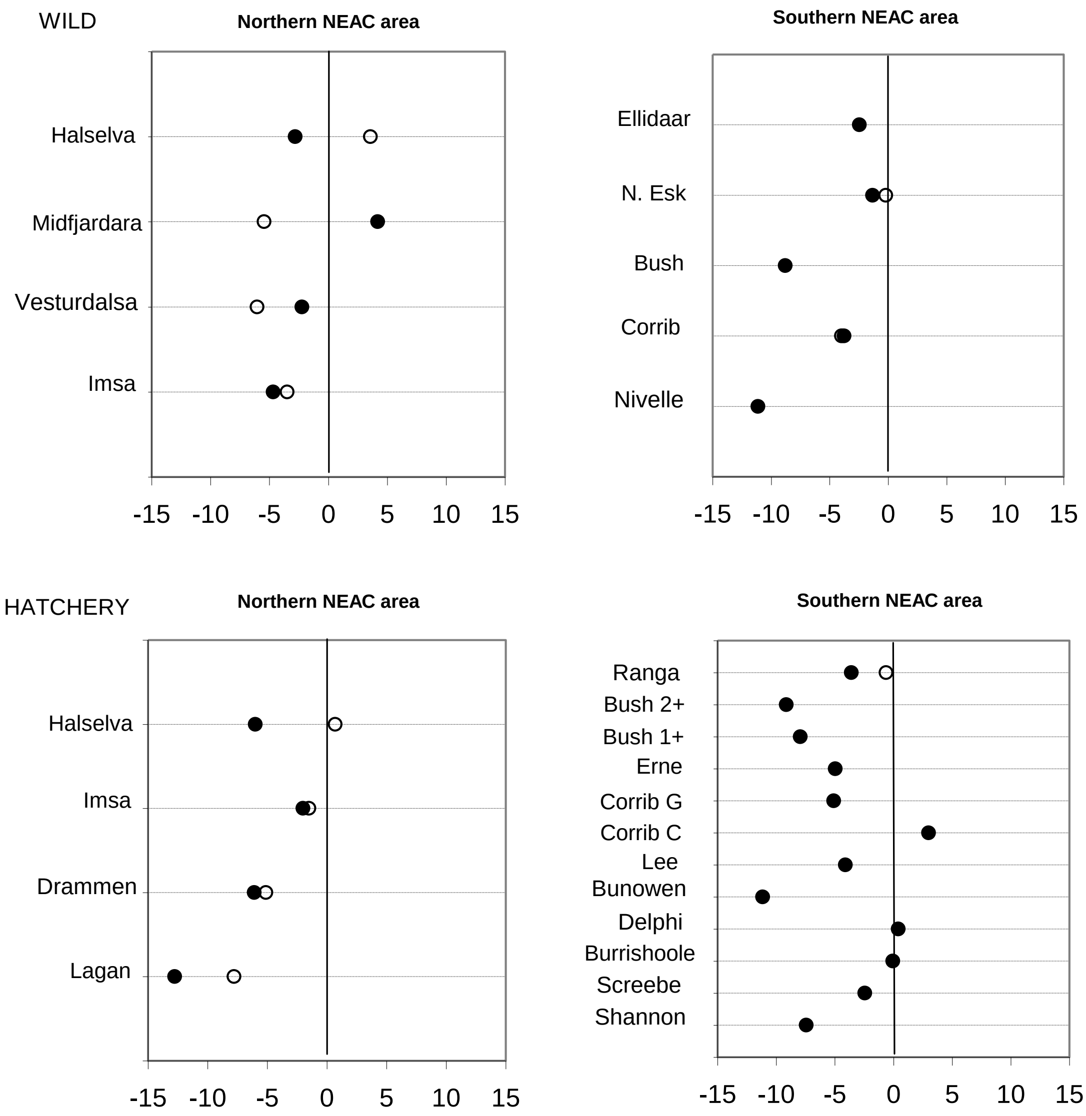


Figure 3.8.10.1. Annual rates of change (%) in marine survival indices of wild and hatchery smolts to adult returns to homewaters (prior to coastal fisheries) in different rivers in northern and southern NEAC areas. Filled circle = 1SW salmon; open circle = 2SW salmon. Note: the annual rates of change presented come from data sets of variable durations. It is therefore not possible to compare rivers directly.

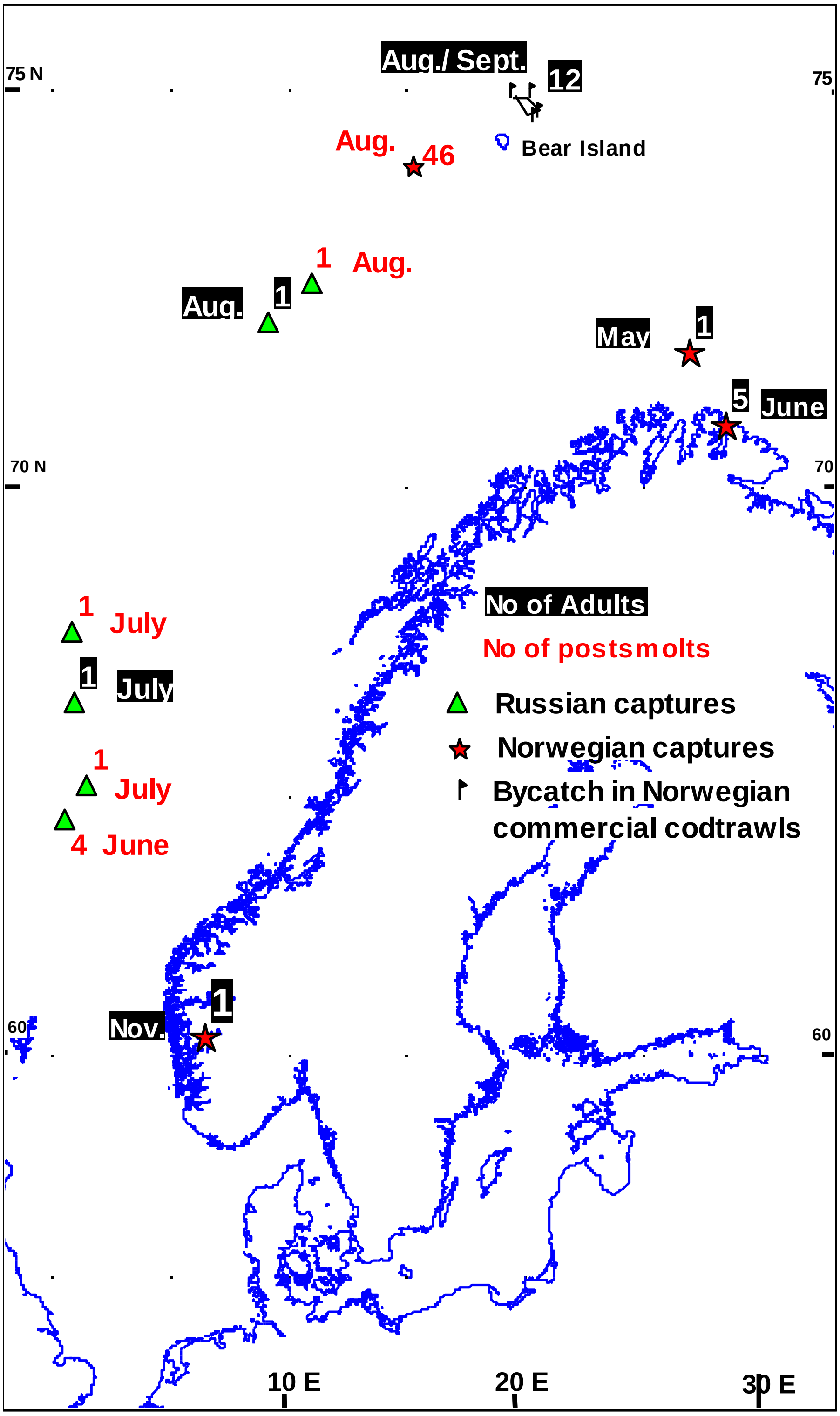


Figure 3.10.2. Number and month of capture of post-smolts and adult salmon in non-target fisheries by Russian commercial trawlers (triangles) and Norwegian research ships (stars) in 2006.

4 North American Commission

4.1 Status of stocks/exploitation

In 2006, the midpoints of the 2SW spawner estimates for six geographic areas indicated that all areas except Newfoundland were below their conservation limit (Figure 4.1.1) and are suffering reduced reproductive capacity. Newfoundland was at risk of suffering reduced reproductive capacity.

The estimated exploitation rate of North American origin salmon in NAC fisheries has declined (Figure 4.1.2) from approximately 80% to 17% for 2SW salmon and from approximately 60% to 17% for 1SW salmon.

The stock status is elaborated in Section 4.9.

4.2 Management objectives

Management objectives are included in Section 1.3.

4.3 Reference points

There are no changes recommended in the 2SW salmon conservation limits (CLs) from those identified previously. CLs for 2SW salmon for Canada total 123 349 and for the USA, 29 199 for a combined total of 152 548.

4.4 Management advice

As the predicted number of 2SW salmon returning to North America in 2007 is substantially lower than the 2SW CL there are no catch options for the composite North American fisheries. Where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

Wild salmon populations are critically low in an extensive portion of North America and remnant populations require alternative conservation actions to fisheries regulation to maintain their genetic integrity and their persistence.

4.5 Relevant factors to be considered in management

The management for all fisheries should be based upon assessments of the status of individual stocks. Fisheries on mixed stocks, particularly in coastal waters or on the high seas, pose particular difficulties for management as they cannot target only stocks that are at full reproductive capacity. 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.

4.6 Updated forecast of 2SW maturing fish for 2007

The updated 2007 forecast for 2SW maturing fish is based on an updated forecast of the 2006 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2006 as 1SW non-maturing fish.

4.6.1 Catch options for 2007 fisheries on 2SW maturing salmon

The updated forecast of the pre-fishery abundance for 2006 provides a PFA mid-point of 117 431, about 1% lower than the forecast last year. The 2006 pre-fishery abundance of maturing 2SW salmon will be available in homewaters in 2007.

Adjusted for natural mortality these catches are the equivalent of 3616 2SW salmon which potentially leaves 80 808 2SW salmon to return to rivers in North America in 2007.

As the predicted number of 2SW salmon returning to North America in 2007 is substantially lower than the 2SW conservation limit of 152 548, there are no catch options at probability levels of 75% for the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management is necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

4.7 Pre-fishery abundance of 2SW salmon for 2007–2009

Catch options derived from the pre-fishery abundance forecast for 2007–2009 apply to North American fisheries in 2008–2010. The pre-fishery abundance for 2007–2009 is expected to be about 115 000 non-maturing 1SW salmon, a value similar to the estimated abundance for the period 1988 to 2005.

4.7.1 Catch options for 2008–2010 fisheries on 2SW maturing salmon

Accounting for potential catches in 2007–2009, natural mortality to home waters, and the management objective to achieve conservation escapements (assuming a sharing arrangement of 40% of the surplus to West Greenland and 60% to North America) the only risk averse catch option for 2SW salmon in 2008–2010 is zero catch on the composite North American stock.

4.8 Comparison with previous assessment and advice

The updated forecast of the pre-fishery abundance for 2006 provides a PFA mid-point of 117 000 fish. This is essentially unchanged (−1%) from the value forecast last year at this time of 119 000 fish and is mainly due to slight changes in the input values to the model used to forecast PFA for these stocks, as well as changes in the parameter values resulting from the additional year of PFA and lagged spawner values used in the model.

4.9 NASCO has requested ICES to describe the key events of the 2006 fisheries and the status of the stocks

4.9.1 Fisheries in 2006

Homewater fisheries

Three user groups exploited salmon in Canada in 2006: Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. There were no commercial fisheries in Canada in 2006. There was no harvest of sea-run Atlantic salmon in the USA in 2006.

The provisional harvest of salmon in 2006 by all users was 132 t (Table 2.1.1.1), about 5% lower than the 2005 harvest. The 2006 harvest was 44 233 small salmon and 11 131 large salmon, 7% less small salmon and 2% more large salmon, compared to 2005. The dramatic decline in harvested tonnage since 1988 is in large part due to major reductions in commercial fishery effort throughout Canada, introduced as a result of declining abundance of salmon.

The Aboriginal peoples' harvests in 2006 were 58.9 t, representing an increase of 11% from 2005 and a 6% decrease from the previous 5-year mean. The estimated harvest for residents fishing for food in Labrador was 2.6 t, about 1052 fish (73% small salmon by number). The recreational fisheries harvest totalled 35 171 small and large salmon, 22% below the previous 5-year average, 8% below the 2005 harvest level, and the lowest total harvest reported. The small salmon harvest of 32 171 fish was 5% below 2005 and 22% below the previous 5-year mean. The large salmon harvest of 3000 fish was 31% below the previous five-year mean and 27% below 2005. The small salmon size group has contributed 88% on average of the total harvests since the imposition of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland in 1984.

France (Islands of Saint-Pierre and Miquelon)

In 2006, there were 14 professional and 48 recreational gillnet licenses issued for the fishery that operates between May 1 and July 31. These figures may not accurately reflect the fishing effort in 2006 as the number of fishers that actually fished is unknown.

The total reported harvest in 2006 was 3.6 t, an increase of 0.3 t from 2005 and the largest catch reported since 1983 (Table 2.1.1.1). Professional and recreational fishers reported catching 1730 kg and 1825 kg of salmon, respectively. There is no estimate of unreported catch.

It is unknown if a biological sampling program was conducted in 2006; no reports were received by ICES.

YEAR	PROFESSIONAL LICENSES (KG)	RECREATIONAL LICENSES (KG)	TOTAL (KG)
1990	1146	734	1880
1991	632	530	1162
1992	1295	1024	2319
1993	1902	1041	2943
1994	2633	790	3423
1995	392	445	837
1996	951	617	1568
1997	762	729	1491
1998	1039	1268	2307
1999	1182	1140	2322
2000	1134	1133	2267
2001	1544	611	2155
2002	1223	729	1952
2003	1620	1272	2892
2004	1499	1285	2784
2005	2243	1044	3287
2005	1730	1825	3555

4.9.2 Status of stocks

In 2006, the midpoints of the spawner abundance estimates for six geographic areas indicated that five areas were below their conservation limit for 2SW salmon and are suffering reduced reproductive capacity. Newfoundland was at risk of suffering reduced reproductive capacity (Figure 4.1.1).

Estimates of pre-fishery abundance suggest continued low abundance of North American adult salmon (Figure 4.9.2.1). The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has oscillated around a generally declining trend since the 1970s (4.9.2.2). During 1993 to 2005, the total population of 1SW and 2SW Atlantic salmon was about 600 000 fish, about half of the average abundance during 1972 to 1990. The maturing component has declined by 47%, while the non-maturing has declined by 92%.

The returns of 2SW fish in 2006 were similar to 2005 in Labrador, the Gulf of St. Lawrence, Scotia–Fundy, and in the USA, increasing slightly in Newfoundland but declining slightly in Québec. However, all area returns remain close to the lower end of the 35-year time-series (1971–2005). While 2SW salmon are a minor component of Newfoundland stocks, decreases of about 30% have occurred from peak levels of the 1990s. Returns in 2006 of 1SW salmon increased from 2005 in Newfoundland and Labrador but declined or were similar in all other areas.

Egg depositions by all sea-ages combined in 2006 exceeded or equalled the river-specific conservation limits in 35 of the 77 assessed rivers (45%) and were less than 50% of CLs in 27 other rivers (35%, Figure 4.9.2.3).

Return rates to 1SW and 2SW salmon remain variable and unpredictable, with higher return rates in the northern areas and lower rates in the southern areas (Maritimes and USA).

Based on the genera1 increase in 1SW returns in 2006 in all areas except Labrador an increase could be expected for 2SW salmon in 2007. However, return rates of 2SW salmon in monitored stocks remain low. An additional concern is the number of salmon stocks suffering reduced reproductive capacity in eastern NAC, particularly in the Bay of Fundy, Atlantic coast, and USA. Despite major changes in fisheries management, returns have continued to decline in these southern areas and many populations are currently threatened with extirpation.

4.10 NASCO has requested ICES to evaluate the extent to which the objectives of any significant management measures introduced in recent years have been achieved

There have been no significant management measures introduced within the NAC in recent years.

4.11 NASCO has asked ICES to provide a comprehensive description of coastal fisheries including timing and location of harvest, biological characteristics (size, age, origin) of the catch, and potential impacts on non-local salmon stocks

In Canada all Aboriginal Peoples have a constitutional right to harvest salmon for food, social, and ceremonial purposes (FSC). In 2006, there were four subsistence fisheries harvesting salmonids in Labrador:

- Nunatsiavut Government (NG) members – fishing in the northern Labrador and in Lake Melville;
- Innu Nation members – fishing in northern Labrador and in Lake Melville;
- Labrador residents – fishing in Lake Melville and in southern Labrador;
- Labrador Métis Nation (LMN) – members fishing in southern Labrador.

The Innu and LMN fisheries were jointly regulated by Aboriginal Fishery Guardians administered under the Aboriginal Fisheries Strategy Program with the Department of Fisheries and Oceans (DFO) as well as by DFO Fishery Officers and Guardian staff. The new Nunatsiavut Government is directly responsible through the Torngat Fisheries Board for regulating its fishery through its Conservation Officers. DFO staff is responsible for regulating the Labrador residents fishery. There are no FSC fisheries currently active in the northern portion of SFA 1 and in SFA 14B (Figure 4.11.1).

Description of the fisheries

The fishing gear is multifilament gillnets which are mainly set in estuarine waters although some nets are also set in coastal areas, usually within bays.

FSC fisheries catch statistics are based on logbook reports and fisheries guardians. The overall reporting rate for subsistence fisheries was 79% in 2005 and 2006.

Detailed descriptions of the timing and location of the four FSC fisheries are described in 2006 Management Plans for these fisheries. The harvest limits vary, depending on the management plan, from a minimum of 4 individual fish (Labrador residence) to a maximum of 3 t for the community of Sheshatsiu in Lake Melville and Natuashish (Innu Nation). Various location and timing restrictions apply (generally May through September).

Coastal versus estuary landings

The division of catch between coastal and estuary origins in Labrador FSCs was revised in 2006. In 2000–2005, coastal harvests were determined as all catches in FSCs in Labrador with the exception of Lake Melville, which was estuarine. In 2006, Fishery Officers employed by DFO in Labrador and aboriginal enforcement staff were asked to provide proportions of catch in estuary and coastal areas based on their expert knowledge. The definition used for an estuary was that of Pritchard (1967) which states that an estuary is a partly enclosed coastal body of water in which river water is mixed with seawater. These new proportions are shown in Figure 4.11.1. The text table below compares the new breakdown of catches into estuary and coastal areas to the old breakdown. The new proportions have been applied to the time-series in Section 2.1.1. ICES concluded that the revised approach improved the assignment of fishing locations to estuarine and coastal areas.

						Previous methods	
	Weight (kg)			Percentages (kg)		Percentages (kg)	
Year	Estuarine	Coastal	Total	Estuarine	Coastal	Estuarine	Coastal
2000	13,278	2,335	15,613	85	15	38	62
2001	13,497	2,792	16,288	83	17	26	74
2002	13,987	3,585	17,572	80	20	23	77
2003	17,485	4,622	22,108	79	21	20	80
2004	24,862	6,787	31,649	79	21	23	77
2005	25,303	6,611	31,914	79	21	35	65
2006	23,169	7,073	30,242	77	23	30	70

Results of sampling program for Labrador FSCs

A sampling program was in place for the FSC fisheries in Labrador in 2006 and landed fish were sampled opportunistically. A total of 336 samples were collected from Northern and Southern Labrador. Scale reading indicated that 86% of the samples were from 1SW fish, 8% from 2SW, and 6% from previously spawned salmon.

The river ages of the FSC samples were compared to ages from scales obtained from adults at four assessment facilities in Labrador. There were no differences in river age distributions of adults from fisheries compared to returns to rivers in North (Chi-square=4.64, P=0.46) or South Labrador (Chi-square=4.25, P=0.51). Further, the freshwater age distribution did not differ (Chi-square=2.32, P=0.80) between the two regions of Labrador.

The relative absence of age 1 and 2 smolts in the FSC catches in 2006 suggests that these fisheries did not exploit southern North America stocks to any extent. The presence of river age 5 to 7 years in the FSC samples provides evidence that the FSC fisheries are exploiting northern area (predominantly Labrador) stocks.

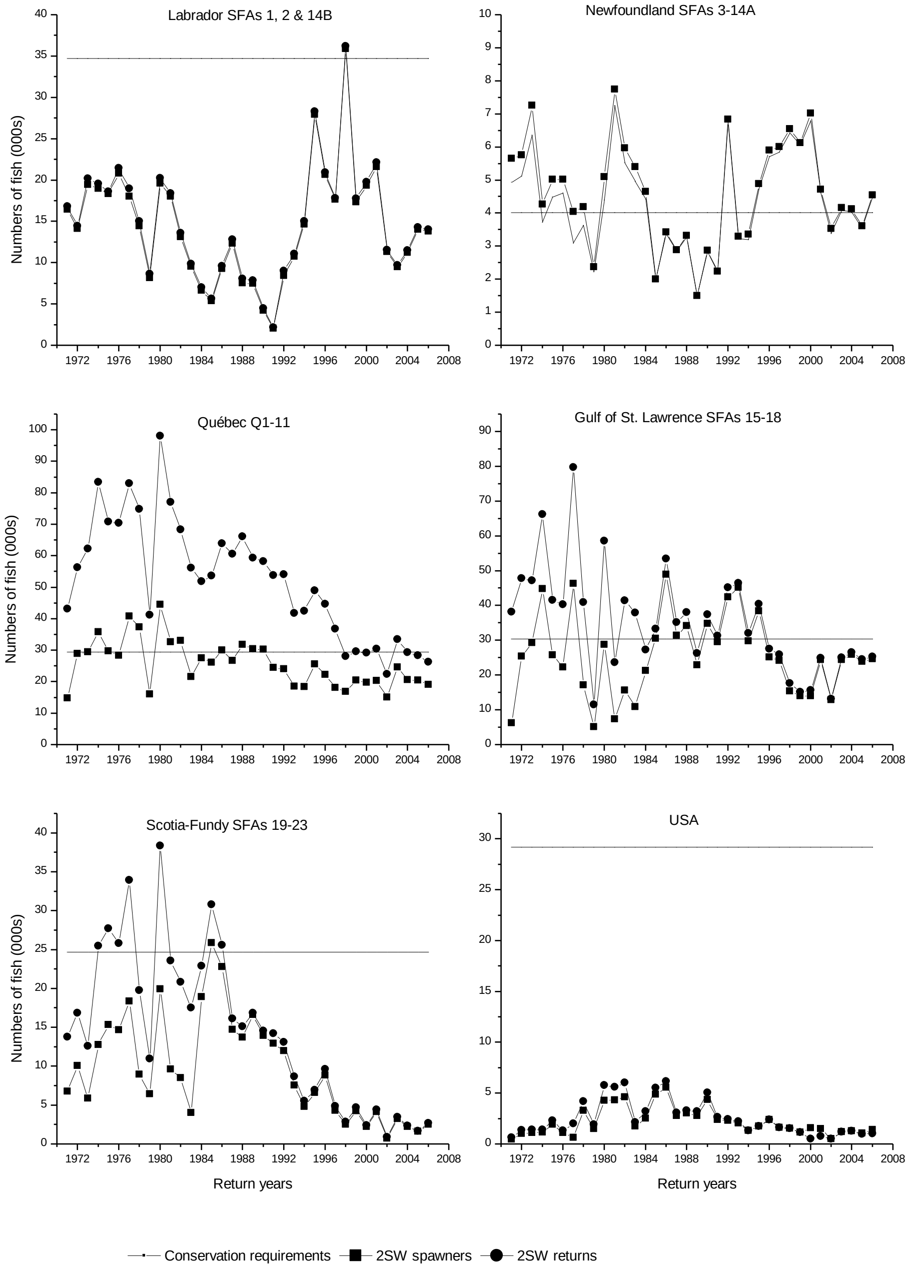


Figure 4.1.1. Comparison of estimated midpoints of 2SW returns, 2SW spawners, and 2SW conservation requirements for six geographic areas in North America. Returns and spawners for Scotia–Fundy do not include those from SFA 22 and a portion of SFA 23.

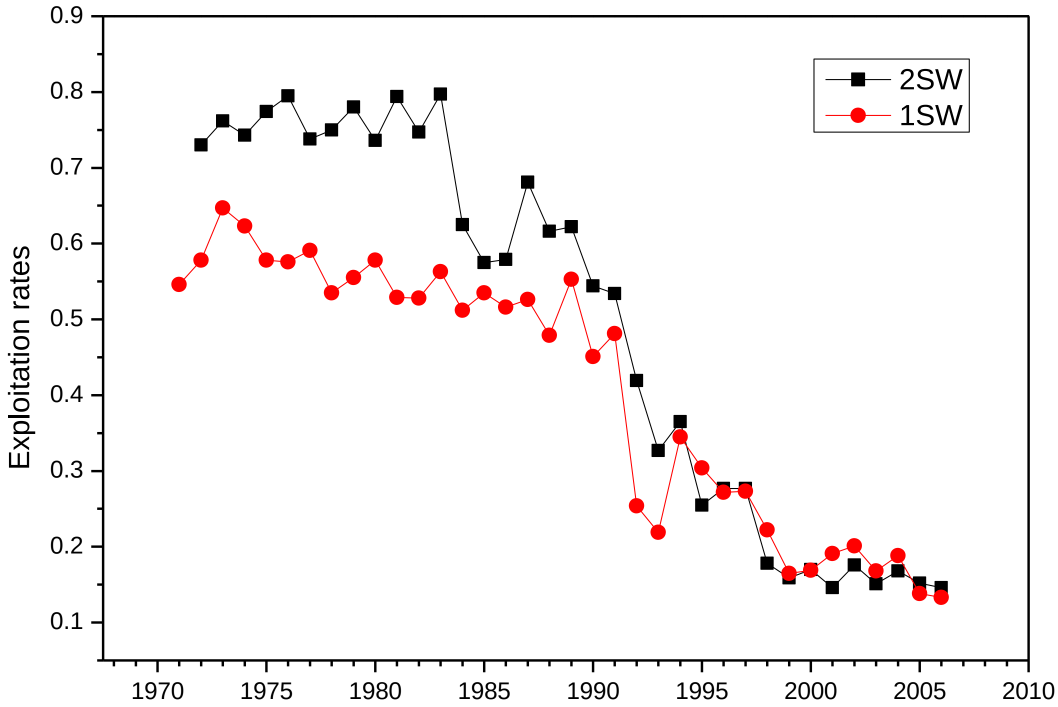


Figure 4.1.2. Exploitation rates in North America on the North American stock complex of 1SW and 2SW salmon.

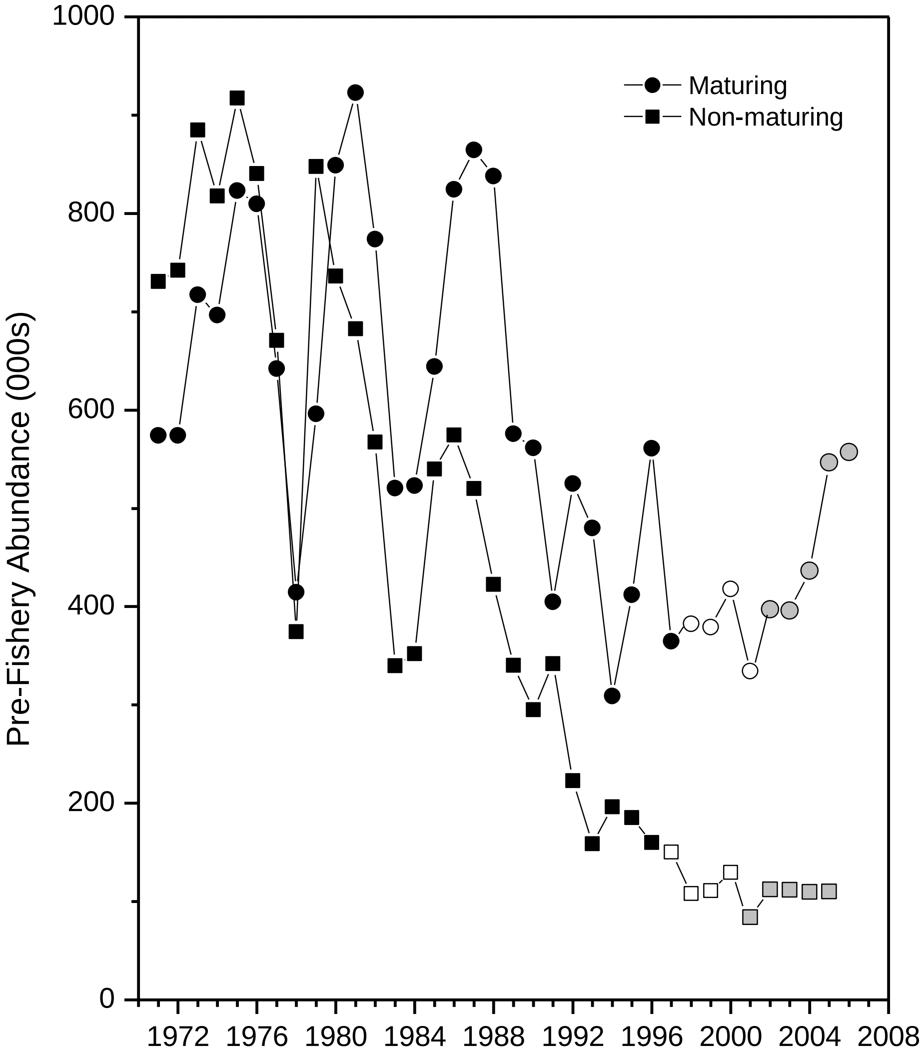


Figure 4.9.2.1. Pre-fishery abundance estimate of maturing and non-maturing salmon in North America. Open symbols are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America and the grey symbols for deriving returns to Labrador using returns per unit of drainage area.

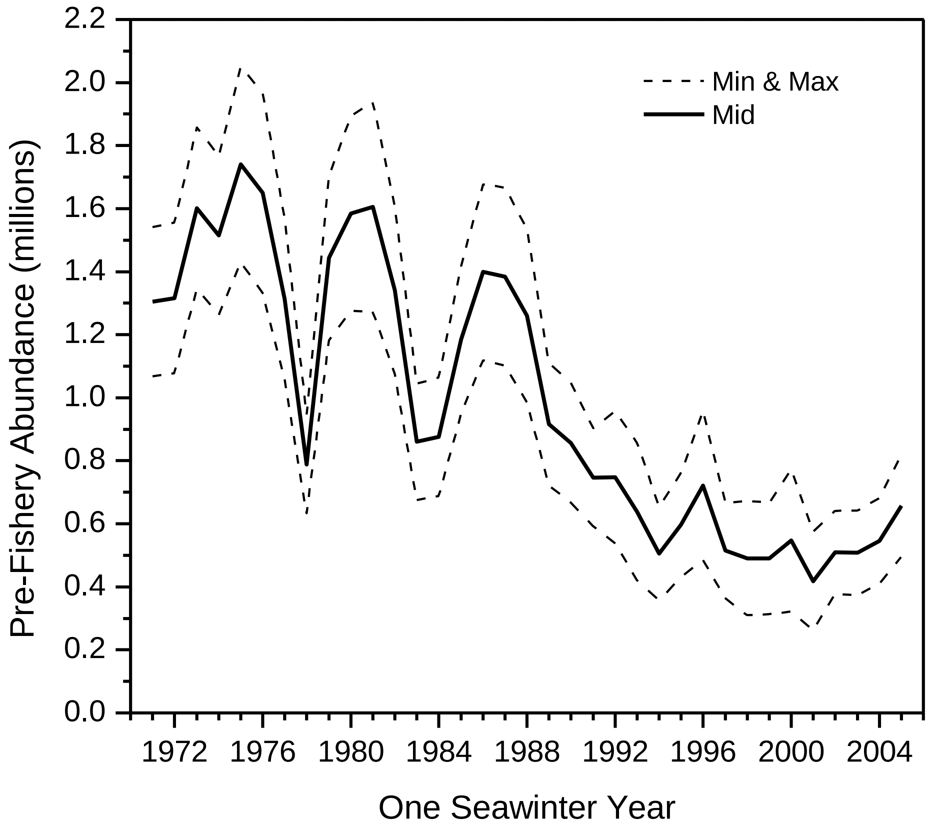


Figure 4.9.2.2. Total 1SW recruits (non-maturing and maturing) originating in North America.

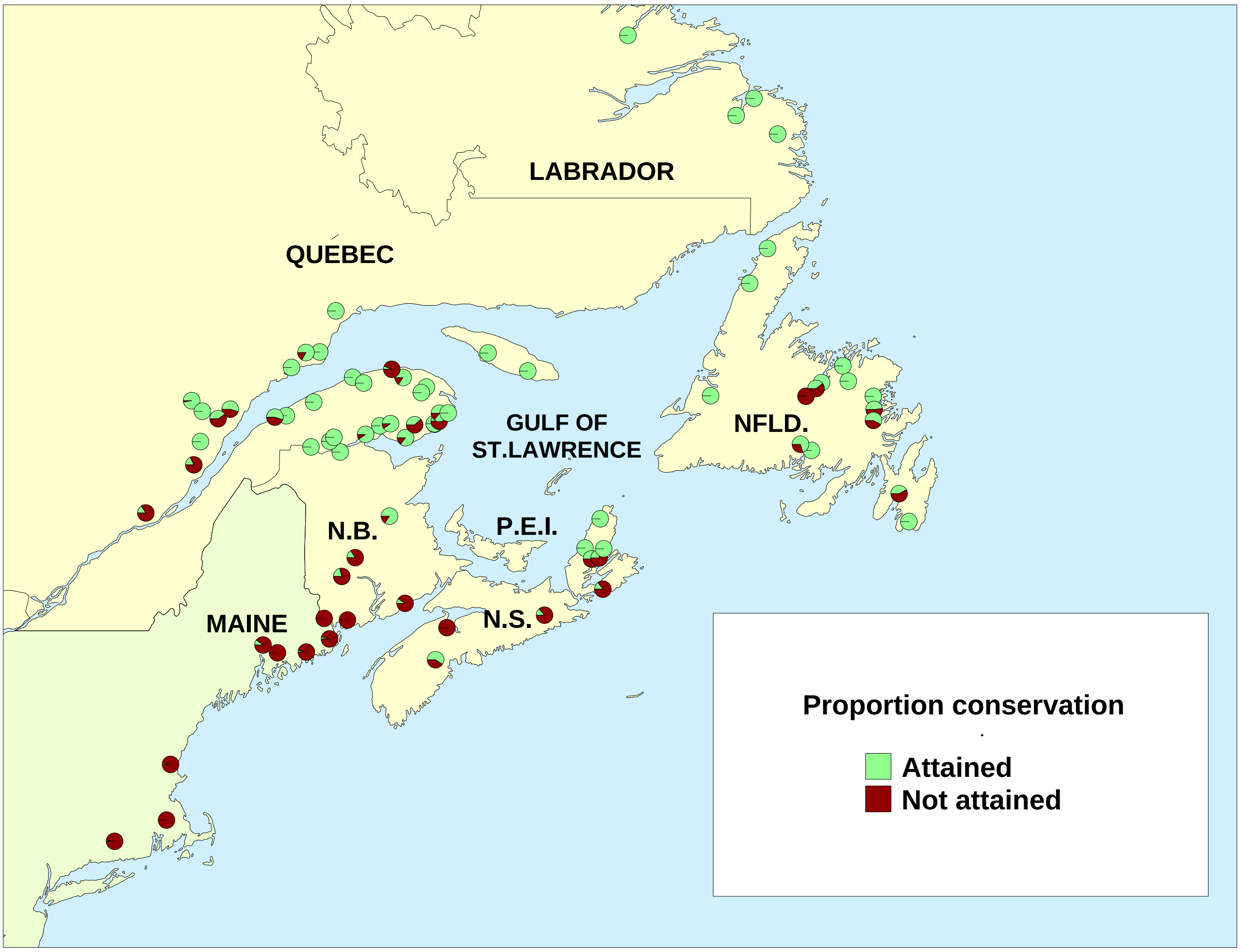


Figure 4.9.2.3. Proportion of the conservation requirement attained (by all sea-age spawners) in assessed rivers of the North American Commission in 2006.

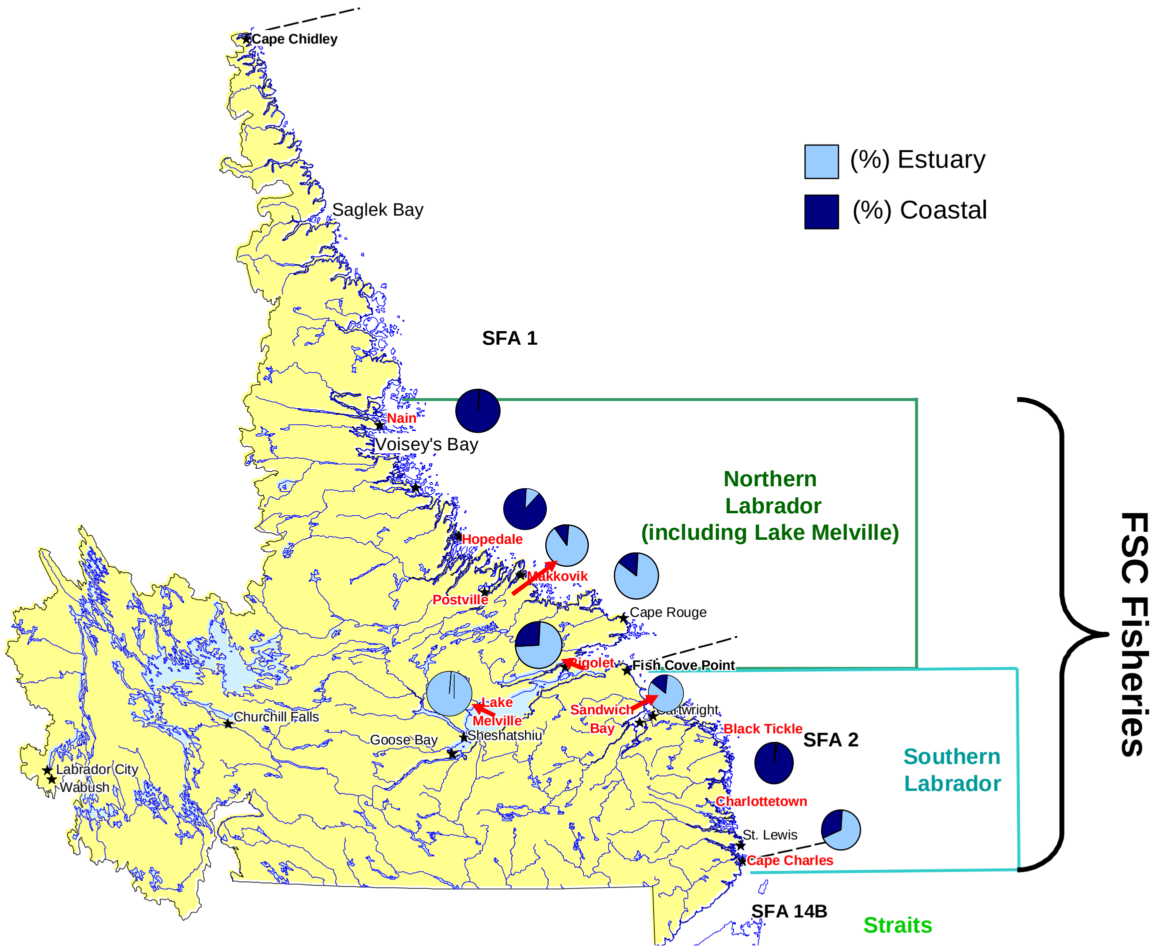


Figure 4.11.1. Map showing community locations mentioned in the text, SFAs, and proportions of estuary versus coastal in Labrador.

5 Atlantic salmon in the West Greenland Commission

5.1 Status of stocks/exploitation

ICES considers the stock complex at West Greenland to be below conservation limits and thus suffering reduced reproductive capacity.

North American stock

The North American stock complex of non-maturing salmon has declined to the lowest levels in the time-series (Figure 5.1.1). In 2006, the estimated overall spawning escapement was below the conservation limit for the stock complex. Specifically, 2SW spawners in the regions (Figure 4.1.1) are:

- **Newfoundland:** at risk of suffering reduced reproductive capacity (112% of 2SW CL);
- **Labrador:** suffering reduced reproductive capacity (40% of 2SW CL);
- **Québec:** suffering reduced reproductive capacity (65% of 2SW CL);
- **Gulf of St. Lawrence**: suffering reduced reproductive capacity (81% of 2SW CL);
- **Scotia–Fundy:** suffering reduced reproductive capacity (10% of 2SW CL);
- **United States:** suffering reduced reproductive capacity (6% of 2SW CL).

The exploitation rate for North American non-maturing 1SW fish at West Greenland has averaged around 3% in the last four years (Figure 5.1.2).

European stocks

Estimates of pre-fishery abundance suggest a downward trend in southern European MSW adult salmon over the last 10 years (Figure 5.1.1). The midpoint of spawners has been close to or below conservation limits in recent years (Figure 3.1.1). Specifically:

- **Southern European stock complex:** suffering reduced reproductive capacity (82% of 2SW CL).

Status of stocks in the NEAC and NAC areas are presented in the relevant Commission sections (Sections 3 and 4).

5.2 Management objectives

For management advice for the West Greenland fishery, NASCO has adopted a precautionary management plan requiring at least a 75% probability of achieving three management objectives:

- Meeting the conservation limits simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf;
- Achieving increases in returns to the Scotia–Fundy and USA regions relative to the base years 1992–1996. Improvements of greater than 25% and 10% relative to base year returns are presented although, to achieve a 25% increase, by definition the 10% increase is also achieved;
- Meeting the conservation limit for the southern NEAC MSW complex.

Although not a formal management objective, ICES also provides the probability of returns to North America being less than the previous five-year average.

5.3 Reference points

The reference points for West Greenland catch options are the conservation limits (CLs) for North American and southern European stock complexes. Region-specific conservation limits are derived in three ways:

- 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 maximum sustainable yield (MSY), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993).

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

CLs for the West Greenland fishery for North America are limited to 2SW salmon and for southern European stocks are limited to MSW fish, because fish at West Greenland are primarily (> 90%) 1SW non-maturing salmon destined to mature as either 2SW or 3SW salmon.

The North America 2SW CL is 152 548 fish, with 123 349 required in Canadian rivers and 29 199 in USA rivers (see Section 4.3). The CL for the southern European MSW stocks is 269 000 fish (Section 3.3). There is still considerable uncertainty in the CLs for European stocks and estimates may change from year to year due to new data in the pseudo stock–recruitment relationship.

5.4 Management advice

None of the stated management objectives would allow a fishery at West Greenland to take place in 2007, 2008, or 2009. There should be no catch on the stocks at West Greenland in 2007, 2008, or 2009.

Risk analyses for these years illustrate that attaining CLs for the NAC stock complex is sensitive to the magnitude of catches at West Greenland (Table 5.4.1). Therefore, where catches are allowed, it is imperative that fishing is closely monitored and full details are provided to ICES.

In the absence of a fishery, the probability that returns in all regions of North America will be less than the 2002–2006 average is 36% for 2008, 30% for 2009, and 34% for 2010 (Table 5.4.2).

5.5 Relevant factors to be considered in management

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

For all fisheries, management should be based upon assessments of the status of individual stocks. Fisheries on mixed stocks, either in coastal waters or on the high seas, pose particular difficulties for management, as they cannot target only those stocks that are within precautionary limits. Conservation would be best achieved if fisheries can be targeted at stocks that have been shown to be within precautionary limits. Fisheries in estuaries and rivers are more likely to fulfil this requirement.

5.6 Pre-fishery abundance forecasts 2007, 2008, and 2009

The PFA forecasts for the West Greenland stock complex are among the lowest in time-series (Figure 5.1.1).

5.6.1 North American stock complex

Two temporal phases of salmon production in the Northwest Atlantic have been previously described (ICES, 2003). Lower recruitment rates are evident throughout eastern Canada and USA. The North American pre-fishery abundance (PFA_{NA}) forecasts for 2007–2009 have median values of 113 100, 118 000, and 114 200, respectively. These forecasts are among the lowest in the time-series and are highly unlikely to meet the 2SW spawner escapement reserves of 212 189 salmon to North America in each year.

5.6.2 Southern European MSW stock complex

The spawning escapement for the southern NEAC MSW stock complex has not exceeded its conservation limit throughout most of the time period. The PFA forecasts for the southern NEAC non-maturing 1SW stock complex for 2007–2009 have median values of 455 415, 434 060, and 413 701, respectively. These forecasts are among the lowest in the time-series and are highly unlikely to meet the spawner escapement reserve of 455 413, except for 2007.

5.7 Comparison with previous assessment and advice

The management advice and catch options for the West Greenland fishery have been the same since 2003. The current modelling approach has provided stable comparisons of the previous year’s predictions and updated PFA_{NA} in the last two years. For 2006, the median value of the updated analysis for NAC has decreased to 117 431 fish from the 119 000 predicted in the previous year’s analysis. The revised forecast of the southern NEAC MSW PFA for 2006 provides a PFA midpoint of 483 700. This is close to the value forecast last year at this time of 489 000.

5.8 NASCO has requested ICES to describe the events of the 2006 fishery and status of the stocks

At its annual meeting in June 2006 NASCO agreed to restrict the fishery at West Greenland *to that amount used for internal subsistence consumption in Greenland*. Consequently, the Greenlandic authorities set the commercial quota to nil, i.e. landings to fish plants, resale in grocery shops/markets, and commercial export of salmon from Greenland was forbidden. Licensed fishers were allowed to sell salmon at the open markets, to hotels, restaurants, and institutions. A private fishery for personal consumption without a license was allowed. All catches, licensed and private were to be reported to the License Office on a daily basis. In agreement with the Organization for Fishermen and Hunters in Greenland the fishery for salmon was allowed from August 1 to October 31.

5.8.1 Catch and effort in 2006

By the end of the season a total of 20.7 t of landed salmon were reported. In total, 236 reports were received, a 61% increase from the 145 received last year. Catches were distributed among the six NAFO divisions on the western coast of Greenland (Figure 5.8.1.1), with catches in 1A, 1D, and 1F higher than the other three divisions (Table 5.8.1.1). In 2006, catch was reported from week 32 to week 44, with 44% of the catch by weight reported in week 44 and no more than 10% in any of the remaining weeks. Since 2003, the proportion of the catch reported in week 44 or later has ranged from 2% to 20%. In late October 2006, the Greenland Home Rule License Office broadcast TV requests that catch reports be submitted for the season. Thus, it is possible that the temporal distribution of reported catch in 2006 reflects changes in reporting practice.

In 2006 a total of 136 people landed salmon, with five reporting landings in more than one NAFO Division. The number of fishers reporting catches has steadily increased from approximately 40 to 136 over the last 5 years, but is below the 400 to 600 people reporting landings in the commercial fishery 1987 to 1991. There is presently no quantitative approach for estimating the unreported catch. However, in 2006 it is likely to have been at the same level proposed in recent years (10 t).

5.8.2 Biological characteristics of the catches

The international sampling program for landings at West Greenland initiated by NASCO in 2001 was continued in 2006. Temporal coverage was adequate to assess the fishery. Tissue and biological samples were collected from five landing sites: Qaqortoq (NAFO Div. 1F), Paamiut (NAFO Div. 1E), Nuuk (NAFO Div. 1D), Maniitsoq (NAFO Div. 1C), and Ilulissat (NAFO Div. 1A) (Figure 5.8.1.1). In total 1253 salmon were inspected for the presence of tags, representing 25% by weight of the reported landings. Of these, 1104 were measured for fork length and weight, and scales were collected from 1118. Unlike in previous years, there was no need to adjust the total landings by replacing the reported catch with the weight of fish sampled for use in assessment calculations.

The average weight of a fish from the 2006 catch was 3.24 kg across all ages, with North American 1SW fish averaging 65.3 cm and 3.10 kg whole weight and European 1SW salmon averaging 65.3 cm and 3.25 kg (Table 5.8.1.1).

North American salmon up to river-age 6 were caught at West Greenland in 2006 (Table 5.8.1.1), with approximately 44% being river-age 3 and 27% being river-age 4. The river ages of European salmon ranged from 1 to 5 (Table 5.8.1.1). Over half (54%) of the European fish in the catch were river-age 2 and 23.6% were river-age 3. The proportion of the European origin river-age 1 salmon in the catch has ranged been between 9% and 19% since 2001.

In 2006, 98.8% of the European samples were 1SW salmon, with previous spawners 1.2% of the samples. 1SW salmon dominated (93%) the North American component, with previous spawners decreasing to 5.6% from 6.4% of the samples last year (Table 5.8.1.1).

Tissue for disease testing was obtained from 119 whole fish in Nuuk. These samples were tested for the presence of ISAv by RT-PCR assay only and all test results were negative. The sex was determined by examining gonads for 121 salmon (119 whole and 3 viscera); of these 23 (18%) were males and 98 (82%) females.

Of the 1193 samples collected for genetic characterization, most (1042) were genotyped at four microsatellites (Ssa202, Ssa289, SSOSL438, and SSOSL311). Two samples were removed from the analysis and the remainder were genotyped at 2 (n=3) or 3 (n=146) loci. A database of approximately 5000 Atlantic salmon genotypes of known origin was used as a baseline to assign these salmon to continent of origin. In total, 72% of the salmon sampled from the 2006 fishery were of North American origin and 28% fish were of European origin.

Applying the continental percentages for the NAFO division catches resulted in estimates of 14.3 t of North American origin and 6.4 t of European origin fish (4000 and 1800 rounded to the nearest 100 fish, respectively) landed in West Greenland in 2006 (Table 5.8.2.1).

5.9 NASCO has requested ICES to provide a detailed explanation and critical examination of any changes to the models used to provide catch options

There were no changes to the models used to provide catch options.

5.9.1 Run-reconstruction models

The run-reconstruction models to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West Greenland fishery are the same as those used since 2003 (ICES, 2003).

5.9.2 Forecast models for pre-fishery abundance of 2SW salmon

The forecast models used to estimate pre-fishery abundance of non-maturing 1SW salmon (potential MSW) for North America were the same as those used since 2004 (ICES, 2004). The overall approach is to model the natural log transformed PFA_{NA} and LS_{NA} using linear regression and the Monte Carlo method to derive the probability density for the PFA_{NA} forecast.

The forecast models used to estimate pre-fishery abundance of non-maturing 1SW salmon (potential MSW) from the southern European stock group were the same as those used since 2002 (ICES, 2002). The overall approach is to select the best model by adding variables (eg. spawners, habitat, PFA of maturing 1SW salmon, and year) until addition of any other parameter was not significant.

5.9.3 Development and risk assessment of catch options

The 2007–2009 PFA estimates were used to develop the risk analysis and catch options presented in Section 5.4. The risk assessment for the two stock complexes in the West Greenland fishery is developed in parallel and then combined at the end of the process into a single summary plot or catch options table. The primary inputs to the risk analysis for the complex at West Greenland are:

- PFA forecast for the year of the fishery; PFA_{NA} and PFA_{NEAC};
- Harvest level being considered (t of salmon);
- Conservation spawning limits.

The final step in the risk analysis of the catch options involves combining the conservation requirement with the probability distribution of the returns to North America for different catch options. The returns to North America are partitioned into regional returns based on the regional proportions of 2SW returns of the last five years, 2002 to 2006. Estimated returns to each region are compared to the conservation objectives of Labrador, Newfoundland, Quebec, and Gulf. Estimated returns for Scotia–Fundy and USA are compared to the objective of achieving an increase of 10% and 25% relative to average returns of the base period, 1992–1996.

There were no changes to the risk assessment of catch options model.

5.10 NASCO has requested ICES to provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved

NASCO management is directed at reducing exploitation to allow river-specific conservation limits to be achieved. Although spawning escapement is influenced by measures taken in homewaters, it is possible to evaluate the extent to which management at West Greenland successfully achieved the objectives (Table 5.10.1):

- Reduction of exploitation at West Greenland has been achieved;
- The simultaneous attainment of conservation limits in Labrador, Newfoundland, Quebec, and the Gulf of St Lawrence has not been achieved;
- There has not been a 10% or 25% increase in spawners to either Scotia–Fundy or the USA;
- The objective of consistently meeting the conservation limits for the southern NEAC MSW complex has not been achieved.

Table 5.4.1. Catch options (t) for West Greenland harvest in 2007, 2008, and 2009 with the probability of meeting management objectives: meeting the 2SW conservation limits simultaneously in the four northern areas of North America; achieving increases in returns from base year average (1992–1996) in the two southern areas; and meeting the MSW conservation limit of the southern European stock complex relative to quota options.

2007				
West Greenland Harvest (t)	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Improvement (SF, USA) of Returns		Conservation MSW Salmon Southern NEAC
		> 10%	> 25%	
0	0.016	0.002	0.001	0.635
5	0.015	0.002	0.001	0.629
10	0.015	0.002	0.001	0.624
15	0.014	0.002	0.001	0.618
20	0.013	0.002	0.001	0.612
25	0.012	0.002	0.001	0.606
30	0.012	0.002	0.001	0.603
35	0.011	0.002	0.001	0.597
40	0.011	0.002	0.001	0.592
45	0.011	0.002	0.001	0.587
50	0.010	0.002	0.001	0.582
100	0.007	0.001	0.001	0.525
2008				
West Greenland Harvest (t)	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Improvement (SF, USA) of Returns		Conservation MSW Salmon Southern NEAC
		> 10%	> 25%	
0	0.025	0.007	0.005	0.559
5	0.024	0.007	0.005	0.552
10	0.023	0.007	0.004	0.546
15	0.022	0.007	0.004	0.540
20	0.021	0.007	0.004	0.535
25	0.021	0.006	0.004	0.529
30	0.020	0.006	0.004	0.523
35	0.020	0.006	0.004	0.516
40	0.019	0.006	0.004	0.509
45	0.018	0.006	0.004	0.503
50	0.018	0.006	0.004	0.497
100	0.015	0.005	0.003	0.441

Table 5.4.1. Continued. Catch options (t) for West Greenland harvest in 2007, 2008, and 2009 with the probability of meeting management objectives: meeting the 2SW conservation limits simultaneously in the four northern areas of North America; achieving increases in returns from base year average (1992–1996) in the two southern areas; and meeting the MSW conservation limit of the southern European stock complex relative to quota options.

2009				
West Greenland Harvest (t)	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Improvement (SF, USA) of Returns > 10%	Improvement (SF, USA) of Returns > 25%	Conservation MSW Salmon Southern NEAC
0	0.024	0.006	0.003	0.470
5	0.023	0.005	0.003	0.464
10	0.022	0.005	0.003	0.457
15	0.021	0.005	0.003	0.452
20	0.021	0.005	0.003	0.445
25	0.020	0.005	0.003	0.440
30	0.019	0.005	0.003	0.434
35	0.018	0.004	0.003	0.430
40	0.018	0.004	0.002	0.424
45	0.017	0.004	0.002	0.418
50	0.017	0.004	0.002	0.413
100	0.012	0.003	0.002	0.358

(Lab, NF, Queb, Gulf) = Labrador, Newfoundland, Quebec, Gulf

(SF, USA) = Scotia–Fundy and USA

A sharing arrangement of 40:60 (Fna) was assumed.

Table 5.4.2. Probability of 2SW returns in 2008, 2009, and 2010 being less than the previous five-year average (2002–2006) returns to regions of North America, relative to catch options at West Greenland.

West Greenland Harvest	2008	2009	2010
Tons	Probability	Probability	Probability
0	0.359	0.304	0.340
5	0.385	0.331	0.367
10	0.411	0.360	0.394
15	0.436	0.390	0.421
20	0.463	0.416	0.448
25	0.486	0.442	0.473
30	0.510	0.467	0.500
35	0.537	0.491	0.527
40	0.559	0.517	0.554
45	0.582	0.541	0.578
50	0.605	0.563	0.598
100	0.784	0.760	0.784

Table 5.8.1.1. Nominal catches and biological characteristics of the West Greenland catch, 2006. NA = North American salmon, E= European salmon.

Distribution of 2006 nominal catch (metric tons) among NAFO Divisions.

Total	NAFO Division					
	1A	1B	1C	1D	1E	1F
20	5	2	3	4	2	4

River age distribution (%) by origin

	1	2	3	4	5	6	7	8
NA	0.6	13.9	44.6	27.6	12.3	1.0	0	0
E	17.7	54.0	23.6	3.7	0.9	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	65.3	3.10	90.0	9.72	76.8	5.05	66.0	3.25
E	65.3	3.25			69.5	3.67	65.4	3.26

Biological Characteristics of Atlantic salmon sampled from the 2006 West Greenland food fishery.

Continent of Origin (%)	
North America	Europe
72.0	28.0

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

	Sea-age composition (%)		
	1SW	2SW	Previous Spawners
NA	93.0	0.8	5.6
E	98.8	0.0	1.2

Table 5.8.2.1. The catch weighted numbers of North American (NA) and European (E) Atlantic salmon caught at West Greenland 1995-2006. Numbers are rounded to the nearest hundred fish.

Year	Numbers of Salmon caught	
	NA	E
1995	22 100	10 400
1996	23 400	8700
1997	17 200	4300
1998	3200	900
1999	5600	700
2000	5800	2500
2001	9900	4500
2002	2300	1100
2003	2800	1300
2004	4000	1500
2005	3700	1200
2006	4000	1800

Table 5.10.1. Assessing the objectives of NASCO management of the West Greenland fishery.

OBJECTIVE	ASSESSMENT	OUTCOME/EXTENT ACHIEVED	FURTHER CONSIDERATION
Reduce exploitation.	Assessment, reported and unreported landings compared to negotiated catch quotas for the fishery.	There is no commercial fishery (quota set at nil). The internal consumption fishery has no quota.	Reporting rate for the internal consumption fishery and reported catch increased in 2006. Estimates of unreported catch are unchanged.
75% chance of meeting the conservation limits simultaneously in the four northern regions of North America.	Assessment of returns to North America. Run reconstruction to estimate overall returns (Sec. 4.9) related to estimated spawning escapement reserve at West Greenland.	This objective has not yet been achieved.	Restrict fisheries on mixed stocks and stocks below Conservation Limits. Examine other limiting factors such as causes of increased marine mortality, habitat quality, predators, etc.
75% chance of achieving increases in returns relative to previous years, with the hope that this leads to the rebuilding of Scotia–Fundy and USA stocks.	Assessment of returns to North America. Run reconstruction to estimate overall returns (Sec. 4.9). Improvements of greater than 10% and greater than 25% relative to returns are evaluated (Sec 4.9)	This objective has not been achieved.	Restrict fisheries on mixed stocks and stocks below Conservation Limits. Examine other limiting factors such as causes of increased marine mortality, habitat quality, predators, etc. Recovery plans developed for the stocks listed as endangered/ at risk.
75% chance of meeting spawner escapement requirement for the southern NEAC MSW complex.	Assessment of returns to southern NEAC. Run reconstruction to estimate overall returns (Sec. 3.3) related to estimated spawning escapement reserve at West Greenland.	This objective has not been achieved.	Restrict fisheries on mixed stocks and stocks below Conservation Limits. Examine other biologically limiting factors such as causes of increased or high marine mortality, habitat quality, bycatch, predators, etc.

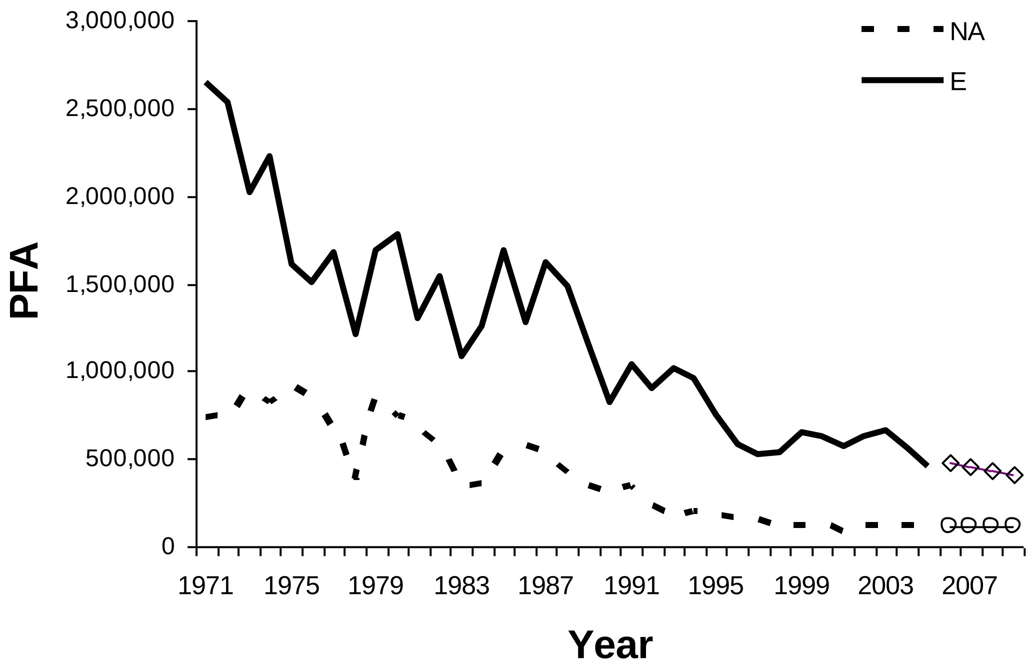


Figure 5.1.1. PFA estimated for North American (NA) and European (E) non-maturing 1SW salmon contributing to the stock complex at West Greenland. Open symbols are forecast estimates.

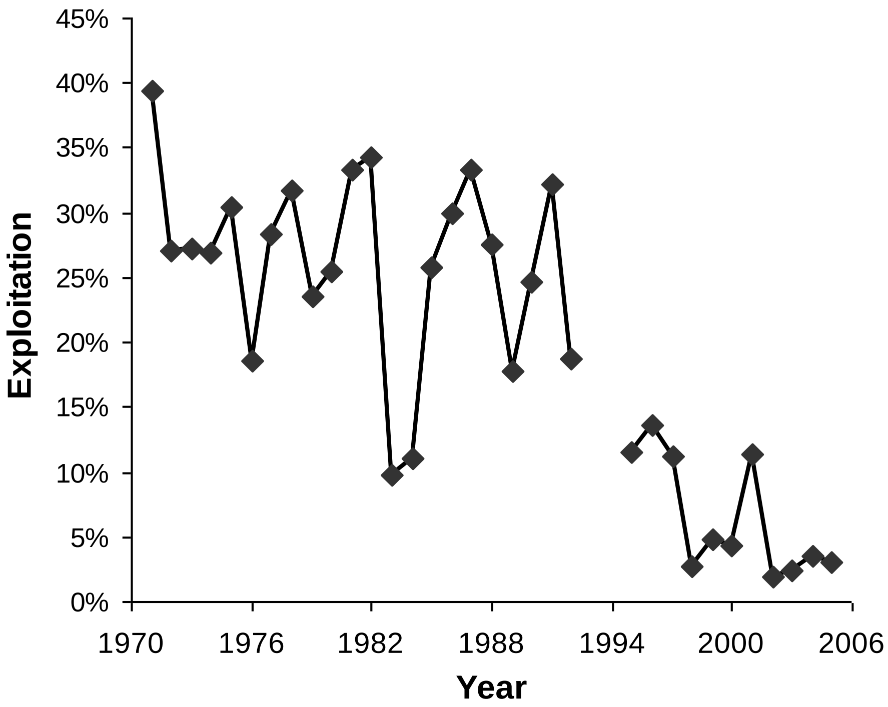


Figure 5.1.2. Exploitation rate for non-maturing 1SW Atlantic salmon at West Greenland, estimated from harvest and PFA of North American non-maturing 1SW salmon.

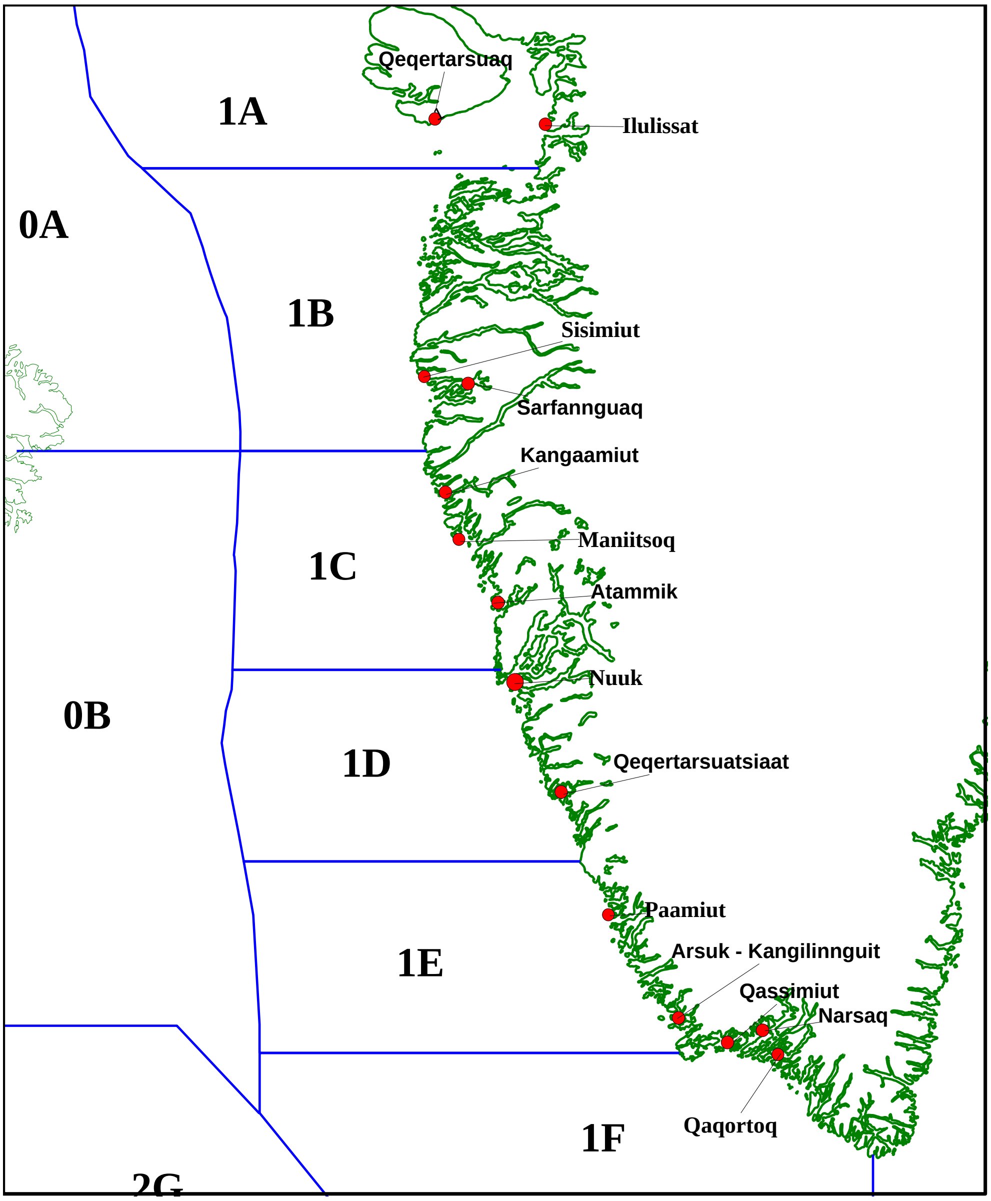


Figure 5.8.1.1. Location of NAFO divisions along the coast of West Greenland.

6 NASCO has requested ICES to identify relevant data deficiencies, monitoring needs, and research requirements, taking into account NASCO's international Atlantic salmon research board's inventory of ongoing research relating to salmon mortality in the sea

6.1 Data deficiencies and research needs

Atlantic salmon in the North Atlantic Area

1) ICES recommends that the Diadromous Fish Committee consider adopting a resolution to organize a second workshop to complete the collation of historical tag data initiated by the Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas (WKDUHSTI) and further examine the available datasets in relation to pertinent environmental and oceanographic information. The standardized, collated dataset from this workshop will provide opportunities to conduct more detailed analysis of historical marine growth, mortality, and oceanic distribution and migration patterns.

2) ICES recommends that NASCO considers facilitating research using new and evolving technologies (e.g. acoustic tags, DST, and popup tags) and techniques (e.g. use of kelts) and recommends further presentations from countries on the approaches taken to address questions on the marine ecology of Atlantic salmon. The coordination of efforts between countries would improve studies into the migration routes and early marine ecology of Atlantic salmon to further the presently limited understanding of the factors influencing marine survival.

3) ICES recommends that the Diadromous Fish Committee should consider adopting a resolution to organize a workshop to review and develop standardized circuli spacing techniques with particular consideration of recently available analytical technologies such as computer-assisted image analysis. These techniques provide opportunities to share and coordinate the examination of scale material available from different research agencies (or from different stocks and stock components) to identify spatial and temporal anomalies in the time-series of scale growth during the marine phase, which may indicate common causes or factors influencing mortality.

4) ICES recognizes the movement to river-specific management which requires more extensive monitoring on individual river basins and recommends continued and extended monitoring programmes by all Parties of NASCO.

North East Atlantic Commission

1) ICES recognizes that current limitations associated with forecasting pre-fishery abundances in the NEAC area pose difficulties in providing management advice for the Faroese fishery. ICES recommends that the Diadromous Fish Committee should consider adopting a resolution to form a special Study Group to develop and refine pre-fishery abundance forecast models.

North American Commission

No recommendations from the North American Commission.

Atlantic salmon in the West Greenland Commission Area

1) ICES recommends that NASCO continues to encourage the Home Rule Government of Greenland to provide information on the extent of fishing activity by all license holders. These inputs are essential to provide management advice on mixed stock fisheries at Greenland.

2) ICES recommends that NASCO continues to facilitate the formation of a broad geographic sampling program at West Greenland (multiple NAFO divisions) to more accurately estimate the continent of origin in the mixed stock fishery. These inputs are essential to provide management advice for this mixed stock fishery.

Annex 1: Glossary of acronyms used by ICES on North Atlantic Salmon, 2007

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.

ASAP *(The Atlantic Salmon Arc Project)* The initial aim of ASAP is to collect samples from the majority of salmon rivers on the Western Atlantic coast of Europe and use methods of Genetic Stock Identification (GSI).

BHSRA *(Bayesian Hierarchical Stock and Recruitment Approach)* Models for the analysis of a group of related stock–recruit data sets. Hierarchical modeling is a statistical technique that allows the modeling of the dependence among parameters that are related or connected through the use of a hierarchical model structure. Hierarchical models can be used to combine data from several independent sources.

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.

DST *(Data Storage Tag)* A miniature data logger with sensors including salinity, temperature, and depth that is attached to fish and other marine animals.

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

FWI *(Framework of Indicators)* A model which relies on informative relationships between historical monitoring metrics and estimates of population abundance to derive current abundance levels from contemporary metric values. These abundance estimates (and therefore the associated metric values) may be characterized as either meeting or failing to meet fishery-specific management objectives and can also be characterized as identifying whether a significant change in the previously provided multi-annual management advice in subsequent years had occurred.

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 the Atlantic.

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.

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

PGA *(The Probabilistic-based Genetic Assignment model)* An approach to partition the harvest of mixed stock fisheries into their finer origin parts. PGA uses Monte Carlo sampling to partition the reported and unreported catch estimates to continent, country, and within-country levels.

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.

RT-PCR *(Reverse Transcription-Polymerase Chain Reaction)* is the most sensitive technique for mRNA detection and quantitation currently available. Compared to the two other commonly used techniques for quantifying mRNA levels, Northern blot analysis and RNase protection assay, RT-PCR can be used to quantify mRNA levels from much smaller samples.

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

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.

SGBYSAL *(Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries).* The ICES Study Group that was established in 2005 to study Atlantic salmon distribution at sea and fisheries for other species with a potential to intercept salmon.

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

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.

VHSV *(Viral Haemorrhagic Septicaemia Virus)* VHS is a highly infectious virus disease caused by the virus family *Rhabdoviridae*, genus *Novirhabdovirus*.

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.

WKDUHSTI *(Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas)* The Workshop established by ICES was held in February 2007.

This glossary has been extracted from various sources, but chiefly the EU SALMODEL report (Crozier et al., 2003).

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