Extract of the Report of the Advisory Committee on Fishery Management

North Atlantic Salmon Stocks

to the North Atlantic Salmon Conservation Organization

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1 INTRODUCTION

This report has been produced by ICES in response to requests from the North Atlantic Salmon Commission (NASCO). The report has been prepared by the Advisory Committee on Fisheries Management on the basis of analysis undertaken by the Working Group on North Atlantic Salmon. This report represents summaries of background and conclusions regarding issues on which information has been requested. Details of the underlying analysis and detailed data are available in the report of the Working Group (ICES CM 2005/ACFM:17). The analysis undertaken and the advice given have been subject to independent peer review.

1.1 Requests from NASCO to ICES

NASCO has requested ICES to provide advice on the following issues (CNL(04)13). The section in which this request is addressed is indicated:

a) With respect to Atlantic salmon in the North Atlantic area:	Section 2
i. provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and worldwide production of farmed and ranched salmon in 2004;	2.1 and 2.2
ii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.3
iii. provide a compilation of tag releases by country in 2004;	2.4
iv. identify relevant data deficiencies, monitoring needs and research requirements.	6
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	Section 3
i. describe the key events of the 2004 fisheries and the status of the stocks;	3.9
ii. provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	3.10
iii. further develop the age-specific stock conservation limits where possible based upon individual river stocks;	3.3
iv. provide catch options or alternative management advice, if possible based on forecasts of PFA, for northern and southern stocks, with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding;	3.4, 3.6
v. provide an estimate of bycatch of salmon in pelagic fisheries.	3.11
c) With respect to Atlantic salmon in the North American Commission area:	Section 4
i. describe the key events of the 2004 fisheries and the status of the stocks;	4.9

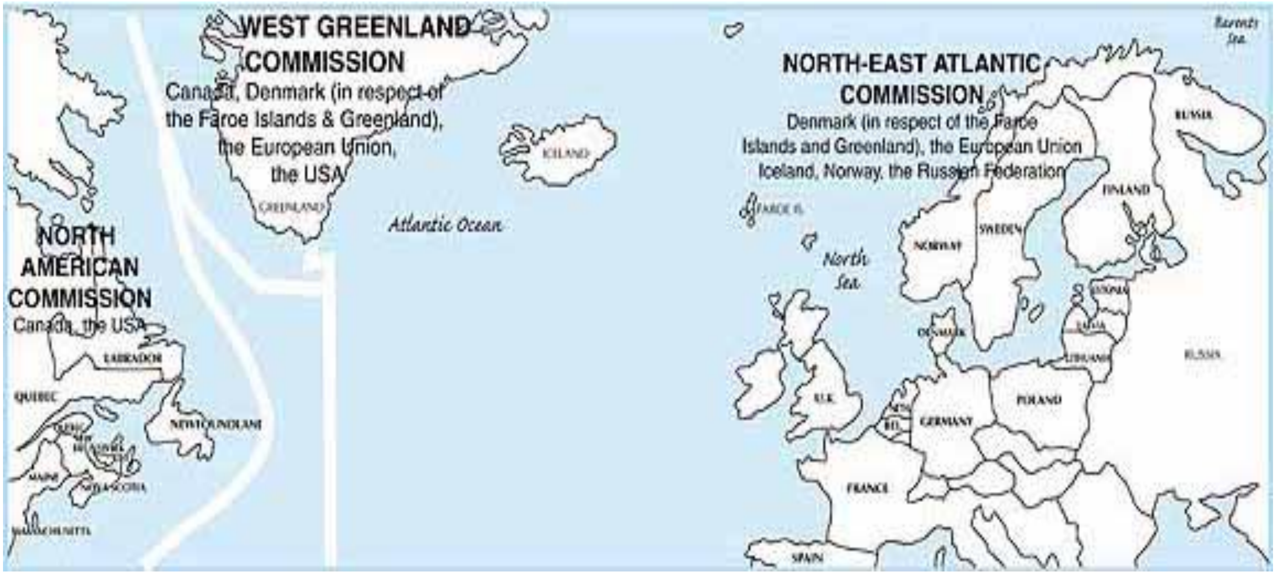
ii. provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	4.10
iii. update age-specific stock conservation limits based on new information as available;	4.3
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding;	4.4, 4.6
v. provide an analysis of any new biological and/or tag return data, to identify the origin and biological characteristics of Atlantic salmon caught at St. Pierre and Miquelon.	4.11
d) With respect to Atlantic salmon in the West Greenland Commission area:	Section 5
i. describe the events of the 2004 fisheries and the status of the stocks;	5.9
ii. provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;	5.11
iii. provide information on the origin of Atlantic salmon caught at West Greenland at a finer resolution than continent of origin (river stocks, country or stock complexes);	5.9.3
iv. provide catch options or alternative management advice 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.	5.4, 5.6
Notes: 1) *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.* 2) *In the responses to questions b.i, c.i and d.i 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 of salmon in any existing and new fisheries for other species is also requested.* 3) *In response to questions b.iv, c.iv and d.iv provide a detailed explanation and critical examination of any changes to the models used to provide catch advice.* 4) *In response to question d.i, 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.i and c.i.	

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. While sovereign states retain their role in the regulation of salmon fisheries for salmon originating from their own rivers, distant water salmon fisheries, such as those at Greenland and Faroes, which take salmon originating from rivers of another Party are regulated by NASCO under the terms of the Convention. NASCO now has seven Parties that are signatories to the Convention, including the EU which represents its Member States.

NASCO discharges these responsibilities via the three Commission areas shown below:



1.3 Management objectives

NASCO (NASCO CNL31.210) has identified the primary management objective of that organisation as:

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

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

NASCO'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), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted this definition of CLs (NASCO, 1998). Therefore, the CL is a limit reference point (S_{lim}) which should be avoided with high probability. Management advice for Atlantic salmon is referenced to the S_{lim} conservation limit, therefore stocks assessed here are reported as being outside precautionary limits when the confidence limits of the most recent stock estimate includes S_{lim}.

Management targets have not yet been defined for 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 mid-point is above, then ICES considers the stock to be at risk of suffering reduced reproductive capacity.
- Finally, when the mid-point 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 reference point (S_{pa}). 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 each salmon-producing country in the North Atlantic are given in Table 2.1.1.1 for the years 1960 to 2004. These catches (in tonnes) are illustrated in Figure 2.1.1.1 for four North Atlantic regions. Catch statistics in the North Atlantic also include fish farm escapees and, in some North-East Atlantic countries, also ranched fish. Reported catches for the three NASCO Commission Areas for 1996–2004 are provided below:

Area	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
NEAC	2750	2074	2225	2073	2736	2876	2495	2303	1922
NAC	294	231	159	154	155	150	150	144	162
WGC	92	59	11	19	21	43	9	9	15
Total	3135	2364	2396	2246	2913	3069	2654	2456	2099

The catch data for 2004 are provisional, but the total nominal catch of 2099 t is the lowest on record. Catches for most countries were below the recent 5- and 10-year averages, and in three countries were the lowest in the time-series.

The nominal catch (in tonnes) of wild fish in 2004 was partitioned according to whether the catch was taken in coastal, estuarine, or riverine fisheries. These are shown below for the NEAC and NAC Commission Areas. It was not possible to apportion the small Danish catches in 2004 and these have been excluded from the calculation. The percentages accounted for by each fishery varied considerably between countries. In total, however, coastal fisheries accounted for 50% of catches in North East Atlantic countries compared to 17% in North America, whereas in-river fisheries took 42% of catches in North East Atlantic countries compared to 66% in North America.

Area	**Coast**		**Estuary**		**River**		**Total**
	Weight	**%**	**Weight**	**%**	**Weight**	**%**	**Weight**
NEAC	967	50	137	7	815	42	1919
NAC	27	17	28	18	106	66	162

2.1.2 Catch and release

Catch and release data have been provided since the early 1990s by 6 countries. In 2004, the percentage of the total rod catch that was released ranged from 16% in Iceland to 76% in Russia. Catch and release rates have generally increased over the last decade. Overall, almost 144 000 salmon were reported to have been released in 2004, the highest in the time-series.

2.1.3 Unreported catches

The estimated unreported catch within the NASCO Commission Areas in 2004 was 686 t (Table 2.1.1.1), or 25% of the total catch (reported and unreported). Levels of unreported catch have declined over the past six years as a result of various measures. For example, the introduction of carcass tagging programmes in Ireland and UK (N. Ireland) has lead to reductions in unreported catches in these countries. After 1994 there are no available data on the extent of possible salmon catches in international waters. Limited surveillance flights, which were the basis of past estimates of catches in international waters, have not reported any such salmon fishing in recent years. Estimates (in tonnes) of unreported catches for the three Commission Areas for the period 1996–2004 are given below:

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

Expressed as a percentage of the total North Atlantic catch, unreported catch estimates range from 0% to 12% for individual countries. However, it should be noted that methods of estimating unreported catch vary both within and among countries. The non-reporting rates range from 1% to 57% of the total national catch in individual countries. An allowance for unreported catch is included in the assessments and catch advice for each Commission area.

2.2 Production of farmed and ranched salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area was 796 839 t in 2004, broadly similar to that in 2003 and 13% above the average of the previous five years. Most of the production in the North Atlantic took place in Norway (64%) and UK (Scotland) (22%).

World-wide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002. Total production in 2004 is provisionally estimated at over 1.1 million tonnes (Figure 2.2.1), similar to that in 2003. Production outside the North Atlantic is currently estimated to account for about 30% of the total farmed production, with Chile (261 000 t) contributing the largest proportion of the production in this area. World-wide production of farmed Atlantic salmon in 2004 was almost 550 times the reported nominal catch of Atlantic salmon in the North Atlantic. As a result, farmed salmon dominate world markets.

Catches of ranched salmon have declined substantially from a high of over 500 t in 1993 to around 12 t in 2004 (Figure 2.2.2). This is due to the cessation of salmon ranching in Iceland from 1999.

2.3 NASCO has asked ICES to report on significant developments which might assist NASCO with the management of salmon stocks

2.3.1 Update on the estimation of natural mortality at sea of Atlantic salmon

ICES examined further datasets for evidence of changes in M for NAC and NEAC Atlantic salmon stocks, particularly in the second year at sea. The reviews of natural mortality undertaken by ICES in 2002 to 2004 were motivated by concerns about whether the value for natural mortality (M) assumed in the run reconstruction models was appropriate (ICES, 2002, 2003, 2004a). In 2005, ICES reviewed further data from NAC and NEAC stocks to examine for trends in M over time and among stocks.

There was no evidence in the analyses presented that marine mortality had declined and in some stocks from both NAC and NEAC areas, there was an indication that mortality had increased (Figure 2.3.1). In the northern and southern NEAC areas, both wild and hatchery smolts show a constant decline in marine survival over the last two decades, with the sharpest decline in the wild smolts of the southern NEAC area. Similar declines in return rates of hatchery and wild salmon to the NAC area were also reported and return rates of recent years were low compared to historic levels. Return rates of maiden salmon to repeat spawning in some monitored stocks has increased over the last decade suggesting that the mortality factors affecting smolts and non-maturing salmon in the second year may be different from those interacting with the larger repeat spawning fish.

These analyses confirmed the previous conclusion that monthly mortality in the second year at sea was greater than 1% and distributed around 3% for the wild fish.

2.3.2 Progress in developing precautionary catch advice for Irish salmon fisheries

In 2004 and 2005, the precautionary catch advice for Irish fisheries was modified to take account of the risk of not achieving fisheries management objectives (conservation limits in all rivers within a district), uncertainty in biological reference points (i.e. sex ratio and required egg deposition), and the formulation of pre-agreed management actions in the form of procedures to be applied over a range of stock conditions (harvest guidelines). The harvest level corresponding to a desired probability of meeting the CL can be interpolated from risk plots.

The following harvest guidelines (illustrated using fishery districts) apply to the catch advice:

- Generally, the harvest option providing a 75% chance of meeting the CL in a given district is chosen as the precautionary catch advice (Figure 2.3.2.1).
- In following a precautionary approach, increases over the average catch for the period 2000 to 2004 should not be permitted even if the harvest option at the 75% probability of meeting the CL is higher. This is because each district fishery catches salmon destined for other districts and there is clearly a need to protect vulnerable stocks in these other districts. This advice will be reviewed annually to assess any improvement in the status of these vulnerable stocks (Figure 2.3.2.2).
- Where there is no harvest option which will provide a 75% chance of meeting the district CL, then the precautionary catch advice is that there is no surplus of fish to support a harvest (commercial or rod). This is illustrated in Figure 2.3.2.3.

This advice is predicated on wild fish only (i.e. estimated returns from hatchery-released smolts have been removed). It also relates to the total removal of fish by all means, and is not restricted to commercial fisheries. There are eight districts, mainly located on the east and south coasts, where the CL will probably not be met even in the absence of harvests of salmon. A further six districts reductions in the average catch in 2005 would be required if there is to be a 75% chance of meeting the CL. The remaining districts are meeting or exceeding their CLs. In this instance, the average catch is advised for 2005, even where the harvest option providing a 75% chance of meeting the CL is higher. This recognizes the fact that these fisheries intercept salmon destined for districts that are below their CL. The status of these districts will be assessed on an ongoing basis, and the advice will change in line with any significant and consistent improvement in stock size. The maximum harvest by all methods being recommended is 122 541 one-sea winter salmon for the 2005 season.

2.3.3 Catch and release

The practice of catch and release in salmon rod fisheries has become a common management/conservation measure. In some areas of Canada and USA, anglers have been required to practice catch and release since 1984. More recently it has also been widely used in many

NEAC countries both as a regulation and a voluntary practice. In 2004, anglers reported releasing almost 144 000 salmon around the North Atlantic, the highest number in the time-series.

A probabilistic method to predict the risk of mortality for caught and released salmon from the Penobscot River USA was reviewed. Simulations drawing from a random binomial function for temperature dependent mortality (i.e. 0.05 to 0.30 for temperatures greater than 20^{o}C) were done to calculate the number of hooked and released fish that died. The resulting distribution described the mortality losses from reported numbers of caught and released salmon. The simulations suggest that mortality following capture can be low. A recent radio tracking study in northwest England found that upwards of 85% of released spring salmon can be expected to survive to spawning (UK Environment Agency, 2003).

The survivors of catch and release angling are vulnerable to being hooked again. Additional information from rod fisheries on four Icelandic rivers documented that 24.4% (range: 22.1-27.8%) of salmon were captured for a second time. Salmon captured a third time were rare (1.8%). Exploitation rates in these rivers range from 45% to 60%. These results provide a means for adjusting the catch and release statistics to account for multiple recapture in these rivers and potentially for Iceland as a whole.

2.3.4 Regional growth patterns

Systematic collection of salmon scales from anglers' catches has been carried out in seven rivers in Norway. Back-calculated growth of the first year at sea of 1SW fish was systematically lower than that of MSW fish of the same smolt year class in all rivers. For six of the seven river stocks, the first year growth of 1SW and MSW fish of the same smolt year class was significantly correlated.

Growth of salmon the first year at sea varied among years and stocks, with a systematic trend for slower growth in salmon originating from Northern latitudes. There were significant correlations in growth between salmon originating from nearby rivers, whereas growth in more distant stocks were less correlated.

The marine growth of the four most northerly salmon stocks was significantly correlated with the mean sea temperature at 50-m depth in the Norwegian Sea (66°N; 2°E) and mean temperature in the 0–50 m layer in the Barents Sea (70°30'N–72°30'N; 33°30'E) during July–December. However, the most northerly populations were more strongly correlated with temperatures in the north than with temperatures in the southern area. Growth of salmon from rivers in mid-Norway showed the highest correlation with temperatures in the Norwegian Sea. Salmon growth from the three most southern rivers was not correlated with temperatures at any of the two areas.

Further support to the regional grouping of rivers is provided by analyses from three subarctic rivers running to the Barents Sea within a small geographic area in northeastern Europe. Salmon from the rivers Teno/Tana (Finland and Norway), Näätämöjoki/Neidenelva (Finland and Norway), and Kola (Russia) showed significant temporal synchrony in marine growth and variation in abundance, and these variables were also significantly correlated with the sea water temperature in the Barents Sea.

These findings support the contention that PFA should be developed at a regional scale. In the case of Norwegian stocks, at least two regions should be established, divided by the Lofoten Islands at a latitude of 68°N.

2.3.5 Long-term projections for stock rebuilding

In 2004, ICES advised that further stock rebuilding projections should reflect declining stock trajectories and population viability given that the probability of rebuilding in the short term is low in most areas and that the main result of recent management measures may have been to reduce this rate of decline rather than lead to any significant stock rebuilding.

2.3.5.1 Long-term projections of PFA for North America

Seven different types of regression models have been used to relate lagged spawners (LS) and Pre-Fishery Abundance for North America ($PFA_{NA,}$ Section 5.10). Some of these allow for a "regime shift" in the relationship identified by ICES (ICES, 2003), whereby early years in the time-series demonstrate higher PFA per lagged spawner while the more recent years demonstrate lower PFA per lagged spawner. The LS value for the current year is used to predict a distribution of the expected PFA_{NA} in the current year which is used to provide catch advice for the upcoming fishing season in West Greenland. However, medium-term (up to 5 years) and long-term (up to 20 years) projections have not been developed to date. Therefore ICES has adapted and extended the analysis in Section 5.10 to complete the cycle over a longer time period to examine potential long-term trajectories in stock size. The only new assumption made is that the allocation by region of surviving fish after the West Greenland fishery in year t is proportional to the distribution of the lagged spawners by region that produced the predicted PFA_{NA} for that year. This additional assumption allows medium- and long-term predictions for PFA_{NA} to be made, demonstrating directly the implications of the different relationships between LS and PFA_{NA} and also providing a basis for comparison with the simple Population Viability Analysis (PVA) results presented to ICES in 2004 (ICES, 2004a).

PFA projections were made assuming either no fishing, or that a fishery occurs in West Greenland at 20, 50, or 100 t annually for the next 20 years, and that all home river fisheries are stopped (Figure 2.3.5.1). The harvest in tonnes was converted to numbers of fish and split between North America and Europe following the standard approach. In all three West Greenland harvests considered, PFAs from the high phase projections were essentially the same with large increases up to an *ad hoc* cap of five million fish. In contrast, PFA from the low phase projections showed a strong response to West Greenland harvest, with a continued harvest of 100 tonnes causing the median PFA to decline to zero by 2013 (Figure 2.3.5.1). The overlap of medians for the first five years of projections is due to the fact that the lagged spawners that produced these PFA values come from spawners that are already back in the river for most SFAs. Thus, there is no feedback from the cycling nor from forecast catches in West Greenland in this period.

These results demonstrate that medium- to long-term forecasts of PFA depend most on the phase used for projections. The PFA is much more resilient to fishing when in the high phase than when in the low phase. The ability to detect a switch from the current low phase to the high phase depends on future PFA estimates from observed returns that are much higher than expected from the low phase model. A single observation is not sufficient to claim that a change in phase has occurred, multiple years in the high phase will be required. There is a time lag between observing large PFA and the feedback through the cycle to generate higher returns, spawners, and PFA that needs to be considered when making management decisions.

2.3.5.2 Potential for rebuilding two multi-sea-winter salmon stocks of the Maritime Provinces

Catch advice for the management of the West Greenland fishery and the management of NAC homewater fisheries (ICES, 2003) has been provided on the basis of achieving conservation objectives of the four northern regions (Labrador, Newfoundland, Quebec, and Gulf) and an alternate objective for the southern regions of achieving at least a 10% increase or a 25% increase relative to the average returns to the regions during a specified time period (Chaput *et al.*, 2005). In this regard it is presumed that stocks in these areas have the potential to rebuild if adequate spawning occurs. The stock status and potential for rebuilding of two multi-sea-winter salmon stocks (Mirimichi and Saint John rivers) of the Maritime Provinces of eastern Canada were examined in this context.

For a population to replace itself, one egg in the recruitment is required for every egg spawned. For the Miramichi River, the wild salmon stock produced maiden fish recruitment surplus to spawners for most year classes between 1971 and 1989, but was consistently below replacement for the 1990 to 1997 year classes. The eggs in the maiden returns of the 1998 year class (the last year where an assessment was possible) are estimated to have been equivalent to the eggs which were spawned. For the Saint John River, wild salmon production had varied around the replacement line for the 1972 to 1988 year classes but decreased sharply and remained well below replacement for the 1989 to 1999 year classes.

There has been a decline in the proportion of the eggs produced in the lifetime of the year class by maiden MSW salmon of the Miramichi River. For the 1981 and subsequent year classes, the lifetime egg production from MSW maiden salmon amounts to about 50% of the lifetime production of the year class. This is a decline from the previous time period and parallels a decline in 2SW maiden salmon abundance and an increase in the repeat spawner abundance. This contrasts with the Saint John River stock in which the MSW maiden salmon continue to contribute over 80% of the eggs in the lifetime of the year class, with a slight decline for the recent three year classes.

Calculations of replacement ratio indicate that the Miramichi River population had the potential historically to produce a surplus of maiden egg production. In the recent decade, maiden egg production (i.e. recruit egg production) has been well below replacement for a time period when spawner egg depositions exceeded the conservation requirements by 50% to 100%. With a decline in egg depositions, returns of maiden fish have resulted in at least the replacement of the parental stock and the potential for increased returns appear feasible. An examination of the spawners to recruits indicated that there was a greater chance that the recruitment will be less than the spawners when egg depositions exceed 150 million eggs (equivalent to 2.7 eggs m^{-2}) than when egg depositions were less than 150 million.

The prognosis for the Miramichi remains positive. Marine return rates of 1SW and 2SW maiden salmon appear sufficient to replace the eggs that produced them. Size-at-age has increased, such that every female now has the potential to produce more eggs, there is a high survival to second and third spawning, and the interstage survival of the juvenile stages have not changed over time.

In contrast, the Saint John River population has failed to achieve replacement ratio throughout the time-series. For the last ten year classes, the eggs from the returns of maiden salmon have been substantially below replacement. There are no positive changes in life history characteristics of this stock (e.g. increased size at age or proportion female, or increased survival of previous spawners) and it is likely that the stock will continue to decline.

The continued decline in the Saint John stock contrasted with the apparent rebuilding of the Miramichi stock suggests that the factors which contributed to the decline differ. The restriction in fisheries exploitation, both marine and freshwater, has not been sufficient to arrest the decline in salmon abundance in the Saint John River, whereas reductions in fisheries resulted in the Miramichi in increased spawning escapement and the production of juvenile salmon to record levels. Clearly, declines in stocks and sustained failures to achieve conservation limits may result from a number of factors which may be related or unrelated to insufficient stock abundance and exploitation patterns.

2.3.5.3 Catch advice and projected attainment of conservation limits for an Irish salmon fishing district

The theoretical recovery trajectories developed by ICES (2004a) were extended with a case study using data from an Irish district salmon fishery to examine the implications of current catch advice and other catch levels to the objective of meeting district conservation limits in subsequent years. Catch advice has been provided for this district based on 75% probability of achievement of the total conservation requirement for all 14 rivers in the district. Consequences of this catch level for individual rivers, along with the district as a whole were examined.

Obtaining recruits for seven years (the longest period required to obtain complete recruitment) initialized projections at the selected starting stock size before accumulating recruits for any trajectory. In the simulations, since the district is currently estimated to be at 63% of S_{opt}, (before exploitation in commercial and recreational fisheries) each river had its starting spawning stock sizes set to 63% of their S_{opt}. Although the 14 rivers had quite similar stock recruitment relationships on an eggs m^{-2} basis, they varied in size considerably. The CL for the individual rivers ranged from 67 to 13 646 fish, with three rivers accounting for 91% of the total of 39 164. Projections were run using either no catch or linear increases of catches from zero to 10 000, 20 000, or 50 000 fish. Forward simulations of 20 years were run 10 000 times in an @Risk© framework in Excel©. The current mean catch from the district (2000–2004) is just over 15 000 fish.

Forward simulations were applied, while maintaining the catch at 0, immediately resulting in a high probability (> 75%) of achieving the total district CL, which was maintained throughout the projected time-series (Figure 2.3.5.3.1). Linearly increasing catch from zero to 10 000 fish over 20 years produced a decrease in the probability of meeting the CL in the first few years, but this increased subsequently. Doubling this rate of increase initially caused a decrease in the probability of meeting the CL, followed by an increase, suggesting that this rate of increase could be sustained for a short period while rebuilding occurred. Within 10 years however, the probability of meeting the CL decreased significantly as the catch became too large relative to the available population. A catch option building to 50 000 over 20 years caused an immediate and consistent decline in the probability of meeting the CL.

The probability for the alternative management objective of achieving CL simultaneously for all 14 rivers increased significantly in the projection at zero catch, however, it was never higher than 65% (Figure 2.3.5.3.2). None of the other catch options provided a high probability of meeting the CLs. The apparent difficulty in meeting the CL in each river is due to:

- Uncertainties in input data, including s/r parameters.
- Surpluses in some rivers, which allow the district CL to be met, despite some individual rivers being below CL.

While the probability of achieving the CL in every river is a much more difficult management objective to achieve than the total CL objective, it is clearly desirable from a precautionary perspective.

This analysis provides some information about the implications of being below CL. In this example the district was 63% of its CL. In these simulations, where stocks have been below CL and when catches have been kept at zero for an initial seven-year period, it is possible to increase the advised catch as the stocks improve. However, these simulations show that rates of increase must be carefully managed. Clearly, the attainment of CL in all rivers simultaneously may be difficult to achieve but is still a desirable objective. Following rebuilding, if exploitation is close to the optimum exploitation rate (h_{opt}) annual assessments and catch advice are warranted. However, when stock status is fully satisfactory, and when fishing below optimum exploitation rates, continual assessments and annual catch advice may not be required.

2.3.5.4 DST- tagging of salmon in the Norwegian Sea

In an inter-Nordic study in which Data Storage Tags (DST) were applied to 406 pre-adult and adult salmon in the Norwegian Sea, 4 fish have to date been recovered in mid-Norway, and 1 fish was recovered in SW Sweden. DSTs were set to log depth and temperature at intervals varying from 1–120 minutes and yielded 439 days of observations. After an initial period of inactivity of 14–20 days, the five fish exhibited varying periods of intense diving (up to 150 m) during migration, until they presumably arrived in shallower coastal waters and entered the home river (e.g. salmon recovered in Sweden, Fig. 2.3.5.4.1). Further tags might still be returned from the 2005 fishing season.

These tags provide new insights to the behaviour of salmon at sea. These data can be used for assessing mean swimming depths and specifically time spent at depths where the fish may risk interception by pelagic fishing gear.

2.4 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2004

Data on releases of tagged, fin-clipped, and otherwise marked salmon in 2004 were provided by ICES and are compiled as a separate report. In summary (see Table 2.4.1), about 4.95 million salmon were marked in 2004, an increase from the 3.94 million fish marked in 2003. The adipose clip was the most used primary mark (3.49 million), with microtags (0.9 million) the next most common primary mark. Most marks were applied to hatchery-origin juveniles (4.83 million), while 110 461 wild juveniles and 17 899 adults were marked. ICES also reports information on various types of tags including DST, radio and/or sonic transmitting tags (pingers).

ICES noted that a number of commercial fish farms are applying tags to fish placed in sea cages. Two jurisdictions, USA-Maine and Iceland, require that some or all of the sea-cage farmed fish reared in their area are marked. In Maine some producers have opted for genetic ‘marking’ procedure. In Iceland, coded wire tags are being applied to about 10% of sea-cage farm produced fish, and are included in the tag compilation.

Table 2.1.1.1 **Nominal catch of salmon by country (in tonnes round fresh weight), 1960-2004. (2004 figures include provisional data).**

Year	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch	Sweden (West)	Den.	Finland	Ireland (4,5)	UK (E & W)	UK (N.Irl.) (5,6)	UK (Scotl.)	France (7)	Spain (8)	Faroes (9)	East Grld.	West Grld. (10)	Other (11)	Reported Nominal Catch	NASCO Areas	International waters (12)
1960	1,636	1	-	1,659	1,100	100		40	-	-	743	283	139	1,443	-	33	-	-	60	-	7,237	-	-
1961	1,583	1	-	1,533	790	127		27	-	-	707	232	132	1,185	-	20	-	-	127	-	6,464	-	-
1962	1,719	1	-	1,935	710	125		45	-	-	1,459	318	356	1,738	-	23	-	-	244	-	8,673	-	-
1963	1,861	1	-	1,786	480	145		23	-	-	1,458	325	306	1,725	-	28	-	-	466	-	8,604	-	-
1964	2,069	1	-	2,147	590	135		36	-	-	1,617	307	377	1,907	-	34	-	-	1,539	-	10,759	-	-
1965	2,116	1	-	2,000	590	133		40	-	-	1,457	320	281	1,593	-	42	-	-	861	-	9,434	-	-
1966	2,369	1	-	1,791	570	104	2	36	-	-	1,238	387	287	1,595	-	42	-	-	1,370	-	9,792	-	-
1967	2,863	1	-	1,980	883	144	2	25	-	-	1,463	420	449	2,117	-	43	-	-	1,601	-	11,991	-	-
1968	2,111	1	-	1,514	827	161	1	20	-	-	1,413	282	312	1,578	-	38	5	-	1,127	403	9,793	-	-
1969	2,202	1	-	1,383	360	131	2	22	-	-	1,730	377	267	1,955	-	54	7	-	2,210	893	11,594	-	-
1970	2,323	1	-	1,171	448	182	13	20	-	-	1,787	527	297	1,392	-	45	12	-	2,146	922	11,286	-	-
1971	1,992	1	-	1,207	417	196	8	18	-	-	1,639	426	234	1,421	-	16	-	-	2,689	471	10,735	-	-
1972	1,759	1	-	1,578	462	245	5	18	-	32	1,804	442	210	1,727	34	40	9	-	2,113	486	10,965	-	-
1973	2,434	3	-	1,726	772	148	8	23	-	50	1,930	450	182	2,006	12	24	28	-	2,341	533	12,670	-	-
1974	2,539	1	-	1,633	709	215	10	32	-	76	2,128	383	184	1,628	13	16	20	-	1,917	373	11,877	-	-
1975	2,485	2	-	1,537	811	145	21	26	-	76	2,216	447	164	1,621	25	27	28	-	2,030	475	12,136	-	-
1976	2,506	1	3	1,530	542	216	9	20	-	66	1,561	208	113	1,019	9	21	40	<1	1,175	289	9,327	-	-
1977	2,545	2	-	1,488	497	123	7	10	-	59	1,372	345	110	1,160	19	19	40	6	1,420	192	9,414	-	-
1978	1,545	4	-	1,050	476	285	6	10	-	37	1,230	349	148	1,323	20	32	37	8	984	138	7,682	-	-
1979	1,287	3	-	1,831	455	219	6	12	-	26	1,097	261	99	1,076	10	29	119	<0,5	1,395	193	8,118	-	-
1980	2,680	6	-	1,830	664	241	8	17	-	34	947	360	122	1,134	30	47	536	<0,5	1,194	277	10,127	-	-
1981	2,437	6	-	1,656	463	147	16	26	-	44	685	493	101	1,233	20	25	1,025	<0,5	1,264	313	9,954	-	-
1982	1,798	6	-	1,348	364	130	17	25	-	54	993	286	132	1,092	20	10	606	<0,5	1,077	437	8,395	-	-
1983	1,424	1	3	1,550	507	166	32	28	-	58	1,656	429	187	1,221	16	23	678	<0,5	310	466	8,755	-	-
1984	1,112	2	3	1,623	593	139	20	40	-	46	829	345	78	1,013	25	18	628	<0,5	297	101	6,912	-	-
1985	1,133	2	3	1,561	659	162	55	45	-	49	1,595	361	98	913	22	13	566	7	864	-	8,108	-	-
1986	1,559	2	3	1,598	608	232	59	54	-	37	1,730	430	109	1,271	28	27	530	19	960	-	9,255	315	-
1987	1,784	1	2	1,385	564	181	40	47	-	49	1,239	302	56	922	27	18	576	<0,5	966	-	8,159	2,788	-
1988	1,310	1	2	1,076	420	217	180	40	-	36	1,874	395	114	882	32	18	243	4	893	-	7,737	3,248	-
1989	1,139	2	2	905	364	141	136	29	-	52	1,079	296	142	895	14	7	364	-	337	-	5,904	2,277	-
1990	911	2	2	930	313	146	280	33	13	60	567	338	94	624	15	7	315	-	274	-	4,924	1,890	180-350

Table 2.1.1.1 continued

Year	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch	Sweden (West)	Den.	Finland	Ireland (4,5)	UK (E & W)	UK (N.Irl.) (5,6)	UK (Scotl.)	France (7)	Spain (8)	Faroes (9)	East Grld.	West Grld. (10)	Other (11)	Reported Nominal Catch	NASCO Areas	International waters (12)
1991	711	1	1	876	215	130	345	38	3	70	404	200	55	462	13	11	95	4	472	-	4,106	1,682	25-100
1992	522	1	2	867	167	175	461	49	10	77	630	171	91	600	20	11	23	5	237	-	4,119	1,962	25-100
1993	373	1	3	923	139	160	496	56	9	70	541	248	83	547	16	8	23	-	-	-	3,696	1,644	25-100
1994	355	0	3	996	141	141	308	44	6	49	804	324	91	649	18	10	6	-	-	-	3,945	1,276	25-100
1995	260	0	1	839	128	150	298	37	3	48	790	295	83	588	10	9	5	2	83	-	3,629	1,060	-
1996	292	0	2	787	131	122	239	33	2	44	685	183	77	427	13	7	0	0	92	-	3,135	1,123	-
1997	229	0	2	630	111	106	50	19	1	45	570	142	93	296	8	3	0	1	58	-	2,364	827	-
1998	157	0	2	740	131	130	34	15	1	48	624	123	78	283	8	4	6	0	11	-	2,396	1,210	-
1999	152	0	2	811	103	120	26	16	1	62	515	150	53	199	11	6	0	0	19	-	2,246	1,032	-
2000	153	0	2	1,176	124	83	2	33	5	95	621	219	78	274	11	7	8	0	21	-	2,913	1,269	-
2001	148	0	2	1,267	114	88	0	33	6	126	730	184	53	251	11	13	0	0	43	-	3,069	1,180	-
2002	148	0	2	1,019	118	97	0	28	5	93	682	161	81	191	11	9	0	0	9	-	2,654	1,039	-
2003	141	0	3	1,071	107	110	0	25	4	78	551	89	56	192	13	7	0	0	9	-	2,456	847	-
2004	159	0	3	784	82	130	0	19	4	39	474	108	47	209	19	7	0	0	15	-	2,099	686	-
Average																							
1999-2003	148	0	2	1,069	113	100	6	27	4	91	620	161	64	221	11	8	2	0	20	-	2,668	1,073	-
1994-2003	204	0	2	934	121	115	96	28	3	69	657	187	74	335	11	8	3	0	38	-	2,881	1,086	-

Key:

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches taken in the recently developed recreational (rod) fishery.
4. From 1994, includes increased reporting of rod catches.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Includes angling catch from 2002.
7. Data for France include some unreported catches.
8. Weights estimated from mean weight of fish caught in Asturias (80-90% of Spanish catch).
9. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place, the commercial fishery resumed in 2000, but has not operated between 2001 and 2004.
10. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
11. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
12. Estimates refer to season ending in given year.

Country	Origin	Primary Tag or Mark: Microtag	External mark	Adipose clip	Total
Canada	Hatchery	0	9,347	1,197,991	1,207,338
	Wild	1,073	31,639	4,565	37,277
	Adult	0	6,926	829	7,755
	Total	1,073	47,912	1,203,385	1,252,370
France	Hatchery	0	132,396	458,991	591,387
	Wild	0	28,346	891	29,237
	Adult	15	0	0	15
	Total	15	160,742	459,882	620,639
Germany	Hatchery	43,785	0	95,000	138,785
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	43,785	0	95,000	138,785
Iceland	Hatchery [1]	278,848	0	0	278,848
	Wild	3,090	0	0	3,090
	Adult	0	513	0	513
	Total	281,938	513	0	282,451
Ireland	Hatchery	392,635	0	0	392,635
	Wild	8,280	0	0	8,280
	Adult	0	0	0	0
	Total	400,915	0	0	400,915
Norway	Hatchery	14,127	54,820	0	68,947
	Wild	1,923	2,446	0	4,369
	Adult	0	282	0	282
	Total	16,050	57,548	0	73,598
Russia	Hatchery	0	0	1,077,620	1,077,620
	Wild	0	0	0	0
	Adult	0	2,402	0	2,402
	Total	0	2,402	1,077,620	1,080,022
Spain	Hatchery	76,160	974	140,326	217,460
	Wild	0	954	0	954
	Adult	0	0	0	0
	Total	76,160	1,928	140,326	218,414
Sweden	Hatchery	0	3,000	40,157	43,157
	Wild	0	552	0	552
	Adult	0	0	0	0
	Total	0	3,552	40,157	43,709
UK (England & Wales)	Hatchery	80,868	0	87,458	168,326
	Wild	9,682	2,800	1,906	14,388
	Adult	0	1,216	0	1,216
	Total	90,550	4,016	89,364	183,930
UK (N. Ireland)	Hatchery	17,436	0	47,610	65,046
	Wild	1784	0	0	1,784
	Adult	0	0	0	0
	Total	19,220	0	47,610	66,830
UK (Scotland)	Hatchery	11043	0	0	11,043
	Wild	4712	2519	2304	9,535
	Adult	0	1292	0	1,292
	Total	15,755	3,811	2,304	21,870
USA [2]	Hatchery	0	568,846	438,204	569,143
	Wild	0	459	0	995
	Adult	0	2,698	0	4,424
	Total	0	572,003	438,204	574,562
All Countries	Hatchery	871,117	769,383	3,488,357	4,829,735
	Wild	30,544	69,715	9,666	110,461
	Adult	15	15,329	829	17,899
	Total	901,676	854,427	3,498,852	4,958,095

[1] The number of microtagged hatchery fish in Iceland includes 200.926 fish reared in seapens.

[2] The total numbers includes internal tags.

TABLE 2.4.1. Summary of Atlantic Salmon Tagged and Marked in 2004. 'Hatchery' and 'Wild' refer to smolt and parr; 'Adults' refers to both wild and hatchery fish.

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions, 1960-2004

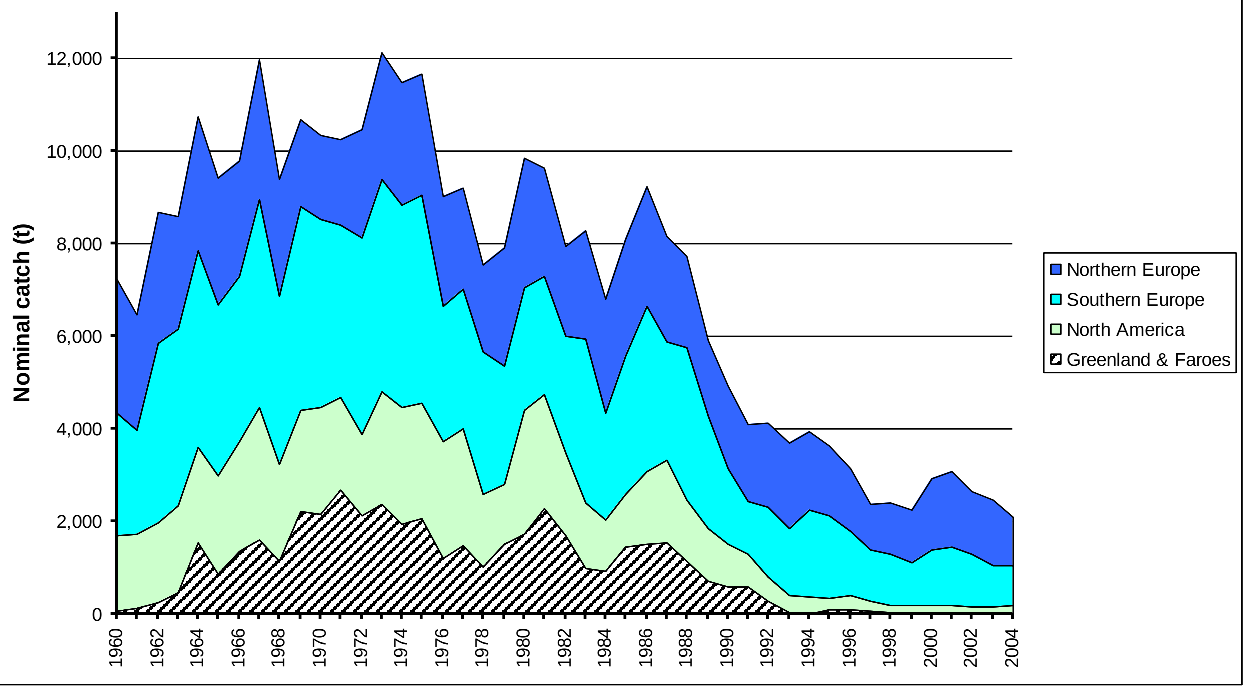


Figure 2.2.1. World-wide farmed Atlantic salmon production, 1980-2004.

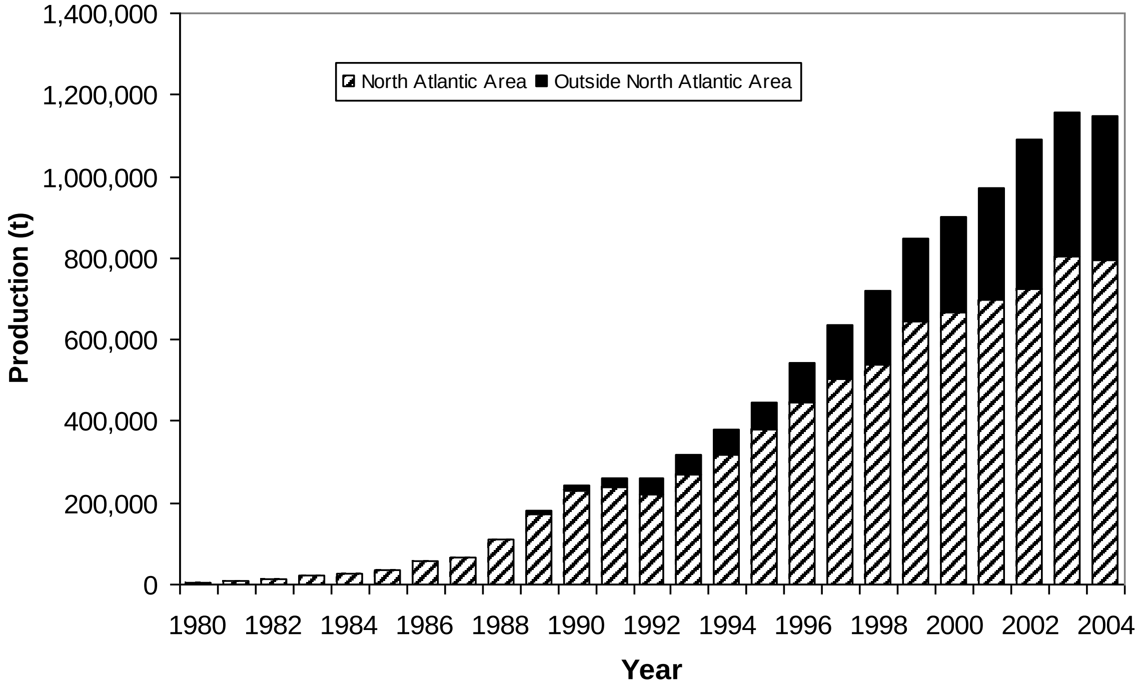
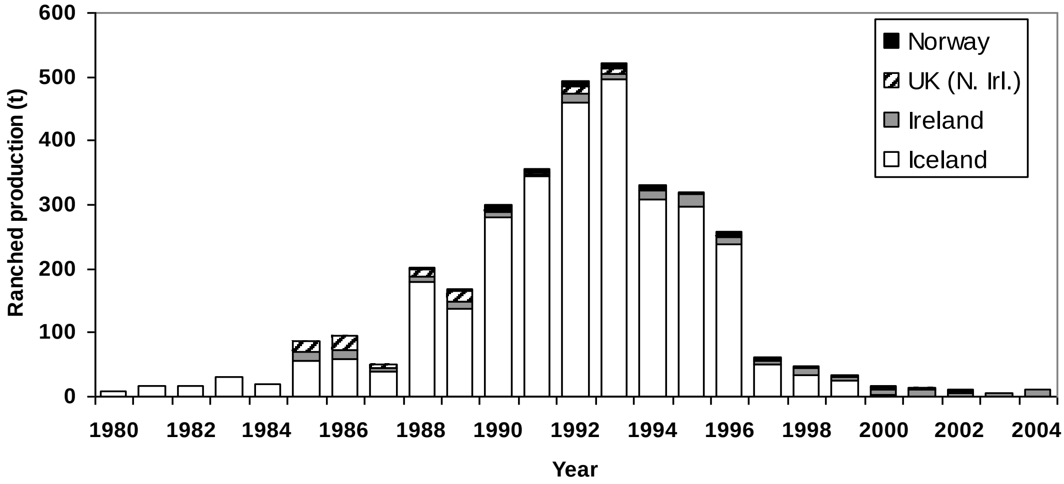


Figure 2.2.2. Production of ranched salmon (tonnes round fresh weight) as harvested at ranching facilities in the North Atlantic, 1980-2004.



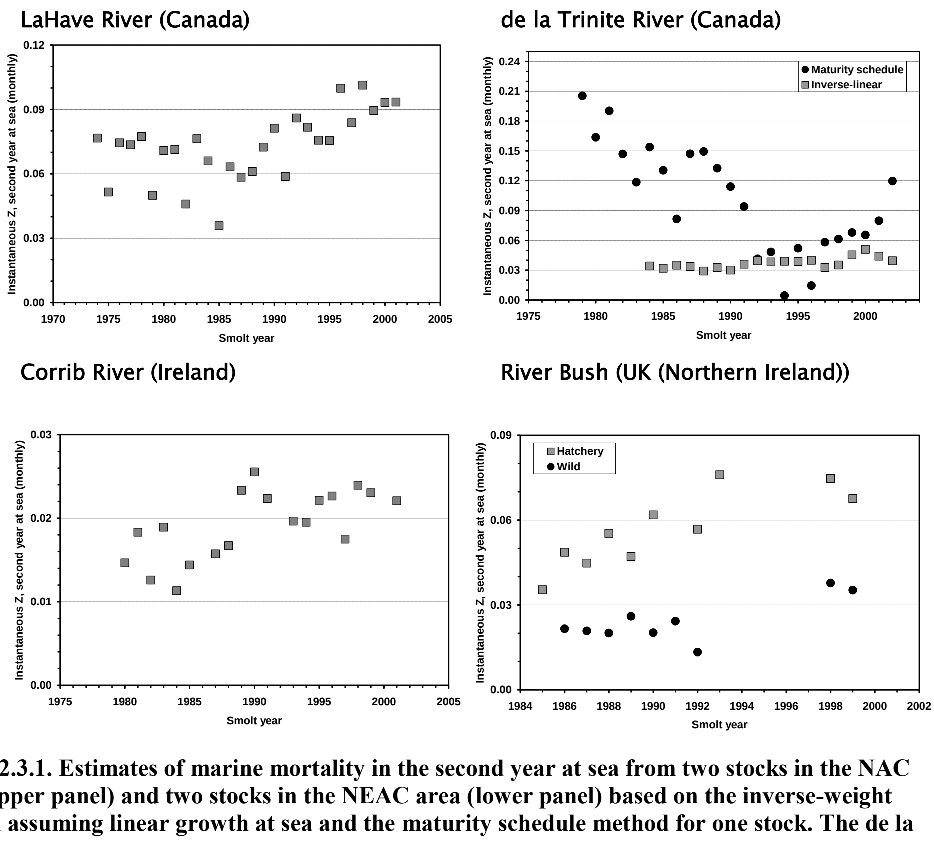


Figure 2.3.1. Estimates of marine mortality in the second year at sea from two stocks in the NAC area (upper panel) and two stocks in the NEAC area (lower panel) based on the inverse-weight method assuming linear growth at sea and the maturity schedule method for one stock. The de la Trinite River and Corrib River are wild stocks. The River Bush is for wild and hatchery stocks whereas the Lahave River is a hatchery stock.

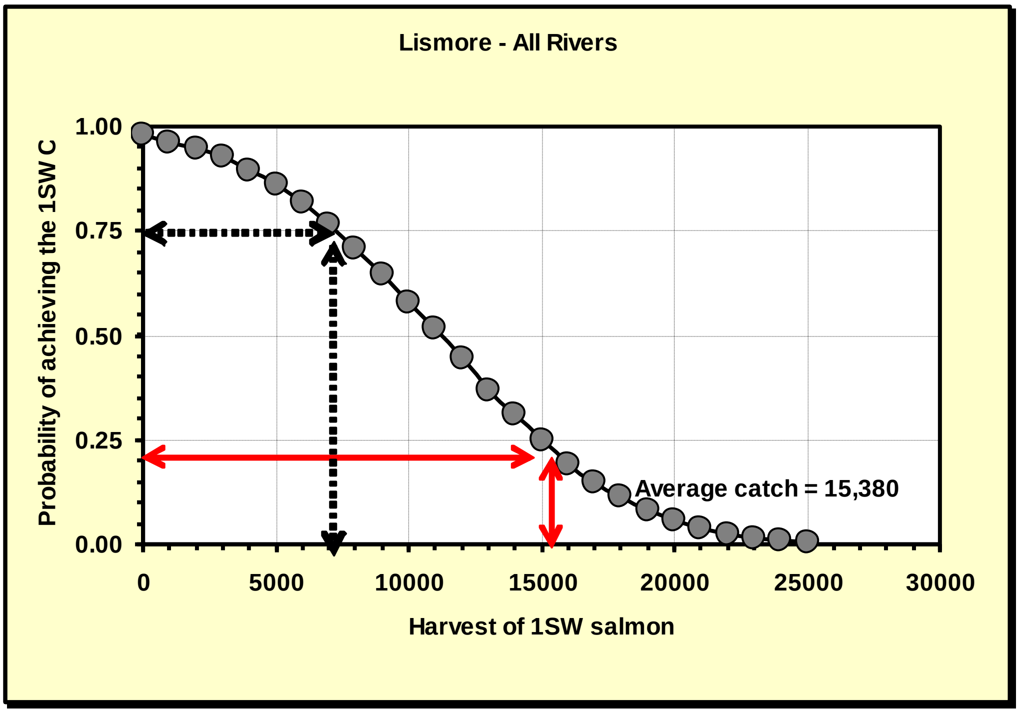


Figure 2.3.2.1 Risk plot showing the probability of meeting or exceeding the district CL and the harvest options by all methods (commercial and rods) of 1SW salmon. The average catch for the Lismore district (2000 to 2004, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 15 380 1SW salmon. At this level of harvest there is less than 25% chance that the CL will be met. The harvest option which provides a 75% chance of meeting the CL is approximately 7200 1SW salmon and this has been recommended as the precautionary catch advice for 2005.

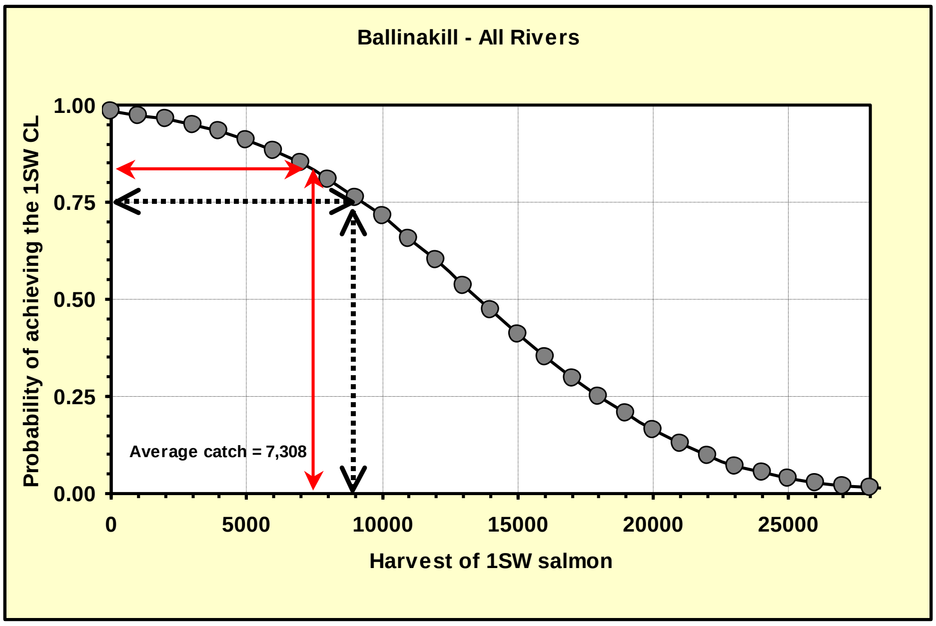


Figure 2.3.2.2 Risk plot showing the probability of meeting or exceeding the district CL (CL) and the harvest options by all methods (commercial and rods) of 1SW salmon. The average catch for the Ballinakill district (2000 to 2004, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 7308 1SW salmon. At this level of harvest there is an 85% chance that the CL will be met. The harvest option which provides a 75% chance of meeting the CL is approximately 9000 1SW salmon. As the average catch is lower than the harvest option at 75%, the lower catch is selected as the precautionary catch advised for 2005. This is because the Ballinakill district fishery catches salmon destined for other districts and there is clearly a need to protect vulnerable stocks in these other districts.

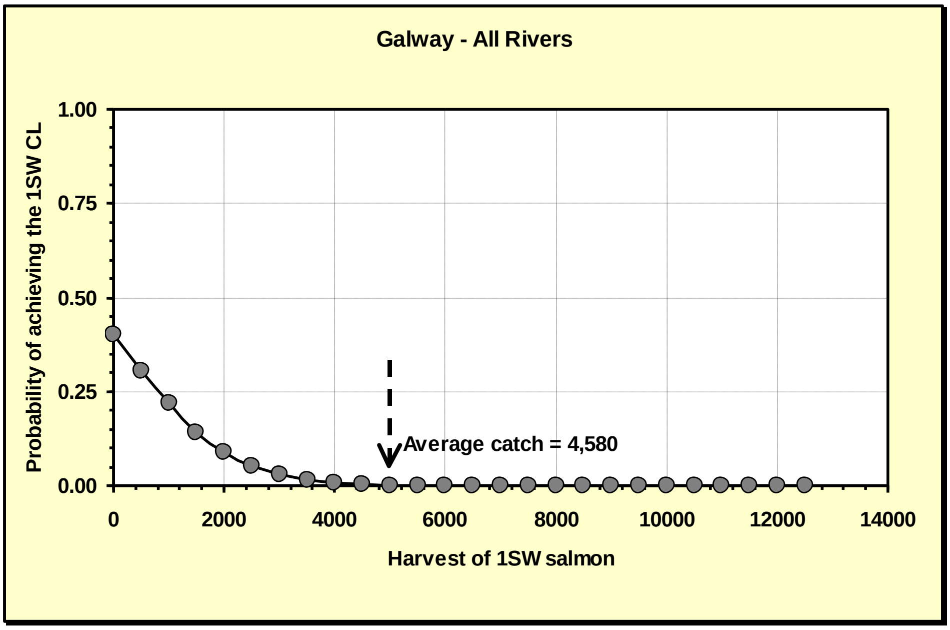


Figure 2.3.2.3. Risk plot showing the probability of meeting or exceeding the district CL (CL) and the harvest options by all methods (commercial and rods) of 1SW salmon. The average catch for the Galway district (2000 to 2004, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 4580 1SW salmon. At this level of harvest there is no chance that the CL will be met. Similarly, there is no harvest option which provides 75% chance of meeting the CL. In this instance there is no surplus of fish over spawning requirements to support a harvest.

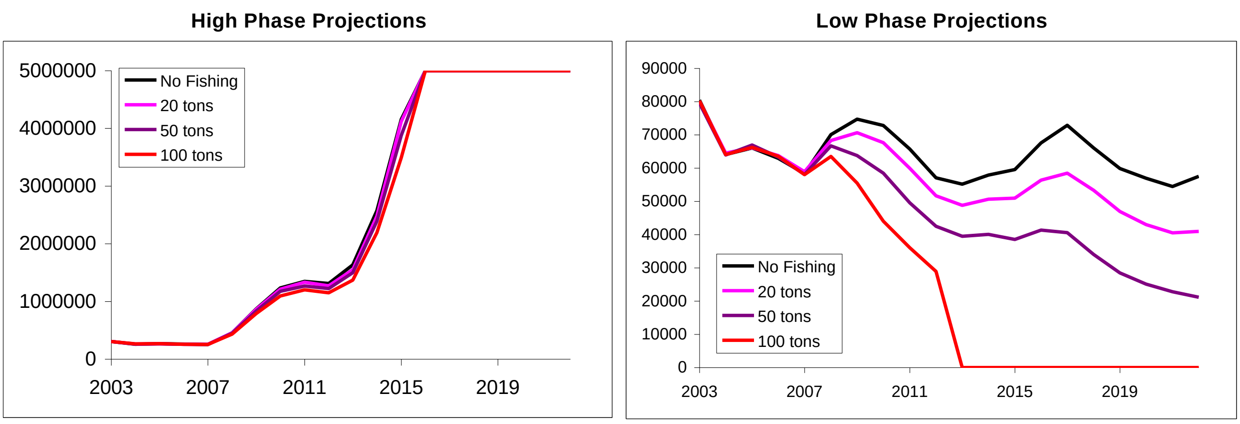


Figure 2.3.5.1 Comparison of medians of PFA from projections assuming different levels of catch in the West Greenland fishery each year for all models except those that have a flat relationship between LS and PFA (models 1 and 3).

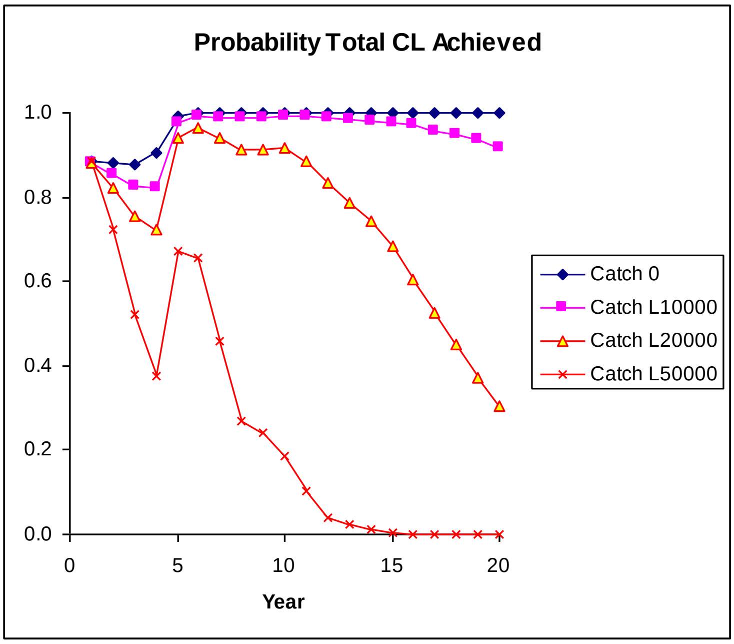


Figure 2.3.5.3.1. Probability that the total CL is achieved in the district each year under four levels of catch.

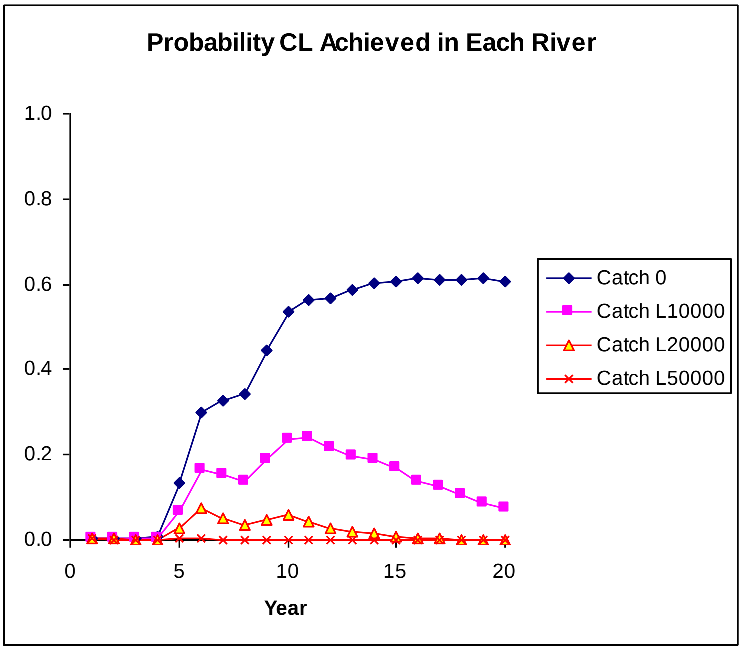


Figure 2.3.5.3.2 Probability that all 14 rivers achieve their CL for each year under four levels of catch.

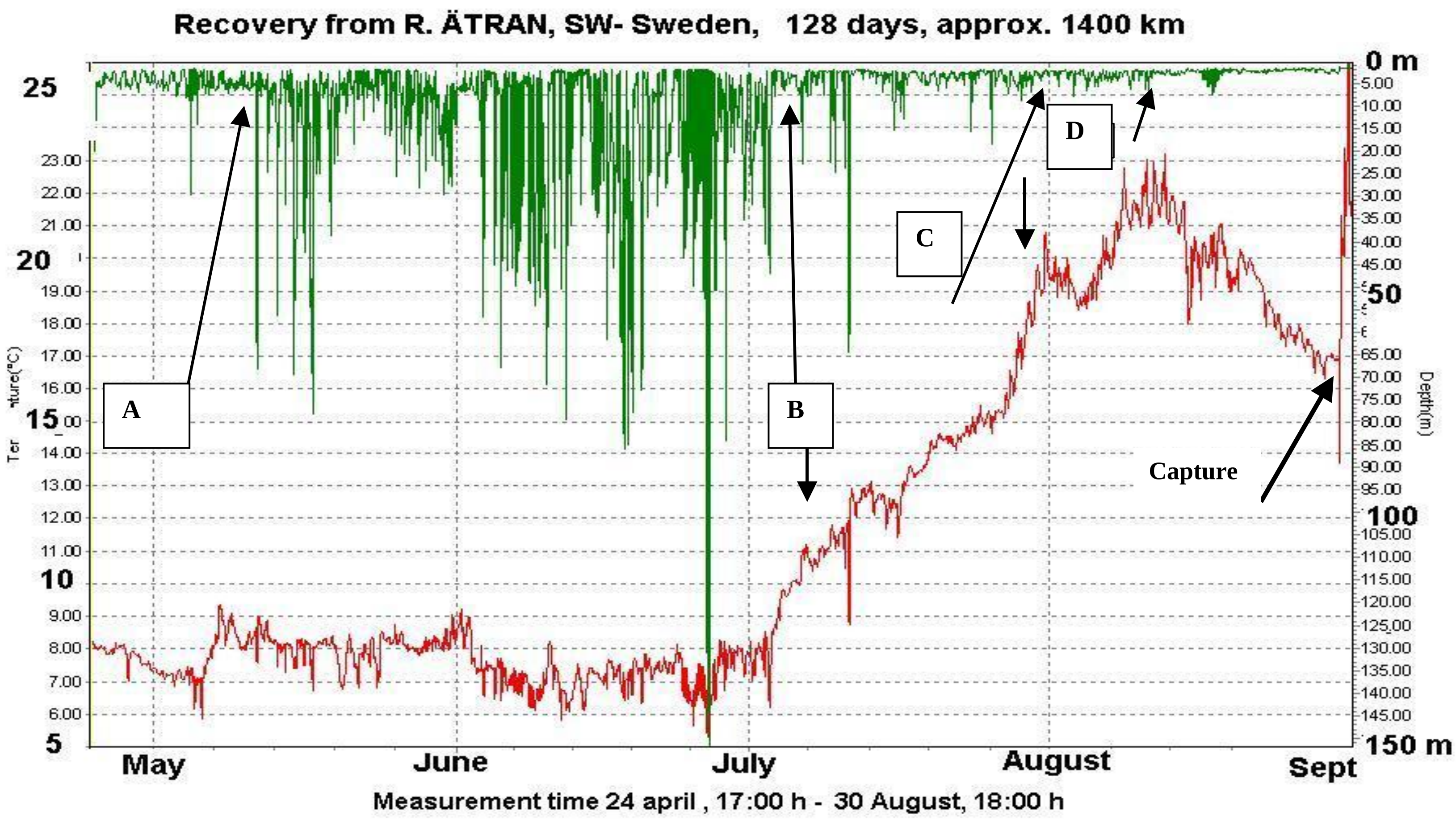


Figure 2.3.5.4.1. Data records of a salmon recovered in R. Ätran, Sweden. Depth above and temperature track below. To the left of A) post-release period , and probable periods of B) feeding and migration activity, C) Coastal migration (rising temperature), D) Estuarine dwelling and migration followed by in-river dwelling when the diving activity ceases.

3 NORTH-EAST ATLANTIC COMMISSION

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), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted this definition of CLs (NASCO, 1998). In this regard, the CL is a limit reference point (S_{lim}) which should be avoided with high probability. Management advice for Atlantic salmon is referenced to the S_{lim} conservation limit, therefore stocks assessed here are reported as being outside precautionary limits when the confidence limits of the most recent stock estimate includes S_{lim}.

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 mid-point is above, then ICES considers the stock to be at risk of suffering reduced reproductive capacity.
- Finally, when the mid-point is below the CL, ICES considers the stock to be suffering reduced reproductive capacity.

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

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 European countries:	**Northern European countries:**
Ireland	Finland
France	Norway
UK(England & Wales)	Russia
UK(Northern Ireland)	Sweden
UK(Scotland)	Iceland (north/east regions)
Iceland (south/west regions) (from 2005)	Iceland (south/west regions) (until 2004)

3.1 Status of stocks/exploitation

The status of stocks is shown in Figure 3.1.1.

ICES classifies the stock complexes with respect to conservation requirements as follows:

All 4 stock complexes (Northern European 1SW, Northern European MSW, Southern European 1SW and Southern European MSW) were estimated to be **outside precautionary limits.**

In the evaluation of the status of stocks in Figure 3.1.1, Estimated recruitment (PFA) values should be assessed against the Spawning Escapement Reserve while the Estimated spawning escapement values should be compared with the conservation limit.

Northern European 1SW stocks: Recruitment of maturing 1SW salmon (potential grilse) showed a steady decline from the mid-1980s to the mid-1990s (Figure 3.1.1). Following an upturn in the late 1990s, there has been a steep downturn in recent years. The number of 1SW spawners has been outside the precautionary limits for most of the time-series. Although it was within these limits for 5 of the last 6 years, the 2004 spawner value is again outside precautionary limits. This is consistent with a decline in PFA over the recent period.

Northern European MSW stocks: Numbers of non-maturing 1SW recruits (potential MSW returns) (Figure 3.1.1) are also estimated to have fallen throughout the period from the early 1980s to the late 1990s. The number of MSW spawners was outside the precautionary limits for most of the time-series. Although it has been within these limits since 2000, the 2004 spawner value has again fallen outside precautionary limits. These trends in recruitment for the Northern European stocks are broadly consistent with the data available on the marine survival of monitored stocks in the Northern area.

Southern European 1SW stocks: The estimated numbers of maturing 1SW recruits have fallen substantially since the 1970s (Figure 3.1.1). With the exception of the early 1970s and two years in the late 1980s, the number of 1SW spawners has been outside the precautionary limits for most of the time-series and remained so in 2004. This pattern is consistent with the data obtained from a number of monitored stocks which showed that survival of wild smolts to return as 1SW fish fell to very low levels in the Southern European area.

Southern European MSW stocks: The PFA estimates suggest that the number of non-maturing 1SW recruits has followed a fairly steady and substantial decline over the past 30 years (Figure 3.1.1). The number of MSW spawners was generally within the precautionary limits for most of the time-series until 1995. Thereafter, spawners have been outside precautionary limits. This is broadly consistent with the general pattern of decline in marine survival of 2SW returns in most monitored stocks in the area.

In assessing stock status for the major geographic stock complexes in the NEAC area, it was considered appropriate to aggregate the National CLs. On a national level, they can be used to provide a general indicator of overall stock status based on the same criteria adopted for the stock complexes (i.e. relative location of the mean and lower 95% confidence limit). However, they may not be appropriate for the provisional catch advice at this level. Stock status, expressed as outside or within precautionary limits, and the method by which conservation limit was determined is summarised by country below.

Country	1SW Spawners	MSW Spawners	Determination of Conservation Limit
Northern NEAC			
Finland	outside	outside	National CL model
Iceland	outside	outside	National CL mode
Norway	outside	outside	National CL model
Russia	outside	outside	National CL model
Sweden	within	within	National CL model
Southern NEAC			
France	outside	outside	River Specific
Ireland	outside	outside	River Specific
UK(England & Wales)	outside	outside	River Specific
UK (Northern Ireland)	within	within	National CL model
UK (Scotland)	outside	outside	National CL model

For individual rivers the status with respect to conservation requirements may vary considerably from this picture.

An overview of the estimates of marine survival for wild and hatchery-reared smolts returning to homewaters (i.e. before homewater exploitation) for the 2003 and 2002 smolt year classes (returning 1SW and 2SW salmon, respectively) is presented in Figure 3.1.2. The survival values presented are standardized (Z-score) indices relative to the averages of the time-series. An overall trend in both the Northern and Southern NEAC areas, both wild and hatchery smolts, show a constant decline in marine survival over the past 10–20 years. The steepest decline appears for the wild smolts in the Southern NEAC area. Results from these analyses are consistent with the information on estimated returns and spawners (Section 3.1), and suggest that returns are strongly influenced by factors in the marine environment.

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 Progress with setting river-specific conservation limits

Specific progress in individual countries is summarised below:

A new compliance assessment scheme designed to assess the performance of salmon stocks in UK (England Wales), and provide an early warning that a river has fallen below its CL, was introduced in 2004. The approach retains the same underlying statistical assumptions and operating characteristics as before, and provides a way of summarising the performance of a river's salmon stock over the last 10 years, including the current year, in relation to its CL. The new scheme also allows extrapolation beyond the current year in order to predict the likely future performance of the stock relative to its CL, and so assess the likely effect of recent management intervention and the need for additional measures.

Changes to management using river-specific CLs were applied for Irish salmon rivers in 2005. These changes increased the probability of meeting the required female:male ratio and the probability that the CL will be achieved simultaneously in every river in each of the 17 salmon fishing districts. This resulted in an increase in the CL for each river individually and a resultant increase in the National CL from 212 910 to 251 378. It is planned to use automatic fish counters in approximately 15 rivers to assess the status of individual stocks relative to the attainment of river-specific CLs and as an independent index of district compliance with CLs in future assessments.

3.3.2 National Conservation Limits

The national model has been run for all countries for which no river-specific conservation limits have been developed, i.e. all countries except France, Ireland, and UK (England & Wales). For Iceland, Russia, Norway, UK (Northern Ireland), and UK (Scotland) the input data for the PFA analysis (1971–2004) have been provided separately for more than one region; the lagged spawner analysis has therefore been conducted for each region separately and the estimated conservation limits combined for the country. ICES has previously noted that outputs from the national model are only designed to provide a provisional guide to the status of stocks in the NEAC area.

For catch advice to NASCO, conservation limits 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 CL model. For the NEAC area, the conservation limits have been calculated by ICES as 269 194 1SW spawners and 144 263 MSW spawners for the northern NEAC grouping, and 610 520 1SW spawners and 277 985 MSW spawners for the southern NEAC grouping.

3.4 Advice on management

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

ICES emphasised that the national stock conservation limits 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 conservation limits 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 conservation limits for the main stock groups (national stocks) exploited by the distant water fisheries could be used to provide general management advice to the distant water fisheries.

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

- **Northern European 1SW stocks:** ICES recommends that the overall exploitation of the stock complex should decrease so that the conservation limit can be consistently met. In addition it should be noted that the inclusion of farmed fish in the Norwegian data results in the stock status being overestimated. Since very few of these salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea, management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks. **Thus, the only fisheries on maturing 1SW salmon should be on river stocks shown to be within precautionary limits.**
- **Northern European MSW stocks:** ICES considers that the overall exploitation, particularly in mixed stock fisheries, should immediately decrease, so that the conservation limit can be consistently met. In addition it should be noted that the inclusion of farmed fish in the Norwegian data results in the stock status being

overestimated. **Thus, the only fisheries on non-maturing 1SW salmon should be on river stocks shown to be within precautionary limits.**

- **Southern European 1SW stocks:** ICES considers that, as this stock complex remains outside precautionary limits, reductions in exploitation are required for as many stocks as possible, to increase the probability of the complex meeting conservation limits. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stocks below reproductive capacity. **Thus, the only fisheries on maturing 1SW salmon should be on river stocks that are shown to be within precautionary limits.**
- **Southern European MSW stocks:** This stock complex is currently outside precautionary limits and the quantitative forecast of PFA for 2005 (486 000) indicates that stock levels will remain close to current levels at least in the next year. ICES considers that reductions in exploitation are required for as many stocks as possible, to increase the probability of the stock complex meeting conservation limits. Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to stocks below reproductive capacity. **Thus, the only fisheries on non-maturing 1SW salmon should be on river stocks that are shown to be within precautionary limits.** *(quantitative catch advice for this stock complex at West Greenland is provided in the context of a risk framework in Section 5).*

3.5 Relevant factors to be considered in management

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

National outputs of the NEAC PFA model are combined into northern and southern groups to provide NASCO with catch advice or alternative management advice for the distant water fisheries at West Greenland and Faroes.

The groups were considered appropriate as they fulfilled an agreed set of criteria for defining stock groups for the provision of management advice, criteria that were considered in detail by ICES (2002). In 2005, ICES re-evaluated tag recapture information previously provided by Iceland (ICES, 2002) and decided that the south/west region of Iceland would be included in the southern grouping while the north/east regions would remain in the northern grouping.

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

3.6 Catch forecast for 2005

In order to develop quantitative catch options for NEAC stock complexes, forecasts of PFA are required for each stock complex and for each sea age component. These are currently only available for the MSW component of the southern European stock complex. The forecast of PFA for 2005 has been used in the catch advice for West Greenland for 2005 (Section 5). ICES has adopted a model to forecast the pre-fishery abundance (PFA) of non-maturing (potential MSW) salmon from the Southern European stock group (ICES, 2002, 2003). Model options were re-evaluated in 2004 when ICES explored the relative contribution of several variables to predictions of PFA (ICES, 2004a). In 2004, ICES decided to apply a model that used only the *Year* and *Spawners* terms to predict the PFA of non-maturing salmon. This model was again used in 2005 where it was fitted to data from 1978–2003 and used to update the PFA in 2004 and to forecast the PFA in 2005 (Figure 3.6.1).

Forecasts and 95% confidence limits of PFA non-maturing 1SW salmon (all values in thousands) for Southern NEAC are given below:

Year	Forecast	Lower limit	Upper limit
2004	524	338	813
2005	486	313	755

3.7 Medium- to long-term projections

The quantitative forecast for the southern NEAC MSW stock component gives a projected PFA (at 1st January 2005) of 486 000 fish for catch advice in 2005. No projections are available beyond that, or for other stock components or complexes in the NEAC area.

3.8 Comparison with previous assessment

PFA forecast model

The revised forecast of the southern NEAC non-maturing 1SW PFA for 2004 provides a PFA mid-point of 524 000. This is close to the value forecast last year at this time of 489 000. However, in comparing these two forecasts it must be noted that the estimate derived this year now includes Iceland (south/west) in the Southern European stock complex. The Iceland (south/west) non-maturing 1SW component represents about 10 700 fish added to the PFA of this stock complex.

Developments to the National PFA model and national or other conservation limit models

Five countries made changes to the input data to these models.

Unreported catch rates for France in 2002 and 2003 were increased to take account of (a) recent information on illegal net catches in the coastal zone and (b) the absence of estimated catches for the drift net fishery of the Adour estuary.

- The proportion of 1SW salmon in the UK (Northern Ireland) catch has been decreased from 95% to 93% throughout the time-series following analysis of scale sample data. Rod catch data for 2002 onwards have also become available, following introduction of a carcass tagging scheme, and are included in the analysis.
- Size and sea age composition of the returns in 2003 for Russia (Pechora River) region was based on limited sample data and has been revised using data from other years.
- In Ireland, the CL was increased from 212 910 to 251 378 for 1 and 2SW salmon combined (see Section 2.3.2 for details of the methods and justification) and catches have been corrected to account for some of the hatchery-reared returns which are not considered to contribute significantly to spawning or to returns in subsequent generations. New exploitation rate indices for wild stocks (1 and 2SW) are being developed which may replace exploitation rates used in the current model in the future.
- Corrections to the estimations of river-specific conservation limits have led to revised figures for UK (England & Wales), which have resulted in a 58% increase in the national total.

ICES also noted that some countries are developing PFA models for national management. For example, in Norway, the development of national PFA estimates has been initiated, and some provisional modification to the NEAC model is proposed. The NEAC model uses total exploitation rate. In Norway it is more appropriate to use freshwater exploitation rate, as there are more data available and they are easier to estimate. In contrast to the NEAC model the Norwegian catch in the River Tana is included. The output from the Norwegian model was similar to the results for Norway from the NEAC model.

ICES encourages further development of assessment models reflecting stock characteristics in areas or countries to replace the National Conservation Limits approach.

3.9 NASCO has requested ICES to describe the key events of the 2004 fisheries and the status of the stocks

3.9.1 Fishing in the Faroese area 2003/2004 commercial fishery

No fishery for salmon was carried out in 2003/2004 or, to date, in 2004/2005. Consequently, no sample data are available from the Faroese area for this season. No buyout arrangement has been made since 1999.

Homewater fisheries in the NEAC area:

3.9.2 Significant events in NEAC homewater fisheries in 2004

In several countries, national measures aimed at reducing exploitation were implemented or strengthened in 2004. These include: a reduction of net fisheries in UK (England & Wales) with the aim of reducing mixed stock fisheries and the use of a TAC to limit catches and the continuation of a carcass tagging scheme to monitor catches in Ireland.

3.9.3 Gear and effort

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

3.9.4 Catches

In the NEAC area there has been a general reduction in catches since the 1980s (Table 2.1.1.1). This reflects the decline in fishing effort as a consequence of management measures as well as a reduction in the size of stocks. The provisional declared catch in the NEAC area in 2004 was 1922 tonnes, 17% down on 2003 (2302 t) and also below the previous 5-year mean. The catch in the Southern area declined from about 4500 t in 1972–1975 to less than 1000 t in the last two years. The catch trend features two sharp declines, one in 1976 and the other in 1989–1991. The catch in the Northern area also shows an overall decline over the time-series, but this is less steep than for the Southern area. The catch in the Northern area varied between 1850 t and 2700 t from 1971 to 1986, falling to a low of 962 t in 1997, before increasing to over 1500 t in 2001. The catch has declined again since this time to 1058 t. Thus, the catch in the Southern area, which comprised around two-thirds of the NEAC total in the early 1970s, is now lower than that in the Northern area.

3.9.5 Catch per unit effort (CPUE)

An overview of the CPUE data for the NEAC area was undertaken. In the Southern NEAC area, CPUE shows a general decrease in UK (Scotland) net and coble fisheries, whereas no trend was observed in UK (Scotland) fixed-engine fisheries, UK (England & Wales) net fisheries, and in France rod fisheries. In UK (Northern Ireland), the river Bush rod fishery CPUE showed a general increase until the late 1990s, followed by a decrease, but has slightly increased after 2002, which was the lowest level in recent years. In most of the Northern NEAC area, there has been a generally increasing trend in the CPUE figures for various fisheries in recent years, but the figures since 2002 have generally been lower than before.

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.

3.9.6 Age composition of catches

One Sea Winter salmon comprised 58% of the total catch in the Northern area in 2004 which was below the 5- and 10-year means (63% and 64% resp.). In general, there has been greater variability in the proportion of 1SW fish between countries in recent years (since 1994) than prior to this time. For the Southern European countries, the overall percentage of 1SW fish in the catch (59%) was close to the 5- and 10-year mean (60%).

3.9.7 Farmed and ranched salmon in catches

The contribution of farmed and ranched salmon to national catches in the NEAC area in 2004 was again generally low (<2% in most countries) and is similar to the values that have been reported in previous reports (e.g. ICES, 2004a). 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 coastal, fjord, and rod fisheries. An assessment of the likely effect of these fish on the output data from the PFA model was included in ICES (2001).

3.9.8 National origin of catches

Only one specific analysis outlining the national origin of catches in fisheries in the NEAC area was made available.

ICES reviewed information resulting from analysis of coded wire tagging (CWT) programmes in UK (England & Wales) and tag recovery programmes in Ireland to estimate the effects of Irish fisheries on salmon stocks returning to UK (England & Wales). The favoured approach for estimating exploitation rates in distant water fisheries is working backwards from estimates of the numbers of each sea-age class of salmon returning to spawn (Potter and Dunkley, 1993; Rago *et al.*, 1993; Potter *et al.*, 2004). River-specific models based on this run reconstruction approach were presented for a number of English and Welsh stocks and ICES notes the inclusion of confidence limits on the estimates of exploitation, which were a further advance on earlier models.

The tagging studies demonstrated that salmon from all parts of England and Wales are exploited in the Irish coastal fishery. However, levels of exploitation have varied between stocks from different regions and from year to year, and have also declined following the introduction of management measures in the Irish fishery in 1997. Based on aggregated data for all available years, the extant exploitation rates for the modelled stocks (1SW fish only) were estimated for the periods before and after the management changes in the Irish fishery.

Prior to the introduction of the management measures, exploitation rates in the Irish fishery were estimated at about 1% for stocks from the north east of England, higher (15 to 22%) for the two rivers in Wales, but highest (28%) for the River Test in southern England. Since the introduction of the regulatory changes, exploitation rates have fallen to 0.5% for the Tyne (data for one year only), 2–10% for Welsh rivers, and 12% for the River Test. While it was not possible to use the modelling approach to estimate exploitation rates for other stocks, the overall pattern of tag recapture rates was consistent with this regional pattern of exploitation.

Noting that exploitation rates in the Irish fishery were higher on hatchery stocks than on wild stocks (e.g. Burrishoole and Bush) ICES advised applying a correction factor where tags from hatchery-reared and wild salmon had been combined to provide adequate tag returns for the analyses.

It therefore appears that exploitation on salmon from northeast England in the Irish fishery is negligible, that exploitation on stocks from northwest England and north Wales is currently low, but that levels increase for rivers further south in Wales and for rivers in southern and possibly southwest England. ICES also recognised that exploitation rates varied considerably from year to year and that exploitation rates on particular stocks may still be relatively high in some years and negligible in others. For stocks below their conservation limit, ICES noted that even low levels of exploitation may represent an impediment to stock recovery.

In 2004, a number of tags originating from fish released from other countries (34 from UK (Northern Ireland), 8 from UK (England & Wales), 2 from UK (Scotland), 2 from Spain, and 2 from Denmark) were recovered in Irish fisheries.

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

The effect of specific management measures on stocks and fisheries has been evaluated in a number of NEAC countries. In summary:

NEAC northern area

Russia – commercial catches have continued to decline as a result of various management changes, including the prohibition of some important in-river fisheries, aimed at reducing the fishing effort and enhancing the development of recreational and catch-and-release fisheries. The mean commercial catch in the last five years (2000–2004) is 26% below that of the previous five years (1995–1999).

NEAC southern area

Ireland – legislation has been introduced recently with the objectives of reducing exploitation and increasing escapement. This has resulted in a general decline in exploitation rate on wild salmon from 65% (pre-1997) to 48% (post-1997) for wild salmon, and a reduction from 82% to 67% for hatchery returns for the same periods. Exploitation on salmon from UK (England & Wales) in the Irish fishery has also been reduced by about half following the introduction of the management measures in the fishery in 1997 (Section 3.9.8). In the context of increasing escapement, information from index rivers suggests a marginal increase in freshwater survival from 5.1%, on average, (pre-1997) to 5.6% (post-1997). An increase in returns to freshwater for hatchery stocks is also noted (0.8% to 1.4%) for the same periods.

With the recent provision of catch advice for Irish salmon fisheries on a district basis, the emphasis is beginning to shift towards the objective of meeting or exceeding conservation limits in all districts. Although the process is only recent (2002 starting year), and TACs have been set which result in significant reductions in commercial catches, this objective is not as yet being met.

UK (Northern Ireland) – Significant management measures came into effect in 2002, aimed at reducing exploitation on salmon stocks in the Fisheries Conservancy Board (FCB) area. A voluntary buyout agreement with commercial licensed net operators has resulted in a reduction in nets licensed from 27 in 2000 to 6 for the 2004 season. Accompanying measures to regulate angling, first introduced on a voluntary basis in 2001, operated again in 2004. While the impact of these measures on stock status will require some years to fully evaluate, it is noted that the voluntary net buyout scheme probably contributed to the reduction in net catch in the FCB area from 23.4 t in 2001 to 5.8 t in 2004.

UK (England & Wales) – a review in 2004 demonstrated that, whilst many conservation measures had been implemented, the majority of stocks remained below the CL and a significant number were in decline. An action plan has been drawn up to take forward the recommendations from the review. A range of local and national measures have been implemented over recent years to address concerns about stock status. In particular, measures have been implemented to safeguard MSW 'spring' fish and phase out coastal mixed stock fisheries.

Reductions in spring salmon exploitation were estimated, in 2004, to have increased escapement from net fisheries by around 1200 salmon and by around 2200 from rod fisheries. It is estimated that spawning escapement of spring salmon may have increased by up to one-third on some rivers as a result of these measures.

In 2003, compensation arrangements helped accelerate the phasing out of the mixed stock fishery on the northeast coast. Nine other small coastal mixed stock fisheries have also been subject to reductions in recent years, eight of which are no longer operating. The overall effect of these measures has been to reduce the catches in these coastal fisheries from an average of about 41 000 fish for the period 1988–92 to a little under 32 000 for the period 1998–2002 and around 11 000 fish in 2003 and 2004.

UK (Scotland) – concerns about the status of early-running MSW salmon led to a voluntary agreement to delay fishing until the beginning of April. Members of the Salmon Net Fishing Association, to which the majority of active net operators are affiliated, have observed this agreement since 2000. This has resulted in about an 80% reduction in the catch of MSW salmon by nets and fixed engines in the months of February and March compared with the previous five years.

France – various measures have been introduced with the objective of reducing exploitation, on MSW fish in particular, and increasing spawning escapement and compliance with river-specific CLs:

- Sport and commercial fisheries in the Loire-Allier basin have been closed since 1994 to aid recovery of the population. However, this did not seem to enhance salmon numbers. Physical obstructions and other environmental factors are now considered the more likely impediments to recovery of this population.
- In Brittany and Lower Normandy, TACs introduced in 1996 have been successful in reducing catches, although the only monitored river, the Scorff, has failed to meet its CL consistently since 1994. Early season restrictions failed to protect spring salmon. MSW TACs have led to temporary closures on some rivers and have reduced MSW catches in Brittany since 2000 and Lower Normandy since 2003.
- In the Adour-Gaves basin, management measures introduced between 1999 and 2003 resulted in some reduction in rod catch, although not in the proportion of MSW caught. Rod catches increased in 2004 once the measures lapsed and there has also been a steady increase in fishing effort and catches in the estuary drift net fishery over the last 5 years. The current regulations have therefore been unable to reduce overall exploitation on MSW salmon.

In conclusion, most management measures introduced in recent years in relation to national and local objectives have aimed to reduce levels of exploitation on NEAC stocks. However, despite these, it is noted that all four NEAC stock complexes are currently outside precautionary limits (Section 3.1).

3.11 NASCO has requested ICES to provide an estimate of bycatch of salmon in pelagic fisheries

3.11.1 Estimate of bycatch of salmon in pelagic fisheries

Reports over a number of years have indicated the possibility of post-smolts and salmon being intercepted in various pelagic fisheries and in trawl fisheries in particular. However, preliminary estimates derived from observed ratios of salmon and mackerel taken in research and commercial fisheries scaled with the total mackerel catch in the Norwegian Sea have been highly variable (ICES, 2002, 2003, 2004a).

In 2005, ICES reviewed new data made available on disaggregated catches and fishing operations in pelagic fisheries and provided the following guidelines applicable to developing estimates of bycatch of salmon:

a) only disaggregated pelagic trawl catch data provided on a weekly basis for 2000–2003 would be used, as data prior to then were incomplete.

b) as some individual years of the Institute of Marine Research (Norway) pelagic surveys had produced very few salmon recaptures resulting in insufficient temporal or spatial coverage, the salmon recapture data series would be pooled (1990–2003).

The weekly distribution of post-smolts and the overlap with pelagic catches was compared for each of the weeks for which post-smolt distributions were available (weeks 21 to 31). Some overlap was noted throughout the period, more significant overlap was identified in weeks 26–28. The entire period and the more restricted period were both used when estimating the potential post-smolt bycatch.

The detailed description of the various pelagic fisheries was given in ICES (2004b). Based on the area covered and fishing depth, the fishery with the greatest potential to intercept post-smolts was identified to be the near-surface mackerel trawl fishery in the Norwegian Sea.

A number of differences were noted between survey trawls and commercial trawls and it was concluded that only the Russian pelagic survey trawl had design properties similar to the commercial gears in use in the fishery.

Since the end of the 1990s scientific observers have been working onboard Russian vessels fishing herring, mackerel, and blue whiting in the Norwegian Sea. The vessels are subject to inspection by Russian, Norwegian, Faroese, and NEAFC authorities. In addition, all the Russian commercial catches of mackerel, herring, and blue whiting are essentially handled more or less individually and the probability of detecting salmon (either post-smolts or adults) should therefore be very high.

For the purposes of estimating bycatch, it was therefore decided that only the catch data from the Russian research survey and the commercial trawl catch scanning should be used for extrapolation purposes (ICES, 2004). The catch rate data from Norwegian research surveys targeted at salmon were not used in developing bycatch estimates, as these employ gear which differs substantially in design and use from that used in the commercial fisheries.

Estimates of the bycatch of post-smolt salmon

Two estimates of post-smolt catch rate (*i.e.* post-smolts/tonne mackerel) were available based on :

a) Russian research trawl catches;

b) Russian observer-based screening of commercial mackerel catches.

Bycatch estimates were developed by applying these catch rates to disaggregated trawl catches of mackerel:

- Estimates were calculated for the whole area IIA, IVa, and Vb, using disaggregated catches of mackerel in 2001 and 2002;
- Two standard time periods were selected *i.e.*, the total period from which post-smolt records exist (weeks 21–31), and the peak period (weeks 26–28);
- Only mackerel catches in rectangles with simultaneous salmon catches were included.

The results indicate a wide variation in potential post-smolt bycatch depending mainly on the catch rates used (Table 3.11.1.1).

ICES notes that the resultant estimates based on the **research trawl** (40,188 - 154,482 post-smolts, depending on the range of weeks considered), may overestimate the ratio of post-smolts taken compared to mackerel, as the research trawl operates at lower speed and may thus be less effective in catching mackerel.

In contrast, the estimates based on ratios derived from the **observer-based screening** and individual handling on board factory ships (14–52 post-smolts, depending on the range of weeks considered), may be underestimates, due to difficulties in observing smolts amongst a large catch of mackerel on board a commercial vessel.

ICES notes that despite using the best available information, including appropriate disaggregation of catches, there is a very wide variation in the results. Therefore, although the estimates are thought to encompass the likely range of bycatch, these values cannot be regarded as formal estimates of bycatch for any particular year or fishery. Further developments and data would be required before bycatch estimates could be used as part of the overall assessment of salmon stocks in the NEAC area or for specific management advice.

Due to the absence of documented ratios of post-smolts or salmon to catches of other species of pelagic fish it is not possible to make any estimates of bycatches from fisheries other than mackerel fisheries at present. ICES recommends that future estimates should be refined, if possible with annual estimates, based on observer-based screening of catches. As yet, no other relevant pelagic fisheries have provided salmon catch rate data, but in the light of information presented to ICES, the possible interception of salmon by e.g. herring or blue whiting fisheries should be further investigated.

Despite this, ICES notes that the upper estimate of potential salmon post-smolt bycatch in the mackerel fishery (154 482) represents approximately 5% of the estimated combined PFA for the NEAC stock complexes (10-year average 3.4 million). As PFA is estimated at 1st January of the first sea winter and the post-smolt surveys are carried out in June/July of the first year at sea, further mortality will take place between the survey and the estimate of PFA; therefore, the percentage of PFA accounted for as bycatch will be lower.

Estimates of the bycatch of adult salmon

As adult salmon were reported also from the Russian scientific surveys and the observer-based screenings, ICES expanded the analysis carried out on post-smolt bycatch to provide an estimate of adult salmon bycatch.

An example was developed using mackerel catches in weeks 21–32 in 2001, using the whole area approach similar to the post-smolt estimates. The observed ratios of adult salmon to total catch of mackerel from the Russian scientific and commercial fishery have been scaled with the tonnage of mackerel taken in the overlapping rectangle for a specific period, in this case ±2 weeks from the time when the post-smolt capture was registered. Only catches from those rectangles where salmon have been recorded were used for scaling up. Extrapolation from the research catch shows that the number of adult salmon potentially taken was zero in 2002 and 4460 in 2003. The observer-based estimates were 15 salmon in 2002 and 32 salmon in 2003. The reasons for the differences between adult bycatch estimates are expected to parallel those discussed for the post-smolt estimates.

These estimates only apply to adult salmon in the mackerel fisheries. Similar information was not available for other pelagic fisheries, therefore ICES was not in a position to make estimates for pelagic fisheries other than mackerel.

While it is recognised that direct onboard observation is the most reliable method of bycatch estimation, ICES draws attention to the possibility of using indirect estimation methods (surveys, polls) of commercial fishers to estimate the occurrence and frequency of salmon bycatch in different areas, fisheries, and time of year. These methods may also provide an approximation of the potential number of salmon taken. ICES underlines the importance of having recognised and proven survey professionals operating in such fields as social science research and socio-economic evaluation.

3.11.2 Sampling of post-smolts and pre-adults in Norway and the Norwegian Sea

There was only one Norwegian research cruise targeting salmon at sea in 2004. Relevant data was also collected during two surveys aimed at investigating sea lice infections in selected southwestern Norwegian fjords. The targeted cruise for salmon took place in the last part of April between 66–68ºN and was designed to tag and release adult salmon with DST tags (Section 2.3). There were no cruises dedicated to post-smolt investigations at sea, but the salmon trawl was used during a mackerel egg survey in the area north of Ireland up to the Shetland-Faroes Channel. During this cruise 124 post-smolts were caught at 8 of 14 stations sampled. The last time this area was surveyed was in 1995–97, so these captures extend the database on the temporal and spatial distribution of post-smolts. Relative to other years, the CPUE for post-smolts in the southern area was considered high at 16.2. CPUE for adult salmon captures was calculated for the first time.

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2001	Smolt catch rate/ t mackerel	Period weeks	Catch (t)	Bycatch (n)
Russian research survey	5.93	21-31	26051	154482
Russian observer programme	0.002	21-31	26051	52
Russian research survey	5.93	26-28	6777	40188
Russian observer programme	0.002	26-28	6777	14

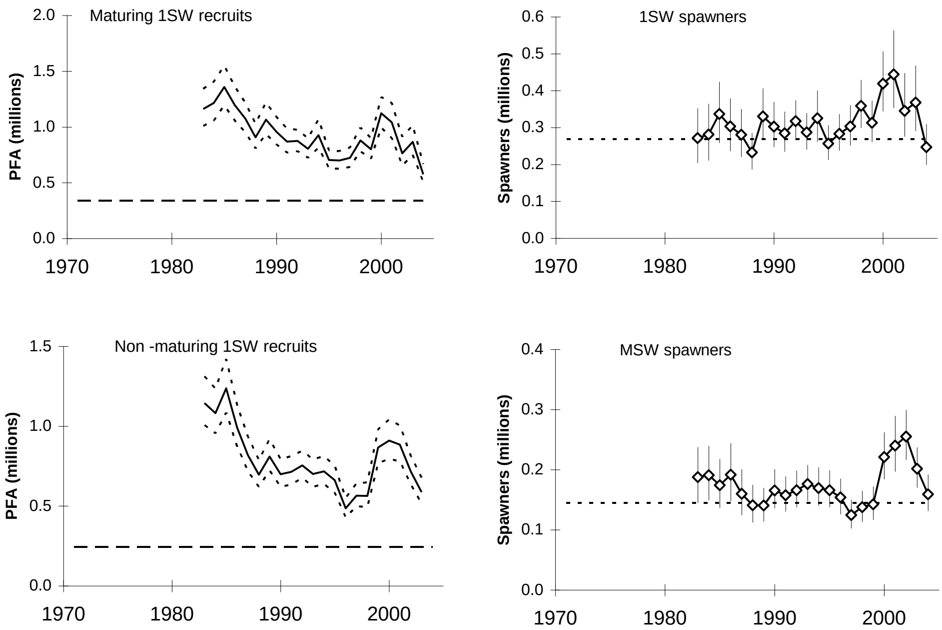
2002	Smolt catch rate/ t mackerel	Period weeks	Catch (t)	Bycatch (n)
Russian research survey	5.93	21-31	21265	126101
Russian observer programme	0.002	21-31	21265	43
Russian research survey	5.93	26-28	7594	45032
Russian observer programme	0.002	26-28	7594	15

Table 3.11.1.1. Estimates of bycatch of salmon post-smolts potentially taken in the Norwegian Sea for two periods in 2001 and 2002.

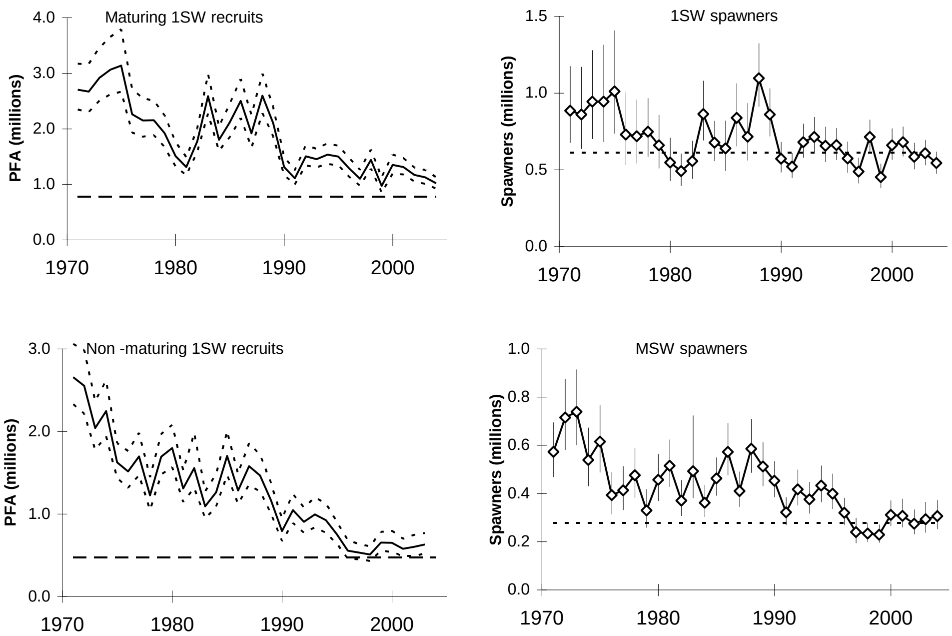
Figure 3.1.1 Estimated recruitment (PFA), with 95% confidence limits, and Spawning Escapement Reserve for maturing and non-maturing salmon in Northern & Southern Europe.

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

Northern Europe



Southern Europe



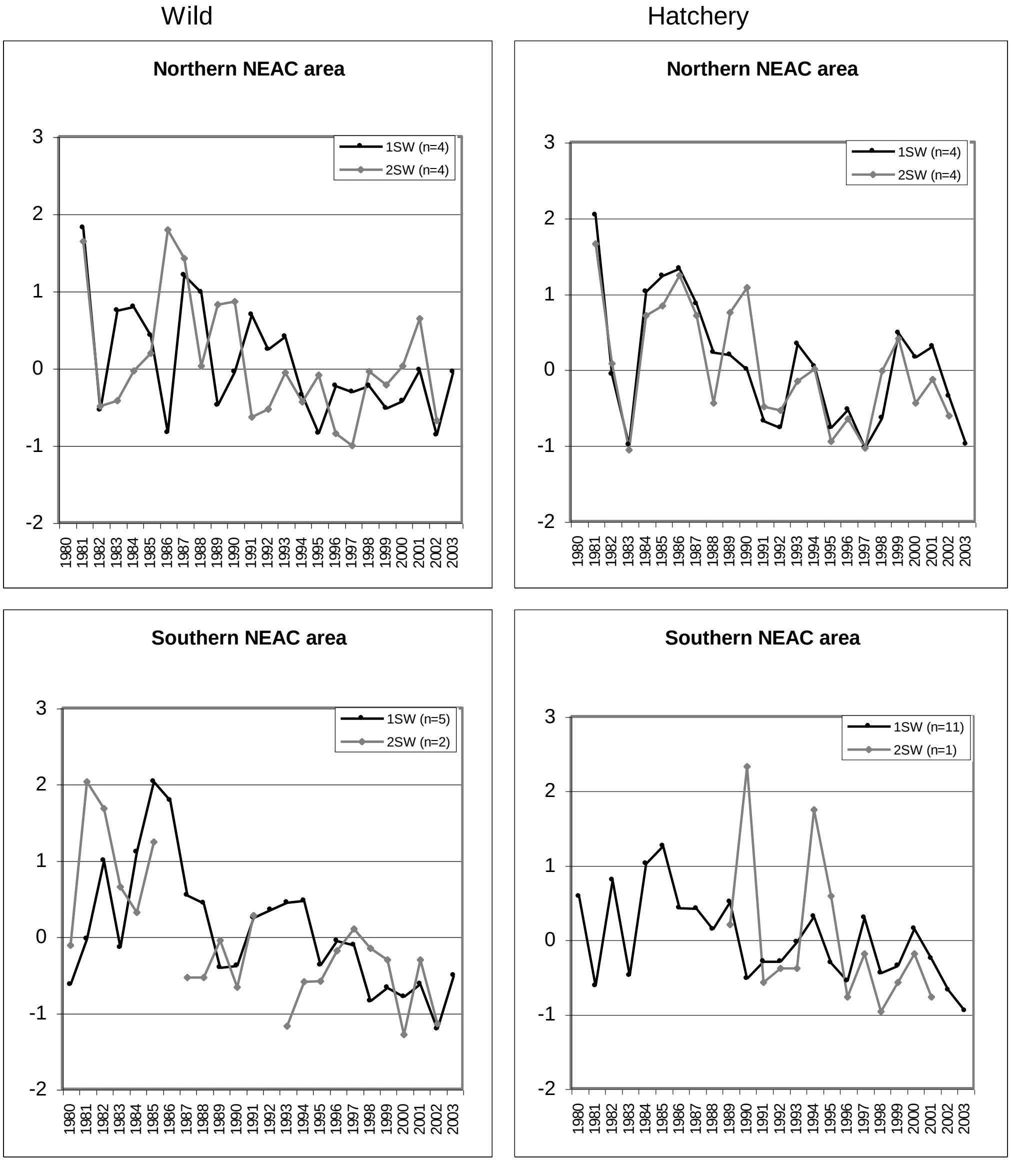
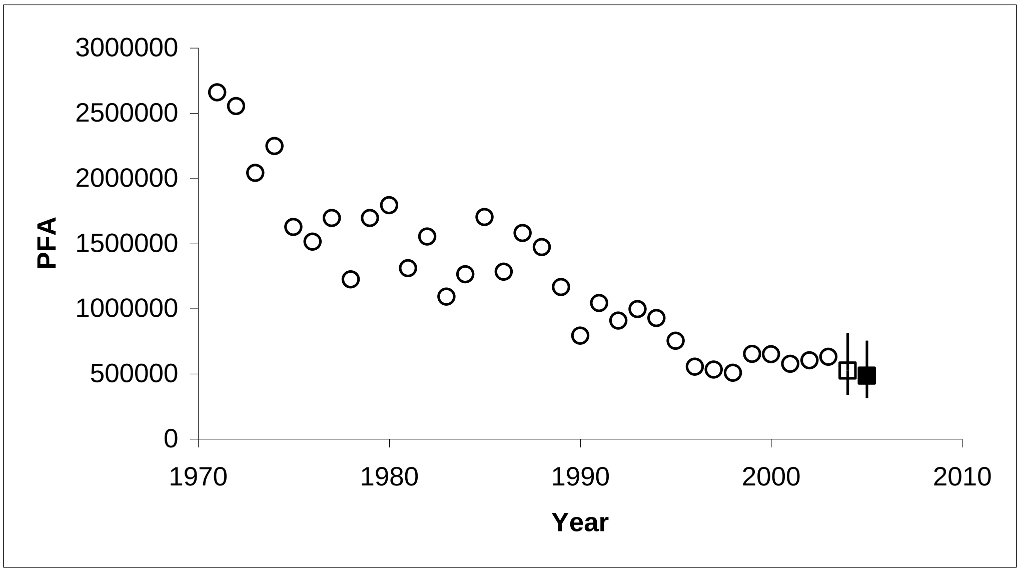


Figure 3.1.2. An overview of the estimated survival indices of wild and hatchery smolts to adult returns to homewaters (prior to coastal fisheries) in Northern and Southern NEAC area. Index values represent averages of standardized (Z-score) survival estimates for monitored rivers and experimental facilities, and are relative to the average of the time-series (0). The number of rivers included are indicated in each panel legend.

Figure 3.6.1 PFA trends and predictions (+/- 95% confidence intervals) for non-maturing 1SW European stock

Note: open square is 2004 update and blocked square is 2005 forecast



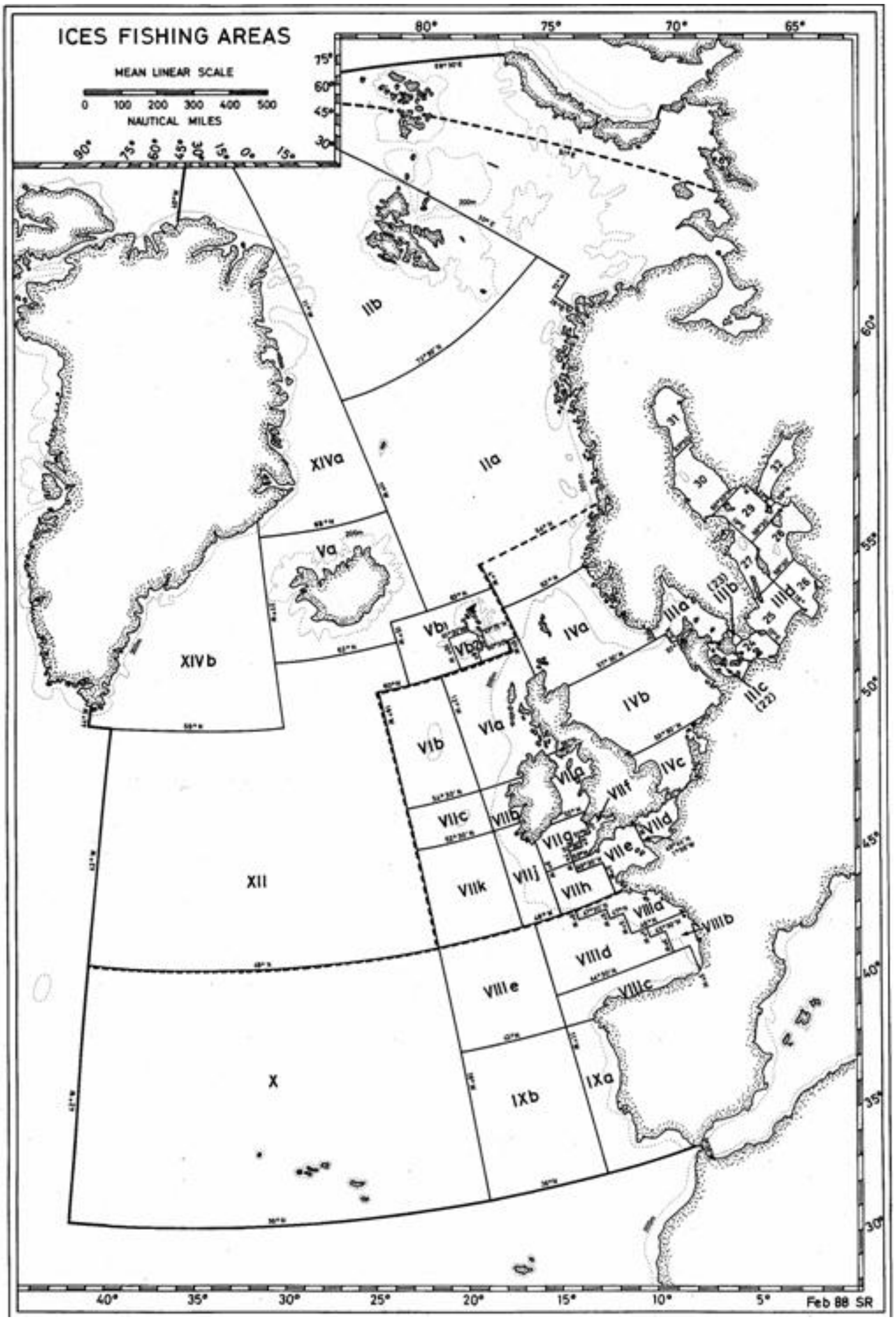


Figure 3.11.1.1. ICES fishing Areas.

4 NORTH AMERICAN COMMISSION

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), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted this definition of CLs. Therefore, the CL is a limit reference point (S_{lim}) which should be avoided with high probability. Management advice for Atlantic salmon is referenced to the S_{lim} conservation limit, therefore stocks assessed here are reported as being outside precautionary limits when the confidence limits of the most recent stock estimate includes S_{lim}.

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

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.

4.1 Status of stocks/exploitation

In 2004, the overall conservation limit (S_{lim}) for 2SW salmon was only met in the Newfoundland area, therefore the stock complexes in the other regions are considered to be outside precautionary limits.

Estimates of pre-fishery abundance suggest a continuing decline of North American adult salmon over the last 10 years. The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has oscillated around a generally declining trend since the 1970s (Figure 4.9.5.2). During 1993 to 2004, the total population of 1SW and 2SW Atlantic salmon was about 600 000 fish, about half of the average abundance during 1972 to 1990. A 21% increase however has occurred between 2001 and 2003, the most recent year for which it is possible to estimate the total population. The decline from earlier higher levels of abundance has been more severe for the 2SW salmon component than for the small salmon (maturing as 1SW salmon) age group.

The returns in 2004 of 2SW fish increased slightly from 2003 in Labrador, Newfoundland, the Gulf of St. Lawrence, and the USA (Figure 4.1.1). In Quebec and Scotia-Fundy, 2SW returns decreased from the previous year. In Newfoundland, the 2SW salmon are a minor age group component of the stocks in this area and even here, decreases of about 30% have occurred from peak levels of a few years ago. Returns of 1SW salmon increased from 2003 in all areas (Figure 4.1.2).

When compared to conservation limits, 2SW spawners in 2004 only exceeded the limit in one area (Newfoundland 113%); the other areas were less than (Gulf 85%, Quebec 70%), or substantially less than (Labrador 32%, Scotia-Fundy 9%, USA 4%) the limits.

In 2004, estimated return rates for 1SW fish improved somewhat in 2 of 3 hatchery stocks, and 10 out of 11 wild stocks compared to 2003. By contrast, 2SW fish estimated return rates in 2004 decreased in 4 of 6 wild stocks and improved in 2 of 3 hatchery stocks compared to 2003. Measures of marine survival rates over time indicate that survival of North America stocks to home waters has not increased as expected as a result of fisheries changes. There have been no significant increasing trends in survival indices of any of the stock components following the commercial closures in 1992.

Based on the generally improved 1SW returns in 2004, an increase is expected for large salmon in 2005 although return rates of 2SW salmon in monitored stocks remain low. An additional concern is the low abundance level of many salmon stocks in rivers in eastern Canada, particularly in the Bay of Fundy and the Atlantic coast of Nova Scotia. USA salmon stocks exhibit these same downward trends. Most salmon rivers in the USA are hatchery-dependent and remain at low levels compared to conservation requirements. Despite major changes in fisheries management, returns have continued to decline in these southern areas and many populations are "listed" and/or currently threatened with extirpation.

The rank of the estimated returns in the 1971–2004 time-series and the proportion of the 2SW conservation limit achieved in 2004 for six regions in North America is shown below:

Region	Rank of 2004 returns in 1971-2004 (1=highest)		Rank of 2004 returns in 1994-2004 (1=highest)		Mid-point estimate of 2SW spawners as proportion of conservation limit (S_{lim})
	1SW	2SW	1SW	2SW	(%)
Labrador	10	22	7	10	32
Newfoundland	4	19	3	8	113
Québec	11	31	2	8	70
Gulf	17	24	2	4	85
Scotia-Fundy	32	33	9	10	9
USA	19	28	7	6	4

Egg depositions by all sea-ages combined in 2004 exceeded or equaled the river specific conservation limits in 43 of the 87 assessed rivers (49%) and were less than 50% of conservation limits in 27 other rivers (31%) (Figure 4.1.3).

4.2 Management objectives

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

4.3 Reference points

In Atlantic Canada, CLs have been set on the basis of stock and recruitment studies which provided for MSY on a limited number of river stocks where data was available, and these derived egg deposition rates were used on the remainder of rivers where only habitat area and spawner demographics were available, as documented in O'Connell *et al.* (1997). The added production from lacustrine areas in SFA 14B of Labrador and throughout Newfoundland was also accommodated. In USA, conservation limits were set following a similar approach. Recently, for stocks in Quebec, stock-recruitment analysis for six local rivers was used to define the CL, defined as the S_{MSY} level at 75% probability level, calculated by Bayesian analysis. For the purposes of management, egg deposition requirements are converted into 2SW fish equivalents.

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

4.4 Advice on management

As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management is necessary. On individual rivers where spawning requirements are being achieved, there may be surplus available for harvest. Advice regarding management of this stock complex in the fishery at West Greenland is provided in Section 5.4.

4.5 Relevant factors to be considered in management

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

4.6 Catch forecast for 2005

Catch options are only provided for the non-maturing 1SW and maturing 2SW components as the maturing 1SW component is not fished outside of home waters, and in the absence of significant marine interceptory fisheries, is managed in homewaters by the producing nations.

It is possible to provide catch advice for the North American Commission area for two years. The revised forecast for 2005 for 2SW maturing fish is based on an updated forecast of the 2004 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2004 as 1SW non-maturing fish. The second is an estimate for 2006 (see Section 4.7) based on the pre-fishery abundance forecast for 2005 from Section 5.6.

The updated forecast of the pre-fishery abundance for 2004 provides a PFA mid-point of 118 600.

In order to compare the PFA to conservation limits, the pre-fishery abundance of 118 600 can be expressed as 2SW equivalents by considering natural mortality of 3% per month for 11 months (a factor of 0.72), resulting in 85 392 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 2004 for both the Labrador (459) and Greenland (2775) fisheries for a total of 3234 2SW salmon equivalents. Adjusted for natural mortality, this equates to 82 158 2SW salmon potentially returning to North America in 2005.

As the predicted number of 2SW salmon returning to North America (82 158) in 2005 is substantially lower than the 2SW conservation limit (S_{lim}) of 152 548, there are no harvest possibilities at forecasted levels (at probability levels of 75%). Harvest possibilities refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management is necessary. On individual rivers where spawning requirements are being achieved, there may be surplus available for harvest.

4.7 Medium- to long-term projections

Catch advice for 2006 fisheries on 2SW maturing salmon

Most catches (85%) in North America now take place in rivers or in estuaries. The commercial fisheries are now closed and the remaining coastal food fisheries in Labrador by aboriginal peoples are mainly located close to river mouths and likely harvest few salmon from other than local rivers. Fisheries are principally managed on a river-by-river basis and, in areas where retention of large salmon is allowed, it is closely controlled.

Catch options which could be derived from the pre-fishery abundance forecast for 2005 (median 120 460) would apply principally to North American fisheries in 2006, and hence the level of fisheries in 2005 needs to be accounted for before providing them.

Accounting for mortality and the conservation limit and considering an allocation of 60% of the surplus to North America, the only risk averse catch option for 2SW salmon in 2006 is “zero” catch. This “zero” catch option refers to the composite North American fisheries.

4.8 Comparison with previous assessment and advice

The revised forecast of the pre-fishery abundance for 2004 provides a PFA mid-point of 118 600. This is about 18% higher than the 100 400 value forecast last year. This is mainly due to slight changes in the input values to the model used to forecast PFA for these stocks, as detailed in Section 5.10.

4.9 NASCO has asked ICES to describe the key events of the 2004 fisheries and the status of the stocks

4.9.1 Gear and effort

Canada

There were no commercial fisheries in Canada in 2004.

Salmon fisheries in the Maritime provinces of Canada are managed by the Department of Fisheries and Oceans in 23 Salmon Fishing Areas (SFAs); and in Québec by the Société de la Faune et des Parcs du Québec, in fishing areas Q1 through Q11 (Figure 4.9.1.1). Three user groups exploited salmon in Canada in 2004: Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. For the first time in 2004, the Labrador Metis Nation was included in arrangements for a food fishery. The Metis fishery was controlled by a negotiated quota of 10 t. On an individual fisher basis, the catch was limited by the issuance of 6 tags, which had to be applied to the fish. No fish could be landed without a tag.

There were no other changes in gear and effort in Canada.

USA

There was no fishery for sea-run Atlantic salmon in the USA in 2004 as a result of angling closures in 1999. Therefore, effort measured by license sales, was zero.

France (Islands of St. Pierre and Miquelon)

In 2004, there were 13 professional and 42 recreational gillnet licenses issued for the fishery that operates between May 1 and July 31. Due to a sharp decline in other fish resources exploited by the professional fishermen (lumpfish, snow crab, and cod), more of them have expressed interest in having salmon licenses. An increase in the number of professional licences could be compensated by a reduction in the number of recreational licences.

Year	Number of Professional Licenses	Number of Recreational Licenses
1995	12	42
1996	12	42

1997	6	36
1998	9	42
1999	7	40
2000	8	35
2001	10	42
2002	12	42
2003	12	42
2004	13	42

4.9.2 Catches in 2004

Catch histories of salmon, expressed as 2SW salmon equivalents, which could have been available to the Greenland fishery, 1972–2004, are provided in Tables 4.9.2.1 and 4.9.2.2. The Newfoundland-Labrador commercial fisheries were historically, mixed stock fisheries and harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. Mortalities within North America peaked at about 365 000 in 1976 and are now about 13 200 2SW salmon equivalents. In the most recent five years estimated (that is those since the closure of the Labrador commercial fishery), those taken as non-maturing fish in Labrador comprise 3%, or less, of the total in North America.

Of the North American fisheries on the cohort destined to be 2SW salmon, 74% of the catch comes from terminal fisheries in the most recent year. This value has ranged from as low as 20% in 1973, 1976 and 1987 to values of 74–91% in 1996–2004 fisheries (Table 4.9.2.1). The percentage increased significantly since 1992 with the reduction and closures of the Newfoundland and Labrador commercial mixed stock fisheries however this value decreased in 2004 to 74% from 83% in 2003. The number of 2SW salmon equivalents taken in the food fisheries in Labrador (3412) in 2004 was the highest since the commercial fishery closed in 1997.

The percentage of the total 2SW equivalents that have been harvested in North American waters has ranged from 48–100%, with the most recent year estimated at 87% (Table 4.9.2.2.)"

Canada

The provisional harvest of salmon in 2004 by all users was 159 t, about 13% higher than the 2003 harvest (Figure 4.9.2.1). The 2004 harvest was 52 726 small salmon and 12 941 large salmon, 13% more small salmon and 15% more large salmon, compared to 2003.

Aboriginal food fishers accounted for harvests in 2004 of 60.4 t, about 18 400 fish (56% small by number) and were up 35% from both the 2003 and the previous 5-year average harvest, while for residents fishing for food in Labrador the estimated catch in 2004 was 2.2 t, about 880 fish (75% small salmon by number).

Harvest in recreational fisheries in 2004 totalled 46 377 small and large salmon, 2% below the previous 5-year average, 8% above the 2003 harvest level, and the second lowest total harvest reported (Figure 4.9.2.2). The small salmon harvest of 41 802 fish was 3% below the previous 5-year mean. The large salmon harvest of 4575 fish was about 2% greater than the previous five-year mean. Small and large salmon harvests were up 9% and down 3% from 2003, respectively. In 2004, about 57 000 salmon were caught and released, representing about 55% of the total number caught. This was a 6% increase from the number released in 2003.

Unreported catches in Canada were estimated at about 118 t.

USA

All fisheries (commercial and recreational) for sea-run Atlantic salmon within the USA remained closed, including rivers previously open to catch-and-release fishing. Thus, there was no legal harvest of sea-run Atlantic salmon in the USA in 2004.

Unreported catches in the USA were estimated to be 0 t.

France (Islands of St. Pierre and Miquelon)

The total harvest in 2004 was reported to be 2.8 t from professional and recreational fishers, about the same as in 2003 and among the largest recorded since 1983. There was no estimate of unreported catch.

4.9.3 Origin and composition of catches

The Aboriginal peoples' and resident food fisheries that exist in Labrador may intercept some salmon from other areas of North America although there are no reports of tagged fish being captured there. The fisheries of Saint-Pierre and Miquelon catch salmon of North American origin. Sampling was carried out on this fishery in 2003 and 2004 (Section 4.11).

The returns in 2004 to the majority of the rivers in Newfoundland and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon. Hatchery-origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy, the Atlantic coast of Nova Scotia, and the USA.

Aquaculture escapees were noted in the returns to the Magaguadavic and St. Croix rivers of the Bay of Fundy. In the Magaguadavic River, which is located in close proximity to the centre of both the Canadian and USA east coast salmon farming areas, the proportion of the adult run composed of fish farm escapees has been high (greater than 50%) since 1994 and 89% in 2004. However, while fish farm escapees have dominated the run in terms of percentages, in absolute terms, their numbers have been trending downwards. Fish farm escapees were also monitored in the international St. Croix River (Canada/USA border), and Maine's Dennys, Narraguagus, and Union rivers. Percentages of returns that were fish farm escapees in the returns to the St. Croix in 2004 were 29%, whereas no escapees were noted in the USA rivers.

4.9.4 Exploitation rates

Canada

There is no exploitation by commercial fisheries and exploitation rates for the remaining fisheries have not been reported.

USA

There was no exploitation of USA salmon in home waters.

4.9.5 Pre-Fishery Abundance

ICES used the North American run-reconstruction model to estimate pre-fishery abundance, which serves as the basis of abundance forecasts used in the provision of catch advice. The catch statistics used to derive returns and spawner estimates are routinely updated from those used in the previous year (ICES 2004/ACFM:20). In addition, in 2005, ICES revised the basis for updating estimates of returns and spawners for Labrador, as follows:

The basis for estimates of 2SW and 1SW salmon returns and spawners for Labrador (SFAs 1, 2 & 14B) prior to 1998 are catch data from angling and commercial fisheries. In 1998, the commercial fishery in Labrador was closed and so the model developed to determine returns and spawners from commercial catch data could not be used. In 2002–2004, salmon counting facilities were installed on four out of about 100 Labrador rivers with salmon (one in SFA 1B, northern Labrador and three in SFA 2).

Based on three years of data, small and large salmon returns per accessible drainage area in these four rivers were extrapolated to accessible drainage areas of unmonitored rivers in Labrador. The accessible drainage areas in Labrador were 9267 km^2 for Lake Melville (SFA 1A), 25 485 km^2 for northern Labrador (SFA 1B), 28 160 km^2 for southern Labrador (SFA 2), and

2651 km^2 for the Straits Area (SFA 14B). Accessible drainage area in the monitored rivers was 1878 km^2, resulting in an expansion factor of 35 to one.

Not all rivers in Lake Melville were included due to a lack of information on the presence of salmon. ICES recognized that this was a crude method for deriving returns and spawners for Labrador and encouraged the installation of additional counting facilities and collection of additional information on drainage areas and salmon occurrence, particularly for Lake Melville.

Comparison of PFA values including the new data for deriving returns and spawners for Labrador, 2002–2004, indicated only minor differences in results between old and new PFA values. Thus, ICES adopted these PFA values for predictive purposes and the provision of catch advice.

As the pre-fishery abundance estimates for potential 2SW salmon requires estimates of returns to rivers, the most recent year for which an estimate of PFA is available is 2003. This is because pre-fishery abundance estimates for 2004 require 2SW returns to rivers in North America in the year 2005. The 2003 abundance estimates ranged between 78 572 and 146 249 salmon. The mid-point of this range (112 410) is almost identical to the 2002 value (112 282) and is the 5th lowest in the 32-year time-series (Figure 4.9.5.1). Even though the 2003 value has increased by 33% from the 84 561 value in 2001, which was the lowest in the time-series, the general trend towards lower values in recent years is still evident and current year values are still much lower than the 917 282 in 1975.

For the 1SW cohort, the mid-point values of the pre-fishery abundance are shown in Figure 4.9.5.1. The mid-point of the range of pre-fishery abundance estimates for 2004 (456 002) is 15% higher than in 2003 (395 831) and 48% higher than the low 1994 value of 309 034, which was the lowest estimated in the time-series 1971–2004. The reduced values observed in 1978 and 1983–84 and 1994 were followed by large increases in pre-fishery abundance.

Although the declining trend appears common to both maturing and non-maturing (Figure 4.9.5.2) portions of the cohort, non-maturing 1SW salmon have declined further.

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

New management measures introduced in Labrador in 2004 resulted in changes within allocations among Aboriginal peoples' food fisheries. It is not possible yet to evaluate the effects of these management measures.

4.11 NASCO has asked ICES to provide an analysis of any new biological and/or tag return data to identify the origin and biological characteristics of Atlantic salmon caught at St. Pierre and Miquelon

Sampling of the fishery took place in both 2003 and 2004 and was reported to ICES in 2005. The sampling programme was designed to provide a representative sample of the fishery. Approximately 30% of the reported catch was sampled in each year:

	2003	2004
No. periods	12	11
Sampling Time Period	June 4 – July 6	June 5 – June 29
Gutted weight sampled (kg)	872	837

Number of fish sampled	340	355
Fish sampled for scales	0	166
Fish sampled for genetics	0	25

The size distribution of fish sampled was similar in both years. Two distinct size modes were noted, with the smaller fish averaging approximately 56 cm and the larger fish averaging approximately 76 cm. The smaller sized fish represented about 80% of those sampled.

Scale analysis provided information on the age of salmon captured in the fishery in 2004. There were three sea-ages noted in the 143 usable scale samples: 1SW (81.1%), 2SW (18.2%), and a repeat spawner (0.7%). River-age distributions (based on 141 fish) were: river-age 1 (0.7%); 2 (29.8%); 3 (49.7%); 4 (17.7%), and 5 (2.1%).

Results were not yet available on the genetic origin of the 25 sampled fish. The river-age distribution is generally characteristic of eastern Canadian wild stocks, except for the single river-age 1 fish, which likely originated from a hatchery in Canada or from a hatchery or river in the USA. No tag returns were obtained from this fishery in 2004.

4.12 Data deficiencies and research needs

Data deficiencies and research needs are presented in Section 6.

Table 4.9.2.1 Catches expressed as 2SW salmon equivalents in North American salmon fisheries, 1972-2005.
Only mid-points of the estimated values have been used.

	CANADA												
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i						USA	Total	
Year i	NF-LAB Comm 1SW (Year i-1) (b)	Year i % 1SW of total 2SW equivalents	Year i NF-LAB Comm 2SW (b)	Year i NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total			Terminal Fisheries as a % of Total
1972	20,857	9	153,775	174,632	314	633	27,417	22,389	6,801	232,186	346	232,532	25
1973	17,971	6	219,175	237,146	719	895	32,751	17,914	6,680	296,105	327	296,433	20
1974	24,564	7	235,910	260,475	593	542	47,631	21,430	12,734	343,405	247	343,652	24
1975	24,181	7	237,598	261,779	241	528	41,097	15,677	12,375	331,696	389	332,085	21
1976	35,801	10	256,586	292,388	618	412	42,139	18,090	11,111	364,758	191	364,949	20
1977	27,519	8	241,217	268,736	954	946	42,301	33,433	15,562	361,932	1,355	363,287	26
1978	27,836	11	157,299	185,135	580	559	37,421	23,806	10,781	258,281	894	259,175	29
1979	14,086	10	92,058	106,144	469	144	25,234	6,300	4,506	142,798	433	143,231	26
1980	20,894	6	217,209	238,103	646	699	53,567	29,832	18,411	341,257	1,533	342,789	31
1981	34,486	11	201,336	235,822	384	485	44,375	16,329	13,988	311,383	1,267	312,650	25
1982	34,341	14	134,417	168,757	473	433	35,204	25,709	12,353	242,929	1,413	244,342	31
1983	25,701	12	111,562	137,263	313	445	34,472	27,097	13,515	213,105	386	213,491	36
1984	19,432	14	82,807	102,238	379	215	24,408	5,997	3,971	137,210	675	137,884	26
1985	14,650	11	78,760	93,410	219	15	27,483	2,708	4,930	128,765	645	129,410	28
1986	19,832	12	104,890	124,723	340	39	33,846	4,542	2,824	166,313	606	166,919	25
1987	25,163	13	132,208	157,371	457	20	33,807	3,757	1,370	196,781	300	197,082	20
1988	32,081	21	81,130	113,211	514	29	34,262	3,832	1,373	153,220	248	153,468	26
1989	22,197	16	81,355	103,551	337	9	28,901	3,426	265	136,488	397	136,886	24
1990	19,577	18	57,359	76,937	261	24	27,986	2,700	593	108,501	696	109,197	30
1991	12,048	14	40,433	52,481	66	16	29,277	1,777	1,331	84,949	231	85,180	38
1992	9,979	14	25,108	35,087	581	67	30,016	2,673	1,114	69,539	167	69,706	50
1993	3,229	8	13,273	16,502	273	63	23,153	1,211	1,110	42,312	166	42,478	61
1994	2,139	5	11,938	14,077	355	165	24,052	2,206	756	41,612	1	41,613	66
1995	1,242	3	8,677	9,918	331	155	23,331	2,007	330	36,073	0	36,073	73
1996	1,075	3	5,646	6,721	273	183	22,413	2,389	766	32,746	0	32,746	79
1997	969	4	5,390	6,360	155	157	18,574	1,849	581	27,675	0	27,675	77
1998	1,155	7	1,872	3,027	276	112	11,256	2,238	322	17,231	0	17,231	82
1999	179	1	894	1,073	311	72	9,032	1,127	450	12,064	0	12,064	91
2000	152	1	1,115	1,267	404	218	9,425	1,714	193	13,221	0	13,221	90
2001	286	2	1,380	1,666	336	102	10,104	616	255	13,079	0	13,079	87
2002	263	3	1,185	1,448	221	152	7,297	309	179	9,606	0	9,606	85
2003	312	3	1,794	2,106	221	68	8,870	590	189	12,045	0	12,045	83
2004	355	3	3,057	3,412	221	59	8,827	635	105	13,260	0	13,260	74
2005	459			459						459		459	

NF-Lab comm as 1SW = NC1(mid-pt) * 0.677057 (M of 0.03 per month for 13 months to July for Canadian terminal fisheries)
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.970446 (M of 0.03 per month for 1 month to July of Canadian terminal fisheries)
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998-2004and resident food fishery harvest in 2000-2004

Table 4.9.2.2. Catches of North American salmon expressed as 2SW salmon equivalents, 1972 2005, in North America and Greenland

Year	Canadian Total	USA Total	North America Total	% USA of Total North American	Greenland Total	NW Atlantic Total	Harvest in homewaters as % of total NW Atlantic
1972	232,186	346	232,532	0.15	206,814	439,346	53
1973	296,105	327	296,433	0.11	144,348	440,781	67
1974	343,405	247	343,652	0.07	173,615	517,267	66
1975	331,696	389	332,085	0.12	158,583	490,668	68
1976	364,758	191	364,949	0.05	200,464	565,413	65
1977	361,932	1,355	363,287	0.37	112,077	475,364	76
1978	258,281	894	259,175	0.34	136,386	395,561	66
1979	142,798	433	143,231	0.30	85,446	228,677	63
1980	341,257	1,533	342,789	0.45	143,829	486,618	70
1981	311,383	1,267	312,650	0.41	135,157	447,807	70
1982	242,929	1,413	244,342	0.58	163,718	408,060	60
1983	213,105	386	213,491	0.18	139,985	353,476	60
1984	137,210	675	137,884	0.49	23,897	161,781	85
1985	128,765	645	129,410	0.50	27,978	157,388	82
1986	166,313	606	166,919	0.36	100,098	267,017	63
1987	196,781	300	197,082	0.15	123,472	320,553	61
1988	153,220	248	153,468	0.16	124,868	278,336	55
1989	136,488	397	136,886	0.29	83,947	220,832	62
1990	108,501	696	109,197	0.64	43,634	152,831	71
1991	84,949	231	85,180	0.27	52,560	137,740	62
1992	69,539	167	69,706	0.24	79,571	149,277	47
1993	42,312	166	42,478	0.39	30,091	72,569	59
1994	41,612	1	41,613	0.00	0	41,613	100
1995	36,073	0	36,073	0.00	0	36,073	100
1996	32,746	0	32,746	0.00	15,343	48,089	68
1997	27,675	0	27,675	0.00	15,776	43,451	64
1998	17,231	0	17,231	0.00	12,088	29,319	59
1999	12,064	0	12,064	0.00	2,175	14,240	85
2000	13,221	0	13,221	0.00	3,863	17,084	77
2001	13,079	0	13,079	0.00	4,005	17,084	77
2002	9,606	0	9,606	0.00	6,989	16,596	58
2003	12,045	0	12,045	0.00	1,627	13,672	88
2004	13,260	0	13,260	0.00	1,958	15,218	87
2005	459	-	459	-	2,755	-	-

Greenland harvest of 2SW equivalents = NG1 * 0.718924 (M of 0.03 per month for 11 months to July of Canadian terminal fisheries)

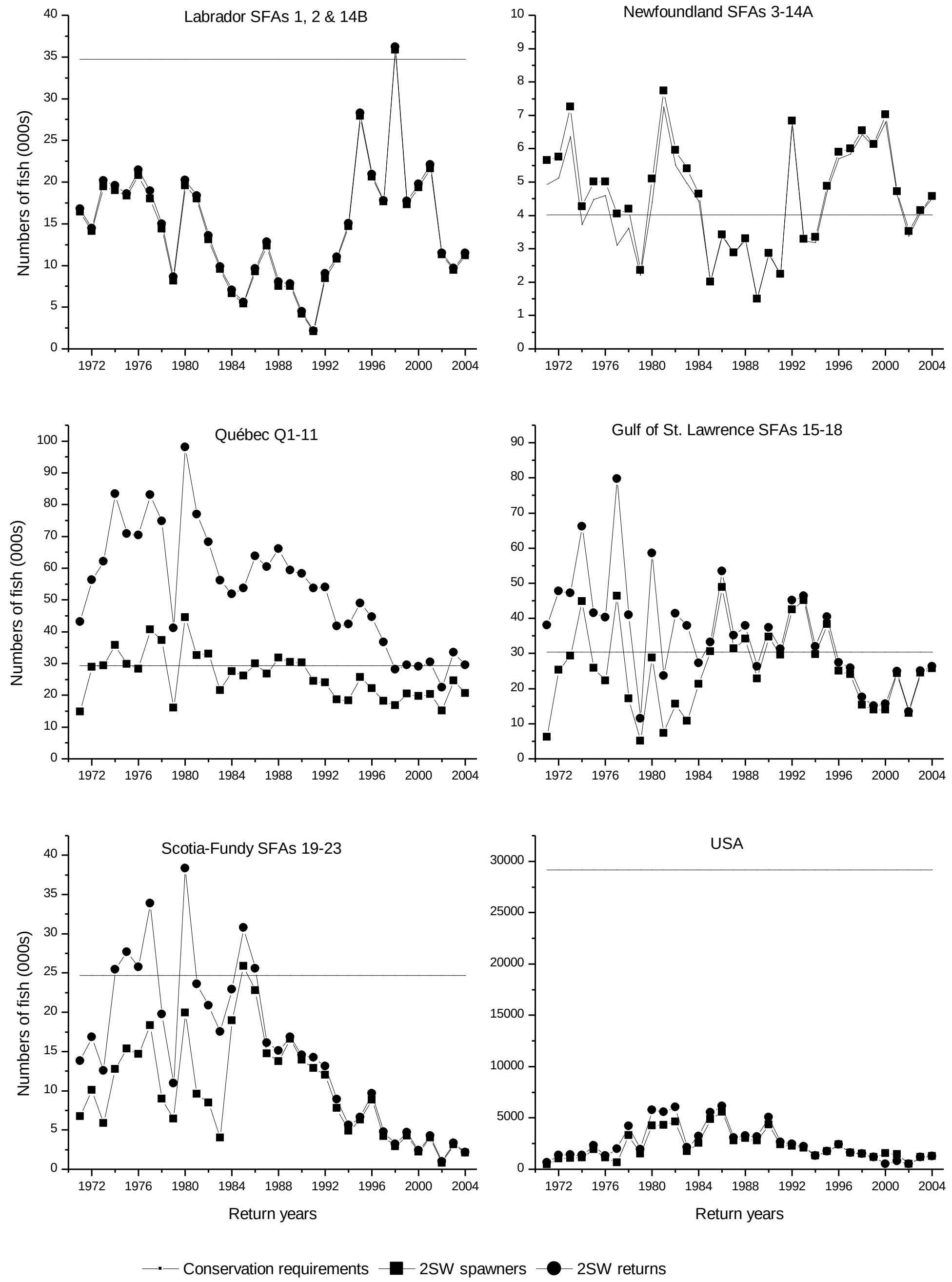


Figure 4.1.1 Comparison of estimated mid-points of 2SW returns, 2SW spawners, and 2SW conservation requirements for six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

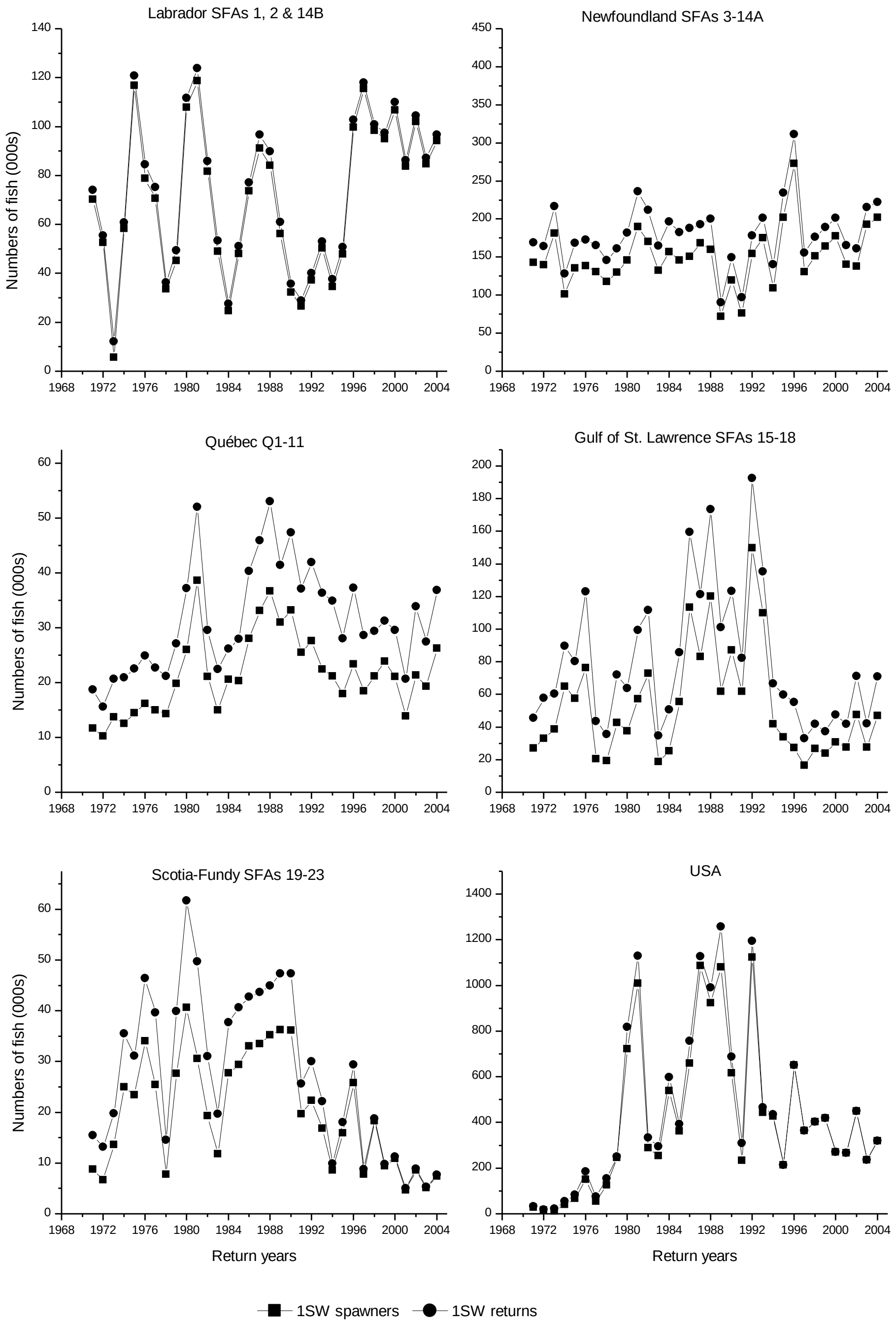


Figure 4.1.2 Comparison of estimated mid-points of 1SW returns to and 1SW spawners in rivers of six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

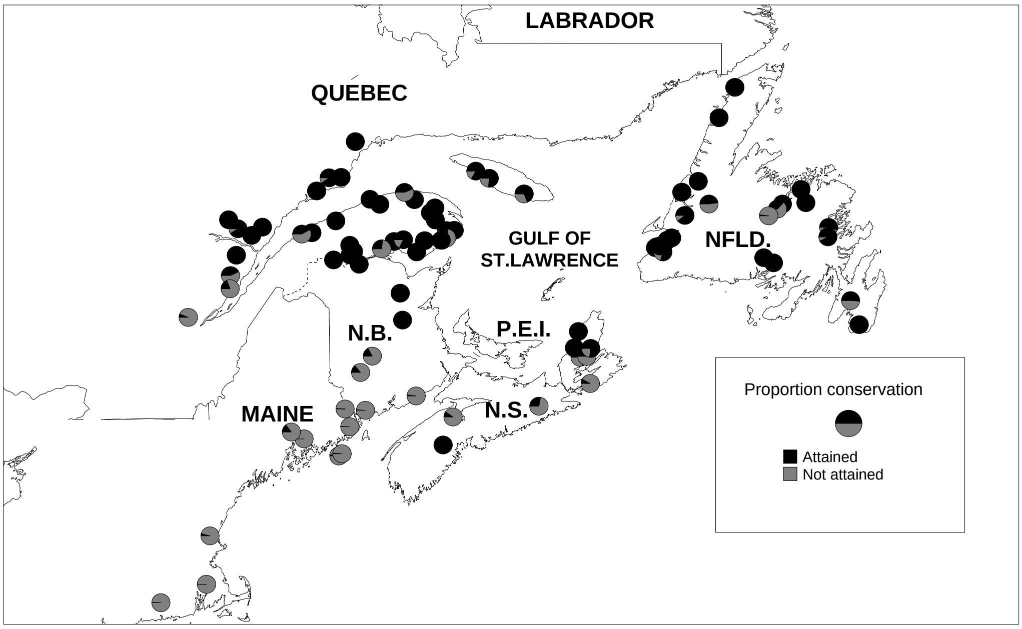


Figure 4.1.3 Proportion of the conservation requirement attained in assessed rivers of the North American Commission Area in 2004.

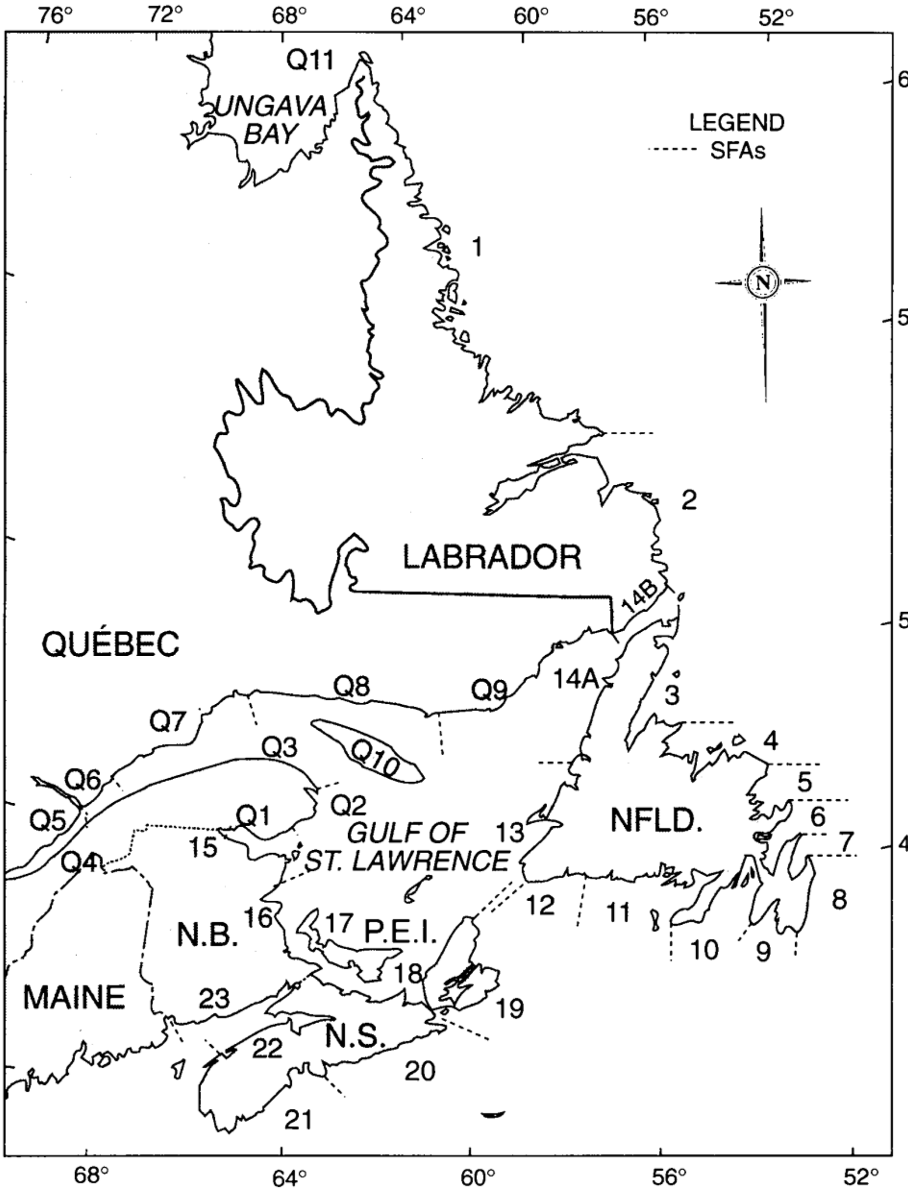


Figure 4.9.1.1. Map of Salmon Fishing Areas (SFAs) and Quebec Management Zones (Qs) in Canada.

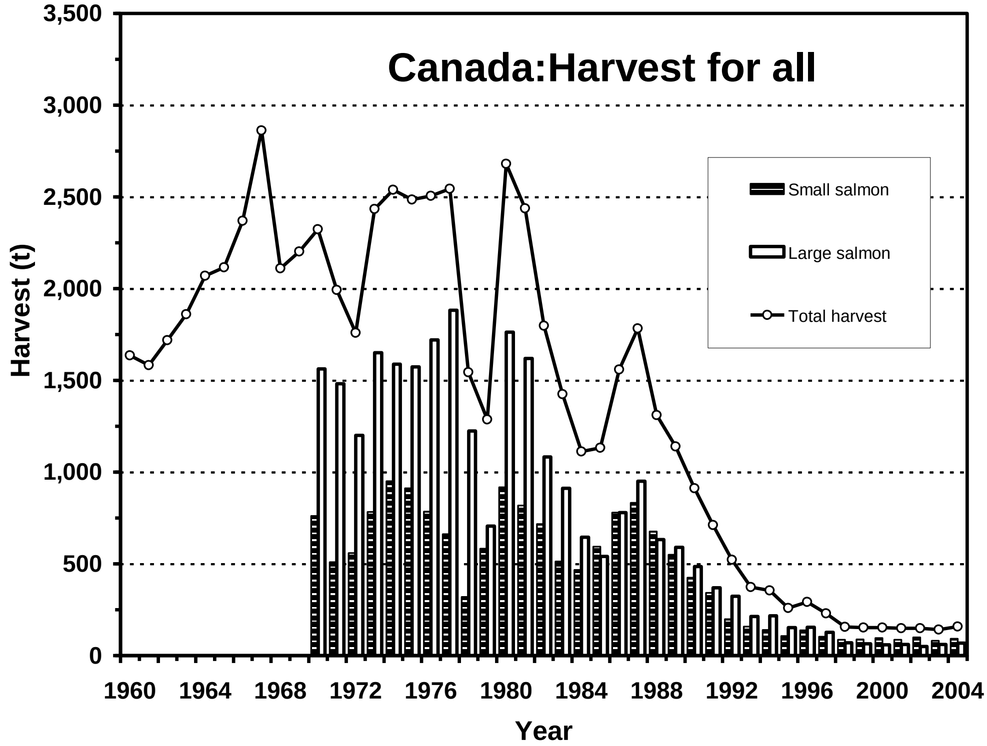


Figure 4.9.2.1. Harvest (t) of small salmon, large salmon, and combined for Canada, 1960–2004 by all users.

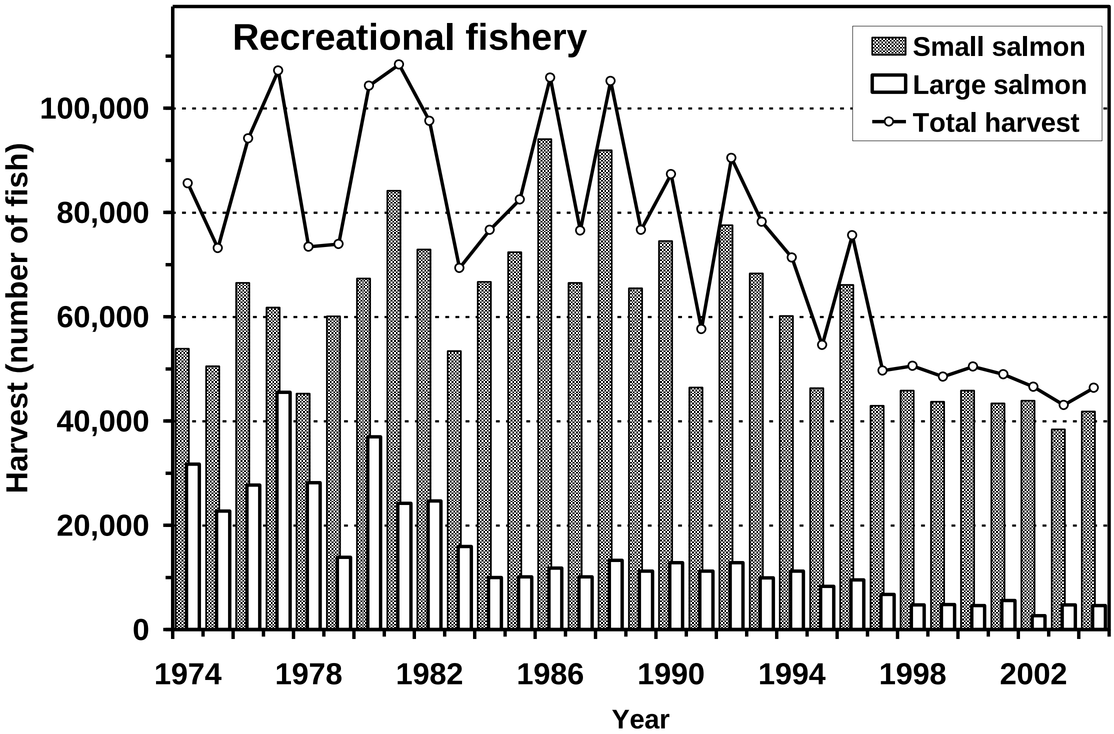


Figure 4.9.2.2. Harvest (number) of small and large salmon and both sizes combined in the recreational fisheries of Canada, 1974 to 2004.

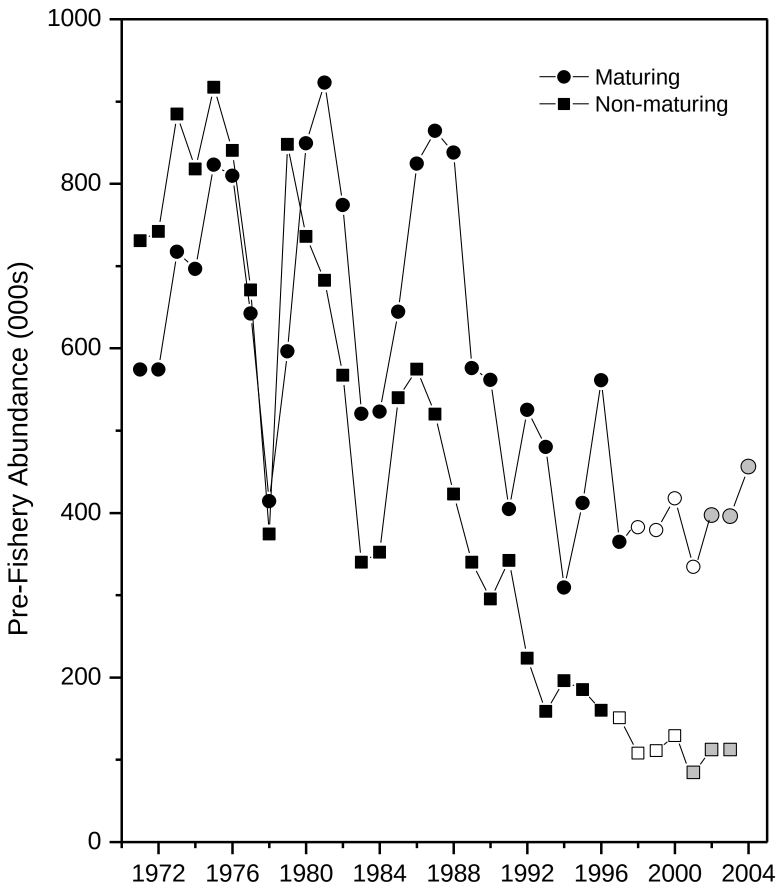


Figure. 4.9.5.1. Pre-fishery abundance estimate of maturing and non-maturing salmon in North America. Open symbols are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America and grey symbols are returns estimated from returns per unit of drainage area.

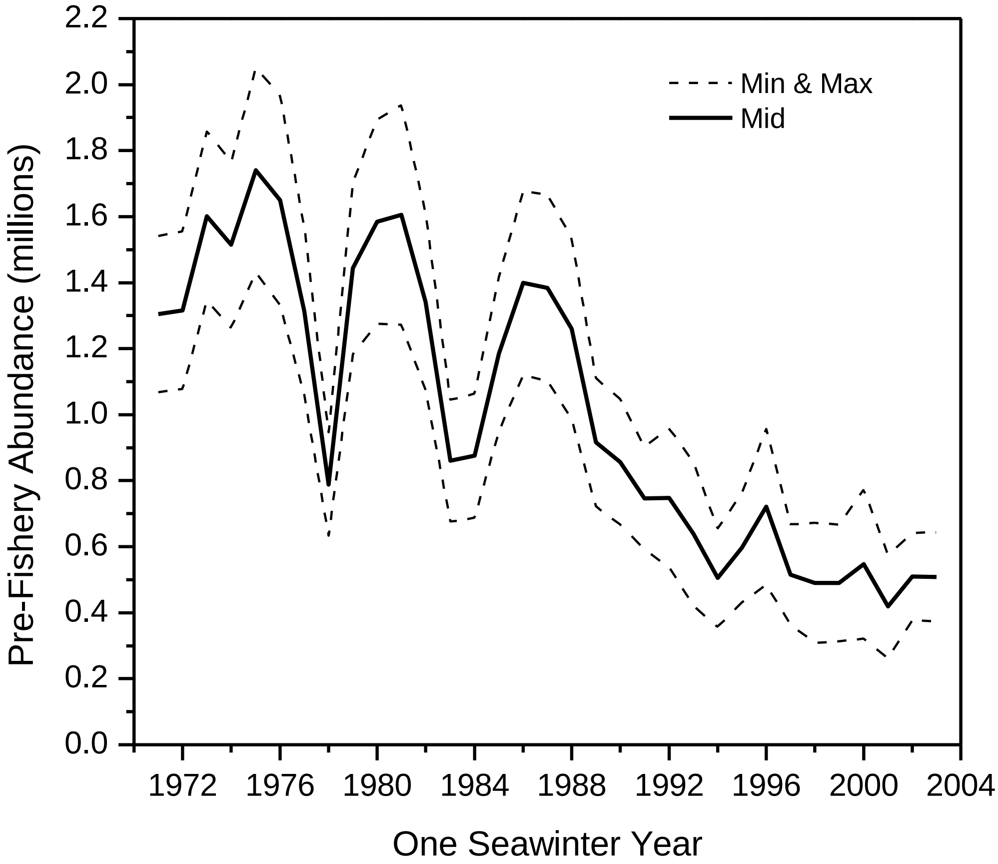


Fig. 4.9.5.2. Total 1SW recruits (non-maturing and maturing) originating in North America.

5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION

5.1 Status of stocks/exploitation

ICES considers the stock complex at West Greenland to be **outside precautionary limits**.

The salmon caught in the West Greenland fishery are mostly (>90%) non-maturing 1SW salmon, most of which would be destined to return to homewaters in Europe or North America as MSW fish if they survived. There are also 2SW salmon and repeat spawners. The most abundant European stocks in West Greenland are thought to originate from the UK and Ireland, although low numbers may originate from northern European rivers. Most MSW stocks in North America are thought to contribute to the fishery at West Greenland.

North American stocks

ICES notes that the North American stock complex of non-maturing salmon has declined to record low levels and is in tenuous condition. The forecast PFA for this stock complex for 2005 is 120 400. Despite the closure of Newfoundland (1992), Labrador (1998), and Québec (2000) commercial fisheries, sea survival of adults returning to rivers has not improved and in some areas has declined further. The abundance of maturing 1SW salmon has also declined in many areas of eastern North America. Smolt production in 2003 and 2004 in monitored rivers of eastern Canada was similar to the average of the last five years. Unless sea survival improves, the abundance of non-maturing 1SW salmon in the Northwest Atlantic is not expected to increase above the levels of the last five years and is more likely to decline.

A summary of the stock status by region is provided below:

Newfoundland:	2SW spawners are within precautionary limits.
Labrador:	2SW spawners are outside precautionary limits (32% of 2SW S_{lim}).
Québec:	2SW spawners are outside precautionary limits (70% of 2SW S_{lim}).
Gulf of St. Lawrence:	2SW spawners are outside precautionary limits (85% of 2SW S_{lim}).
Scotia-Fundy:	2SW spawners are outside precautionary limits (9% of 2SW S_{lim}).
United States:	2SW spawners are outside precautionary limits (4% of 2SW S_{lim}). Stocks in 8 rivers are listed as Endangered under the Endangered Species Act

ICES noted that tentative exploitation rates for non-maturing 1SW fish at West Greenland can be calculated by dividing the recorded harvest of 1SW salmon of North American origin at West Greenland by the PFA estimate for the corresponding year. This indicates that exploitation rates in the last five years have averaged around 5% compared to values prior to 1993 averaging 26%, and suggests that recent management measures in this fishery have reduced exploitation in this stock complex.

European stocks

ICES also noted that the non-maturing 1SW salmon from southern Europe have been declining steadily since the 1970s (Figure 3.6.1), and the preliminary quantitative prediction of pre-fishery abundance for this stock complex is low for 2005 (486 000 fish).

The main contributor to the abundance of the European component of the West Greenland stock complex is non-maturing 1SW salmon from southern Europe. The percentage of European fish in catches at West Greenland was around 30% in the early 1990s and the 2000s, but was below 20% from 1996 to 1999. The contributions of countries within NEAC, based on historic tagging data are: France, 2.7%; Ireland, 14.7%; UK (England &Wales), 14.9%; UK (Northern Ireland), <0.01%; UK (Scotland), 64.5%; and northern NEAC countries, 3.2%.

Southern European MSW salmon stocks in the NEAC area consistently declined over the past 10–15 years, and the stock complex has been outside precautionary limits in recent years.

A summary of the status of multi-sea winter (MSW) stocks known to contribute to the West Greenland fishery and which originate from the southern NEAC countries is presented below:

France:	MSW spawners are outside precautionary limits
Ireland:	MSW spawners are outside precautionary limits
UK (England & Wales):	MSW spawners are outside precautionary limits
UK (Northern Ireland):	MSW spawners are within precautionary limits
UK (Scotland):	MSW spawners are outside precautionary limits

The status of stocks in the NEAC and NAC areas are presented in the relevant commission sections of this report.

ICES notes that the relative proportions of the historical and forecast PFA values for the NAC and southern NEAC stock complexes are not consistent with the relative proportions of the NAC and Southern NEAC salmon in the fishery at West Greenland, as determined from the sampling programme (Section 5.9). The reasons for this apparent discrepancy are not immediately obvious but warrant further investigation.

5.2 Management objectives

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), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted this definition of CLs (NASCO, 1998). Therefore, the CL is a limit reference point (S_{lim}) which should be avoided with high probability. Management advice for Atlantic salmon is referenced to the S_{lim} conservation limit.

For management advice for the West Greenland fishery, NASCO has adopted a precautionary management plan:

- NASCO considers quotas at West Greenland with the management objectives of meeting the conservation limits (S_{lim}) simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf.
- Further, for the two southern regions, Scotia-Fundy and USA, where there is a zero chance of meeting conservation limits, the alternate objective has been to achieve increases in returns relative to previous years with the hope that this may lead to the rebuilding of stocks.
- In 2004, ICES established 1992 to 1996 as the range of years to define the baseline for the Scotia-Fundy and USA regions to assess PFA_{NA} abundance and fishery options. Improvements of greater than 10% and greater than 25% relative to returns during this base period are evaluated.

The management plan in place for this stock complex at West Greenland does not require that this total conservation requirement is achieved, this provides NASCO with consistent criteria to assess performance of the fisheries management being considered. Although not a formal management objective, ICES also calculates the probability of returns to North America being equal or less than the previous five-year average when considering the current low marine survival and the recent status of the stock complex.

5.3 Reference points

Sampling of the fishery at West Greenland since 1985 has shown that European and North American stocks harvested are primarily (greater than 90%) 1SW non-maturing salmon destined to mature as either 2 or 3SW salmon. Usually less than 3% of the harvest is composed of salmon that have previously spawned and a few percent are 2SW salmon that would mature as 3SW or older salmon. Therefore, conservation limits defined for North American stocks have been limited to the 2SW salmon. These numbers have been documented previously by ICES and are in Section 4.3. The 2SW spawner limits of salmon stocks from North America total 152 548 fish.

Conservation limits for the NEAC area have been split into 1SW and MSW components on the basis of the average age composition of catches in the past ten years. The stocks have also been partitioned into northern and southern stock complexes, as tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern stock complex. The current conservation limit estimate for southern European MSW stocks is approximately 278 000 fish (Section 3.3). There is still considerable uncertainty in the conservation limits for European stocks and estimates may change from year to year as the input of new data affects the estimate of CL from the pseudo-stock-recruitment relationship.

5.4 Advice on management

ICES provides management advice for the West Greenland fishery, based on the NAC stocks, and for the combined NAC and NEAC stock complexes.

ICES advises that there should be no catch on these stock complexes in 2005 at West Greenland.

Analyses carried out in Section 4 illustrate that attainment of CLs for the NAC stock complex is highly sensitive to the magnitude of catch at West Greenland. Therefore, where catches are allowed, it is imperative that fishing is closely monitored and full details are provided to ICES (Section 5.9.1).

5.5 Relevant factors to be considered in management

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

5.6 Catch forecast for 2005

Catch forecast for the NAC area

For 2005, the PFA_{NA} forecast remains among the lowest of the time-series with a median value of 120 400 fish and a 75% probability that the abundance will be less than 153 200 fish (i.e. highly unlikely to meet the 2SW spawner reserve of 212 189 salmon to North America) (Figure 5.6.1). In the absence of any marine-induced fishing mortality, there is a very low probability (9% probability) that the returns of 2SW salmon to North America in 2006 will be sufficient to meet the conservation requirements of the four northern regions (Labrador, Newfoundland, Quebec, and Gulf) (Table 5.6.1). There is essentially no chance (<1%) that the returns in the southern regions (Scotia-Fundy and USA) will be greater than the returns observed in the 1992 to 1996 base period.

None of the stated management objectives would allow a fishery to take place.

Furthermore, ICES notes that even in the absence of a fishery there is a 64% probability that returns of 2SW fish in these regions in 2006 will be less than the average of the period 1999 to 2003.

Catch forecast for the NAC/NEAC combined

ICES followed the process developed last year for providing catch advice for West Greenland, using the PFA and CLs of the NAC and NEAC areas. The PFA for NAC and NEAC are applied in parallel to the Greenland fishery and then combined at the end of the process into a single catch advice table. In the absence of any fishery at West Greenland, there is a less than 75% probability that the MSW conservation limit for southern Europe will be met (Table 5.6.1).

None of the stated management objectives in NAC or NEAC would allow a fishery to take place.

5.7 Medium- to long-term projections

Projections of PFA are not made beyond one year for either the NAC or the NEAC. Based on available lagged spawners the provision of catch advice for the West Greenland fishery would be possible up to 2007. However, to extend the forecast, a number of assumptions in addition to those within the current models would need to be made. In order to progress with this objective, ICES carried out further exploratory analyses (Section 2.3.5) to extend PFA predictions over medium- and long-term (5 and 20 years) time scales.

5.8 Comparison with previous assessment and advice

The current modelling approach was applied to the PFA_{NA} series that now includes the 2003 PFA to update the 2004 forecast. The median value of the updated analysis has increased to 114 600 fish from 100 000 based on the previous year's model and data. The upper bound on the distribution remained unchanged.

5.9 NASCO has requested ICES to describe the events of the 2004 fishery and status of the stocks

At its annual meeting in June 2004 NASCO agreed to restrict the fishery at West Greenland *to that amount used for internal subsistence consumption in Greenland, which in the past has been estimated at 20 t*. Consequently, the Greenlandic authorities set the commercial quota to nil, i.e. landings to fish plants, sale of salmon to shops, and commercial export of salmon from Greenland was forbidden. Licensed fishermen were allowed to sell salmon at the open markets, to hotels, restaurants, and institutions. A private fishery for personal consumption without a license was allowed. All catches, licensed and private, were to be reported to the License Office on a daily basis. In agreement with the Organisation for Fishermen and Hunters in Greenland the licensed fishery for salmon was allowed from the 9th of August to the end of the year. The consequences in terms of overall catches of extending the allowed fishing period are unknown.

5.9.1 Catch and effort in 2004

By the end of the season a total of 14.7 t of landed salmon were reported. In total, 169 reports were received. The geographical distribution of the reported catches differed from all recent years with catches in NAFO Div. 1A and 1B comprising approximately 27% of landings reported. The catch from NAFO Division 1F was less than 15% of the reported landings (Table 5.9.1.1). In the last few years approximately 50% of the catch was in NAFO Div 1F. The catch was distributed relatively evenly across the weeks, perhaps even increasing in weeks 44 and 45. In the last few years, reported catches decreased during the season.

The number of active participants in the salmon fishery has decreased sharply since 1987, when a catch of more than 900 tons was allowed and more than 500 licenses were active in the fishery. In 2004 there were 151 licenses issued, similar to the 152 in 2003. In 2004, of the 66 fishers who reported catch, only 24 were licensed. However, the total number of fishers reporting is an increase from approximately 40 active fishers in 2002 and 2003. ICES notes that sampling provided more fish than were reported in Nuuk, confirming that the nominal catch is an underestimate. In addition, ICES has been unable to estimate average CPUE values for several years.

There is presently no quantitative approach to estimating the magnitude of personal consumption or subsistence fishing in this fishery. Since 2000, an arbitrary figure for unreported catch of 10 t has been proposed; however, there is no method to verify the accuracy.

5.9.2 Biological characteristics of the catches

The international programme to sample landings at West Greenland has continued. The sampling program in 2004 included sampling teams from Greenland, Ireland, United Kingdom, and United States. Teams were in place at the start of the fishery and continued through October. In total, 1890 specimens, representing 40% by weight of the reported landings, were sampled for presence of tags or fork length, weight, scales, and tissue samples for DNA analysis. The broad geographic distribution of the subsistence fishery caused practical problems for the sampling teams. However, the sampling program adequately sampled the Greenland catch temporally. The sampling teams at Nuuk sampled larger amounts of salmon than reported for sale in the official statistics. Therefore, the total reported landings were corrected for the total weight of fish sampled for assessment purposes.

Tissue and biological samples were collected from three landing sites: Qaqortoq (NAFO Div. 1F), Nuuk (NAFO Div. 1D), and Maniitsoq (NAFO Div. 1C) (Figure 5.9.1.1). Biological characteristics (length, weight, or age) were recorded from approximately 1800 fish in catches from NAFO Div. 1C, 1D and 1F in 2004 (Table 5.9.1.1). The smallest fish sampled was 54 cm fork length and weighed 1.46 kg gutted weight, while the largest was 95 cm and weighed 10.30 kg. The average weight of a fish from the 2004 catch was 3.18 kg, with North American 1SW fish averaging 64.7 cm and European 1SW fish averaging 64.2 cm in length (Table 5.9.1.1). The mean lengths and mean weights for the 2004 samples were among the highest in the last decade.

The river ages of European salmon ranged from 1 to 5 (Table 5.9.1.1). Over half (58%) of the European fish in the catch were river-age 2 and 20% were river-age 3. Although the proportion of the European origin river-age 1 salmon in the catch has been variable in the last 15 years, it has been between 9% and 18% since 2001. North American salmon up to river-age 6 were caught at West Greenland in 2004, with over half being river-age 3 (52%).

In 2004, 97% of the European samples were 1SW salmon, with previous spawners 0.2% of the samples and 2SW salmon 2.8%. One sea winter salmon dominated (97%) the North American component, with repeat spawners comprising 2.5% of the samples (Table 5.9.1.1).

The sampling team stationed in Nuuk obtained 120 whole fish for disease testing. Tissue samples were tested for the presence of ISAv by RT-PCR assay only and all test results were negative. The sex of 115 salmon collected in Nuuk was determined; of these 35 (30%) were males and 80 (70%) females. ICES recommends that sex be determined on as many whole fish as practicable, and methods be considered for determining sex on gutted fish.

A total of 1639 samples were genotyped at four microsatellites. In total, 1192 (72.7%) of the salmon sampled from the 2004 fishery were of North American origin and 447 (27.3%) fish were determined to be of European origin (Table 5.9.1.1). Applying the continental percentages to the nominal total catch (14.7 t) resulted in estimates of 9.9 t of North American origin and 4.8 t of European origin fish (3900 and 1500 rounded to the nearest 100 fish, respectively) landed in West Greenland in 2004 (Fig. 5.9.2.1).

5.9.3 NASCO has requested ICES to provide information on the origin of Atlantic salmon caught at West Greenland at a finer resolution than continent of origin (river stocks, country or stock complexes)

In 2005 an updated probabilistic genetic assignment (PGA) model was applied to the 2000–2002 West Greenland fisheries data, assigning both continent and country of origin based on genotyping at 11 loci traditionally used for continent of origin assignment (King *et al.*, 2001). The suite of 11 loci allowed for suitable classification accuracy within North America to the country of origin level.

The PGA model 90% confidence intervals for the North American and European contributions to the West Greenland fishery encompass the deterministic point estimates previously reported by ICES. Canadian origin fish dominated the North American component of the harvest, ranging from 96% to 99% for the period 2000–2002.

ICES has previously noted that reference baseline datasets for the European and Canadian stock complexes lacked adequate spatial and temporal coverage for finer scale assignments with acceptable accuracy. Some progress has been made to bolster reference datasets; however, deficiencies remain, particularly for NEAC stocks. An international collaboration is currently establishing a reference genetic dataset to improve the ability of assigning origin of Atlantic salmon caught during any mixed stock fishery or sampling endeavour at a finer resolution than continent of origin (river stocks, country, or stock complexes).

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

The forecast model used to estimate pre-fishery abundance of 2SW salmon in 2005 was the same as that used in 2004 (ICES, 2003). The approach accounts for uncertainty in the data and in model selection. The overall approach of modelling the natural log transformed PFA_{NA} and LS_{NA} using linear regression and the Monte Carlo method used to derive the probability density for the PFA_{NA} forecast was also retained from 2004.

The lagged spawner variable used in the forecast model is an index of the 2SW parental stock of the PFA. It provides a means of examining the value in managing for spawning escapement and predicting recruitment in existing fisheries. The lagged spawner index was the sum of the lagged spawner estimates for six regions of North America. ICES developed a method for deriving Labrador spawners for the recent years and therefore Labrador is again included in the index (Section 4.9.5). With the inclusion of Labrador, the lagged spawner series begins in the 1978 year of PFA.

5.10.1 North American Forecast Model

The advice for any given year has been dependent on obtaining a reliable predictor of the abundance of non-maturing 1SW North American stocks prior to the start of the fishery in Greenland. A two-phase regression between North American pre-fishery abundance (PFA_{NA}) and lagged spawners (LS_{NA}), assuming a break between the phases occurred during 1989 or

1990, was described in 2003 and elaborated upon in 2004. This pattern was reinforced with the addition of the 2003 PFA_{NA} estimate (Figure 5.10.1.1). The relative recruits (PFA_{NA}) per spawner index (LS_{NA}) has declined from an average of 5.7 during 1978–1989 to an average of 1.9 during the period 1990 to 2003 (Figure 5.10.1.1).

As in 2004, 42 models were fitted to each dataset derived using Monte Carlo simulation. These models included two models without phase shifts, plus five models with phase shifts and with eight possible break year points (1986 to 1993) for each model (Table 5.10.1.1). In each simulation the most parsimonious model was selected using Akaike's Information Criterion and this selected model was used to generate a value for the probability density for the 2005 PFA_{NA}.

Seven models and eight break years (1986 to 1993) were run for ten thousand datasets of PFA_{NA} and LS_{NA} created based on the estimated ranges for each year and PFA. One PFA_{NA} prediction was carried forward for the parsimonious model for each randomly selected dataset. For phase shift models, the probability of being in either phase was based on changes in PFA_{NA} from year t to year t–2 (Figure 5.10.1.2). The approach taken in 2005 was identical to the method used in 2003 and 2004. The two-year lag is used because current year PFA (i.e 2004) is not available due to its dependence upon 2SW returns in the next year.

Although it was possible that up to 42 models might be represented in estimating the distribution of PFA_{NA}, those selected most often were model III and VII and break years 1989 through 1992 (see below). The lagged spawner index variable was informative for PFA_{NA} in 63% of the simulated data sets. In such cases, the break years describing the phase shift were mostly 1991 and to lesser extents, 1992, 1989, and 1988. Model VII (intercept through the origin) was favoured more often (57% of all models). In 37% of the data sets, the lagged spawner variable (Model III) was uninformative and therefore this model with two means describing phases in PFA was selected. The corresponding break years were 1991 and 1992. For the 2005 forecast of PFA_{NA}, the probability (runs/10 000) of being in the high phase was negligible (0.6%) and the probability of being in the lower productivity phase was over 99%.

Model	Phase	1998	1989	1990	1991	1992	1993	Models
III	High	0	0	0	1	0	0	
	Low	0	0	0	2260	1395	0	3656
VII	High	1	4	1	29	12	0	
	Low	273	1375	162	2616	1206	1	5680
IV to VI	High	10	6	0	0	0	0	
	Low	300	285	4	48	11	0	664
Phases	High	11	10	1	30	12	0	64
	Low	573	1660	166	4924	2612	1	9936

5.10.2 Critical evaluation of model updates

Critical evaluations of updates to the model input data were documented during the process of developing catch advice. These include:

- Application of the updated model to estimate the 2004 PFA produced a higher estimate (median 118 600) than the estimate provided last year (median 100 000).
- The lagged spawner variable used in the model declined in 2005 to its lowest value and was used to predict PFA using spawner abundances that are outside the range of previously observed values. The uncertainty of associations increases as the predictor variable gets farther from the mean, which has been the case for the 2004 and 2005 projections.

5.11 Provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved

Based on the previous five-year average biological characteristics of 1SW non-maturing salmon in the fishery at West Greenland, each tonne of salmon catch equates to 316–366 fish (5^{th} to 95^{th} percentiles). After discounting for eleven months of natural mortality, each tonne not harvested equates to 159 to 187 (5^{th} to 95^{th} percentiles) fish returning to home waters in North America and 64 to 80 (5^{th} to 95^{th} percentiles) salmon returning to European home waters. Because these spawners are distributed among a large number of rivers on both continents, it has been difficult to show direct benefits to individual stocks. No further information is available on the effect of recent management measures.

5.12 Data deficiencies and research needs

Data deficiencies and research needs for West Greenland are presented in Section 6.

West Greenland Harvest (t)	Simultaneous Conservation (Lab, NF, Quebec, Gulf)	Improvement (SF, USA) of returns in 2006		Conservation MSW Salmon Southern NEAC
		> 10%	> 25%	
0	0.091	0.000	0.000	0.684
5	0.084	0.000	0.000	0.680
10	0.079	0.000	0.000	0.673
15	0.073	0.000	0.000	0.669
20	0.069	0.000	0.000	0.664
25	0.065	0.000	0.000	0.656
30	0.061	0.000	0.000	0.650
35	0.057	0.000	0.000	0.645
40	0.054	0.000	0.000	0.640
45	0.050	0.000	0.000	0.634
50	0.046	0.000	0.000	0.628
100	0.023	0.000	0.000	0.576

Table 5.6.1. Probability of meeting the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf), of achieving increases in returns from the 1992 to 1996 base year average in the two southern areas (Scotia-Fundy and USA) of the NAC area, and of meeting the MSW conservation limit of the southern European stock complex relative to quota options for West Greenland. A sharing arrangement of 40:60 (F_{NA}) of the salmon from North America and southern European MSW stocks was assumed.

Distribution of 2004 nominal catch (metric tons) among NAFO Divisions.

Total	NAFO Division					
	1A	1B	1C	1D	1E	1F
15	3	1	4	2	3	2

River age distribution (%) by origin

	1	2	3	4	5	6	7	8
NA	1.9	19.1	51.9	22.9	3.7	0.5	0	0
E	18.3	57.7	20.5	3.2	0.2	0	0	0

Length and weight by origin and sea age.

	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)	Fork length (cm)	Whole weight (kg)
NA	64.7	3.11	86.2	7.33	77.6	4.71	65.1	3.17
E	65.0	3.15	76.4	5.22	88	6.48	65.3	3.22

Biological Characteristics of Atlantic salmon sampled from the 2004 West Greenland food fishery.

Continent of Origin (%)	
North America	Europe
72.7	27.3

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

	Sea-age composition (%)		
	1SW	2SW	Previous Spawners
NA	97.0	0.5	2.5
E	97.0	2.8	0.20

Table 5.9.1.1. Nominal catch and biological characteristics of the West Greenland catch, 2004.

Model	Function $Ln(PFA_{NA})$ =	Model description
I	$\mu + \xi$	A single mean PFA_{NA}; No phases or lagged spawner index variable
II	$\alpha + \gamma * Ln(LS_{NA}) + \xi$	A single regression of PFA_{NA} on lagged spawner index
III	$\beta * Ph + \xi$	Two means of PFA_{NA} for the two phases; no lagged spawner index variable
IV,V,VI	$\alpha + \beta * Ph + (\gamma + \delta * Ph) * Ln(LS_{NA}) + \xi$	Two regressions of PFA_{NA} on lagged spawner index with possible variations in slopes and intercepts
VII	$(\gamma + \delta * Ph) * Ln(LS_{NA}) + \xi$	Two regressions of PFA_{NA} on lagged spawner index with intercept through the origin
PFA_{NA} = PFA for North America (1977 to 2002) *LS_{NA} = Lagged spawner index excluding Labrador (1977 to 2002)* *Ph = Phase (indicator variable representing two time periods)* *α, β, γ, δ = coefficients of the slope and intercept variables* *ξ = residual error, normal* *phase shift periods: ranging from 1977-1985 and 1986-2002 to 1977-1993 and 1994-2002*		

Table 5.10.1.1. Reference number, formula, and brief description of the nested models included in the approach to modelling lagged spawner index and PFA_{NA} encompassing a possible phase shift relative recruitment per spawner.

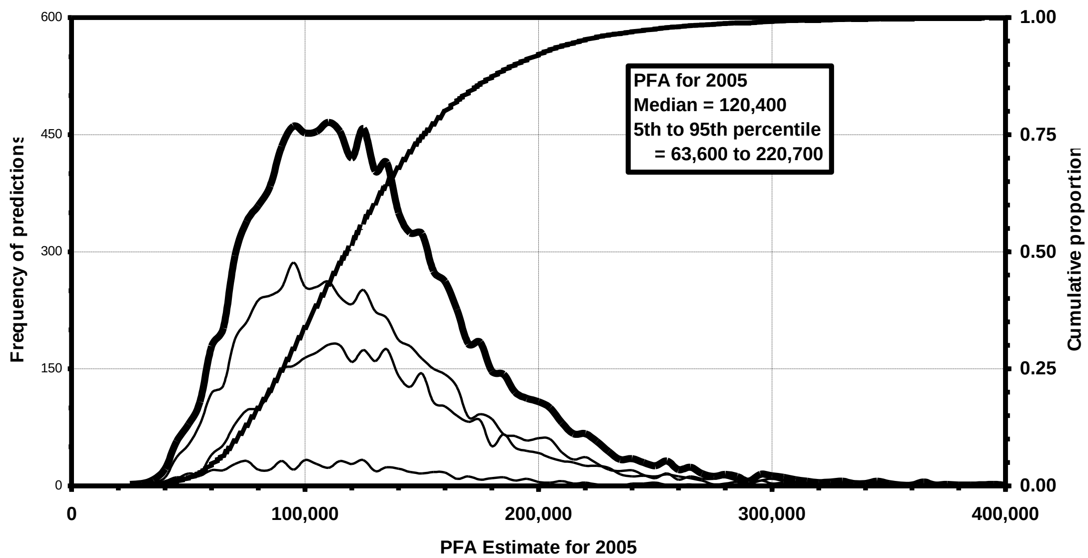


Figure 5.6.1. PFA_{NA} forecast estimate distribution for the year 2005 non-maturing 1SW salmon.

Percentile	Estimate
5	63,645
10	73,321
15	80,509
20	87,109
25	92,725
30	98,151
35	103,830
40	109,312
45	114,715
50	120,360
55	125,768
60	132,023
65	138,048
70	145,407
75	153,173

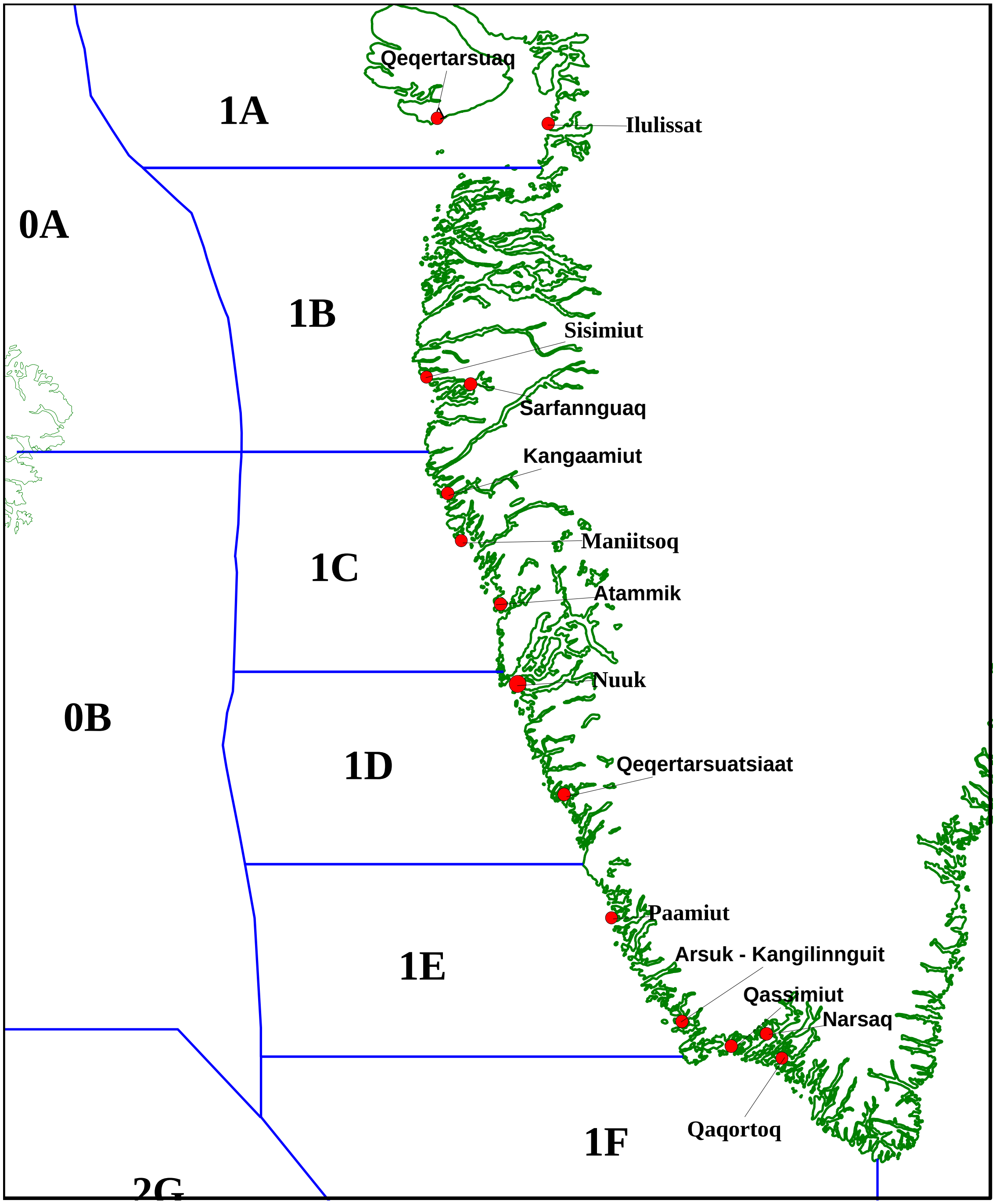


Figure 5.9.1.1. West Greenland NAFO divisions.

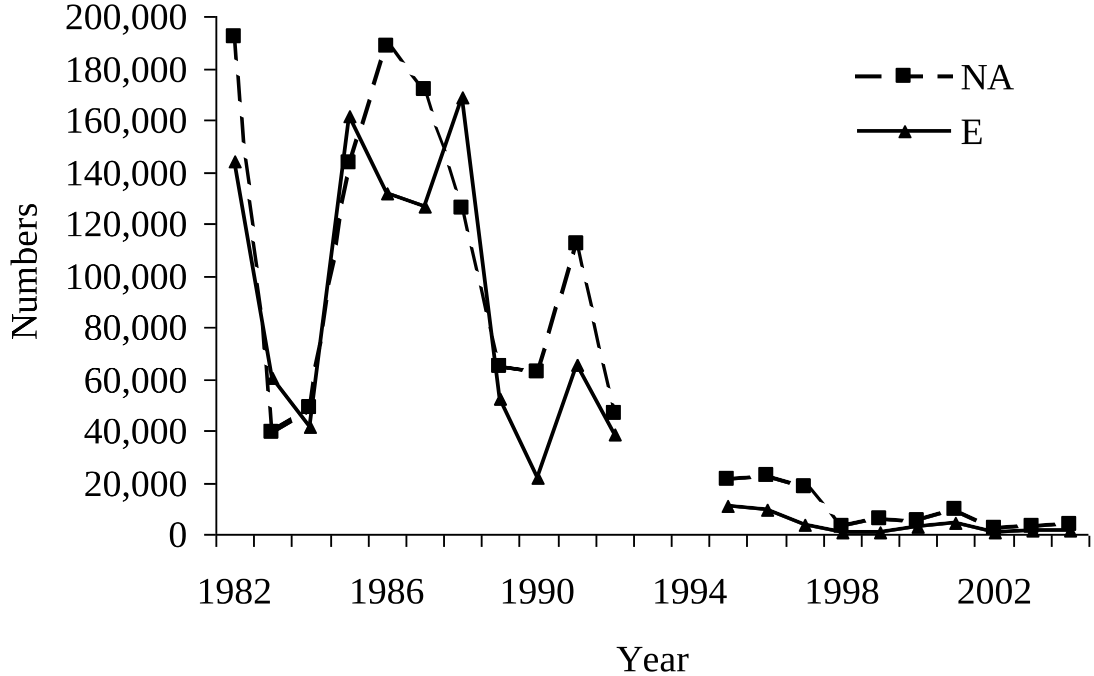


Figure 5.9.2.1. Number of North American (NA) and European (E) salmon caught at West Greenland, 1982–1992 and 1995–2004.

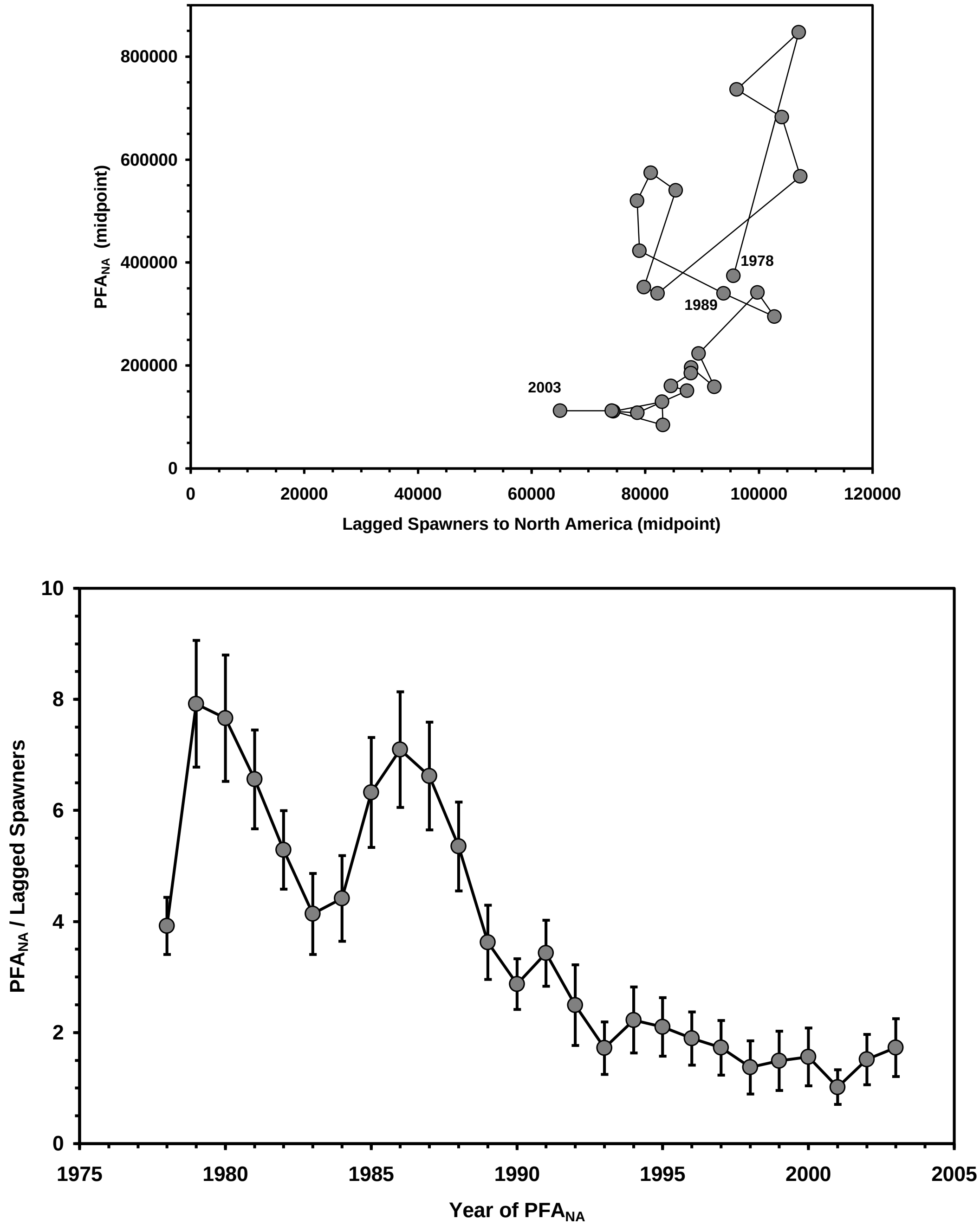


Figure 5.10.1.1. PFA (mid-point) and lagged spawner (mid-point) association for the NAC area showing the sequence from 1978 to 2003 (upper panel) and the relative change of the PFA to lagged spawners over the time-series (lower panel).

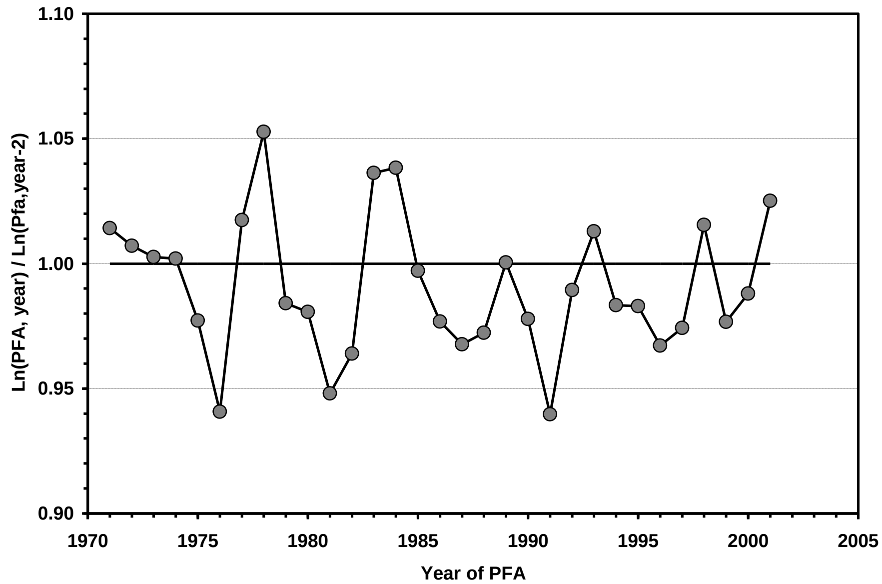


Figure 5.10.1.2. Relative change in Ln(PFA) in year relative to Ln(PFA) in year-2.

6 NASCO has requested ICES to identify relevant data deficiencies, monitoring needs and research requirements taking into account NASCO's International Atlantic Salmon Research Board's inventory of on-going research relating to salmon mortality in the sea

6.1 Data deficiencies and research needs

<u>Recommendations from Section 2 – Atlantic salmon in the North Atlantic Area:</u>

1) ICES recommends that in regions where fishery closures have not resulted in stock rebuilding, urgent research work should be continued to forecast population viability, to determine the cause or causes of declines, and activities should be implemented to reverse declining population trends.

2) Coordinated tagging/tracking studies should be carried out to give information on migration, distribution, survival, and growth of escaped farmed salmon.

3) Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates:

- As depth and temperature recording tags (DSTs) have proven to be a good method in assessing the marine life history of salmon, further DST-tagging experiments on smolts, adult salmon, and kelts should be conducted in different areas of the North Atlantic area.
- Experimental trawling surveys should be conducted to evaluate the vertical distribution of post-smolts and older salmon in the sea, if possible in combination with tagging of post-smolts and salmon with DST tags.

<u>Recommendations from Section 3 – Fisheries and Stocks from the North East Atlantic Commission Area:</u>

1) Further progress should be made in establishing a PFA predictive model using the PFA of maturing 1SW salmon, in addition to the spawner term, as a predictor variable for the PFA of non-maturing 1SW in the northern NEAC area.

2) Efforts should be made in developing PFA estimation models for smaller units than national levels as marine survival may vary between rivers and regions and temporal variation in marine growth and abundance are more correlated between rivers in small geographical areas than between rivers more distant to each other.

<u>Recommendations from Section 4 – Fisheries and Stocks from the North American Commission Area:</u>

1) There is a need to develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava region of Québec.

2) There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age and river-age composition) of returns to rivers, of smolt output, of spawning stocks of Canadian and US rivers, and the harvest in food fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model.

3) ICES recommends that the smolt age distribution for the six North American areas be re-evaluated on a five-year schedule.

Recommendations from Section 5 – Atlantic Salmon in the West Greenland Commission Area:

1) Continued efforts should be made to improve the estimates of the annual catches of salmon taken for private sales and local consumption in Greenland.

2) Efforts should be made by the Home Rule Government of Greenland to provide information on the extent of fishing activity by all license holders.

3) The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. In addition, sampling to determine sex on as many whole fish as practicable and methods to test for ISAv and other diseases in Atlantic salmon caught in West Greenland should be included in the program. Methods for determining sex on gutted individuals should be considered. ICES recommends that the sampling program be continued and closely coordinated with a fishery harvest plan to be executed annually in West Greenland.

ICES considers that the identification of data deficiencies and research requirements, although mainly driven by specific tasks under the terms of reference, was assisted by reference to the NASCO inventory of on-going research into salmon mortality in the sea.

APPENDIX

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