EXTRACT OF THE REPORT OF THE ICES ADVISORY COMMITTEE

NORTH ATLANTIC SALMON STOCKS

AS REPORTED TO

THE NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

2010

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Executive Summary

- In the North Atlantic, the nominal catch of Atlantic salmon in 2009 (1300 t) was the lowest in the time-series.
- Marine survival remains low.
- Northern North-East Atlantic Commission stock complexes (1SW and MSW) are at full reproductive capacity prior to the commencement of distant water fisheries.
- Southern European 1SW stock complex is considered to be suffering reduced reproductive capacity.
- Southern European MSW stock complex is considered to be at risk of suffering reduced reproductive capacity.
- The current estimates for both stock complexes are amongst the lowest in the time series.
- Estimated exploitation rates have generally been decreasing over the time period for both 1SW and MSW stocks in Northern and Southern NEAC areas and in North America.
- Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks over time. This is mainly because of continuing poor survival in the marine environment attributed to climate effects. Efforts continue to improve our understanding of causal relationships contributing to marine mortality.

1 Introduction

1.1 Main tasks

At its 2009 Statutory Meeting, ICES resolved (C. Res. 2009/2/ACOM:09) that the **Working Group on North Atlantic Salmon** [WGNAS] (chaired by: Gérald Chaput, Canada) will meet at ICES HQ, 22–31 March 2010 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). The terms of reference were met and the sections of the report which provide the answers are identified below:

a)	With respect to Atlantic Salmon in the North Atlantic area:	Section 2
2)	provide an overview of salmon catches and landings, including unreported catches by country and catch and re-lease, and production of farmed and ranched Atlantic salmon in 2009[1];	2.1 and 2.2
3)	report on significant new or emerging threats to, or opportunities for, salmon conservation and management[2];	2.4
4)	continue the work already initiated to investigate associations between changes in biological characteristics of all life stages of Atlantic salmon, environmental changes and variations in marine survival with a view to identifying predictors of abundance[3];	2.5
5)	describe how catch and release mortality and unreported catch are incorporated in national and international stock assessments and indicate how they can best be incorporated in future advice to NASCO;	2.6
6)	further develop approaches to forecast pre-fishery abundance for North American and European stocks with measures of uncertainty;	2.3
7)	provide a compilation of tag releases by country in 2009 and advise on progress with analysing historical tag recovery data from oceanic areas;	2.7
8)	identify relevant data deficiencies, monitoring needs and research requirements[4].	Sec 6

b)	With respect to Atlantic salmon in the North-East Atlantic Commission area:	Section 3
1)	describe the key events of the 2009 fisheries[5];	3.8
2)	review and report on the development of age-specific stock conservation limits;	3.3

3) describe the status of the stocks and provide annual catch options or alternative management advice for 2011–2013, with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding[6];	3.1, 3.4, 3.5 to 3.7
◎ supplementary request from NASCO for an assessment of the issues that would need to be addressed before quantitative catch advice could be provided for the Faroes fishery.	3.10
4) further investigate opportunities to develop a framework of indicators or alternative methods that could be used to identify any significant change in previously provided multi-annual management advice.	3.9

c) With respect to Atlantic salmon in the North American Commission area:	Section 4
1) describe the key events of the 2009 fisheries (including the fishery at St Pierre and Miquelon) [5];	4.3
2) update age-specific stock conservation limits based on new information as available;	4.2
• *In the event that NASCO informs ICES[8] that the framework of indicators (FWI) indicates that reassessment is required:*	4.3
3) describe the status of the stocks and provide annual catch options or alternative management advice for 2010-2013 with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding[6].	

d) With respect to Atlantic salmon in the West Greenland Commission area:	Section 5
1) describe the key events of the 2009 fisheries[5];	5.1
2) provide clarification of the levels of reported and unre-ported catch in the subsistence fishery since 2002,	5.2
• *In the event that NASCO informs ICES[8] that the framework of indicators (FWI) indicates that reassessment is required:*	
3) describe the status of stocks and provide annual catch op-tions or alternative management advice for 2010–2012 with an assessment of risk relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding[6,7];	

Notes:

1. With regard to question a-1 , ICES is asked to ensure that the terminology used in presenting the data on ranching is clearly defined. For the estimates of unreported catch the information provided should, where possible, indicate the location of the unreported catch in the following categories: in-river; estuarine; and coastal.

2. With regard to question a-2, ICES is requested to include information on any new research into the migration and distribution of salmon at sea.

3. With regard to question a-3, there is interest in determining if 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.) and with environmental changes.

4. 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 it in this task.

5. In the responses to questions b-1, c-1 and d-1 ICES is asked to provide details of catch, gear, effort, composition and origin of the catch and rates of exploitation. For homewater fisheries, the information provided should indicate the location of the catch in the following categories: in-river; estuarine; and coastal. Any new information on non-catch fishing mortality, of the salmon gear used, and on the by-catch of other species in salmon gear, and on the by-catch of salmon in any existing and new fisheries for other species is also requested.

6. In response to questions b-3, c-3 and d-3 provide a detailed explanation and critical examination of any changes to the models used to provide catch advice.

7. In response to question d-3, ICES is requested to provide a brief summary of the status of North American and North-East Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions b-3 and c-3.

8 The aim should be for NASCO to inform ICES by 31 January of the outcome of utilising the FWI.

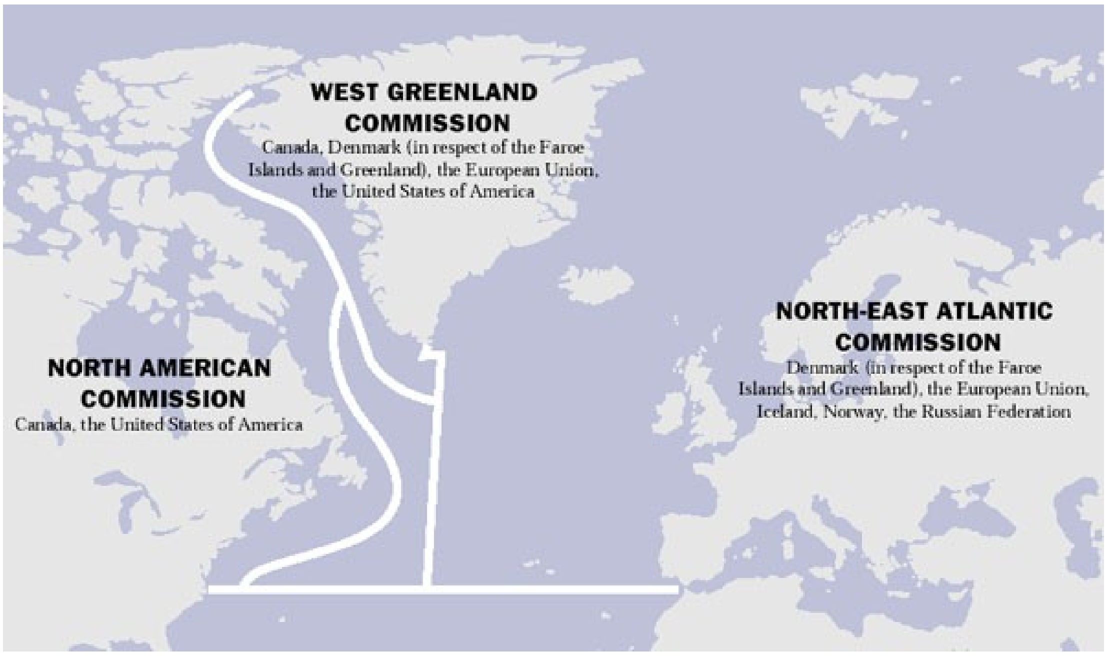
At the 2009 Annual Meeting of NASCO, conditional multi-annual regulatory measures were agreed to in the West Greenland Commission (2009–2011) and for the Faroe Islands (2009–2011) in the Northeast Atlantic Commission. The measures were conditional on a Framework of Indicators (FWI) being provided by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

In response to the terms of reference, the Working Group considered 36 Working Documents.

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

NASCO discharges these responsibilities via three Commission areas shown below:



1.3 Management objectives

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

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

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

NASCO's Action Plan for Application of the Precautionary Approach (NASCO, 1999) provides 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 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 the region specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

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

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

- ICES requires that the lower bound of the 95% confidence interval of the current estimate of spawners is above the CL for the stock to be considered at full reproductive capacity.
- When the lower bound of the confidence limit is below the CL, but the midpoint is above, then ICES considers the stock to be at risk of suffering reduced reproductive capacity.
- Finally, when the midpoint is below the CL, ICES considers the stock to suffer reduced reproductive capacity.

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

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 countries in the North Atlantic for 1960 to 2009 are given in Table 2.1.1.1. Catch statistics in the North Atlantic include fish farm escapees and in some north-east Atlantic countries also include ranched fish.

Icelandic catches have traditionally been split into two separate categories, wild and ranched, reflecting the fact that Iceland has been the only North Atlantic country where large-scale ranching has been undertaken with the specific intention of harvesting all returns at the release site. The release of smolts for commercial ranching purposes ceased in Iceland in 1998, but ranching for rod fisheries in two Icelandic rivers continued into 2009 (Table 2.1.1.1). While ranching does occur in some other countries, this is on a much smaller scale. Some of these operations are experimental and at others harvesting does not occur solely at the release site. The ranched component in these countries has therefore been included in the nominal catch.

Reported catches in tonnes for the three NASCO Commission Areas for 2000 to 2009 are provided below.

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NEAC	2736	2876	2495	2304	1978	1998	1867	1407	1532	1151
NAC	155	150	150	144	164	142	140	114	162	122
WGC	21	43	9	9	15	15	22	25	26	26
Total	2912	3069	2654	2457	2157	2155	2029	1546	1720	1300

The provisional total nominal catch for 2009 was 1300 tonnes, 420 t below the updated catch for 2008 (1720 t) and the lowest in the time-series (Figure 2.1.1.1). The 2009 catch was over 620 t below the average of the last five years (1921 t), and almost 1000 t below the average of the last 10 years (2295 t). Catches were well below the previous five- and ten-year averages in all southern NEAC countries and slightly below the averages in the majority of northern NEAC countries.

ICES recognises that mixed stock fisheries present particular threats to stock status. These fisheries predominantly operate in coastal areas and NASCO specifically requests that the nominal catches in homewater fisheries be partitioned according to whether the catch is taken in coastal, estuarine or riverine areas. The 2009 nominal catch (in tonnes) was partitioned accordingly and is shown below for the NEAC and NAC Commission Areas. There is considerable variability in the distribution of the catch among individual countries. In most countries the majority of the catch is now taken in freshwater; the coastal catch has declined markedly.

Area	Coast		Estuary		River		Total
	Weight	%	Weight	%	Weight	%	Weight
NEAC	358	31	47	4	745	65	1150
NAC	11	9	40	32	73	59	122

Coastal, estuarine and riverine catch data aggregated by region are presented in Figure 2.1.1.2. In northern Europe, about half the catch has typically been taken in rivers and half in coastal waters (although there are no coastal fisheries in Iceland and

Finland), with estuarine catches representing a negligible component of the catch in this area. There has been a reduction in the proportion of the catch taken in coastal waters over the last five years. In southern Europe, catches in all fishery areas have declined dramatically over the period. While coastal fisheries have historically made up the largest component of the catch, these fisheries have declined the most, reflecting widespread measures to reduce exploitation in a number of countries. In the last three years, the majority of the catch in this area has been taken in fresh water.

In North America, the total catch over the period 2000 to 2009 has been relatively constant. The majority of the catch in this area has been taken in riverine fisheries; the catch in coastal fisheries has been relatively small in any year (13 t or less), but has increased as a proportion of the total catch over the period.

2.1.2 Catch and release

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

The nominal catches presented in Section 2.1.1 do not include salmon that have been caught and released. Table 2.1.2.1 presents C&R information from 1991 to 2009 for countries that have records; C&R may also be practiced in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released: in 2009 this ranged from 6% in Norway (this is a minimum figure) and 24% in Iceland to 60% in Canada and 68% in UK (Scotland) reflecting varying management practices and angler attitudes among these countries. Catch and release rates have typically been highest in Russia (average of 84% in the 5 years 2004 to 2008) and are believed to have remained at this level. However, there were no obligations to report caught-and-released fish in Russia in 2009. Within countries, the percentage of fish released has tended to increase over time. Overall, over 143 000 salmon were reported to have been released around the North Atlantic in 2009. This is fewer than that reported in 2008 due to the absence of any data for fish released in Russia.

Summary information on how catch and release levels are incorporated into national assessments is provided in Section 2.6.

2.1.3 Unreported catches

The total unreported catch in NASCO areas in 2009 was estimated to be 327 t, however there were no estimates for Canada and Russia. The unreported catch in the North East Atlantic Commission Area in 2009 was estimated at 317 t and that for the West Greenland Commission Area at 10 t. There was no estimate for the North American Commission Area. The 2009 unreported catch by country is provided in Table 2.1.3.1. Over recent years efforts have been made to reduce the level of unreported catch in a number of countries (e.g. through improved reporting procedures and the introduction of carcass tagging and logbook schemes). In the past, salmon fishing by non-contracting parties is known to have taken place in international waters to the north of the Faroe Islands. A number of surveillance flights have taken place over this area in recent years. There were no sightings of vessels in 2009, although there have been extended periods over the winter period when no flights took place.

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NEAC	1135	1089	946	719	575	605	604	465	433	317
NAC	124	81	83	118	101	85	56	-	-	-
WGC	10	10	10	10	10	10	10	10	10	10

2.2 Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2009 is 1076 kt and in excess of one million tonnes for the first time (Figure 2.2.1). This represents a 13% increase on 2008 and a 23% increase on the previous 5-year mean due to increased production in Norway (up 16% on 2008). Norway and UK (Scotland) continue to produce the majority of the farmed salmon in the North Atlantic (80% and 12% respectively). Farmed salmon production in 2009 was below the previous five-year average in Canada, Ireland, Iceland and Russia. In the absence of production figures for 2009 for some countries, values from 2008 were assumed as provisional values for 2009.

World-wide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002. It is difficult to source reliable production figures for all countries outside the North Atlantic area and it has been necessary to use 2008 estimates for some countries in deriving a world-wide estimate for 2009. Noting this caveat, total production in 2009 is provisionally estimated at around 1385 kt (Figure 2.2.1), a 5% decrease on 2008 and the first drop in production since the beginning of the time-series. This reflects a fall in production outside the North Atlantic in 2009. Production in this area is estimated to have accounted for 22% of the total in 2009 (down from 34% in 2008). Production outside the North Atlantic is still dominated by Chile despite a 49% decrease in farmed salmon production in this country compared with 2008 due to an outbreak of infectious salmon anaemia (ISA) virus. The ISA outbreak is reported to have had a catastrophic impact on the Chilean salmon industry, where a further reduction in production is expected.

The world-wide production of farmed Atlantic salmon in 2009 was over 1000 times the reported nominal catch of Atlantic salmon in the North Atlantic.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic in 2009 was 43 t, the majority of which (42 t) was taken by the Icelandic ranched rod fisheries (Figure 2.2.2). Small catches of ranched fish from experimental projects were also recorded in two of the three other countries that typically report such fish (Ireland and UK (N. Ireland)); these data include catches in net, trap and rod fisheries.

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

The new Bayesian modelling approaches for both the NAC and NEAC areas had been presented previously (ICES, 2009a). The new models were run alongside the existing forecast models and it was agreed that these were an improvement and should replace the previous models in developing catch advice in the future. The ICES Study Group on Salmon Stock Assessment and Forecasting (SGSAFE) did not meet in the past year and no further developments to the forecast models were made in 2010. However, the performance of the models has been further assessed.

2.3.1 Diagnostics of the Bayesian combined sea-age models for NEAC

As described in ICES (2009a), the Bayesian predictive models for the northern NEAC and the southern NEAC complexes are constructed to account simultaneously for the dynamics of the recruitment to 1SW maturing and 1SW non-maturing (or MSW) salmon. For each year t, a proportional relationship is assumed between lagged eggs (LE_t) and the expected means of the maturing $PFAm_t$, with a recruitment rate factor am_t (in the log-scale). The recruitment rate is considered to be random with independent and identically distributed log-normal errors.

$$PFAm_t = LogN(\mu.PFAm_t\ , \sigma.PFAm^2)$$

$$\mu.PFAm_t = \log(LE_i) + am_t$$

Similarly, for each year t, a proportional relationship is assumed between LE_t and the expected means of the non-maturing *PFAnm*, with a productivity factor anm_t (i.i.d. multiplicative log-normal random errors).

$$PFAnm_t = LogN(\mu.PFAnm_t\ , \sigma.PFAnm^2)$$

$$\mu.PFAnm_t = \log(LE_i) + anm_t$$

As indicated in ICES (2009a), the recruitment rate for the non-maturing *PFA* is modelled dependently on the recruitment rate for the maturing PFA as:

$$\alpha nm_t = \alpha m_t + \log(\frac{1 - p.PFAm_t}{p.PFAm_t})$$

The expected rate of maturing PFA vs total PFA recruitment rate is $p.PFAm_t$.

Therefore, the hypothesis underlying this model is that the time variability of the recruitment rate for maturing and non-maturing PFA will be closely related. A high recruitment rate for maturing PFA will correspond to a high productivity of non-maturing PFA. However, time variations of the parameter $p.PFAm_t$ introduce some flexibility in the synchrony of the maturing and non-maturing recruitment rates.

2.3.2 Performance of the parameter estimation portion of the model

As indicated above, the recruitment rates were modelled as a first order time varying parameter following a simple random walk over the time series:

$$t = 1,\dots,n\text{-}1 \quad am_{t+1} = am_t + \omega_t \qquad with \quad \omega_t \overset{i.i.d}{\sim} N(0, \sigma^2_{\alpha})$$

The independence of the annual deviates of the successive recruitment rates is assessed based on the first order difference in the error term (w_t), calculated as:

$$Dif.w_t = am_{t+1} - am_t$$

Under this assumption the differences in the successive annual rates should generally be normally distributed with a mean of zero.

Secondly, the predicted PFA values for maturing and non-maturing age groups conditional on only the LE and productivity parameters (termed ElogPFA) relative to the PFA estimates which are conditioned by the preceding parameters as well as the observations on returns, catches and assumptions on M (PFA) was also considered.

$$Res.PFAm_t = \log(PFAm_t - ElogPFAm_t)$$

where: $ElogPFAm_t = \log(LE_t + am_t)$

$Res.PFAnm_t = \log(PFAnm_t – ElogPFAnm_t)$

where: $ElogPFAnm_t = \log(LE_t + anm_t)$

The performance of the parameter estimation portion of the model relative to these diagnostics was examined for the southern NEAC complex model with the updated data for maturing 1SW salmon to 2009 (see Section 3.6.2) and the results are presented below.

Annual deviates of successive recruitment rates

The annual differences in the productivity parameter (*am*) in most years were distributed around zero, and for many of the year comparisons, zero was contained within the interquartile range of the posterior distributions (Figure 2.3.2.1). The obvious exception to this was the 1988 and 1989 productivity years for which the differences from one year to the next were mostly negative, indicating that for those years, the change in productivity over the years was strongly negative. This corresponds to the years in which a large decline in productivity was noted in the time series of maturing salmon from the Southern NEAC complex. The distribution of the differences for this diagnostic indicates that the assumptions of the first order dynamic model were for the most part consistent with the observations and the assumed dynamics. There remains a pattern of successive positive and negative deviates that could potentially be corrected using a higher order autoregressive process in the model. This is a subject for further evaluation.

Partially conditioned predicted PFA to fully conditioned PFA

The predicted PFA of maturing and non-maturing components based on only the lagged eggs and the corresponding productivity parameters show deviations from the predicted PFA based on the full model (using lagged eggs, catches, mortality assumptions and returns) (Figure 2.3.2.2). Over the 31 years of observations, differences in the PFA predicted values for which zero was not contained within the 95% Bayesian Credibility Intervals (B.C.I.) were noted in only four years: 1981, 1991, 1998 and 2000 (Figure 2.3.2.2). There were no large deviations observed for the PFA non-maturing component, the 95% B.C.I. of the residual differences in the log of the PFA's all contained zero (Figure 2.3.2.2).

2.3.3 Performance of the forecast portion of the models

A retrospective comparison of model forecasts was undertaken to investigate the model's ability to predict PFAs for maturing and non-maturing recruits in both Northern and Southern NEAC stock complexes. Run-reconstructed PFAs for 2008 were compared with the model predictions. Data in the forecast model were successively truncated to allow forecasts to be run simulating the viewpoints for the years 2005 to 2009 (Figures 2.3.3.1 and 2.3.3.2); 2005 is the earliest year for which lagged spawner estimates, derived from the run-reconstruction model, allow prediction of the 2008 PFA values. The 2009 forecast is necessary to predict PFAs for non-maturing stocks in 2008 as the MSW spawners for that cohort do not return until 2009 and abundance estimates are not available until 2010.

In the case of all four stock complexes, the uncertainties associated with the forecasts decrease as the interval between reconstructed estimate and forecast year decreases. This is most apparent in the upper bounds of the uncertainty estimates. In all cases, median forecast values approach the run-reconstructed estimates as the forecast year interval decreases. In the cases of the Northern non-maturing and Southern maturing stocks, run-reconstructed estimates are within the interquartile range of the forecasts for at least the 2006 year run onwards.

Model forecasts generally overestimated run-reconstructed values for the 2008 PFA, particularly as the interval between run and forecast year increases. For the Northern maturing and Southern non-maturing stocks, however, the model forecasts one year forward still produced estimates which were notably optimistic compared to the run-reconstructed values. This over estimation is consistent with the recent pattern in the productivity parameter deviate shown in Figure 2.3.2.1. During a time period when the productivity parameter is increasing the model would under-estimate abundance. This forecast performance could potentially be improved using a higher order auto-regressive process in the model.

2.3.4 Next steps

The Bayesian model developed in ICES (2009a) has been employed to provide stock forecasts for maturing and non-maturing 1SW salmon in the Southern and Northern NEAC areas for the years 2011 to 2013. In addition, the following points have been highlighted for consideration in the coming year:

- The proportion of maturing 1SW fish in the Southern NEAC area is markedly lower in the forecast years relative to the most recent historic years reflecting the fact that the productivity parameters are derived for the total time series. Consideration should be given to using an alternative approach such as deriving the maturation parameter over a shorter time period (from more recent years) or modelling this process through time.
- The uncertainty in the returns is not currently accounted for in the model, due to difficulties in model fitting.
- The influence of environmental variables on productivity should be investigated for incorporation into the model and/or to further inform timescales for the autoregressive components of the model.

ICES has suggested (Section 3.10) that future catch advice could be based around a management framework which addresses the probability of national stocks exceeding their CLs. If this approach is implemented, it will be more appropriate to consider forecasts of PFA at the national (or regional) level.

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

2.4.1 Update on SALSEA-Merge

The overall objective of SALSEA-Merge is, by merging genetic and ecological investigations, to advance understanding of stock specific migration and distribution patterns and overall ecology of the marine life of Atlantic salmon and gain an insight into the factors responsible for recent significant increases in marine mortality. ICES noted recent progress relating to various work packages within the overall programme.

Work Package 1: *the development of a genetic tool for identifying the region/river of origin of marine samples of Atlantic salmon.* An operational molecular genetic tool to determine the region or river of origin of European Atlantic salmon captured at sea, using both historical and newly collected tissues has been developed. The final data base will encompass approximately 500 rivers.

Work package 2: *the collection and assembly of marine samples for analysis along with associated ecological data.* Tissue samples from 1800 post-smolts from surveys undertaken prior to the SALSEA-Merge project have been identified for genetic stock identification and a scale reading workshop was held to harmonise methods. During marine surveys conducted by the Irish, Faroes and Norwegian partners over 1700 post-smolts and 37 adult salmon have been captured.

Work package 3: *application of the genetic tool to identify the region/river of origin of marine samples of salmon*. Preliminary analyses were completed to identify the origin of collected samples; these will be refined as new material is added to the genetic baseline.

Work package 4: *the biological analysis of marine samples*. Training of researchers from partner laboratories was completed in the use of digital scale reading techniques and new imaging equipment. Historical scale samples of salmon from selected rivers are under investigation and a digital scale library, including image files, established. Stomach samples from salmon and other pelagic species (mainly mackerel) from the 2008 expeditions have been analysed.

Work package 5: *the integration of genetic, biological and oceanographic information to generate ecological insights*. Development of a migration model is progressing and a fundamental particle drift model has been completed and tested.

Work Package 6: *dissemination of information*. A website has been established with web pages providing a description of the scientific work completed and planned under the relevant SALSEA work packages.

2.4.2 Update on SALSEA N. America

A research cruise was completed in the Labrador Sea between 55 ^{0} N and 58 ^{0} N in September 2009. The broad scale objectives were to:

(1) Sample the ecosystem components within the upper 20 m of the water column by fishing a pelagic trawl;

(2) Assess size-selective catchability of the pelagic trawl to validate trawl catchability by fishing surface set gillnets;

(3) Relate salmon geographic distribution (latitude, longitude) and oceanographic (fronts, temperature, salinity) characteristics from the salmon catches;

(4) Provide information from catches and relative abundance of other species, including macroplankton aggregations on the role of salmon within this larger pelagic ecosystem; and,

(5) Collect oceanographic data to define the habitat of the salmon post-smolts and other species.

In spite of poor weather, the survey objectives of sampling the ecosystem components within the upper 20 m of the water column were achieved. The salmon that were intensively sampled (85 fish), when analysed, will define the characteristics, origin, age, health, and diet of the salmon population in the northern Labrador Sea. Stable isotope analysis will define the salmon's place trophically in the ecosystem. Other observations included showing that salmon could be caught in the surface trawl at night and the high productivity and species diversity of the upper portion of the water column in the Labrador Sea. No salmon were caught in sets on the shelf area influenced by the Labrador Current versus fishing sets in the mid-Labrador Sea where salmon were commonly caught.

2.4.3 Update on SALSEA West Greenland

SALSEA West Greenland is designed to enhance the current Baseline Sampling Program (Section 5.1) and integrate with the co-ordinated marine surveys in other oceanic areas to provide data for investigating hypotheses on the causal mechanisms driving stock-specific performance in the ocean (i.e. marine survival).

In 2009, the SALSEA West Greenland Enhanced Sampling Program resulted in detailed examination of 412 fresh whole salmon, which were purchased directly from individual fishermen. Fresh whole fish were needed, as the protocols for many of the samples require the collection of fresh internal tissues. The following provides the samples collected in 2009 and their purpose:

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

ICES recommends that SALSEA West Greenland be conducted in 2010 and that efforts continue to integrate the results from this sampling program with results obtained from both SALSEA-Merge and SALSEA North America.

2.4.4 Genetic identification of North American fish recovered at West Greenland to region of origin

A recent genetic microsatellite investigation was carried out to identify the region of origin of salmon of North American origin captured at three different localities in the Greenland mixed-stock fishery (Gauthier-Ouellet *et al.*, 2009). This study showed that it is possible to identify the region of origin of Atlantic salmon in the Greenland fishery with high precision. It is also possible to evaluate river origin for regions where moderate to high genetic differentiation between rivers is evident. The contribution of each group ranged from <1% (Maine) to 40% (Southern Quebec). The estimated regional contribution to the Greenland fishery was significantly correlated to the number of MSW salmon produced in each region in the two years examined (2002 and 2004). As such, no regional group was overrepresented in landings compared to their respective productivity according to these results. Decreasing annual contributions were observed for Southern Quebec (-22.0%) and New Brunswick (-17.4%), while an increasing contribution was observed for Labrador (+14.9%) over the course of the study.

2.4.5 Atlantic salmon genetics - new initiatives

Steps towards an integrated and standardized genetic data base

Building on a SALSEA initiative to develop a compatible genetic database over the entire salmon distribution area, a North American project supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) has just started. A Canadian genetic database will first be constructed by expanding the river coverage for each province and standardizing genetic data from rivers already sampled. Combining, calibrating and integrating databases of salmon populations from both sides of the Atlantic will provide a valuable tool for identifying the origin of salmon from the Greenland fishery, as well as other high seas catches where salmon from the whole distribution range might occur.

Mixed stock coastal fisheries in northern Norway

SALSEA-Merge and other projects, have contributed to the establishment of a comprehensive genetic baseline for salmon populations in northern Europe. This has facilitated a pilot project to look into the composition of catches in the coastal salmon fishery in Finnmark County, North Norway. Tagging studies conducted in the late 1960s and early 1970s demonstrated that these fisheries exploited populations from a wide geographic range, including from Russia as far east as the Pechora River (ICES, 2009a). Preliminary data from Finnmark rivers indicate that the genetic differentiation between rivers in this region is on a scale that may allow for assignment of individuals to rivers, and not only regions.

Further initiatives to extend the genetic baseline of these northern populations are underway. A co-operative project between Finland, Russia and Norway is currently being developed with the objective of developing a model for coastal migration of returning spawners to these northern salmon rivers and providing a more informed basis for the management of the coastal fisheries.

2.4.6 The development of tributary specific conservation limits in Norway

Conservation limits have been established for a number of Norwegian tributaries of the River Tana (Teno in Finnish) and for the river system as a whole (Hindar *et al.* 2007). The assessments suggest that spawning populations have been very low in five Norwegian tributaries of the River Tana in recent years.

Over 90% of the catch in the Tana river system is estimated to take place in the main stem, whereas most of the total conservation limit is derived from the tributaries. The stocks in the River Tana system are genetically differentiated (Vähä *et al.*, 2007), and management should therefore take account of the fact that multiple populations contribute to the fisheries in the main stem of the river. Furthermore, the salmon from the River Tana are also exploited in sea fisheries in the Tana fjord and along the coast of Northern Norway. Heavy exploitation reducing the number of salmon reaching the tributaries is thus the most likely cause for the deficiency of spawners in the Norwegian tributaries of the River Tana.

2.4.7 Estimating river-specific conservation limits for Atlantic salmon stocks in UK(Scotland)

NASCO has asked that age specific conservation limits be developed for individual river stocks of salmon. Progress with setting such limits has varied among countries; within the NEAC area, river-specific CLs have so far been developed for salmon stocks in UK(England & Wales), France and Ireland (ICES, 2009a). ICES noted that progress with setting river-specific CLs has also been made in Norway and UK(Scotland).

The CL (maximum sustainable yield) for the North Esk has been estimated as 18.14 million eggs using stock and recruitment data. A transport model based on wetted area has been developed to allow river-specific CLs to be estimated for salmon stocks in UK(Scotland). CLs for other areas are estimated by scaling the North Esk CL according to the ratio of North Esk and recipient wetted areas. Wetted areas are estimated from digital mapping information. This has resulted in a range of values for the North Esk CL of 6.75 to 6.95 eggs/m^2. Estimating the all Scotland wetted area on a similar basis resulted in a CL which was 23% lower than the current estimate provided by the ICES run reconstruction model.

The methods for estimating CLs for Scottish stocks, the transport model and the resulting CL estimates are under development. Continued efforts to develop river-specific CLs will include further evaluation of the data and methods in collaboration with local biologists and stakeholders.

2.4.8 Red vent syndrome

Over recent years, there have been reports from a number of countries in the NEAC and NAC areas of salmon returning to rivers with swollen and/or bleeding vents. The condition, known as red vent syndrome (RVS), has been noted since 2005, and has been linked to the presence of a nematode worm, *Anisakis simplex* (Beck *et al*., 2008). A number of regions within the NEAC stock complex observed a notable increase in the incidence of salmon with RVS during 2007 (ICES, 2008a), but levels were typically lower in NEAC countries during 2008 (ICES, 2009a) and 2009. However, levels of RVS on monitored rivers in UK (England & Wales) typically remained high (30-40%) and above those noted in previous years. Trapping records for these rivers for the last 5 years indicate that RVS has generally been less prevalent in early and late running fish than mid-season fish. Early running fish comprise mainly MSW salmon whereas late running fish are predominantly 1SW fish. There is also some evidence of a higher infestation rate in female fish than in males. Within the NAC stock complex, RVS has been detected in the Scotia-Fundy (2008 and 2009) and Quebec regions.

2.4.9 Reduced sensitivity and development of resistance towards treatment in salmon louse (Lepeophtheirus salmonis)

The Working Group previously highlighted concerns arising from Norway regarding the development of reduced sensitivity of the salmon louse (*Lepeophtheirus salmonis*) to oral treatment (ICES 2009a). In the past year, reduced sensitivity to treatment has been observed over much larger areas, and while the problem in 2008 was mainly restricted to west and central Norway, cases have now been registered along much of the coast, including the northern part of the country (http://www.mattilsynet.no/smittevern_og_bekjempelse/fisk/lakselus).

The monthly sea lice reports from fish farmers show that the number of adult lice on salmon in January and February 2010 continued to increase in several areas compared with earlier years (www.lusedata.no). This, together with the increase in geographic spread of incidences of treatment failure and resistance, gives cause for concern. If the level of infestation in fish farms is not reduced before the smolt migration in 2010, increased salmon lice infestations on wild smolts might lead to increased mortality and/or reduced growth at sea (Finstad and Jonsson 2001; Skilbrei and Wennevik 2006; Hvidsten *et al*. 2007). With an increasing number of salmon produced in aquaculture (see Section 2.2), the number of lice per farmed fish needs to be reduced simply to maintain the infection pressure at a constant level (Heuch and Mo, 2001).

2.4.10 Catches of pink salmon in the NEAC area

Pink salmon were introduced to Atlantic salmon rivers in the White Sea region of Russia between the 1950s and 1990s. Eggs from the Sakhalin Island and Magadan regions in the far east of Russia were transferred to hatcheries in the Murmansk and Archangelsk regions and juveniles released annually to White Sea rivers during spring. No juvenile releases have taken place since 2003, but pink salmon now spawn naturally in a number of salmon rivers in Russia and possibly in some other NEAC countries (Norway, Iceland and UK (Scotland)).

There is now a fishery for pink salmon in coastal areas of the White Sea using the same gears, and over the same period, as the fishery for Atlantic salmon. Pink salmon run in relatively large numbers only in odd years; in even years the abundance of pink salmon is very low. Fishing for pink salmon in Russia is only allowed in licensed fisheries, and the total declared catch in 2009 was 139 t, the second highest in the time-series and double the declared catch of Atlantic salmon. The potential interactions between pink salmon and Atlantic salmon in freshwater and the sea are unknown, and fisheries targeting pink salmon also catch Atlantic salmon.

2.4.11 Reintroduction of salmon – developments on the River Rhine

The programme of reintroducing Atlantic salmon to the River Rhine started 20 years ago and the first adult salmon was recorded in the River Sieg, a tributary of the Rhine, in 1990, more than 30 years after the extirpation of salmon from the Rhine catchment. Naturally produced juvenile salmon were first observed in 1994 and since the start of the programme more than 5600 adult salmon, mainly from stocking, have now been recorded in the Rhine and its tributaries. Stocking of juveniles is planned to continue.

The downstream migration of Atlantic salmon smolts was again monitored in the River Rhine in 2009. The study aims to investigate the success of downstream migration and to assess the migration routes in relation to the obstructions within the Rhine Delta, particularly the Haringvliet sluices. Overall, 120 tagged fish were released into two tributaries of the River Rhine about 330 km from the sea. By the end of the migration period (end of April), 73 of the 120 tagged fish (61%) had been detected leaving the tributaries, but only 15 (13 %) were recorded reaching the sea after passage through the delta. In addition to the 47 tagged fish (39%) lost in the tributaries where the fish were released, another 20 fish (17 %) were lost in the German part of the Rhine and a further 38 smolts (32%) failed to migrate successfully through the delta (the Netherlands) to the sea. Losses in 2009 and 2008 were significantly higher than in 2007when 46% of the smolts were recorded reaching the sea; this may reflect higher discharge in 2007.

The study will be repeated after the planned re-opening of the Haringvliet dam. This is scheduled to occur by the end of 2010 and is aimed specifically at improving conditions for migratory fish species during their passage from freshwater to the sea and vice versa.

2.4.12 European regulations

ICES has previously noted that European regulations such as the Habitats Directive and Water Framework Directive have implications for management of salmon and are consistent with NASCO objectives (ICES, 2009a). In addition, the EU data collection regulation was expanded in 2009 to include both salmon and eels and for these species into inland waters (ICES 2009a).

2.5 NASCO has asked ICES to continue work already initiated to investigate associations between changes in biological characteristics of all life stages of Atlantic salmon, environmental changes and variations in marine survival with a view to identifying predictors of abundance

ICES considered a preliminary report from the second meeting of the Study Group on the Identification of Biological Characteristics for Use as Predictors of Salmon Abundance [SGBICEPS] and a new approach for estimating at-sea survival of repeat spawning adult salmon, applied to data from the LaHave River, Canada.

2.5.1 Report from the Study Group on the Identification of Biological Characteristics for use as Predictors of Salmon Abundance [SGBICEPS]

The Study Group on the Identification of Biological Characteristics for Use as Predictors of Salmon Abundance [SGBICEPS] was established by ICES with the following terms of reference:

a. identify data sources and compile time series of data on marine mortality of salmon, salmon abundance, biological characteristics of salmon and related environmental information;

b. consider hypotheses relating mortality (freshwater and marine) and/or abundance trends for Atlantic salmon stocks with changes in biological characteristics of all life stages and environmental changes;

c. conduct preliminary analyses to explore the available datasets and test the hypotheses.

At its first meeting, the Study Group completed a review of the information on the life history strategies of salmon and changes in the biological characteristics of the fish in relation to key environmental variables as a foundation for addressing the ToR (ICES 2009b).

Data sources on Biological characteristics

The Study Group continued the work to compile a suite of standard biological measures over time series (>15 years) sufficient to account for natural variability and to facilitate trend analysis. Additional data sets were made available at the second meeting for 7 rivers in Norway and 3 rivers in the Baltic and a number of gaps were filled and time-series extended in other, existing data sets. Thus, data on average annual values for various biological characteristics were available for North Atlantic stocks from Canada, USA, Iceland, Russia, Finland, Norway, Sweden, UK(Scotland), UK(England & Wales), UK(N. Ireland) and France, as well as for three stocks in the Baltic Sea (Table 2.5.1.1).

Data quality issues

At its first meeting, the Study Group noted a number of potential constraints and caveats, mostly relating to sampling programmes and methodological differences, which might affect analysis of available data sets. Descriptions of the data sources and the methodology used to collect the data were therefore collected from the various tagging agencies.

Condition Factor investigations

The Study Group completed initial investigations of changes in condition factor (CF) at its first meeting, building on the analyses (1993 to 2006) described by Todd *et al.* (2008) of CF variation in 1SW fish from two fisheries in UK(Scotland) in relation to ocean climate change. Work is ongoing to further analyse CF in both 1SW and 2SW fish for a number of rivers in UK(Scotland) (Tweed, Tay, Spey, North Esk), Wales (Dee) and three rivers from Norway (located in southern, central and northern areas); some of these time series date back to the early 1960s. With the availability of data on 2SW fish, SST analyses have been extended to the NW Atlantic and investigations have included consideration of the most appropriate SST databases to utilise.

Exploratory data analyses

Investigations at the first meeting highlighted significant trends over time for many of the variables explored. The results of some of the new analyses completed during the second meeting of the Study Group are summarised below.

Mean length of returning adult 1SW salmon

The extended biological characteristics data set was used to investigate changes in the size of returning 1SW salmon. Standardised z-scores were generated for twelve rivers in the N NEAC area and six rivers in the S NEAC area over the time period 1989 to 2008; this period was chosen to maximise the number of available data sets, a number of which only extended back to 1989. The mean lengths of N NEAC and S NEAC fish were found to be significantly correlated ($r = 0.60$, $n = 20$, $p = 0.006$) (Figure 2.5.1.1), suggesting that 1SW salmon over a large area of the NE Atlantic experience similar growth conditions during their first year at sea.

Further investigation indicated that the z-scores of 1SW length were also significantly correlated with the PFA of maturing 1SW salmon for both the N and S NEAC areas (N NEAC: $r = 0.70$, $n = 20$, $p = 0.001$, Figure 2.5.1.2; S NEAC: $r = 0.49$, $n = 20$, $p = 0.027$, Figure 2.5.1.3). This suggests that reduced growth in the first year at sea leads to reduced survival or delayed maturation, and/or that better growth leads to increased survival or earlier maturation.

Wider geographical patterns - Meta analysis

The Study Group repeated earlier analyses on the extended data sets to explore patterns in the changes in biological characteristics over broader spatial scales. For these purposes the individual river stocks were allocated to the five different stock complex groupings as indicated in Table 2.5.1.1. Meta-analysis (ICES, 2009b) was used to examine spatial patterns in these groups for most of the biological characteristics available over the period since 1989. Example plots are provided at Figure 2.5.1.4 and the results summarised in Table 2.5.1.2. These analyses indicated a number of significant changes over time at the stock complex level. For example, significant differences from the mean were noted for:

- N NEAC and S NEAC Regions – reduction in river age;
- N NAC and S NAC Regions - earlier adult return date;
- N NEAC and S NEAC Regions – reduced size of 1SW and 2SW fish;

- N NEAC region and Baltic – decrease in proportion of 1SW fish and increase in proportion of 2SW.

Life-history modelling

A life history model (LHM) developed by Aprahamian *et al.* (2008) was used to estimate overall egg to adult mortality. The model was validated by comparing outputs (estimated numbers of spawning adults by sea-age) with observed values for five southern NEAC indicator rivers: the Welsh Dee, Bush, Burrishoole, Frome and North Esk for various 5-year periods. The overall lifetime mortality estimates showed no consistent systematic increase for the various stocks and no major change in overall lifetime mortality was apparent since the late 1970s/early 1980s suggesting that any increases in natural mortality had been largely offset by declines in fishing mortality and/or other anthropogenic factors.

Lifetime fecundity (eggs/female surviving to spawn) is suggested to provide the most suitable measure of fitness for stable populations (e.g. Roff, 1992; Stearns, 1992). The model was re-run to predict the optimal sea-age at maturity which maximised the number of eggs per female for the five rivers for the various 5-year periods (the Optimal Age Model - OAM). There was no significant difference between the observed proportions of salmon maturing at different sea-ages and that estimated from the OAM for the: Bush, Burrishoole, North Esk and Frome; differences for the Dee were relatively small, but significant. The results therefore suggest that lifetime fecundity is being maximised for most of these rivers.

The Study Group noted that both the LHM and OAM would benefit from estimating / using life-stage specific values of mortality – to explore their effects on age at maturity. It seemed unlikely that changes in sea-age at maturity (or other biological characteristics) could be used to predict mortality. Changes in such characteristics reflect changes in mortality, and/or growth and fecundity, so are likely to be manifest retrospectively after an unknown number of generations.

Case studies

The Study Group reviewed information from a number of river or area-specific investigations.

River Burrishoole (Ireland)

The smolt run on the River Burrishoole has been monitored since 1970; since this time there has been a significant trend towards earlier commencement of the run (measured as 5% of the fish migrating), with the run now starting around 10 days earlier than at the start of the period. Survival of wild salmon ova to smolt has varied between 0.32% and 1.22% over the time period with no significant trend.

River Bush (N. Ireland)

The smolt run on the river has been monitored for 30 years. Over this time, the run has occurred progressively earlier, by around 3.6 to 4.8 days every 10 years. The onset of the run (measured as the date on which 25% of total annual emigration has occurred) is now 10 to 11 days earlier than at the start of the period. The change is believed to be linked to changes in the ambient river temperature.

The survival of 1SW salmon returning to the Bush has been strongly influenced by smolt run timing, with later emigrating cohorts having better survival (Figure 2.5.1.5). It has been suggested that this might be explained by a thermal mismatch mechanism, since there has been a marked divergence in spring river and sea temperatures over recent years (Kennedy and Crozier, *in press*). It is unclear whether this mis-match mechanism might apply more widely or is peculiar to the Bush. The Bush is unusual in discharging to the sea over a beach and does not have a typical estuary to provide a transition zone for migrating smolts. Preliminary investigation of river and inshore sea temperatures for a number of rivers in UK(England & Wales) did not provide any evidence of a potential spring thermal mis-match.

Later age at maturity in Norwegian salmon stocks in recent years

There is a significant positive relationship between the PFA of 1SW Norwegian salmon stocks in one year and the PFA of 2SW salmon in the following year. However, in recent years evidence for three regions in Norway indicates that more salmon return as 2SW fish than expected from this relationship. The change in proportion at age could be explained by later maturation, and/or by an increase in survival in the second year at sea relative to the first year. If the first is true one might expect an increase in the proportion of male salmon among the returning 2SW fish (since grilse are traditionally male dominated), whereas the sex ratio among 2SW fish is likely to be unchanged if the second explanation is more valid. These competing hypotheses are still under investigation.

Analysis of North Esk (UK(Scotland)) smolt age data

Time series of age data for four major salmon rivers in Scotland were investigated. It was noted that at least some of the observed variability in river ages could be explained by changes in the scale sampling procedures on returning adult fish (e.g. changes in the sampling periods due to altered netting seasons). This highlighted the importance of ensuring a consistent approach in the selection of the data which may require truncation of the time series.

The smolt run on River North Esk has been monitored since the early 1960s and consistent sampling of returning adults provided an opportunity for comparing the age-structure of the annual emigrant smolt population with the river age-structure of returning adults for the period 1975 to1999 (the period over which consistent methods have been used for sampling both smolts and adults). Since 1964, there has been a slight, but significant, increase in the proportion of S1 smolts ($P = 0.037$) on the North Esk; no change in the S2s ($P = 0.068$), but a significant decrease in both the S3s ($P = 0.004$) & S4s ($P = 0.001$). Overall, there is a downward trend in the mean river age of emigrant smolts, probably reflecting recent warming of the freshwater environment.

Comparison of the river-age structure of emigrant smolts with that in returning adults indicates close concordance - the overall river age-structure of returning adult fish reflects that of the emigrant population 1 or 2 years previous, as appropriate. In returning 1SW fish, S2 smolts are slightly over-represented and S1s & S3s slightly under-represented (Figure 2.5.1.6(a)), whereas for 2SW salmon, smolts that emigrated as S3s are slightly over-represented (Figure 2.5.1.6(b)). However, when 1SW and 2SW fish from consecutive years are pooled, the data converge on the line of unity (Figure 2.5.1.6(c)).

These results suggest that S1 to S4 smolts have an equal probability of returning to reproduce. Early mortality at sea, generally perceived to be critical to recruitment, does not appear to be dependent on river-age.

It was noted that if these findings were generally applicable, then monitoring of the river-age structure of emigrant smolts could have predictive value for subsequent returning adults. Similarly, there would be potential to use river age-distribution from adult scale archives to assess earlier changes in age at smoltification.

Baltic salmon

The Study Group noted that WGBAST were also addressing concerns related to at-sea survival of salmon. Further progress was made at the last meeting (ICES, 2009c).

Post-smolt survival in the Baltic Sea has decreased in recent years, both for wild and hatchery-reared smolts. This decline started in the mid 1990s, though the reasons are not entirely clear. There have been pronounced changes in the Baltic in the last two decades and a number of hypotheses have been proposed to explain the reduction in post-smolt survival:

- competition hypothesis – intra-specific competition;
- food availability hypothesis – juvenile herring are important prey for young salmon;
- seal predation hypothesis;
- smolt quality hypothesis.

Initial analyses of predictor variables have indicated that survival of wild post-smolts is negatively correlated with seal abundance, negatively correlated with total smolt production in the Gulf of Bothnia and positively correlated with herring recruitment in both Bothnian Bay and Bothnian Sea. Results from modelling investigations (31 models were fitted to post-smolt survival estimates) suggest that herring recruitment in the Gulf of Bothnia is able to explain a large proportion of the annual variation in post-smolt survival, but not the negative trend in survival over the last decade. The addition of seal abundance to the models captures this decline. The levels of seal predation required to explain the estimated reduction in post-smolt survival is within realistic levels. However, available information on seal diet is limited and more work is needed on this and in relation to the spatial distribution of seals in the spring and summer months, and on post-smolt migration routes.

Next steps

The second Study Group report is in progress. The report will address the terms of reference as fully as possible in terms of summarising evidence for linking abundance trends for Atlantic salmon stocks with changes in biological characteristics. However, in the absence of oceanographic expertise or representation from the NW Atlantic at the second meeting, the Study Group's ability to explore changes in biological characteristics of salmon across the entire range of the species and relate these to environmental variables was somewhat constrained. In completing the report, the Study Group will therefore aim to highlight hypotheses that might be explored further and seek to recommend ways in which this work might best be developed in support of wider ICES objectives. The Study Group is also continuing to liaise in developing a number of proposed peer reviewed papers.

ICES recognised the value of the work completed by SGBICEPS and that the Study Group had been constrained by the lack of wider representation and the difficulties of involving oceanographers. ICES noted the ongoing efforts of the Study Group with regard to developing peer-reviewed outputs and recommended that the data sets collated by the Study Group should be fully utilised and made available to ICES in support of further analyses as appropriate.

2.5.2 Bayesian application of the ratio method for estimating at-sea survival to repeat spawning adult salmon in the LaHave River, Nova Scotia, Canada

To further our understanding of the causes of declines in salmon abundance and population viability, a model was developed for estimation of the survival of repeat spawning kelts. The model is a statistical, Bayesian extension of the ratio model that has been used to calculate survival of post-smolts (Chaput *et al.*, 2003). The model produces annual estimates of the probability of consecutive spawning, as well as annual estimates of mortality in the 1st (Z1) and 2nd (Z2) years. When fitted to adult count data, the Z1 parameter includes mortality associated with spawning, reconditioning, over-wintering and a brief period at sea, whereas the vast majority of the mortality modelled using the Z2 parameter occurs at sea.

The model was fitted to adult repeat-spawning Atlantic salmon data from the LaHave River (above Morgans Falls), Nova Scotia, Canada, for the period 1978 to 2008. The resulting estimates of Z1 show an increasing trend throughout the time series, whereas Z2 also increased but tended to oscillate (Figure 2.5.2.1). Decadal comparisons of parameter estimates (Table 2.5.2.1) indicate that Z1 has continued to trend upward, potentially indicating increasing mortality in freshwater or marine near-field regions, whereas average Z2 values increased from the 1980s to the 1990s, consistent with a regime shift in the oceanic (far field) environments. The probability of consecutive spawning varied during the time period without any obvious trend. A preliminary comparison of the Z2 parameter indicated that from 1978 to 2000, fluctuations in the Z2 parameter matched fluctuations in the North Atlantic Oscillation Index (Figure 2.5.2.2), although this relationship was not apparent after 2000, potentially indicative of a change in regulatory mechanism in the later time period (low abundance effects cannot be ruled out as a confounding factor at this time).

2.6 NASCO has asked ICES to describe how catch and release mortality and unreported catch are incorporated in national and international stock assessments and indicate how they can best be incorporated in future advice to NASCO

ICES reviewed information on how catch and release mortality and unreported catches are incorporated in national and international stock assessments.

2.6.1 Catch and release mortality

ICES previously reviewed information on the levels of pre-spawning mortality of salmon and the implications for stock assessments at its meeting in 2009 (ICES, 2009a). Table 2.6.1 outlines the procedures currently used to incorporate C&R mortality in regional and national assessments and provides suggestions for possible future improvements.

In most areas of North America, mortality from catch and release in incorporated in the river-specific and regional assessments of spawning escapements and returns. Catch and release in some areas are underestimates as they are not required to be reported.

In the NEAC areas, catch and release estimates from the rod fisheries are not available and when they are, no corrections for catch and release mortality have been applied. As the practice of catch and release is increasing in most countries in NEAC, consideration should be made for incorporating mortality associated with this practice in river-specific, regional and national assessments. ICES recommends continued monitoring of catch and release practices in all countries with a view to incorporating these in future assessments.

ICES also noted that there were new projects aimed at estimating the impact of C&R on the reproductive success of Atlantic salmon, which had started in Canada in 2009. Results are expected to be available in 2011.

2.6.2 Unreported catch

ICES noted that descriptions of the national approaches used for evaluating unreported catches have previously been reported at various meetings (e.g. ICES, 1996; ICES, 2000; ICES, 2002). In addition, detailed reports describing national procedures for evaluating unreported catch, and efforts to minimise this, were submitted by parties to NASCO in 2007 in support of a special theme session on this issue.

Unreported catches, when available are not treated equally between NAC and NEAC. Unreported catches at West Greenland are treated similarly in the NAC and NEAC run-reconstructions. In most NEAC countries, estimates of unreported catches are incorporated in the run-reconstruction models. In all areas, unreported catches may be incorporated in the assessment of spawners and returns depending upon where the unreported catches occur and the assessment models used. When the assessment of spawners is conducted using spawner counts just before spawning, all catches, reported and unreported, have been accounted for. However, in that case, the returns would exclude unreported catch.

Table 2.6.2 outlines the procedures currently used to incorporate unreported catches into regional, national and international assessments and provides suggestions for possible future improvements.

2.7 NASCO has asked ICES to provide a compilation of tag releases by country in 2009 and advise on progress with analysing historical tag recovery data from oceanic areas

2.7.1 Compilation of tag releases and fin clip data by ICES member countries in 2009

Data on releases of tagged, fin-clipped, and otherwise marked salmon in 2009 were provided by ICES and are compiled as a separate report (ICES, 2010). A summary of tag releases is provided in Table 2.7.1.1.

2.7.2 Summary of the Workshop on Learning from Salmon Tagging records (WKLUSTRE)

This Workshop on Learning from Salmon Tagging Records (WKLUSTRE) (ICES, 2009d) was the third of a series of three such workshops aimed to record and analyse data from old tagging experiments. The first was the Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas (WKDUHSTI) (ICES, 2007a) and the second was the Workshop on Salmon Historical Information – New Investigations from Old Tagging Data (WKSHINI) (ICES, 2008b).

The objectives of the WKLUSTRE Workshop were to: (a) further develop the international database of marine tagging and tag recovery information for Atlantic salmon; (b) use the database to investigate the distribution of salmon for differences in time and space, and assess changes in the distribution over time; (c) investigate the use of the database to verify outputs from migration models and (d) recommend future salmon tagging studies and investigations of salmon mortality at sea.

The Workshop described and updated the NE and NW Atlantic tag databases and suggested how the Faroese data could be analysed further in relation to information from the fisheries. Analysis of the proportion of recoveries from East Greenland suggested that MSW salmon from northern Europe have a more easterly distribution than those from southern Europe. Temporal variation in size at capture and spatial differences in patterns of recovery were also reported.

ICES endorsed the recommendations made by WKLUSTRE, which include: long-term storage of the tag databases so that the data are not lost; the reports of the three Workshops on salmon tagging data (WKDHUSTI, WKSHINI, WKLUSTRE) should be combined into a single ICES Co-operative Research Report; and the peer-reviewed publication of these results (possibly as special issue of ICES journal). Permission is being sought from the owners of the tag data to store the data centrally, and the ICES Data Centre has indicated they would be willing to act as the central repository.

Table 2.1.1.1 Reported total nominal catch of salmon by country (in tonnes round fresh weight), 1960 to 2009. (2009 figures include provisional data).

Year	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total Reported Nominal Catch
	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch (4)	Sweden (West)	Denmark	Finland	Ireland (5,6)	UK (E & W)	UK (N.Irl.) (6,7)	UK (Scotl.)	France (8)	Spain (9)	Faroes (10)	East Grld.	West Grld. (11)	Other (12)	
1960	1636	1	-	1659	1100	100	-	40	-	-	743	283	139	1443	-	33	-	-	60	-	7237
1961	1583	1	-	1533	790	127	-	27	-	-	707	232	132	1185	-	20	-	-	127	-	6464
1962	1719	1	-	1935	710	125	-	45	-	-	1459	318	356	1738	-	23	-	-	244	-	8673
1963	1861	1	-	1786	480	145	-	23	-	-	1458	325	306	1725	-	28	-	-	466	-	8604
1964	2069	1	-	2147	590	135	-	36	-	-	1617	307	377	1907	-	34	-	-	1539	-	10759
1965	2116	1	-	2000	590	133	-	40	-	-	1457	320	281	1593	-	42	-	-	861	-	9434
1966	2369	1	-	1791	570	104	2	36	-	-	1238	387	287	1595	-	42	-	-	1370	-	9792
1967	2863	1	-	1980	883	144	2	25	-	-	1463	420	449	2117	-	43	-	-	1601	-	11991
1968	2111	1	-	1514	827	161	1	20	-	-	1413	282	312	1578	-	38	5	-	1127	403	9793
1969	2202	1	-	1383	360	131	2	22	-	-	1730	377	267	1955	-	54	7	-	2210	893	11594
1970	2323	1	-	1171	448	182	13	20	-	-	1787	527	297	1392	-	45	12	-	2146	922	11286
1971	1992	1	-	1207	417	196	8	18	-	-	1639	426	234	1421	-	16	-	-	2689	471	10735
1972	1759	1	-	1578	462	245	5	18	-	32	1804	442	210	1727	34	40	9	-	2113	486	10965
1973	2434	3	-	1726	772	148	8	23	-	50	1930	450	182	2006	12	24	28	-	2341	533	12670
1974	2539	1	-	1633	709	215	10	32	-	76	2128	383	184	1628	13	16	20	-	1917	373	11877
1975	2485	2	-	1537	811	145	21	26	-	76	2216	447	164	1621	25	27	28	-	2030	475	12136
1976	2506	1	3	1530	542	216	9	20	-	66	1561	208	113	1019	9	21	40	<1	1175	289	9327
1977	2545	2	-	1488	497	123	7	10	-	59	1372	345	110	1160	19	19	40	6	1420	192	9414
1978	1545	4	-	1050	476	285	6	10	-	37	1230	349	148	1323	20	32	37	8	984	138	7682
1979	1287	3	-	1831	455	219	6	12	-	26	1097	261	99	1076	10	29	119	<0.5	1395	193	8118
1980	2680	6	-	1830	664	241	8	17	-	34	947	360	122	1134	30	47	536	<0.5	1194	277	10127
1981	2437	6	-	1656	463	147	16	26	-	44	685	493	101	1233	20	25	1025	<0.5	1264	313	9954
1982	1798	6	-	1348	364	130	17	25	-	54	993	286	132	1092	20	10	606	<0.5	1077	437	8395
1983	1424	1	3	1550	507	166	32	28	-	58	1656	429	187	1221	16	23	678	<0.5	310	466	8755
1984	1112	2	3	1623	593	139	20	40	-	46	829	345	78	1013	25	18	628	<0.5	297	101	6912
1985	1133	2	3	1561	659	162	55	45	-	49	1595	361	98	913	22	13	566	7	864	-	8108
1986	1559	2	3	1598	608	232	59	54	-	37	1730	430	109	1271	28	27	530	19	960	-	9255
1987	1784	1	2	1385	564	181	40	47	-	49	1239	302	56	922	27	18	576	<0,5	966	-	8159
1988	1310	1	2	1076	420	217	180	40	-	36	1874	395	114	882	32	18	243	4	893	-	7737
1989	1139	2	2	905	364	141	136	29	-	52	1079	296	142	895	14	7	364	-	337	-	5904
1990	911	2	2	930	313	141	285	33	13	60	567	338	94	624	15	7	315	-	274	-	4925

Table 2.1.1.1 continued.

Year	NAC Area: Canada (1)	NAC Area: USA	NAC Area: St. P&M	NEAC (N. Area): Norway (2)	NEAC (N. Area): Russia (3)	NEAC (N. Area): Iceland Wild	NEAC (N. Area): Iceland Ranch (4)	NEAC (N. Area): Sweden (West)	NEAC (N. Area): Denmark	NEAC (N. Area): Finland	NEAC (S. Area): Ireland (5,6)	NEAC (S. Area): UK (E & W)	NEAC (S. Area): UK (N.Irl.) (6,7)	NEAC (S. Area): UK (Scotl.)	NEAC (S. Area): France (8)	NEAC (S. Area): Spain (9)	Faroes & Greenland: Faroes (10)	Faroes & Greenland: East Grld.	Faroes & Greenland: West Grld. (11)	Faroes & Greenland: Other (12)	Total Reported Nominal Catch
1991	711	1	1	876	215	129	346	38	3	70	404	200	55	462	13	11	95	4	472	-	4,106
1992	522	1	2	867	167	174	462	49	10	77	630	171	91	600	20	11	23	5	237	-	4,119
1993	373	1	3	923	139	157	499	56	9	70	541	248	83	547	16	8	23	-	-	-	3,696
1994	355	0	3	996	141	136	313	44	6	49	804	324	91	649	18	10	6	-	-	-	3,945
1995	260	0	1	839	128	146	303	37	3	48	790	295	83	588	10	9	5	2	83	-	3,629
1996	292	0	2	787	131	118	243	33	2	44	685	183	77	427	13	7	-	0	92	-	3,136
1997	229	0	2	630	111	97	59	19	1	45	570	142	93	296	8	4	-	1	58	-	2,364
1998	157	0	2	740	131	119	46	15	1	48	624	123	78	283	8	4	6	0	11	-	2,395
1999	152	0	2	811	103	111	35	16	1	62	515	150	53	199	11	6	0	0	19	-	2,247
2000	153	0	2	1,176	124	73	11	33	5	95	621	219	78	274	11	7	8	0	21	-	2,912
2001	148	0	2	1,267	114	74	14	33	6	126	730	184	53	251	11	13	0	0	43	-	3,069
2002	148	0	2	1,019	118	90	7	28	5	93	682	161	81	191	11	9	0	0	9	-	2,654
2003	141	0	3	1,071	107	99	11	25	4	78	551	89	56	192	13	9	0	0	9	-	2,457
2004	161	0	3	784	82	111	18	20	4	39	489	111	48	245	19	7	0	0	15	-	2,157
2005	139	0	3	888	82	129	21	15	8	47	422	97	52	215	11	13	0	0	15	-	2,156
2006	137	0	3	932	91	93	17	14	2	67	326	80	29	192	13	11	0	0	22	-	2,029
2007	112	0	2	767	63	93	36	16	3	58	85	67	30	169	11	9	0	0	25	-	1,546
2008	158	0	4	807	73	132	69	18	9	71	89	64	21	160	12	9	0	0	26	-	1,720
2009	119	0	3	595	71	121	42	17	8	36	68	51	17	120	4	2	0	1	26	-	1,300
Average																					
2004-2008	141	0	3	836	78	112	32	17	5	56	282	84	36	196	13	10	0	0	21	-	1,921
1999-2008	145	0	3	952	96	101	24	22	5	74	451	122	50	209	12	9	1	0	20	-	2,295

Key:

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches taken in the recreational (rod) fishery.
4. From 1990, catch includes fish ranched for both commercial and angling purposes.
5. Improved reporting of rod catches in 1994 and data derived from carcase tagging and log books from 2002.
6. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
7. Angling catch (derived from carcase tagging and log books) first included in 2002.
8. Data for France include some unreported catches.
9. Weights estimated from mean weight of fish caught in Asturias (80-90% of Spanish catch).
10. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place; the commercial fishery resumed in 2000, but has not operated since 2001.
11. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
12. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
13. No unreported catch estimate for Canada since 2007 and for Russia since 2008.
14. Estimates refer to season ending in given year.

Table 2.1.2.1 Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for countries in the North Atlantic where records are available, 1991–2008. Figures for 2008 are provisional.

Year	Canada		USA		Iceland		Russia [1]		UK (E&W)		UK (Scotland)		Ireland		UK (N Ireland) [2]		Denmark		Norway [3]	
	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch
1991	28497	33	239	50			3211	51												
1992	46450	34	407	67			10120	73												
1993	53849	41	507	77			11246	82	1448	10										
1994	61830	39	249	95			12056	83	3227	13	6595	8								
1995	47679	36	370	100			11904	84	3189	20	12151	14								
1996	52166	33	542	100	669	2	10745	73	3428	20	10413	15								
1997	57252	49	333	100	1558	5	14823	87	3132	24	10965	18								
1998	62895	53	273	100	2826	7	12776	81	5365	31	13464	18								
1999	55331	50	211	100	3055	10	11450	77	5447	44	14846	28								
2000	64482	55	0	-	2918	11	12914	74	7470	42	21072	32								
2001	59387	55	0	-	3611	12	16945	76	6143	43	27724	38								
2002	50924	52	0	-	5985	18	25248	80	7658	50	24058	42								
2003	53645	55	0	-	5361	16	33862	81	6425	56	29160	55								
2004	62316	55	0	-	7362	16	24679	76	13211	48	46279	50					255	19		
2005	63005	62	0	-	9224	17	23592	87	11983	56	46069	55	2553	12			606	27		
2006	60486	62	1	100	8735	19	33380	82	10959	56	47556	55	5409	22	302	18	794	65		
2007	44423	59	3	100	9691	18	44341	90	10917	55	55515	61	13125	40	470	16	959	57		
2008	67643	58	61	100	17178	20	41881	86	13035	55	53139	62	13312	37	648	20	2033	71	5512	-
2009	47862	60	0	-	17619	24	-	-	8828	58	49557	68	10265	37	847	21	1709	53	6696	6
5-yr mean 2004-2008	59575	59			10438	18	33575	84	12021	54	49712	56					1059	49		
% change on 5-year mean	-20	+1			+69	+33			-27	+7	0	+20					+61	+8		

Key: [1] No data for 2009 was provided by the authorities. However, catch and release has remained at similar high levels.

[2] Data for the DCAL area only

[3] The statistics were collected on a voluntary basis, the numbers reported should be regarded as a minimum

Table 2.1.3.1 Estimates of unreported catches (tonnes round fresh weight) by various methods by country within national EEZs in the North East Atlantic, North American and West Greenland Commissions of NASCO, 2009.

2009 Commission Area	Country	Unreported catch (t)	Reported catch (t)	Unreported as % of Total National Catch (Unreported + Reported)	Unreported as % of Total North Atlantic Catch (Unreported + Reported)
NEAC	Denmark	4	8	33.9%	0.3%
NEAC	Finland	7	36	16.3%	0.4%
NEAC	Iceland	12	163	6.8%	0.7%
NEAC	Ireland	7	68	9.1%	0.4%
NEAC	Norway	255	595	30.0%	15.7%
NEAC	Russia	na	71	na	na
NEAC	Sweden	2	17	10.5%	0.1%
NEAC	France	1	4	21.7%	0.1%
NEAC	UK (E & W)	12	51	19.1%	0.7%
NEAC	UK (N. Ireland)	0	17	0.0%	0.0%
NEAC	UK (Scotland)	17	120	12.4%	1.0%
NEAC	Spain	na	2	na	na
NAC	Canada	na	119	na	na
NAC	St. P&M	na	3	na	na
NAC	USA	0	0		
WGC	West Greenland	10	26	27.5%	0.6%
	Total	327	1300	20.1%	20.1%

Table 2.5.1.1. Biological characteristics data sets made available to the second meeting of SGBICEPS (Y denotes data available for all or part of the time series).

Stock complex	Country	Stock	Hatchery/Wild	Time series	Latitude	Stock status	Median run date	Mean run date	River age mean	Sea age mean	Prop. Run by sea-age	Mean fork length	Mean whole weight	Condition Factor	Prop. female by sea-age	Prop. maiden spawners by sea-age class
NAC(N)	Canada	Western Arm Brook	W	1971-06	51.2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	Middle Brook	W	1975-05	48.8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	Conne River	W	1986-06	47.9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	Miramichi	W	1971-07	47.0	Y			Y	Y	Y	Y	Y	Y	Y	Y
NAC(S)	Canada	Nashwaak	W	1972-08	46.0	Y	Y	Y	Y	Y	Y	Y			Y	Y
	Canada	St John (Mactaquac)	W	1978-08	45.3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	St John (Mactaquac)	H	1978-08	45.3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	La Have	W	1970-08	44.4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Canada	La Have	H	1972-08	44.4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	USA	Penobscot	H	1978-08	44.5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N NEAC	Finland/Norway	Teno	W	1972-07	70.8	Y			Y	Y	Y	Y	Y	Y	Y	
	Finland/Norway	Näätämöjoki	W	1975-06	69.7	Y			Y	Y	Y	Y	Y	Y	Y	
	Russia	Tuloma	W	1983-08	68.9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Norway	Vestre Jakobselv	W	1989-08	70.1	Y			Y	Y	Y	Y	Y	Y		
	Norway	Årgårdsvassdraget	W	1992-08	64.3	Y			Y	Y	Y	Y	Y	Y		
	Norway	Nausta	W	1989-08	61.3	Y			Y	Y	Y	Y	Y	Y		
	Norway	Gaula Sogn og Fjordane	W	1989-08	61.2	Y			Y	Y	Y	Y	Y	Y		
	Norway	Etneelva	W	1989-08	59.4	Y			Y	Y	Y	Y	Y	Y		
	Norway	Skienselva	W	1989-08	59.1	Y			Y	Y	Y	Y	Y	Y		
	Norway	Numedalslågen	W	1989-08	59.1	Y			Y	Y	Y	Y	Y	Y		
	Norway	Enningdalselva	W	1990-08	58.6	Y			Y	Y	Y	Y	Y	Y		
	Norway	Gaula	W	1989-08	63.3	Y			Y	Y	Y	Y	Y	Y		
	Iceland (N&E)	Laxa I Adaldalur	W	1974-08	65.6				Y	Y	Y		Y		Y	
	Iceland (N&E)	Hofsa	W	1971-08	65.4				Y	Y	Y		Y		Y	
S NEAC	Iceland (S&W)	Nordura	W	1968-08	64.6				Y	Y	Y		Y		Y	
	Iceland (S&W)	Ellidaar	W	1949-08	64.1				Y	Y	Y		Y		Y	
	UK (Scot)	N. Esk	W	1981-08	56.7	Y					Y	Y	Y	Y		
	UK (NI)	Bush	W	1973-07	55.1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	UK (E&W)	Lune	W	1987-08	54.0	Y			Y	Y	Y	Y	Y	Y		
	UK (E&W)	Dee	W	1937-08	53.4	Y			Y	Y	Y	Y	Y	Y	Y	
	UK (E&W)	Wye	W	1910-07	51.6	Y		Y	Y	Y	Y	Y	Y	Y		
	UK (E&W)	Frome	W	1968-08	50.7	Y			Y		Y	Y				
	France	Bresle	W	1984-08	50.1					Y	Y	Y				
Baltic	Sweden	Kalix	W	1980-08	65.8	Y					Y					
	Finland/Sweden	Tornionjoki	W	1980-09	65.5	Y			Y	Y	Y				Y	Y
	Sweden	Ume/Vindel	W	1987-08	63.8	Y	Y	Y			Y					
	Sweden	Ume/Vindel	H	1974-08	63.8	Y	Y	Y	Y	Y	Y		Y		Y	

Table 2.5.1.2. Results of meta analysis at the stock complex level - indicating significant increase (+) or decrease (-) relative to the mean (o denotes non-significant relationship).

Stock complex	H/W	Time series	Latitude	Stock size - 1SW	Stock size - 2SW	Mean river age	Mean sea age	Mean total age	Median run date	Mean run date	Prop. 1SW in run	Prop. 2SW in run	Prop. PS in run	Mean length - 1SW	Mean weight - 1SW	Condition - 1SW	Mean length - 2SW	Mean weight - 2SW	Condition - 2SW	Mean length - PS	Mean weight - PS	Condition - PS	Prop. female in 1SW
All		1989-08		-	o	-	o	o	-	-	o	o	+	-	-	o	-	-	o	o	o	+	o
NAC(N)	W	1989-08	47.0 - 51.2	o	-	o	o	+	-	-	o	o	o	+	o	o	o	o	o	o	+	o	-
NAC(S)	H/W	1989-08	44.4 - 46.0	-	-	o	o	o	-	-	o	o	-	-	o	o	o	o	o	o	o	o	o
N NEAC	W	1989-08	65.4 - 70.8	o	+	-	+	o			-	+	+	-	-	-	-	-	o	o	o	o	o
S NEAC	W	1989-08	50.1 - 64.6	o	o	-	-	-		+	o	o	o	-	-	o	-	-	o	o	-	o	o
Baltic	H/W	1989-08	63.8 - 65.8				o	+	o	o	-	+											o

Table 2.5.2.1. Decadal comparison of the average survivals in the first and second year and the probabilities of consecutive spawning for adult salmon from the LaHave River, Nova Scotia, Canada. The parameters are S1: survival in the first year (including during spawning, over-wintering, reconditioning and a brief period at sea); S2: mortality in the second year (mostly at sea); and p: the probability of being a consecutive repeat spawner. The subscripts are: M – male, F – female, G – grilse, S – 2SW salmon.

	Period		
Parameter	**1979 to 1988**	**1989 to 1998**	**1999 to 2008**
$S1_{MG}$	0.12	0.08	0.05
$S1_{MS}$	0.49	0.41	0.36
$S1_{F}$	0.25	0.19	0.14
S2	0.40	0.27	0.26
p_{MG}	0.058	0.055	0.062
p_{MS}	0.022	0.026	0.022
p_{FG}	0.028	0.033	0.020
p_{FS}	0.033	0.071	0.043

Table 2.6.1. Description of how catch-and-release mortality is incorporated in regional and national stock assessments.

Commission Area	Country/Region	How it is used in regional and national assessments	Future developments / improvements
NAC	Canada-Quebec	C&R has become more popular in the region and C&R only angling licenses are sold. C&R data are incomplete as there is no requirement to report C&R numbers. Generally, C&R mortality is considered in the assessment but the majority of the assessments are conducted as spawner counts after the fisheries so any losses due to C&R mortality are accounted for in the spawner estimates but not in the returns (which are the sum of known losses and spawning escapement).	New studies of the contribution of C&R fish to spawning success have been initiated. C&R monitoring is become more complete. Consideration will be given in the future to incorporating these losses in the returns and in the assessments based on angling catches, especially as reporting improves.
	Canada-Newfoundland & Labrador	Catch and release mortality is included in estimates of spawners. Spawning escapement is reduced by 5-15% (mean 10%) of the released catch.	No plans for further development.
	Canada - Gulf	Assessments of spawners are adjusted by mortality rates of 3% to 6% of the total C&R estimates of small and large salmon. The rates vary by river according to angling seasons, and the occurence of other factors such as disease which can affect survival of salmon.	Catch and release mortality is known to be affected by the water temperatures when fish are angled. In some cases, angling fisheries are closed when water temperatures are high in the summer to reduce the losses of fish from C&R. Methods to determine catch and release numbers vary by river and in some cases, the number of released fish is estimated from returns and historical creel survey data. As the practice of C&R becomes more popular, estimation methods for C&R values will have to be revisited.
	Canada – Scotia/Fundy	Assessments are currently adjusted by 4% of the C&R fish to correct for C&R mortality.	Numbers of C&R fish are currently low (retention fisheries are closed). If C&R catches increase, further research on the correction factor would be warranted.
	USA	No correction for mortality due to C&R used in estimating spawner numbers. However, all fisheries have been closed and the number of fish caught relative to stock size is very small.	
NEAC	Russia	With increasing C&R the retained catch for similar effort is reduced. Therefore the exploitation rate for retained fish is lower. The increase in C&R in recent years is incorporated into the national run-reconstruction model by reducing the exploitation rate value used in the model input. This is assessed qualitatively. No correction for increased C&R mortality is applied when estimating the spawning escapement.	If C&R information is incorporated into formal assessments then muliple recaptures should be taken into account. C&R mortality should be incorporated into estimates of spawning escapement.
	Norway		
	Sweden		
	Iceland		
	UK(Scotland)		
	Ireland	No correction for mortality due to C&R used in estimating spawner numbers or in the national run-reconstruction model.	Incorporation of formal method for estimating the effect of C&R on number of returning fish. Incorporation of C&R mortality in estimates of spawning escapement
	UK(England & Wales)	With increasing C&R the retained catch for similar effort is reduced. Therefore the exploitation rate for retained fish is lower. The increase in C&R in recent years is incorporated into the national run-reconstruction model by reducing the exploitation rate value used in the model input. This is assessed qualitatively. 20% mortality of C&R fish used in assessing compliance with river-specific conservation	If C&R information is incorporated into formal assessments then multiple recaptures should be taken into account.
	UK(N. Ireland)	Returns are estimated by raising the reported net catch by exploitation rate. No correction for increased C&R mortality is applied when estimating the spawning escapement.	If C&R information is incorporated into formal assessments then multiple recaptures should be taken into account. C&R mortality should be incorporated into estimates of spawning escapement.
	Denmark	C&R rates recorded, but no national run-reconstruction assessment applied.	
	Finland	No record of C&R	If C&R information is collected, it should be incorporated into formal assessments and multiple recaptures should be taken into account. C&R mortality should be incorporated into estimates of spawning escapement.
	France	No record of C&R	
NEAC	Faroes	Not applicable	
W. Greenland	W. Greenland	Not applicable	

Table 2.6.2. Description of how unreported catch is incorporated in regional, national and international stock assessments.

Commission Area	Country/Region	How it is used in regional and national assessments	How used in international assessments	Future developments / improvements
NAC	Canada-Quebec	Unreported catches are based on historical estimates relative to stock size or are provided by field conservation and protection staff. Unreported catches when available are included in the regional assessment of returns and spawners.	Unreported catches which occur in marine waters outside the jurisdiction of the regions are not included in the run reconstruction models.	If unreported catch estimates were provided they could be incorporated in the regional assessments and in the continent estimates of abundance and spawners. Unreported catch may be accounted for in either the returns or the spawners, depending upon when and where the illegal activity occurs relative to the location and time of the assessment model.
	Canada-Newfoundland & Labrador	Catch statistics include estimates of harvests by log book non-respondents. Therefore they are included in the regional assessments and the PFA estimate. No account is taken of illegal fisheries.		
	Canada - Gulf	Unreported catches are sometimes provided by Conservation and Protection Personnel and are estimates of illegal fishing removals within specific regions. Unreported catches have not been used in the assessments of returns or spawners.		
	Canada – Scotia/Fundy	No adjustment made, with the exception of the Saint John River where returns/spawners are adjusted for estimated bycatch and poaching. In other rivers where assessments directly quantify spawners, returns would be underestimated if catch is under reported.		
	USA	Unreported catch is estimated to be zero and therefore has no effect on national assessments.		
NEAC	Russia	Minimum and maximum estimates of the unreporting rate are used in deriving national PFA estimates from the catch of 1SW & MSW salmon.	National estimates (which incorporate unreported ctaches) are aggregated to provide PFA, return and spawner estimates for stock complexes.	Incorporate revised estimates of minimum and maximum estimates of unreporting rate as national estimates are improved.
	Finland			
	Norway			
	Sweden			
	Iceland			
	Ireland			
	UK(Scotland)			
	UK(England & Wales)			
	UK(N. Ireland)			
	France			
	Denmark	No national assessment		
NEAC	Faroes	Not applicable	Assumed to be negligible unreported catch. Estimate of discard mortality for 1SW fish is incorporated in stock assessments.	Sampling programme if fishery resumes.
W. Greenland	W. Greenland	Not applicable	Unreported catch at West Greenland is incorporated in assessments for both the NAC and NEAC areas. Since 1993, this has been provided by the Greenlandic authorities. Prior to this time, no unreported catch component is included in the models.	Annual variation in unreported catch estimates would be incorporated into the model.

Table 2.7.1.1. Summary of Atlantic salmon tagged and marked in 2009 – '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	Other Internal[1]	Total
Canada	Hatchery Adult		982	332	440	1,754
	Hatchery Juvenile		2,798	684,213	106	687,117
	Wild Adult		3,693	0	539	4,232
	Wild Juvenile	6,867	21,921	16,614	338	45,740
	Total	6,867	29,394	701,159	1,423	738,843
France	Hatchery Adult		8			8
	Hatchery Juvenile	2,202	2,384	257,050		261,636
	Wild Adult	20				20
	Wild Juvenile	302				302
	Total	2,524	2,392	257,050	0	261,966
Germany	Hatchery Adult					0
	Hatchery Juvenile	21,444		83,096		104,540
	Wild Adult					0
	Wild Juvenile					0
	Total	21,444	0	83,096	0	104,540
Iceland	Hatchery Adult		22			22
	Hatchery Juvenile	47,258				47,258
	Wild Adult		455			455
	Wild Juvenile	2,021	12			2,033
	Total	49,279	489	0	0	49,768
Ireland	Hatchery Adult					0
	Hatchery Juvenile	241,002				241,002
	Wild Adult					0
	Wild Juvenile	5,850				5,850
	Total	246,852	0	0	0	246,852
Norway	Hatchery Adult					0
	Hatchery Juvenile	77,076	12,938			90,014
	Wild Adult		1,273			1,273
	Wild Juvenile		1,299			1,299
	Total	77,076	15,510	0	0	92,586
Russia	Hatchery Adult					0
	Hatchery Juvenile			950,678		950,678
	Wild Adult		3,221			3,221
	Wild Juvenile					0
	Total	0	3,221	950,678	0	953,899
Sweden	Hatchery Adult					0
	Hatchery Juvenile		3000	192,024		195,024
	Wild Adult					0
	Wild Juvenile					
	Total	0	3,000	192,024	0	195,024
UK (England & Wales)	Hatchery Adult					0
	Hatchery Juvenile	13,788		88,675		102,463
	Wild Adult		924	11,607		12,531
	Wild Juvenile	14,882				14,882
	Total	28,670	924	100,282	0	129,876
UK (N. Ireland)	Hatchery Adult					0
	Hatchery Juvenile	19,531		29,245		48,776
	Wild Adult					0
	Wild Juvenile	1357				1,357
	Total	20,888	0	29,245	0	50,133
UK (Scotland)	Hatchery Adult					0
	Hatchery Juvenile	10,007			3,000	13,007
	Wild Adult		732			732
	Wild Juvenile	3491	942		3,856	8,289
	Total	13,498	1,674	0	6,856	22,028
USA	Hatchery Adult		524	2,108	833	3,465
	Hatchery Juvenile		172,235	381,424	43,988	597,647
	Wild Adult				647	647
	Wild Juvenile					
	Total	0	172,759	383,532	45,468	601,759
All Countries	Hatchery Adult	0	1,536	2,440	1,273	5,249
	Hatchery Juvenile	432,308	193,355	2,666,405	47,094	3,339,162
	Wild Adult	20	10,298	11,607	1,186	23,111
	Wild Juvenile	34,770	24,174	16,614	4,194	79,752
	Total	467,098	229,363	2,697,066	53,747	3,447,274

[1] Includes other internal tags (VIE, PIT, ultrasonic, radio, DST, etc.)

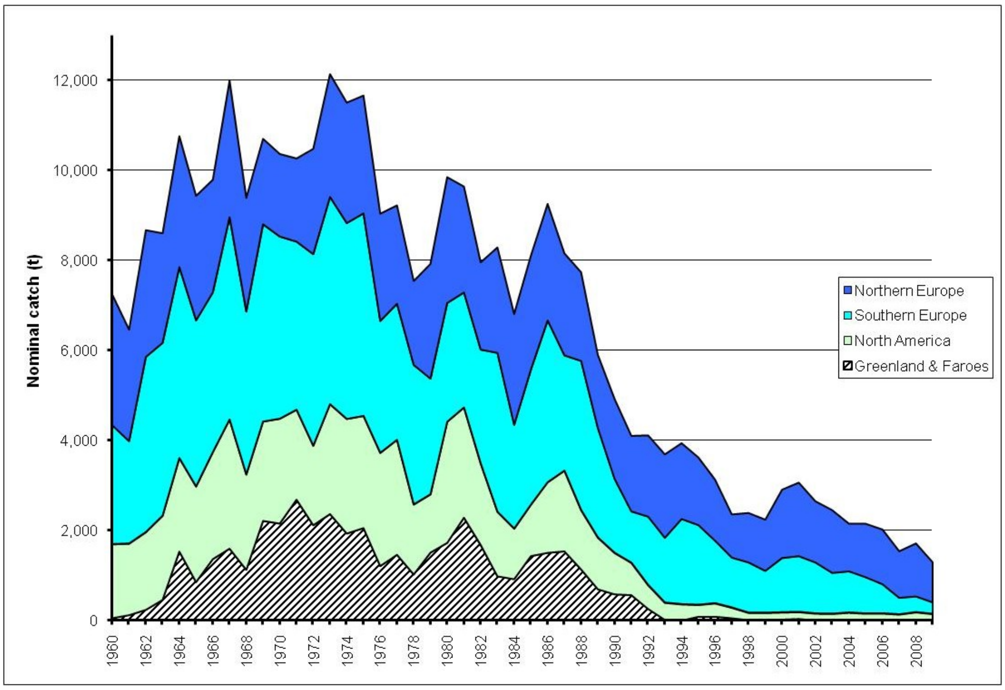


Figure 2.1.1.1. Reported total nominal catch of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960 to 2009.

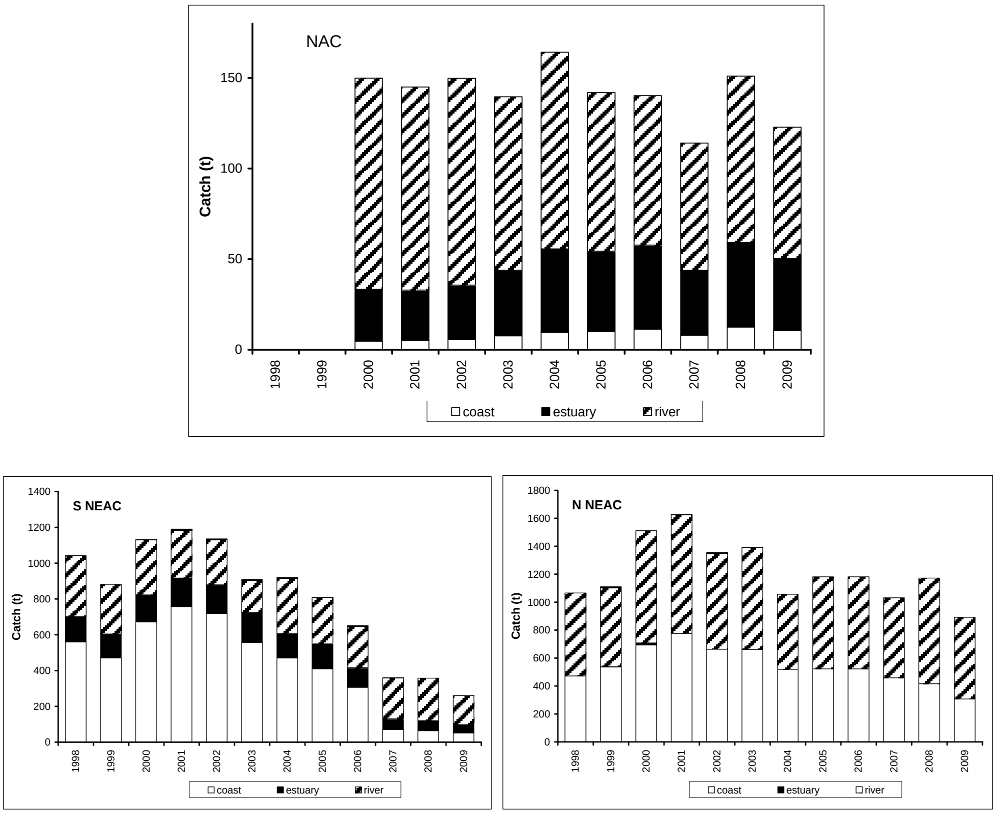


Figure 2.1.1.2. Nominal catch taken in coastal, estuarine and riverine fisheries for the NAC area, and for the northern and southern NEAC areas. Note that y-axes scales vary.

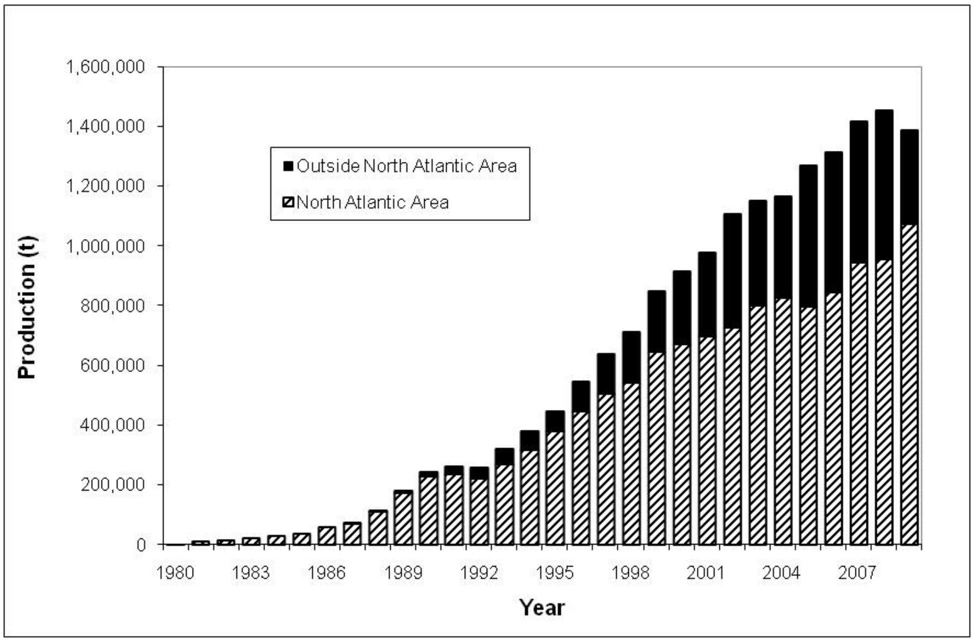


Figure 2.2.1. World-wide production of farmed Atlantic salmon, 1980 to 2009.

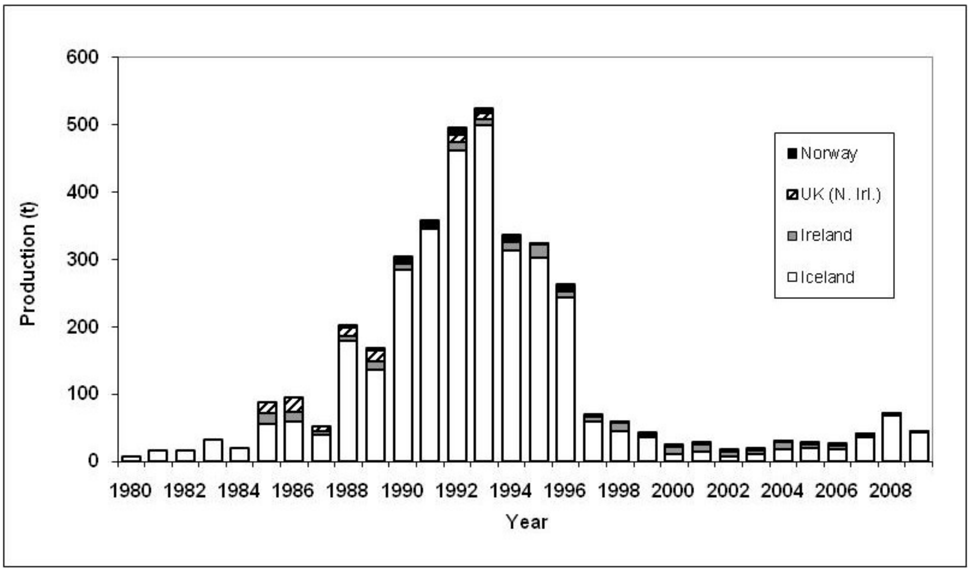


Figure 2.2.2. Production of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2009.

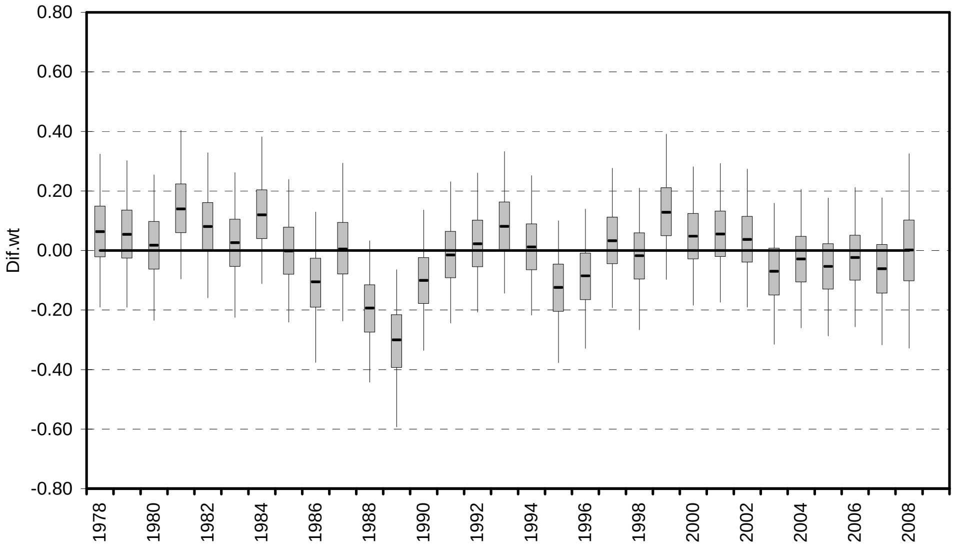
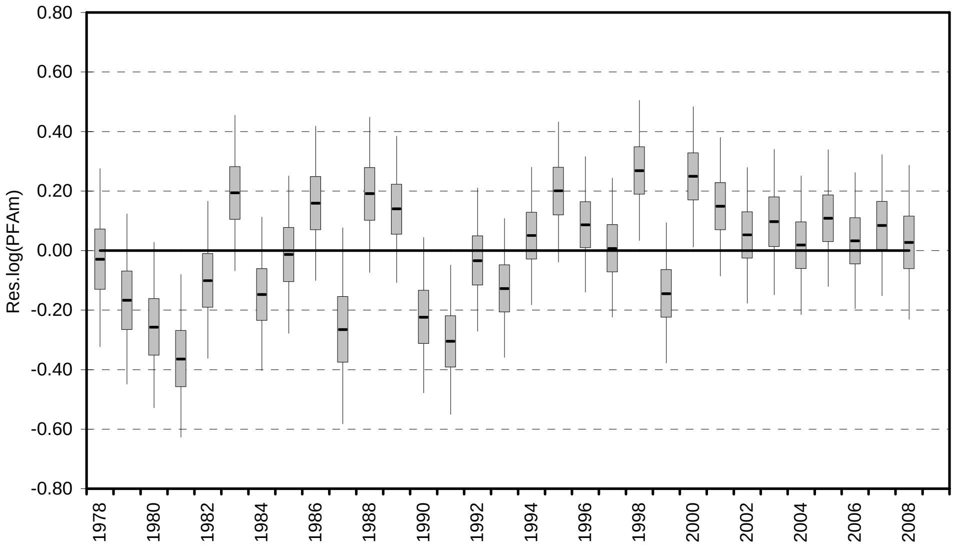


Figure 2.3.2.1. Annual deviates of successive recruitment rates (*am*$_{t+1}$ – *am*$_t$). Boxplots show the 95% Bayesian Credibility Interval (B.C.I.) as the vertical line, the interquartile range as the shaded rectangle and the median as the horizontal dash.



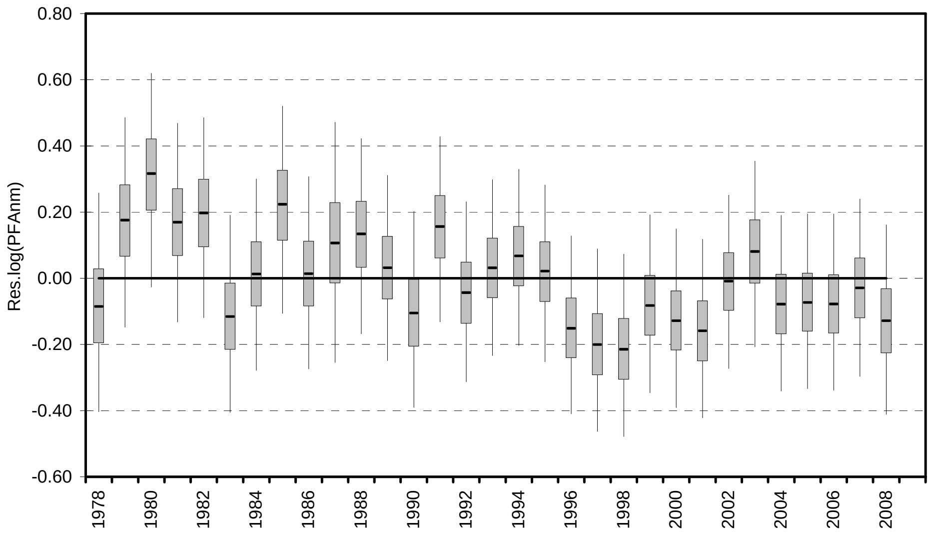
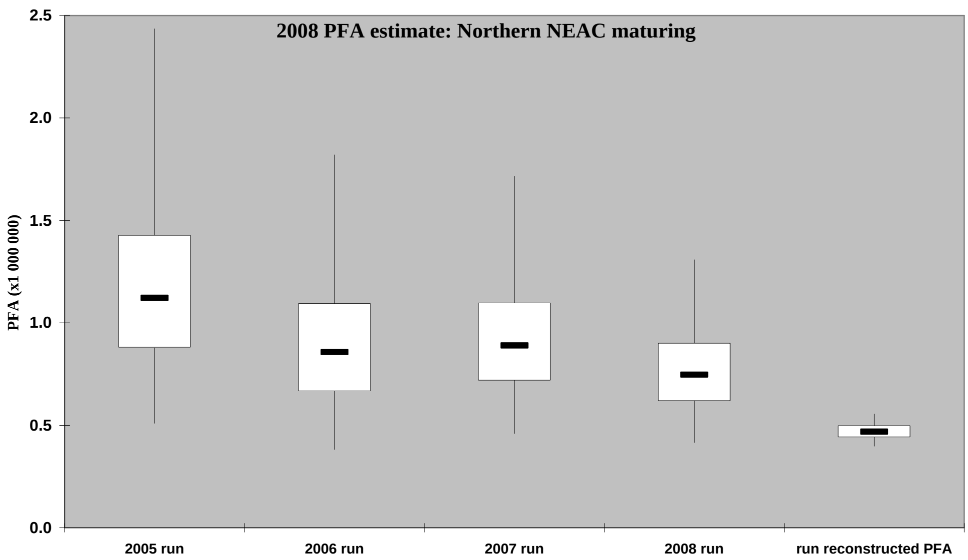


Figure 2.3.2.2. Partially conditioned predicted PFA to fully conditioned PFA; maturing PFA in upper panel and non-maturing PFA in lower panel. Box plots are interpreted as in Figure 2.3.3.1.



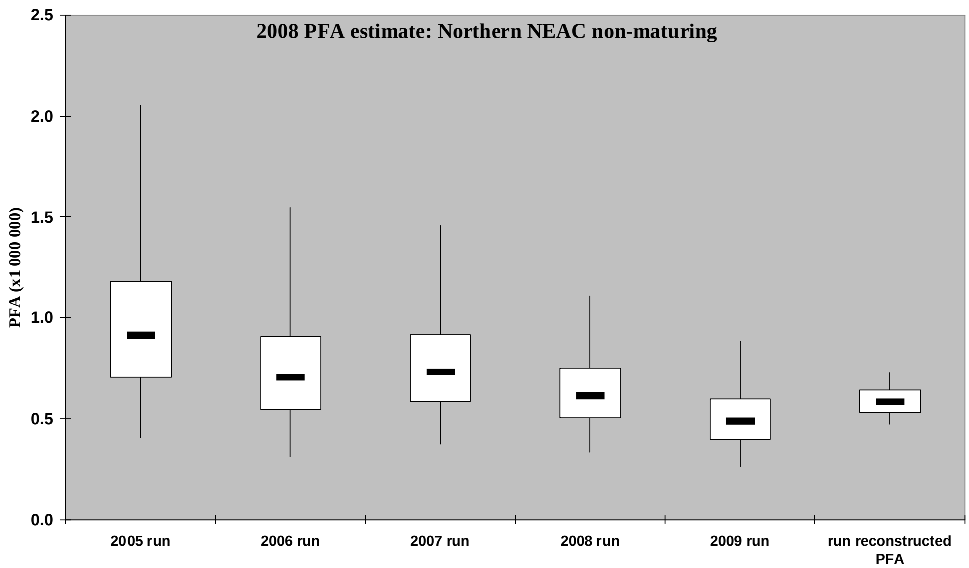
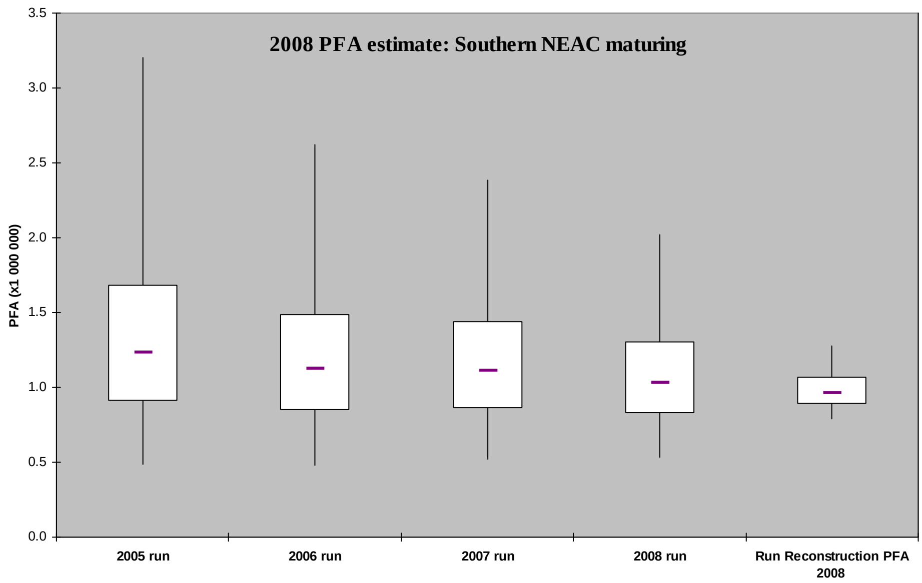


Figure 2.3.3.1. Retrospective comparisons of the model forecasts of the 2008 PFA for maturing and non-maturing Northern NEAC stock complexes. Run-reconstructed PFA is compared with model forecasts using data available to the Working Group over the period 2005 to 2008 in the case of the maturing stock and up to 2009 for the non-maturing stock. Box plots are interpreted as in Figure 2.3.2.1.



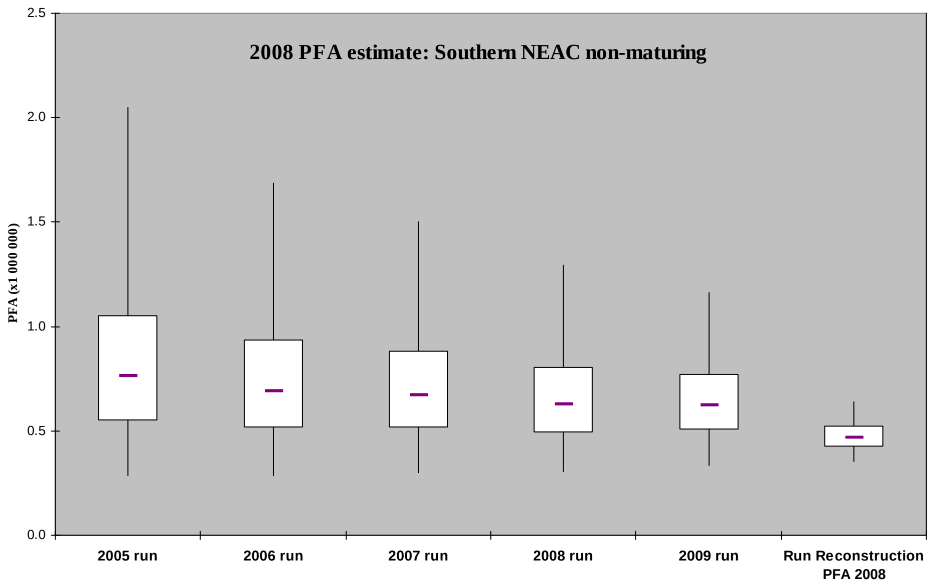


Figure 2.3.3.2. Retrospective comparisons of the model forecasts of the 2008 PFA for maturing and non-maturing Southern NEAC stock complexes. Run-reconstructed PFA is compared with model forecasts using data available to the Working Group over the period 2005 to 2008 in the case of the maturing stock and up to 2009 for the non-maturing stock. Box plots are interpreted as in Figure 2.3.2.1.

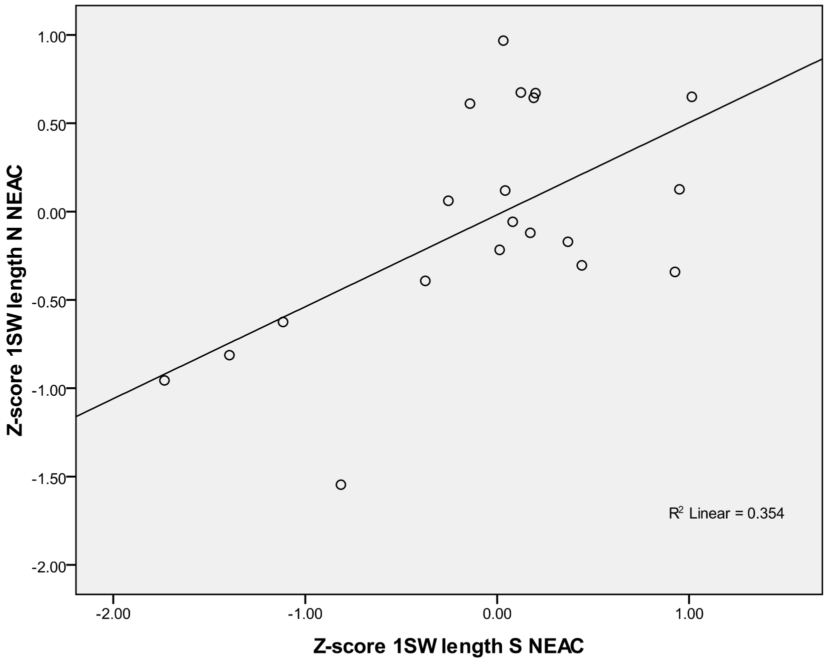


Figure 2.5.1.1. Z-scores of 1SW salmon length for N NEAC v S NEAC areas for the period 1989-2008.

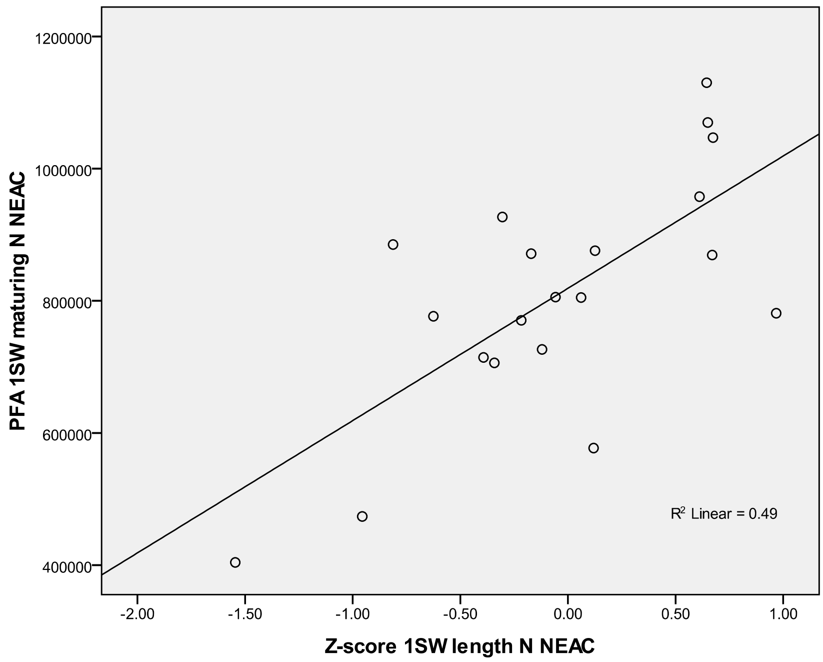


Figure 2.5.1.2. PFA of maturing 1SW salmon for N NEAC plotted against the z-score of 1SW length for N NEAC populations.

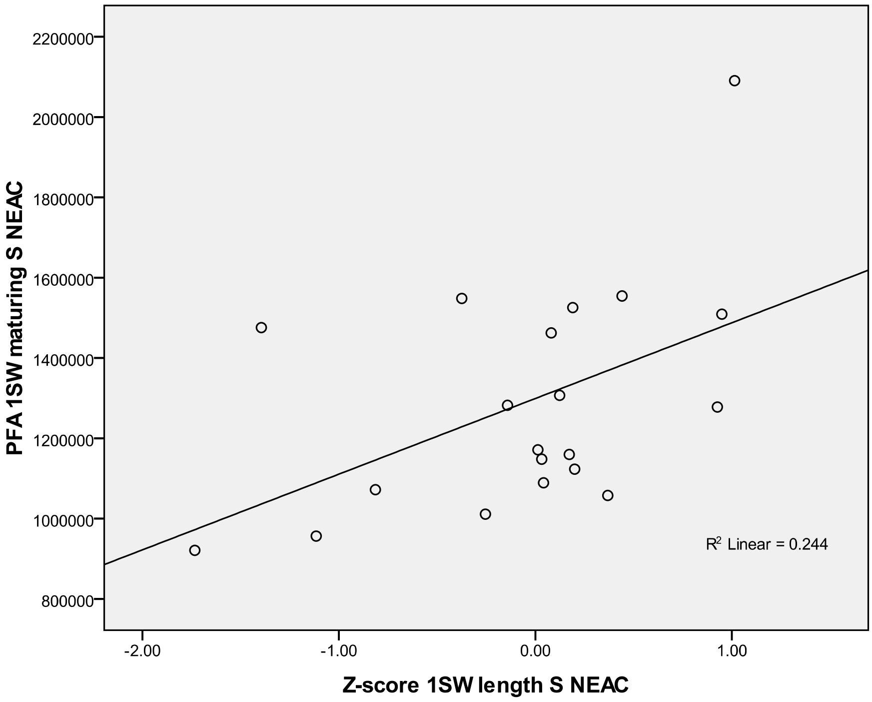


Figure 2.5.1.3. PFA of maturing 1SW salmon for S NEAC plotted against the z-score of 1SW length for S NEAC populations.

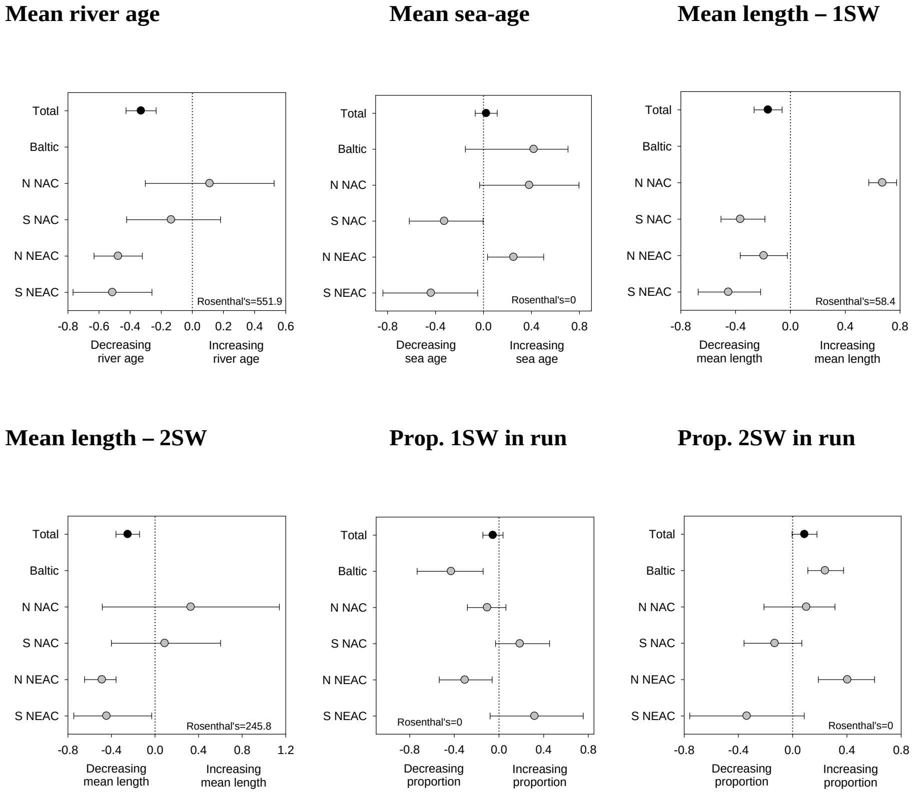


Figure 2.5.1.4. Example meta-analysis plots for selected biological characteristics – for stock groupings see text.

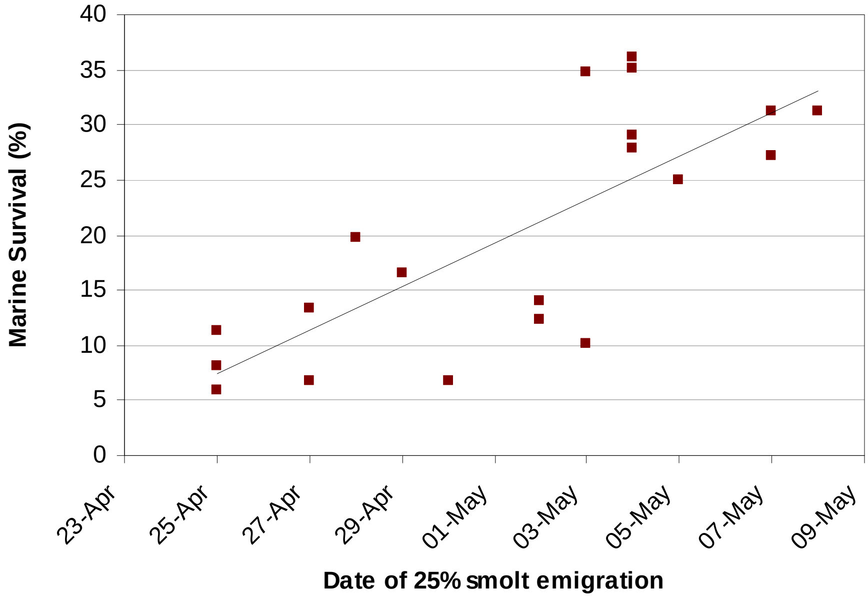
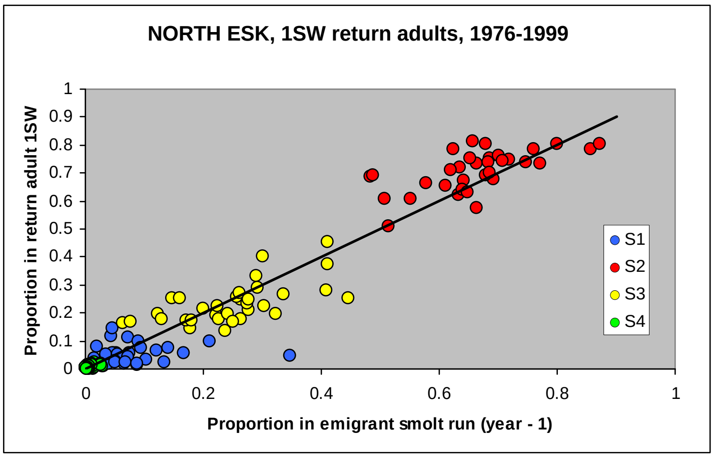
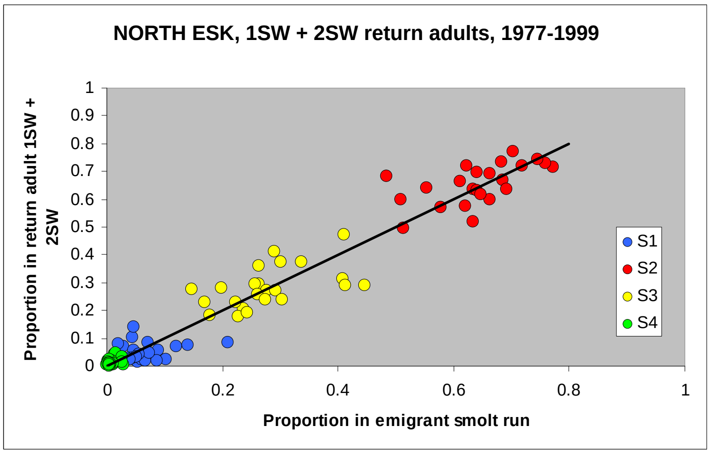


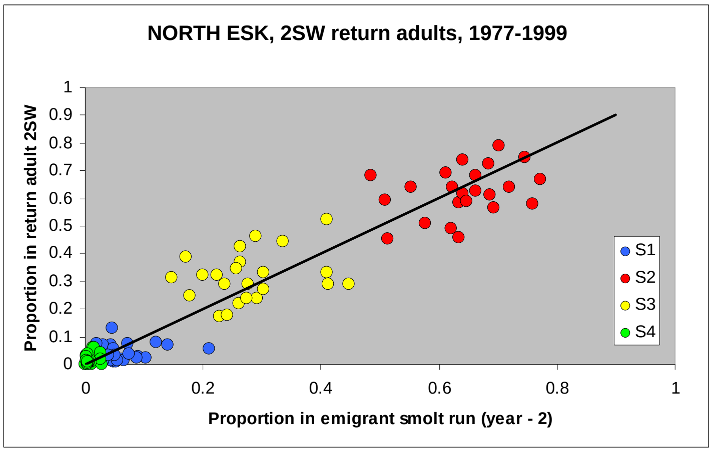
Figure 2.5.1.5. Relationship between the date of the onset of the smolt run (denoted by the data on which 25% of smolt emigration had occurred) and subsequent marine survival of 1SW River Bush salmon.



a)



b)



c)

Figure 2.5.1.6. River North Esk, Scotland: (a) Proportion of S1–S4 river ages among returning adult 1SW fish (1976-1999) in relation to the proportion of emigrant S1–S4 smolts in the previous year; (b) Proportion of S1–S4 river ages among returning adult 2SW fish (1977–1999) in relation to the proportion of emigrant S1–S4 smolts two years earlier; and (c) Proportion of S1–S4 river ages among returning adult 1SW and 2SW fish (1977–1999) in relation to the proportion of S1–S4 in the relevant emigrant smolt run. The lines are not fitted regressions, but show the one-to-one relationship between the two variates.

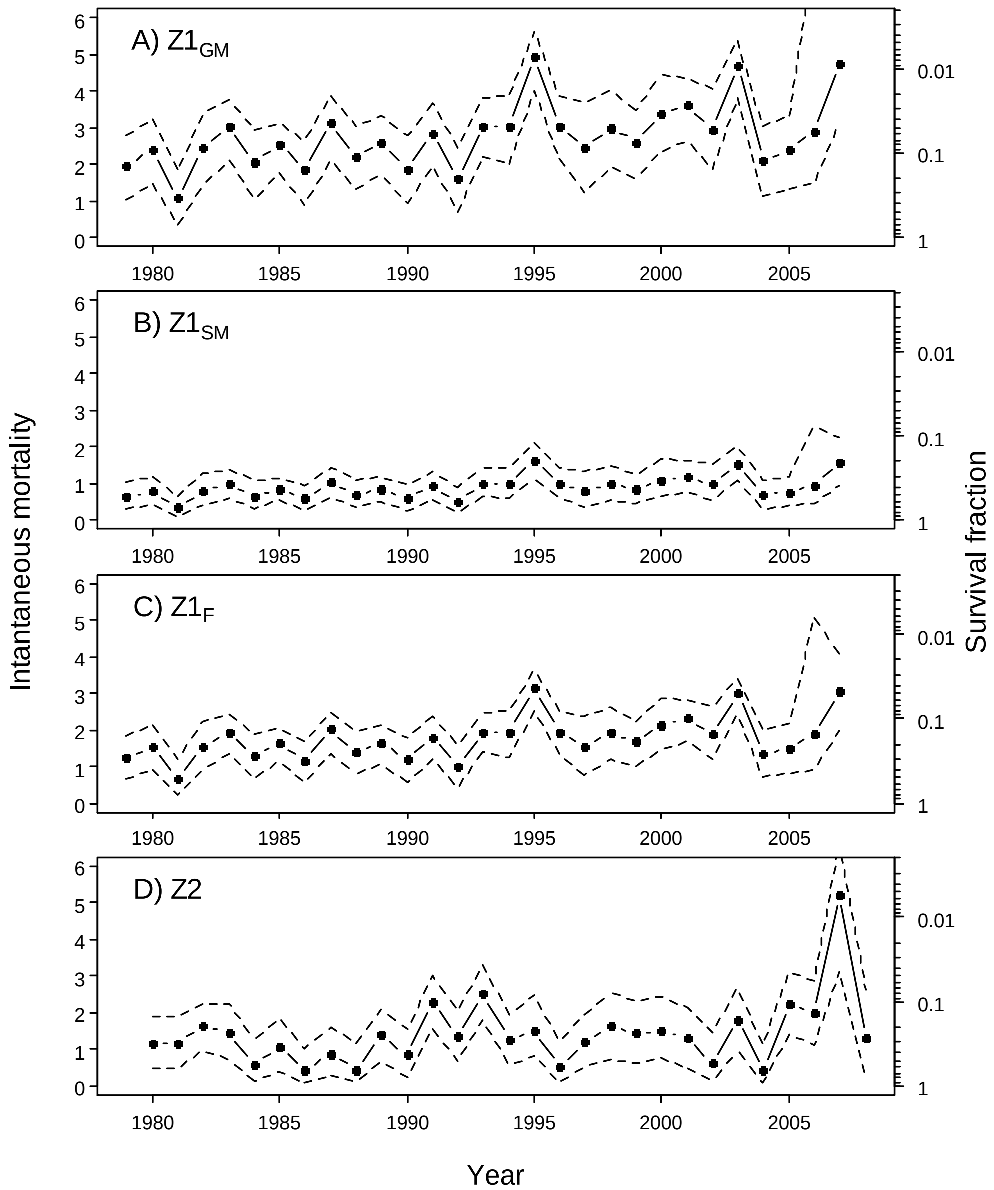


Figure 2.5.2.1. Time series of the estimated instantaneous mortality rates of adult salmon from the LaHave River, Nova Scotia, Canada. Broken lines represent the 80% confidence intervals. The different mortality parameters are A: first year mature mortality for male 1SW B: first year mature mortality for male 2SW, C: first year mature mortality for female 1SW and 2SW, and D: second year mature mortality for alternate spawners.

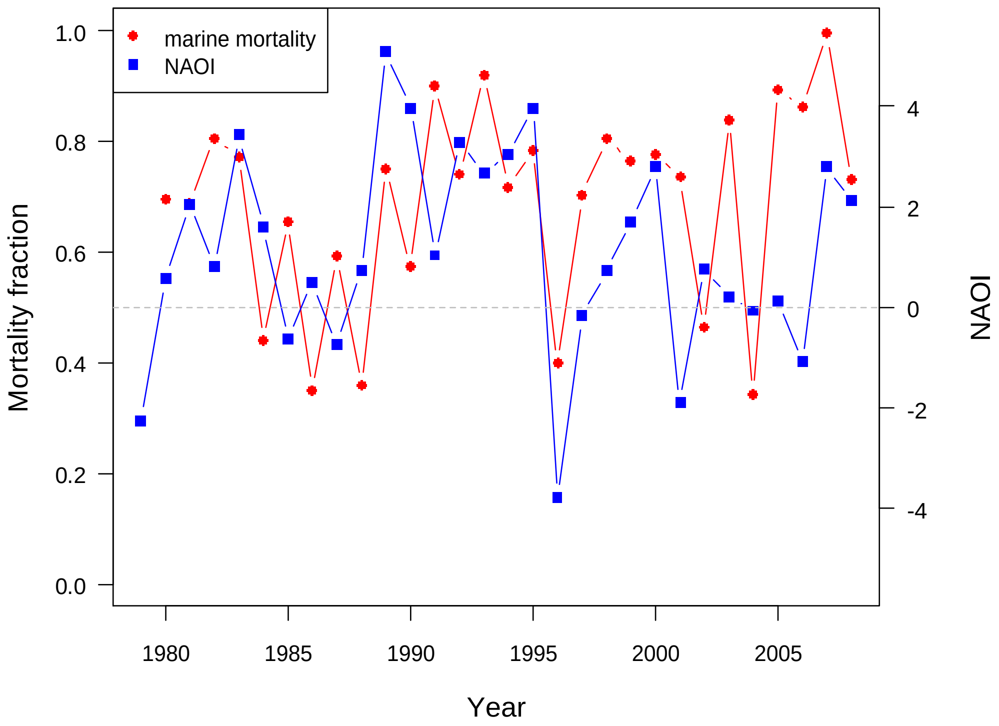


Figure 2.5.2.2. Relationship between the second year annual mortality fraction (the proportion of salmon destined to be alternate-year spawners that die in the second year at sea) of adult salmon from the LaHave River, Nova Scotia, Canada, and the annual North Atlantic Oscillation Index (NAOI) for the corresponding year at sea.

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 Atlantic salmon stocks.

Therefore:

- ICES considers homewater stocks in the NEAC Commission to be at full reproductive capacity only if the lower boundary 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 only if the lower boundary 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 confidence limit is below the CL/SER, but the midpoint is above.
- ICES considers a stock to be suffering reduced reproductive capacity when the 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% that is part of the agreed management plan (ICES, 2003).

For stock assessment purposes, ICES groups NEAC stocks into two stock groupings: Northern and Southern NEAC stocks. The composition of these groups is shown below:

Southern NEAC	Northern NEAC
Ireland	Finland
France	Norway
UK (England and 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:

[1] The Iceland stock complex was split 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.

- Northern European 1SW stock complex is considered to be at full reproductive capacity.
- Northern European MSW stock complex is considered to be at full reproductive capacity.
- Southern European 1SW stock complex is considered to be suffering reduced reproductive capacity.
- Southern European MSW stock complex is considered to be at risk of suffering reduced reproductive capacity.

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. The current estimates for both stock complexes are amongst the lowest in the time series.

Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks over time. This is mainly as a consequence of continuing poor survival in the marine environment attributed to climate effects (Friedland et al. 2009). Efforts continue to improve our understanding of causal relationships contributing to marine mortality.

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 CLs (i.e. all countries except France, Ireland, and UK (England & Wales)).

Iceland, Russia, Norway, UK (N. Ireland), and UK (Scotland) have provided regional input data for the PFA analysis (1971–2009). For these countries the lagged spawner analysis has been conducted by region. The regional results were combined to estimate CLs 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, CLs are required for stock complexes. These have been derived either by summing of individual river CLs to national level, or by taking overall national CLs, as provided by the national model and then summing to the level of the four NEAC stock complexes. For the NEAC area, the CLs have been calculated by ICES as:

- Northern NEAC 1SW spawners – 218 842
- Northern NEAC MSW spawners – 131 152
- Southern NEAC 1SW spawners – 625 652
- Southern NEAC MSW spawners – 268 920

3.3.2 Progress with setting river-specific conservation limits

In Norway, CLs have been set for 439 rivers since 2007. The CLs are based on stock recruitment relationships in nine rivers. Productivity is mostly based on catch statistics, and scale samples are used to assess the river age and sea age structure in a sub set of the populations. To derive the CLs, wetted areas have been computed from digital maps and analysis of river length accessible to adult fish. CLs for salmon populations are grouped into four categories of egg densities, approximately 1, 2, 4 and 6 eggs/ m^2 wetted area. Most of the rivers fall into the 2 and 4 eggs/ m^2 wetted area categories.

Based on data from 1993 to 2008 the attainment of CLs was evaluated in 180 Norwegian rivers, and advices on exploitation were given for 153 of them. Of the 153 populations, 56 populations were given advice 1 (harvest rates appear sustainable), 34 were given advice 2 (harvest rates should be moderately reduced), 34 were given advice 3 (harvest rates should be considerably reduced) and 29 were given advice 4 (harvest rates should be substantially reduced). For 97 of 153 populations, corresponding to 63 %, the advice given was for reduced harvest rates.

3.4 Management advice

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

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

Given the current (from the NEAC run reconstruction model) and forecasted (from the Bayesian forecast models) abundances, ICES provides the following advice on management:

- **Northern European 1SW stocks:** ICES considers that 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. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status. The newly developed Bayesian forecast model shows that the lower bounds of the forecasted PFA for 2010 to 2013 are below SER indicating that the stock may be at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries.
- **Northern European MSW stocks:** ICES considers that 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. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status. The newly developed Bayesian forecast model shows that the lower bounds of the

forecasted PFA for 2009 to 2013 are below SER indicating that the stock may be at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries.

- **Southern European 1SW stocks:** ICES considers that 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. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status. The newly developed Bayesian forecast model shows that the lower bounds of the forecasted PFA for 2010 to 2013 are below SER indicating that the stock may be at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries.
- **Southern European MSW stocks:** ICES considers that 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. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stock status. There are no catch options at West Greenland that would allow the management objectives to be met for this stock complex. The newly developed Bayesian forecast model shows that the lower bounds of the forecasted PFA for 2009 to 2013 are below SER indicating that the stock may be at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries.

3.5 Relevant factors to be considered in management

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

ICES also emphasised that the national stock CLs discussed above are not appropriate for the management of homewater fisheries. This is because of the relative imprecision of the national CLs which do not take account of differences in the status of different river stocks or sub-river populations, and because of the capacity of homewater fisheries to target specific stocks. Nevertheless, ICES agreed that the combined CLs for national stocks exploited by the distant water fisheries could be used to provide general management advice at the level of the stock complexes.

It should also be noted that the inclusion of farmed fish in the Norwegian data could result in the stock status being overestimated.

3.6 Pre-fishery abundance forecasts

ICES previously used a regression model to forecast PFA of non-maturing (potential MSW) salmon from the Southern European stock group (ICES 2002, 2003, 2009a). In 2009 this was superseded by a new forecast model developed in a Bayesian framework which produced forecasts for all four NEAC stock complexes.

3.6.1 Pre-fisheries abundance forecasts

In 2010, ICES ran the new Bayesian forecast models for the Southern NEAC and Northern NEAC complexes. The two models have the same structure and are run independently (ICES, 2009a).

For both Southern and Northern NEAC complexes, forecasts for maturing stocks were derived for 4 years of lagged spawners starting from 2010 to 2013 and for non-maturing stocks for 5 years, from 2009 to 2013. Risks were defined each year as the posterior probability that the PFA would be below the age and stock specific SER levels. For illustrative purposes, risk analyses were derived based on the probability that the PFA abundance would be greater than or equal to the SER under the scenario of no exploitation

3.6.2 Results of the NEAC Bayesian forecast models

The trends in the posterior estimates of PFA for both the Southern NEAC and Northern NEAC complexes closely match the PFA estimates derived from the run reconstruction model.

For the Southern NEAC stock complex, the productivity parameters for the maturing and non-maturing components peaked in 1985 and 1986, and reached the lowest values in 1997 (Figure 3.6.2.1). There was a sharp drop in the productivity parameter during 1989 to 1991 and the median values post-1991 are all lower than during the previous time period.

Over the entire time series, the maturing proportions averaged about 0.6 with the lowest proportion in 1980 and the highest proportion in 1998 (Figure 3.6.2.2). There is an increasing trend in the proportion maturing (8 of 13 values below the average during 1978 to 1990 compared with 4 of 17 values between 1991 and 2007). The total PFA (maturing and non-maturing 1SW salmon at January 1st of the first winter at sea) for the Southern NEAC complex ranged from 3 to 4 million fish between 1978 and 1989, declined rapidly to just over 2 million fish in 1990, and fell to its lowest level of just over one million fish in 2008 (Figure 3.6.2.3).

For the Northern NEAC complex, peak PFA abundance was estimated at about 2 million fish in year 2000 with the lowest value of the series in 2008 at over 1 million fish (Figure 3.6.2.4). The proportion maturing has varied around 0.55 over the time series but in 2007 there was an abrupt drop in the proportion maturing to below 0.35. This showed some recovery in 2008 to around 0.44, though still below the 1991 to 2006 level (Figure 3.6.2.2).

The productivity parameter is higher for maturing 1SW salmon than for the non-maturing component in both stock complexes, with the separation being larger in the Southern NEAC complex (Figure 3.6.2.1).

Forecasts from these models into 2009 to 2013 for the non-maturing age group and for 2010 to 2013 for the maturing age group were developed within the Bayesian model framework. Variations in the median abundance over the forecasts are related to variations in lagged eggs (Figure 3.6.2.5) as the productivity parameters are set at the level of the last year with available data (Figures 3.6.2.1). The variability in the productivity parameters increased sequentially over the forecasts.

For the Southern NEAC stock complex, the 25th percentiles of the posterior distributions of the forecasts are below the SER for both the maturing and non-maturing age components (Figures 3.6.2.3). The abundances of the Northern NEAC age components have declined over the 1983 to 2009 time period. The lower bound of the 95% Bayesian credible interval has fallen below the age-specific SERs for 2010 to 2013 but the expectation is for the 2009 abundance of maturing and non-maturing salmon to remain above the SER (Figures 3.6.2.4).

3.6.3 Probability of attaining PFA above SER

The structure of the previously used regression forecast model generally led to a forecast of declining PFA with time, a pattern not apparent in the Bayesian model output (ICES, 2009a).

Probabilities that the PFAs will be above or equal to SERs in 2009 to 2013 from the Bayesian model are given in the table below. Probabilities are lower for the Southern complex, ranging from 0.62 to 0.78. In the Northern complex probabilities range from 0.821 to 0.975.

Probability that PFAs will be greater than or equal to the complex and age specific SERs			
Southern complex		Maturing	Non- maturing
	SER	795 360	454 753
Year		*P*	*p*
2009		0.735	0.780
2010		0.641	0.689
2011		0.699	0.741
2012		0.668	0.710
2013		0.602	0.648
Northern complex		Maturing	Non- maturing
	SER	276 140	221 590
Year		*p*	*p*
2009		0.964	0.975
2010		0.856	0.900
2011		0.842	0.886
2012		0.821	0.868
2013		0.840	0.881

3.6.4 Use of the NEAC Bayesian forecast models in catch advice

In the absence of specific management objectives for the Faroes fishery, ICES requires that the lower bound of the 95% confidence interval of the PFA estimate be above the SER for the stock to be considered at full reproductive capacity. ICES noted that for both the northern and Southern NEAC stock complexes the Bayesian models predicts the 97.5 percentile (equivalent to the lower 95% confidence interval) as being below the respective SER in all forecast years, except for non-maturing 2009 Northern NEAC complex which is barely above the SER (at 221 590) by 410. It is also noteworthy that for the Southern NEAC the 25th percentiles, in all but the non-maturing 2009 instance, fall below the respective SER. For the West Greenland Commission area, the probability of achieving management objectives has been set to 75%.

3.7 Comparison with previous assessment

3.7.1 National PFA model and national conservation limit model

Provisional catch data for 2008 were updated where appropriate and provisional data for 2009 were incorporated into the assessment. A correction was made to the way that the catch of Scottish salmon in the English NE coast fishery is added into the Scottish assessment; this has resulted in a decrease in the estimates of returns and PFA for Scotland of 3–19%; this has also affected the conservation limit estimate. Exploitation rates for UK(England & Wales) for the period 1998 to 2009 were recalculated on the basis of utilised fishing effort (days or tides fished) rather than the licence numbers used previously; this has resulted in a small decrease in the exploitation rate values used for more recent years, thereby increasing the estimates of returns and PFA.

3.8 NASCO has requested ICES to describe the key events of the 2009 fisheries and the status of the stocks

3.8.1 Fishing at Faroes in 2008/2009

No fishery for salmon has been prosecuted since 2000.

3.8.2 Significant events in NEAC homewater fisheries in 2009

In several countries, measures aimed at reducing exploitation were implemented or extended in 2009. These include a reduction of net fisheries in UK (England & Wales) and the introduction of a carcass tagging scheme for net caught fish, a reduction in the extent of mixed-stock fisheries in Norway and the introduction of regulations in Russia aimed at controlling exploitation.

3.8.3 Gear and effort

No significant changes in the types of gear used for salmon fishing were reported in the NEAC area in 2009. The number of licensed gear units has, in most cases, continued to fall although there are no such consistent trends for the rod fishing effort in NEAC countries over this period.

3.8.4 Catches

The NEAC area has seen a general reduction in catches since the 1980s (Section 2.1.1). 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 reported catch in the NEAC area in 2009 was 1151 tonnes, 25% lower than the 2008 value (1533 t) and 34% lower than the previous 5-year mean (1757t). The catch in the Southern area has declined over the period from about 4500 t in 1972–75 to below 1000 t since 2003 and is now well below 300 t. The catch showed marked declines in 1976, 1989–91. The catch in the Northern area also indicated an overall decline over the time series, although this decrease was less distinct than the reductions noted in the Southern area. The catch in the Northern area varied between 2000 and 2800 t from 1971 to 1988, fell to a low of 962 t in 1997 and then increased to over 1600 t in 2001 although it has exhibited a downward trend since this time. Thus, the catch in the Southern area, which comprised around two-thirds of the total NEAC catch in the early 1970s, has been lower than that in the Northern area since 1999.

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.

An overview of the cpue data for the NEAC area was undertaken. 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 values compared to 2008 and the previous 5-year averages. In the Northern NEAC area, there has been an increasing trend in CPUE figures for the Russian rod fisheries in both the Barents and White Sea rivers. A decreasing trend was noted for rod fisheries in Finland (River Teno) and for the Norwegian net fisheries.

3.8.6 Age composition of catches

1SW salmon comprised 58% of the total catch in the Northern area in 2009 which was the same as the previous 5-year mean (58%) and below the previous 10-year mean (60%). 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 (54%) is below the 5- and 10-year means (both 59%).

3.8.7 Farmed and ranched salmon in catches

The contribution of farmed and ranched salmon to national catches in the NEAC area in 2009 was again generally low in most countries, with the exceptions of Norway, Iceland and Sweden, and is similar to the values that have been reported in previous years (e.g. ICES, 2009a). Thus, 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 those fisheries which have been sampled (29% in coastal fisheries, 36% in fjordic fisheries and 8% in rod fisheries). The number of coastal and fjordic fisheries sampled in 2009 was lower than in previous years and incidence of framed fish in these fisheries is thought to be an overestimate of the overall picture. An assessment of the likely effect of these fish on the output data from the PFA model has been reported previously (ICES, 2001).

The release of smolts for commercial ranching purposes ceased in Iceland in 1998, but ranching for rod fisheries in two Icelandic rivers continued into 2009. In 2009 42 t were reported as ranched salmon in contrast to 121 t harvested as wild.

Ranching occurs on a much smaller scale in other countries and the ranched component of the catch in these countries has therefore been included in the nominal catch.

3.8.8 National origin of catches

Evidence of Russian origin salmon being caught in coastal mixed-stock fisheries in northernmost Norway have been reported in previous years (e.g. ICES, 2009a). Norway has recently decreased fishing effort in coastal areas and available information shows a decline in the number of fishing days and in the number of fishermen operating in marine waters of Finnmark County. However, there are still extensive salmon fisheries operating in this coastal area which are very likely to exploit Russian salmon. In 2009, a joint Russian and Norwegian project began, the aims of which included establishing a baseline genetic characterization of salmon populations which could be used for estimating the composition of mixed stock fisheries in the area. (see section 2.4.5). This work will continue under the Joint Russian-Norwegian Scientific Research Program on Living Marine Resources in 2010 (Appendix 10 of the 38th Joint Russian-Norwegian Fishery Commission).

Data on catches of salmon originating from other countries in Ireland have been reported in previous years (e.g. ICES, 2007c). In 2007, following the closure of the mixed stock fishery only a single tag from UK(N. Ireland) was recovered and one tag of Irish origin was taken in Scottish waters. In 2008, no tags of foreign origin were recovered in the Irish tag scanning programme most likely due to the closer proximity of the existing fisheries to estuaries or rivers. In 2009, one tag was recovered from a River Bush (UK(N. Ireland)) origin fish.

3.8.9 Trends in the PFA for NEAC stocks

In the evaluation of the status of stocks in Figure 3.1.1, estimated recruitment (PFA) values should be assessed against the SER values, while the estimated spawning escapement values should be compared with the CL.

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 or at risk of reduced reproductive capacity. However, over the recent period 2007 to 2009, the 1SW spawner estimate indicated that the stock complex was suffering reduced reproductive capacity. These patterns are 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 most of the time period with the exception of 2008, when it was at risk of suffering reduced reproductive capacity, and in 2009, when it was suffering reduced reproductive capacity, prior to the commencement of distant water fisheries. The non-maturing 1SW stock has been at full reproductive capacity over most of the time period but has been at risk of suffering reduced reproductive capacity before any fisheries took place in ten of the thirteen years between 1996 and 2009. Declining trends in spawner number are evident in the Southern stock complexes for both 1SW and MSW. 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 1996 from when the stock was 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 overview of the trends of marine survival for wild and hatchery-reared smolts returning to homewaters (i.e. before homewater exploitation) is presented in Figure 3.8.10.1. The survival indices presented are the percent change in return rate between five year averages for the periods 1999 to 2003 and 2004 to 2008 for 1SW salmon, and 1998 to 2002 and 2003 to 2007 for 2SW salmon.

The overall trend in for Northern and Southern NEAC areas, in both wild and hatchery smolts, is indicative of a decline in marine survival. The percentage change between the means of the five year periods varied from a 97% decline to a 212% increase in one river (Fig. 3.8.10.1). However, the scale of change in some rivers is influenced by low total return numbers, where a few fish more or less returning may have a significant impact on the percent change. Most of the survival indices for wild and reared smolts were below the previous 5- and 10-year averages although some increases in survival were detected.

Results from these analyses are consistent with the information on estimated returns and spawners as derived from the PFA model, and suggest that returns are strongly influenced by factors in the marine environment.

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

In 2006, ICES provided multi-annual management advice for all three NASCO Commission Areas and presented a preliminary framework (Framework of Indicators - FWI) which would indicate if any significant change in the status of stocks used to inform the previously provided multi-annual management advice had occurred. This FWI was subsequently developed further at the Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance [SGEFISSA] in November 2006 (ICES, 2007b).

ICES (2007c) adopted a FWI for the Greenland fishery based on the seven contributing regions/stock complex with direct links to the three management objectives established by NASCO for that fishery. However, SGEFISSA was unable to develop a FWI for the Faroese fishery for a number of different reasons. Among these were the lack of quantitative catch advice, the absence of specific management objectives and a sharing agreement for this fishery and the fact that none of the available indicator data sets met the criteria for inclusion in the FWI. ICES (2007c) endorsed the SGEFISSA report of applying the FWI in respect of the West Greenland and North American Commissions. However, in the absence of a FWI for the Faroese fishery, it was recommended that annual assessments be conducted to verify the multi-year catch advice.

In 2009, ICES (2009a) updated the NEAC data sets previously examined in the FWI. However, these still did not satisfy the criteria for inclusion in the FWI as being informative of a significant change, since over the time series the PFA estimates have predominately remained above the SER. ICES decided that these data sets would need to be re-evaluated for use in the future, should PFA estimates decline to levels consistently below the limit reference points for each stock complex. Alternatively different approaches to that applied in respect of the Greenland fishery should be explored.

ICES concluded that, as NEAC stocks remained close to their respective SERs, none of the available indicator data sets would meet the criteria for inclusion in the FWI and, additionally, as no alternative approaches had been proposed, the only indication of a change in the status of stocks would be provided by a full assessment of the NEAC stock complexes.

3.10 Development of a risk based framework for the provision of catch advice at the Faroes.

3.10.1 The basis for developing a risk assessment framework

ICES has previously developed a risk framework for the provision of catch advice for the West Greenland fishery (WGF) which involves estimating the uncertainty in meeting defined management objectives at different levels of catch (catch options) (ICES, 2009a). The procedure has been accepted by NASCO and employed by ICES in providing catch advice for a number of years (e.g. ICES, 2009a); it could therefore provide the basis for establishing a parallel risk framework for the Faroes fishery.

The analysis of risk involves four steps (ICES, 2009a):

a. identifying the sources of uncertainty;

b. describing the precision of the assessment;

c. defining management objectives; and

d. evaluating the probability of an event (either desirable or undesirable) resulting from the fishery action.

The uncertainties have been identified and quantified in the assessment of PFA for salmon stocks in both the NAC and NEAC areas. NASCO's strategy for the management of salmon fisheries is based upon the principle of ensuring that stocks are above CLs (defined in terms of spawner escapement or egg deposition) with a high probability. The undesirable event to be avoided is that the spawning escapement after the fisheries will be below the CL.

For the WGF, the risk assessment is based upon management units within two stock complexes (NAC 2SW salmon and NEAC non-maturing 1SW salmon) which are evaluated in parallel and then combined at the end of the process into a single catch options table. The primary inputs to the risk analysis for the WGF are the catch options, PFA forecasts for the years of the fishery and conservation limits for agreed management units. The estimation procedures for PFA in the NAC and NEAC areas have been described in ICES (2009a) and take account of the uncertainty in most (but not all) of the input variables, thereby providing a measure of the uncertainty for the final estimates. The number of fish of NAC and NEAC origin in a given catch is derived from biological sampling data.

3.10.2 Current risk assessment procedure for the West Greenland fishery

The following procedure is used to estimate the probability of meeting the management objectives for each catch option (weight of catch) considered for the WGF:

(i) PFA is estimated for NAC 1SW non-maturing salmon and Southern NEAC non-maturing 1SW salmon using the continental run-reconstruction models and forecasts for three years in advance.

(ii) The weight of the (potential) catch for a particular catch option is converted to numbers of NAC and NEAC fish.

(iii) These numbers are subtracted from the forecast values of the NAC and NEAC stock complexes respectively.

(iv) The North American 'share' which matches the West Greenland catch option is then deducted from the fish that are forecast to escape the Greenland fishery. NASCO has agreed a sharing allocation of 40% to West Greenland to 60% to North America (NASCO 1994), which means that the number of fish deducted at this stage equals the catch option multiplied by 60/40. NASCO has not agreed a sharing allocation for the Southern NEAC stocks exploited at West Greenland, and so ICES has assumed the same sharing allocation as for NAC (See section 3.10.4).

(v) The number of fish forecast to return to home waters after the fishery is then reduced to take account of natural mortality from the time of the WGF to the time they return to rivers in the NAC and NEAC areas.

(vi) The fish forecast to survive to North American homewaters are then distributed among the six regions based on the regional proportions of 2SW returns of the previous five years.

(vii) For each forecast year, the number of fish forecast to escape to each NAC region and to the Southern NEAC area is assessed against the management objective for that region/area.

A risk framework for the development of catch options for the Faroes fishery could be based on similar principles to the WGF framework, but there will be a need for both management and scientific decisions on the principles to be adopted. The following sections discuss a number of factors that will need to be addressed if a risk framework is established following the general principles developed for the WGF.

3.10.3 Management objectives for the Faroes risk framework

The primary objective of the risk framework will be to meet predetermined management objectives, which will need to be agreed between Parties in NASCO; the following discussion is designed to inform that decision making process.

West Greenland fishery

For management advice for the WGF, NASCO has adopted a pre-cautionary management plan requiring at least a 75% probability of achieving three management objectives:

a. Meeting the CLs simultaneously in the four northern regions of the NAC stock complex: Labrador, Newfoundland, Quebec, and Gulf.

b. Achieving more than a 25% increase in returns relative to a baseline period (1992-1996) for the two southern regions in the NAC stock complex: Scotia-Fundy and USA.

c. Meeting the SER for the Southern NEAC MSW complex.

Faroes fishery

Establishing parallel management objectives for the Faroes fishery will require agreement on:

a. The management units to be employed; and

b. The management objectives for each of those units.

ICES currently provides advice on the status of four NEAC stock complexes, based on two age groups (maturing and non-maturing 1SW salmon) within two geographic regions (Northern NEAC and Southern NEAC). The total conservations limits for these stock complexes are:

Northern NEAC 1SW conservation limit – 218 842

Northern NEAC MSW conservation limit – 131 152

Southern NEAC 1SW conservation limit – 625 652

Southern NEAC MSW conservation limit – 268 920

These CLs for the NEAC stock complexes are considerably larger than the total CL for North American 2SW salmon (152 458). The large size of the NEAC complexes is likely to increase the risks to regional and river stocks in these stock complexes, particularly where these are already in a more depleted state than the average. It is also notable that the overall status of the stocks in each stock complex tends to be dominated by the stocks in one region or country. Thus for example, the PFA of non-maturing 1SW salmon in the Southern NEAC area is dominated by stocks in UK(Scotland), with the mean PFA for several Southern NEAC countries being significantly less than the average year to year variation observed for Scotland.

Reducing the average size of the management units to the same as that for NAC (i.e. units with CLs of ~25,000) would result in about 50 units. However, ICES is unlikely to be able to provide reliable assessments at this scale (in the short term at least).

ICES currently undertakes the assessment of NEAC stocks at the country/region level, and these might reasonably be defined as the management units for the development of the Faroes risk framework.

A similar management decision to that of WGF could be applied to the Faroes fishery; achieve the CLs simultaneously at a probability level of greater than 75%. This would mirror the approach for the WGF and would be in line with the general principles agreed by NASCO.

3.10.4 Assigning Faroes catches (or catch options) to NEAC management units

The assessment requires the catch in the fishery (i.e. the catch option) to be converted to numbers of fish from the contributing management units.

West Greenland Fishery

Allocation of the WGF catch to continent of origin is based upon data collected in the West Greenland sampling programme which has been running (in various forms) almost every year for over three decades (ICES, 2009a). The allocation requires estimates of the following parameters for future years (the years of the fishery):

- proportion of the catch originating from NAC and NEAC (propNA and propE)
- Mean weight of NAC and NEAC 1SW salmon caught (Wt1SWNA, Wt1SWE)
- A correction factor by weight for the other age groups in the fishery (AFC)

In Step (i) of the WGF risk assessment, it is assumed that these parameters could vary uniformly within the values observed in the past five years.

In Step (v) of the WGF risk assessment the fish forecast to survive to North American homewaters are also distributed among the regions based on the regional proportions of 2SW returns of the previous five years.

Faroes Fishery

Biological data on the catches in the Faroes fishery (age composition and mean weights by sea age) were collected while the commercial fishery operated in the 1980s and for the small research fishery in subsequent years, but no data have been collected since that time. The NEAC PFA assessment currently uses an estimate of the national composition of the stock at Faroes based on historic tagging data; the most recent data employed are at least 15 years old and no account has been taken of any changes in stock abundance among regions.

Initially it will be necessary to base any risk assessment on the best available data derived from historical surveys, sampling and tagging studies. If the Faroes fishery was re-opened, it might be possible to initiate new sampling programmes and thereby derive more up-to-date parameter values for the assessment.

3.10.5 Stock forecasts for NEAC stock units in the Faroes risk framework

Forecasts must clearly be developed for the stock complexes/units on which the management objectives are based, or for components of these if this allows greater accuracy and/or precision in the forecasts.

The NEAC forecast is currently based on the two stock complexes (northern and Southern NEAC), but because of the wide geographic spread of the rivers in these areas, it may be more appropriate to forecast the stocks for smaller regions (e.g. countries or national regions). Furthermore, if there is a desire to include environmental parameters into the forecast models they may be more appropriately applied at a more regional level, particularly if the post-smolt stage is considered to be a critical phase in the life-cycle. The same modelling approach (e.g. Bayesian model) can be provided to the national or regional data sets.

3.10.6 Sharing arrangement for the Faroes risk framework

Determination of the sharing arrangement is a management decision which will require input from NASCO. The following discussion is designed to inform that decision making process.

NASCO has determined that the allocation of a harvestable surplus of salmon at West Greenland should be based on the average for the period 1986 to 1990 of the harvest share of the potential 2SW salmon of North American origin caught at west Greenland (40%), although the agreement also allows for an alternative proportion to be agreed between the Parties (NASCO, 1994). To date the value of 40% has been used. The baseline period was based on a recent 5 year period, although not the 5 years immediately prior to the agreement; the basis for this choice is not known.

A sharing allocation could be determined in a similar manner for the Faroes fishery on the basis of historic catches (weights) and a similar baseline period. Figure 3.10.6.1 shows the proportions of historic catches (5yr averages for the same cohort) of NAC (2SW), Southern NEAC (all ages) and Northern NEAC (all ages) in the West Greenland, Faroes and homewater fisheries. These data might be considered by managers when determining the sharing allocations for the NEAC stock complexes.

Southern-NEAC non-maturing 1SW stocks are potentially exploited at both Faroes and West Greenland as well as in homewaters and so a three-way sharing allocation should ideally be agreed for this stock complex (Figure 3.10.6.1c). Any decision about a sharing allocation for the Southern NEAC stock complex should also be applied when assessing the West Greenland catch options.

3.10.7 Possible assessment procedure for Faroes

Based on the foregoing discussions, and assuming the various scientific and management decisions have been made, the procedure for the assessment of catch options based on a risk framework could take the following form (Figure 3.10.7.1):

(i) PFA is estimated for each of the agreed management units;

(ii) the weight of the potential catch (i.e. a particular catch option) is converted to numbers of fish from each of the stock complexes/units;

(iii) these numbers are subtracted from the forecast values of the corresponding stock complexes/units;

(iv) the fish that are forecast to escape the Faroes fishery are discounted by the fixed sharing fractions for each of the stock complexes (to be agreed by managers) (NB: the sharing fraction does not need to be the same for all of the stock complexes/units);

(v) fish forecast to return to home waters after the fishery are discounted for natural mortality from the midpoint of the Faroes fishery to the mid-point of returns to rivers;

(vi) for each forecast year, the number of fish forecast to escape to each region is assessed against the management objective for that region.

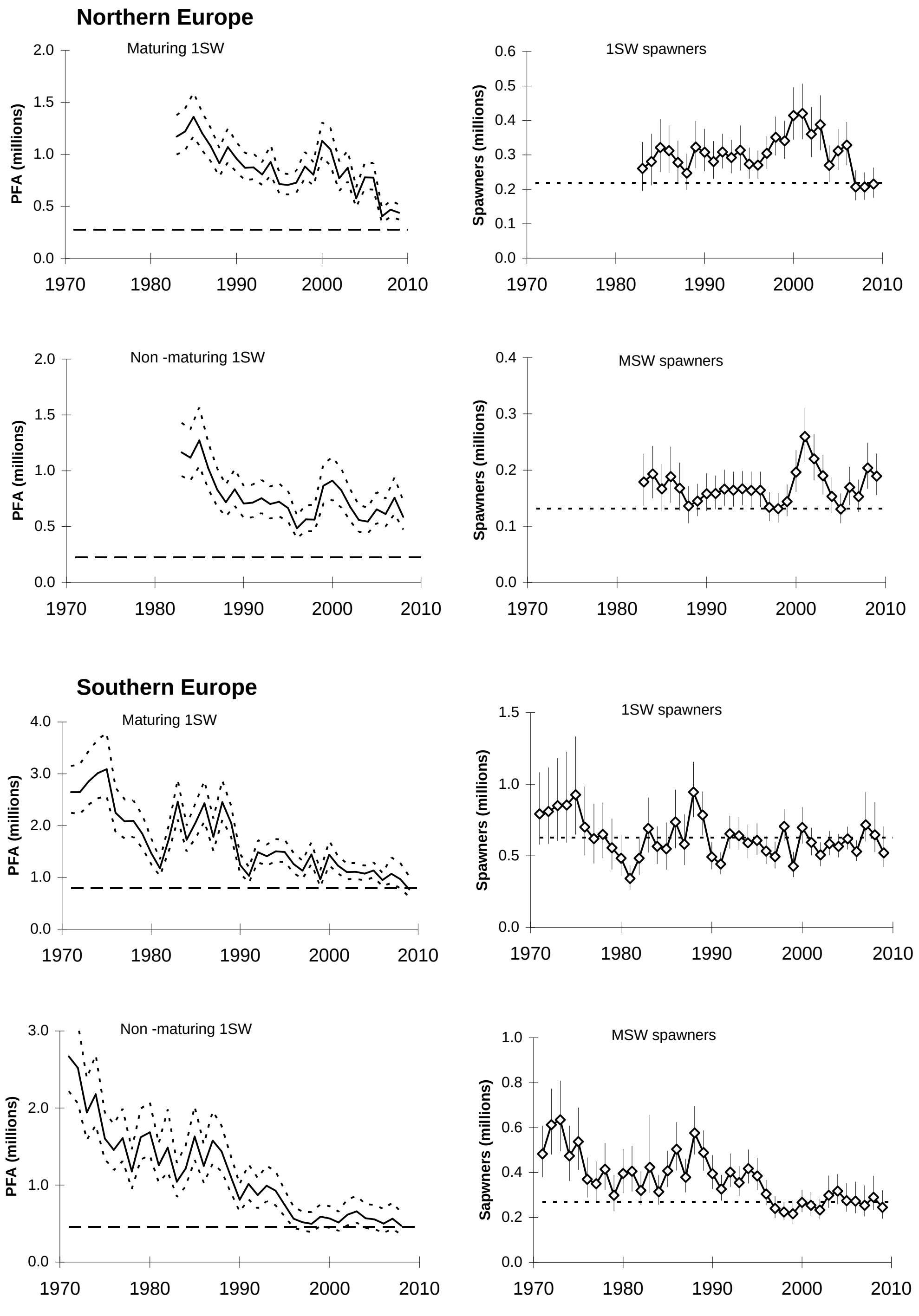


Figure 3.1.1. Estimated PFA (recruits) (left panels) and spawning escapement (right panels), with 95% confidence limits, for maturing 1SW and non-maturing 1SW salmon in Northern and Southern Europe (NEAC). The horizontal line is the Spawner Escapement Reserve (SER, left panels) or the Conservation Limit (right panels) for the age and stock complex.

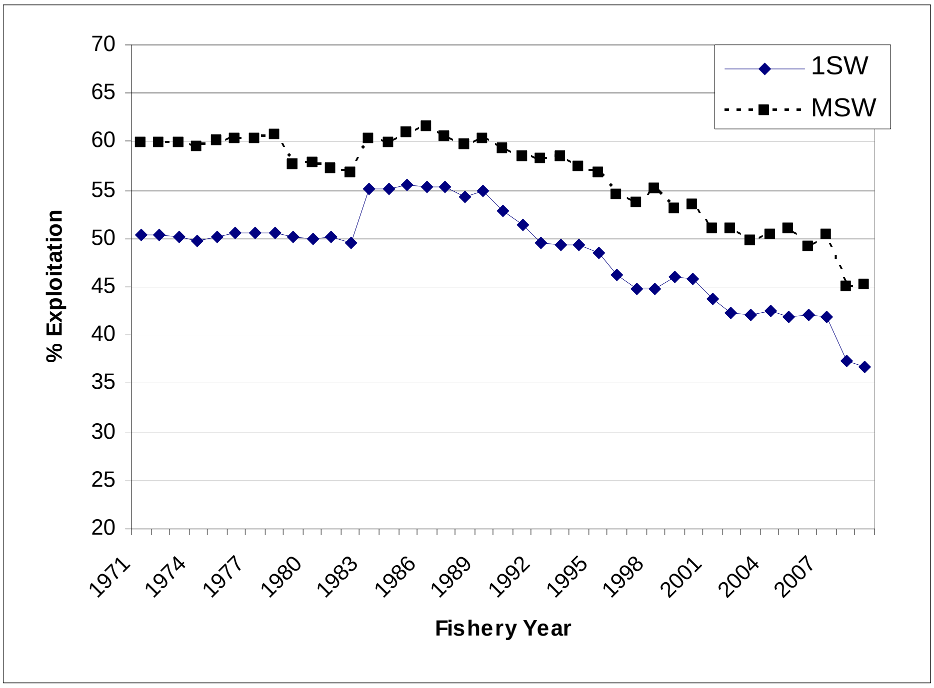


Figure 3.1.2. Exploitation rates of wild 1SW and MSW salmon by commercial and recreational fisheries in the Northern NEAC area from 1971 to 2009.

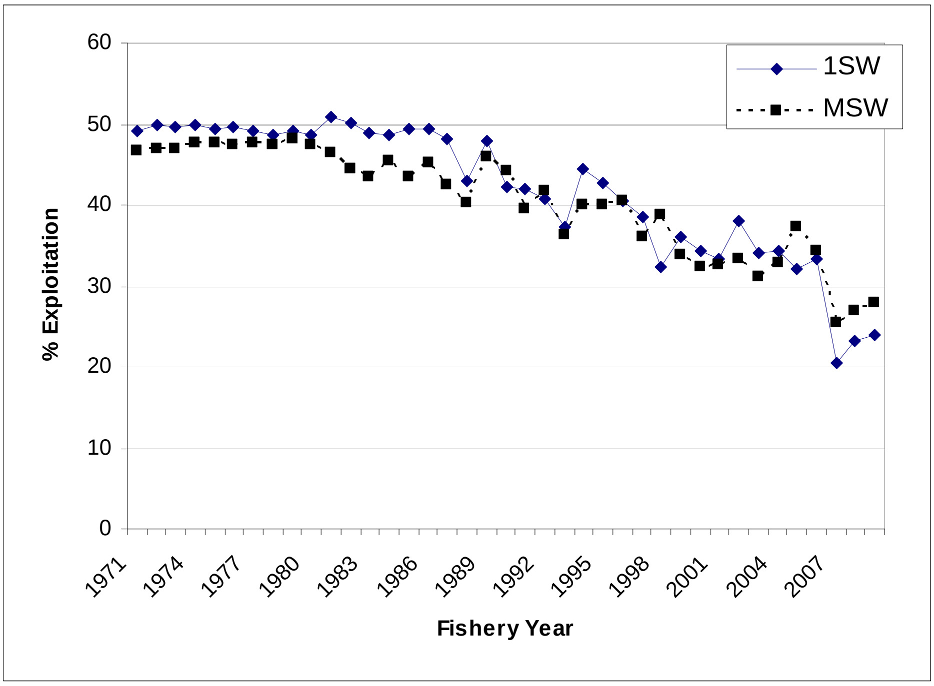


Figure 3.1.3. Exploitation rates of wild 1SW and MSW salmon by commercial and recreational fisheries in the Southern NEAC area from 1971 to 2009.

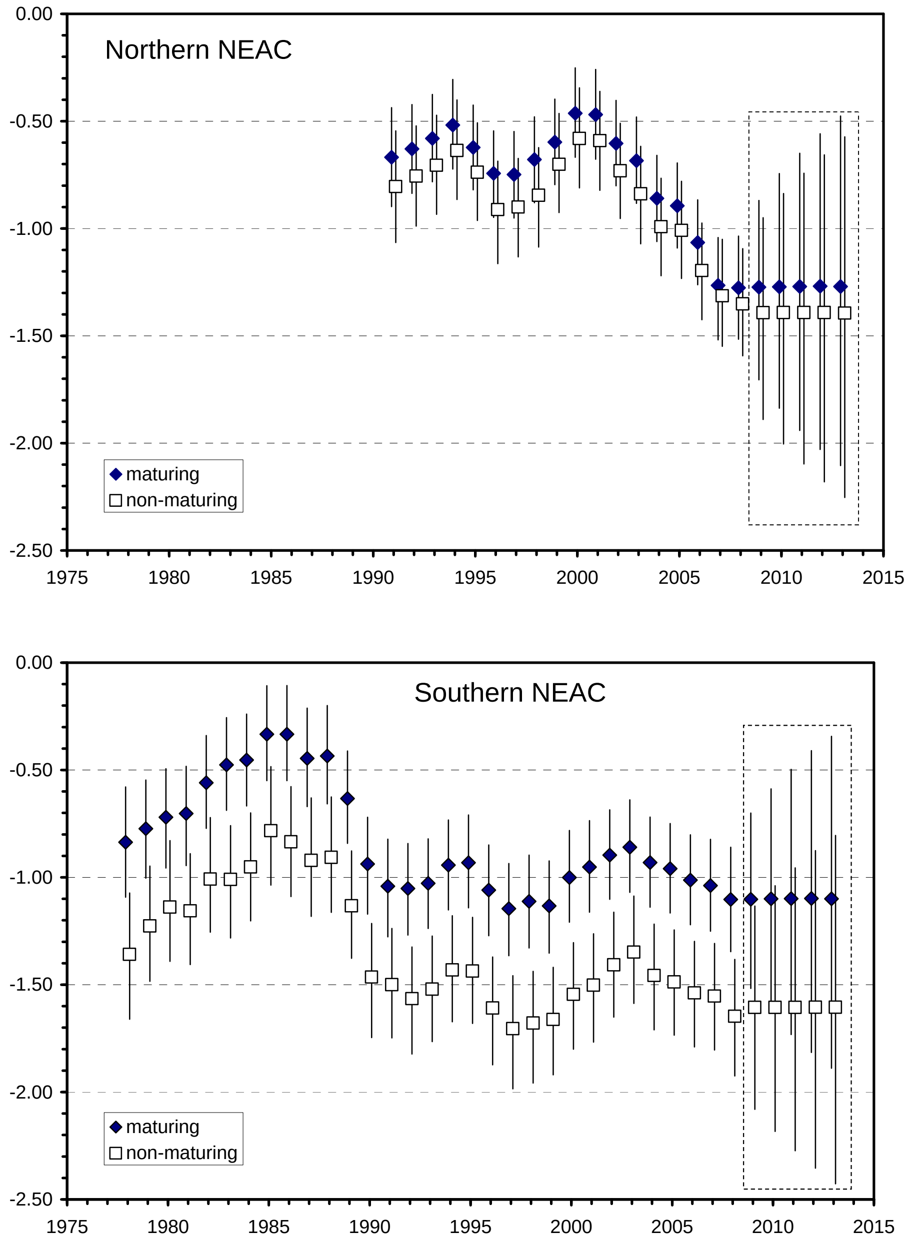


Figure 3.6.2.1. Productivity parameters (log-scale, median) by year for the maturing and non-maturing Northern and Southern NEAC forecast models. Error bars are 2.5 and 97.5 BCI. Model forecasts are enclosed within the boxed areas.

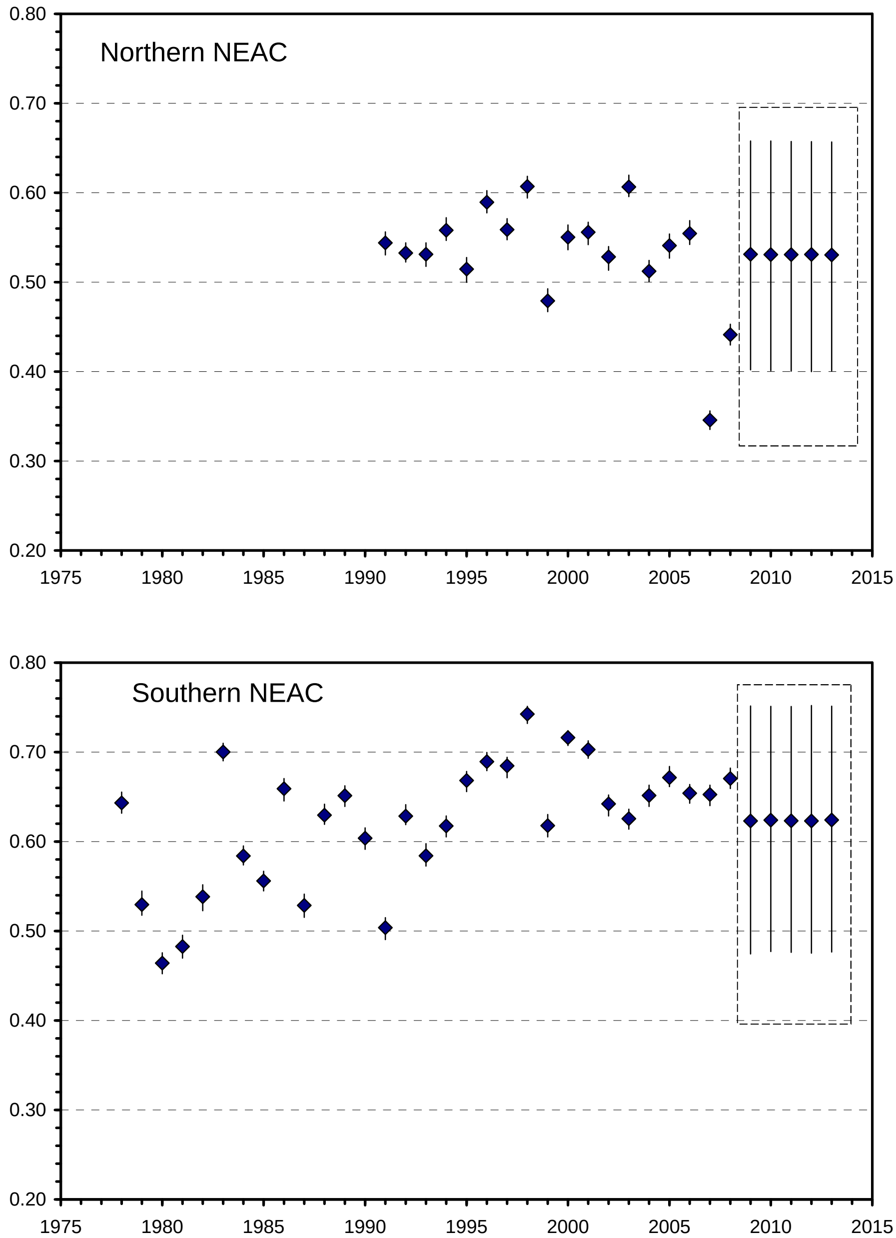


Figure 3.6.2.2. Proportion of maturing 1SW parameter (median) by year from the Northern and Southern NEAC forecast models. Error bars are 2.5 and 97.5 BCI. Model forecasts are enclosed within the boxed areas.

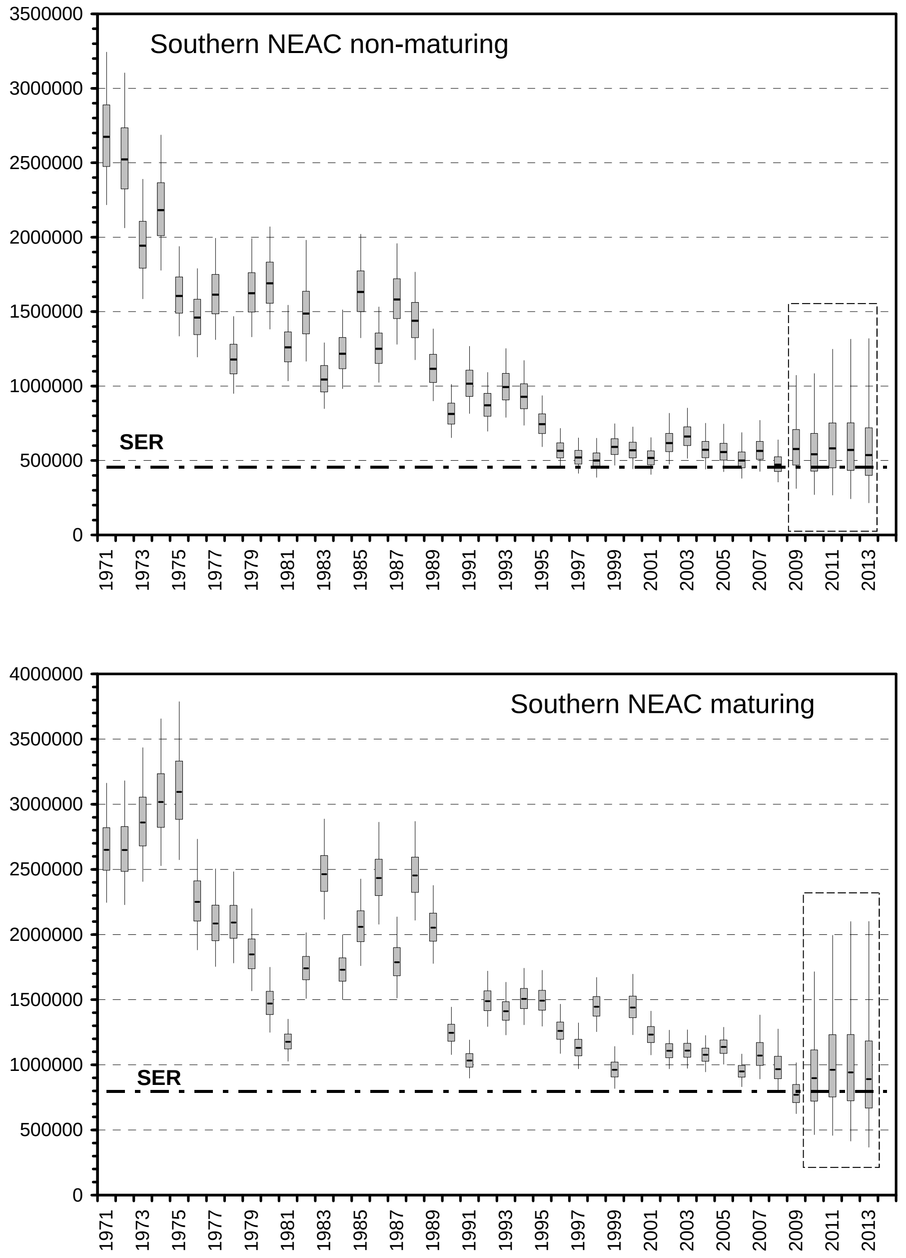
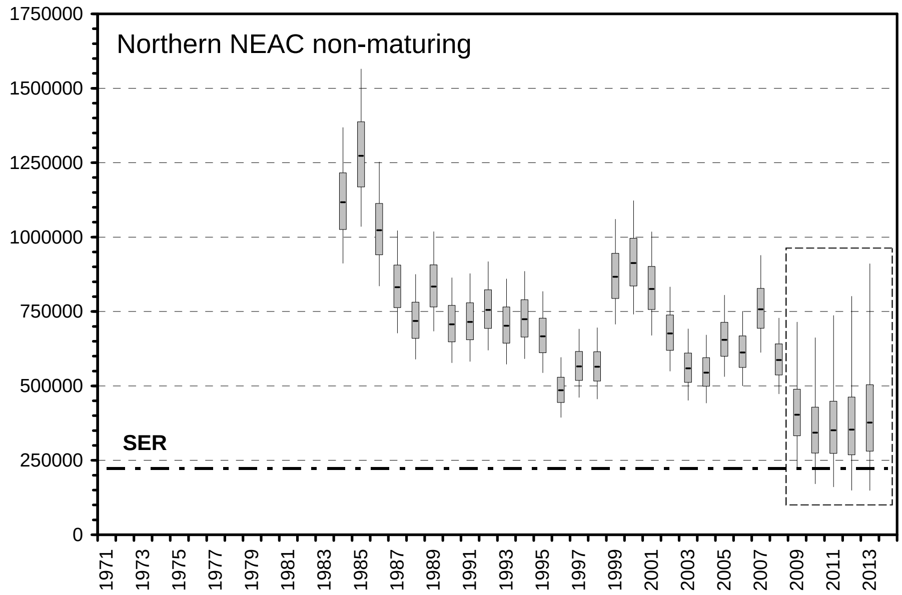


Figure 3.6.2.3. Southern NEAC PFA estimates (number of fish) by year (of PFA). The model forecast years are enclosed within the boxed areas. The horizontal dash is the median, upper and lower bounds represent 2.5th to 97.5th BCI and boxes 25th to 75th BCI.



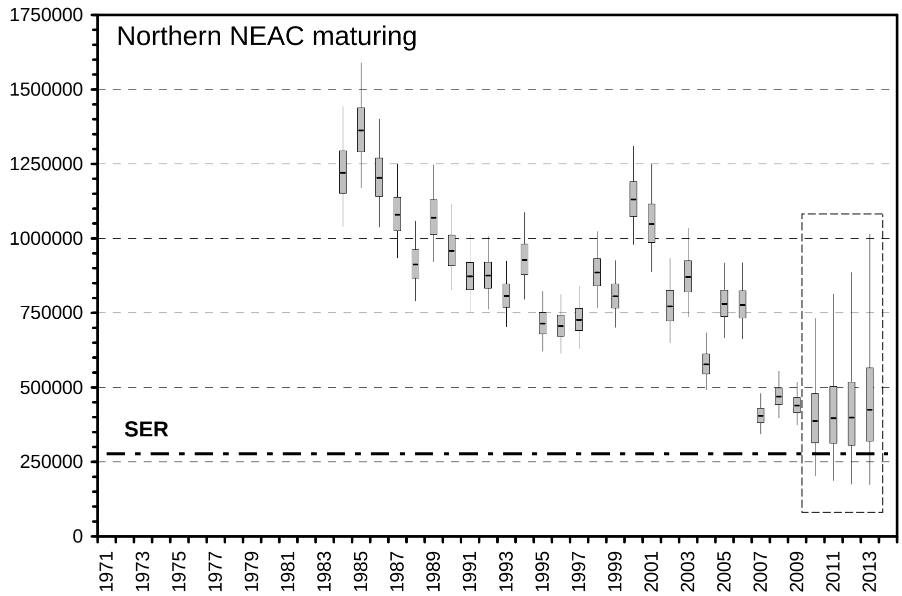
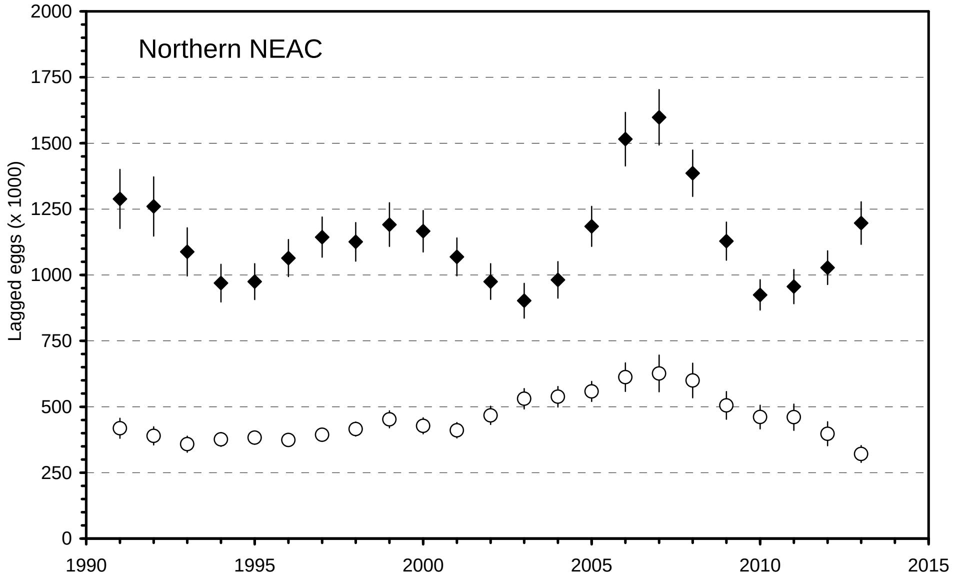


Figure 3.6.2.4. Northern NEAC PFA estimates (number of fish) by year (of PFA). The model forecast years are enclosed within the boxed areas. The horizontal dash is the median, upper and lower bounds represent 2.5th to 97.5th BCI and boxes 25th to 75th BCI.

a)



b)

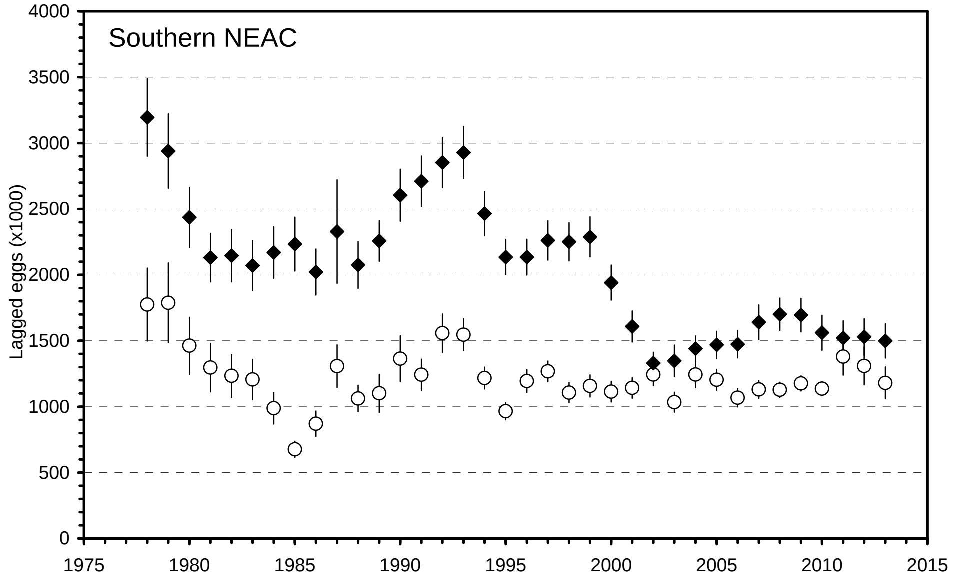


Figure 3.6.2.5. Estimates of the lagged egg depositions used in the PFA forecast model for the Northern and Southern NEAC areas. (a) Northern NEAC area for 1991 to 2013 forecast years. (b) Southern NEAC area for 1978 to 2013 forecast years. Symbols are: solid diamonds = MSW salmon, open circles = 1SW salmon.

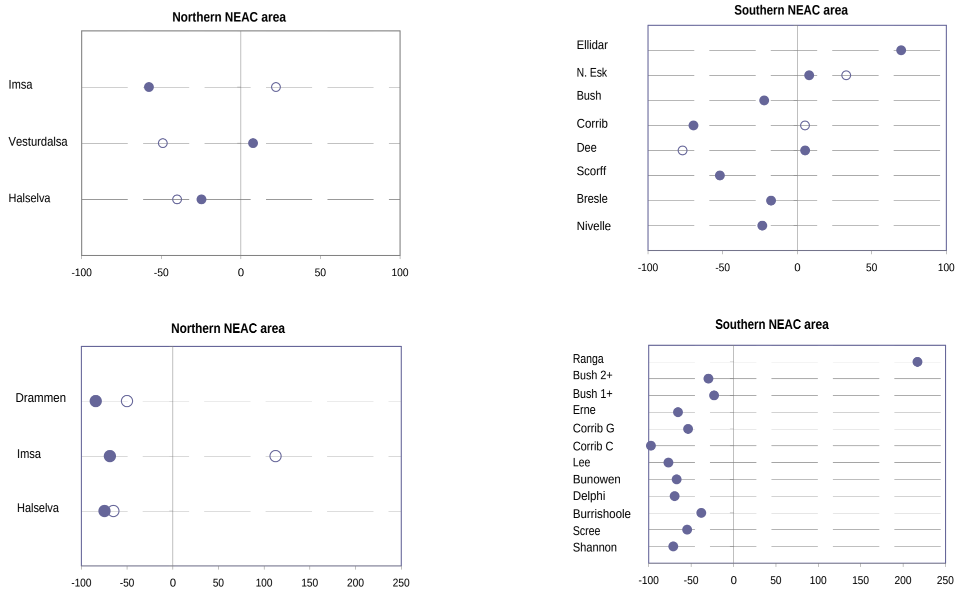


Figure 3.8.10.1. Comparison of the percent change in the five-year mean return rates for 1SW and 2SW salmon by wild (top) and hatchery (lower) salmon smolts to rivers of Northern and Southern NEAC areas for the 1999-2003 and 2004 - 2008 smolt years (1998-2002 and 2003-2007 for 2SW salmon). Filled circles are for 1SW and open circles are for 2SW data series. Populations with at least 3 data points in each of the two time periods are included in the analysis. The scale of change in some rivers is influenced by low return numbers, where a few fish more or less returning may have a significant impact on the percent change.

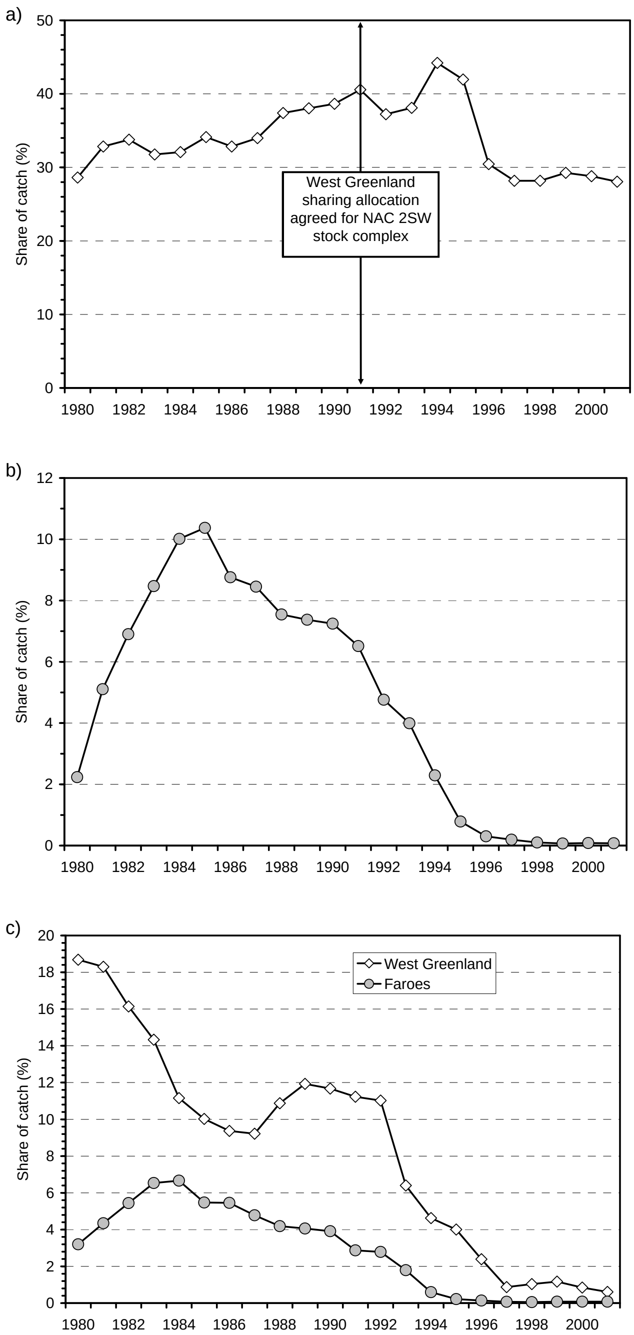


Figure 3.10.6.1. Allocation of catches between West Greenland, Faroes and homewater fisheries, (a) proportion of total catch (weight) of NAC 2SW salmon taken at West Greenland, (b) proportion of total catch (weight) of Northern NEAC salmon (all ages) taken at Faroes and (c) proportion of total catch (weight) of Southern NEAC salmon (all ages) taken at West Greenland and Faroes. In each case the proportions are based on running means of the previous 5 years for the corresponding PFA cohorts.

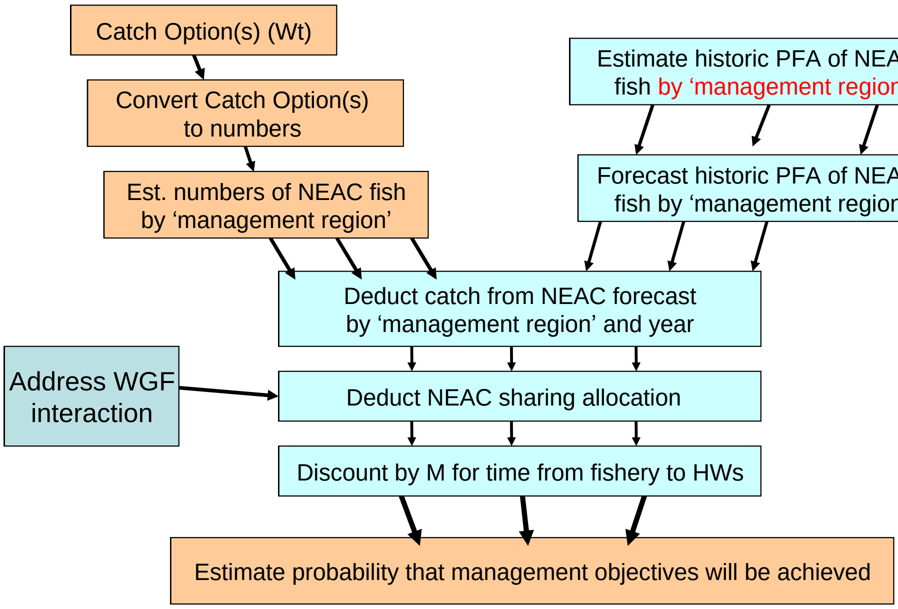


Figure 3.10.7.1 Diagrammatic representation of possible assessment procedure for provision of catch advice for the Faroes fishery within a risk framework. Multiple arrows refer to flow of information from multiple management regions.

4 North American Commission

4.1 Management objectives

Management objectives are included in Section 1.3.

4.2 Reference points

There are no changes recommended in the 2SW salmon 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 2SW salmon.

Country and Comission Area	Stock Area	2SW spawner requirement
	Labrador	34 746
	Newfoundland	4022
	Gulf of St. Lawrence	30 430
	Québec	29 446
	Scotia-Fundy	24 705
Canada Total		123 349
USA		29 199
North American Total		152 548

4.3 NASCO has requested ICES to describe the key events of the 2009 fisheries

4.3.1 Key events of the 2009 fisheries

- The majority of harvest fisheries were directed to small salmon.
- 2009 harvest was 38 656 small salmon and 11 316 large salmon, 34% less small salmon and 3.6% less large salmon compared to 2008.
- Catches remain very low relative to pre 1990 values.

4.3.2 Harvest of North American salmon, expressed as 2SW salmon equivalents

Harvest histories (1972 to 2009) of salmon, expressed as 2SW salmon equivalents are provided in Table 4.3.2.1. The Newfoundland-Labrador commercial fishery historically was a mixed stock fishery and harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. The fishery at St. Pierre & Miquelon is also a mixed stock fishery. The harvest in these fisheries of repeat spawners and older sea-ages is not considered in this analysis.

Harvests of 1SW non-maturing salmon in Newfoundland-Labrador commercial fisheries have been adjusted by natural mortalities of 3% per month for 13 months, and 2SW harvests in these same fisheries have been adjusted by one month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. The Labrador commercial fishery has been closed since 1998. Harvests from the Aboriginal Peoples' fisheries in Labrador (since 1998) and the residents′ food fishery in Labrador (since 2000) are both included. Mortalities in mixed stock and terminal fisheries areas in Canada were summed with those of USA to estimate total 2SW equivalent mortalities in North America. The terminal fisheries included coastal, estuarine and river catches of all areas, except Newfoundland and Labrador where only river catches were included. Harvest equivalents (2SW) within North America peaked at about 363 000 fish in 1976 and are now about 11 400 2SW salmon equivalents (Table 4.3.2.1).

In the most recent year, the harvest of cohorts destined to be 2SW salmon in terminal fisheries was 69% of the total catch of North America. Harvest values ranged from 19 to 32% during 1972 to 1990 and 61 to 89% during 1993 to 2009 (Table 4.3.2.1). Percentages increased significantly after 1992 with the reduction and closures of the Newfoundland and Labrador commercial mixed stock fisheries.

4.3.3 Gear and effort

Canada

The 23 areas for which the Department of Fisheries and Oceans (DFO) manages the salmon fisheries are called Salmon Fishing Areas (SFAs); for Québec, the management is delegated to the Ministère des Ressources naturelles et de la Faune and the fishing areas are designated by Q1 through Q11 (Figure 4.3.3.1). Harvest (fish which are retained) and catches (including harvests and fish caught–and–released in recreational fisheries) are categorized in two size groups: small and large. Small salmon, generally 1SW, in the recreational fisheries refer to salmon less than 63 cm fork length, whereas in commercial fisheries, it refers to salmon less than 2.7 kg whole weight. Large salmon, generally MSW, in recreational fisheries are greater than or equal to 63 cm fork length and in commercial fisheries refer to salmon greater than or equal to 2.7 kg whole weight.

Three groups exploited salmon in Canada in 2009; Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. There were no commercial fisheries in Canada in 2009.

In 2009, four subsistence fisheries harvested salmonids in Labrador: 1) Nunatsiavut Government (NG) members fishing in the northern Labrador communities of Rigolet, Makkovik, Hopedale, Postville, and Nain and in Lake Melville; 2) Innu Nation members fishing in Natuashish and in Lake Melville from the community of Sheshatshiu; 3) LMN (Labrador Métis Nation) members fishing in southern Labrador from Fish Cove Point to Cape St. Charles and, 4) Labrador residents fishing in Lake Melville and coastal communities in southern Labrador from Cartwright to Cape St. Charles. The NG, Innu, and LMN fisheries were regulated by Aboriginal Fishery Guardians jointly administered by the aboriginal groups and the Department of Fisheries and Oceans (DFO) as well as by DFO Fishery Officers and Guardian staff. The Nunatsiavut Government is directly responsible through the Torngat Fisheries Board for regulating its fishery through its Conservation Officers. The fishing gear is multifilament gillnets of 15 fathoms in length of a stretched mesh size ranging from 3 to 4 inches. Although nets are mainly set in estuarine waters some nets are also set in coastal areas usually within bays. Catch statistics are based on log book reports.

Most catches (95%, Figure 2.1.1.2) in North America now take place in rivers or in estuaries. Fisheries are principally managed on a river-by-river basis and, in areas where retention of large salmon is allowed, it is closely controlled. The commercial fisheries are now closed and the remaining coastal food fisheries in Labrador are mainly located close to river mouths and likely harvest few salmon from other than local rivers.

The following management measures were in effect in 2009.

Aboriginal peoples' food fisheries

In Québec, Aboriginal peoples′ food fisheries took place subject to agreements or through permits issued to the bands. There are 10 bands with subsistence fisheries in addition to the fishing activities of the Inuit in Ungava (Q11), who fished in estuaries or within rivers. The permits generally stipulate gear, season, and catch limits. Catches in food fisheries have to be reported collectively by each Aboriginal user group. However, if reports are not available, the catches are estimated. In the Maritimes (SFAs 15 to 23), food fishery harvest agreements were signed with several Aboriginal peoples groups (mostly First Nations) in 2009. The signed agreements often included allocations of small and large salmon and the area of fishing was usually in-river or estuaries. Harvests that occurred both within and outside agreements were obtained directly from the Aboriginal peoples. In Labrador (SFAs 1 and 2), food fishery arrangements with the Nunatsiavut Government, the Innu First Nation, and the LMN, resulted in fisheries in estuaries and coastal areas. By agreement with First Nations, there were no food fisheries for salmon on the island of Newfoundland in 2009. Harvest by Aboriginal peoples with recreational licenses is reported under the recreational harvest categories.

Resident food fisheries in Labrador

In 2009, a licensed food fishery for local residents took place, using gillnets, in Lake Melville (SFA 1) and in estuary and coastal areas of southern Labrador (SFA 2). Residents who requested a license were permitted to retain a maximum of four salmon of any size while fishing for trout and charr; four salmon tags accompanied each license. All licensees were requested to complete logbooks. DFO is responsible for regulating the Resident Fishery.

Recreational fisheries

Licenses are required for all persons fishing recreationally for Atlantic salmon. Gear is restricted to fly fishing and there are daily/seasonal bag limits. Recreational fisheries management in 2009 varied by area and large portions of the southern areas remained closed to all directed salmon fisheries. Except in Québec and Labrador (SFA 1 and some rivers of SFA 2), only small salmon could be retained in the recreational fisheries.

USA

There were no recreational or commercial fisheries for Atlantic salmon in the USA in 2009.

France (Islands of Saint Pierre and Miquelon)

Eight professional and 50 recreational gill net licences were issued in 2009. This level of effort is similar to previous years. The time-series of available data is in Table 4.3.3.1.

4.3.4 Catches in 2009

Canada

The provisional harvest of salmon in 2009 by all users was 119 t, about 25% lower than the 2008 harvest of 158 t (Table 2.1.1.1; Figure 4.3.4.1). The 2009 harvest was 38 656 small salmon and 11 316 large salmon, 34% less small salmon and 3.6% less large salmon compared to 2008. The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort, the closure of the insular Newfoundland commercial fishery in 1992, the closure of the Labrador commercial fishery in 1998, and the closure of the Québec commercial fishery in 2000.

Aboriginal peoples' food fisheries

The total harvest by Aboriginal people in 2009 was 51.1 t (Table 4.3.4.1). Harvests (by weight) decreased by 18% from 2008.

Residents fishing for food in Labrador

The estimated catch for the fishery in 2009 was 2.9 t. This represents approximately 1100 fish, 28% of which were large.

Recreational fisheries

Harvest in recreational fisheries in 2009 totalled 32 120 small and large salmon (approximately 65 t), was 26% below the 2008 harvest level, and remains among the lowest of the time-series (Figure 4.3.4.2). The small salmon harvest of 28 656 fish was 29% below the 2008 harvest. The large salmon harvest of 3 464 fish was 22% above the 2008 harvest. The small salmon size group has contributed 88% on average of the total recreational harvests since the imposition of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland (SFA 3 to 14B, 15 to 23) in 1984. In 2009, about 47 892 salmon (about 24 682 small and 23 209 large) were caught and released (Table 4.3.4.2), representing about 60% of the total number caught (including retained fish). There is some mortality on these released fish, which is accounted for in the spawner estimates.

Commercial fisheries

All commercial fisheries for Atlantic salmon remained closed in Canada in 2009 and the catch therefore was zero.

Unreported catches

There was no total unreported catch estimate available for Canada in 2009.

USA

There are no commercial or recreational fisheries for Atlantic salmon in USA and the catch therefore was zero. Unreported catches in the USA were estimated to be 0 t.

France (Islands of Saint-Pierre and Miquelon) harvests

A total harvest of 3.4 t was reported in the professional and recreational fisheries in 2009. This is similar to the 2008 harvest which was one of the highest in the available time series (Table 4.3.3.1).

There are no unreported catch estimates.

4.3.5 Origin and composition of catches

In the past, salmon from both Canada and the USA were taken in the commercial fisheries of eastern Canada. The Aboriginal Peoples' and resident food fisheries that exist in Labrador may intercept some salmon from other areas of North America; however, in 2009, there were no salmon tagged in other areas and reported from the food fisheries. Also none of the salmon sampled during the Food Fishery Sampling Program were tagged or marked. There were no tagged salmon of USA origin reported in Canadian fisheries in 2009.

Results of sampling program for Labrador subsistence fisheries

As in previous years a sampling program was in place for the 2009 subsistence fisheries in Labrador. Landed fish were sampled opportunistically. Fish were measured (fork length), weighed (gutted weight or whole weight if available) and if possible the sex was determined. Scales were taken for subsequent age analysis. Fish were also examined for the presence of external tags, brands or elastomer marks, and adipose fin clips. In southern Labrador, two people were hired by the Labrador Metis Nation to conduct sampling and aboriginal Guardians were asked to sample salmon when possible. In northern Labrador, Conservation Officers of the Nunatsiavut Government conducted the sampling.

In total, 583 samples were collected from the subsistence fisheries. Scale reading indicated that the sample consisted of 76% 1SW, 18% 2SW and 6% previously spawned salmon. Small and large salmon based on a 2.7 kg cut off, similar to that used in the Aboriginal fishery, indicated small salmon were 96% 1SW, 2% 2SW and 2% previously spawned salmon and large salmon were 19% 1SW, 63% SW and 17% previously spawned salmon. This is similar to the distribution observed in 2008. The river ages (Figure 4.3.5.1) of samples collected from the subsistence fisheries (for food social and ceremonial purposes (FSC)) were compared to ages from scales (1946 samples from north Labrador and 975 in south Labrador) obtained from assessment facilities in 2000-2005.

There was a difference in river age distribution of adults from subsistence fisheries compared to returns to rivers in northern Labrador (Chi square=21.5, P=<0.0015), but not in southern Labrador (Chi square=9.1, P=0.1). The significant difference in river age in the samples from northern Labrador is likely owing to a larger than expected number of river age 3 fish in the upper Lake Melville sample (Figure 4.3.5.2). The absence of age 1 and rarity of age 2 smolts in the catches in 2009 suggests that these fisheries did not exploit southern North America stocks to any great extent. The presence of river age 5 to 7 years in the samples provides evidence that the fisheries are exploiting northern area (predominantly Labrador) stocks.

ICES noted that the sampling program conducted in 2009 provided biological characteristics of the harvest and that the information may be useful for updating parameters used in the Run Reconstruction Model for North America. As well it provides material to assess the origin of salmon in this fishery. ICES recommends that sampling be continued and expanded in 2010 and future years.

4.3.6 Exploitation rates

Canada

In the Newfoundland recreational fishery, exploitation rates for retained small salmon ranged from a high of 13% on Torrent River to a low of 5% on Terra Nova River. Overall, exploitation of small salmon in these rivers declined from 30% in 1986 to approximately 10% in 2009 which is one of the lowest rates of the past 25 years. In Labrador, at Sand Hill River, exploitation on small salmon was 4.6% and 0.41% on large salmon.

In Quebec, the 2009 total fishing exploitation rate was around 18%; about the average of the five previous years. Native peoples′ fishing exploitation rate was 7% of the total return. Recreational fishing exploitation rate was 11% on the total run, 15% for the small and 8% for the large salmon, representing a decrease from the previous five year average of 18% for small salmon and 9% for large salmon.

USA

There was no exploitation of USA salmon in home waters.

Exploitation trends for North American salmon fisheries

Annual exploitation rates of small salmon (mostly 1SW) and large salmon (mostly MSW) in North America for the 1971 to 2009 time period were calculated by dividing annual harvests in all North American fisheries by annual estimates of the returns to North America prior to any fisheries in North America. The fisheries included coastal, estuarine and river fisheries in all areas, as well as the commercial fisheries of Newfoundland and Labrador which harvested salmon from all regions in North America.

Exploitation rates of both small and large salmon fluctuated annually but remained relatively steady until 1984 when exploitation of large salmon declined sharply with the introduction of the non-retention of large salmon in angling fisheries and reductions in commercial fisheries (Figure 4.3.6.1). Exploitation of small salmon declined steeply in North America after 1991 with the closure of the Newfoundland commercial fishery in 1992. Declines continued in the 1990s with continuing management controls in all fisheries to reduce exploitation. In the last few years, exploitation rates on small salmon and large salmon have remained at the lowest in the time-series, average of 15% for both small salmon and large salmon over the past ten years. However, exploitation rates across regions within North America are highly variable.

Table 4.3.2.1. Harvests (number of fish) expressed as 2SW salmon equivalents in North American salmon fisheries, 1972–2009. Only mid-points of the estimated values have been used.

	Mixed stock fisheries				Homewater fisheries (Returns - Spawners)						Harvests	Spawners			Proportion harvests
Region	W. Greenland	Newfoundland and Labrador		SP&M	Labrador	Newfoundland	Quebec	Gulf	Scotia-Fundy	USA	North America	North America	Exploitation rate		of North America
Age group	1SW non-mat	1SW non-mat	2SW	2SW	2SW	2SW	2SW	2SW	2SW	2SW	2SW	2SW	NW Atlantic	North America	in homewater fisheries
Year (i)	year (i-1)	year (i-1)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)	year (i)
1971			154,592		490	604	28,430	24,410	6,452	163		50,090			
1972	197,632	20,217	153,719	0	420	590	27,360	20,190	5,600	346	228,441	85,110	0.576	0.421	0.239
1973	148,098	17,515	219,127	0	1,010	770	32,750	15,470	6,213	327	293,182	90,210	0.535	0.433	0.193
1974	186,201	23,839	235,915	0	800	499	47,580	18,220	13,060	247	340,160	120,000	0.534	0.425	0.236
1975	154,640	23,555	237,565	0	330	501	41,080	14,070	12,510	389	330,000	97,840	0.531	0.435	0.209
1976	194,541	35,139	256,586	333	830	377	42,200	16,140	11,130	191	362,926	91,060	0.551	0.444	0.195
1977	112,943	26,852	241,156	0	1,290	779	42,270	29,220	13,460	1,355	356,382	129,900	0.491	0.423	0.248
1978	142,778	27,103	157,309	0	770	532	37,440	20,330	9,369	894	253,747	81,520	0.542	0.431	0.273
1979	103,813	13,582	92,047	0	609	125	25,250	6,253	3,828	433	142,127	38,470	0.577	0.440	0.257
1980	141,844	20,650	217,186	0	890	640	53,570	26,990	17,400	1,533	338,858	121,900	0.511	0.424	0.298
1981	120,923	33,833	201,270	0	520	432	44,360	14,824	12,850	1,267	309,356	79,280	0.525	0.443	0.240
1982	161,183	33,690	134,407	0	620	395	35,240	21,050	8,935	1,413	235,750	80,900	0.556	0.427	0.287
1983	145,870	25,308	111,504	333	428	419	34,490	17,640	12,300	386	202,808	53,090	0.577	0.442	0.324
1984	26,837	19,100	82,798	333	510	181	24,830	3,580	3,970	675	135,977	82,010	0.428	0.384	0.248
1985	32,438	14,381	78,752	333	294	22	27,800	940	4,930	645	128,096	97,740	0.415	0.362	0.270
1986	99,140	19,628	104,905	277	467	34	34,190	1,820	2,830	606	164,757	120,200	0.481	0.366	0.242
1987	123,439	24,841	132,175	222	630	18	34,220	1,930	1,360	300	195,696	87,340	0.530	0.409	0.197
1988	123,799	31,646	81,120	222	710	25	34,600	1,360	1,380	248	151,310	95,090	0.528	0.380	0.253
1989	84,977	21,943	81,343	222	461	7	29,350	1,240	260	397	135,223	81,330	0.504	0.384	0.235
1990	43,617	19,323	57,353	211	357	19	28,460	1,110	600	696	108,129	86,570	0.438	0.357	0.289
1991	52,215	11,869	40,429	133	93	11	29,660	840	1,330	231	84,595	76,290	0.460	0.345	0.380
1992	79,585	9,865	25,105	255	782	53	30,490	1,070	1,110	167	68,897	87,930	0.486	0.305	0.489
1993	29,814	3,125	13,266	322	387	55	23,540	570	1,107	166	42,538	83,230	0.365	0.253	0.607
1994	1,892	2,085	11,936	377	490	152	24,580	660	758	1	41,040	69,440	0.280	0.271	0.649
1995	1,891	1,192	8,675	89	460	143	23,710	530	325	0	35,124	101,300	0.213	0.205	0.717
1996	19,181	1,039	5,645	177	390	173	22,690	800	768	0	31,683	84,730	0.304	0.214	0.783
1997	19,339	947	5,390	166	210	139	18,590	820	580	0	26,842	67,920	0.328	0.221	0.758
1998	13,048	1,133	1,761	255	205	104	11,290	500	321	0	15,570	49,320	0.306	0.194	0.798
1999	4,323	175	841	258	270	81	9,180	790	449	0	12,044	55,200	0.196	0.152	0.894
2000	6,442	150	1,049	251	260	157	8,890	560	193	0	11,511	58,200	0.205	0.142	0.874
2001	5,930	284	1,298	239	310	71	9,650	890	253	0	12,996	67,210	0.191	0.139	0.860
2002	8,606	260	1,115	217	200	50	6,180	520	179	0	8,721	41,790	0.255	0.147	0.817
2003	3,222	310	1,689	321	232	70	8,490	770	190	0	12,071	64,100	0.167	0.137	0.808
2004	3,474	351	2,869	309	270	72	8,380	820	106	0	13,177	60,530	0.184	0.152	0.732
2005	4,339	464	2,186	365	280	77	7,450	940	89	0	11,851	63,150	0.178	0.136	0.746
2006	4,179	559	2,399	394	220	84	7,120	780	138	0	11,694	59,990	0.181	0.140	0.713
2007	4,933	559	2,058	216	230	69	6,710	850	95	0	10,787	57,330	0.188	0.137	0.737
2008	6,616	495	3,034	393	230	99	6,450	820	82	0	11,602	66,130	0.190	0.130	0.662
2009	7,542	539	2,595	377	230	63	6,570	900	118	0	11,392	79,760	0.172	0.111	0.692

W. Greenland: harvest of 1SW non-maturing salmon as 2SW equivalents by adjusting for natural mortality (M) = 0.03 per month for 11 months
Newfoundland and Labrador sea fisheries: harvest of 1SW non-maturing as 2SW equivalents by adjusting for natural mortality (M) = 0.03 per month for 13 months
Newfoundland and Labrador sea fisheries: harvest of 2SW as 2SW equivalents by adjusting for natural mortality (M) = 0.03 per month for 1 month

Table 4.3.3.1. The number of professional and recreational gillnet licenses issued at St. Pierre and Miquelon and landings, 1995 to 2009.

	Number of licences		Reported landings (tonnes)		
Year	Professional	Recreational	Professional	Recreational	Total
1990			1.146	0.734	1.880
1991			0.632	0.530	1.162
1992			1.295	1.024	2.319
1993			1.902	1.041	2.943
1994			2.633	0.790	3.423
1995	12	42	0.392	0.445	0.837
1996	12	42	0.951	0.617	1.568
1997	6	36	0.762	0.729	1.491
1998	9	42	1.039	1.268	2.307
1999	7	40	1.182	1.140	2.322
2000	8	35	1.134	1.133	2.267
2001	10	42	1.544	0.611	2.155
2002	12	42	1.223	0.729	1.952
2003	12	42	1.620	1.272	2.892
2004	13	42	1.499	1.285	2.784
2005	14	52	2.243	1.044	3.287
2006	14	48	1.730	1.825	3.555
2007	13	53	0.970	0.977	1.947
2008	na	na	na	na	3.540
2009	8	50	1.8	1.6	3.4

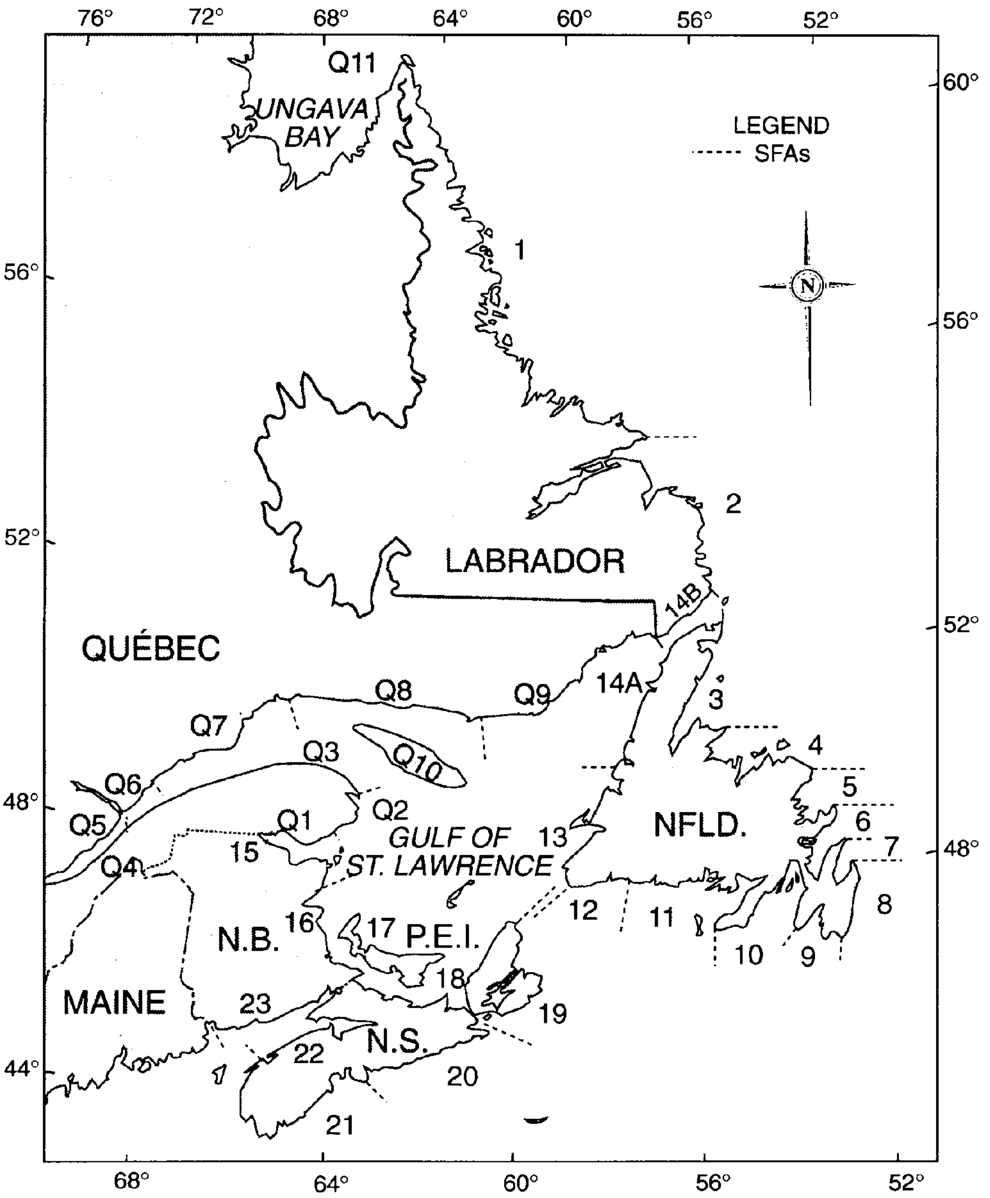
Table 4.3.4.1. Harvests in 2009 (by weight) and the percent large by weight and number in the Aboriginal Peoples' Food Fisheries in Canada.

Aboriginal peoples' food fisheries			
Year	Harvest (t)	% large	
		by weight	by number
1990	31.9	78	
1991	29.1	87	
1992	34.2	83	
1993	42.6	83	
1994	41.7	83	58
1995	32.8	82	56
1996	47.9	87	65
1997	39.4	91	74
1998	47.9	83	63
1999	45.9	73	49
2000	45.7	68	41
2001	42.1	72	47
2002	46.3	68	43
2003	44.3	72	49
2004	60.8	66	44
2005	56.7	57	34
2006	61.4	60	39
2007	48.0	62	40
2008	62.4	66	44
2009	51.1	65	45

Table 4.3.4.2. Numbers of salmon catch and released in Eastern Canadian salmon angling fisheries. Data for years prior to 1997 are incomplete.

	Newfoundland			Nova Scotia			New Brunswick					Prince Edward Island			Quebec			CANADA		
Year	Small	Large	Total	Small	Large	Total	Small Kelt	Small Bright	Large Kelt	Large Bright	Total	Small	Large	Total	Small	Large	Total	**SMALL**	**LARGE**	**TOTAL**
1984				939	1,655	2,594	661	851	1,020	14,479	17,011							**2,451**	**17,154**	**19,605**
1985		315	315	1,323	6,346	7,669	1,098	3,963	3,809	17,815	26,685			67				**6,384**	**28,285**	**34,669**
1986		798	798	1,463	10,750	12,213	5,217	9,333	6,941	25,316	46,807							**16,013**	**43,805**	**59,818**
1987		410	410	1,311	6,339	7,650	7,269	10,597	5,723	20,295	43,884							**19,177**	**32,767**	**51,944**
1988		600	600	1,146	6,795	7,941	6,703	10,503	7,182	19,442	43,830	767	256	1,023				**19,119**	**34,275**	**53,394**
1989		183	183	1,562	6,960	8,522	9,566	8,518	7,756	22,127	47,967							**19,646**	**37,026**	**56,672**
1990		503	503	1,782	5,504	7,286	4,435	7,346	6,067	16,231	34,079			1,066				**13,563**	**28,305**	**41,868**
1991		336	336	908	5,482	6,390	3,161	3,501	3,169	10,650	20,481	1,103	187	1,290				**8,673**	**19,824**	**28,497**
1992	5,893	1,423	7,316	737	5,093	5,830	2,966	8,349	5,681	16,308	33,304			1,250				**17,945**	**28,505**	**46,450**
1993	18,196	1,731	19,927	1,076	3,998	5,074	4,422	7,276	4,624	12,526	28,848							**30,970**	**22,879**	**53,849**
1994	24,442	5,032	29,474	796	2,894	3,690	4,153	7,443	4,790	11,556	27,942	577	147	724				**37,411**	**24,419**	**61,830**
1995	26,273	5,166	31,439	979	2,861	3,840	770	4,260	880	5,220	11,130	209	139	348		922	922	**32,491**	**15,188**	**47,679**
1996	34,342	6,209	40,551	3,526	5,661	9,187						472	238	710		1,718	1,718	**38,340**	**13,826**	**52,166**
1997	25,316	4,720	30,036	713	3,363	4,076	3,457	4,870	3,786	8,874	20,987	210	118	328	182	1,643	1,825	**34,748**	**22,504**	**57,252**
1998	31,368	4,375	35,743	688	2,476	3,164	3,154	5,760	3,452	8,298	20,664	233	114	347	297	2,680	2,977	**41,500**	**21,395**	**62,895**
1999	24,567	4,153	28,720	562	2,186	2,748	3,155	5,631	3,456	8,281	20,523	192	157	349	298	2,693	2,991	**34,405**	**20,926**	**55,331**
2000	29,705	6,479	36,184	407	1,303	1,710	3,154	6,689	3,455	8,690	21,988	101	46	147	445	4,008	4,453	**40,501**	**23,981**	**64,482**
2001	22,348	5,184	27,532	527	1,199	1,726	3,094	6,166	3,829	11,252	24,341	202	103	305	809	4,674	5,483	**33,146**	**26,241**	**59,387**
2002	23,071	3,992	27,063	829	1,100	1,929	1,034	7,351	2,190	5,349	15,924	207	31	238	852	4,918	5,770	**33,344**	**17,580**	**50,924**
2003	21,379	4,965	26,344	626	2,106	2,732	1,555	5,375	1,042	7,981	15,953	240	123	363	1,238	7,015	8,253	**30,413**	**23,232**	**53,645**
2004	23,430	5,168	28,598	828	2,339	3,167	1,050	7,517	4,935	8,100	21,602	135	68	203	1,291	7,455	8,746	**34,251**	**28,065**	**62,316**
2005	33,129	6,598	39,727	933	2,617	3,550	1,520	2,695	2,202	5,584	12,001	83	83	166	1,116	6,445	7,561	**39,476**	**23,529**	**63,005**
2006	30,491	5,694	36,185	1,014	2,408	3,422	1,071	4,186	2,638	5,538	13,433	128	42	170	1,091	6,185	7,276	**37,981**	**22,505**	**60,486**
2007	17,719	4,607	22,326	896	1,520	2,416	1,164	2,963	2,067	7,040	13,234	63	41	104	951	5,392	6,343	**23,756**	**20,667**	**44,423**
2008	25,226	5,007	30,233	1,016	2,061	3,077	1,146	6,361	1,971	6,130	15,608	3	9	12	1,361	7,713	9,074	**35,113**	**22,891**	**58,004**
2009	19,192	4,484	23,676	670	2,665	3,335	1,338	2,387	1,689	8,174	13,588	6	25	31	1,089	6,173	7,262	**24,682**	**23,209**	**47,892**

Figure 4.3.3.1. Map of Salmon Fishing Areas (SFAs) and Québec Management Zones (Qs) in Canada.



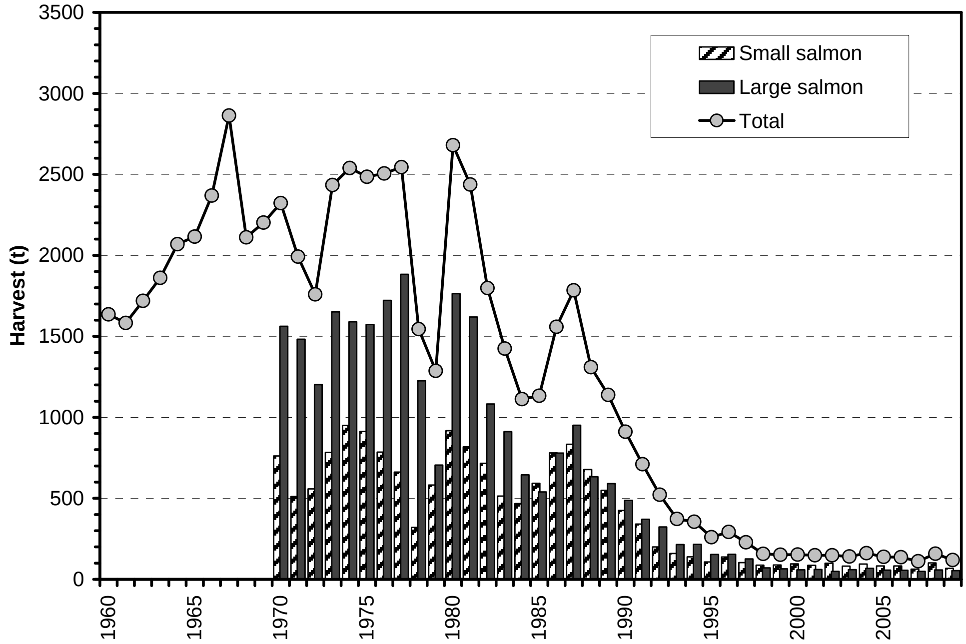


Figure 4.3.4.1. Harvest (t) of small salmon, large salmon and combined for Canada, 1960–2009 by all users.

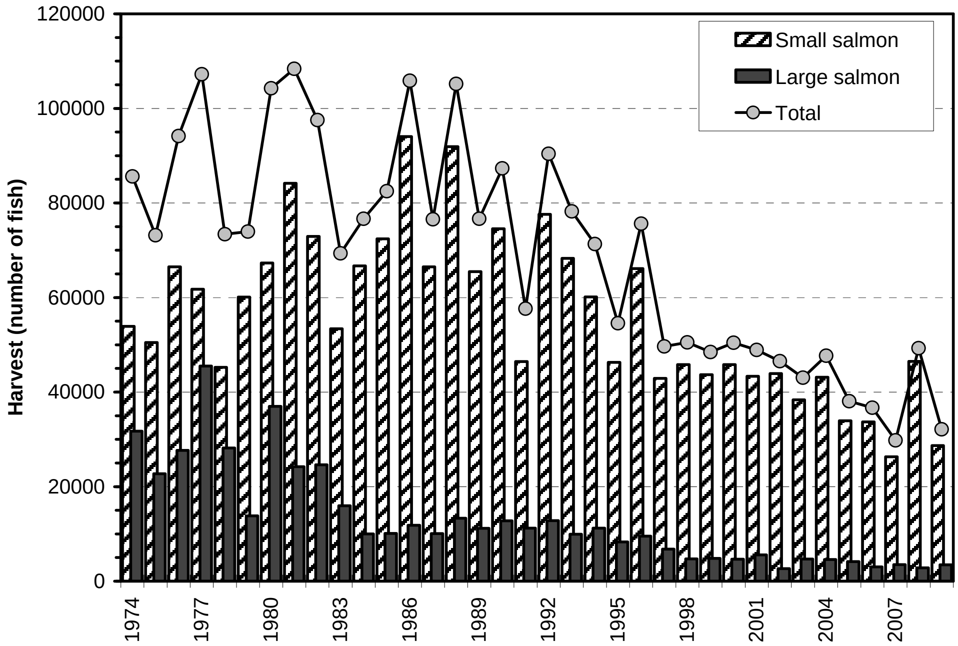


Figure 4.3.4.2. Harvest (number) of small salmon, large salmon and both sizes combined in the recreational fisheries of Canada, 1974 to 2009.

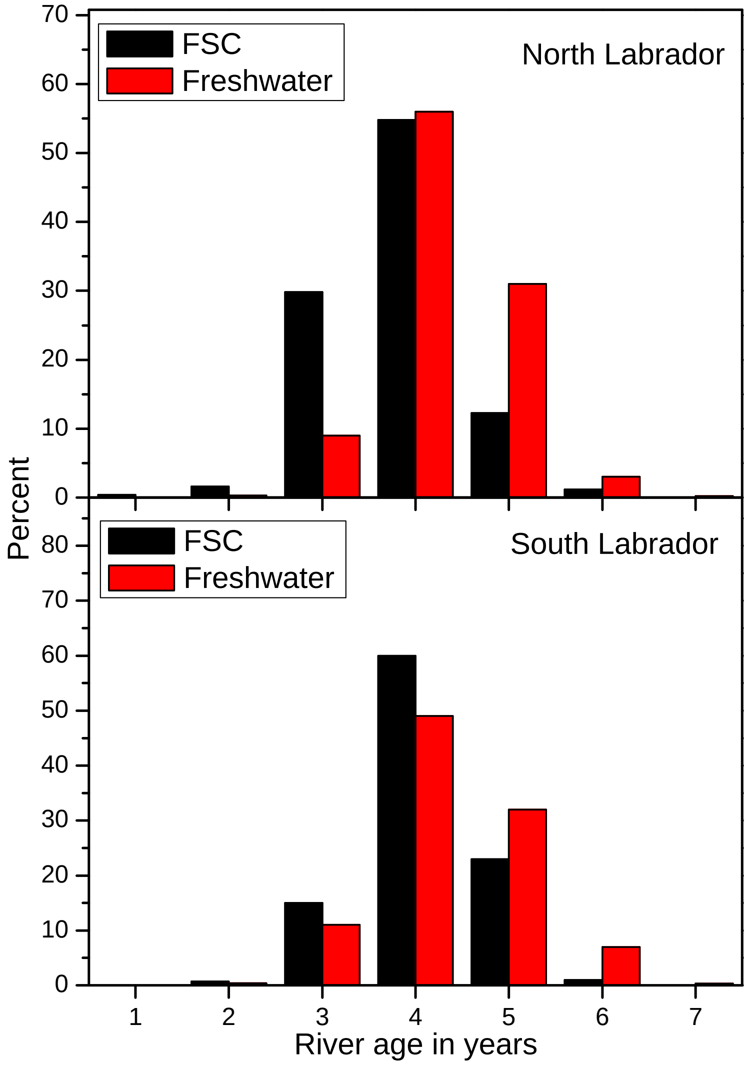


Figure 4.3.5.1. River age distribution of salmon from FSC (food social and ceremonial purposes) fisheries in North and South Labrador in 2009 compared to those at corresponding assessment facilities (freshwater) for 2000 to 2005.

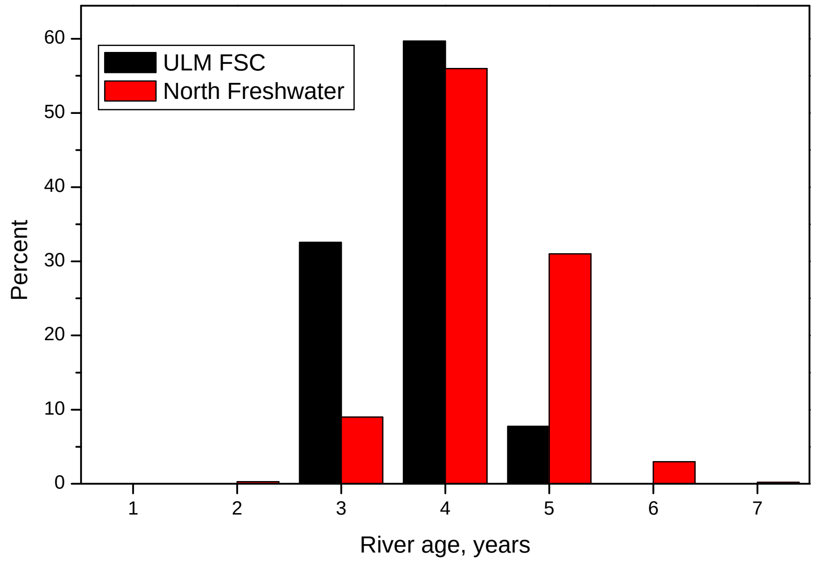


Figure 4.3.5.2. River age distribution of salmon from FSC (food social and ceremonial purposes) fishery in upper Lake Melville (ULM FSC) in 2009 compared to river age distribution from freshwater monitoring facilities in North Labrador for 2000 to 2005.

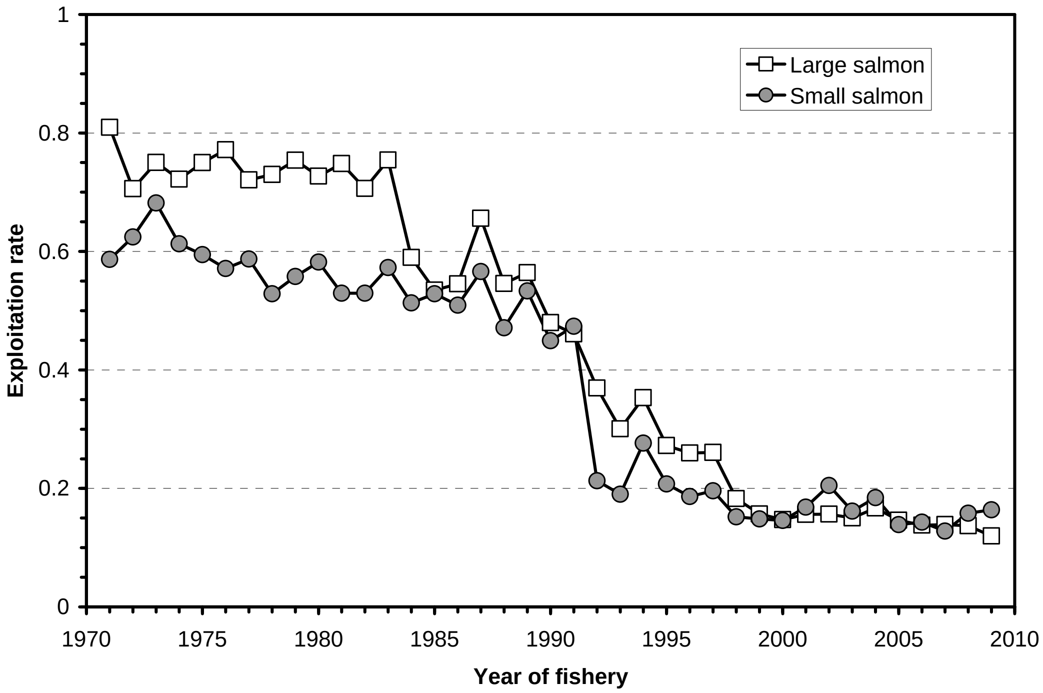


Figure 4.3.6.1. Exploitation rates in North America on the North American stock complex (after West Greenland fisheries) of small salmon and large salmon, 1971 to 2009.

5 Atlantic salmon in the West Greenland Commission

5.1 NASCO has requested ICES to describe the key events of the 2009 fishery

5.1.1 Catch and effort in 2009

A total catch of 25.5 t of salmon was reported during the 2009 fishery (Table 5.1.1.1). Catches were distributed among the six NAFO divisions on the western coast of Greenland. In 2009, a catch of 0.8 t was also reported from East Greenland, accounting for approximately 3% of the combined reported catch (26 t). Catches coming from divisions 1B-1E (Table 5.1.1.2) represented approximately 78% of the total catch. In NAFO Division 1A, the fishery experienced much lower catches in 2009 than in 2008. Only 195 kg were reported by 19 different people and of these nine reported zero catch. This contrasts with the 4.9 t reported in this area by 44 people in 2008.

There is presently no quantitative approach for estimating the unreported catch but the 2009 value is likely to have been at the same level proposed in recent years (10 t).

The Greenland Authorities received 238 reports of salmon catches in 2009 compared to 259 in 2008. In total, 145 people provided reports to the Greenland Home Rule License Office in 2009 which was similar to the previous year (143). Twenty three of these people reported zero catch compare to four people in 2008.

The number of fishers reporting catches has steadily increased up to 2008 from a low of 41 in 2002 to its current level. These levels remain well below the 400 to 600 people reporting landings in the commercial fishery from 1987 to 1991. Since October 2006, the Greenland Home Rule License Office has broadcast TV requests that catch reports be submitted for the season. Thus, it is possible that the increase in the number of people reporting catches, and hence the increased reported landings, reflect changes in reporting practices rather than increased harvest.

5.1.2 Biological characteristics of the catches

International Sampling Program

The international sampling program for landings at West Greenland, initiated by NASCO in 2001, was continued in 2009. The sampling was undertaken by teams from Canada, Ireland, UK (Scotland), UK (England & Wales), and USA. Additionally, staff from the Greenland Institute of Natural Resources assisted with the overall coordination of the program and sampling in Nuuk. Sampling began in August and continued through October.

Samplers were stationed in three different communities representing three different NAFO Divisions. No sampling occurred in the fishery in East Greenland in 2009. One sample collected in Nuuk was identified as having originated from the waters of Division 1C. Nuuk is close to the border between divisions 1C and 1D and a single fisher harvested fish from division 1C, but sold his catch at the market in Nuuk (1D). As has been done in the past, that specific catch has been allocated to Division 1C and therefore, division-specific statistics are presented from four divisions.

In the Baseline Sampling Programme, tissue and biological samples were collected from three landing sites: Sisimiut (NAFO Div. 1B), Nuuk (NAFO Div. 1D), and Qaqortoq (NAFO Div. 1F, Figure 5.1.2.1). In total 1738 salmon were inspected for the presence of tags, representing 29 % by weight of the reported landings. Of these, 1662 were measured for fork length, 1324 for gutted weight and 668 for whole weight (Table 5.1.2.1). Scales samples were taken from 1683 salmon for age and origin determination and tissue was removed from 1671 for DNA analysis and subsequently used for assignment of continent of origin. In addition the sex of 426 fish was identified from gonadal examination. Of the 23 adipose finclipped fish recovered four of these had either external or internal tags. In addition, nine tags were submitted to the Nature Institute by local fishers from unsampled fish. The overall breakdown therefore was four coded wire tags and nine streamer/Carlin tags; three from Norway (two of these from East Greenland), one from the US and the five remaining tags were from Canada.

Non-reporting of harvest becomes evident when reported landings are compared with the sample data. Since 2002 the sampling team has seen more fish than were reported as being landed onwards, in at least one of the divisions where international samplers were present. When there is this type of weight discrepancy, the reported landings are adjusted according to the weight of sampled fish and these adjusted landings are used for all subsequent assessments. In 2009 this occurred only at Nuuk. The total discrepancy equaled 2479 kg and the adjusted catch used in the assessment for West Greenland was 28.0 t (Table 5.1.2.2).

The average weight and length of fish from the 2009 catch was 3.5 kg across all ages and 66 cm fork length, with North American 1SW fish averaging 64.9 cm and 3.28 kg whole weight and European 1SW salmon averaging 65.5 cm and 3.40 kg (Table 5.1.2.3). The mean lengths and mean weights for the 2009 samples are larger than the 2007 and 2008 values, but remain close to the previous 10 year mean. It should be noted that the size data is not adjusted for standard week and may not represent a true increase.

North American salmon up to river age six were caught at West Greenland in 2009, with over 93% of the fish being of river-ages 2 to 4, river-age 3 fish were 47.3% of the total (Table 5.1.2.3). The river ages of European salmon ranged from 1 to 4 years. About 60% of the European fish in the catch were river-age 2 and 23.8% were river-age 3 (Table 5.1.2.3). The percentage of the European origin river age 1 salmon (14.3%) was higher than in 2008 (7.0%).

In 2009, the North American samples were 93.4% 1SW salmon, 2.8% 2SW (the highest value in 12 years) and 3.8% previous spawners (Table 5.1.2.3). The European samples were 89.4% 1SW salmon, 7.6% 2SW (the highest in the time series) and 3.0% previous spawners (Table 5.1.2.3).

As part of the sampling, a total of 417 individuals were sexed by gonadal examination. The sex ratio was 14.1% males (n=59) to 85.9% females (n=358) and 9 individuals were classified as unknown sex.

Enhanced Sampling Programme (SALSEA Greenland)

In addition to the Baseline Sampling Program described above, an Enhanced Sampling Programme (SALSEA Greenland) was developed to conduct broader and more detailed sampling on a fixed number of fish harvested from the waters off West Greenland. The Enhanced Sampling was designed to be integrated within the International Sampling Program's infrastructure. Fresh whole fish were purchased directly from individual fishers and these were used in both the International Sampling Program as well as a more detailed and enhanced sampling program.

A total of 412 fresh whole fish were purchased directly from individual fishers. These fish underwent the Enhanced Sampling process and all carcasses were returned to the local community where sampling took place. These fish were part of the nominal catch and not an additional catch from the fishery.

Origin of the catches

Of the 1671 samples collected for genetic characterisation, 1621 were genotyped at between seven and ten microsatellites and assigned to a continent of origin. Apart from 17 samples which could not be genotyped, there were 33 samples collected late in the season which were not available at the time for genotyping but will be included in an update of the database in 2010. In total, 91.5% of the salmon sampled from the 2009 fishery were of North American origin and 8.5% fish were of European origin.

The division-specific and overall continent of origin assignments for the samples collected in 2009 are listed below. Applying the continental percentages for the NAFO division catches (excluding the reported harvest from East Greenland) resulted in estimates of 23 t of North American origin and 2.6 t of European origin fish (7000 and 800 rounded to the nearest 100 fish, respectively) landed in West Greenland in 2009.

CONTINENTAL PERCENTAGES BY NAFO DIVISION OF CATCHES AT WEST GREENLAND
NA = NORTH AMERICA, E = EUROPE

2009		Numbers			Percentages	
NAFO Div	Sample dates	NA	E	Totals	NA	E
1B	Aug 27 - Oct 10	601	44	645	93.2	6.8
1C	Sept 21 - Sept 23	35	6	41	85.4	14.6
1D	Aug 17 - Oct 15	619	33	652	94.9	5.1
1F	Aug 13 - Sept 10	228	55	283	80.6	19.4
Total		1483	138	1621	91.5	8.5

ICES recommends a continuation and expansion of the broad geographic sampling program (multiple NAFO divisions) to more accurately estimate continent of origin in the mixed stock fishery.

5.2 NASCO has requested ICES to provide clarification of the levels of reported and unreported catch in the subsistence fishery since 2002

The salmon fishery is currently regulated according to The Government of Greenland Executive Order no. 21 of August 10, 2002. Landings to fish plants, sale of salmon to shops, and any export of salmon from Greenland were forbidden. However, licensed fishers were allowed to sell salmon at the open markets, to hotels, restaurants and institutions and unlicenced fishers could fish for their own consumption. Only hook, gillnet, and drift net are allowed and minimum mesh size is 140 mm stretched. People participating in the salmon fishery are required to report all catches of salmon to the Greenland Fisheries Licence Office (GFLK) immediately after the fishery has taken place.

5.2.1 Reported catches

There are two types of catch reports. One report is for fish caught for personal use and it must contain information on the identity of the fisherman, number of salmon caught, gutted weight (including the head) and community of the individual. The other report covers situations where the catch is sold, and requests information on identity of the fisherman, number of salmon caught, gutted weight (including the head), community, landing site, vessel number and vessel size. Both reports also request a date and signature although the date may not necessarily be the date when the fishery took place. None of the reports requires reporting the effort (number of nets and hours fishing), where the fishery took place, or where the catch was sold.

The data provided by GFLK are screened for data errors and missing values have been filled in whenever possible based on available information. Catches have been assigned to NAFO/ICES area by community, and also the number of licenses per community has been estimated from addresses from the license list. Some reports only contain either a number or a weight of the salmon caught, and these missing data have been adjusted by a standard gutted weight of 2.75 kg.

The statistics obtained are limited due to the current reporting system. Also, a large proportion of the fishers may not be inclined to report every time they have had their nets in the water and instead they only report once at the end of the season. The problem is partially caused by the fact that only reporting date is requested on the report form, and not the catch date.

ICES supports the proposal from the Greenlandic authorities for the establishment of a logbook programme which is a condition of the licencing system for the salmon fishery at west Greenland. Such a logbook or equivalent reporting form, should also request effort information such as, catch site (field code, GPS or fjord), catch date, number of nets, net length, mesh size and number of hours the gillnet has been fishing, so that a more accurate CPUE index can be developed.

5.2.2 Unreported catches

An unreported catch will always occur and this may be due to the scattered nature of this fishery. Information campaigns have been launched to encourage people to apply for a license and report their catches. The present increase in reported catches, issued licenses and number of people reporting their catches, may therefore reflect an increased awareness in the population and the success of these campaigns. It is therefore impossible to say whether the observed increase in salmon catches is a true increase or the result of a decrease in unreported catch.

The unreported catch has previously been estimated as 10 t. A large proportion of the catches reported as being for private consumption are however reported by licensed fishers. Of the 26 t reported in 2009, 22 t (83.5%) were reported by licensed fishers as either sold or private. Furthermore, a large proportion of the remaining 4.3 t salmon reported as being for private consumption by unlicensed fishers may still be caught by professional hunters and fishers who forgot to apply for a license or were unaware that a license is required. This suggests that the vast majority of reported harvest caught in Greenland is taken by professional hunters and fishers.

5.2.3 Summary of sources of uncertainty in the reported catches for the Greenland fishery since 2002.

There are distinct groups allowed to partake in a fishery at Greenland.

Commercial fishers

This group of fishers require a licence if they wish to sell their catch and they are required to report this catch.

- While the number of commercial fishers who obtain a licence is known, their reported catches may only be partial. Although they are obliged to report all of the catch which they sell, it is unclear to what level this sector is reporting.
- Commercial fishers are obliged to report any catch they take for personal consumption. It is unclear as to the level of unreported catch from this source.
- The commercial fishers are supposed to obtain a licence to fish but not all commercial fishers do so. Again, the level of unreporting in this situation is unclear.

Private fishers

Anybody in Greenland can fish for salmon if it is for private consumption and they are required to report this catch.

- The number of individuals who fish privately for salmon is not known.
- The accuracy of the reporting by the private fishers is uncertain.
- The catch by private fishers sector is largely unknown.

Adding to the uncertainty in estimating the catch is the situation whereby reports received by the authorities are not always correctly filled in and this may lead to a loss of catch information.

ICES notes that there are several sources of unreported landings that remain unquantified but which might be estimated provided that basic catch returns are provided to authorities by all fishers both commercial and private. It is also essential that the total number of commercial and private fishers is known. Similarly, in order to verify the returns, a follow up mechanism where some or all of the data can be verified would be required to ensure that the data being received are accurate.

Table 5.1.1.1 Nominal catches of salmon, West Greenland 1971 to 2009 (metric tons round fresh weight).

YEAR	TOTAL	QUOTA	COMMENTS
1971	2689	-	
1972	2113	1100	
1973	2341	1100	
1974	1917	1191	
1975	2030	1191	
1976	1175	1191	
1977	1420	1191	
1978	984	1191	
1979	1395	1191	
1980	1194	1191	
1981	1264	1265	Quota set to a specific opening date for the fishery
1982	1077	1253	Quota set to a specific opening date for the fishery
1983	310	1191	
1984	297	870	
1985	864	852	
1986	960	909	
1987	966	935	
1988	893	840	Quota for 1988–1990 was 2520 t with an opening date of August 1. Annual catches were not to exceed an annual average (840 t) by more than 10%. Quota adjusted to 900 t in 1989 and 924 t in 1990 for later opening dates.
1989	337	900	
1990	274	924	
1991	472	840	
1992	237	258	Quota set by Greenland authorities
1993		895	The fishery was suspended
1994		137	The fishery was suspended and the quotas were bought out
1995	83	77	
1996	92	174	Quota set by Greenland authorities
1997	58	57	
1998	11	206	
1999	19	206	
2000	21	206	
2001	43	114	Final quota calculated according to the ad hoc management system
2002	9	55	Quota bought out, quota represented the maximum allowable catch (no factory landing allowed), and higher catch figures based on sampling programme information are used for the assessments
2003	9		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments
2004	15		same as previous year

Table 5.1.1.1 cont'd Nominal catches of salmon, West Greenland 1971 to 2009 (metric tons round fresh weight).

YEAR	TOTAL	QUOTA	COMMENTS
2005	15		same as previous year
2006	22		Quota set to nil (no factory landing allowed) and fishery restricted to catches used for internal consumption in Greenland
2007	25		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments
2008	26		same as 2007
2009	26		same as 2007

Table 5.1.1.2 Distribution of nominal catches (rounded to nearest metric tonne) by Greenland vessels (1977 to 2009).

	NAFO Division							West	East	Total
Year	1A	1B	1C	1D	1E	1F	NK	Greenland	Greenland	Greenland
1977	201	393	336	207	237	46	-	1420	6	1426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1395	+	1395
1980	52	275	404	231	158	74	-	1194	+	1194
1981	105	403	348	203	153	32	20	1264	+	1264
1982	111	330	239	136	167	76	18	1077	+	1077
1983	14	77	93	41	55	30	-	310	+	310
1984	33	116	64	4	43	32	5	297	+	297
1985	85	124	198	207	147	103	-	864	7	871
1986	46	73	128	203	233	277	-	960	19	979
1987	48	114	229	205	261	109	-	966	+	966
1988	24	100	213	191	198	167	-	893	4	897
1989	9	28	81	73	75	71	-	337	-	337
1990	4	20	132	54	16	48	-	274	-	274
1991	12	36	120	38	108	158	-	472	4	476
1992	-	4	23	5	75	130	-	237	5	242
1993 [1]	-	-	-	-	-	-	-	-	-	-
1994 [1]	-	-	-	-	-	-	-	-	-	-
1995	+	10	28	17	22	5	-	83	2	85
1996	+	+	50	8	23	10	-	92	+	92
1997	1	5	15	4	16	17	-	58	1	59
1998	1	2	2	4	1	2	-	11	-	11
1999	+	2	3	9	2	2	-	19	+	19
2000	+	+	1	7	+	13	-	21	-	21
2001	+	1	4	5	3	28	-	43	-	43
2002	+	+	2	4	1	2	-	9	-	9
2003	1	+	2	1	1	5	-	9	-	9
2004	3	1	4	2	3	2	-	15	-	15
2005	1	3	2	1	3	5	-	15	-	15
2006	6	2	3	4	2	4	-	22	-	22
2007	2	5	6	4	5	2	-	25	-	25
2008	5	2	10	2	2	5	-	26	-	26
2009	0	6	7	3	4	5	-	25.5	0.8	26

[1] The fishery was suspended

+ Small catches <0.5 t

- No catch

Table 5.1.2.1. Size of biological samples and percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969 to 1982) from commercial samples (1978 to 1992, 1995 to 1997 and 2001) and from local consumption samples (1998 to 2000 and 2002 to 2009).

		Sample Size			Continent of origin (%)			
Source		Length	Scales	Genetics	NA	(95%CI)[1]	E	(95%CI)[1]
Research	1969	212	212		51	(57,44)	49	(56,43)
	1970	127	127		35	(43,26)	65	(75,57)
	1971	247	247		34	(40,28)	66	(72,50)
	1972	3488	3488		36	(37,34)	64	(66,63)
	1973	102	102		49	(59,39)	51	(61,41)
	1974	834	834		43	(46,39)	57	(61,54)
	1975	528	528		44	(48,40)	56	(60,52)
	1976	420	420		43	(48,38)	57	(62,52)
	1978[2]	606	606		38	(41,34)	62	(66,59)
	1978[3]	49	49		55	(69,41)	45	(59,31)
	1979	328	328		47	(52,41)	53	(59,48)
	1980	617	617		58	(62,54)	42	(46,38)
	1982	443	443		47	(52,43)	53	(58,48)
Commercial	1978	392	392		52	(57,47)	48	(53,43)
	1979	1653	1653		50	(52,48)	50	(52,48)
	1980	978	978		48	(51,45)	52	(55,49)
	1981	4570	1930		59	(61,58)	41	(42,39)
	1982	1949	414		62	(64,60)	38	(40,36)
	1983	4896	1815		40	(41,38)	60	(62,59)
	1984	7282	2720		50	(53,47)	50	(53,47)
	1985	13272	2917		50	(53,46)	50	(54,47)
	1986	20394	3509		57	(66,48)	43	(52,34)
	1987	13425	2960		59	(63,54)	41	(46,37)
	1988	11047	2562		43	(49,38)	57	(62,51)
	1989	9366	2227		56	(60,52)	44	(48,40)
	1990	4897	1208		75	(79,70)	25	(30,21)
	1991	5005	1347		65	(69,61)	35	(39,31)
	1992	6348	1648		54	(57,50)	46	(50,43)
	1995	2045	2045		68	(72,65)	32	(35,28)
	1996	3341	1297		73	(76,71)	27	(29,24)
	1997	794	282		80	(84,75)	20	(25,16)
Local consumption	1998	540	406		79	(84,73)	21	(27,16)
	1999	532	532		90	(97,84)	10	(16,3)
	2000	491	491		70		30	
Commercial	2001	4721	2655		69	(71,67)	31	(33,29)
Local consumption	2002	501	501	501	68		32	
	2003	1743	1743	1779	68		32	
	2004	1639	1639	1688	73		27	
	2005	767	767	767	76		24	
	2006	1209	1209	1193	72		28	
	2007	1116	1110	1123	82		18	
	2008	1854	1866	1853	86		14	
	2009	1,662	1,683	1,671	91		9	

[1] CI - confidence interval calculated by method of Pella and Robertson (1979) for 1984 -86 and binomial distribution for the others.

[2] During 1978 Fishery

[3] Research samples after 1978 fishery closed

Table 5.1.2.2. Reported landings by NAFO Division of Atlantic salmon provided by the Home Rule Government for the fisheries at West Greenland, 2002 to 2009. Adjusted landings are calculated for divisions where the sampling teams observed more fish landed than were reported.

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

Table 5.1.2.3 Biological characteristics of Atlantic salmon sampled during the 2009 West Greenland Atlantic salmon fishery. NA = North America, E = Europe.

River age distribution (%) by continent of origin								
	1	2	3	4	5	6	7	8
NA	2.6	30.7	47.3	15.4	3.7	0.4	0	0
E	14.3	59.5	23.8	2.4	0.0	0	0	0

Length and weight by origin and sea age.								
	1SW		2SW		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	64.9	3.28	84.6	7.59	75.9	5.25	64.7	3.67
E	65.5	3.40	81.7	6.54	73.5	4.28	64.1	3.50

Sea age composition (%) by continent of origin			
	1SW	2SW	Previous Spawners
NA	93.4	2.8	3.8
E	89.4	7.6	3

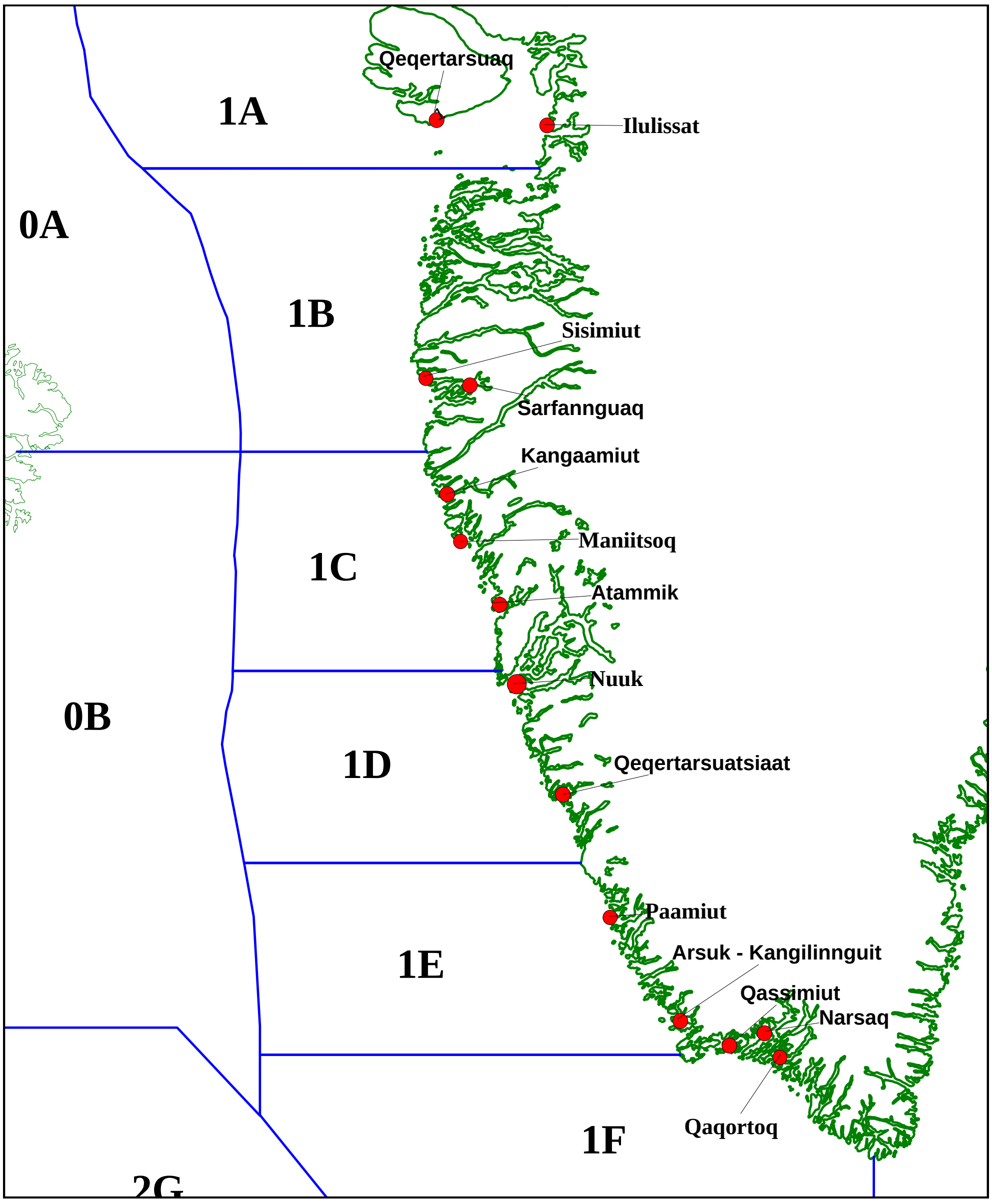


Figure 5.1.2.1. Location of NAFO divisions along the coast of West Greenland.

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

ICES recommends that The Working Group meet in 2011 to address questions posed by ICES, including those posed by NASCO. The Working Group intends to convene in the headquarters of the ICES in Copenhagen, Denmark from 29 March to 7 April 2011.

List of recommendations

1) ICES recommends that the Study Group on Salmon Stock Assessment and Forecasting (SGSSAFE) meet to continue the efforts to develop the models formulated for the NAC and NEAC areas, particularly with regard to combining sea age classes, to incorporating environmental variables, and in the spatial disaggregation below the stock complex level. The Study Group should report back to ICES in April 2011.
2) ICES recognised the value of the work completed by SGBICEPS and that the Study Group had been constrained by the lack of wider representation and the difficulties of involving oceanographers. ICES noted the ongoing efforts of the Study Group with regard to developing peer-reviewed outputs and recommended that the data sets collated by the Study Group should be fully utilised and made available to the Working Group in support of further analyses as appropriate.
3) ICES endorsed the recommendations made by WKLUSTRE, which include: long-term storage of the tag databases so that the data are not lost; the reports of the three Workshops on salmon tagging data (WKDHUSTI, WKSHINI, WKLUSTRE) should be combined into a single ICES Cooperative Research Report; and the peer-reviewed publication of these results.
4) ICES recommends that efforts be initiated to transfer and archive in the ICES Data Centre the numerous data sets on Atlantic salmon biological characteristics which have been assembled over the over 30 years of sampling the fisheries at West Greenland, tagging data set from international waters and any other international databases which would be of interest to the Working Group and others in the scientific community.
5) ICES supports the proposal from the Greenlandic authorities for the establishment of a logbook program for commercial and private fishers in the salmon fishery at West Greenland. Additional data to help characterize the nature and extent of the fishery should include catch location, catch date, numbers of nets, net dimensions, and numbers of hours the nets were fished.
6) ICES recommends the continuation of the broad geographic sampling program (multiple NAFO divisions) to more accurately estimate continent of origin in the mixed stock fishery at West Greenland. The Enhanced Sampling Programme undertaken in 2009 should be repeated in 2010.
7) ICES recommends that the sampling program conducted in the Labrador subsistence fishery during recent years and which provided biological characteristics of the harvest material to assess the origin of salmon be continued and expanded in 2010 and future years.

8) ICES recognises that river specific, regional and international management requires extensive monitoring and recommends expanded monitoring programmes across all stock complexes.

9) ICES notes that factors other than fishing are currently constraining and, in some areas, threatening with extirpation populations of Atlantic salmon throughout the North Atlantic. Factors acting in both the freshwater and marine environment are of concern. A review of successes and failures in wild salmon restoration could lead to a classification of activities which could be recommended under various conditions or threats to the persistence of populations. Such a classification would be of benefit to management tasked with rebuilding and restoration actions. Such a review could be undertaken by a Study Group.

Annex 1 Glossary of acronyms used in this report

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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

WKSHINI (*Workshop on Salmon historical information-new investigations from old tagging data*) The Workshop is set to meet from 18–20 September 2008 in Halifax, Canada.

WKLUSTRE *(Workshop on Learning from Salmon Tagging Records)* The ICES Workshop established to complete compilation of available data and analyses of the resulting distributions of salmon at sea. WKLUSTRE will report by 30 November 2009 for the attention of the WGNAS.

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