Advisory Committee on Fishery Management **ICES CM 2001/ACFM:15**

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REPORT OF THE

WORKING GROUP ON NORTH ATLANTIC SALMON

Part one

Aberdeen, Scotland

2–11 April 2001

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1 INTRODUCTION

1.1 Main Tasks

At its 2000 Statutory Meeting, ICES resolved (C. Res. 2000/2ACFM07) that the Working Group on North Atlantic Salmon [WGNAS](Chair: Dr. N. Ó Maoiléidigh, Ireland) will meet in Edinburgh, UK from the 2-11 April 2001 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). An alternative venue was selected in Aberdeen, UK during the same period. The terms of reference and sections of the report in which the answers are provided, follow.

a) With respect to Atlantic salmon in the North Atlantic area:	Section
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 2000;	2.1 & 2.2
ii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.4, 3.9
iii. use case studies to illustrate options for taking account of risk in the provision of catch advice and comment on the relative merits of each option;	2.3
iv. assess the possible reasons for the differences in the occurrence of escaped farmed fish in fisheries and stocks in different areas;	2.4
v. advise on the potential biases in the catch advice model resulting from the inclusion of fish farm escapes in the assessment models;	3.6
vi. provide a compilation of tag releases by country in 2000.	2.5
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	
i. describe the events of the 2000 fisheries and the status of the stocks;	3.1-3.4
ii. update the evaluation of the effects on stocks and homewater fisheries of significant management measures introduced since 1991;	3.5
iii. further develop the age-specific stock conservation limits where possible based upon individual river-based stocks;	3.7
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	3.8
v. update the information on by-catch of salmon post-smolts in pelagic fisheries;	3.9
vi. identify relevant data deficiencies, monitoring needs and research requirements.	3.10
c) With respect to Atlantic salmon in the North American Commission area:	Section
i. describe the events of the 2000 fisheries and the status of the stocks;	4.1 & 4.2
ii. update the evaluation of the effects on US and Canadian stocks and fisheries of management measures implemented after 1991 in the Canadian commercial salmon fisheries;	4.3
iii update age-specific stock conservation limits based on new information as available;	4.4
v. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	4.5
v. identify relevant data deficiencies, monitoring needs and research requirements.	4.6

d) With respect to Atlantic salmon in the West Greenland Commission area:	Section
i. describe the events of the 2000 fisheries and the status of the stocks;	5.1 & 5.2
ii. update the evaluation of the effects on European and North American stocks of the Greenlandic quota management measures and compensation arrangements since 1993;	5.4
iii. provide a detailed explanation and critical examination of any changes to the model used to provide catch advice and of the impacts of any changes to the model on the calculated quota;	5.5
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	5.7
v. evaluate potential causes for the changes in the Continent of origin of salmon captured in the West Greenland fishery including potential changes in marine migration patterns;	5.3
vii. identify relevant data deficiencies, monitoring needs and research requirements.	5.9

The Working Group considered 31 Working Documents submitted by participants (Appendix 1); other references cited in the report are given in Appendix 2.

1.2 Participants

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A full address list for the participants is provided in Appendix 3.

2 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

2.1 Catches of North Atlantic Salmon

2.1.1 Nominal catches of salmon

The nominal catch of a fishery is defined as the round, fresh weight of fish which are caught and retained. Total nominal catches of salmon reported by country in all fisheries for 1960-2000 are given in Table 2.1.1.1. Catch statistics in the North Atlantic also include fish farm escapees and, in some north-east Atlantic countries, ranched fish (see Section 3).

The Icelandic catches are presented under two separate categories; wild and ranched. Iceland is the only North Atlantic country where large scale ranching has previously been undertaken and where the intent was to harvest all returns at the release site. While ranching does occur in other countries it is on a much smaller scale. Some of these operations are experimental and at others harvesting does not occur solely at the release site. The ranched component in these countries has therefore been included within a single figure for the nominal catch.

Figure 2.1.1.1 shows the nominal catch data grouped by the following areas: 'Scandinavia and Russia' (including Denmark, Finland, Iceland, Norway, Russia and Sweden); 'Southern Europe' (including Spain, France, Ireland, UK (England and Wales), UK (Northern Ireland) and UK (Scotland)); and 'North America' (including Canada, USA and St Pierre et Miquelon); and 'Greenland and Faroes'.

The provisional total nominal catch for 2000 is 2814 t, which is the highest since 1996. This catch is 568t greater than the updated catch for 1999 (2246t) and although greater than the previous 5-year average (2754t) , is 636t less than the previous 10-year average (3450t). In all, 10 countries reported an increase in the 2000 catch compared to the final 1999 values. Catches in 10 countries were greater than the previous 5-year averages and catches in 5 were greater than previous 10-year averages.

Several countries partition reported nominal catches by size or sea-age category and these data, where available, are given in Tables 2.1.1.2 and 2.1.1.3. The figures for 2000 are provisional and, as in Table 2.1.1.1, catches in some countries include both wild and reared salmon (excluding ranched fish from Iceland) and fish farm escapees. Different countries use different methods to partition their catches by sea-age class and these methods are described in the footnotes to Table 2.1.1.3. The composition of catches in different areas is discussed in more detail in Sections 3, 4 and 5.

Table 2.1.1.4 presents, where data are available, the nominal catch by country partitioned according to whether the catch was taken by coastal, estuarine or riverine fisheries. In addition, fisheries in West Greenland, Faroes and St. Pierre et Miquelon are exclusively coastal or on the high seas. The proportions accounted for by each fishery varied considerably among countries although overall proportions remained relatively stable. In total, coastal fisheries accounted for 53% of catches in North East Atlantic countries in 2000 compared to 52% in 1999, whereas in-river fisheries took 41% of catches in both 1999 and 2000. In North America, coastal fisheries accounted for 9% of the catch in 2000 compared to 7% in 1999, while in-river fisheries took 77% of catches in 2000 compared to 67% in 1999.

2.1.2 Catch and release

The practice of catch and release (often termed hook and release) in rod (recreational) fisheries has been used as a conservation measure for salmon in some areas of Canada and USA since 1984. Recent declines in salmon abundance in the North Atlantic have resulted in an increased use of this management option., either as a voluntary practice or through statutory regulation. The nominal catches presented in Section 2.1.1 are comprised of fish which have been caught and retained and do not include catch-and-release salmon. Table 2.1.2.1 presents catch-and-release information from 1991-2000 for those countries that have records. Catch-and-release may be practiced in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released reflecting the varying management practices among these countries. Within countries, however, this percentage has tended to increase in recent years. Thus in 2000, although release rates range from approximately 10% in Iceland to 74% in Russia, rates in 2000 are among the highest in each 10-year series for most countries.

2.1.3 Unreported catches

Unreported catches by year and Commission Area are presented in Table 2.1.3.1. A description of the methods used to evaluate the unreported catches was provided in ICES 2000/ACFM:13. The 2000 unreported catch can be compared to previous years values as the estimation method used by each country is relatively unchanged. However, it may not be appropriate to compare the unreported catch of one country to another as the same information may not be included in the estimate. For example, some countries include only the illegal landings in the unreported catch, while other countries include unreported legal catch and illegal catches in their estimates and the illegal catch is included with the nominal catch for France.

The total unreported catch in NASCO areas in 2000 was estimated to be 1,269 t, an increase of 23% from the 1999 estimate. Estimates were derived for the North American Commission Area (124 t), the West Greenland Commission Area (10 t) and North East Atlantic Commission Area (1,135 t). Figure 2.1.3.1 shows that the unreported catch has remained a relatively constant proportion (30%) of the total catch since 1987. No data for the combined three Commission Areas are available prior to 1987. Where available, data are presented by country for 2000 (Table 2.1.3.2). The individual inputs to the total North Atlantic catch range from 0% to 16 %. While this broadly indicates the level of unreporting by each country relative to the total catch in the North Atlantic, it should be noted that these estimates are not precise and are difficult to validate. The percentage of the total national catches (reported + unreported) by country ranges from 0% to 67%.

It is not known whether any vessels fished for salmon in the international waters in the Norwegian Sea. There were no surveillance flights reported to have been undertaken by the Icelandic and Norwegian Coastguards over the winter period 2000/2001 when fishing for salmon would be most likely to occur.

2.2 Farming and Sea Ranching of Atlantic Salmon

2.2.1 Production of farmed Atlantic salmon

The production of farmed Atlantic salmon in the North Atlantic area was 658,735 t, in 2000 (Table 2.2.1.1 and Figure 2.2.1.1), an increase in production over 1999 (636,783 t). The 2000 production was 30% higher than the 1995-99 average (504,809 t) for the area. The countries with the largest production were Norway and Scotland, accounting for 65% and 20% of the reported North Atlantic total. Reported increases compared to average production for 1995 to 1999 (Table 2.2.1.1) ranged from 75% for eastern Canada to 6% for UK(N. Ireland).

The worldwide production of farmed Atlantic salmon in 2000 was 704,134 t (excluding Chile; Table 2.2.1.1 and Figure 2.2.1.1). Outside the North Atlantic area, data were only compiled for production of farmed Atlantic salmon in western North America (Washington and British Columbia), where 2000 production was greater than 1999. The worldwide production of farmed Atlantic salmon compiled for 2000 was over 200 times the reported nominal catch of Atlantic salmon in the North Atlantic. As a result, aquaculture fish dominate world markets, and have probably contributed to the decline in commercial fishing effort in many countries.

2.2.2 Production of ranched Atlantic salmon

Ranching has been defined as the production of salmon through smolt releases with the intent of harvesting the total population that returns to freshwater (harvesting may include collecting fish for broodstock) (ICES 1994/Assess:16). The total production of ranched Atlantic salmon in countries bordering the North Atlantic in 2000 was 11 t, 22 t lower than in 1999 (33 t) and the lowest value since 1984 (Table 2.2.2.1 and Figure 2.2.2.1). Production in Iceland declined dramatically because no smolts were released into ocean ranching in 1999, thus, only 2SW fish were harvested in 2000. Production of ranched fish was less than 5 t in each of the three other countries reporting (Ireland, UK(N. Ireland), and Norway). Production in these three countries includes catches in net, trap and rod fisheries. Icelandic catches, on the other hand, are entirely from estuarine and freshwater traps at the ranching stations.

2.3 Use of Case Studies to Illustrate Options for Taking Account of Risk in the Provision of Catch Advice

The Working Group considered this question, together with the supplementary request that "ICES provide information that will assist with the implementation and evaluation by NASCO and its Contracting parties of the decision structure (Annex 4 of document CNL(00)18, provisionally adopted by the Council).

Management of Atlantic salmon in the North American and Greenland Commission areas is based on a fixed escapement strategy. All potential recruits in excess of the conservation requirement are considered to be available for harvest. The conservation requirement is considered to be a threshold reference point. The undesirable event is that the spawning escapement to North America will be below the conservation limit. The probability of achieving the biological objective (conservation requirement) depends on the quota selected, the uncertainties of the harvest, and the uncertainties of the forecast. The level of quota selected by managers should be based on the level of risk that they consider acceptable. The greater uncertainty in the forecast and harvest the lower the target exploitation or quota would have to be to attain the same risk acceptance level. The exploitation rate, the quota available at this risk acceptance level or the quota plus the spawner escapement reserve could be considered as management targets for that fishery for that year.

The current management approach used or the West Greenland fishery considers the catch options relative to a 50% probability of achieving the conservation limit (or a 50% chance of the undesirable event occurring) and ignores the uncertainty in the stock assessment. Ignoring uncertainty is inconsistent with the principles defined under the precautionary approach. The provision of catch advice in a risk framework involves the incorporation of the uncertainty in all the factors contributing to the assessment of stock status, development of the forecast, and fisheries management.

Risk analysis is useful for making decisions in uncertain situations and may be used to select management options that convey lower levels of risk. Risk analysis for Atlantic salmon is conducted with respect to achieving a conservation limit or combinations of conservation limits. Analysis is based on uncertain exploitation rates, harvest components and imprecise forecasts.

Risk management for mixed stock fisheries is complex. A prime consideration for achieving the biological objective in all stock components is the minimum acceptable probability of achieving the objective for the smallest component. Based on acceptance of this probability, a target exploitation rate or quota can be set from the uncertainty distributions of the forecast and exploitation.

The Working Group considered case studies to illustrate two approaches for taking account of risk in the provision of catch advice. The first considers incorporating the uncertainties in a risk analysis to provide a probability profile of meeting the conservation objective. The second approach addresses the use of management targets to increase the probability of meeting the conservation objective.

2.3.1 Case studies for calculating risk for the provision of catch advice.

The case studies below consider a mixed stock fishery example for two levels of abundance and a single stock example for a homewater fishery.

Case Study 1 Mixed stock fishery – West Greenland fishery

The deterministic calculation of catch options for the West Greenland fishery uses the point estimates of the input parameters. When the input parameters have uncertainty (for example the PFA value), the value at the 50% probability level is used. The procedure is described in Appendix 6 and summarized for two stock levels (low and moderate) (Figure 2.3.1.1). For the low abundance period, the catch option at the point estimates and for a 40% allocation of surplus to West Greenland was 19 tons. For the period of higher abundance, the deterministic catch option was 561 t.

The deterministic calculation does not provide any analysis of the risk of achieving conservation requirements in North America at the calculated catch level. The data inputs are uncertain and a risk analysis for the objective of achieving the conservation limits must appropriately incorporate these uncertainties. The uncertainties included in these case studies are:

- Conservation requirement uncertainty for six stock areas
- Uncertainty in the forecast PFA value
- Uncertainty in the biological characteristics of the salmon in the fishery

Management error (for example, not catching the exact quota) has not been incorporated but it could be included if an estimate was made from historic data.

2.3.1.1 Conservation requirement uncertainty.

The 2SW spawner requirement for North America used by ICES is the sum of point estimates of individual river or fishing area spawner requirements. It has been shown that the sum of individual river or area requirements provides a probability level of less than 50% of simultaneously meeting the conservation requirements in individual rivers or areas (ICES 1996/Assess:11). This excludes the uncertainty in the individual river reference points which have not been quantified for the majority of rivers of North America (except for Quebec rivers). The sum of the 2SW spawner requirements for North America is 152,548 fish and adjusted for natural mortality to the point prior to the fishery (spawner reserve) is 170,286 fish. To ensure a spawner escapement of 100% of conservation into six stock areas simultaneously at a 50% probability level, 169,000 2SW are required to return to North America, 188,650 2SW fish released from the fishery (Figure 2.3.1.2). The uncertainty increases as the number of stock areas defined by managers increases. Additionally, the analysis assumes that the stock areas are all producing at the same rate relative to their conservation limits.

Probability of achieving conservation requirements simultaneously in six stock areas		
Probability Level	In North America	Prior to fishery (adjusted by M for 11 months)
Point estimate	152,548	170,286
50%	169,000	188,650
75%	173,000	193,100
90%	177,000	197,600

2.3.1.2 PFA Forecast Uncertainty

Forecasts of abundance in the year to come are dependent upon stochastic functional relationships. Generally, the forecasts have large uncertainty. The PFA forecasts for the low abundance and moderate abundance periods are shown in Figure 2.3.1.3. The PFA forecast value at a 50% level for the moderate abundance period was 437,000 fish compared to 183,000 fish in the low abundance period.

	Forecast values	
Probability level	Moderate abundance	Low abundance
10%	236,782	120,000
30%	342,213	155,000
50%	436,770	183,000
70%	553,223	215,000
90%	801,849	280,000

2.3.1.3 Biological characteristics of the fish

Biological characteristics of the fish in the fishery of the coming year are also unknown. These are estimated based on characteristics of previous years taking account of any temporal trends in characteristics if they occur. In the deterministic approach, the point estimates (such as the average weight of previous years, the average fecundity of females in recent years) are used. In the risk analysis, the uncertainty in the characteristics are considered. The four characteristics are: proportion North American origin 1SW salmon, mean weight of 1SW salmon of North America, the mean weight of 1SW salmon of European origin, and the age correction factor for older age groups in the fishery. The variability in the number of 1SW salmon at a given catch option is illustrated in Figure 2.3.1.4. For a catch of 50 tons, the expected catch of 1SW salmon of North American origin can vary between 11,700 fish and 15,450 fish (10^{th} to 90^{th} percentiles).

2.3.1.4 Completing the Risk Analysis

Incorporating all these uncertainties results in a measure of the reliability of the stock assessment for making management decisions. The reliability of the assessment has different and profound consequences on the catch options considerations.

In the theoretical example shown in Figure 2.3.1.5, two assessments provide the same point estimate (50% probability value) but the precisions are very different. Under a risk-prone management approach, the allowed catch would be greater for the imprecise assessment: at a 70% risk level, the advised catch under the precise assessment would be 500 t but the uncertain assessment would provide for a catch of 800 t. The risk-averse management approach would advise for lower catch options for the imprecise assessment: at a 20% risk level, the precise assessment would provide a catch option of about 400 t but for the imprecise assessment, no catch is advised. A risk-averse approach is a pre-requisite of precautionary management.

The risk analysis probability profiles for the two years of contrasting stock abundance are shown in Figure 2.3.1.6. In the higher abundance year, a catch option of about 1,250 tons produces a 50% probability level of achieving the conservation requirement. This contrasts with the low abundance year when a catch option of just over 100 tons provides a 50% probability of meeting conservation. Note that these catch levels are higher than the deterministic calculations because high prefishery abundance values cannot be discounted. To adopt a more risk-averse approach, managers must select a higher probability (or lower risk of stocks) exceeding their conservation limits. At a 65% probability level, there would not be any available harvest in the low abundance scenario and a quota of about 900 t in the higher abundance scenario.

The risk analysis described above has not incorporated management uncertainty. When management is imperfect, as is generally the case, the effect on the risk analysis is to increase the uncertainty in the probability of meeting the conservation objectives. The analysis has also excluded any differences in status among the stock areas. In the case where stock status differs, the probability of meeting conservation for a given year will be overestimated since the spawning escapement to the areas will be different from those assumed in the model. An evaluation of performance of previous year fisheries would provide valuable insight into the appropriateness of the data inputs and the assumptions of the risk analysis.

Case Study 2 Single River Example – Miramichi River

The Miramichi River, at a maximum axial length of 250 km and draining an area of about 14,000 km^2, has the largest Atlantic salmon run of eastern North America. There are two major branches: the Northwest Branch covers about 3,900 km^2 and the Southwest Branch about 7,700 km^2 of drainage area. The two branches drain into a common estuary and subsequently drain into the Gulf of St. Lawrence at latitude 47°N. Separate branch assessments were introduced in 1992 to account for the differences in exploitation between the Northwest and Southwest branches. Native Peoples fisheries were historically conducted almost exclusively in the Northwest Miramichi (exploitation also occurs in the estuarial waters of the Miramichi River, downstream of the confluence of the two branches) and recreational fisheries exploitation also differs between the Northwest and Southwest branches.

Temporal stock distinctiveness has also been highlighted as an important component of the Atlantic salmon resource of the Miramichi. Early runs and late runs have different composition in terms of small and large salmon proportions and sex ratios. The early runs in both branches are also exploited more heavily than the late runs.

Atlantic salmon are presently exploited in Native Peoples and recreational fisheries. No large salmon (>= 63 cm fork length) can be retained in the recreational fishery (mandatory catch and release) and Native Peoples fisheries for small and large salmon are under gear, season and quota controls.

The conservation spawning requirement for the Miramichi River and each branch separately is based on an egg requirement of 2.4 eggs/m^2 of spawning and rearing habitat area. The objective is to obtain all the egg depositions from large salmon although compliance relative to the achievement of the conservation requirement is determined relative to egg depositions from both small and large salmon.

2.3.1.5 Forecast of returns in 2001

The association between small salmon (almost exclusively 1SW salmon) and large salmon returns the subsequent year was examined over the time series, 1985 to 2000 (Figure 2.3.1.7). The ratio of small salmon to large salmon for this time period varied between 1.4 and 7.1 with the most recent year ratio (1999 small, 2000 large salmon) at 1.41. The median ratio model for the recent five-year period (1995 to 1999) would predict returns of large salmon (including previous spawners) of 16,400 fish (ranging between 14,700 and 25,200).

2.3.1.6 Risk analysis of the fishery

The probability of meeting conservation requirements in 2001 was estimated from the predicted return of large salmon in 2001 based on the small:large salmon ratio of 1996 to 2000 and assuming that small salmon returns in 2001 would be similar to the previous five-year average. The model to assess the risk to conservation if fisheries were to occur in year 2001 can account for seasonal differences in harvest levels, catch-and-release mortality, and biological characteristics of the adults (Figure 2.3.1.8).

Risk is quantified in terms of the probability of meeting conservation and the egg loss resulting from the fisheries harvests as a percentage of total eggs in the returns of adult salmon to the river. For the Miramichi River overall, there is a 54% probability of meeting conservation in year 2001, in the absence of fisheries (Figure 2.3.1.9). Egg loss as a percentage of total eggs in the returns would be less than 5% and the probability of meeting the conservation objectives would be 45% if large salmon losses due to fisheries (regardless of user) were less than 1000 fish and small salmon losses were less than 9000 fish (Figure 2.3.1.9).

2.3.2 Case studies for use of management targets as a means of minimizing risk

NASCO (1998) proposed that "stocks be maintained above conservation limits by means of management targets". The purpose of the management target would be to satisfy the management objective of ensuring a high probability that the conservation limit will be exceeded. Targets are aim points. In 2000, the Working Group acknowledged that it was the responsibility of managers to define the level of risk, resulting from uncertainty, of stocks falling below the conservation limit (ICES CM 2000/ACFM: 13). Once the level of risk is defined, it may be possible to set a management target.

Within the case study examples provided in the draft decision structure, the use of management targets at some value proportionally higher than the conservation limit was used. The challenge is to assess whether a management target can be defined which would provide a consistent increase to the probability of meeting the conservation requirement.

The derivation of a mangement target to increase the probability of meeting the conservation requirements can be based upon an assessment of the same uncertainties as the previous approach, namely conservation requirement uncertainty for six stock areas, uncertainty in the forecast PFA value, and uncertainty in the biological characteristics of the salmon in the fishery.

The use of a management target assumes that managers may choose to harvest all the surplus, and the risks are therefore assessed on the assumption that this will be done. The analysis provided in Section 2.3.1 illustrates how a management target could be set which would increase the probability of achieving the stock conservation limits by a fixed amount. For the low abundance year, a probability of achieving the conservation requirement of 60% would result from a management target set at 116% of the conservation requirement which would result in a foregone harvest of 100 t (Figure 2.3.1.6). For the higher abundance year, a management target of 128% of the conservation requirement would be required to achieve a probability of meeting conservation of 60% and this target would result in a foregone harvest of 250 t (from 1,250 t at 50% to 1,000 t at 60%) (Figure 2.3.1.6).

The problem with this approach is that the same management target (a fixed proportion above the conservation limit) will not have a consistent effect in reducing risk. Although an average value could be employed, it could result in significant over-exploitation (or foregone harvest) in different years.

2.3.3 Relative merits of the approaches

Our analysis shows that there is no single management target level which will provide the same level of risk of failing to meet the conservation objectives over variations in abundance and assessment uncertainty. The Working Group therefore favours the approach of providing an annual risk analysis which considers the variations in abundance, and in the uncertainty of the assessment. The deterministic calculations for any year can be completed by the managers and the resultant probability of meeting the conservation objective at the calculated catch level is visually derived from the risk analysis probability profile plot (such as in Figure 2.3.1.6). The Working Group recognizes that it is the responsibility of managers to select the level of risk of stocks falling below the conservation limit and emphasizes that the appropriate risk level might be different for different fisheries; mixed stock fisheries pose a greater risk to conservation of individual salmon populations than single river stock fisheries.

2.3.4 Review of draft decision structure (NASCO CNL(00)18)

The Working Group tabled the Report of the Standing Committee on the Precautionary Approach- (CNL(00)18 *Application of a Precautionary Approach to Management of Salmon Fisheries*) for discussion and comment.

The Group considered that the draft decision structure provided a very useful first step in developing mechanisms for guiding managers towards appropriate actions for fisheries, compatible with the underlying goal that conservation requirements (both abundance and diversity) of contributing stocks is achieved. The Working Group endorsed the emphasis given in the draft decision structure to systematically monitoring the effect of management measures and taking results into account in future management decisions. It was also felt that the various elements of the decision structure, if widely applied to fisheries and stocks, would provide a useful audit trail, showing the data available for stocks and the basis of the management decisions taken for the fisheries where those stocks are represented. This would also provide clear indications of data deficiencies and highlight where lack of data was impeding sound management.

The Group was concerned by the absence of any clear indication of how the structure was meant to be used, as both questions and instructions were included. The presentation would be improved by adopting a $\mathbf{F}_{low}$ diagram type of approach, similar to that provided in the working group report (ICES CM 2000/ACFM: 13). This should make the review and evaluation of measures taken more explicit (by means of feedback loops) and should indicate where where risk should be considered.

The step in the single stock framework that refers to stocks threatened by external factors is unclear, as it is not obvious what happens if the stock is threatened but is not yet below the conservation limit (for example recently introduced disease into a still productive stock). It may be better to incorporate this into the general assessment of status, such that if status is threatened by external factors, the reasons could be identified and appropriate pre-agreed management actions taken.

The Group noted the clear distinction between action under conditions of unsatisfactory stock status (i.e. identify reasons and implement corrective action) and actions under conditions of surplus (implement pre-agreed management actions to harvest the surplus). However, the Group felt it was likely that many stocks with an exploitable surplus are also subject to impacts that may cause them to fall below surplus at some future time, if measures to mitigate impacts (for example, habitat rehabilitation) are not implemented. Therefore, it was insufficient to recommend implementation of measures only when status had become fully unsatisfactory.

The Working Group noted that pre-agreed management actions should take account of all sources of uncertainty, with management targets being suggested where appropriate, however the draft decision framework did not fully address the incorporation of risk into the decision process. In this respect, the use of further case studies specifically to illustrate this would be valuable (see Section 2.3.1).

It was noted that no pre-agreed management actions were specified, though it is accepted that a generic structure may not be able to cover all specific cases.

In summary, the Working Group recommends some modifications and reference to similar salmon management structures being developed by contracting parties for use in homewater fisheries.

2.4 Significant development towards the management of salmon

2.4.1 Infectious salmon anaemia: implications for wild salmon management

Information was presented to the Working Group about infectious salmon anaemia (ISA) in North America.

ISA has caused extensive mortalities at salmon farms. The disease has been reported from the industry in Norway (1984), East Coast Canada (1996), Scotland (1999) and the Faroes (2000). Positive tests in wild fish were obtained in Canada and Scotland in (1999). In 2000 the Working Group expressed concern about the spread of the disease within wild populations, and the subsequent mortalities that could result in wild fish.

In Canada, aggressive control measures taken by the East Coast salmon farming industry seem to be working. At present, only one site has reported the disease in the smolt class that was transferred to the sea cages in spring 2000. No ISA was detected in wild and escaped-farmed fish entering the Magaguadavic River in 2000, where positive tests for both groups were obtained for the first time in 1999.

Initial reports in 2000 of the presence of the virus for the first time in the Margaree River in Nova Scotia (2 of 30 fish tested), the Morell River in Prince Edward Island (4 of 30 fish), and the Saint John River New Brunswick (16 of 36 fish) are problematic because they could not be confirmed with additional testing. The Working Group remains concerned about the potential spread of this disease.

The first confirmed case of ISA from the East Coast USA salmon farming industry was announced on 16 March 2001. The US industry is now implementing measures similar to those used in Norway, Scotland, and Canada to manage the problem.

Recent genome comparisons of European and Canadian strains of the virus found Scottish and Norwegian strains were 98-100% similar, whereas the Canadian isolate was only about 84-88% similar to the European group. The two strains may have diverged from each other in about 1900, at which time transfers of salmonids from North America to Europe (Rainbow trout) and from Europe to North America (sea run brown trout) were occurring. Both rainbow trout and brown trout have been shown to be asymptomatic hosts of the virus. It is not known where the virus originated (Krøssoy *et al.* 2001).

Independent trials are underway in Canada to evaluate the efficacy of one of the ISA vaccines that is now widely used. The initial results have confirmed a significantly increased survival rate for fish that had been vaccinated.

2.4.2 Causes of fish farm escapes

The Working Group reviewed information on the reasons for the escape of farmed salmon from the British Columbia and East Coast North American salmon farming industries. This was considered relevant to the request to the Working Group (TOR 1.4) to assess possible reasons for the differences in the occurrence of escaped-farmed fish in fisheries and stocks in different areas. For these farmed salmon to find their way into fisheries or rivers, they first have to escape.

The British Columbia Fisheries Department has reviewed the causes of farm escape incidents that were reported to it by the salmon growers. Over the last five years the total number of reported escaped-farmed fish has stabilized at about 1% of the annual total salmon production (49,100 mt in 1999; all species of salmon). On average, there were 5.2 reported escape incidents per year in 1996 – 2000 (26 events total reported over this time period). Escapes resulted from net failures (42% of the total; caused by predator attacks (6 of 11 net failures) and other factors), mechanical problems with cage systems or boats (4% of total), handling errors (39%), and boat collisions with cages (15%).

In the East Coast North American sea cage industry, the reporting of escapes has been imperfect, and the numbers of fish liberated is frequently uncertain. Six incidents could be documented between December 1999 and December 2000. The smallest escape of salmon was 3000, and the largest > 100,000. One event released 25,000 rainbow trout. Three of these six releases were storm related, one involved a boat collision, one was due to vandalism, and the cause for one is uncertain.

Escapes from individual fish farms in these two areas appear to predominantly result from inevitable human errors, and severe events like storms. While severe storms occur most frequently in autumn and winter, it will be difficult to predict when human error will occur. Consequently, the entry of farmed fish to the wild will retain a large degree of unpredictability. In addition, different salmon farming regions are characterized by different climates and operating conditions. Releases of farmed fish to the wild, and their occurrence in fisheries and rivers, will vary in both magnitude and frequency among these regions depending upon the severity of the conditions.

2.4.3 Differences in the occurrence of escaped farmed salmon in fisheries and stocks in different areas.

In 2000, about 627,000 tonnes of farmed salmon were produced in the Atlantic area, with Norway and Scotland accounting for the majority of production (see Section 2.2.1). In comparison, the total nominal landings of salmon in commercial fisheries in the north Atlantic in 2000 was about 2,800 tonnes. The catch included a relatively small proportion of salmon released as smolts for ranching, or for stock enhancement, and a proportion of escapees from fish farms. Salmon escape from fish farms at all life stages, they are caught in fisheries and enter freshwater to spawn (e.g. Hansen *et al.* 1987; Gausen & Moen 1991; Webb & Youngson, 1992; Youngson *et al.* 1997; Crozier 1998).

Farmed salmon are abundant in large numbers in Norwegian coastal commercial salmon fisheries. The proportion is lower in fjord and freshwater catches, but increases in spawning populations (Tables 2.4.3.1, 2.4.3.2). These differences have been suggested to be due to failure of the farmed salmon to home, and therefore the fish are not motivated to enter fjords and freshwater until later in the summer (Lund *et al.* 1991). Tagging experiments have shown that farmed salmon from Norway are caught in the Faroes fisheries (Hansen *et al.* 1987), and it has been shown that the incidence of escaped farmed salmon in this fishery can be high (Hansen *et al.* 1999). Estimates from the commercial fishery at West Greenland in 1991 and 1992 showed that the incidence of farmed fish was less than 1.5% (Hansen *et al.* 1997). Results from monitoring salmon fisheries and stocks in Scotland, Ireland and Northern Ireland have suggested a much lower proportion of farmed salmon (Webb & Youngson 1992; Youngson *et al.* 1997; Crozier 1998; Tables 3.3.7.2 – 3.3.7.6) Fish farm escapees also occur in rivers in Canada and USA, particularly in areas with high density of farms. Estimates of the proportion of escaped farmed salmon in relation to nominal salmon catch in several countries are shown in Table 2.4.3.1 (ICES 2000/ACFM: 13). It should be noted however, that different methods used in the assessments as well as different geographical locations of the farms relative to salmon rivers could make it difficult to compare the figures between countries.

Analyses carried out in Norway have shown that the occurence of farmed salmon is highest in rivers close to areas with high density of fish farms. (Lund *et al.* 1994). In Ireland there have been 13 reported incidents between 1986 and 2000 involving 189,000 adults and 120,000 smolts escaping primarily from sites in the West, but also from sites in the North

West, South West and North. The relationship between the number of escapees in the declared catches and the reported salmon farm escapes is shown in Figure 2.4.3.1. The smolt escapes of any given year have been added to the following year to improve interpretation of the results on the assumption that the smolts could return in the following year. Although there are only 5 years data, the trend indicated would suggest that there is a relationship between the number of escapes and the number identified in the catch although these numbers are very low.

Wild salmon leave their home rivers as smolts in the spring and move quickly into oceanic areas (e.g. Holm *et al.* 1982). In the north east Atlantic areas results from smolt tagging experiments and post-smolt surveys have strongly indicated that ocean currents are the vectors that force the fish northwards (Jonsson *et al.* 1993; Shelton *et al.* 1997; Holst *et al.* 2000). Hatchery-reared salmon released as smolts in freshwater are thought to have a similar migratory pattern as wild salmon (Hansen *et al.* 1993). Hatchery smolts released on the coast tend to return to the same area from where they were released. (Carlin 1969; Sutterlin *et al.* 1979; Hansen *et al.* 1989), but apparently enter any river in that area to spawn.

Hansen & Jonsson (1989; 1991) observed that when released tagged hatchery-reared salmon post-smolts kept in saltwater sequentially over one year, there was annual variation in both survival and homing precision, with poor survival of the groups released in late summer and autum, and poor homing precision of fish released in winter. Large salmon escaping early in the summer, a few months before spawning, tended to move northwards with the current, and when they were ready to spawn, they entered freshwater in that area. They did not appear to have a homing instinct (Hansen *et al.* 1987).

The returns from over 39,000 farmed fish experimentally tagged and released as smolts in Ireland 1984, 1985 and 1990 showed a very low rate of return in subsequent years. Compared to the return rates of between 3 and 13% on average for tagged smolts released for enhancement and for ranching, the rate of tag recovery was extremely low (less than 0.1%) indicating that the survival rate of farmed fish which escape as smolts is very low.

An experiment carried out with large farmed salmon released from two farms on the Norwegian coast, Bersagel in south Norway and Meløy in mid Norway. The results were similar and supported the conclusions from studies cited above. Salmon that escape from fish farms in the autumn have lower survival rates than fish released in the winter/early spring (Table 2.4.3.2). The fish released from the two farms were recaptured in the sea, as well as in freshwater north of the site of release (Figure 2.4.3.2 and 2.4.3.3). Some of the fish released from the southern fish farm turned up in areas southeast of the site of release and entered freshwater in this area. Assuming that fish entering freshwater had made their final decision on where to spawn, it could be concluded that the farmed salmon used in the present experiment were not imprinted to any particular river or marine site, and could therefore be regarded as "homeless".

The distribution and direction of migration of the farmed salmon could be explained by transportation with currents (Figure. 2.4.3.4). If so, this may also explain why so few fish released in November and December were recovered. These fish would have been transported with the currents so far north that when they attained sexual maturity, they either were off route to detect freshwater, or they were simply lost in the cold Artic water. Fish that were released closer to maturity, might still have a higher probability to entering freshwater to spawn than groups released earlier, but the low recovery rates of these fish (less than 6%) suggest that significant numbers of them were also lost.

Based on the current knowledge from the literature, the results from the tagging experiments, direction and speed of ocean currents, and from available information of the apparent low proportion of fish farm escapees in Ireland and Scotland relative to the production of farmed salmon, it is hypothetised that fish farm escapees from Faroes, Ireland and Scotland are transported with the currents, and fish that become sexually mature when they are relatively close to the coast enter Norwegian and Russian fisheries and salmon rivers. Under the same hypothesis some fish farm escapees from Ireland may enter fisheries and salmon rivers in N. Ireland and Scotland, some Irish and Scottish fish farm escapees may even turn up in Denmark and Sweden, and some Norwegian fish farm escapees may enter fisheries and rivers in Sweden, Denmark and Russia. It may be that a continous supply of fish farm escapees in the coastal current leads to a high proportion in Norwegian coastal salmon fisheries, although their survival are still low.

2.4.4 Causes of post-smolt mortality in the marine phase

Possibility of by-catch of post-smolts in pelagic fisheries

Between 10 – 20 June 2000, special fishing experiments for post-smolts carried out in the Norwegian Sea yielded 268 post-smolts and 6 salmon in 14 tows during three consecutive days west and southwest of the Voeringplateau (68° 30'N – 63°N and 1° W - 5° E) Table 3.9.1. Most of these fish were taken in three tows (170, 60, and 34 respectively, Figure 2.4.4.1). The CPUE at this particular cruise was 9 post-smolts per trawl hour, which is one of the highest recorded since 1990 (Table 3.9.1). Microtagged and Carlin-tagged fish occurred for the first time in the same hauls. In Norway no microtagging was carried out in 2000, indicating a south European origin of these fish, which supports the hypothesis that south Norwegian fish and European fish are mixed on the feeding areas in the Norwegian Sea also at the post-smolt stage. These large catch numbers are of concern with respect to the potential impact of the mackerel fishery in the Norwegian Sea in June – August. There is overlap between the mackerel fishing areas and the anticipated northward migration routes for the post-smolts of south and central Europe and south- Norway (ICES 2000/ACFM13). The surface trawl method used by the Norwegian Research vessels resembles the commercial fishing method which also operates with a flotation on the trawl wings. However, the commercially used trawls are considerably deeper and longer, they are towed at higher speed, i.e. ~5 – 6 knots vs. 3-3.5 for the research ships, and the tows also last longer. The commercial trawlers thereby sweep much larger areas, and hence are likely to catch more post-smolts. So far it has not been possible to obtain detailed information on the methods used by the commercial ships, but the Norwegian Coastguards report a fleet of 25 –30 Russian and East European trawlers operating annually in the mackerel fishery in international area. Due to the assumed surface-near location of the post-smolts during migration and on their oceanic feeding grounds (Holm *et al.* 2000) the Working Group has previously recommended that ICES /NASCO should consider the advantages of commercial trawlers lowering the head ropes to a minimum of 5 m below the sea surface (ICES 1999/ACFM: 14) Furthermore the Working Group recommends that specific gear trials and extra observers are arranged for some periods during the pelagic fisheries in order to further investigate the possible impact on post-smolt survival.

Salmon lice observations in selected Norwegian fjords and the Norwegian Sea

The status of salmon lice (*Lepheoptheirus salmonis* Krøyer) on seaward migrating post-smolts has been monitored by surface trawling in two southwest Norwegian fjords (Figure 2.4.4.2.) since 1998, i.e. since the live-fish sampling technique with the "Fish-lifter" (Holst and McDonald 2000) was introduced. In 2000, a special salmon survey was also carried out for the first time in four large north Norwegian fjords, and the Fish-lift technique was also used during a week in the Norwegian Sea (Table 3.9.1). This technique allows the majority of the fish to pass through the cod-end of the trawl with very little damage and loss of scales and external parasites (ICES 2000/ACFM:13).

The two southwest fjords were selected because they are different both hydrographically and in densities of fish farms, with the Nordfjord containing the largest number of net-pens. The northern fjords, again, represent areas with low (Altafjord) or no fish farms at all (Tana-/ Teno- and Neiden-/ Näätämöfjords) and large numbers of wild post-smolts (cf. Figure 2.4.4.3).

The northern post-smolt samples were infested with, on average, only 0.4 salmon lice per fish. The results of the analyses of salmon lice in post-smolt samples from the 1998 –2000 captures in the Nordfjord and the Sognefjord are presented in Figure 2.4.4.3. The numbers have varied greatly between the years, especially in the Sognefjord, where the mean number of lice per fish has been over 30 the two last years. These particular outmigrating cohorts may therefore have been subjected to infestation rates surpassing even conservative estimates of lethal limits.

In the Nordfjord, which actually houses a high number of net-pens, the average number of lice per fish was relatively high in 1998-1999, while it was zero in the samples of 2000. This reflects a combination of an apparently recent entry of the post-smolts into the sea, and a thick layer of fresh water extending to the outlet of this fjord. Holst *et al.* (2001) report salinities of less than 10 ppm down to 4.5 m depth in the Nordfjord during the days the post-smolts were sampled. This may have protected the fish from infestation, thus underlining the possible importance for survival of the hydrography at the time of smolt passage through the fjords.

None of the samples analysed from the Norwegian Sea, carried more than 10 chalimus or older stages of lice per fish. This has been hypothesised to indicate that fish with high infestation rates either die, or lag behind the main cohorts of sea migrating post-smolts.

At present there is no data available to the Working Group that could enable correlation of the influence of the observed lice infestation rates on subsequent return rates of 1 SW or MSW salmon to the particular fjords. However, the high observed infestation rates are a matter of concern, which should be investigated in more detail.

2.4.5 Marine growth checks as evidence for sub-catchment population structuring.

The FRS, Freshwater Laboratory has routinely examined scale samples from adult Atlantic salmon (*Salmo salar* L.) returning to Scottish homewaters since the 1960s for the purposes of assessing age structure. As previously reported, scales from fish returning in 1997 showed a higher than previously recorded incidence of summer checks (ICES 1998/ACFM:15 and MacLean *et al.* 2000). This examination has been extended to incorporate salmon returning to Scottish home waters in 1998 and 1999.

The occurrence of a group of tightly-spaced circuli can be interpreted either as a winter annulus or as a summer growth check (Shearer, 1992). Recaptures of adult salmon previously tagged as emigrating North Esk smolts provide scale samples from fish whose sea age may also be derived from tagging records and thus where the presence of summer checks may be determined unambiguously. Between 1997 and 1999, 320 salmon which had been tagged as smolts on the North Esk were recaptured as returning adults in Scottish home water fisheries. Of these, 64 were identified as exhibiting growth checks on the marine zone of their scales. The sea-age of each fish was estimated both from scale samples and tagging records. In all cases, the ages derived from both methods corresponded and thus supported the interpretation of the growth checks as summer checks rather than as winter annulii.

The occurrence of summer checks on the scales of salmon returning to Scottish home waters in the years 1997-1999 was shown to be significantly greater than levels derived from the previous 35-year period. There was no evidence that the incidence of checks varied between sexes. There was also no association between the presence of checks with either size at return or marine survival indices.

Where summer checks were identified on scales, the year when the check occurred was recorded, as was the relative position of the check within that year's marine growth zone. Examination of scale samples taken from the North Esk net & coble fishery, which was the largest sample data set available, showed that checks were not distributed randomly over the marine zone. Three categories of summer check (1SW salmon returns and 2SW returns with checks on the first or second summer at sea) were identified and their distribution of occurrence with respect to the growing season was analysed. The majority of checks tended to occur within a relatively narrow band within the third quarter of the marine zone. The proportion of salmon whose scales exhibited summer checks was highly variable both among years and sea age categories, but, in general, salmon showed a higher incidence of growth checks in their first year at sea than during their second year

The incidence of summer checks was also strongly related to the subsequent run-timing (the calendar month when fish returned to freshwater) of the adult fish. In particular, the incidence of summer checks in the first year of sea life was significantly associated with run-timing for each category of fish tested except 1SW salmon returning in 1999, when few checks were identified. Figure 2.4.5.1 shows the trends in incidence of summer checks with month of return to freshwater for the three categories of salmon. Seasonal patterns vary among groups but within each group, the pattern remained generally consistent between years.

The cause of the summer checks is unknown and the direct effects difficult to detect. Their relatively high incidence in recent years, however, may allow speculation on the mechanisms responsible for the observed patterns of association between groups of salmon in the ocean. While summer checks are present in scale samples taken from salmon returning to home waters throughout the sampling season the extent to which they occur varies both with adult run-time and sea age. These patterns of variation are relatively consistent among years suggesting that either different "run-timing groups" of salmon are differentially predisposed to the causal event or, salmon are not randomly mixed in the ocean and different groups follow, to some extent, different migration routes.

Radio tracking studies on a number of Scottish rivers show, within each sea age group, there is a relationship between the temporal pattern of return and the spatial distribution at spawning time (Anon, 1997, 1999; Laughton & Smith, 1992; Smith *et al.,* 1998, Walker & Walker, 1991). Thus, the "run-timing groups" referred to above may be thought of as proxies for populations differentiated at a sub-catchment scale in freshwater. The pattern of association between individuals in the ocean as evidenced by the proportion whose scales show summer checks may thus reflect the sub-catchment population structure found in rivers.

These observations may assist our understanding of recent trends in marine survival. Decreases in marine survival have been documented in the last decade throughout the north Atlantic at several monitored sites (ICES 2000/ACFM:13; Potter & Crozier, 2000). Furthermore, differential rates of decline in different monthly components of the catch have also been documented (ICES 2000/ACFM:13). Early running spring salmon, in particular, appear to have declined most markedly (Youngson, 1995a) and the upper catchment populations associated with these runs of fish also mirror these declines (Youngson, 1995b; ICES 2000/ACFM:13). The structured variation in the incidence of summer checks between "run-timing groups" reported here provides an association through which differential trends in marine survival may occur as it demonstrates that coherent freshwater populations may encounter similar conditions in a patchy marine environment.

2.4.6 Estimates of M at sea for Atlantic salmon

In the run-reconstruction models of the prefishery abundance (PFA) for the North American and Northeast Atlantic stock complexes, it is assumed that the natural mortality rate is 1% per month after the first year at sea. The assumed rate is from an analysis of weight and age data from the River Bush (U.K.) as developed by Doubleday *et al.* (1979)

(see below). This rate of natural mortality is used to calculate the number of fish immediately after the first winter, prior to the high seas fisheries, and between the high seas fisheries and returns to homewaters. If marine mortality rate is higher than previously assumed then its impact on assessments may be significant. In the time series of catches and returns used to estimate the PFA, there have been reductions in the level of sea fisheries such that presumably a smaller proportion of the estimated PFA consists of actual observed/harvested animals than was the case a decade ago (ICES CM 2000/ACFM:13). The concern is that the perception of reduced / declining abundance is in part an artifact of the model assumption about natural mortality during the second year at sea in terms of its assumed level and assumed constant rate over time. Two methods for estimating mortality at sea were reviewed, the inverse-weight method and the maturity schedule method.

Method 1 - Inverse Weight Method

Ricker (1976) described a method for estimating the natural mortality rate based on the assumption that M decreases with increased size because marine natural mortality is assumed to be primarily the result of predation. Following on that approach, Doubleday *et al.* (1979) used the inverse weight hypothesis to estimate natural survival during the second year at sea based on catches, size-at-age, and return rates to the river and concluded that the natural mortality rate between Greenland and home waters (approx. 12 months) was between 3% and 12%, i.e. about 1% per month. Lorenzen (1996) modelled the mortality of juvenile and adult fish as a power function of weight and using empirical observations of 113 species/stocks, derived parameter estimates for M relative to weight. Based on these parameter values and using estimates of weight at age for River Bush salmon (tabled in Doubleday *et al.* 1979), the monthly mortality rate of Atlantic salmon in the second year of ocean life is about 3% per month (Figure 2.4.6.1).

Method 2 - Maturity Schedule Method

It is possible to estimate the sea survival rates of 1SW and 2SW salmon during the first and second years at sea by modeling the dynamics in the ocean using a simple life history model. Assuming that survival rates at age for males and females are similar, the model provides equations relating the survival rates and maturation profiles for 1SW and 2SW salmon.

$1SW_M = N_0 * \delta_M * S_1 * \alpha_M$ or $S1SW_M = \delta_M * S_1 * \alpha_M$

$1SW_F = N_0 * (1-\boldsymbol{\delta}_M) * S_1 * \alpha_F$ or $S1SW_F = (1-\boldsymbol{\delta}_M) * S_1 * \alpha_F$

$2SW_M = N_0 * \boldsymbol{\delta}_M * S_1 * (1 - \alpha_M) * S_2$ or $S2SW_M = \boldsymbol{\delta}_M * S_1 * (1 - \alpha_M) * S_2$

$2SW_F = N_0 * (1-\boldsymbol{\delta}_M) * S_1 * (1 - \alpha_F) * S_2$ or $S2SW_F = (1-\boldsymbol{\delta}_M) * S_1 * (1 - \alpha_F) * S_2$

where $1SW_M$ and $1SW_F$ returns of 1SW maiden salmon from smolt run in year i

$2SW_M$ and $2SW_F$ returns of 2SW maiden salmon from smolt run in year i

N_0 smolt abundance from year i, sexes combined

δ_M proportion male in the smolt run

S_1 annual survival rate during the first year at sea

S_2 annual survival rate during the second year at sea

α_M proportion of survivors after one year maturing as males

α_F proportion of survivors after one year

maturing as females

$S1SW_M$, $S1SW_F$ survival rates (relative to N_0) of 1SW salmon

$S2SW_M$, $S2SW_F$ survival rates (relative to N_0) of 2SW salmon

The four parameters to estimate and their constraints are:

$0 =< S_1, S_2, \alpha_M, \alpha_F <= 1$

The model was applied to data from three rivers:

1. Saint John River hatchery returns of age-1 smolts stocked at Mactaquac

2. LaHave River at Morgans Falls, wild smolts

3. Rivière de la Trinité (Québec) wild smolts

Sex ratios for the wild smolts were derived from sampling. Sex ratio for the age-1 smolts from Mactaquac were obtained from one year's sampling and assumed constant for the years analysed.

Estimates of Marine Survival Rates

Survival rates during the first year at sea were low for the hatchery origin salmon of the Saint John River (range 1.4% to 3.3% annual) but higher for wild smolts of de la Trinite River (range 1.5% to 8.5%) (Figure 2.4.6.2). During the second year at sea, survival rates of the hatchery salmon ranged between 8% and 24% whereas the wild salmon survival rates in the second year at sea ranged between 17% and 79% (Figure 2.4.6.2). These survival rates are total survival rates after both natural and fishing mortality. Since 1992, most the sea fisheries have been closed or declining and the estimated survival rates can be considered equivalent to natural survival rates.

Survival rates during the first year have not responded to the closure of the fisheries in either of the stocks but survivals in the second year for de la Trinite salmon since the closure of the commercial fisheries are almost double the rates prior to the closure (Figure 2.4.6.2). Survival rates in both the first year and second year are better for wild smolts than hatchery smolts, and wild smolts from the northern stock (Trinite) are higher than those of the more southern LaHave River stock (Figure 2.4.6.3).

Mortality rates during the first and second years at sea are variable and since 1992 are high for both age groups. Based on the data from de la Trinite River, monthly Zs of between 0.02 and 0.15 have been estimated with the most frequently estimated value of 0.05 (Figure 2.4.6.4). Survival rates during the first year at sea have declined and in the 1990s remain as low or lower than those during the period of the 1980s when there were commercial fisheries. M therefore has increased over time.

The model results support the widely held view that the major source of mortality in the ocean occurs during the first year. They also provide evidence against the constant mortality rate assumptions used in the run-reconstruction model and for at least one wild stock of eastern Canada, monthly instantaneous mortality rates of 5% (ranging between 2% and 15%) would seem more appropriate.

Although there appears to be increasing evidence of M being greater than 1% per month in the second year at sea and that M varies annually, the Working Group cautioned that only three rivers were evaluated and the data series on only one was longer than ten years. For this reason the revised values from preceding analysis have not been used in the forecast model for 2002. While an analysis of more rivers would be required to assess the among stock variability in the estimated survival rates and the representative level for the North American stock complex, it will be necessary to incorporate revised values for the forecast model in future as they become available. The Working Group recommended that further evaluation of the maturity schedule method be undertaken particularly as it relates to the sensitivities of the survival estimates to the sex ratio values of the smolts and the assumption of equal survival of male and female salmon.

2.4.7 Potential impact of climate change on juvenile salmon

Climate change has been identified as an important source of aquatic disturbance on a global scale and may alter species composition and dominance in aquatic ecosystems. Cold water ecosystems are particularly at risk and predictions from the climate change models for North America include:
from 1990 – 2100, mean surface air temperature increases of 1.4 – 5.8° C, with more rapid warming in the Northern regions of North America,

largest increases in air temperature in winter,

increased frequency and duration of summer hot spells (Hengeveld 1990),

increased water temperatures in the range of 2 – 5° C with maximum changes occurring in spring and fall,

advanced timing of snowmelt and spring runoff,

earlier start of a drier spring-summer season contributing to more extreme low $\mathbf{F}_{low}$ conditions (Manabe and Wetherald 1987).

Climate change has the potential to alter thermal regimes in aquatic environments, adversely affecting Atlantic salmon populations. Water temperature can affect survival, growth and behaviour of salmon in freshwater habitats. Juvenile Atlantic salmon begin feeding in the spring at water temperatures of 6 – 7° C, and grow optimally at 16 – 19° C. At water temperatures ranging from 22 – 24° C, juvenile salmon have been observed to seek refuge from thermal stress. In some Atlantic salmon rivers in eastern Canada, juvenile salmon are already experiencing water temperatures approaching the upper lethal limit (30°C).

The Working Group reviewed an analysis of the hydrological conditions and river temperatures in the Miramichi River over a 50 year time period and the associated variability in juvenile salmon size-at-age during 1971 to 1999.

Mean annual air temperature increased significantly, at a rate of 0.42*C/decade from 1970-1999 with the warmest annual temperatures recorded in 1998 and 1999 (Figure 2.4.7.1). Mean air temperature in spring increased significantly, due to an increase of 0.58* C/decade in April ($p<0.011$). High temperatures were most frequently observed in 1999 and the frequency of high temperatures increased significantly in fall.

Mean summer water temperature was warmer in the Southwest Miramichi River than the Northwest Miramichi River, ranging from 12.3 to 15.3° C. The warmest water temperatures in the 30-year series were observed in 1999. Mean summer water temperature increased significantly from 1970 to 1999, at a rate of 0.29° C/decade ($p<0.037$). The frequency of high water temperatures ranged from 22 days in 1986 to 114 days in 1999. The frequency of high water temperatures increased significantly during the parr growth season (early May to July 15), by approximately 4 days/decade ($p<0.041$).

The most significant change in discharge was observed in the timing of the spring snowmelt event which has shifted from April and May in the 1960s to March and April in the 1990s (Figure 2.4.7.2).

The range of mean annual fork length of Atlantic salmon fry was 4.0 to 5.4 cm (Figure 2.4.7.3). Mean annual fork length of 1+ parr ranged from 7.6 to 9.1 cm , while size of 2+ parr ranged from 10.6 to 12.3 cm (Figure 2.4.7.4). Mean annual fork length of parr decreased significantly from 1970 to 1999, at a rate of 0.18 cm/decade for 1+ parr and 0.21 cm/decade for 2+ parr ($p<0.029$).

In terms of the timing of the seasonal growth of parr, weight increased during spring and early summer, levelling off or decreasing slightly in late summer. Observed juvenile fish weight was consistently higher than that predicted from water temperature during May to August.

Annual and seasonal changes in meteorological and hydrological conditions were correlated with decreased fork length of juvenile Atlantic salmon. Fork length of parr was most strongly associated with maximum annual and spring air temperatures and mean spring water temperatures in the Southwest Miramichi River (Figure 2.4.7.4). Fork length of parr was also strongly associated with the frequency of high air temperatures during the parr growing season (May – July 15) and the extreme high summer air temperatures.

Declines in fork length of juvenile Atlantic salmon parr (1+ and 2+) over the past 30 years suggest that conditions supporting growth have changed in the Northwest and Southwest Miramichi rivers. The functional model of growth relative to water temperature was a poor predictor of fish growth in the Miramichi River. The model tended to underestimate fish weight in spring and summer and overestimate in fall. For Atlantic salmon populations in the Miramichi, neither the theoretical functional model for maximum growth or growth potential index (as derived from the theoretical model) can be reliably used as predictors of fish growth in response to climate change.

Climate change is projected to have significant implications for aquatic ecosystems, altering thermal regimes and stream $\mathbf{F}_{low}$ conditions. The results of the analyses suggest that growth of juveniles in the Miramichi River are likely to be adversely affected by climate change, particularly during the spring months. Increases in air and water temperatures are expected to contribute to reduced size-at-age of juveniles with the potential effect of altering survival, age at smoltification, and ultimately sea survival

2.5 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2000

2.5.1 Compilation of tag releases and finclip data for 2000

Data on releases of tagged, fin-clipped, and marked salmon in 2000 were provided by the Working Group and are compiled as a separate report. A summary of Atlantic salmon marked in 2000 is given in Table 2.5.1. About 3.36 million salmon were marked in 2000, a decrease from the 4.43 million fish marked in 1999. The decrease was due largely to the reduced number of adipose fin clips. Primary marks are summarized in three classes: microtag (i.e., coded wire tag), external tag/mark, and adipose clips (without other external marks or fin clips. Secondary marks (primarily adipose clips on fish with coded wire tags) are also presented in the Annex. The adipose clip was the most used primary mark (2.35 million), with microtags (0.65 million) the next most used primary mark. Most marks were applied to hatchery-origin juveniles (3.30 million), while 44,115 wild juveniles and 16,150 adults were marked.

Table 2.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-2000. (2000 figures include provisional data).

Year	Canada (1)	Den.	Faroes (2)	Finland	France	East Grld.	West Grld. (3)	Iceland Wild	Iceland Ranch	Ireland (4,5)	Norway (6)	Russia (7)	Spain (8)	St. P. & M.	Sweden (West)	UK (E & W) (12)	UK N.Ireland (6,9)	UK (Scotland)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100	-	743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127	-	707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125	-	1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145	-	1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135	-	1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133	-	1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	2	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-	-
1967	2863	-	-	-	-	-	1601	144	2	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-	-
1968	2111	-	5	-	-	-	1127	161	1	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-	-
1969	2202	-	7	-	-	-	2210	131	2	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-	-
1970	2323	-	12	-	-	-	2146	182	13	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-	-
1971	1992	-	-	-	-	-	2689	196	8	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-	-
1972	1759	-	9	32	34	-	2113	245	5	1804	1578	462	40	-	18	442	210	1727	1	486	10965	-	-
1973	2434	-	28	50	12	-	2341	148	8	1930	1726	772	24	-	23	450	182	2006	2.7	533	12670	-	-
1974	2539	-	20	76	13	-	1917	215	10	2128	1633	709	16	-	32	383	184	1628	0.9	373	11877	-	-
1975	2485	-	28	76	25	-	2030	145	21	2216	1537	811	27	-	26	447	164	1621	1.7	475	12136	-	-
1976	2506	-	40	66	9	<1	1175	216	9	1561	1530	542	21	2.5	20	208	113	1019	0.8	289	9327	-	-
1977	2545	-	40	59	19	6	1420	123	7	1372	1488	497	19	-	10	345	110	1160	2.4	192	9414	-	-
1978	1545	-	37	37	20	8	984	285	6	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-	-
1979	1287	-	119	26	10	<0.5	1395	219	6	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-	-
1980	2680	-	536	34	30	<0.5	1194	241	8	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-	-
1981	2437	-	1025	44	20	<0.5	1264	147	16	685	1656	463	25	-	26	493	101	1233	6	313	9954	-	-
1982	1798	-	606	54	20	<0.5	1077	130	17	993	1348	364	10	-	25	286	132	1092	6.4	437	8395	-	-
1983	1424	-	678	58	16	<0.5	310	166	32	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-	-
1984	1112	-	628	46	25	<0.5	297	139	20	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-	-
1985	1133	-	566	49	22	7	864	162	55	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-	-
1986	1559	-	530	37	28	19	960	232	59	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9255	315	-
1987	1784	-	576	49	27	<0.5	966	181	40	1239	1385	564	18	2	47	302	56	922	1.2	-	8159	2788	-
1988	1310	-	243	36	32	4	893	217	180	1874	1076	420	18	2	40	395	114	882	0.9	-	7737	3248	-
1989	1139	-	364	52	14	-	337	140	136	1079	905	364	7	2	29	296	142	895	1.7	-	5903	2277	-
1990	911	13	315	60	15	-	274	146	280	567	930	313	7	1.9	33	338	94	624	2.4	-	4924	1890	180-350
1991	711	3.3	95	70	13	4	472	130	345	404	876	215	11	1.2	38	200	55	462	0.8	-	4106	1682	25-100
1992	522	10	23	77	20	5	237	175	460	630	867	167	11	2.3	49	171	91	600	0.7	-	4118	1962	25-100
1993	373	9	23	70	16	-	-	160	496	541	923	139	8	2.9	56	248	83	547	0.6	-	3696	1644	25-100
1994	355	6	6	49	18	-	-	140	308	804	996	141	10	3.4	44	324	91	649	-	-	3944	1276	25-100
1995	260	3.1	5	48	9	2	83	150	298	790	839	128	9	0.8	37	295	83	588	-	-	3628	1060	n/a
1996	292	1.7	-	44	14	0.5	92	122	239	687	787	131	7	1.6	33	183	77	427	-	-	3139	1123	n/a
1997	229	1.3	-	45	8	1	58	106	50	570	630	111	3	1.5	19	142	93	296	-	-	2364	827	n/a
1998	157	1.3	6	48	9	-	11	130	34	624	740	131	4	2.3	15	123	78	283	-	-	2397	1210	n/a
1999	152	0.5	-	63	11	0.5	19	119	26	515	811	103	6	2.3	16	150	53	199	-	-	2246	1032	n/a
2000	150	4.6	8	95	11	0	21	82	2	621	1176	124	-	2.3	33	214	78	192	-	-	2814	1269	n/a
Means																							
1995-1999	218	2	6	50	10	1	53	125	129	637	761	121	6	2	24	179	77	359	-	-	2755	1050	-
1990-1999	396	5	68	57	13	2	156	138	254	613	840	158	8	2	34	217	80	468	1	-	3456	1371	-

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place, the commercial fishery resumed in 2000
3. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
4. From 1994, includes increased rate of reporting of rod catches.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Before 1966, sea trout and sea charr included (5% of total).
7. Figures from 1991 onwards do not include catches taken in the recently developed recreational (rod) fishery.
8. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 based on mean wt. from R. Asturias.
9. Not including angling catch (mainly 1SW).
10. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
11. Estimates refer to season ending in given year.
12. Data for 1993-98 altered from previous reports to take account of catch & release

Table 2.1.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-2000. (2000 figures include provisional data).
S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). Sm = small. Lg = large; for definitions, see Section 4.1. T = S + G or Lg + Sm

Year	Canada (1)			Finland			France	Iceland Wild	Iceland Ranch	Ireland (2,3)			Norway (4)			Russia	Spain (5)	Sweden (West)	UK (7) (E&W)	UK(N.I.) (6)	UK(Scotland)			USA	Total
	Lg	Sm	T	S	G	T	T	T	T	S	G	T	S	G	T	T	T	T	T	T	S	G	T	T	T
1960	-	-	1636	-	-	-	-	100		-	-	743	-	-	1659	1100	33	40	283	139	971	472	1443	1	7177
1961	-	-	1583	-	-	-	-	127		-	-	707	-	-	1533	790	20	27	232	132	811	374	1185	1	6337
1962	-	-	1719	-	-	-	-	125		-	-	1459	-	-	1935	710	23	45	318	356	1014	724	1738	1	8429
1963	-	-	1861	-	-	-	-	145		-	-	1458	-	-	1786	480	28	23	325	306	1308	417	1725	1	8138
1964	-	-	2069	-	-	-	-	135		-	-	1617	-	-	2147	590	34	36	307	377	1210	697	1907	1	9220
1965	-	-	2116	-	-	-	-	133		-	-	1457	-	-	2000	590	42	40	320	281	1043	550	1593	1	8573
1966	-	-	2369	-	-	-	-	104	2	-	-	1238	-	-	1791	570	42	36	387	287	1049	546	1595	1	8422
1967	-	-	2863	-	-	-	-	144	2	-	-	1463	-	-	1980	883	43	25	420	449	1233	884	2117	1	10390
1968	-	-	2111	-	-	-	-	161	1	-	-	1413	-	-	1514	827	38	20	282	312	1021	557	1578	1	8258
1969	-	-	2202	-	-	-	-	131	2	-	-	1730	801	582	1383	360	54	22	377	267	997	958	1955	1	8484
1970	1562	761	2323	-	-	-	-	182	13	-	-	1787	815	356	1171	448	45	20	527	297	775	617	1392	1	8206
1971	1482	510	1992	-	-	-	-	196	8	-	-	1639	771	436	1207	417	16	18	426	234	719	702	1421	1	7575
1972	1201	558	1759	-	-	32	34	245	5	200	1604	1804	1064	514	1578	462	40	18	442	210	1013	714	1727	1	8357
1973	1651	783	2434	-	-	50	12	148	8	244	1686	1930	1220	506	1726	772	24	23	450	182	1158	848	2006	2.7	9768
1974	1589	950	2539	-	-	76	13	215	10	170	1958	2128	1149	484	1633	709	16	32	383	184	912	716	1628	0.9	9567
1975	1573	912	2485	-	-	76	25	145	21	274	1942	2216	1038	499	1537	811	27	26	447	164	1007	614	1621	1.7	9603
1976	1721	785	2506	-	-	66	9	216	9	109	1452	1561	1063	467	1530	542	21	20	208	113	522	497	1019	0.8	7821
1977	1883	662	2545	-	-	59	19	123	7	145	1227	1372	1018	470	1488	497	19	10	345	110	639	521	1160	2.4	7756
1978	1225	320	1545	-	-	37	20	285	6	147	1082	1229	668	382	1050	476	32	10	349	148	781	542	1323	4.1	6514
1979	705	582	1287	-	-	26	10	219	6	105	922	1027	1150	681	1831	455	29	12	261	99	598	478	1076	2.5	6341
1980	1763	917	2680	-	-	34	30	241	8	202	745	947	1352	478	1830	664	47	17	360	122	851	283	1134	5.5	8120
1981	1619	818	2437	-	-	44	20	147	16	164	521	685	1189	467	1656	463	25	26	493	101	834	389	1223	6	7342
1982	1082	716	1798	49	5	54	20	130	17	63	930	993	985	363	1348	364	10	25	286	132	596	496	1092	6.4	6275
1983	911	513	1424	51	7	58	16	166	32	150	1506	1656	957	593	1550	507	23	28	429	187	672	549	1221	1.3	7298
1984	645	467	1112	37	9	46	25	139	20	101	728	829	995	628	1623	593	18	40	345	78	504	509	1013	2.2	5883
1985	540	593	1133	38	11	49	22	162	55	100	1495	1595	923	638	1561	659	13	45	361	98	514	399	913	2.1	6668
1986	779	780	1559	25	12	37	28	232	59	136	1594	1730	1042	556	1598	608	27	54	430	109	745	526	1271	1.9	7744
1987	951	833	1784	34	15	49	27	181	40	127	1112	1239	894	491	1385	564	18	47	302	56	503	419	922	1.2	6615
1988	633	677	1310	27	9	36	32	217	180	141	1733	1874	656	420	1076	420	18	40	395	114	501	381	882	0.9	6595
1989	590	549	1139	33	19	52	14	140	136	132	947	1079	469	436	905	364	7	29	296	142	464	431	895	1.7	5200
1990	486	425	911	41	19	60	15	146	280	-	-	567	545	385	930	313	7	33	338	94	423	201	624	2.4	4520
1991	370	341	711	53	17	70	13	130	345	-	-	404	535	342	876	215	11	38	200	55	177	285	462	0.8	3531
1992	323	199	522	49	28	77	20	175	460	-	-	630	566	301	867	167	11	49	171	91	362	238	600	0.7	3841
1993	214	159	373	53	17	70	16	160	496	-	-	541	611	312	923	139	8	56	248	83	320	227	547	0.6	3661
1994	216	139	355	38	11	49	18	140	308	-	-	804	581	415	996	141	10	44	324	91	400	248	649	-	3929
1995	153	107	260	37	11	48	9	150	298	-	-	790	590	249	839	128	9	37	295	83	364	224	588	-	3534
1996	154	138	292	23	21	44	14	122	239	-	-	687	571	215	787	131	7	33	183	77	267	160	427	-	3043
1997	126	103	229	29	16	45	8	106	50	-	-	570	389	241	630	111	3	19	142	93	182	114	296	-	2302
1998	70	87	157	29	19	48	9	130	34	-	-	624	445	296	740	131	4	15	123	78	162	121	283	-	2376
1999	64	88	152	30	32	63	11	119	26	-	-	515	493	318	811	103	6	16	150	53	142	57	199	-	2224
2000	62	87	150	61	35	95	11	82	2	-	-	621	673	504	1176	124	n/a	33	214	78	126	66	192	-	2767
Means																									
1995-99	113	105	218	30	20	50	10	125	129	-	-	637	498	264	761	121	6	24	179	77	223	135	359	-	2696
1990-99	218	179	396	38	19	57	13	138	254	-	-	613	533	307	840	158	8	34	217	80	280	188	468	1	3276

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
3. From 1994, includes increased reporting of rod catches.
4. Before 1966, sea trout and sea charr included (5% of total).
5. Weights prior to 1990 are estimated from 1994 mean weight.
   Weights from 1990 based on mean wt. from R. Asturias.
6. Not including angling catch (mainly 1SW).
7. Data for 1993-98 altered from previous reports to take account of catch & release

Table 2.1.1.3 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 2000 may be provisional. Methods used for estimating age composition given in footnotes.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,559
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,310
	1989	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	233,690	425	-	-	-	-	-	-	-	-	106,379	486	-	-	340,069	911
	1991	189,324	341	-	-	-	-	-	-	-	-	82,532	370	-	-	271,856	711
	1992	108,901	199	-	-	-	-	-	-	-	-	66,357	323	-	-	175,258	522
	1993	91,239	159	-	-	-	-	-	-	-	-	45,416	214	-	-	136,655	373
	1994	76,973	139	-	-	-	-	-	-	-	-	42,946	216	-	-	119,919	355
	1995	61,940	107	-	-	-	-	-	-	-	-	34,263	153	-	-	96,203	260
	1996	82,490	138	-	-	-	-	-	-	-	-	31,590	154	-	-	114,080	292
	1997	58,988	103	-	-	-	-	-	-	-	-	26,270	126	-	-	85,258	229
	1998	51,251	87	-	-	-	-	-	-	-	-	13,274	70	-	-	64,525	157
	1999	50,901	88	-	-	-	-	-	-	-	-	11,368	64	-	-	62,269	152
	2000	50,108	87	-	-	-	-	-	-	-	-	11,459	62	-	-	61,567	150
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/86	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/87	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/88	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/89	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/90	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/92	16	-	7,611	-	837	-	-	-	-	-	-	-	-	-	8,464	31
	1992/93	-	-	4,212	-	1,203	-	-	-	-	-	-	-	-	-	5,415	22
	1993/94	-	-	1,866	-	206	-	-	-	-	-	-	-	-	-	2,072	7
	1994/95	-	-	1,807	-	156	-	-	-	-	-	-	-	-	-	1,963	6
	1995/96	-	-	268	-	14	-	-	-	-	-	-	-	-	-	282	1
	1996/97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1997/98	339	-	1,315	-	109	-	-	-	-	-	-	-	-	-	1,763	6
	1998/99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1999/00	225	-	1560	-	205	-	-	-	-	-	-	-	-	-	1,990	8
	2000/01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Finland	1982	2,598	5	-	-	-	-	-	-	-	-	5,408	49	-	-	8,406	54
	1983	3,916	7	-	-	-	-	-	-	-	-	6,050	51	-	-	9,966	58
	1984	4,899	9	-	-	-	-	-	-	-	-	4,726	37	-	-	9,625	46
	1985	6,201	11	-	-	-	-	-	-	-	-	4,912	38	-	-	11,113	49
	1986	6,131	12	-	-	-	-	-	-	-	-	3,244	25	-	-	9,375	37
	1987	8,696	15	-	-	-	-	-	-	-	-	4,520	34	-	-	13,216	49
	1988	5,926	9	-	-	-	-	-	-	-	-	3,495	27	-	-	9,421	36
	1989	10,395	19	-	-	-	-	-	-	-	-	5,332	33	-	-	15,727	52
	1990	10,084	19	-	-	-	-	-	-	-	-	5,600	41	-	-	15,684	60
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49
	1995	7,786	11	-	-	-	-	-	-	-	-	5,344	38	-	-	13,130	48
	1996	10,726	21	1,103	5	1,359	13	242	4	13	1	-	-	-	-	13,443	44
	1997	9,469	16	2,357	10	1,742	17	163	2	10	0	-	-	-	-	13,741	45
	1998	11,410	19	1,642	7	1,945	19	162	2	10	0	-	-	-	-	15,169	48
	1999	16,861	32	1,556	8	1,708	17	130	2	10	0	-	-	444	3	20,709	63
	2000	17,499	35	4899	24	2,672	28	105	2	-	-	-	-	1,022	7	26,196	95
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,124	3	1,971	9	311	2	-	-	-	-	-	-	-	-	3,406	14
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
	1991	1,362	3	1,935	9	190	1	-	-	-	-	-	-	-	-	3,487	13
	1992	2,490	7	2,450	12	221	2	-	-	-	-	-	-	-	-	5,161	20
	1993	3,581	10	987	4	267	2	-	-	-	-	-	-	-	-	4,835	16
	1994	2,810	7	2,250	10	40	1	-	-	-	-	-	-	-	-	5,100	18
	1995	1,669	4	1,073	5	22	0	-	-	-	-	-	-	-	-	2,764	9
	1996	2,063	5	1,891	9	52	0.4	-	-	-	-	-	-	-	-	4,005	14
	1997	1,060	3	964	5	37	0.3	-	-	-	-	-	-	-	-	2,061	8
	1998	2,065	5	824	4	22	0.2	-	-	-	-	-	-	-	-	2,911	9
	1999	690	2	1,799	9	32	0.2	-	-	-	-	-	-	-	-	2,521	11
	2000	1792	4.3	1253	6	24	0.2	-	-	-	-	-	-	-	-	3,069	11
Iceland	1991	30,011	-	11,935	-	-	-	-	-	-	-	-	-	-	-	41,946	130
	1992	38,955	-	15,416	-	-	-	-	-	-	-	-	-	-	-	54,371	175
(Wild fish	1993	37,611	-	11,611	-	-	-	-	-	-	-	-	-	-	-	49,222	160
only,	1994	25,480	62	14,408	78	-	-	-	-	-	-	-	-	-	-	39,888	140
ranched fish	1995	34,046	93	13,380	57	-	-	-	-	-	-	-	-	-	-	47,426	150
not	1996	28,039	69	9,971	53	-	-	-	-	-	-	-	-	-	-	38,010	122
included)	1997	23,945	62	8,872	44	-	-	-	-	-	-	-	-	-	-	32,817	106
	1998	35,537	90	7,791	40	-	-	-	-	-	-	-	-	-	-	43,328	130
	1999	23,723	63	10,961	56	-	-	-	-	-	-	-	-	-	-	34,684	119
	2000	23,850	58	4,456	24	-	-	-	-	-	-	-	-	-	-	28,306	82

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330,558	1,079
	1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	188,890	567
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,474	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,435	630
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,120	541
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286,266	804
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288,225	790
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	249,623	687
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	209,214	570
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	237,663	624
	1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	180,477	515
	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	228,220	621
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348
	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	235,703	491	-	-	-	-	-	-	-	-	153,554	894	-	-	389,257	1,385
	1988	217,617	420	-	-	-	-	-	-	-	-	120,367	656	-	-	337,984	1,076
	1989	220,170	436	-	-	-	-	-	-	-	-	80,880	469	-	-	301,050	905
	1990	192,500	385	-	-	-	-	-	-	-	-	91,437	545	-	-	286,466	930
	1991	171,041	342	-	-	-	-	-	-	-	-	92,214	535	-	-	263,255	876
	1992	151,291	301	-	-	-	-	-	-	-	-	92,717	566	-	-	244,008	867
	1993	153,407	312	62,403	284	35,147	327	-	-	-	-	-	-	-	-	251,957	923
	1994	-	415	-	319	-	262	-	-	-	-	-	-	-	-	-	996
	1995	134,341	249	71,552	341	27,104	249	-	-	-	-	-	-	-	-	232,997	839
	1996	110,085	215	69,389	322	27,627	249	-	-	-	-	-	-	-	-	207,101	787
	1997	124,387	241	52,842	238	16,448	151	-	-	-	-	-	-	-	-	193,677	630
	1998	162,185	296	66,767	306	15,568	139	-	-	-	-	-	-	-	-	244,520	740
	1999	164,905	318	70,825	326	18,669	167	-	-	-	-	-	-	-	-	254,399	811
	2000	250,648	504	99,934	454	24,319	219	-	-	-	-	-	-	-	-	374,721	1176

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Russia	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	139,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,066	420
	1989	78,023	-	23,123	-	4,118	-	26	-	-	-	-	-	2,187	-	107,477	364
	1990	70,595	-	20,633	-	2,919	-	101	-	-	-	-	-	2,010	-	96,258	313
	1991	40,603	-	12,458	-	3,060	-	650	-	-	-	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	-	-	-	-	824	-	47,452	167
	1993	28,100	-	11,780	-	4,280	-	377	-	-	-	-	-	1,470	-	46,007	139
	1994	30,877	-	10,879	-	2,183	-	51	-	-	-	-	-	555	-	44,545	141
	1995	27,775	62	9,642	50	1,803	15	6	0	-	-	-	-	385	2	39,611	128
	1996	33,878	79	7,395	42	1,084	9	40	0.5	-	-	-	-	41	0.5	42,586	131
	1997	31,857	72	5,837	28	672	6	38	0.5	-	-	-	-	559	3	39,003	111
	1998	34,870	92	6,815	33	181	2	28	0.3	-	-	-	-	638	3	42,532	131
	1999	24,016	66	5,317	25	499	5	-	-	-	-	-	-	1131	6	30,963	102
	2000	27,702	75	7,027	34	500	5	3	0.1	-	-	-	-	1853	9	37,115	124
Sweden	1989	3,181	7	-	-	-	-	-	-	-	-	4,610	22	-	-	7,791	29
	1990	7,428	18	-	-	-	-	-	-	-	-	3,133	15	-	-	10,561	33
	1991	8,987	20	-	-	-	-	-	-	-	-	3,620	18	-	-	12,607	38
	1992	9,850	23	-	-	-	-	-	-	-	-	4,656	26	-	-	14,507	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,695	44
	1995	9,761	22	-	-	-	-	-	-	-	-	2,770	14	-	-	12,531	37
	1996	6,008	14	-	-	-	-	-	-	-	-	3,542	19	-	-	9,550	33
	1997	2,747	7	-	-	-	-	-	-	-	-	2,307	12	-	-	5,054	19
	1998	2,421	6	-	-	-	-	-	-	-	-	1,702	9	-	-	4,123	15
	1999	3,573	8	-	-	-	-	-	-	-	-	1,460	8	-	-	5,033	16
	2000	7,103	18	-	-	-	-	-	-	-	-	3196	15	-	-	10,299	33
UK	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
(England &	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
Wales)	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,439	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
(2)	1989	64,424	-	-	-	-	-	-	-	-	-	19,244	-	-	-	83,668	296
	1990	53,143	-	-	-	-	-	-	-	-	-	33,533	-	-	-	86,676	338
	1991	34,596	-	-	-	-	-	-	-	-	-	17,053	-	-	-	51,649	200
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44,586	171
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	69,177	248
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88,121	324
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80,478	295
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46,696	183
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41,374	142
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36,917	123
	1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41,094	150
	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60,801	214

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
UK (Scotland)	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,3032	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	81,094	201	-	-	-	-	-	-	-	-	87,924	423	-	-	169,018	624
	1991	73,608	177	-	-	-	-	-	-	-	-	65,193	285	-	-	138,801	462
	1992	101,676	238	-	-	-	-	-	-	-	-	82,841	361	-	-	184,517	600
	1993	94,517	227	-	-	-	-	-	-	-	-	71,726	320	-	-	166,243	547
	1994	99,459	248	-	-	-	-	-	-	-	-	85,404	400	-	-	184,863	649
	1995	89,921	224	-	-	-	-	-	-	-	-	78,452	364	-	-	168,373	588
	1996	66,413	160	-	-	-	-	-	-	-	-	57,920	267	-	-	124,333	427
	1997	46,872	114	-	-	-	-	-	-	-	-	40,427	182	-	-	87,299	296
	1998	53,447	121	-	-	-	-	-	-	-	-	39,248	162	-	-	92,695	283
	1999	25,183	57	-	-	-	-	-	-	-	-	30,651	142	-	-	55,834	199
	2000	26,896	66	-	-	-	-					29,774	126	-	-	56,671	192
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1.0	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
	1990	52	0.1	562	2.2	12	-	-	-	-	-	-	-	16	-	642	2.4
	1991	48	0.1	185	0.7	1	-	-	-	-	-	-	-	4	-	238	0.8
	1992	54	0.1	138	0.6	1	-	-	-	-	-	-	-	-	-	193	0.7
	1993	17	-	133	0.5	-	-	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	0	-	-	-	-	-	-	-	-	-	-	-	12	0
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,478	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,052	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,381	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1995	31,241	-	558	-	-	-	-	-	-	-	-	-	478	-	32,270	83
	1996	30,613	-	884	-	-	-	-	-	-	-	-	-	568	-	32,062	92
	1997	20,980	-	134	-	-	-	-	-	-	-	-	-	124	-	21,238	58
	1998	3,901	-	17	-	-	-	-	-	-	-	-	-	88	-	4,006	11
	1999	6, 124	18	50	0.4	-	-	-	-	-	-	-	-	84	0.6	6,258	19
	2000	7,715	20	-	-	-	-	-	-	-	-	-	-	140	0.4	7,855	20

1 MSW includes all sea ages >1, when this cannot be broken down.

Different methods are used to separate 1SW and MSW salmon in different countries:

- Scale reading: Faroe Islands, Finland (1996 onwards), France, Russia, UK (England and Wales), USA and West Greenland.
- Size (split weight/length): Canada (2.7 kg for nets; 63cm for rods), Finland up until 1995 (3 kg), Iceland (various splits used at different times and places),
- Norway (3 kg), UK (Scotland) (3 kg in some places and 3.7 kg in others). All countries except Scotland report no problems with using weight to catergorise
- catches into sea age classes.

In Scotland, misclassification may be very high in some years.

In Norway, catches shown as 3SW refer to salmon of 3SW or greater.

2 . Data for 1993-98 altered from previous reports to take account of catch & release

Table 2.1.1.4 The weight (tonnes round fresh weight) and proportion (%) of the nominal catch by country taken in coastal, estuarine and riverine fisheries.

		Catch						
		Coast		Estuary		River		Total
Country	Year	Weight	%	Weight	%	Weight	%	Weight
Canada	1999	7	5	38	25	105	70	150
	2000	11	7	22	15	117	78	150
Finland	1995	0	0	0	0	48	100	48
	1996	0	0	0	0	44	100	44
	1997	0	0	0	0	45	100	45
	1998	0	0	0	0	48	100	48
	1999	0	0	0	0	63	100	63
	2000	0	0	0	0	95	100	95
France[1]	1995	-	-	2	20	8	80	10
	1996	-	-	4	31	9	69	13
	1997	-	-	3	38	5	63	8
	1998	1	13	2	25	5	63	8
	1999	0	0	4	35	7	65	11
	2000	0	4	4	35	7	61	11
Iceland	1995	20	13	0	0	130	87	150
	1996	11	9	0	0	111	91	122
	1997	0	0	0	0	106	100	106
	1998	0	0	0	0	130	100	130
	1999	0	0	0	0	119	100	119
	2000	0	0	0	0	82	100	82
Ireland	1995	566	72	140	18	84	11	790
	1996	440	64	134	20	110	16	684
	1997	380	67	100	18	91	16	571
	1998	433	69	92	15	99	16	624
	1999	335	65	83	16	97	19	515
	2000	440	71	79	13	102	16	621
Norway	1995	515	61	0	0	325	39	840
	1996	520	66	0	0	267	34	787
	1997	394	63	0	0	235	37	629
	1998	410	55	0	0	331	45	741
	1999	483	60	0	0	327	40	810
	2000	619	53	0	0	557	47	1176
Russia	1995	43	33	9	7	77	60	128
	1996	64	49	21	16	46	35	131
	1997	63	57	17	15	32	28	111
	1998	55	42	2	2	74	56	131
	1999	48	47	2	2	52	51	102
	2000	64	52	15	12	45	36	124

Table 2.1.1.4 continued

Country	Year	Catch						
		Coast		Estuary		River		Total
		Weight	%	Weight	%	Weight	%	Weight
Spain	1995	0	0	0	0	9	100	9
	1996	0	0	0	0	7	100	7
	1997	0	0	0	0	4	100	4
	1998	0	0	0	0	4	100	4
	1999	0	0	0	0	6	100	6
	2000	n/a	-	n/a	-	n/a	-	n/a
Sweden	1995	24	65	0	0	13	35	37
	1996	19	58	0	0	14	42	33
	1997	10	56	0	0	8	44	18
	1998	5	33	0	0	10	67	15
	1999	5	31	0	0	11	69	16
	2000	10	30	0	0	23	70	33
UK	1995	200	68	45	15	49	17	294
England &	1996	83	45	42	23	58	32	183
Wales	1997	81	57	27	19	35	24	143
	1998	65	53	19	16	38	31	122
	1999	101	67	23	15	26	17	150
	2000	152	71	25	12	36	17	213
UK (N. Ireland) [2]	1999	44	83	9	17	0	0	53
	2000	63	82	14	18	0	0	77
UK	1995	201	34	105	18	282	48	588
Scotland	1996	129	30	80	19	218	51	427
	1997	79	27	33	11	184	62	296
	1998	60	21	28	10	195	69	283
	1999	35	18	23	12	141	71	199
	2000	30	16	24	12	139	72	193
Totals								
North East Atlantic [3]	2000	1386	53	161	6	1086	41	2633
North America [4]	2000	13	9	22	14	117	77	152

[1] An illegal net fishery operated from 1995 to 1998, catch unknown in the first 3 years but thought to be increasing.Fishery ceased in 1999

[2] no nominal catch data is collected for river fisheries in UK (NI)

[3] data not available from Denmark & Spain

[4] includes Canada & St Pierre et Miquelon

Table 2.1.2.1 Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for countries in the North Atlantic where records are available, 1991-2000.

Year	Canada [1]		Iceland		Russia		UK(E&W)		UK(Scot)		USA	
	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch
1991					3,211	51					239	50
1992	46,450	34			10,120	73					407	67
1993	53,849	41			11,246	82	1,448	10			507	77
1994	45,804	39			12,056	83	3,227	13	6,595	8	249	95
1995	31,211	36			11,904	84	3,189	20	12,133	14	370	100
1996	36,934	33	669	2	10,745	73	3,428	20	10,409	15	542	100
1997	48,387	49	1,558	5	14,823	87	3,132	24	10,906	18	333	100
1998	56,860	52	2,826	7	12,776	81	5,365	31	13,455	18	273	100
1999	49,268	50	3,051	10	11,450	77	5,447	44	14,839	28	211	100
2000 [2]	49,737	53	2,691	10	12,914	74	7,355	42	19,991	34	-	-

1. Figures for 1992 to 1996 are minimal estimates as not all areas have reported catch and release.
2. Figures for 2000 are provisional.

Table 2.1.3.1	Estimates of unreported catches by various methods in tonnes within national EEZs in the North-East Atlantic, North American and West Greenland Commissions of NASCO, 1986-2000.			
Year	North-East Atlantic	North-American	West Greenland	Total
1987	2,554	234	-	2,788
1988	3,087	161	-	3,248
1989	2,103	174	-	2,277
1990	1,779	111	-	1,890
1991	1,555	127	-	1,682
1992	1,825	137	-	1,962
1993	1,471	161	< 12	1,644
1994	1,157	107	< 12	1,276
1995	942	98	20	1,060
1996	947	156	20	1,123
1997	732	90	5	827
1998	1,108	91	11	1,210
1999	887	133	12,5	1,032
2000	1,135	124	10	1,269
Mean 1995-1999	923	114	< 14	1050

Table 2.1.3.2 Estimates of unreported catches by various methods in tonnes by country within national EEZs in the North-East Atlantic, North America and West Greenland Commissions of NASCO, 2000, (NA = not available).

2000 Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Faroes	< 1	-	-
NEAC	Finland	25	0.6	21
NEAC	Iceland	2	0.0	2
NEAC	Ireland	132	3.2	18
NEAC	Norway	633	15.5	35
NEAC	Russia	250	6.1	67
NEAC	Sweden	4	0.1	11
NEAC	UK (E & W)	38	0.9	15
NEAC	UK (N.Ireland)	8	0.2	9
NEAC	UK (Scotland)	44	1.1	19
NAC	Canada	124	3.0	45
NAC	USA	0	0.0	0
WGC	West Greenland	10	0.2	32
	Total Unreported Catch	1269	31.1	
	Total Reported Catch of North Atlantic salmon	2814		

Table 2.2.1.1 Production of farmed salmon in the North Atlantic area and in areas other than the North Atlantic (in tonnes round fresh weight), 1980-2000.

Year	North Atlantic Area										Outwith North Atlantic Area							Worldwide
	Norway	UK (Scot.)	Faroes	Canada	Ireland	USA	Iceland	UK (N.Ire.)	Russia	Total	Chile	West Coast USA	West Coast Canada	Australia	Turkey	Other	Total	Total
1980	4,153	598	0	11	21	0	0	0	0	4,783	0	0	0	0	0	0	0	4,783
1981	8,422	1,133	0	21	35	0	0	0	0	9,611	0	0	0	0	0	0	0	9,611
1982	10,266	2,152	70	38	100	0	0	0	0	12,626	0	0	0	0	0	0	0	12,626
1983	17,000	2,536	110	69	257	0	0	0	0	19,972	0	0	0	0	0	0	0	19,972
1984	22,300	3,912	120	227	385	0	0	0	0	26,944	0	0	0	0	0	0	0	26,944
1985	28,655	6,921	470	359	700	0	91	0	0	37,196	0	0	0	0	0	0	0	37,196
1986	45,675	10,337	1,370	672	1,215	0	123	0	0	59,392	0	0	0	20	0	0	0	59,392
1987	47,417	12,721	3,530	1,334	2,232	365	490	0	0	68,089	3	0	0	50	0	0	53	68,142
1988	80,371	17,951	3,300	3,542	4,700	455	1,053	0	0	111,372	174	0	0	250	0	0	424	111,796
1989	124,000	28,553	8,000	5,865	5,063	905	1,480	0	0	173,866	1,864	1,100	1,000	400	0	700	5,064	178,930
1990	165,000	32,351	13,000	7,810	5,983	2,086	2,800	<100	5	229,035	9,500	700	1,700	1,700	0	800	14,400	243,435
1991	155,000	40,593	15,000	9,395	9,483	4,560	2,680	100	0	236,811	14,991	2,000	3,500	2,700	0	1,400	24,591	261,402
1992	140,000	36,101	17,000	10,380	9,231	5,850	2,100	200	0	220,862	23,769	4,900	6,600	2,500	0	400	38,169	259,031
1993	170,000	48,691	16,000	11,115	12,366	6,755	2,348	<100	0	267,275	29,248	4,200	12,000	4,500	1,000	400	51,348	318,623
1994	215,000	64,066	14,789	12,441	11,616	6,130	2,588	<100	0	326,630	34,077	5,000	16,100	5,000	1,000	800	61,977	388,607
1995	295,000	70,060	9,000	12,550	11,811	10,020	2,880	259	0	411,580	41,093	5,000	16,000	6,000	1,000	0	69,093	480,673
1996	305,000	83,121	18,600	17,715	14,025	10,010	2,772	338	0	451,581	69,960	5,200	17,000	7,500	1,000	600	101,260	552,841
1997	331,367	99,197	22,205	19,354	14,025	12,140	2,554	225	0	501,067	87,700	6,000	28,751	9,000	1,000	900	133,351	634,418
1998	344,645	110,784	20,362	16,418	14,860	13,166	2,686	114	0	523,035	125,000	3,000	33,057	10,000	1,000	400	172,457	695,492
1999	415,399	126,686	37,000	24,370	18,000	12,194	2,900	234	0	636,783	150,000	5,000	39,000	10,000	1,000	500	205,500	842,283
2000	427,000	130,837	32,000	31,600	17,648	16,400	3,000	250	0	658,735		5,400	40,000				45400	704,135
Mean 1995-1999	338,282	97,970	21,433	18,081	14,544	11,506	2,758	237	0	504,809	94,751	4,840	26,762	8,500	1,000	480	136,332	641,141
% increase over 5 year average	26	34	49	75	21	43	9	6	0	30								

2000 data for some countries are provisional.

Source of production figures for non-Atlantic areas: misc. fishing publications & government reports.

West Coast USA = Washington State
West Coast Canada = British Columbia
Australia = Tasmania
Other includes South Korea

Table 2.2.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight) as harvested at ranching facilities, 1980-2000.

Year	Iceland commercial ranching	Ireland [1]	UK(N.Ireland) River Bush [1]	Norway various facilities [1]	**Total production**
1980	8.0			0.0	8.0
1981	16.0			0.0	16.0
1982	17.0				17.0
1983	32.0				32.0
1984	20.0				20.0
1985	55.0	17.5	17.0		89.5
1986	59.0	22.9	22.0		103.9
1987	40.0	6.4	7.0		53.4
1988	180.0	11.5	12.0	4.0	207.5
1989	136.0	16.3	17.0	3.0	172.3
1990	280.0	5.7	5.0	6.0	296.7
1991	345.0	3.6	4.0	5.0	357.6
1992	460.0	9.4	11.0	10.0	490.4
1993	496.0	9.7	8.0	11.0	524.7
1994	308.0	15.2	0.4	9.5	333.1
1995	298.0	16.8	1.2	2.0	318.0
1996	239.0	18.5	3.0	8.0	268.5
1997	50.0	4.1	2.8	2.0	58.9
1998	34.0	9.6	1.0	1.0	45.6
1999	26.0	4.3	1.4	1.0	32.7
2000	2.0	4.6	3.5	1.0	11.1
Mean 1995-99	129	11	2	3	145

[1] Total yield in homewater fisheries and rivers.

Table 2.4.3.1 Proportion of escaped farmed salmon in relation to nominal salmon catch (ICES 2000).

Year	Norway	Faroes	Ireland	N. Ireland	Scotland
1989	22				
1990	23				
1991	22	42	0.4	1.8	3.0
1992	23	34	0.6	1.2	5.2
1993	23	27	0.4	0.2	5.7
1994	21	17	0.3	0.5	0.8
1995	22	20	0.1	1.8	0.3
1996	28	20	0.2		0.2
1997	31		0.2	0.1	0.3
1998	28		0.3	0.0	0.4
1999	24		0.4	1.3	0.5

Table 2.4.3.2. Number of recoveries and recapture rates of farmed salmon released from two fish farms in Norway.

Meløy				
Date of release	No in marine fisheries	No in freshwater	Total Number	Recapture Rate (%)
03.11.93	1	0	1	0.2
16.12.93	4	0	4	0.8
02.02.94	8	1	9	1.9
23.03.94	21	6	27	5.5
Bersagel				
12.11.93	1	0	1	0.2
17.12.93	2	5	7	1.4
18.02.94	5	1	6	1.3
24.03.94	12	6	18	3.8
25.04.94	17	5	22	4.5

Table 2.5.1 Summary of Atlantic salmon tagged and marked in 2000. 'Hatchery' anc 'Wild' refer to smolts or parr; 'Adult' refers to wild and hatchery fish. Data from Belgium, France, and Spain were not available. Fish were not tagged in Finland.

Country	Origin	Primary Tag or Mark			Total
		Microtag	External mark	Adipose clip	
Canada	Hatchery	0	45,009	1,738,916	1,783,925
	Wild	0	9,083	329	9,412
	Adult	0	6,046	0	6,046
	Total	0	60,138	1,739,245	1,799,383
Denmark	Hatchery	72,900	0	0	72,900
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	72,900	0	0	72,900
Iceland	Hatchery	127,162	0	0	127,162
	Wild	2,516	0	0	2,516
	Adult	0	563	0	563
	Total	129,678	563	0	130,241
Ireland	Hatchery	289,029	0	0	289,029
	Wild	939	0	0	939
	Adult	0	0	0	0
	Total	289,968	0	0	289,968
Norway	Hatchery	0	85,692	0	85,692
	Wild	0	5,436	0	5,436
	Adult	0	631	0	631
	Total	0	91,759	0	91,759
Russia	Hatchery	0	3,000	417,750	420,750
	Wild	0	40	190	230
	Adult	0	1,809	0	1,809
	Total	0	4,849	417,940	422,789
Sweden	Hatchery	0	4,928	39,517	44,445
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	0	4,928	39,517	44,445
UK (England & Wales)	Hatchery	100,537	5,061	65,858	171,456
	Wild	4,139	0	973	5,112
	Adult	0	937	0	937
	Total	104,676	5,998	66,831	177,505
UK (N. Ireland)	Hatchery	34,487	0	35,536	70,023
	Wild	1,483	0	0	1,483
	Adult	0	0	183	183
	Total	35,970	0	35,719	71,689
UK (Scotland)	Hatchery	12,355	2,000	0	14,355
	Wild	6,948	6,462	4,750	18,160
	Adult	0	899	0	899
	Total	19,303	9,361	4,750	33,414
USA	Hatchery	0	172,842	47,857	220,699
	Wild	0	1,800	0	1,800
	Adult	0	5,052	30	5,082
	Total	0	179,694	47,887	227,581
All Countries	Hatchery	636,470	318,532	2,345,434	3,300,436
	Wild	16,025	22,821	6,242	45,088
	Adult	0	15,937	213	16,150
	Total	652,495	357,290	2,351,889	3,361,674

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960-2000.

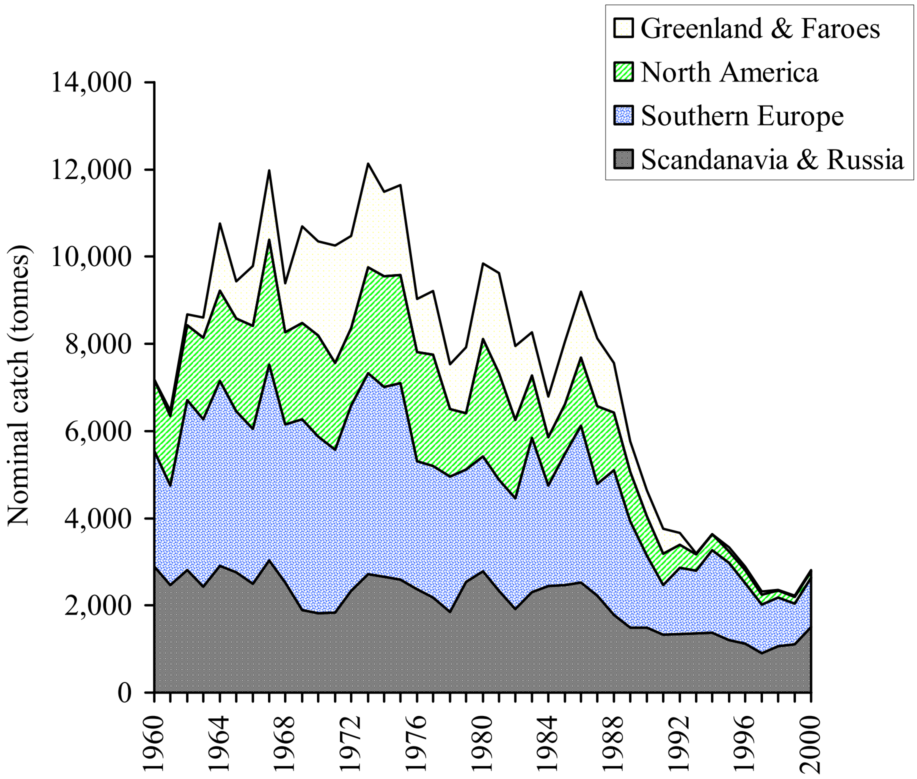


Figure 2.1.3.1 Total reported catch, unreported catch (in NASCO Areas) and % unreported catch of combined catch 1986-2000

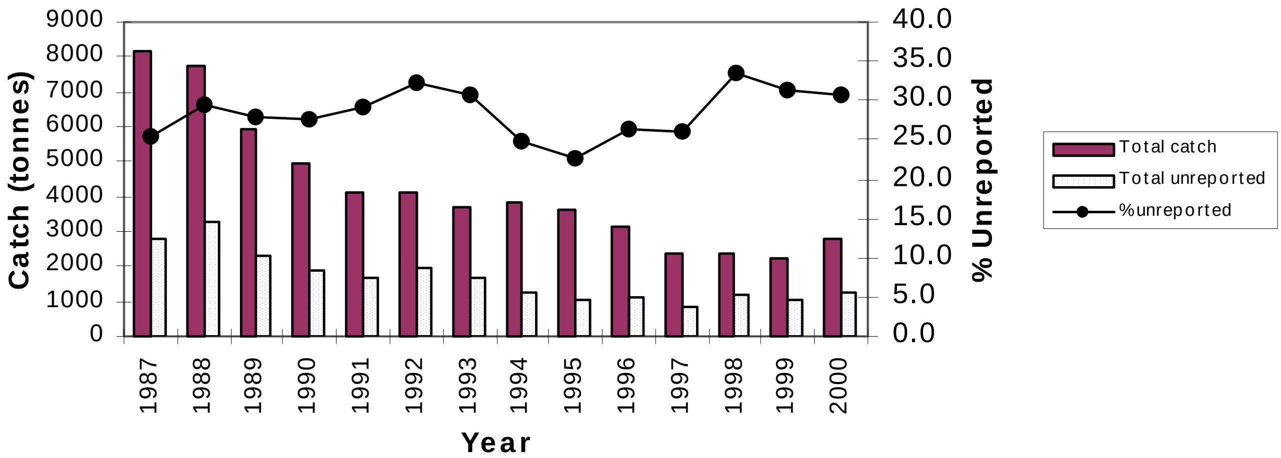


Figure 2.2.1.1 Worldwide farmed Atlantic salmon production, 1980 to 2000. Data for non-North Atlantic area do not include farmed salmon production in some countries (notably Chile, which has a high production relative to other countries)

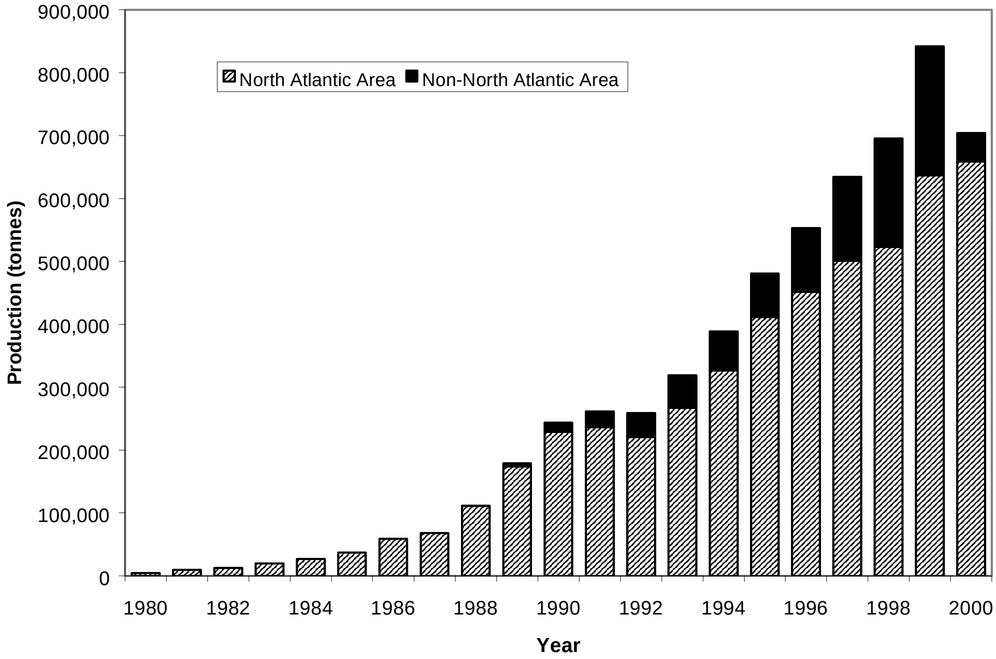


Figure 2.2.2.1 Production of ranched salmon in the North Atlantic, 1980 to 2000

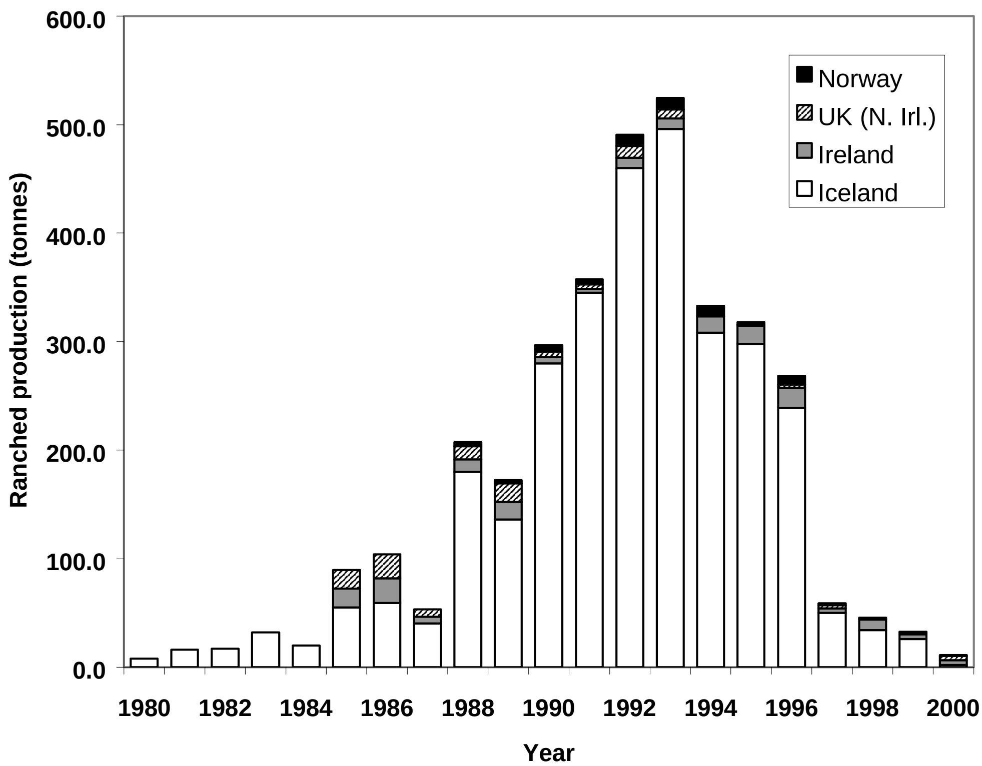


Figure 2.3.1.1. Deterministic calculations of catch options for the fishery at West Greenland for low abundance and moderate abundance periods. Values in bold and in box are parameters with uncertainty.

2.6	**Deterministic calculation of quota for a low abundance period**		
Step 1	SpR = SpT * (exp(11*M))		
	SpT =	**152,548**	SpT = 2SW Conservation requirement for North America
	SpR =	170,286	SpR = Spawning Reserve for North America adjusted for 11 months of natural mortality between West Greenland and North America
Step 2	MAH = PFA – SpR		
	PFA =	**183,000**	PFA value at 50% probability
	MAH =	12,714	MAH = Maximum Allowable Harvest = Number of surplus North American origin fish
Step 3	NA1SW = fNA * MAH		
	FNA =	0.4	FNA = fraction of NA surplus allocated to Greenland
	NA1SW =	5,086	NA1SW = Number of North American surplus fish available for Greenland
Step 4	E1SW = (NA1SW / PropNA) – NA1SW		
	PropNA =	**0.779**	PropNA = proportion NA salmon in the fishery
	E1SW =	1,443	E1SW = number of European origin 1SW salmon expected in the fishery
Step 5	Quota (t) = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF / 1000		
	WT1SWNA =	**2.666 kg**	WT1SWNA = weight (kg) of 1SW NA origin salmon in the fishery
	WT1SWE =	**2.832 kg**	WT1SWE = weight (kg) of 1SW European origin salmon in the fishery
	ACF =	**1.068**	ACF = age correction factor (>=1) to account for fish other than 1SW of age
	Quota (t) =	**19**	Quota = Allowable harvest (t) at West Greenland taking into account all the factors in steps 1 to 4

2.7	**Deterministic calculation of quota for a moderate abundance period**		
Step 1	SpR = SpT * (exp(11*M))		
	SpT =	**152,548**	SpT = 2SW Conservation requirement for North America
	SpR =	170,286	SpR = Spawning Reserve for North America adjusted for 11 months of natural mortality between West Greenland and North America
Step 2	MAH = PFA – SpR		
	PFA =	**436,770**	PFA value at 50% probability
	MAH =	266,484	MAH = Maximum Allowable Harvest = Number of surplus North American origin fish
Step 3	NA1SW = fNA * MAH		
	FNA =	0.4	FNA = fraction of NA surplus allocated to Greenland
	NA1SW =	106,594	NA1SW = Number of North American surplus fish available for Greenland
Step 4	E1SW = (NA1SW / PropNA) – NA1SW		
	PropNA =	**0.59**	PropNA = proportion NA salmon in the fishery
	E1SW =	74,074	E1SW = number of European origin 1SW salmon expected in the fishery
Step 5	Quota (t) = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF / 1000		
	WT1SWNA =	**2.75 kg**	WT1SWNA = weight (kg) of 1SW NA origin salmon in the fishery
	WT1SWE =	**3.13 kg**	WT1SWE = weight (kg) of 1SW European origin salmon in the fishery
	ACF =	**1.068**	ACF = age correction factor (>=1) to account for fish other than 1SW of age
	Quota (t) =	561	Quota = Allowable harvest (t) at West Greenland taking into account all the factors in steps 1 to 4

Figure 2.3.1.2. Probability profiles for simultaneously achieving a given level of escapement relative to conservation in six stock areas of North America.

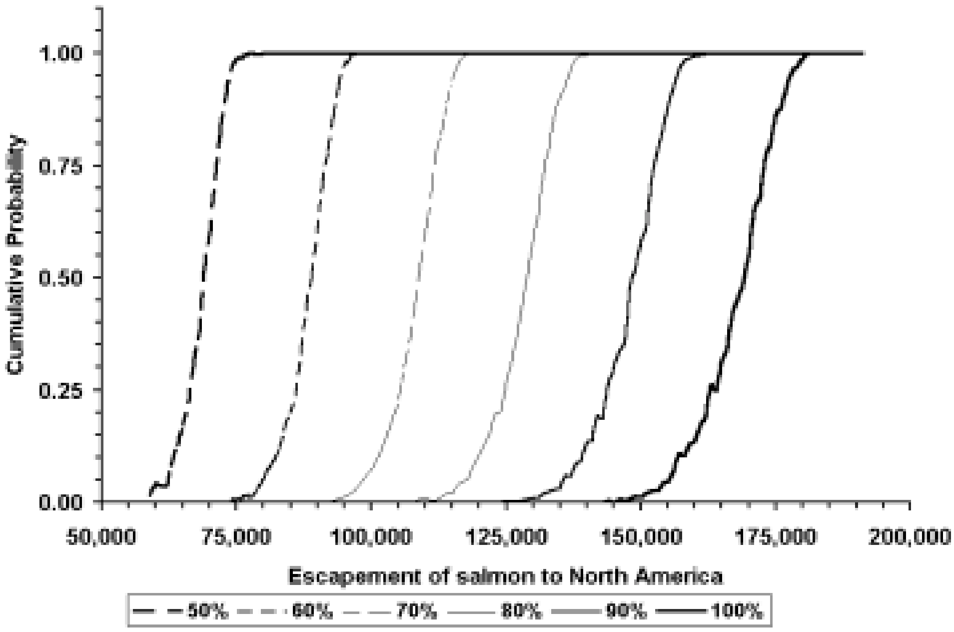


Figure 2.3.1.3. Probability profiles for the PFA forecast values for low abundance and moderate abundance periods.

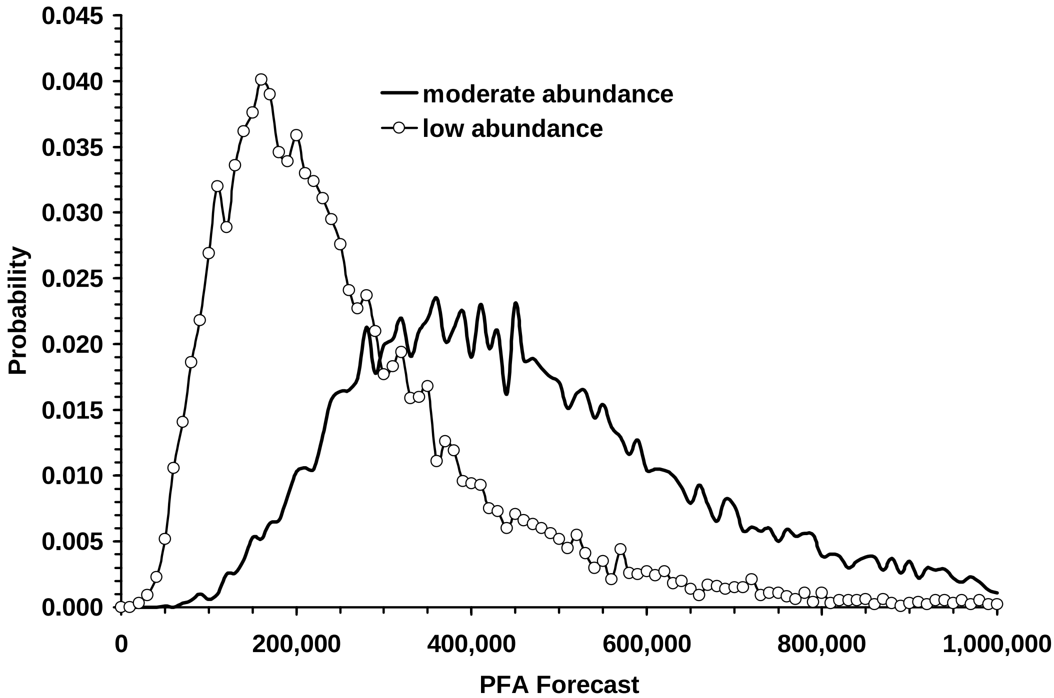


Figure 2.3.1.4. Expected catch of 1SW salmon of North American origin at a catch option of 50 tons at West Greenland. The uncertainty in catch is quantified by incorporating the observed temporal variation in proportion of fish of North American origin, mean weights of 1SW salmon of North American and European origin, and the age correction factor for older age groups.

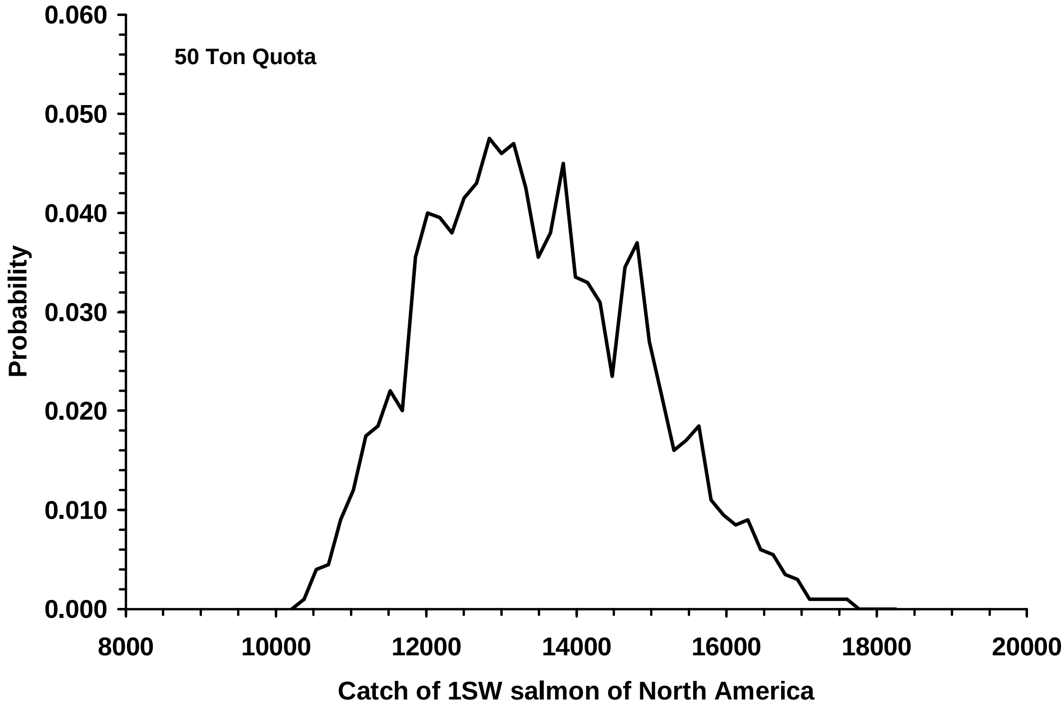


Figure 2.3.1.5. Theoretical risk analysis plots showing the risk-prone and risk-averse zones relative to the uncertainty of the stock assessment.

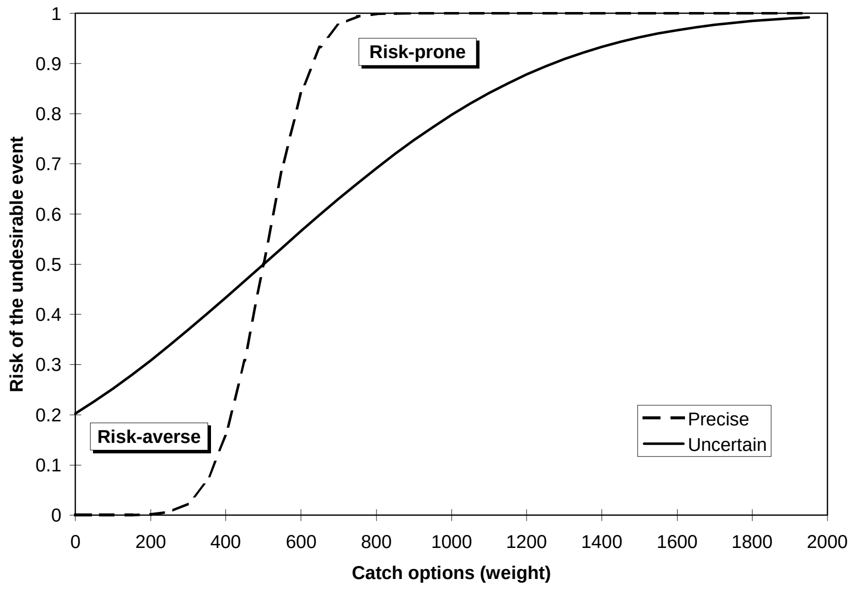


Figure 2.3.1.6. Examples of risk analysis profiles of catch options in West Greenland for low abundance and moderate abundance periods.

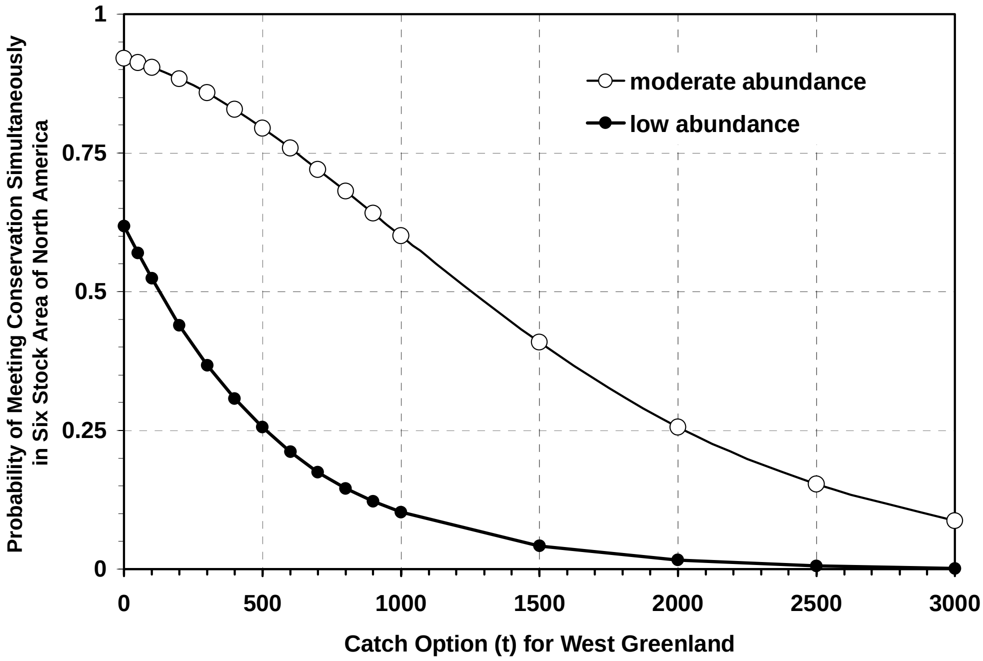


Figure 2.3.1.7. Relationship between small salmon (mostly 1SW salmon) in year i and large salmon (2SW salmon with an important component of multiple spawners) in year i+1, for 1985 to 2000.

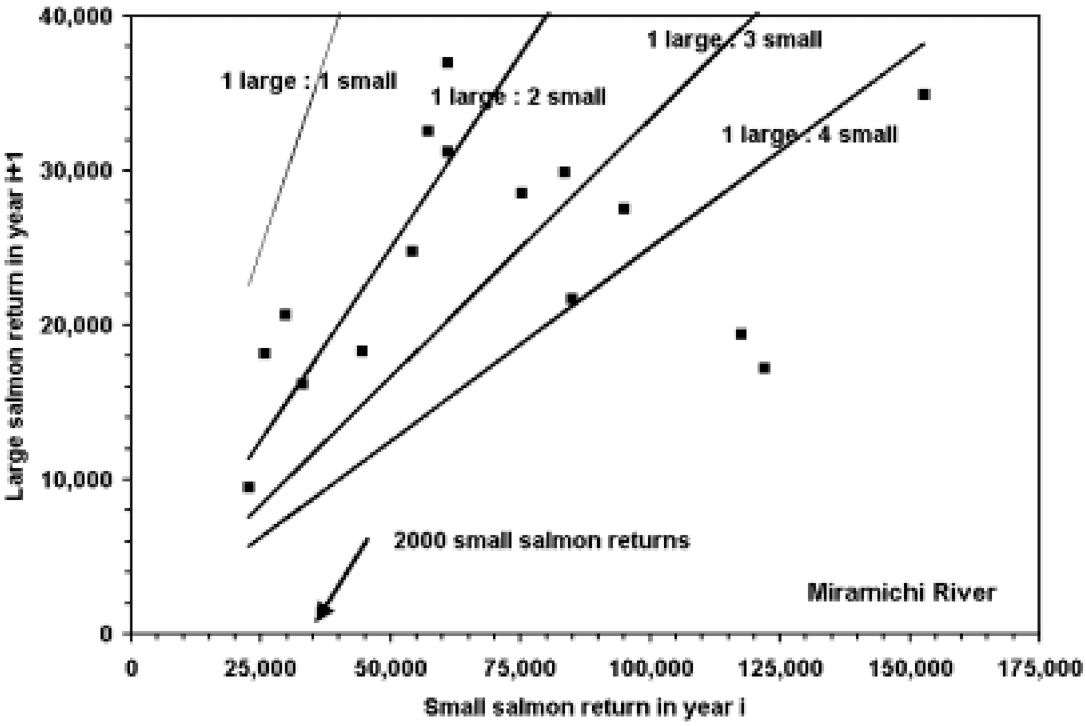
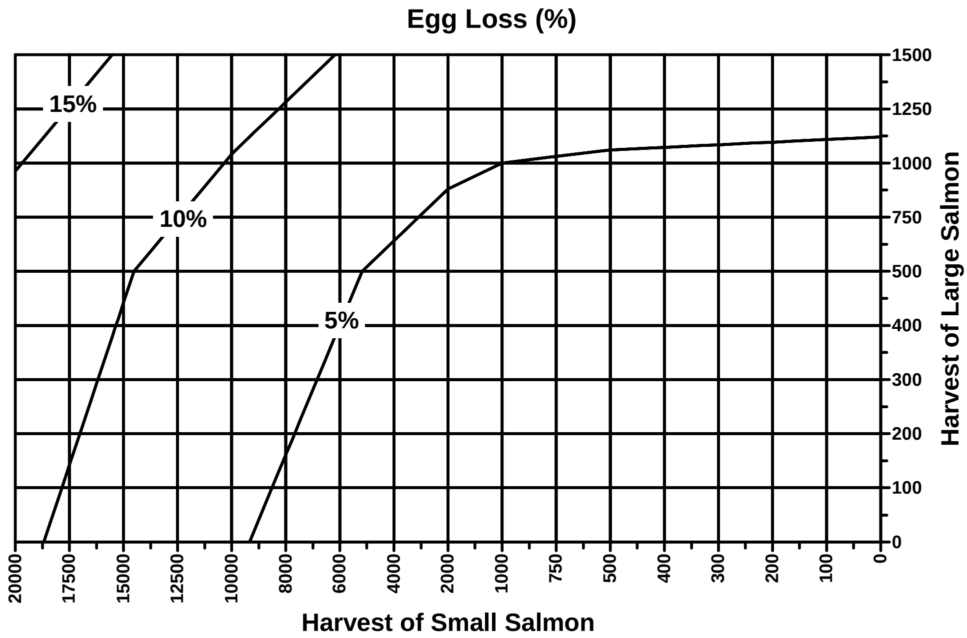


Figure 2.3.1.8. Fishery, biological characteristics, and forecast data inputs to the risk analysis of the 2001 Miramichi homewater fishery.

Assumptions of the fisheries risk analysis model							
						Miramichi River	
						Salmon	Grilse
Assumed exploitation rates in angling fishery						30.0%	30.0%
Hook and release mortality estimates							
	By season		Early			5.0%	5.0%
			Late			1.0%	1.0%
	Integrated value used in assessments					3.0%	3.0%
Fecundity of fish by season (average 1996 to 2000)							
			Integrated			5429	669
First Nations Harvests (maximum harvests achieved 1994 to 1998)							
			Early			358	3595
			Late			190	792
Ratios (small / large) (1996 to 2000) for forecasting							
			Min.			1.39	
			Max.			2.42	
			Median			2.18	
Small salmon returns (1996 to 2000)							
			Mean				32,000
			Std. Dev.				8,676

Figure 2.3.1.9. Risk analysis profiles for the 2001 homewater fisheries in the Miramichi River. The upper panel describes the egg loss from the harvest levels as a percentage of the total eggs in the predicted returns. The lower panel describes the risk to achieving the conservation requirements for different harvest levels



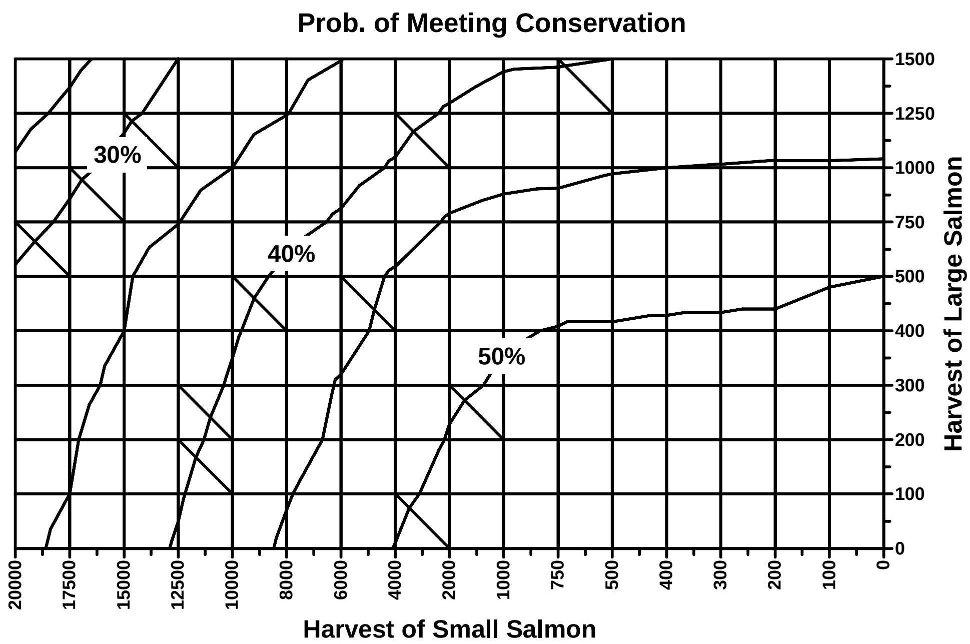
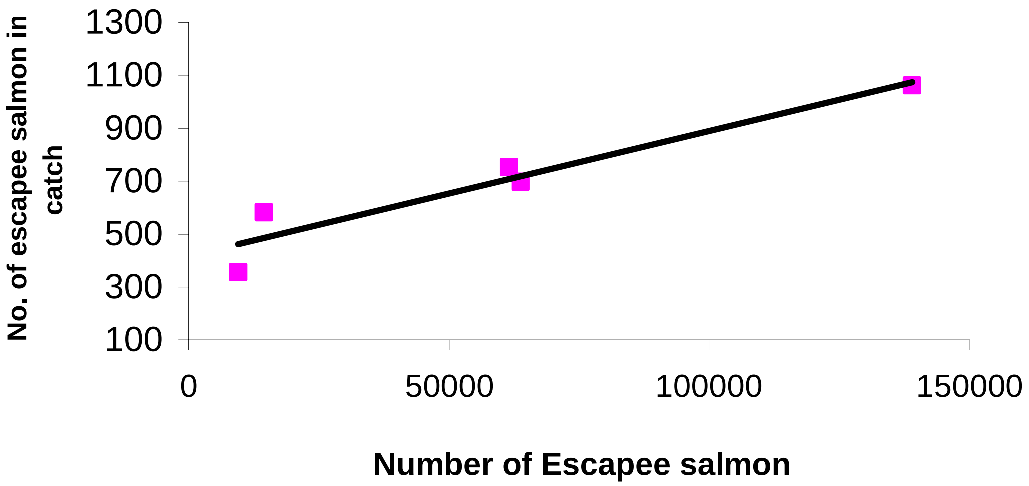


Figure 2.4.3.1 Relationship between reported escapes and estimated escapees in Irish catch (smolts are included with adults of the following year)



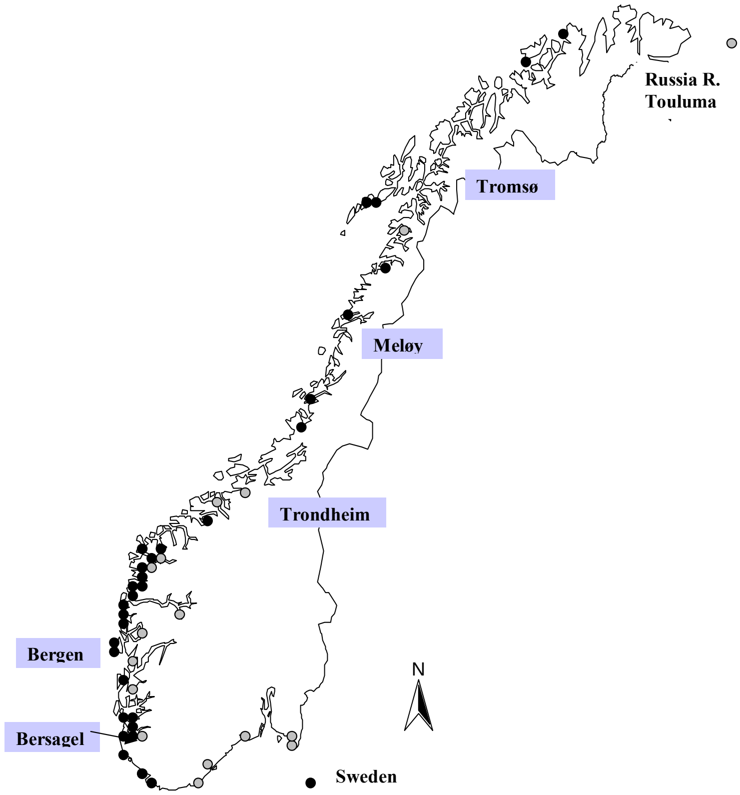


Figure 2.4.3.2. *Geographical distribution of farmed salmon released at Bersagel. Grey and black dots are respectively river and sea recoveries.*

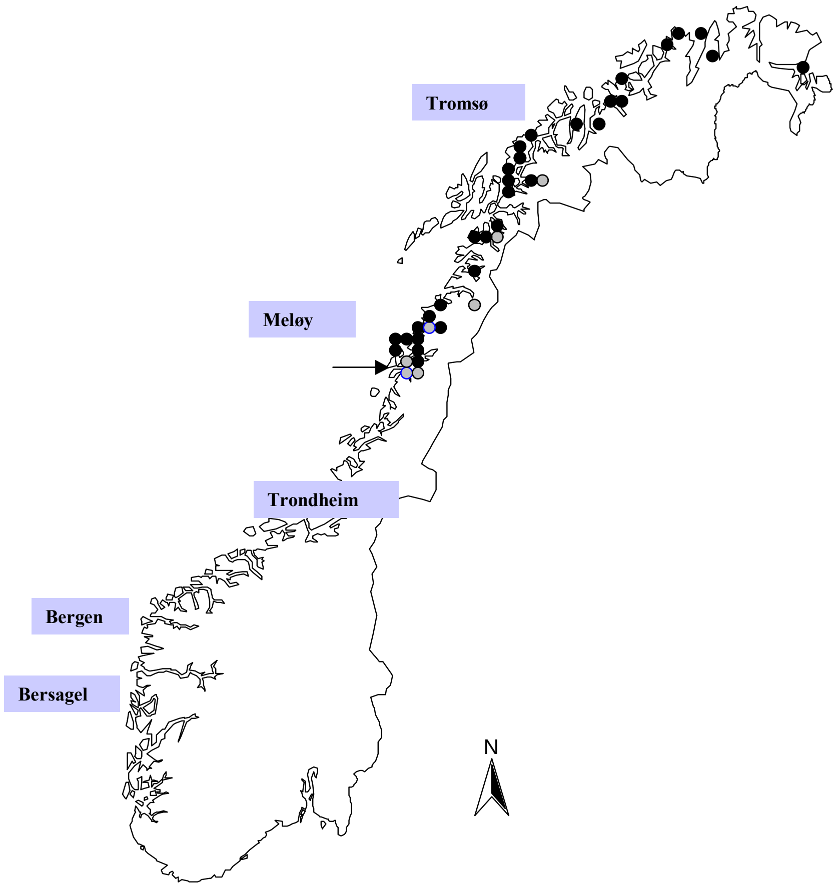


Figure 2.4.3.3. *Geographical distribution of farmed salmon released at Meløy. Red and black dots are respectively river and sea recoveries.*

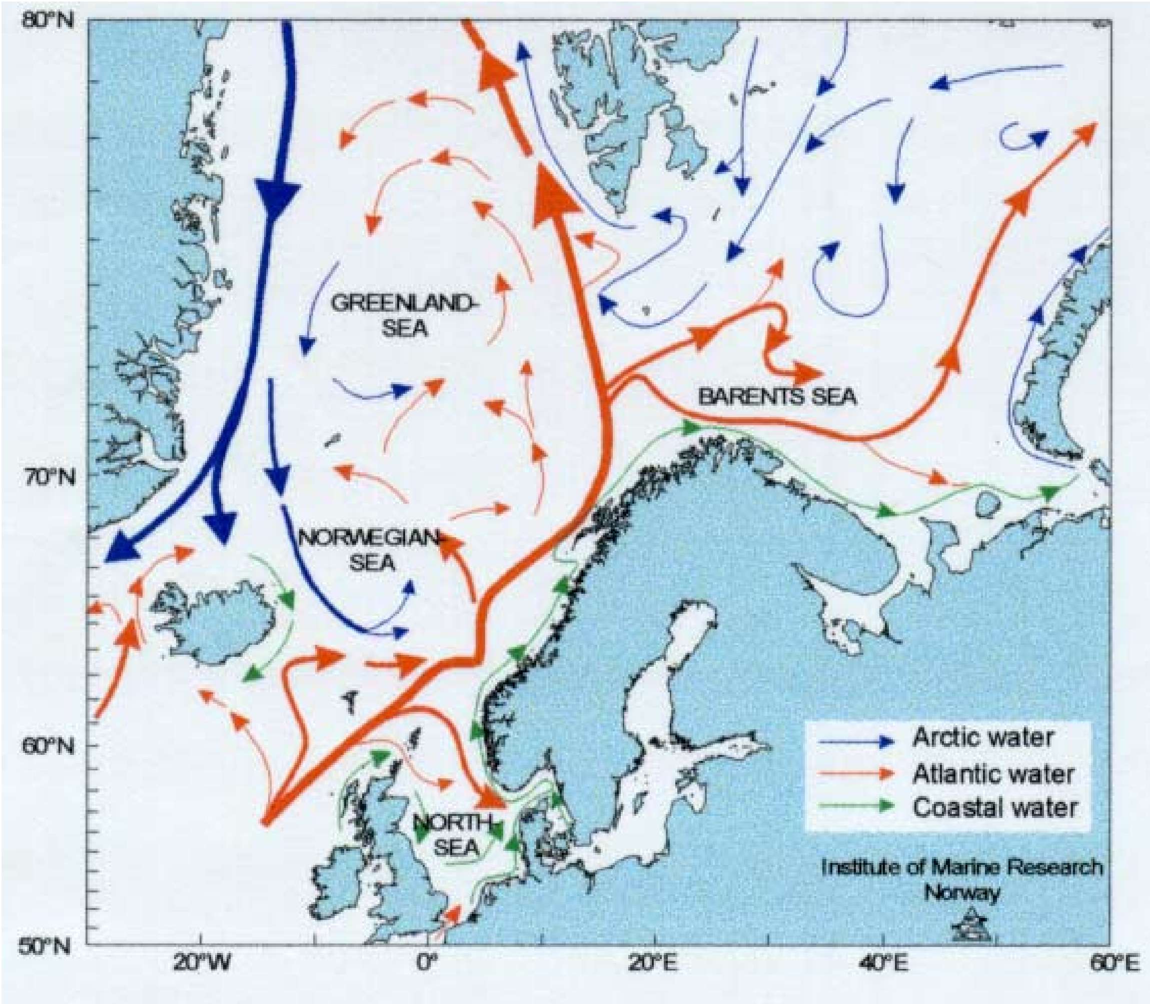


Figure 2.4.3.4 *Ocean currents in the norteast Atlantic*

Figure 2.4.4.1 Locations and numbers of post-smolts captured in surface trawl hauls during a special post-smolt survey tin mid- June 2000. Stars mark trawl-hauls without salmon. Black numbers indicate number of post-smolts and white numbers on black indicate number of older salmon in catch. Micro-tagged and Carlin- tagged fish were captured in the same catch of 170 fish, and a few micro-tagged fish were found on a neighbouring catch site (34). The approximate area where an international mackerel fishing fleet is operating during the summer months is shaded.

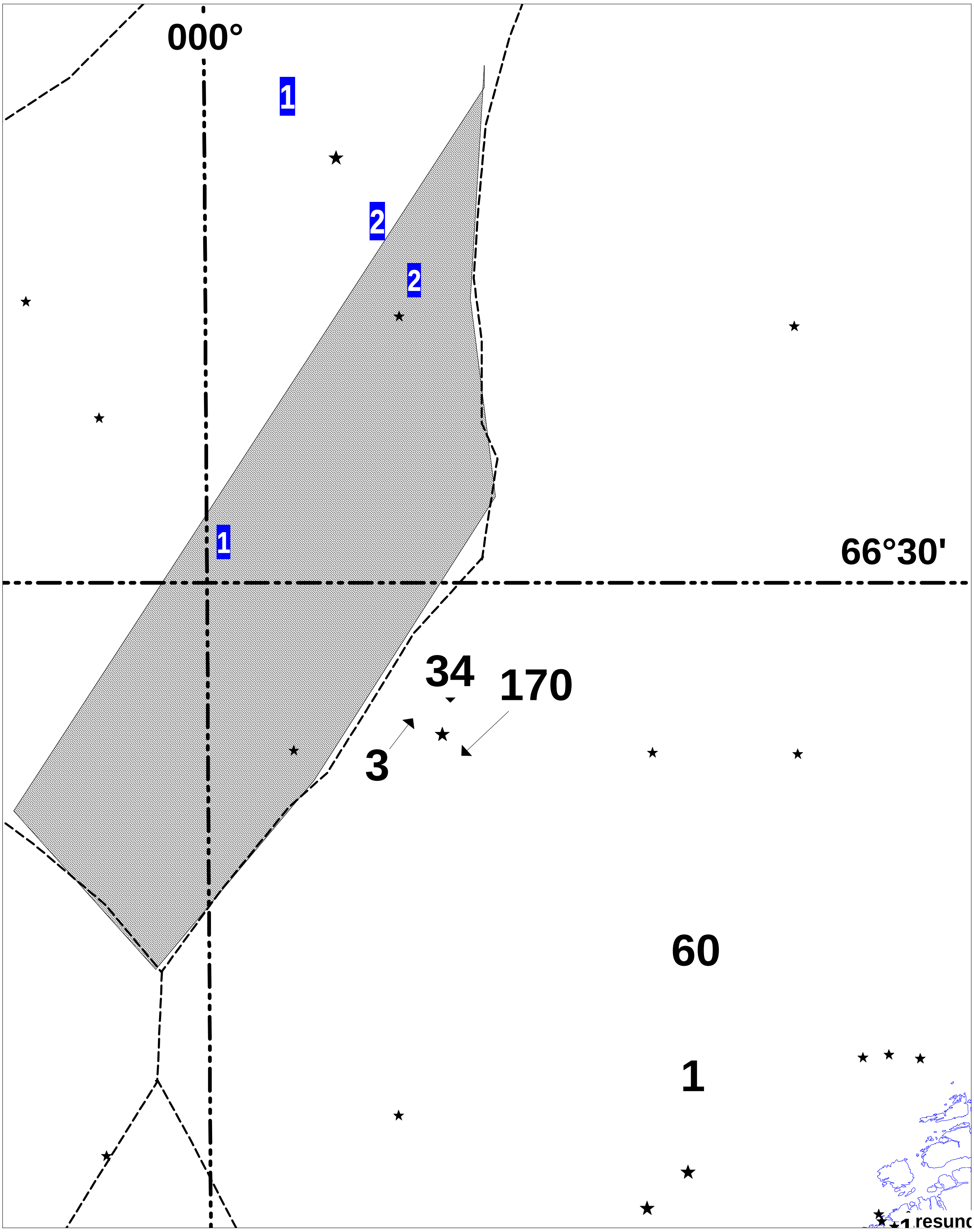


Figure 2.4.4.2 Sites of post-smolts captures 20 – 22 may 2000 during salmon lice investigations in the Sognefjorden and the Nordfjord. Numbers indicate post-smolts captured in Nordfjord, while stars indicate captures in the Sognefjord. Numbers of single catches are not known but the total Sognefjord catch was > 200.

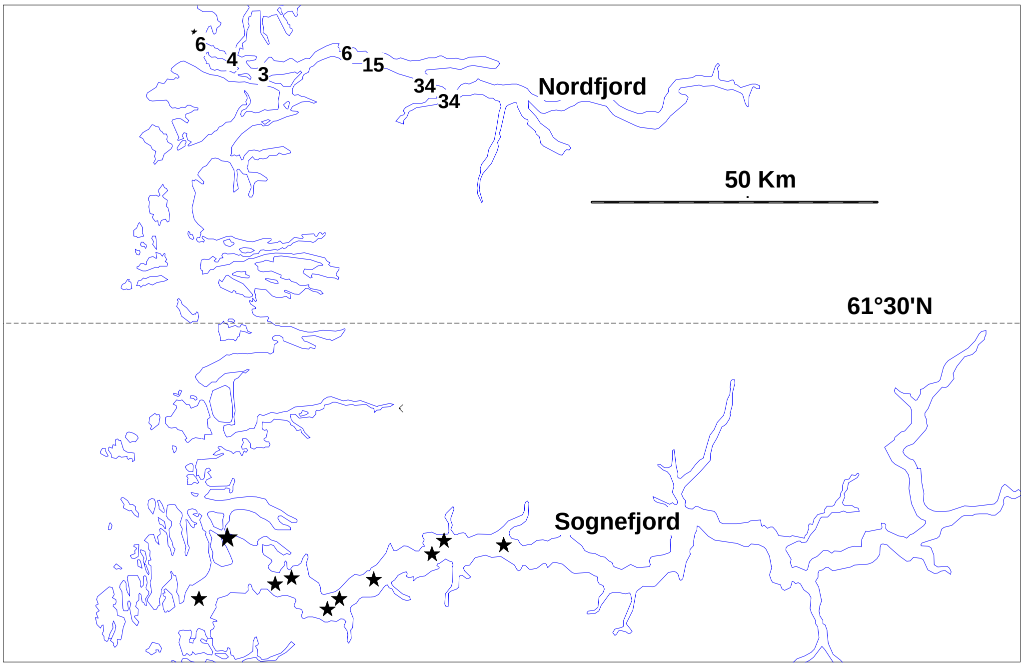


Figure 2.4.4.3 Average number of salmon lice per fish on seaward migrating post-smolts in trawl-captures in two southwest-Norwegian fjords in May 1998 – 2000.

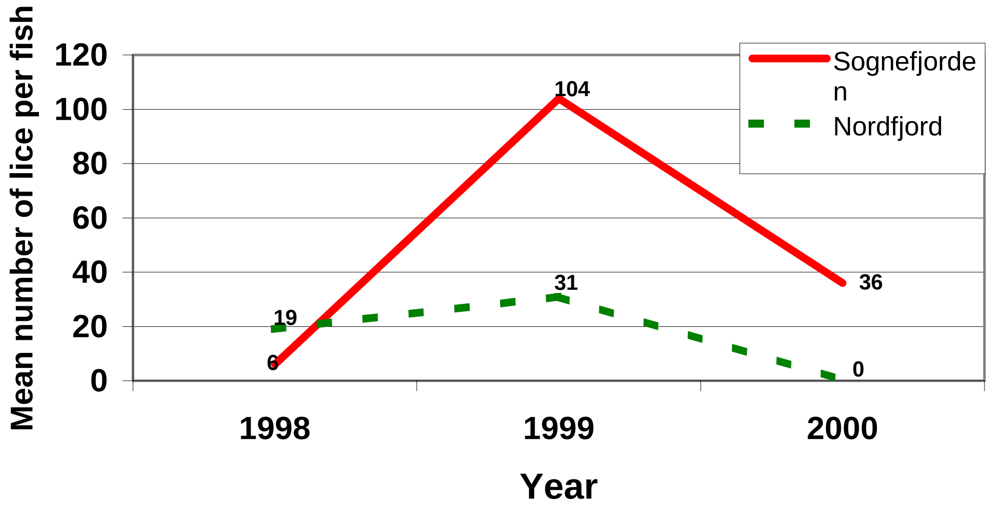


Figure 2.4.5.1 The relationship between seasonal run-timing of returning adults and incidence of scales exhibiting summer checks. Data for 1SW salmon, 2SW salmon exhibiting checks in their first year at sea and 2SW salmon exhibiting checks in their second year at sea are shown separately, grouped by the year when the adults were taken by the net fishery (1997, white bars; 1998, stippled bars; 1999, black bars)

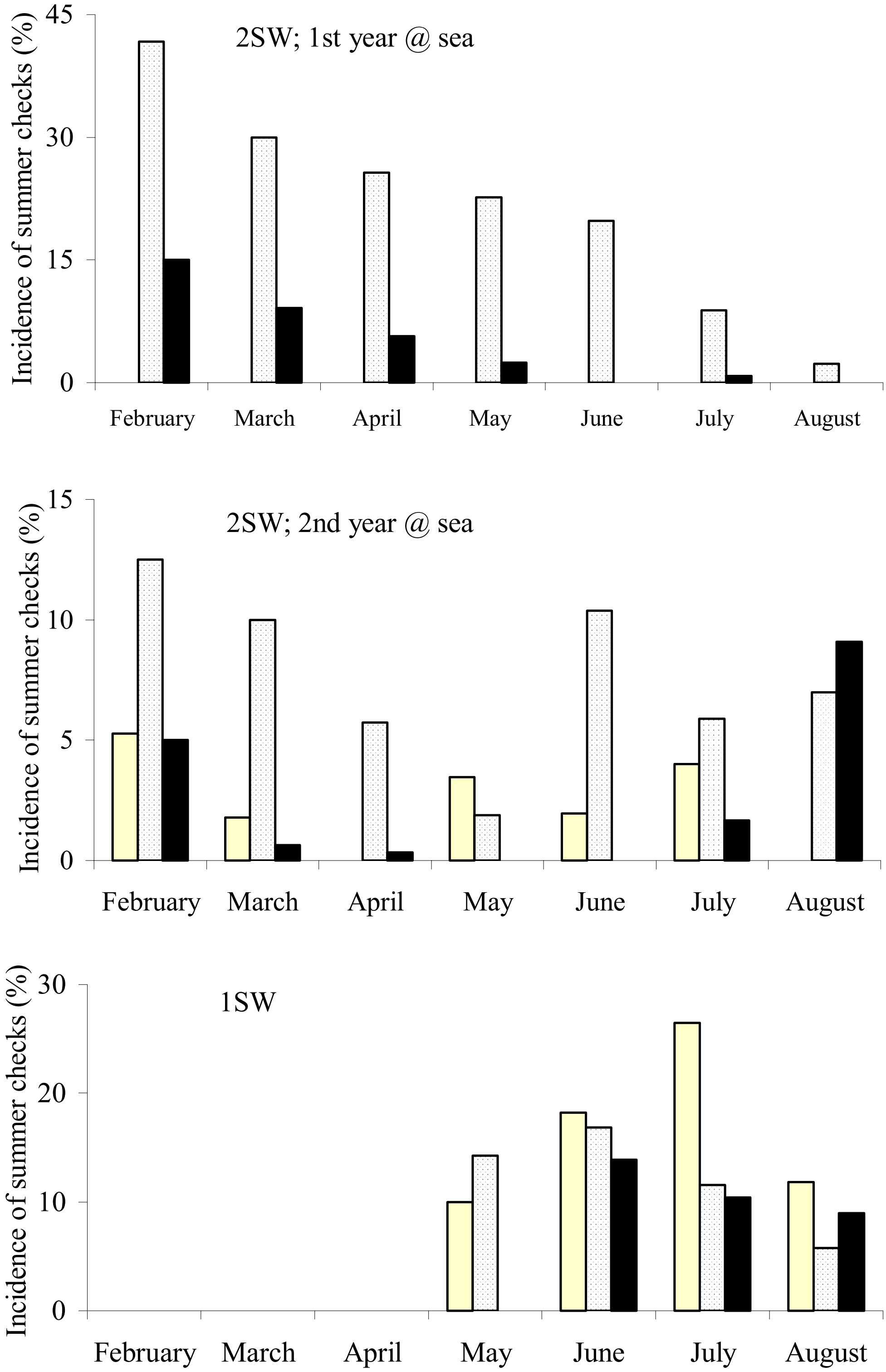


Figure 2.4.6.1. Predicted monthly mortality rate for Atlantic salmon relative to the sea age (days) as per the inverse weight relationship presented by Lorenzen (1996). River Bush data are from Doubleday *et al.* (1979).

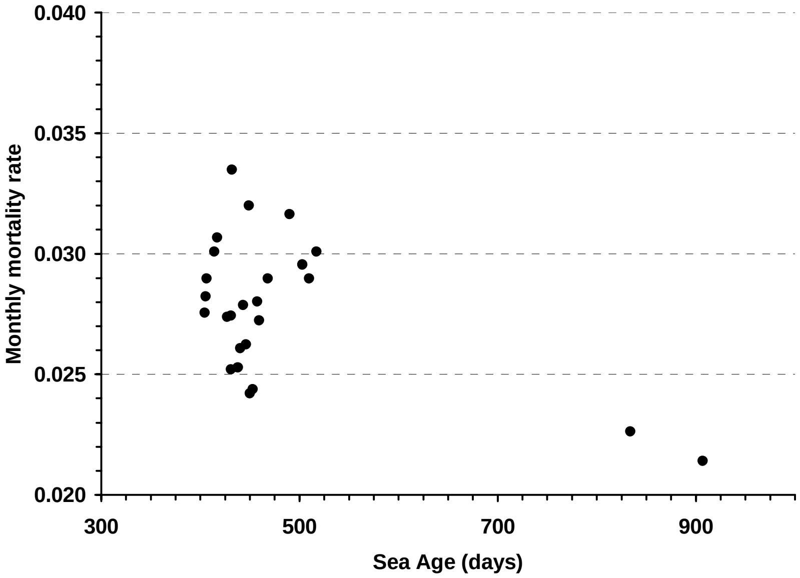
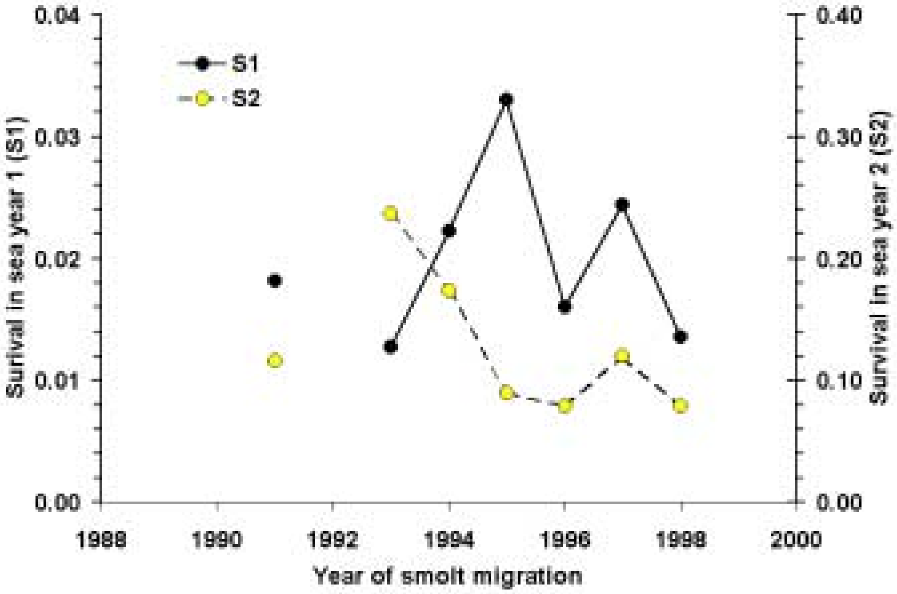


Figure 2.4.6.2. Solutions for S_1 and S_2 for the hatchery returning Atlantic salmon from the Saint John River at Mactaquac (upper) and the wild smolts from de la Trinité River (lower).



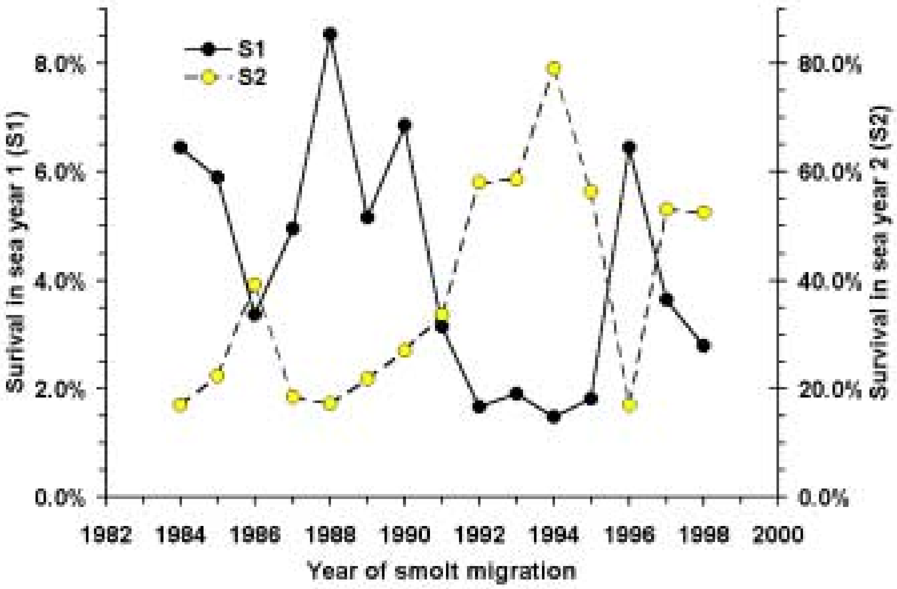


Figure 2.4.6.3. Inter-river comparisons of annual survivals of the 1996 smolt cohort in year one (S1) (upper panel) and year two (S2) (lower panel). The Saint John smolts are hatchery age-1 smolts, the other two rivers are wild smolts.

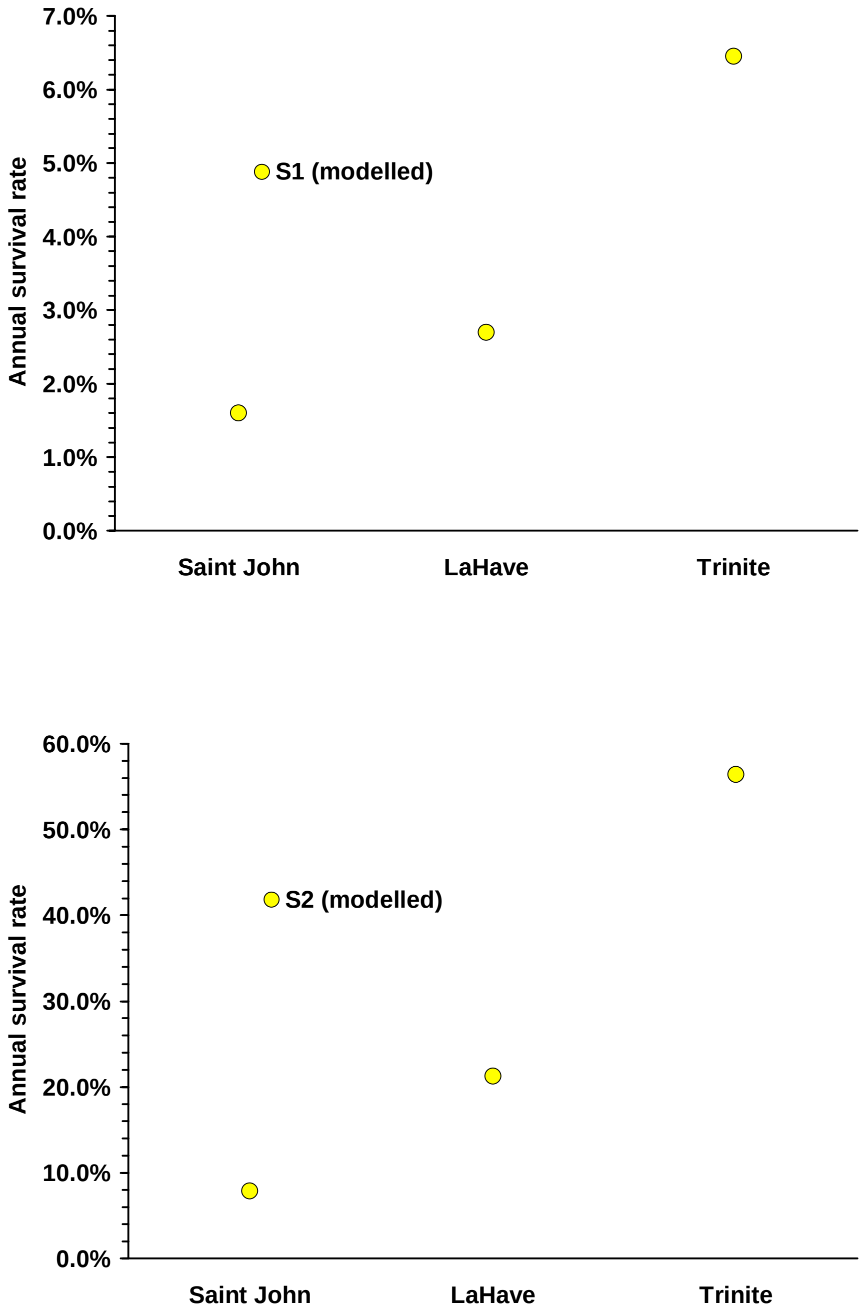


Figure 2.4.6.4. Estimated monthly Z (instantaneous mortality rate) of salmon in their second year at sea. The points in grey (1992 and later smolt cohort) are likely a good representation of M since sea fisheries were declining or eliminated.

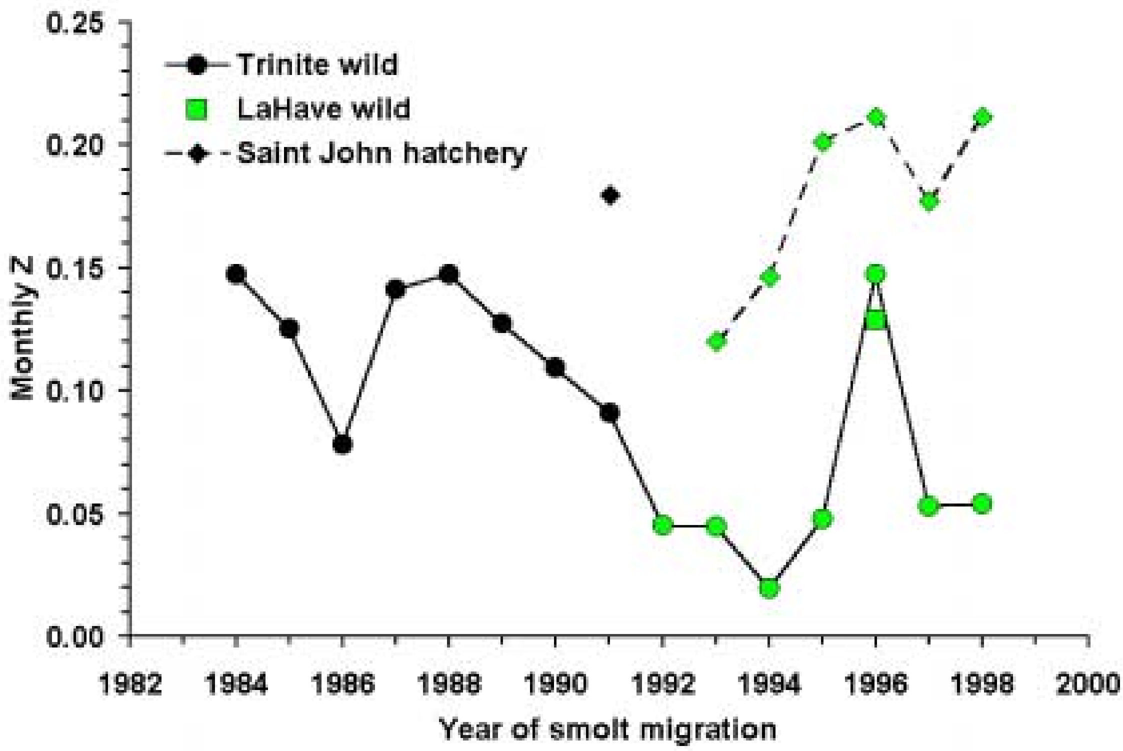


Figure 2.4.7.1. Mean annual air temperature trends for the Southwest and Northwest Miramichi monitoring stations.

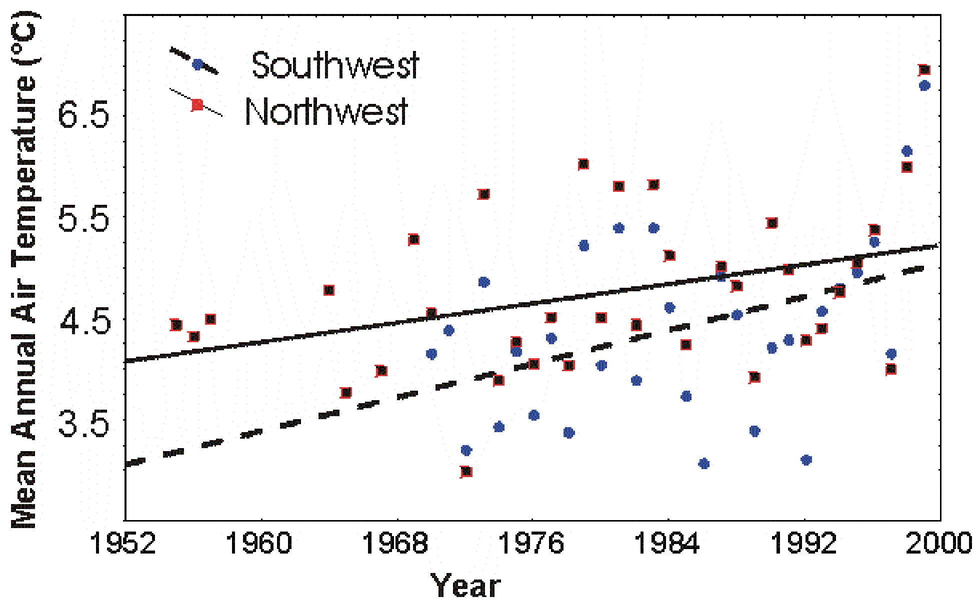


Figure 2.4.7.2. Timing of the peak spring runoff event in the Miramichi River.

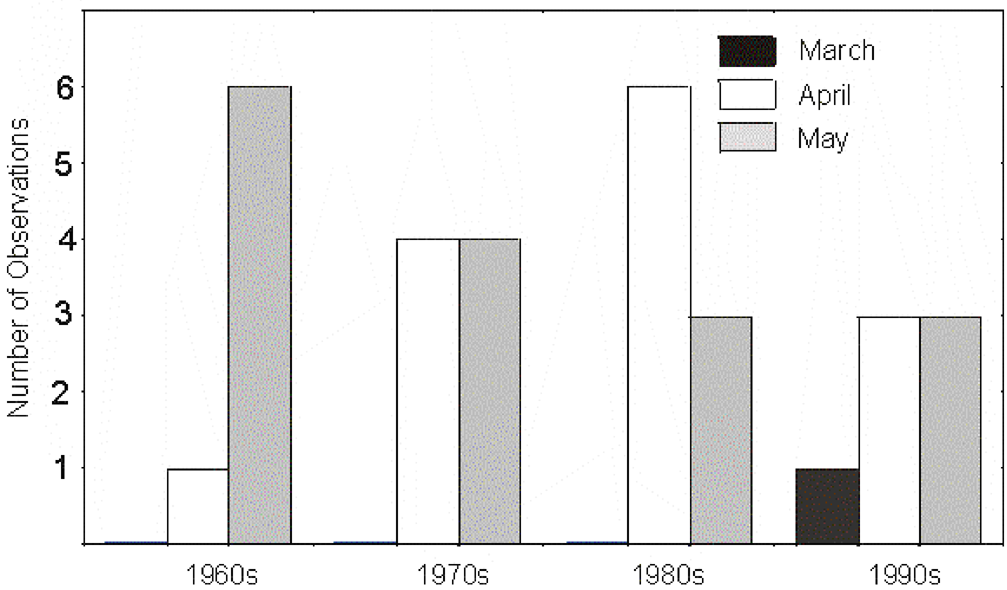


Figure 2.4.7.3. Mean annual fork length of juvenile Atlantic salmon from the Miramichi River, 1971 to 1999.

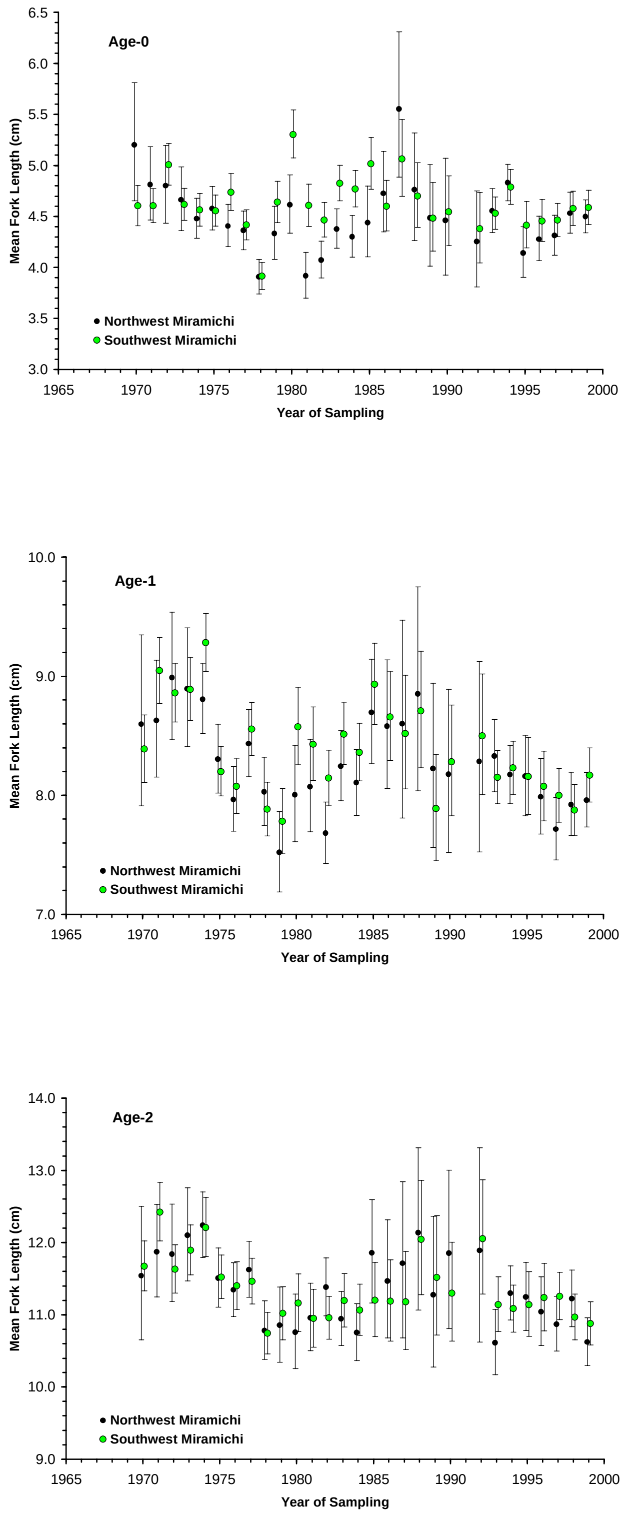
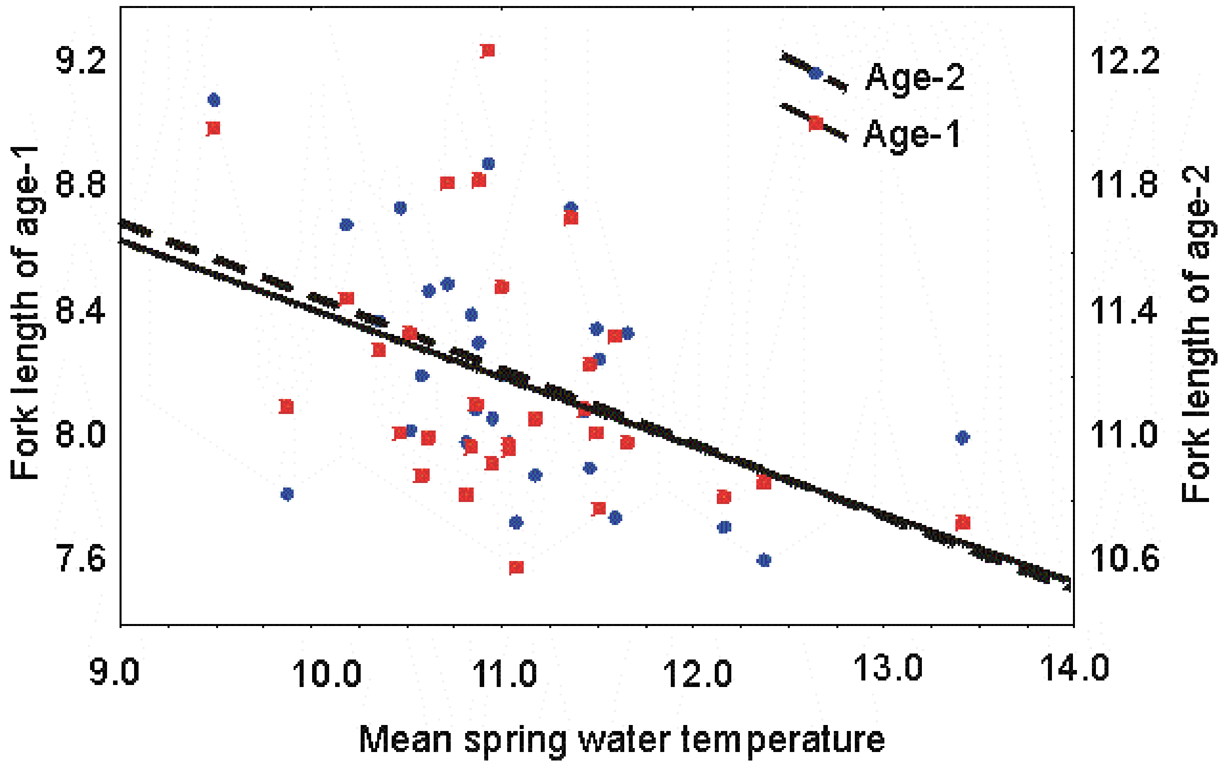


Figure 2.4.7.4. Association between mean annual size-at-age of age-1 and age-2 parr and the mean spring water temperature for the Miramichi River, 1971 to 1999.



3 FISHERIES AND STOCKS IN THE NORTH-EAST ATLANTIC COMMISSION AREA

3.1 Fishing at Faroes in 1999/2000

In the period 1991-98 inclusive the Faroese salmon quota was bought out. However, the Faroese Government continued sampling inside the 200 mile EEZ during most years (ICES 2000/ACFM:13). No buyout was arranged for 1999 and 2000. No fishing took place in 1999 and the commercial fishery resumed in 2000. In the 1999/2000 season approximately 8 t were caught by M/S "Túgvusteinur" during 2 commercial fishing trips between late January and early April 2000 (ICES 2000/ACFM:13).

3.2 Description of the 2000/2001 commercial fishery

No fishery for salmon was undertaken by Faroese fishermen during the 2000/2001 fishing season and, consequently, no biological information was available for this season.

3.3 Homewater Fisheries in the NEAC area

3.3.1 Significant events in NEAC homewater fisheries in 2000

In an effort to accelerate the phase out of mixed stock fisheries, Government funding (£0.75 million) has been made available in UK (England and Wales) to facilitate buy-out initiatives. To be utilised, these 'pump-priming' sums have to be matched by equivalent funding from fishery and riparian interests.

UK (England and Wales), UK (Scotland) and Ireland experienced substantially higher than average rainfall in 2000; river flows were generally above average and provided good conditions for angling. However, flows were particularly high late in the year resulting in the loss of some fishing opportunities; these flows may also have impacted on spawning and recruitment (wash-out of redds).

In UK (Scotland), net fishermen agreed to suspend fishing for the first six weeks of the fishing season to protect the early running MSW (spring) salmon. This was a voluntary measure and was observed by the majority of fishermen.

In Ireland, two major draft net fisheries were suspended during 2000 as part of ongoing catchment management initiatives.

3.3.2 Gear

There were no reports of significant changes in the types of gear units used in the NEAC area countries in the year 2000.

3.3.3 Effort

The number of gear units licenced or authorised in several of the NEAC area countries is shown in Table 3.3.3.1. This provides a partial measure of effort but does not take into account other restrictions, for example, the close season. In addition, there is no indication from these data of actual number of licences utilised or the amount of time each licencee fished.

The change in effort for the last 5 years (1996-2000) for net fisheries is shown in Figure 3.3.3.1. In general there is a substantial decline in the net effort deployed in the NEAC area, the only exception being the driftnet fishery in Ireland.

The number of gear units licenced or authorised in the year 2000 declined in all but one of the countries where this information was available. In UK (England and Wales), UK (Scotland), Ireland, France and Norway the number of gear units licenced or authorised in 2000 was lower than in 1999. The only exception to this was the draftnet fishery in UK (N-Ireland). Longer term trends were also consistent among these countries. In all cases, the number of gear units licenced or authorised were at the same level or lower than the previous 5- and 10-year averages with exception for the driftnet fishery in Ireland where an increase occurred compared to the previous 5- and 10-year averages.

Figure 3.3.3.2 show the change in effort over the last 5 years (1996-2000) for rod fisheries in the NEAC area countries where effort is reported. The rod fishery effort has decreased in UK (England and Wales) but increased in Ireland, Finland and France.

There was an increase in the number of rod licences issued in Ireland compared to 1999 and also compared to the previous 5-year average. In Finland, rod effort in the River Teno recreational fishery increased substantially (41%) compared to 1999 and to the previous 5- and 10-year averages. In River Naatamo the number of fishermen decreased compared to the previous year and to the previous 5- and 10-year averages. A similar decline in effort was evident in the total declared number of rod days fished in UK (England & Wales) with the 2000 value down compared to previous indices.

3.3.4 Catches

NEAC area catches are presented in Table 3.3.4.1. The total catch in the NEAC area was 2633 tonnes, up 27 % on the 1999 catch, and representing 94% of the total North Atlantic nominal catch in 2000. Both homewater and total reported catches in NEAC area showed increases compared to 1999 (27 and 25 % respectively). This increase in total catches arises from substantial increases of the nominal catch in a few countries (Norway, Finland, and Sweden), while others showed only slight increases or even substantial decreases (UK (Scotland) and Iceland). The nominal catches for individual countries can be found in Table 2.1.1.1. Figure 3.3.4.1 shows the percentage change in the 1999 NEAC homewater catches relative to the previous 5-year (1995-99) and 10-year (1990-99) means.

As can be seen in Figure 3.3.4.1, four countries (UK (England & Wales), Sweden Norway and Finland) showed a substantial (20 – 91%) increases in catches relative to the 5-year averages, while two of them (Norway and Finland) also showed large (40 – 65%) increases in relation to the 10-year average. These changes are believed to arise from higher marine survival rates rather than an increase in effort (cf. Section 3.4). The catches in UK (Scotland) and Iceland decreased substantially (> 35 %) in relation to both long-term averages, while Russian and French catch decreased only relative to the 5-year average. For the remaining NEAC countries reporting catches greater than 10 tonnes the changes were minor.

3.3.5 Catch per unit effort (CPUE)

CPUE data for the NEAC area are presented in Tables 3.3.5.1 - 3.3.5.5. The CPUE data for rod fisheries has been collected by relating the catch to rod days or angler season, and that of net fisheries was calculated as catch per licence-day, trap month or crew month. Grouping of data for the trend analysis was based on the units in which CPUE was presented (rod fisheries) and on national/regional distribution (rod and net fisheries) of fisheries considered.

It is assumed that the CPUE of net fisheries is a more stable indicator of the general status of salmon stocks than rod CPUE; the latter may be more affected by varying local factors, e.g. weather conditions, management measures and angler experience. However, both may also be affected by many measures taken to reduce fishing effort, for example, changes in regulations affecting gear.

In Finland, CPUE in the rivers Teno and Naatamo showed increases over the previous year and, in the case of the Teno, an increase over the previous 5 year average. In France, there was a small increase over the previous year but a decrease on the previous 5 year average. The river Bush (UK (NI)) showed a decrease compared to both recent indices (Table 3.3.5.1). Information from eight rivers in Russia showed, in most cases, increases over both 1999 and previous 5 year averages (Table 3.3.5.2). Results of the route regression analysis showed no general trends in rod CPUE over the last 10 years (Table 3.3.5.6).

In UK (England and Wales) CPUE for the net fishery increased in the North East and North West regions compared to 1999 and the previous 5-year averages. In contrast, the Wales, South West and Midland regions showed a decrease compared to recent indices (Table 3.3.5.3). Route regression analysis showed a significant upward trend for the last 10-years in these fisheries. The CPUE for the Scottish net fisheries showed an increase over 1999 but values remained lower than the previous 5-year mean (Table 3.3.5.4). Route regression analysis for the Scottish net fishery revealed a significant downward trend for the last 10-years (Table 3.3.5.6).

CPUE for the marine fishery in Norway has increased for the past three years for bagnets and bendnets and was consistent across all size groups (Table 3.3.5.5). The CPUE was highest for small fish (< 3kg).

CPUE is a measure that can be influenced by various factors. Water level and weather condition can have effects on CPUE as well as operation intensity or number of gear units in an area. If large changes occur for one or more factors a common pattern may not be evident over larger areas. It is, however, expected that for a relatively stable effort CPUE can reflect changes in the status of stocks and stock size. This can be seen in the increase in CPUE for the Norwegian marine fishery that is also reflected in increased catch (Section 3.3.4) as well as the calculated PFA values (Section 3.6.).

3.3.6 Age composition of catches

The percentage of 1SW salmon in catches is presented in Table 3.3.6.1 and Figure 3.3.6.1 for those countries where a time series of data exist. The proportion of 1SW fish in the 2000 catches is presented as a percentage of the 1995-99 and 1990-1999 averages. In comparison with 1999 the differences between countries in Northern and Southern Europe were less apparent in 2000, with southern European countries occurring at both ends of the scale (Figure 3.3.6.1). While the proportion of 1 SW fish in the 2000 catch remained lower than both the 5 and the 10 year average in UK (Scotland), it had changed from lower to higher than the long-term indices in France and UK (England and Wales). Several NEAC countries also report nominal catches partitioned according to sea-age category (Table 2.1.1.3.). These data suggest that for France the change in the age composition of the 2000 catch was driven by the combined effect of an increase in 1SW catches and a reduction in the number of MSW fish taken.

There was no common trend in the age composition of the 2000 catches of northern European countries (Finland, Iceland, Norway, Sweden, and Russia), as two had gone down and three had remained higher than the long-term averages.

3.3.7 Farmed and ranched salmon in catches

The contribution of wild, farm-origin and ranched salmon to national catches in the NEAC Area 1991-2000, is shown in Table 3.3.7.1. Although showing a slight decrease in 2000, farmed salmon continued to account for a relatively large proportion (20%) of the nominal catch in Norway. Farmed salmon was estimated to constitute less than 2% in all other NEAC countries.

Table 3.3.7.2 gives estimates of the incidence of farmed salmon in Norwegian coastal and fjord fisheries. In 2000, farmed fish accounted for 31% of the catch of coastal fisheries, a decline compared to the previous 5 years estimates. In 2000, the proportion of farmed salmon in Norwegian rod catches was similar to the preceding year, whereas the incidence of farmed fish in brood stock samples was estimated to be 8 %, a reduction of almost 50 % (Table 3.3.7.3). This decrease in the proportion of farmed salmon in the catches is probably due to a rise in the Norwegian catches of wild fish rather than to a true decrease in escapees, as the number of farmed salmon captured was the highest in the whole time series.

In the River Teno (Finland and Norway), the incidence of farmed salmon during the fishing season in June-August has been low, varying between 0.04% and 0.4% over the period 1987 to 2000. However, occasional samples taken in 1990 – 91 and 1997 after the fishing season (September-October) have included 0 to 50% farmed fish (Table 3.3.7.4), indicating that the proportion of fish farm escapees in the spawning stock may be higher than shown in the in-season samples. This is similar to data presented from Norway (Table 3.3.7.3).

Catches of salmon in coastal fisheries in both UK (Northern Ireland) and Ireland are examined for escaped farmed salmon (Table 3.3.7.5). Data for both countries are presented together as they constitute a continuous part of the species' geographic range. Escaped farmed fish have been detected every year; the combined frequency being less than 1% in most years. The 2000 figures for two specific areas (UK Northern Ireland and the Galway Limerick area in Ireland), however, show slightly elevated levels (3.1% and 2.2% respectively) compared to previous years.

In UK (Northern Ireland), only 0.3% of the total salmon run trapped in the River Bush comprised farmed salmon, continuing the trend for a low incidence of farmed fish being detected in freshwater (Table 3.3.7.6).

A catch sampling programme in UK (Scotland) from 1981 to the present indicates that the incidence of farmed salmon in catches of fisheries around the country continues to decrease from their highest recorded levels around 1993 (Table 3.3.7.7).

The incidence of farmed salmon in catches is examined in relation to farmed production in Section 2.4.3.

3.3.8 National origin of catches

Some new information on tag recoveries was made available to the Working Group. From 1996 to 1999 a total of 409,762 smolts, mainly hatchery reared were tagged and released in Norway. A total of 3,811 adult recoveries were reported from Norway and 19 from other countries (0.5% of the total number of salmon recovered). This is consistent with previous observations that very few Norwegian salmon are intercepted in other countries.

3.3.9 Exploitation rates in homewater fisheries

The analyses of exploitation rates were greatly expanded in 2000 as data from 15 new rivers were added. Exploitation rates for 25 wild, 4 mixed (wild and hatchery) and 12 hatchery stocks are shown in Table 3.3.9.1. Route regression analysis shows no trend relative to any of the long-term means for the 1SW stock components from the rivers reported. The analysis detected a significant downward trend in exploitation for the past 10-year periods for the 2 SW-component of four of the south- European rivers, two southwest-Norwegian and one Icelandic and the Swedish river included in the analysis. Exploitation rates for these rivers showed no trend for the 2 SW component on a 5 year period. As in 1999, exploitation rates of all ages of salmon in the Russian rivers draining to the White Sea Basin showed a significant downward trend both for the 5 and the 10 year period. Among the rivers draining to the Barents Sea, only the exploitation rates for the 10-year period showed a downward trend while the 5-year period showed no trend (Table 3.3.5.4).

3.3.10 Summary of homewater fisheries in the NEAC area

In the NEAC area there has been a general reduction in catches since the 1980s. This reflects a decline in fishing effort, both as a consequence of management measures and the reduced value of commercially caught salmon, as well as a reduction in the size of stocks. However, the overall nominal catch in the NEAC area in 2000 (2,633 t) was substantially higher than that in 1999 (2074t). Catches in some northern European countries were particularly high and well above the recent five and ten-year averages; catches in most other NEAC countries were close to or below the long-term averages.

While there have been no changes in the types of commercial fishing gear used, the number of licensed gear units has, in most cases, continued to fall. Most fisheries for which data are available record a reduction of over 40% in gear units operated over the last 10 years. There are no such consistent trends for the rod fishing effort in NEAC countries over this period. Further initiatives to reduce fishing effort were introduced in several countries.

CPUE data for the net and rod fisheries show differences between countries but no large scale geographic patterns emerge. The Working Group noted that reduction in the number of fisheries operating can benefit those fisheries still in operation and that the lack of consistent trends in CPUE may reflect the imprecise nature of these indices.

Exploitation rates showed no trends relative to long-term averages for 1SW stock components in the NEAC area, although significant downward trends were detected for the 2SW component of some fisheries. There appeared to be no uniform pattern across NEAC countries.

No common trends were noted in the sea age composition of the 2000 catches in the NEAC areas. Differences in the age composition between countries in Northern and Southern Europe noted in 1999 were less apparent in 2000.

In general, the incidence of farmed salmon in NEAC homewater fisheries remained at low levels (<2%) and similar to recent years, despite the continued increase in the salmon farming industry. The proportion of farmed salmon (20%) in the nominal catch for Norway did not increase, but this was a result of the significantly increased catch of wild fish. The number of farmed fish in the Norwegian catch was the highest recorded in the time series.

3.4 Status of Stocks in the NEAC Area

3.4.1 Attainment of conservation levels

Attainment of conservation limits was examined for 13 rivers in the NEAC area for which spawning escapement data (egg deposition) and river-specific conservation limits were available. The analyses included five rivers from Russia, four from UK (England & Wales), and one each from UK (Northern Ireland), UK (Scotland), Ireland and France, where sufficient data were available for the previous 10 years (Figure 3.4.1.1). However, this set of rivers does not sufficiently represent the entire NEAC area as, for instance, no data are available from Norway. In contrast, from 45 rivers in UK

(England & Wales) where CL attainment data were available, five rivers were selected for the analyses to represent different regions.

In accordance with the analysis carried out last year, four categories of rivers were distinguished (Fig. 3.4.1.2):

- Type A: four rivers in which egg deposition was mostly below CL (means of the river CL attainment rates of 45% to 80%);
- Type B: four rivers in which egg deposition fluctuated around CL (means of the river CL attainment rates of 84% to 119%);
- Type C: three rivers in which egg deposition was mostly above CL (means of the river CL attainment rates of 153%. to 180%);
- Type D: two rivers in which egg deposition was well above CL (means of the river CL attainment rates of 250% and 281%). These rivers never fell below CL during the last 10 years.

Information about the conservation limit attainment for the 13 rivers and one river with a shorter time series available (Coquet, UK England) is given in Table 3.4.1.1. and Fig. 3.4.1.1. Eight rivers (62%) out of the 13 rivers where data were available for the year 2000 showed a decline from 1999 to 2000 in the CL attainment (Table 3.4.1.1, Fig. 3.4.1.1.), and in five cases the reduction varied between 30% and 84%. Rivers with the largest decline belong to the two first categories defined above (Fig. 3.4.1.2). In contrast, three rivers showed a marked increase in their CL attainment (27-57%) all belonging to different categories (Fig. 3.4.1.2). Seven rivers (54%) had an egg deposition above their CL in 2000, which is more than in 1999 (44%) but less than in 1998 (69%).

The slight increase in CL attainment from that of the previous year was in accordance with the increase in catches (Section 3.3.4), although the CL attainment information available is not representative of the entire NEAC area.

3.4.2 Measures of juvenile abundance

Smolt counts or estimates of juvenile abundance were made available to the Working Group for 14 rivers (Table 3.4.2.1). Estimates of juvenile salmon (0+) abundance in the rivers Bush (UK N.Ireland) and Nivelle (France) were clearly higher than the 5-year mean being the highest (Nivelle) or second highest (Bush) for the last 10 years. In the River Teno and its tributaries (Finland), juvenile salmon (fry & parr) abundance was mostly at or below the previous 5-year mean and below the figures for the previous year (Table 3.4.2.1).

About half of the smolt counts in 2000 were higher than those of the previous year and the 5-year means (Table 3.4.2.1). There was a significant downward trend during the last 10 years for the smolt counts in all rivers together ($p=0.981$) and separately for the northern rivers (Norway, Sweden; $p=0.984$), whereas no trends were detected during the last 5 years for these groups of rivers. No trends were detected for southern rivers (UK N-Ireland, Ireland, France) for the 5- or 10- year periods (Table 3.4.2.2).

In general, the declining smolt counts in northern rivers appear to reflect the previous decline in adult returns and variable attainment of the CL in this area. However, the downward trend in returns and PFA estimates of southern rivers does not seem to be reflected in smolt counts of the southern rivers.

3.4.3 Measures of adult returns back to the rivers

Estimates or total counts of adult salmon returning into the rivers were available for 36 rivers in the NEAC area (Table 3.4.3.1). To examine trends in different geographical groups of rivers, the rivers were divided into northern (Nordic countries and Russia) and southern group (UK, Ireland and France). Information from 32 rivers was available to examine the change between 1999-2000 and in relation to the previous 5-year mean.

In the northern group, eight out of 14 rivers (57%) showed an increase from the previous year but only six rivers (43%) exceeded their 5-year mean. A significant downward trend was detected for the previous 10-year period in the northern group ($p=0.99$), whereas no trend was detected for the previous 5-year period ($p=0.32$).

In the southern group, more than half (56%) of the adult salmon counts were lower than those in 1999, and two thirds (66%) were below their 5-year mean (Table 3.4.3.1). Due to technical limitations of the route regression analysis, it was necessary to split the southern rivers into two groups: British Isles ($n=17$) and France ($n=4$). A significant downward trend was detected for the previous 10-year period in both groups (British Isles: $p=0.97$, France: $p=0.98$). The rivers in

France showed a downward trend for the previous 5-year period (p=0.97) whereas no such trend was detected for the rivers in UK and Ireland (p=0.74).

3.4.4 Survival indices

Estimates of marine survival for wild smolts from 5 stocks returning to homewaters (i.e. before homewater exploitation) for the 1999 smolt year class are presented in Table 3.4.4.1. For the Nivelle River (France), indices of survival are also provided for autumn age-0^+ parr. This provides an approximation of marine survival as more than 80% of juveniles migrate after only one year in freshwater. In most rivers marine survival for the 1999 smolt year class was below the 5- and the 10-year mean for both 1SW and 2SW fish. Route regression analysis showed significant downward trend in marine survival for 1SW fish for the last 5- and 10-year period (p=0.95 and 0.99), while no trend was detected for 2SW fish.

Marine survival for 13 hatchery stocks are given in Table 3.4.4.2. For the past 10-year period, route regression analysis showed a significant downward trend for survival to homewaters for 1SW (p=0.983) and 2SW fish (p=0.998), but no trend was detected for the past 5-year period for either 1SW or 2SW fish. However, return rates of hatchery released fish may not always be a reliable indicator of marine survival of wild fish because of differences in release conditions.

These results are consistent with the information on adult salmon counts (Section 3.4.3), and suggest that returns are strongly influenced by factors in the marine environment.

3.4.5 Summary of the status of stocks in the NEAC area

Analysis of attainment of conservation limits (CL) in 2000 showed that the proportion of rivers with an egg deposition above their CL was higher than in 1999 but less than in 1998. However, a majority of rivers showed a decline in their level of attainment in 2000 compared to the previous year and in most cases the decline was substantial (30-80%). This indicates that the recovery of salmon stocks observed in 1998, from a period of low attainment (1994-1997), has not appeared to continue. Although some areas were not represented in the data (e.g. Norway) , the Working Group had no reason to assume that the indices were not representative of stocks in general and noted the analysis broadly corresponded to the results of the PFA analysis in Section 3.4.6.

Measures of smolt production indicated that about half of the rivers showed higher smolt output in 2000 than in 1999. Route regression analysis revealed a significant downward trend over the last 10 years for northern rivers, but no trend was detected for southern rivers. The declining smolt counts in northern rivers appear to reflect the previous decline in adult returns and variable attainment of the CL in this area. However, the downward trend in returns and PFA estimates of southern rivers does not seem to be reflected in smolt counts of the southern rivers.

Measures of adult returns back to the rivers showed that of the rivers examined in 2000, more than half showed increased counts. Both southern and northern rivers showed a significant decline over the last 10 years, whereas no clear trend was detected for the last 5-year period.

For most rivers where information is available, marine survival indices were below both the previous 5-and 10-year means. Route regression analysis showed significant downward trend in marine survival for 1SW fish for the last 5- and 10-year period, while no trend was detected for 2SW fish. A similar analysis showed a downward trend in marine survival for 1SW and 2SW hatchery fish over the last 10 years but no decline over the past 5 year period. These results are consistent with the information on adult salmon counts and suggest that returns are strongly influenced by factors in the marine environment.

In summary, the monitored rivers analysed in this section would suggest that the status of salmon stocks in the NEAC area is, in general poor. This broadly agrees with the results of the PFA-lagged spawner analysis that is based on national catch statistics and and presented in Section 3.6.

3.5 Evaluation of the effects on stocks and homewater fisheries of significant management measures introduced since 1991.

3.5.1 Evaluation of the Effects of the Suspension of Commercial Fishing Activity at Faroes

Between 1991 and 1998 the Faroese fishermen agreed to suspend commercial fishing for the salmon quota set by NASCO, in exchange for compensation payments. The number of fish spared as a result of this period of suspension is the catch that would have been taken if the fishery had operated, minus the catch in the research fishery which operated in most years. No buyout was arranged for 1999 or 2000. Although no fishing took place in 1999, a single vessel carried out commercial fishing in 2000, catching approximately 8t. As for last year (ICES 2000/ ACFM:13), analysis was based on the assumption that full quota would have been taken, had full scale commercial fishing taken place. Thus, the maximum catch that would have been taken in 1999/2000 would have been 300 t (Table 3.2.1.1). For the 1999/2000 analysis therefore the fish spared totalled 292t (300t-8t).

Although commercial fishing was carried out in 1999/2000, no new data on the discard rates, the age composition of the catch, or for the proportion of farm escapees in catches were available. Hence, the same values were used as for the 1998/99 assessment. The assessment is shown in Table 3.5.1. This suggests that if the full quota had been bought out, between 3,000 and 21,000 additional 1SW salmon and between 70,000 and 138,000 additional MSW salmon would have returned to homewaters each year from 1992 to 2000. For the 1999/2000 season, the numbers of fish believed saved were 15,332 1SW and 87,726 MSW, respectively. In addition, between 27,000-55,000 escaped farmed fish each season would have been saved from capture in the Faroese fishery. However, data from tagging experiments suggest that almost all survivors would return to Norway (Hansen and Jacobsen, 1997), provided they behaved in a similar manner to wild fish. The analysis carried out suggests that, for the 1999/2000 season, an estimated 24,000 escaped-farmed fish may have been saved.

Estimates (means of 1000 simulations) of the total numbers of 1SW and MSW salmon returning to homewaters (i.e., Pre Fishery Abundance estimates) in the NEAC area and to countries of northern and southern Europe are provided in Tables 3.6.4.1 and 3.6.4.2. The calculated additional returns represent between 7% and 15% of MSW fish and up to 1% of 1SW fish returning to homewaters between 1992 and 2000 (Table 3.5.1). However, data from adult tagging studies (Hansen and Jacobsen 1997), indicate that the majority (about 65%) of MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. If this were the case, they might have represented from 10% to 20% of MSW returns and up to 2% of 1SW returns to northern European homewaters in the same period (Table 3.5.1). If stocks and fisheries had remained stable, total catches would have been expected to increase by approximately the same proportions in respective areas.

Although the assessment of changes in catch levels prior to and after suspension of the fishery at Faroes were influenced by many other factors (eg. changes in exploitation and effort) could have affected abundance, the benefits of not fishing should be highlighted. The additional returns will still be expected to contribute to catches and spawning stocks, even if any expected increase has been masked by other factors such as changes in marine survival or management measures in homewaters, such as those outlined in Section 3.5.2, below.

3.5.2 Evaluation of the effects of management measures introduced in homewaters since 1991.

The Working Group noted significant reductions in the number of gear units deployed in most countries in the NEAC area (Table 3.5.2). Additional measures have been taken is some countries.

In Ireland new management and conservation legislation was brought into force in 1997 which was aimed at reducing effort and exploitation in the fishery and to facilitate enforcement. These regulations were enforced during the 1997-2000 seasons. In order to show whether there has been a change in the catch subsequent to the introduction of measures in 1997, the data were analysed using a Non-Parametric Random Ratio (NPR) test (Rago 1993, ICES 2000/ACFM:13). This test compares the mean catch in the period following the introduction of new regulatory measures in 1996 (i.e. 1997-2000) with the mean catch reported in the preceding 7 years to 1990. The results of this test indicate that drift net catches in the most recent 4 years were significantly lower than the preceding 7 years ($p < 0.01$) in all regions. Similarly, draft net catches (excluding the North Western Region where the Moy River draft net was suspended in 1994) were also significantly lower in the most recent 4 years ($p < 0.01$) in all regions. A Non Parametric Random (NPR) Ratio Test (Rago, 1993, Anon 2000) was applied to the exploitation data for 10 Irish stocks to examine the effects of the management measures introduced in 1997. The results of this test indicated that the exploitation rates in the period from 1997 to 2000 were also significantly reduced compared to the previous 10 year period ($p < 0.01$). It is concluded therefore that the measures introduced in 1997 contributed to a reduction in both the overall catch and the exploitation rate on Irish stocks.

In UK (England and Wales), the North East coast fishery is the largest net fishery in UK (England and Wales) and has taken 68%, on average, of the national declared net catch over the period 1970-92. A phase out of this fishery was introduced in 1993 and the number of licences issued has subsequently fallen by 50%, from 142 in 1992 to 71 in 2000. The exploitation rate in 1992 was estimated to be in the region of 50%. Assuming the remaining fishermen are representative and that there have been no major changes in the fishery, the average exploitation rate (1996-2000) would have fallen to around 32% (i.e. a 36% reduction). This is in close agreement with the reduction in the average drift net catch (1996-2000), which has fallen by 32% compared with the 5 years (1988-92) prior to the start of the phase out. A number of other smaller coastal mixed stock fisheries have also been phased out since 1991.

National measures introduced in UK (England and Wales) in 1999 to protect spring salmon are estimated to have saved around 3,700 salmon from capture by net fisheries in 2000 before June 1 (based on the catch and the average proportion of fish taken in this period in the 5 years prior to the measures being introduced) and 1,400 by rod fisheries (based on a similar proportion, but adjusted for catch and release).

The Working Group noted that a large number of other measures had been introduced. For example, in UK (England and Wales) the total number of licences issued has been reduced by 46% since 1991, but the introduction of additional controls (e.g. increased close periods) has reduced the total allowable fishing effort by 60%. In UK (Scotland), a voluntary cessation of net effort for the first six weeks of the fishing season was agreed by the majority of fishermen and was introduced in 2000. In the rod fishery, there has been an increase in the practice of catch and release since 1994 as previously reported (Table 2.1.2.1). These recent initiatives, and the continuing decline in overall net effort, are likely to reduce the impact on NEAC stocks. The Working Group expected these changes to reduce homewater exploitation rates.

3.6 Expected abundance of Salmon in the North East Atlantic

3.6.1 Previous development of a NEAC - PFA model

The Working Group has previously developed a model to estimate the pre-fishery abundance (PFA) of salmon from countries in the NEAC area. (PFA in the NEAC area is defined as the number of 1SW recruits on January 1st in the first sea winter). The method employs a basic run-reconstruction approach similar to that described by Rago *et al.* (1993) and Potter and Dunkley (1993). The model estimates the PFA from the catch in numbers of 1SW and MSW salmon in each country. These are raised to take account of minimum and maximum estimates of non-reported catches and exploitation rates of these two sea-age groups. Finally these values are raised to take account of the natural mortality between January 1st in the first sea winter and the mid-point of the respective national fisheries. A Monte Carlo simulation (1000 runs) (using ‘Crystal Ball’ in Excel; Decisioneering, 1996) is used to estimate confidence limits on the PFA values. Full details of the model are provided by Potter *et al.* (1998).

3.6.2 Improvements to the NEAC-PFA model

No changes were made to the structure of the PFA model used in 2001. In addition to adding catch data and other parameter values for 2000, national representatives considered methods for improving the precision of parameter values used in the model, in particular by splitting the national data set into regions. The following changes were made to the input data sets:

Country:	**Changes to data inputs:**
Finland	No changes; national data set applies to only 2 rivers.
France	No changes made to data inputs; a new model for estimating numbers of returns is being developed.
Iceland	National data set split into south-western and north-eastern regions for 1971-2000
Ireland	Seven regional data sets were evaluated but their use in the assessment was considered inappropriate at this stage; the full data set was reviewed and exploitation and non-reporting rates were modified.
Norway	National data set split into 3 regions (South , middle and North) for period 1983-2000.
Russia	Data will be split into 3 regions for 2001; methods for handling ‘fall salmon’ (salmon that start to enter freshwater more than one year before spawning) will also be reviewed.
Sweden	Data will be fully re-evaluated for 2001
UK(England & Wales)	Data set fully reviewed and corrected; a new model for combining counter and catches data to estimate total returns is being developed.
UK(Northern Ireland)	National data set split into 2 regions (Foyle and Fisheries Conservation Board) for 1971-2000
UK(Scotland)	National data set split into eastern and western regions for 1971-2000

The national and regional input data sets listed above for countries in the NEAC area and for the Faroes and West Greenland fisheries are shown in Appendix 7. The maximum and minimum values denote the limits of the uniform distributions used in the Monte Carlo Simulations.

Tables 3.6.2.1 to 3.6.2.6 summarise the outputs from the simulation, giving the mean estimates for each NEAC country of the numbers (plus variances/standard deviations) of:

- returns (1SW and MSW) (Table 3.6.2.1 and 3.6.2.2),

- recruits (PFA) (maturing and non-maturing 1SW and total 1SW) (Table 3.6.2.3 and 3.6.2.4),

- spawners (1SW and MSW) (Table 3.6.2.5 and 3.6.2.6).

Trends in these outputs are discussed in Section 3.6.4.

3.6.3 Grouping of national stocks

The Working Group has previously considered the most appropriate stock groupings for the provision of catch options or alternative management advice. Stock groupings may be proposed for two purposes: first, to provide advice on the status of all the stocks in the NEAC area in a way that can conveniently be used by NASCO managers; and second to provide catch advice for the stocks contributing to specific fisheries. Different stock groupings may be appropriate to fulfil these objectives.

No new information was presented to the Working Group on methods to group stocks in the NEAC assessment, although it was noted that this is one of the topics being considered by a current EU Concerted Action programme ("SALMODEL"). The Working Group has therefore continued to use the following groups of countries to present the PFA data:

Southern European countries:	**Northern European countries:**
Ireland	Finland
France	Norway
UK(England & Wales)	Russia
UK(Northern Ireland)	Sweden
UK(Scotland)	Iceland

3.6.4 Trends in the PFA for NEAC stocks

Tables 3.6.2.1 to 3.6.2.6 show combined results from the PFA assessment for the Northern and Southern European groups and the whole NEAC area. The PFA of maturing and non-maturing 1SW salmon and the numbers of 1SW and MSW spawners for these areas are shown in Figures 3.6.4.1 to 3.6.4.6.

The 95% confidence limits (dotted lines for PFA and vertical bars for the spawning escapement) shown in Figures 3.6.4.1 to 3.6.4.3 indicate the level of uncertainty in this assessment procedure. In more recent years this level of uncertainty has decreased. However, the Working Group recognised that the model provided an interpretation of our current understanding of national fisheries and stocks based upon simple parameters. Errors or inconsistencies in the output must largely reflect errors in our best estimates of these parameters. Furthermore, there are risks that progressive errors could occur if, for example, the rate that exploitation has been reduced over a period of years is underestimated. The results therefore need to be treated with caution.

Figure 3.6.4.1 shows that there has been a general decline in recruitment of 1SW and MSW salmon in the whole NEAC area over the past 30 years, and both age groups have fallen to their lowest levels in the three years. Numbers of 1SW and MSW spawners have also declined (Figure 3.6.4.2) over the past 30 years, although the decline has been less severe, indicating that reductions in exploitation have, to some extent, compensated for the decline in stocks.

Figure 3.6.4.3 shows that recruitment of maturing 1SW salmon (potential grilse) in Northern Europe was generally high (around one million) in the 1970s and 1980s, although the numbers have fluctuated quite widely, but there was a steady decline in these stocks from the mid 1980s to the mid 1990s. In the past four years there has been an upturn in the recruitment, with stocks in 2000 returning to the levels observed in the early 1990s. The number of 1SW spawners was low in the 1970s, increased through the 1980s but declined again in the 1990s (Figure 3.6.4.4). However, escapement in 2000 appears to have been good.

Numbers of non-maturing 1SW recruits (potential MSW returns) for Northern Europe are also estimated to have fluctuated around one million between 1970 and 1985, but subsequently fell to about half this level in the late 1990s; there has been a slight upturn in the past three years. The numbers of MSW spawners, however, show no trend over the time series although numbers appear to have been good in 2000. It therefore appears that the decline in recruitment has been balanced by the reductions in exploitation both in homewater fisheries and at Faroes. These trends in recruitment for the Northern European stocks are broadly consistent with the limited data available on the marine survival of monitored stocks in Norway and Iceland (Section 3.4).

In the Southern European stock complex (Figure 3.6.4.5), the numbers of maturing 1SW recruits are estimated to have fallen substantially since the 1970s. Recruitment was at its lowest during the 1990s and there was a further drop in the estimated recruitment in 1999 with value in 1999 and 2000 being the lowest in the time series. This pattern is consistent with the data obtained from a number of monitored stocks. Survival of wild smolts to return as 1SW fish fell to very low levels on the four monitored rivers in the Southern European area for which data were available (Corrib and Burrishoole (Ireland), Bush (UK(Northern Ireland)), Nivelle (France)) (Section 3.4). This suggests that the marked reduction in 1SW returns in 1999 is likely to have been due in large part to a widespread decline in marine survival. Reductions have also been observed in freshwater production and marine survival could be affected by factors operating in freshwater.

The PFA estimates suggest that the number of non-maturing 1SW recruits in Southern Europe has declined fairly steadily over the past 30 years (Figure 3.4.6.5); these stocks have also reached their lowest levels in the time series in 1999 and 2000. This is broadly consistent with the general pattern of decline in marine survival of 2SW returns in most monitored stocks in the area. In more recent years, reductions in exploitation do not appear to have kept pace with the stock declines and the spawning escapement has thus also fallen over the period (Figure 3.6.4.6).

3.6.5 Forecasting the PFA for NEAC stocks

In order to provide numerical catch advice, PFA values must be forecast one or two years in advance. For example, the PFA of non-maturing 1SW recruits must be predicted for 2000 if we are to provide catch advice for the West Greenland fishery in 2001, for the Faroes fishery (MSW stock) in the 2001/02 fishing season and for homewater MSW fisheries in 2002. Because the latest estimate of non-maturing 1SW recruits is for 1999, the PFA must be forecast two years ahead, as is currently practised for the North American assessment. For maturing 1SW stocks, a single year's projection is sufficient.

The Working Group currently has no method for predicting future PFA levels, other than by extrapolation from the estimated time series which due to the uncertainties is not considered to be appropriate. Co-ordination of work on the PFA assessments and predictive models for NEAC stocks is being considered as part of an EU Concerted Action programme and is expected to be one of the more important deliverables resulting from this Concerted Action. .

3.6.6 Evaluation of effects of farmed salmon on the model

NASCO has asked ICES to evaluate the potential biases in the catch advice resulting from the inclusion of farmed escapees in the assessment models. The NEAC PFA model has previously only taken account of the presence of farm escapees in the Faroese catches. The estimated proportion of wild fish in the Faroese catches is shown in Appendix 8h; values for the years 1984 to 1997 were based on scale sampling (Hansen, *et al.* 1999), while values have been assumed or estimated for other years on the basis of the level of farm production and catches. The recruits back-calculated from the Faroese catches are thus divided into wild and farmed components; the wild fish are re-allocated to the national estimates of 1SW (maturing and non-maturing) recruits according to proportions estimated from various tagging studies; farm escapees in the Faroese catches are ignored in the assessment.

The model has not previously taken any account of farm escapees in other areas. The incidence of farmed fish in catches at West Greenland and in most homewater fisheries has been estimated to be less than 1.5% (Table 3.3.7.1)(Hansen *et al.*, 1997). These fish will therefore have a minimal effect on the PFA and National Conservation Limit assessments.

However, substantial numbers of farm escapees occur in coastal, fjord and river fisheries in Norway. These fish have previously been included in the run-reconstruction model and therefore contributed to the back-calculated estimate of recruitment (PFA), despite the fact that they are clearly not recruits from wild spawners but are derived from cage production. The farm escapees have also been incorporated into the estimates of the numbers of spawners and thus contribute to the estimated egg-deposition. However, farm fish probably don't spawn as successfully as wild fish and their offspring may not be as viable as wild offspring; their contribution to the egg deposition should therefore be reduced.

The PFA and National Conservation Limits for Norway estimated using the unmodified NEAC PFA-CL model have therefore been compared with the same outputs from a modified version of the model taking account of the escapees. In the revised model, the numbers of wild fish of sea age 'i' killed (including unreported catches) (H_i), is estimated by adding a new parameter (F_c) in the model. Thus:

$$H_i = (C_i / (1 - R_i) / U_i) * (1-F_c)$$

where: C = catch of salmon in numbers;
R = estimated proportion of the total catch that is unreported;

U = average level of exploitation of the salmon stock;

F_c = proportion of farmed fish in catches.

The PFA of wild salmon is estimated from the number of returns by back-calculating from the returning stock (H_i).

In estimating the National Conservation Limit for Norway, the number of wild spawners was estimated by deducting the catch of wild fish ($C * (1 - F_c)$) from the estimated number of wild returns (H_i). The total numbers of spawners was then calculated by raising this value for the proportion of farmed fish in samples taken on the spawning grounds (F_s). However, since farmed fish are believed to be less successful spawners than wild fish their contribution must be weighted by a factor, W. Thus the effective number of spawners, S_e , is estimated as follows:

$$S_e = H_i – (C * (1 – F_c)* (1 / (1 – F_s * W)))$$

The effects of these changes on the assessment are shown in Table 3.6.6.1. Over the past 10 years the average proportions of farmed fish in catches of 1SW and MSW salmon (F_c) have been 8% and 14% respectively. Removing these fish from the PFA assessment results in the estimated recruitment of 1SW and MSW salmon being reduced by an average of 10% and 18% over this period. The average proportion (F_s) of farmed fish on the spawning grounds has been 11% and 15% for 1SW and MSW salmon respectively. Taking account of these fish in the assessment, and assuming an arbitrary weighting factor (W) of 0.5, the effective spawning numbers (and hence egg deposition) for 1SW and MSW salmon are reduced by 2% and 4% respectively. The conservation limit estimated by the national lagged-egg deposition model in this scenario is also reduced by about 4%.

This model takes no account of the possibility of farmed fish having an adverse effect on the spawning success of wild fish. There is also considerable uncertainty about the spawning success of farmed escapees (factor 'W'); the assessment currently undertaken by the Working Group assumes that farmed and wild fish contribute equally to the egg deposition. If farmed fish make less contribution to the egg deposition (W closer to 1), the effective spawning escapement (and egg deposition) will be reduced further.

For the 2001 assessment, the Norwegian input data for the PFA model have been split into three regions. However, it has not been possible to provide data on farm escapees for these regions. As a result the potential errors discussed above must be taken into account when considering the catch advice.

3.6.7 Sensitivity analysis of the PFA model

A sensitivity analysis for the spreadsheet model which generates pre-fishery abundance (PFA) estimates based upon a run-reconstruction analysis for national salmon stocks in the North East Atlantic Commission Area (NEAC) of NASCO is described by Potter, *et al.* (1998).

The model (as applied to individual national data sets) is relatively insensitive to the ranges of natural mortality, M, and the time between recruitment and return to home waters, t, estimates currently used. Although 't' can be estimated quite accurately, there is considerable uncertainty about the true values of M at different stages in the marine phase of the life cycle. As suggested in Section 2.6, if estimates of M are revised in the future this parameter may be sensitive to changes and affect the assessments more than is indicated in the present analysis. (This issue is being investigated further as a separate task with the EU SALMODEL Concerted Action programme.) Variation in the values of non-reporting rates, 'R', and exploitation rates, 'U', have a greater effect on the estimates of PFA. The PFA estimate is most sensitive to 'R' when it is large and to 'U', when this is small. The latter is a particular concern because exploitation rates are being reduced in many countries.

The sensitivity of the overall assessment of PFA for the NEAC Area and for the Northern and Southern European stock complexes will therefore depend on the values of the various parameters provided for different countries, but these will also be weighted by the national catches. It is thus not immediately apparent to which parameter values the assessment will be most sensitive. A spreadsheet has been therefore been prepared which evaluates the effects on the overall assessment of changing individual parameter values (Tables 3.6.7.1). The evaluation is based upon the data inputs used for the PFA assessment this year (2001).

Table 3.6.7.1 shows the effects (% change) on the assessment of PFA of maturing and non-maturing 1SW salmon from the Northern and Southern Europe of making the following changes to individual national or regional parameter values:

- adding 0.1 (10%) to 'R'
- adding 0.1 (10%) to 'U'
- adding 2 months to 't'
- multiplying 'R' by 1.2
- multiplying 'U' by 1.2
- multiplying 't' by 1.2

[Adding 0.1 to parameters tends to weight the effects on low values, whereas multiplying them by 1.2 weights that effects on larger values.]

At this level of disaggregation the model is fairly sensitive to some parameter values. Changes (as described above) to the eight parameter values listed in the text table below have a greater than 5% effect on the respective PFA estimates (Table 3.6.7.1); several have effects of more than 10%.

Rank	Country	Sea-age	Parameter
1	Russia	MSW	non-reporting rate
2	Scotland (E)	MSW	exploitation rate
3	Russia	MSW	exploitation rate
4	Scotland (W)	MSW	exploitation rate
5	Scotland (E)	1SW	exploitation rate
6	Ireland	1SW	non-reporting rate
7	Ireland	1SW	exploitation rate
8	Scotland (E)	MSW	non-reporting rate

This analysis does not provide any indication of the reliability of any of the parameter values currently used in the NEAC PFA assessment. It merely indicates the effects on the PFA estimates when modest changes (adding 0.1 or multiplying by 1.2) are made to individual values. However, the sensitivity analysis indicates that particular attention should be paid to ensuring that the parameter values listed in the text table below are accurate.

3.7 Development of age-specific conservation limits

3.7.1 Progress with setting river-specific conservation limits

These issues are being dealt with by the EU funded Concerted Action entitled

"A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic – SALMODEL" (Contract No: QLK5-CT1999-01546). A summary taken from the first years report of this CA is given below:

While NASCO's remit in distant water fisheries requires an international approach, the use of conservation limits at national, regional and local levels is also highly important. At these levels, data on compliance with conservation limits for individual rivers or groups of rivers provides important data on status of stocks. These data are in some cases already being used to manage fisheries at regional and local levels and this is expected to increase as more river-specific conservation limits are set. The use of river specific conservation limits is now generally (though not universally) accepted as providing the most viable means of providing management advice for salmon at all levels from river through to stock complexes. Delivery of conservation limits at all these levels can be enhanced through international co-operation and sharing of data and techniques.

In all, there are around 25 stock and recruitment datasets in the NEAC area, ranging from long time series to rivers where S/R relationships are in the process of being (or could be) developed. These include a mixture of smaller rivers and tributaries of large river systems. Given the time and resource difficulties with collecting meaningful S/R data, it is unlikely that further datasets will be developed in the near future. However, as these rivers are spread throughout the NEAC area and cover a wide array of river types (apart from larger river systems) and productivity levels, even incomplete S/R datasets may provide useful information for helping transport conservation limits to rivers with little or no data (i.e. conservation limits could be tuned to different productivity levels, by comparison across S/R datasets, even if the local data are only partial).

As noted above, two countries (UK(England & Wales) and France) are already using river specific conservation limits to derive national conservation limits. These are supplemented by UK(N. Ireland) and Ireland, where river-specific conservation limits have been produced, but, as these are still viewed as preliminary they have not yet been used for inclusion in the ICES catch advice process. A majority of countries surveyed in the NEAC area (5) have still to develop even interim conservation limits for their rivers, although most are actively working towards this. For example, Sweden has indicated a target for production of river-specific conservation limits by 2001.

The rate of development of river-specific conservation limits has reflected *inter alia* difficulties across various countries with availability and representativeness of S/R data, together with the logistical difficulty of accurately surveying large numbers of rivers in remote locations. As a result, only 271 out of a total of 1446 rivers (18.7%) have river-specific conservation limits at present, and many of those are at interim/developmental stages.

One tendency is to use the most comprehensive S/R data sets and transport conservation limits from these to many rivers. For example, the R. Bush S/R dataset has been used by UK(N. Ireland), UK (England & Wales) and Ireland to derive river-specific conservation limits for most of their rivers. This raises issues of differences in production across these rivers, together with a critical dependence on the value of a single S/R dataset if there is dynamic change in that stock. In contrast, in Norway a good S/R dataset exists for one small river in the south of the country (River Imsa), but this has not been used to set river-specific conservation limits for the whole country, because of concerns about representativeness of the data.

An intermediate approach is the French example, where a river in Brittany with good S/R data has been used primarily for setting Biological Reference Points (BRP) in that region, but also in other regions after correction/calibration for local productivity, based on restricted local information in some cases. Similarly, in England & Wales, the Environment Agency adjusts S/R relationships according to a simple model of river type (productivity) and make further adjustments to take account of local knowledge of river structure, productivity and stock characteristics, where known.

The challenge is to take what is really a continuum of possible approaches to identifying and transporting BRPs and providing guidelines that can suggest a best approach for particular situations, taking into account limitations of the data and the methodology.

The process of setting river-specific conservation limits depends on being able to transport BRPs to other rivers . There are a variety of transport methods in use in the NEAC area, all based on measuring some attributes of area of productive habitat and relative levels of productivity in other rivers. These range from remote sensing (e.g. aerial photographs), through map-based measurements (e.g. catchment area/ gradient/wetted area) to in-river surveys of productive habitat area. In practical terms, remote sensing alone is unlikely to provide satisfactory resolution for meaningful transport, while logistical/resource difficulties mean that in-river surveys of all rivers will be impossible. A trend is emerging for top down surveys (incorporated into GIS supported production models), with in-river surveys used to provide ground truthing and calibration. SALMODEL will address development of survey and transport techniques so that where possible common standards can be applied in future.

While summing river-specific conservation limits is preferable to the pseudo stock-recruitment method for setting national conservation limits, efforts have been made to improve the data inputs used in the latter approach, which will continue to be used until sufficient progress has been made the individual river assessments.

Legitimate concerns have been expressed about the suitability of using single conservation limits for management of larger river systems known to have genetically differentiated sub-populations at the sub-catchment level. A related concern highlighted the possible impact of a single river conservation limit on sub-populations having different production characteristics.

Despite the problems, several countries have developed river-specific conservation limits for all their salmon rivers, though the methods used for transport vary considerably. In one or two cases, river specific conservation limits have been set based on the crudest level of transport (catchment area) and therefore these are not yet regarded as reliable enough to replace the ICES pseudo S/R data for setting national conservation limits (Section 3.7.2). While it is noted that NASCO has specifically asked for the development of age specific conservation limits, there has been little progress with dividing river specific conservation limits between sea-age groups.

3.7.2 Changes to the National Conservation Limits model

As indicated above, relatively few river specific conservation limits have been developed for salmon stocks in the NEAC area. An interim approach has therefore been developed for estimating national conservation limits for countries that cannot provide an estimate based upon river specific estimates. The approach is based on establishing quasi-stock-recruitment relationships for national salmon stocks in the North East Atlantic Commission (NEAC) area (Potter *et al.*, 1998).

In brief, the model provides a means for relating the estimates of numbers of spawners and recruits derived from the PFA model. This is addressed by converting the numbers of 1SW and MSW spawners into numbers of eggs deposited, using the proportion of female fish in each age class and the average number of eggs produced per female. The egg deposition in year 'n' is assumed to contribute to the recruitment in years 'n+3' to 'n+8' in proportion to the numbers of smolts produced of ages 1 to 6 years, and these proportions are therefore used to estimate the 'lagged egg deposition' contributing to the recruitment of maturing and non-maturing 1SW fish in year 'n+8'. The plots of lagged eggs (stock) against the 1SW adults in the sea (recruits) have been presented as 'pseudo-stock-recruitment' relationships.

ICES and NASCO currently define the conservation limit for salmon as the stock size that will result in the maximum sustainable yield in the long term (i.e. S_{MSY}). However, it is not straightforward to estimate this point on the national stock-recruitment relationships because the replacement line is not known. (The replacement line is the line on which 'stock' equals 'recruits'.) This is the case for the quasi-stock-recruitment relationships established by the national model because the stock is expressed as eggs while the recruits are expressed as adult salmon. The Working Group has previously used the following three non-parametric methods (ICES (1993/Assess:10)) to provide Options for setting the conservation limits:

Option 1: the minimum stock size previously observed

Option 2: the stock size where the 90th %ile of survival intersects the 90th %ile of recruitment

Option 3: the stock size where the 90th %ile of survival intersects the median recruitment level.

These values have then been evaluated on the basis that the conservation limit should be set at the egg-deposition level below which recruitment begins to decline, and that if no decline in recruitment is apparent over the range of egg-deposition previously observed, the conservation limit should be set at the lowest previously recorded egg-deposition.

The Working Group considered a more objective approach for setting a conservation limit from the quasi-stock-recruitment relationships. The approach assumes that there is a critical point below which recruitment decreases with stock towards zero levels of stock and recruitment, and above which recruitment is constant.

i.e. $R = \beta \times S \quad S <$ Change point

$R = \mu_S \quad S \geq \textit{Change point}$

where $$\beta = \frac{\mu_S}{Change\ point}.$$

This is a non-linear model with parameters μ_S and *Change point*, estimated by minimising the residual sum of squares. The minimum is obtained by searching for the *Change point* over the range [0, max(S)]. The procedure is demonstrated for two simulated data sets:

$R = S_1 +$ noise $\quad S_1 = 5, 6, \ldots 14$

$R = S_2 +$ noise $\quad S_2 = 15, 16, \ldots 25.$

The results are shown in Figure 3.7.2.1. The top pair of figures correspond to a low level of variability, and show on the left, the residual sum of squares for different values of the *Change point*, passing through a well defined minimum at *Change point* = 15.8. The figure on the right shows the data with the fitted model corresponding to the minimum residual sum of squares. The bottom pair of figures correspond to a higher level of superimposed variability, and we see that the optimum value of *Change point* (14.0) is less well defined. It should be noted that in both cases that the residual sum of squares is not a smooth function, and there are discontinuities as the *Change point* coincides with each data point.

This approach was applied to the 2000 national stock-recruitment relationships and in most cases the model provided a conservation limit very close to the Option (1 to 3) previously selected by the Working Group. The Working Group therefore concluded that, being more objective, this approach was more appropriate for the evaluation of the national conservation limits.

3.7.3 National Conservation Limits

The national model has been run for the countries for which no river specific conservation limits have been developed (i.e. all countries except France, UK(England & Wales) and Sweden). The outputs are illustrated in Appendix 8. For Iceland, UK(Northern Ireland) and UK(Scotland) the input data for the PFA analysis (1971-2000) have been provided for two regions; the lagged spawner analysis has therefore been conducted for each region separately and the estimated conservation limits summed for the country. The conservation limits derived from the national model and river specific estimates are shown in Table 3.7.3.1. The Working Group has previously noted that outputs from the national model are only designed to provide a rough guide to the status of stocks in the NEAC area, where more reliable data are not available because the approach depends upon a number of assumptions. One feature is that it tends to provide estimates close to the minimum level of recruitment previously seen (as estimated by the PFA model). In some cases this will be a conservative estimate of the true conservation limit (S_{MSY}). It will also be noted that the conservation limit estimates may alter from year to year as the input of new data affects the 'pseudo-stock-recruitment relationship'. This further emphasises the fact that this approach only provides a basis for qualitative catch advice.

The estimated national conservation limits have been summed for Northern and Southern Europe (Table 3.7.3.1) and are given on Figures 3.6.4.4 and 3.6.4.6 for comparison with the estimated spawning escapement. The conservation limits have also been used to estimate the spawner escapement reserves (SERs) (i.e. the CL increased to take account of natural mortality between the recruitment date (1st Jan) and return to home waters) for maturing and non-maturing 1SW salmon from the Northern and Southern Europe. The SERs are shown as horizontal lines in Figures 3.6.4.5 and 3.6.4.3. Evaluation of stocks against SERs is thought to be inappropriate for the total NEAC data (Figure 3.6.4.1). The Working Group also consider the current SER levels may be less appropriate for evaluating the historic status of stocks (e.g. pre-1985), which in many cases have been estimated with less precision.

3.8 Catch options or alternative management advice

The Working Group has been asked to provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits in the NEAC area. The Working Group reiterated its concerns about harvesting salmon in mixed stock fisheries, particularly for fisheries exploiting individual river stocks and sub-river populations that are at unsatisfactorily low levels. Annual adjustments in quotas or effort regulations based on changes in the mean status of the stocks is unlikely to provide adequate protection to the individual river stocks that are most heavily exploited by the fishery or are in the weakest condition.

The Working Group also emphasized 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 both because of the relative imprecision of the national conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations. Nevertheless, the Working Group 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 for these fisheries.

In view of the uncertainties expressed about the most appropriate stock groupings and the preliminary nature of the conservation limit estimates, the Working Group is unable to provide quantitative catch options at this stage. In the absence of a predictive estimate of PFA and more reliable estimates of conservation limits, it is unlikely that quantitative catch advice will be developed in the near future. However, the Working Group feels that the following qualitative catch advice is appropriate based upon the PFA data and estimated SERs shown in Figures 3.6.4.3 and 3.6.4.5.

The Southern European stock complex is believed to include the main European stocks that have contributed fish to the West Greenland fishery; evidence from tagging studies suggests that the Nordic countries contribute relatively few fish to this fishery. It is therefore appropriate that the European input to the advice on the West Greenland fishery should be based principally on the status of non-maturing 1SW from the Southern area.

Provision of catch advice for the Faroes fishery is more complex. Recent tagging studies at Faroes (1991/92 – 1994/95), suggest that the main country contributing to the MSW salmon to the fishery is Norway, with significant contributions also from Scotland and Russia (Hansen and Jabobsen, 2001). The 1SW salmon caught in the fishery come mainly from the Southern European countries (Jacobsen *et al.* 2001). This therefore means that the catch advice for both Northern and Southern European stocks must be taken into account when considering management actions for the Faroes fishery.

For all fisheries, the Working Group considers that management of single stock fisheries should be based upon local assessments of the status of stocks. Conservation would be best achieved by fisheries in estuaries and rivers targeting stocks which have been shown to be above biologically-based escapement requirements.

[NB In the evaluation of the status of stocks, PFA or recruitment values should be assessed against the spawner escapement reserve values while the spawner numbers should be compared with the conservation limits.]

Northern European 1SW stocks: The spawning escapement of 1SW salmon from the Northern European stock complex have been within but close to safe biological limits in recent years, although there is evidence of an upturn in the past few years. It should be noted that the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated. The Working Group considers that overall exploitation of the stock complex at the current rate is acceptable, although the status of individual stocks varies considerably. 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.

Northern European MSW stocks: The PFA of non-maturing 1SW salmon from Northern Europe has been declining since the mid 1980s and the exploitable surplus has fallen from around 1 million recruits in the 1970s to about half this level in recent years. The Working Group considers the Northern European MSW stock complex to be within safe biological limits, although it is recognised that the status of individual stocks will vary considerably. In addition, the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated. The Working Group therefore considers that great caution should be exercised in the management of these stocks particularly in mixed stock fisheries and exploitation should not be permitted to increase.

Southern European 1SW stocks: The spawning escapement for the whole stock complex has fallen below the conservation limit throughout the past 10 years. Moreover, recruitment of maturing 1SW salmon in the Southern European stock complex has been below any previously observed value throughout this period. In both 1999 and 2000 recruitment before exploitation was below the spawning escapement reserve. The Working Group considers that reductions in exploitation rates are required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation.

Southern European MSW stocks: The PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s and the spawning escapement for the whole stock complex has been close to or outside safe biological limits throughout much of this period. The upper 95 % confidence limit for PFA of spawners has been below the spawner escapement reserve for the past four years. Qualitative projection of these estimates suggests that the PFA is likely to remain below this reserve in 2001. The Working Group considers that further reductions in exploitation rates are urgently required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation.

3.9 Catches of Post-Smolts in the Norwegian Sea and Adjacent Areas

Since 1995, regular post-smolt surveys have been conducted in the Norwegian Sea and adjacent areas during the summer months. These have been carried out by Norwegian research vessels during routine surface trawl surveys for pelagic species. Extra flotation on trawl-wings and on the head-rope were used when trawling for smolts. In the early 1990s, occasional post-smolt captures were also recorded when the pelagic trawl was being developed and tested, Since 1990 more than 2,400 post-smolts and 99 salmon have been caught in 1,863 surface trawls.

In 2000, trawling for post-smolts was carried out on seven cruises, four of which were specifically aimed at salmon using a 'Fish Lifter' for live fish sampling attached to the cod end of the trawl, as described in Holm *et al.* (2000) and Holst and Mc Donald (2000). One short cruise to the Voering Plateau was carried out during mid- June where, based on previous observations of the spatial and temporal distribution of post-smolts, it was hypothesized that an aggregation of post-smolts should occur. A special cruise was also conducted in July to four of the large northernmost fjords (Alta, Porsanger, Tana and Neiden) into which some of Norway's most important salmon rivers discharge. A further limited survey was also carried out to the southern edge of the North Atlantic Current where this flows eastwards into the Barents Sea. The southern Barents Sea is believed to be an important feeding area in the early marine phase for northern Norwegian and Russian salmon stocks. The aim of this cruise was to investigate the migration paths of the northern post-smolts, and the level of salmon lice infestations in these northern stocks; some of which are located in fjords (Tana and Neiden) without any fish farming activity.

Overall, more than 760 post-smolts and 38 salmon were captured during the 2000 surveys, the majority (~ 60 %) in fjords or in coastal areas (Table 3.9.1). The total post-smolt distribution in 2000 is presented in Figure 3.9.1. Figures 3.9.2 and 3.9.3. provide detailed distributions of the catch locations and the numbers captured on the southwest coast of Norway and in the southern Barents Sea, respectively. The captures in both areas are distributed along the Norwegian Coastal Current. For the first time Carlin tagged fish from Ims, southwest Norway, and microtagged post-smolts, presumably of southern European origin, were taken in the same catch. Nine microtags and three Carlin-tags were recorded in a catch of 170 post-smolts and an additional three microtags were recorded in a catch of 34 post-smolts from a neighbouring area (Figures 3.9.1 and 2.4.4.1) This incidence supports the view that some of the post-smolts captured in these areas in 1990 - 1999 (2-year smolts, aged by scale reading) may have been of south- or southwest-Norwegian origin. It is speculated that these fish would migrate along this route with the Atlantic current. The possibility of a common feeding area, explaining the observed correlation in growth and survival between the North Esk fish in Scotland and the SW- Norwegian Figgjo stock (Friedland *et al.* 1998), may also be supported by this finding. Scale readings from a sample of smolts from the largest catch in June, correspond to earlier recorded age distributions from this area, as the majority of the fish entered the sea as 2-year-old smolts or younger.

The high number of microtags taken in only a few hauls, suggest that even a modest, but co-ordinated effort to microtag more smolts in NE-Atlantic countries could add much to the knowledge about migration routes, spatial and temporal distribution and other characteristics of various salmon stocks in the sea.

The post-smolt CPUE values have been high in the Norwegian Sea during the last two years, assumed to reflect better timing of the cruises. It has previously been suggested that the trawling speed was too low for capturing larger salmon. This was also observed on video recordings from within the trawl during 2000 (Holm, pers obs.). Larger salmon were seen holding station close to the cod-end for a while, but were only occasionally recorded in the catches. Consequently, no efforts have been made to calculate CPUE for larger salmon. The high CPUE values for post-smolts give rise to concern about the interception of these fish in pelagic fisheries in international waters. This issue is addressed in Section 2.4.4.

3.10 Data deficiences and research needs in the NEAC Area

1. More research into the biology of salmon in the marine phase is required. This includes the need to monitor trends in marine mortality for a wider range of stocks than at present, and identify causes for mortality. It should also include the examination of relationships between postsmolt growth and marine mortality. The use of data storage tags will significantly improve the information on the marine life history of salmon.

2. Research on post-smolts in the early marine phase should be continued and expanded. This should include studies of interactions with parasites and assessments of the impact of sea lice on post-smolts.

3. A Study Group is required to quantitatively assess the level of bycatches of post-smolts in pelagic fisheries. It is recommended that such a group should comprise both those with information relating to postsmolt distribution and those who can provide information on the activity and distribution of pelagic fisheries.

4. A coordinated programme of tagging and release of farmed salmon should be undertaken to improve knowledge on the marine survival and migratory behaviour of these fish

If the commercial fishery at Faroes recommences, it is recommended that biological samples from the salmon caught should be collected. Historical samples from this fishery which have not yet been worked up should continue to be analysed.

Table 3.3.3.1 Numbers of gear units licensed or authorised by country and gear type.

Year	England & Wales					UK (Scotland)		UK (N. Ireland)			Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Rod & Line[1]	Fixed engine[2]	Net and coble[3]	Driftnet	Draftnet	Bagnets and boxes	Bagnet	Bendnet	Liftnet	Driftnet (No. nets)
1966	-	-	-	-	-	3,513	861	-	-	-	7,101	-	55	-
1967	-	-	-	-	-	2,982	836	-	-	-	7,106	2,827	48	11,498
1968	-	-	-	-	-	3,495	970	-	-	-	6,588	2,613	36	9,149
1969	-	-	-	-	-	3,239	849	139	311	17	6,012	2,756	32	8,956
1970	-	-	-	-	-	2,861	775	138	306	17	5,476	2,548	32	7,932
1971	-	-	-	-	-	3,069	802	142	305	18	4,608	2,421	26	8,976
1972	-	-	-	-	-	3,437	810	130	307	18	4,215	2,367	24	13,448
1973	-	-	-	-	-	3,241	884	130	303	20	4,047	2,996	32	18,616
1974	-	-	-	-	-	3,182	777	129	307	18	3,382	3,342	29	14,078
1975	-	-	-	-	-	2,978	768	127	314	20	3,150	3,549	25	15,968
1976	-	-	-	-	-	2,854	756	126	287	18	2,569	3,890	22	17,794
1977	-	-	-	-	-	2,742	677	126	293	19	2,680	4,047	26	30,201
1978	-	-	-	-	-	2,572	691	126	284	18	1,980	3,976	12	23,301
1979	-	-	-	-	-	2,698	747	126	274	20	1,835	5,001	17	23,989
1980	-	-	-	-	-	2,892	670	125	258	20	2,118	4,922	20	25,652
1981	-	-	-	-	-	2,704	647	123	239	19	2,060	5,546	19	24,081
1982	-	-	-	-	-	2,377	641	123	221	18	1,843	5,217	27	22,520
1983	232	209	333	74	-	2,514	659	120	207	17	1,735	5,428	21	21,813
1984	226	223	354	74	-	2,438	630	121	192	19	1,697	5,386	35	21,210
1985	223	230	375	69	-	1,999	524	122	168	19	1,726	5,848	34	20,329
1986	220	221	368	64	-	1,976	583	121	148	18	1,630	5,979	14	17,945
1987	213	206	352	68	-	1,693	571	120	119	18	1,422	6,060	13	17,234
1988	210	212	284	70	-	1,536	390	115	113	18	1,322	5,702	11	15,532
1989	201	199	282	75	-	1,224	347	117	108	19	1,888	4,100	16	0
1990	200	204	292	69	-	1,276	334	114	106	17	2,375	3,890	7	0
1991	199	187	264	66	-	1,144	306	118	102	18	2,343	3,628	8	0
1992	203	158	267	65	-	857	296	121	91	19	2,268	3,342	5	0
1993	187	151	259	55	-	909	266	120	73	18	2,869	2,783	-	0
1994	177	158	257	53	293,759	753	245	119	68	18	2,630	2,825	-	0
1995	163	156	249	47	243,288	737	226	122	68	16	2,542	2,715	-	0
1996	151	132	232	42	231,744	614	203	117	66	12	2,280	2,860	-	0
1997	139	131	231	35	269,705	671	196	116	63	12	2,002	1,075	-	0
1998	130	129	196	35	233,401	537	151	117	70	12	1,865	1,027	-	0
1999	120	109	178	30	185,502	355	109	113	52	11	1,649	989	-	0
2000	110	101	150	28	174,690	185	89	109	57	10	1,577	982	-	0
Mean 1995-99	141	131	217	38	232728	583	177	117	64	13	2068	1733		
% change [4]	-21.8	-23.1	-30.9	-25.9	-24.9	-68.3	-49.7	-6.8	-10.7	-20.6	-23.7	-43.3		
Mean 1990-99	167	152	243	50	242900	785	233	118	76	15	2282	2513		
% change [4]	-34.1	-33.3	-38.1	-43.7	-28.1	-76.4	-61.8	-7.4	-24.9	-34.6	-30.9	-60.9		

1 Total number of rods days fished, data for 1999 is provisional.

2 Number of gear units expressed as trap or crew months.

3 Number of gear units expressed as trap months.

2 (2000/mean - 1) * 100

Table 3.3.3.1 continued Number of gear units licensed or authorised by country and gear type.

	Ireland				Finland				France		
					The Teno River			R. Näätämö			
	Driftnets No.	Draftnets	Other nets Commercial	Rod	Recreational fishery Tourist anglers		Local rod and net fishery	Recreational fishery	Rod and line licences	Com. nets in freshwater[4]	Licences in estuary[4,5]
Year					Fishing days	Fishermen	Fishermen	Fishermen			
1966	510	742	214	11,621	-	-	-	-	-	-	-
1967	531	732	223	10,457	-	-	-	-	-	-	-
1968	505	681	219	9,615	-	-	-	-	-	-	-
1969	669	665	220	10,450	-	-	-	-	-	-	-
1970	817	667	241	11,181	-	-	-	-	-	-	-
1971	916	697	213	10,566	-	-	-	-	-	-	-
1972	1,156	678	197	9,612	-	-	-	-	-	-	-
1973	1,112	713	224	11,660	-	-	-	-	-	-	-
1974	1,048	681	211	12,845	-	-	-	-	-	-	-
1975	1,046	672	212	13,142	-	-	-	-	-	-	-
1976	1,047	677	225	14,139	-	-	-	-	-	-	-
1977	997	650	211	11,721	-	-	-	-	-	-	-
1978	1,007	608	209	13,327	-	-	-	-	-	-	-
1979	924	657	240	12,726	-	-	-	-	-	-	-
1980	959	601	195	15,864	-	-	-	-	-	-	-
1981	878	601	195	15,519	16,859	5,742	677	467	-	-	-
1982	830	560	192	15,697	19,690	7,002	693	484	4,145	55	82
1983	801	526	190	16,737	20,363	7,053	740	587	3,856	49	82
1984	819	515	194	14,878	21,149	7,665	737	677	3,911	42	82
1985	827	526	190	15,929	21,742	7,575	740	866	4,443	40	82
1986	768	507	183	17,977	21,482	7,404	702	691	5,919	58 [1]	86
1987	-	-	-	-	22,487	7,759	754	689	5,804 [1]	87 [2]	80
1988	836	-	-	11,539	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	16,484	24,118	8,681	742	696	3,826	83	78
1990	756	525	189	15,395	19,596	7,677	728	614	2,977	71	76
1991	707	504	182	15,178	22,922	8,286	734	718	2,760	78	71
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71
1993	673	457	161	23,875	29,461	10,198	755	705	2,111	53	55
1994	732	494	176	24,988	26,517	8,985	751	671	1,680	17	59
1995	768	512	164	27,056	24,951	8,141	687	716	1,881	17	59
1996	778	523	170	29,759	17,625	5,743	672	814	1,806	21	69
1997	852	531	172	31,873	16,255	5,036	616	588	2,974	10	59
1998	874	513	174	31,565	18,700	5,759	621	673	2,358	16	63
1999	874	499	162	32,493	22,935	6,857	616	850	2,232	15	61
2000	871	490	158	33,527	28,385	8,275	633	624	2,745 [3]	16	35
Mean 1995-99	829	516	168	30549	20093	6307	642	728	2250	16	62
% change [6]	5.0	-5.0	-6.2	9.7	41.3	31.2	-1.5	-14.3	22.0	0.0	-43.7
Mean 1990-99	771	509	173	25245	22571	7574	693	722	2294	36	64
% change [6]	13.0	-3.8	-8.8	32.8	25.8	9.3	-8.6	-13.6	19.7	-54.9	-45.6

[1] Common licence for salmon and seatrout introduced in 1986 leading to a short-term increase in the number of licences issued.

[2] Since 1987 fishermen have been obliged to declare their catches.

[3] This figure is an estimate from a sample of anglers, the sea trout and salmon angling licenses being common since 2000

[4] The number of licences, 1999 included, indicates only the number of fishermen (or boats allowed to fish for salmon. It overestimates the actual number of fishermen fishing for salmon up to 2 or 3 times.

[5] Adour estuary only southwest of France.

[6] (2000/mean - 1) * 100

Table 3.3.4.1 Nominal catch of SALMON in NEAC Area (in tonnes round fresh weight), 1960-2000
(2000 figures are provisional)

Year	Homewater countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches NEAC Area	Unreported catches International waters (2)
1960	5540	-	-	5540	-	-
1961	4753	-	-	4753	-	-
1962	6709	-	-	6709	-	-
1963	6276	-	-	6276	-	-
1964	7150	-	-	7150	-	-
1965	6456	-	-	6456	-	-
1966	6052	-	-	6052	-	-
1967	7526	-	-	7526	-	-
1968	6146	5	403	6554	-	-
1969	6281	7	893	7181	-	-
1970	5882	12	922	6816	-	-
1971	5582	-	471	6053	-	-
1972	6597	9	486	7092	-	-
1973	7331	28	533	7892	-	-
1974	7027	20	373	7420	-	-
1975	7116	28	475	7619	-	-
1976	5314	40	289	5643	-	-
1977	5209	40	192	5441	-	-
1978	4966	37	138	5141	-	-
1979	5121	119	193	5433	-	-
1980	5434	536	277	6247	-	-
1981	4909	1025	313	6247	-	-
1982	4471	606	437	5514	-	-
1983	5873	678	466	7017	-	-
1984	4769	628	101	5498	-	-
1985	5533	566	-	6099	-	-
1986	6183	530	-	6713	-	-
1987	4830	576	-	5406	2554	-
1988	5284	243	-	5527	3087	-
1989	4059	364	-	4423	2103	-
1990	3420	315	-	3735	1779	180-350
1991	2822	95	-	2917	1555	25-100
1992	3343	23	-	3366	1825	25-100
1993	3311	23	-	3334	1471	25-100
1994	3563	6	-	3569	1157	25-100
1995	3277	5	-	3282	942	n/a
1996	2750	-	-	2750	947	n/a
1997	2074	-	-	2074	827	n/a
1998	2222	6	-	2228	1108	n/a
1999	2074	-	-	2074	877	n/a
2000	2633	-	-	2633	1135	n/a
Means 1995-1999	2479	6	-	2482	940	-

Table 3.3.5.1 CPUE for salmon rod fisheries in Finland (Teno, Naatamo), France,the River Bush (UK(N.Ireland)).

	Finland (Teno River)		Finland (Naatamo River)		France	UK(N.Ire.)(R.Bush)
	Catch per angler season	Catch per angler day	Catch per angler season	Catch per angler day	Catch per angler season	Catch per rod day
Year	kg	kg	kg	kg	Number	Number
1974		2.8				
1975		2.7				
1976		-				
1977		1.4				
1978		1.1				
1979		0.9				
1980		1.1				
1981	3.2	1.2				
1982	3.4	1.1				
1983	3.4	1.2				0.248
1984	2.2	0.8	0.5	0.2		0.083
1985	2.7	0.9	n/a	n/a		0.283
1986	2.1	0.7	n/a	n/a		0.274
1987	2.3	0.8	n/a	n/a	0.39	0.194
1988	1.9	0.7	0.5	0.2	0.73	0.165
1989	2.2	0.8	1.0	0.4	0.55	0.135
1990	2.8	1.1	0.7	0.3	0.71	0.247
1991	3.4	1.2	1.3	0.5	0.60	0.396
1992	4.5	1.5	1.4	0.3	0.94	0.258
1993	3.9	1.3	0.4	0.2	0.88	0.341
1994	2.4	0.8	0.6	0.2	2.31	0.205
1995	2.7	0.9	0.5	0.1	1.15	0.206
1996	3.0	1.0	0.7	0.2	1.57	0.267
1997	3.4	1.0	1.1	0.2	0.43 [1]	0.338
1998	3.0	0.9	1.3	0.3	0.67	0.569
1999	3.7	1.1	0.8	0.2	0.76	0.273
2000	5.0	1.5	0.9	0.2	0.79	0.259
Mean 1995-99	3.2	1.0	0.9	0.2	0.90	0.331

[1] Large numbers of new, inexperienced anglers in 1997 because cheaper licence types were introduced.

Table 3.3.5.2 CPUE for salmon rod fisheries in the Barent Sea and White Sea basin in Russia.

	Barents Sea Basin, catch per angler day				White Sea Basin, catch per angler day			
Year	Rynda	Kharlovka	Varzina	Iokanga	Ponoy	Varzuga	Kitsa	Umba
1991					2.794	1.870		1.330
1992	2.370	1.454	1.070	0.135	3.489	2.261	1.209	1.366
1993	1.177	1.464	0.488	0.650	2.881	1.278	1.425	2.720
1994	0.710	0.847	0.548	0.325	2.332	1.596	1.588	1.436
1995	0.486	0.782	1.220	0.718	3.459	2.524	1.784	1.196
1996	0.703	0.845	1.502	1.398	3.503	1.444	1.761	0.930
1997	1.197	0.709	0.613	1.411	5.330	2.364	2.482	1.457
1998	1.010	0.551	0.441	0.868	4.544	2.284	2.784	0.979
1999	0.947	0.642	0.427	1.193	3.300	1.710	1.657	0.756
2000	1.348	0.769	0.565	2.283	3.494	1.526	3.018	1.245
Mean 1995-99	0.869	0.706	0.841	1.118	4.027	2.065	2.094	1.064

Table 3.3.5.3 CPUE data for net and fixed engine salmon fisheries by Region in UK (England and Wales), 1988-2000. (Data expressed as catch per licence-day and catch per licence-tide for Midlands, Wales and North West.)

	Region					
Year	North East	Southern	South West	Midlands[1,2]	Wales[2]	North West[2]
1988	5.49	10.15			-	-
1989	4.39	16.80			0.90	0.82
1990	5.53	8.56			0.78	0.63
1991	3.20	6.40			0.62	0.51
1992	3.83	5.00			0.69	0.40
1993	6.43	No fishing			0.68	0.63
1994	7.53	-			1.02	0.71
1995	7.84	-			1.00	0.79
1996	3.74	-			0.73	0.59
1997	5.30	-	0.59		0.77	0.35
1998	5.12	-	0.78	0.25	0.69	0.32
1999	7.28	-	0.67	0.36	0.83	0.37
2000	11.10	-	0.96	0.43	0.40	0.64
Mean 1995-99	5.86	-			0.80	0.48

[1]Seine nets and lave nets only

[2] Catch per liceence tide

Table 3.3.5.4 CPUE data for Scottish net fisheries.
Catch in numbers of fish per unit effort.

Year	Fixed engine	Net and coble CPUE
	Catch/trap month [1]	Catch/crew month
1952	33.91	156.39
1953	33.12	121.73
1954	29.33	162.00
1955	37.09	201.76
1956	25.71	117.48
1957	32.58	178.70
1958	48.36	170.39
1959	33.30	159.34
1960	30.67	177.80
1961	31.00	155.17
1962	43.89	242.00
1963	44.25	182.86
1964	57.92	247.11
1965	43.67	188.61
1966	44.86	210.59
1967	72.57	329.80
1968	46.99	198.47
1969	65.51	327.64
1970	50.28	241.91
1971	57.19	231.61
1972	57.49	248.04
1973	73.74	240.60
1974	63.42	257.11
1975	53.63	235.71
1976	42.88	150.79
1977	45.58	188.67
1978	53.93	196.07
1979	42.20	157.19
1980	37.65	158.62
1981	49.60	183.86
1982	62.26	181.89
1983	56.20	206.83
1984	58.98	160.98
1985	54.48	156.55
1986	75.93	204.87
1987	64.34	147.14
1988	51.91	204.53
1989	71.68	268.78
1990	33.31	148.37
1991	35.62	100.44
1992	59.10	151.85
1993	52.29	124.06
1994	93.23	123.40
1995	75.03	139.72
1996	60.51	110.93
1997	33.95	56.27
1998	36.75	65.54
1999	24.30	69.70
2000	38.80	86.90
Mean 1995-99	46.11	88.43

[1] - Excludes catch and effort for Solway Region

Table 3.3.5.5 Catch per unit effort for the marine fishery in Norway. The CPUE is expressed as number of salmon caught per net day in Bagnets and Bendnets devided by salmon wight.

	Bagnet			Bendnet		
Year	**< 3kg**	**3-7 kg**	**>7 kg**	**< 3kg**	**3-7 kg**	**>7 kg**
1998	0.88	0.66	0.12	0.80	0.56	0.13
1999	1.16	0.72	0.16	0.75	0.67	0.17
2000	2.01	0.90	0.17	1.24	0.87	0.17

Table 3.3.5.6 Fisheries in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations) (p <0.1 means significance upward trend, p>0.9 means significant downward trend).

Section/Data type	Life stage	Period (years)	Fisheries	'p' value	Trend
Section 3.3.5					
CPUE		10	UK (Scotland) net fisheries. Catch/trap month	0.99	**Dn**
		10	UK (England & Wales) net and fixed engines. Catch per licence-day	0.07	**Up**
		10	Finland (Teno, Näätämö) and France. Rod catch/season,	0.37	Nt
		10	Finland (Teno, Näätämö) and UK (N Ireland) (Bush). Rod catch/day	0.72	Nt
		9	Russia (Barents Sea basin: Rynda, Kharlovka, Varzina, Iokanga). Rod catch/day	0.83	Nt
		10	Russia (White Sea basin: Ponoy, Varzuga, Kitsa, Umba). Rod catch/day	0.03	**Up**
Section 3.3.9					
Exploitation rates	1 SW	10	Burrishoole + Delphi + Screebe + Shannon + Bunowen + Corrib (Ire), Dee (UK (E&W)), North Esk (UK (Scot)), Bush (UK (NI)), Imsa + Drammen (Nor), Ellidaar + Blandar (Ice), Lagan (Swe)	0.16	Nt
	1 SW	5	Burrishoole + Delphi + Screebe + Shannon + Bunowen + Corrib (Ire), Dee (UK (E&W)), North Esk (UK (Scot)), Bush (UK (NI)), Imsa + Drammen (Nor), Ellidaar + Blandar + Vesturdalsa (Ice), Lagan (Swe)	0.33	Nt
	2 SW	10	Corrib (Irl), North Esk (UK Scot), Dee (UK (NI)), Imsa + Drammen (Nor), Blanda (Ice), Lagan (Swe)	1	**Dn**
	2 SW	5	Corrib (Irl), North Esk (UK Scot), Dee (UK (NI)), Imsa + Drammen (Nor), Blanda + Vesturdalsa (Ice), Lagan (Swe)	0.86	Nt
	All ages	10	B.Z.Litsa, Ura, Tuloma, Kola (Russia, Barents Sea basin)	0.99	**Dn**
		5		0.46	Nt
	All ages	10	Ponoy, Kitsa,Varzuga, Umba (Russia, White Sea basin)	0.99	**Dn**
		5		0.94	**Dn**

Table 3.3.6.1 The percent of 1SW salmon in catches from countries in the North East Atlantic Commission, 1987-2000.

Year	Finland	France	Iceland	Norway	Russia	Sweden	UK (Scot)	UK (E&W) (1)
1987	66	77		61	71		61	
1988	63	29		64	53		57	
1989	66	33		73	73	41	63	
1990	64	45		68	73	70	48	
1991	59	39		65	70	71	53	
1992	70	48		62	72	68	55	77
1993	58	74		61	61	62	57	78
1994	55	55	64	-	69	65	54	77
1995	59	60	72	58	70	78	53	72
1996	80	51	74	53	80	63	54	65
1997	70	51	73	64	82	54	54	73
1998	75	71	82	66	82	59	58	83
1999	81	27	71	65	78	71	43	70
2000	67	58	84	67	75	69	48	79
Means								
1995-99	73	52	74	62	78	65	52	73
1990-99	67	52	73	62	74	66	53	74

1. Refers to rod and line catches only.

Table 3.3.7.1 Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic (figures for 2000 include provisional values).

Country	Catches of Salmon						
	Year/Season	Wild	FW Farmed	SEA Farmed	Total Farmed	Ranched	Total
Norway	1989	707	29	166	195	3	905
	1990	709.8	29	185	214	6.2	930
	1991	682.5	20	169	189	5.5	877
	1992	653.7	27	176	203	10.3	867
	1993	707	18	191	209	7	923
	1994	781	18	187	205	10	996
	1995	654	13	170	183	2	839
	1996	557	19	203	222	8	787
	1997	430	21	177	198	2	630
	1998	530	29	180	209	1	740
	1999	612	20	178	198	1	811
	2000	940	34	201	235	1	1176
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
	1992/1993	16.1			5.9	0	22
	1993/1994	5.8			1.2	0	7
	1994/1995	4.8			1.2	0	6
	1995/1996	0.8			0.2	0	1
	1996/1997	0			0	0	0
	1997/1998 [5]	-			-	-	6
	1998/1999	0			0	0	0
	1999/2000 [5]	-			-	-	8
	200072001	-			-	-	-
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
	1993	70			<1	0	70
	1994	49			<1	0	49
	1995	48			<1	0	48
	1996	44			<1	0	44
	1997	45			<1	0	45
	1998	48			<1	0	48
	1999	63			<1	0	63
	2000	95			<1	0	95
France	1991	13			0	0	13
	1992	20			0	0	20
	1993	16			0	0	16
	1994	18			0	0	18
	1995	9			0	0	9
	1996	14			0	0	14
	1997	8			0	0	8
	1998	9			0	0	9
	1999	11			0	0	11
	2000	11			0	0	11
Iceland[1]	1991	130			3	345	478
	1992	175			+	460	635
	1993	160			-	496	656
	1994	140			-	308	448
	1995	150			-	298	448
	1996	122			-	239	361
	1997	106			-	50	156
	1998	130			-	34	164
	1999	119			-	26	145
	2000	82			-	2	84
Ireland[2]	1991	400			1.7	2.3	404
	1992	620			3.8	6.7	630
	1993	531			1.9	8.1	541
	1994	789			2.6	12.5	804
	1995	774			0.7	14.8	790
	1996	668			0.7	15.9	685

Table 3.3.7.1 (continued). Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic (figures for 2000 include provisional values).

Country	Catches of Salmon						
	Year/Season	Wild	FW Farmed	SEA Farmed	Total Farmed	Ranched	Total
Ireland continued	1997	565			1.7	2.9	570
	1998	615			1.1	7.5	624
	1999	509			2.1	3.6	515
	2000	617			1.1	3.3	621
Russia	1991	215			0	0	215
	1992	167			0	0	167
	1993	139			0	0	139
	1994	141			0	0	141
	1995	128			0	0	128
	1996	131			0	0	131
	1997	111			0	0	111
	1998	131			0	0	131
	1999	102			0	0	102
	2000	124			0	0	124
Sweden	1991	23			1	14[3]	38
	1992	24			1	24[3]	49
	1993	35			1	20[3]	56
	1994	15			1	29[3]	44
	1995	12			1	24[3]	37
	1996	10			1	22[3]	33
	1997	9			0	10[3]	19
	1998	9			0	6[3]	15
	1999	8			0	8[3]	16
	2000	12			0	21[3]	33
UK (E&W)	1991	200			0	0	200
	1992	186			0	0	186
	1993	263			0	0	263
	1994	307			0	0	307
	1995	295			0	0	295
	1996	183			0	0	180
	1997	142			0	0	142
	1998	123			0	0	125
	1999	150			0	0	152
	2000	214			0	0	214
UK (N.Ire)	1991	54			<1	-	55
	1992	85.3			1.1	2.6	89
	1993	80.5			0.2	2.3	83
	1994	90.1			0.5	0.4	91
	1995	80.6			1.5	0.9	83
	1996	74.7			n/a	2.3	77
	1997	90.7			0.07	2.2	93
	1998	76.6			0.03	1.0	78
	1999	50.9			0.67	1.4	53
	2000	75			??	2.5	78
UK (Scot)[4]	1991	448			14	0	462
	1992	569			31	0	600
	1993	516			31	0	547
	1994	644			5	0	649
	1995	586			2	0	588
	1996	427			<1	0	427
	1997	296			<1	0	296
	1998	283			<1	0	283
	1999	198			1	0	199
	2000	191			1	0	192

1. "+" indicates a small but unquantified catch. **2.** Smolts released for enhancement of stocks or rod fisheries are categorised as wild
3. Fish released for mitigation purposes and not expected to contribute to natural spawning.
4. Data from 1994 onwards is the figure reported in national catch statistics, previous years' data have been calculated from a sampling programme. **5.** Breakdown of the 1997/1998 & 199/2000 catches not available.

Table 3.3.7.2 Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989- 2000. n = number of salmon examined.

	Coast				Fjords			
Year	n	No. localities	%	Range	n	No. localities	%	Range
1989	1217	7	45	7 - 66	803	4	14	8 – 29
1990	2481	9	48	16 - 64	940	5	15	6 – 36
1991*	1245	6	49	29 - 63	336	3	10	6 – 16
1992	1162	7	44	4 - 72	307	1	21	–
1993	1477	7	47	1 - 60	520	4	20	7 – 47
1994	1087	7	34	2 - 62	615	4	19	2 – 42
1995	976	7	42	2 - 57	745	4	17	2 – 47
1996*	1183	6	54	35 - 68	678	4	16	3 – 22
1997	2046	8	47	7 - 68	793	5	42	15 – 85
1998	1194	8	45	6 - 61	1152	5	43	9 – 91
1999	1351	8	35	20 - 59	872	5	41	2 – 85
2000	1996	9	31	8 - 68	1291	7	31	2 - 80

* In 1991 and 1996 the coastal results do not include the locality in Finnmark.

Table 3.3.7.3 Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June–18 August) and brood stock catches (18 August–30 November) in Norway in 1989– 2000. (n = number of salmon examined; R= number of rivers sampled).

	1 June–18 August				**18 August–30 November**			
Year	**n**	**R**	**%**	**Range**	**n**	**R**	**%**	**Range**
1989	5970	39	7	0 – 26	1892	19	35	2 - 77
1990	5380	39	7	0 – 55	2144	24	34	2 - 82
1991	4563	31	5	0 – 23	1799	26	24	0 - 82
1992	4259	32	5	0 – 24	1489	22	26	0 - 71
1993	4070	29	5	0 – 22	1213	21	22	0 – 75
1994	3243	18	4	0 – 19	1699	19	22	0 – 75
1995*	3480	26	5	0 – 20	1279	19	29	0 – 71
1996*	3020	29	7	0 – 54	1443	23	31	0 – 82
1997*	2747	30	9	0 – 34	1892	36	29	0 – 83
1998*	4161	33	9	0 – 46	1546	26	22	0 – 97
1999*	5003	34	6	0 – 29	1755	23	15	0 – 53
2000*	5036	32	7	0- 48	1835	31	8	0-37

* From 1995 onward the results are presented for the two periods separated at 31 August.

Table 3.3.7.4 Proportions of escaped farmed Atlantic salmon in 1987 – 2000 in the River Teno (Finland, Norway) during the fishing season (June-August) and after the season (September-October).

	Fishing season (June-August)			After season (September-October)		
Year	samples (n)	farmed fish (n)	farmed fish (%)	samples (n)	farmed fish (n)	farmed fish (%)
1987	1430	1	0.07			
1988	1026	1	0.10			
1989	2096	5	0.24			
1990	2467	11	0.45	19	10	47.3
1991	3146	11	0.35	7	4	37.5
1992	3748	2	0.05			
1993	2413	1	0.04			
1994	1529	6	0.39			
1995	1604	5	0.31			
1996	2173	3	0.14	8	1	12.5
1997	3881	7	0.18	28	0	0.0
1998	3722	10	0.27			
1999	6243	10	0.16			
2000	3448	5	0.15			

Table 3.3.7.5 Salmon farm escapees in R. Bush (UK, N.Ireland) based on trapping of the total run throughout the year. (Note: 1994 data includes 14 escapees entering in January 1995).

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Total run (excl. ranched)	2344	2570	3253	2064	1527	1099	1681	2961	959	950
No. escapees	3	24	18	54	6	2	4	6	5	4
% in sample	0.13	0.93	0.55	2.62	0.39	0.18	0.24	0.20	0.5	0.3

Table 3.3.7.6 Geographical distribution by frequency (%) of escaped farmed fish located among commercial catch samples for UK (Northern Ireland) and Ireland inshore catches (1991–2000).

	Frequency (%)									
Location	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Northern Ireland (UK)	-	3.72	0.26	1.18	4.03	-	0.14	0.2	1.9	3.1
Donegal	0.00	0.02	0.09	0.14	0.02	0.34	0.03	0.01	0.04	0.002
Mayo	1.16	1.69	0.27	0.10	0.14	0.25	0.27	0.17	0.79	0.62
Galway	0.39	0.10	0.06	0.08	0.03	0.00	0.06	0.10	0.51	2.16
S. West	0.00	0.01	1.05	1.08	0.19	0.42	0.47	1.10	0.69	0.05
S. and East	-	-	-	-	-	0.00	-	-	-	0.16

Table 3.3.7.7 Frequency of occurrence of escaped farmed salmon (detected by morphological characters and/or scales growth patterns) among Scottish fisheries for wild salmon (1981–2000).

Year	Nets											Rods				
	East Riggs %	Red-point %	Achiltibuie %	Culkein Clachtol %	Strathy %	Bonar %	Spey %	Dee %	N. Esk %	Tay %	Tweed %	Laxford %	Annan %	Cree %	N. Esk %	Dionard %
1981	0				0	0	0		0							
1982	0				0.3	0	0	0	0	0	0					
1983	0				0	0	0	0	0	0	0					
1984	0				0	0	0	0	0	0	0					
1985	0			0	0	0	0	0	0	0	0				0	
1986				0.6	0	0	0	0	0	0	0				0	
1987	0			1.3	0	0	0		0	0	0				0	
1988				1.5	0.6	0	0		0	0	0				0	
1989				6.6	6.1	0.7	0.08		0	0	0				0	
1990		*22		4.7	3.8	0	0		0	0	0.13				0	
1991		19.8		8.6	7.3	0.4	0.14		0.13	0	0				0	
1992		18.5		3.5	2.3	0.5	0		0	0.13	0				0.16	
1993		37.5		14.4	15.2	0.7			0	0	0				0.15	
1994				7.7	7.1	0.6			0	0.18	0.4				0.3	
1995		14.5	4.2		4.1				0	0	0				0	
1996		4.84	6.9		3.4				0	0	0				0	
1997		0	0		2.1				0			0.2			0	
1998			3.45	2.8	0.5				0.05		0	0.0			0.35	
1999					2.76				0.14		0	0.0			0	
2000					2.6				0.05		0	9.4	0	1.9	0	0

* Carotenoid pigment analysis.

Table 3.3.9.1 Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Ireland)

	Ireland[1]											
	Lee	Shannon	CorCong	CorGal	Screebe	Delphi	Burrishoole	Bunowen	Eme	Moy	Corrib	
	All types of gear										net	net
Year	HR 1SW	HR 1SW	HR 1SW	HR 1SW	HR 1SW	HR 1SW	HR 1SW	HR 1SW	HR 1SW	W 1SW	W 1SW	W 2SW
1980	96	94	73	-	-	-	63	-	-	-	82	82
1981	91	96	53	-	-	-	85	-	-	-	95	45
1982	94	96	50	67	-	-	83	-	-	-	62	37
1983	84	97	67	84	-	-	84	-	-	-	59	31
1984	100	98	67	84	99	-	87	-	90	-	79	54
1985	98	98	44	50	100	-	86	-	96	-	68	37
1986	99	97	-	78	100	-	79	-	83	-	-	-
1987	92	98	-	59	100	-	74	-	85	-	54	56
1988	99	96	59	-	95	-	80	-	91	-	62	66
1989	88	94	53	76	96	-	76	-	85	-	54	23
1990	80	79	53	42	0	-	63	-	70	68	41	52
1991	99	86	60	68	96	92	83	-	94	85	40	60
1992	-	84	59	67	86	75	77	86	-	64	52	-
1993	-	89	62		98	74	73	90	-	95	60	16
1994	-	90	-	55	98	90	88	100	-	-	62	52
1995	-	91	57	-	93	76	58	99	-	-	66	100
1996	-	88	-	-	64	68	75	99	-	-	49	62
1997	90	83	-	-	78	68	68	94	83	-	60	16
1998	92	95	18	32	92	95	82	98	100	-	38	11
1999	-	100	-	20	67	79	85	100	79	-	43	-
2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mean												
1989-98	90	89	52	47	77	80	75	96	85	78	51	46
1994-98	91	91	38	26	79	77	74	98	87		51	47

[1] Estimate based on microtag recoveries raised to total catch and including estimate of non-catch fishing mortality.
[2] Estimate based on counter and catch figures.
[3] Provisional figures.

HR = Hatchery reared.
W = Wild.
'-' = no data

Continued……

Table 3.3.9.1 Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (UK)

	UK (England and Wales)													UK (Northern Ireland) [1]					UK (Scotland)[2]			
	Sothern		Southwestern			Welsh				Northwestern												
	Test	Itchen	Frome	Tamar	Fowey	Dee	Dee	Dee	Taff	Leven	Kent	Lune	Lune	River Bush					North Esk			
	rod	rod	rod	rod	rod	rod	rod	nets	rod	rod	rod	rod	net	net	net	net	net	net				
Year	W/H	W	W	W	W	W	W	W	H	W	W	W	W	W	W/HR		HR1+	HR2+	W	W	W	W
	(all ages)		(all ages)			1SW	MSW	(all ages)		(all ages)				1SW	2SW		1SW	1SW	1SW	2SW	1 SW	2 SW
1981	-	-	-			-	-	-	-	-			-	-	-		-	-	24	58	1	4
1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	30	48	1	9
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	16	32	1	14
1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	29	42	2	15
1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		93	-	24	35	2	19
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		82	75	43	30	3	21
1987	-	-	-	-	-	-	-	-	-	-	-	-	-	69	46		94	77	30	38	3	23
1988	39	-	10	-	-	-	-	-	-	-	-	-	-	65	36		72	57	35	37	3	27
1989	29	45	8	-	-	-	-	-	-	-	-	-	44	89	60		92	83	25	26	4	18
1990	36	51	11	-	-	-	-	-	-	-	-	-	36	61	38		63	70	36	34	6	29
1991	26	45	9	-	-	-	-	-	-	-	-	-	30	65	43		57	46	10	15	2	37
1992	25	27	11	-	-	14	18	15	5	-	-	23	30	56	33		74	75	28	27	7	28
1993	26	41	12	-	-	11	15	11	6	-	-	16	30	41	12		67	71	25	18	10	21
1994	25	44	14	13	-	15	21	22	5	-	-	29	35	-	40		71	64	18	18	5	24
1995	23	21	9	7	11	7	11	18	4	35	35	17	27	67	42		69	-	14	12	4	21
1996	19	47	13	7	8	9	11	17	3	21	31	17	24	-	-		81	77	19	10	4	32
1997	12	22	6	5	8	8	9	17	1	58	50	18	29	60	-		79	75	12	12	5	18
1998	18	18	6	6	7	10	10	15	-	43	65	12	14	26	-		-	32	23	12	5	20
1999	10	13	n/a	4	3	11	9	21	12	2	15	12	14	63	-		68	51	18	14	2	14
2000 [3]	9	9	n/a	4	5	6	17	14	n/a	2	16	8	15	55	-		75	67	33	24	1	20
Mean																						
1990 - 99	22	33	10	7	7	10	13	17	5	-	-	17	27	55	35		70	62	20	17	5	24
1995 - 99	16	24	09	06	07	09	10	18	05	32	39	15	22	54	42		74	59	17	12	04	21

[1] Estimate based on microtag recoveries raised to total catch and including estimate of non-catch fishing mortality.

[2] Estimate based on counter and catch figures.

[3] Provisional figures.

HR = Hatchery reared.

W = Wild.

'-' = no data

Table 3.3.9.1 continued……..

Table 3.3.9.1 (cont'd) Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Iceland, Norway and Sweden)

	Iceland[1]					Norway[2]										Sweden[3]	
	Ellidaar	Vesturdalsa		Blanda		Nausta	Øystenså	Orkla	Drammen			Imsa				Lagan	
	rod	rod	rod						rod	net		net		net		net	
Year	W	W	W	W	W	W	W	W	W/HR	HR[4]		W		HR[4]		HR [4]	
	1SW	1 SW	2SW	1 SW	2 SW	All ages				1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW
1985	40	-	-	-	-	-	-	-	33	57	-	73	94	81	100	81	-
1986	34	-	-	74	78	-	-	-	50	81	50	79	82	78	90	93	82
1987	54	-	-	75	72	-	-	-	44	64	52	56	95	83	95	78	55
1988	45	-	-	81	84	-	-	-	53	70	47	51	80	78	91	73	91
1989	41	-	-	72	73	-	-	-	35	40	59	65	74	44	65	76	86
1990	41	-	-	81	81	-	-	-	33	23	40	42	42	47	68	80	82
1991	37	-	-	75	86	-	-	-	28	54	59	37	72	50	66	91	92
1992	48	-	-	46	68	-	-	-	46	-	51	61	76	74	91	73	98
1993	41	-	-	57	64	-	-	-	45	20	-	53	80	85	89	89	82
1994	49	-	-	49	68	-	-	15	42	42	34	58	80	70	94	70	100
1995	43	-	-	53	90	-	-	-	53	29	40	-	86	56	88	58	70
1996	56	61	71	54	59	-	-	9	47	7	23	66	-	80	89	64	78
1997	50	60	80	40	63	-	9	12	44	15	23	58	80	67	-	55	58
1998	55	68	81	50	48	24	19	23	36	21	33	10	33	10	66	83	66
1999	48	55	69	40	55	16	22	22	42	5	0	0	-	19	-	49	17
2000	46	84	65	37	67	34	27	23	35	26	27	28	-	16	33	46	-
Mean																	
1990 - 99	47	61	75	55	68	20	17	16	42	24	34	43	69	56	81	71	74
1995 - 99	50	61	75	47	63	20	17	17	44	15	24	34	66	46	81	62	58

[1]Estimate based on counter and catch figures.
[2]Estimates based on counter catch figures.
[3]Estimate based on external tag recoveries and before 1994 on assumed 50% exploitation in the river brood stock fishery and in 1994-96 on mark-recovery estimates.
[4]HR in R. Drammen, R. Imsa and R. Lagan are pooled groups of 1+ and 2+ smolts.
[5]Provisional figures.
[6]Net only.
W = Wild
HR = Hatchery reared.
'-' = no data

Reporting rates for external tags:

Norway	0.50
Sweden	0.65
Elsewhere	0.50

Continued..........

Table 3.3.9.1 (cont'd) Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic (Sweden and Russia)

	Russia[1,6] Barents sea basin				Russia[1,6] White sea basin			
	B.Z.Litsa	Ura	Tuloma	Kola	Ponoi	Kitsa	Varzuga	Umba
	net	net	net	net	net and rods	net	net	net
Year	W	W	W	W+HR	W	W	W	W
				all sea ages				
1985	48	49	47	90	47	46	39	50
1986	49	50	50	77	50	44	49	50
1987	49	49	49	91	48	35	37	35
1988	49	48	51	87	77	35	36	34
1989	49	48	50	84	78	35	37	31
1990	49	47	50	80	50	35	35	3
1991	51	48	48	58	20	32	31	13
1992	42	49	45	77	11	30	29	5
1993	48	64	39	79	10	23	27	9
1994	38	48	42	73	14	15	30	15
1995	44	45	49	77	14 [7]	22	27	8
1996	42	49	43	66	10 [7]	20	14	8
1997	30	32	16	43	19	21	12	9
1998	24	24	0	31	14	20	32	0
1999	38	39	3	0	12	18	17	0
2000	43	43	3	3	14	16	20	0
Mean								
1990 - 99	41	45	34	58	19	24	25	7
1995 - 99	36	38	22	43	15	20	20	05

[1]Estimate based on counter and catch figures.

[6]Net only.

[7] Commercial fisheries on the Ponoi were closed in 1993 and catch-and-release rod fishing was introduced.

Table 3.4.1.1 Conservation limits achievement (egg deposition/conservation limit) in rivers in the NEAC area. (Rivers ranked by mean % conservation Limit achieved over the last 10 years).

		Year																				
Country	River	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
UK (E&W)	Test										**3**	**4**	**4**	**4**	**3**	**4**	**4**	**4**	**5**	**3**	**3**	**4**
Russia	Litsa	**4**	**5**	**3**	**3**	**2**	**2**	**3**	**2**	**5**	**3**	**3**	**2**	**3**	**4**	**2**	**3**	**4**	**3**	**3**	**3**	**4**
UK (E&W)	Lune										**3**	**3**	**3**	**4**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**
Ireland	Burrishoole	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
UK (N I)	Bush	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**4**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**4**	**4**
UK (E&W)	Dee													**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
Russia	Ura	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**4**	**3**	**3**	**3**	**5**
Russia	Tuloma	**3**	**4**	**4**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
UK (E&W)	Coquet															**2**	**1**	**2**	**2**	**2**	**2**	**2**
Russia	Varzuga		**2**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**2**
Russia	Kitsa	**2**	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**	**3**	**2**	**2**	**2**	**1**	**1**
UK (E&W)	Tamar															**1**	**1**	**2**	**2**	**2**	**2**	**2**
UK (S)	North Esk		**1**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**
Farance	Nivelle					**3**	**4**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	

Percent of conservation attained: (egg deposition/conservation limit)		
	> 200	**1**
	100 - 200	**2**
	50 - 100	**3**
	25 - 50	**4**
	0 - 25	**5**
	N/A	

Table 3.4.2.1 Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East atlantic (Finland, Norway and Sweden).

Year	Finland			Norway				Sweden
	River Teno	River[1] Utsjoki	River[1] Inarijoki	River Halselva	River Imsa	River Orkla	River Stjørdalselva	River Hogvadsån
	Juvenile Survey[2]	Juvenile Survey[2]	Juvenile Survey[2]	Smolt Total count	Smolt Total count	Smolt Estimate	Smolt Estimate	Smolt Partial
1964								9,771
1965								2,610
1966								367
1967								627
1968								1,564
1969								4,742
1970								242
1971								-
1972								-
1973								1,184
1974								184
1975								363
1976								247
1977								-
1978								38
1979	27.0	96.3	19.2					103
1980	38.7	51.1	49.7					1,064
1981	19.8	52.5	23.7		3,214			500
1982	61.4	42.8	27.1		736			1,566
1983	78.5	94.8	64.0		1,287	121,000		2,982
1984	61.2	68.4	54.3		936	183,000		4,961
1985	91.6	92.6	47.0		892	173,000		4,989
1986	78.0	42.6	48.7		477	227,000		2,076
1987	67.6	77.4	51.2	878	480	238,000		3,173
1988	46.9	50.6	56.9	1,754	1,700	152,000		2,571
1989	50.1	76.2	42.9	1,465	1,194	-		882
1990	50.5	78.5	61.9	1,562	1,822	323,000		1,042
1991	49.9	24.7	64.6	2,229	1,995	243,000		1,235
1992	65.1	42.5	55.8	1,490	1,500	262,534	48,151	1,247
1993	54.2	61.0	62.1	1,058	398	297,264	69,288	1,305
1994	92.4	102.5	80.0	1,052	34	165,875	38,123	993
1995	77.7	72.4	62.0	1,128	369	174,677	37,820	1,525
1996	49.2	51.0	36.2	613	773	162,522	64,980	795
1997	42.0	65.8	54.5	1,099	1,180	225,471	73,942	703
1998	33.6	69.7	46.6	1,209	305	124,545	42,476	1,180
1999	47.0	-	66.4	362	532	159,728	58,634	979
2000	41.3	91.7	53.2	462	586	152,807	80,100	1,986
Mean 95–99	49.9	64.7	53.1	882	632	169,389	55,570	1,036

[1] Major tributary of River Teno

[2] Juvenile survey represents mean fry and parr abundance (number 100 m^2 caught by electrofishing) at 35, 10 and 12 sites respectively.

Continued.....

Table 3.4.2.2 Status of stocks in the North East Atlantic. Summary of trend analyses on smolt counts and survival based on a non-parametric method (1000 iterations). (p <0.1 means significance upw trend, p>0.9 means significant downward trend).

Type of data	Life stage	Period (years)	Rivers (Countries)	'p' value	Trend
Section 3.4.2 Smolt counts	Smolts	10	Southern rivers: Oir (Fra), Burrishoole (Irl), Bush (UK NI), North Esk, Girnock, Baddoch (UK Scot)	0.34	Nt
	Smolts	5		0.14	Nt
	Smolts	10	Northern rivers: Orkla, Halselva, Stjordalselva (Nor), Högvadsån (Swe)	0.99	**Dn**
	Smolts	5		0.64	Nt
	Smolts	10	Southern + Northern rivers + Ellidaar, Vesturdalsa (Ice).	0.98	**Dn**
	Smolts	5		0.28	Nt
Section 3.4.4 Wild smolt survival	1SW return to homewaters	10	Corrib (Irl), Bush (UK NI), Imsa (Nor), North Esk (UK Scot), Ellidaar + Midfjardara (Ice)	0.99	**Dn**
	1SW return to homewaters	5	Corrib (Irl)+Bush, Imsa (Nor), North Esk (UK Scot), Ellidaar+Midfjardara (Ice)	0.95	**Dn**
	2SW return to homewaters	10	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Midfjardara (Ice)	0.48	Nt
	2SW return to homewaters	5	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Midfjardara (Ice)	0.11	Nt
Section 3.4.4 Hatchery smolt survival	1SW return to homewaters	10	Shannon, Screebe, Delphi, Bunowen and Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe), Midfjardara (Ice)	0.98	**Dn**
	1SW return to homewaters	5	Shannon, Screebe, Delphi, Bunowen and Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe), Midfjardara (Ice)	0.74	Nt
	2SW return to homewaters	10	Midfjardara (Ice), Imsa and Drammen (Nor), Lagan (Swe)	0.99	**Dn**
	2SW return to homewaters	5	Midfjardara (Ice), Imsa and Drammen (Nor), Lagan (Swe)	0.78	Nt

Trends:
Up = significant increase
Dn = significant decrease
Nt = no trend

Table 3.4.3.1 Wild adult counts to various rivers in the North East Atlantic area (Iceland, Sweden and Russia).

Year	Iceland	Sweden	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia
	River Ellidaar	River Högvadsån	River Ura	River Kitsa	River Tuloma	River Varzuga	River Keret	River Ponoy[1]	River Kola	River Yokanga	R. Zap. Litca
	Estimate	Total trap	Total trap	Total Trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap
1952	3,792				4,800						
1953	2,526				2,950						
1954	2,794	364			4,010						
1955	4,118	210			4,600				4,855		
1956	2,911	144			4,800				2,176		
1957	2,965	126			4,300				2,949		
1958	3,057	632	983		6,228				1,771		1,051
1959	4,773	197	997		6,125				2,790		1,642
1960	4,815	209	3,293		10,360				5,030		2,915
1961	3,779	229	2,178		11,050	55,480			5,121		2,091
1962	3,126	385	1,184		10,920	69,388			5,776	3,655	2,196
1963	4,031	217	811		7,880	64,210			3,656	3,253	1,983
1964	4,526	390	787		4,400	21,424		23,666	3,268	2,642	1,664
1965	3,249	442	1,334		5,600	63,812		12,998	3,676	4,482	1,506
1966	4,274	375	925		3,648	21,086		10,333	3,218	2,488	787
1967	4,839	90	2,679		9,011	20,534		11,527	7,170	4,993	1,486
1968	3,024	172	1,996		6,277	47,258		18,352	5,008	3,357	1,971
1969	3,580	321	967		4,538	53,048		9,267	6,525	1,437	2,341
1970	2,187	610	1,792		6,175	55,556		9,822	5,416	1,117	2,048
1971	2,590	173	1,172		3,284	71,400		8,523	4,784	2,300	1,502
1972	4,627	281	1,693		6,554	48,858		10,975	8,695	1,620	1,316
1973	6,014	100	2,502	4,472	9,726	45,750		20,553	9,780	869	1,319
1974	6,925	270	1,968	3,564	12,784	39,360		24,652	15,419	280	2,605
1975	7,184	138	3,249	13,950	11,074	89,836		41,666	12,793	736	2,456
1976	3,331	65	2,110	6,996	8,060	57,246		44,283	9,360	2,767	1,325
1977	3,756	49	2,784	7,976	2,878	35,354		37,159	7,180	2,488	1,595
1978	4,372	23	1,358	4,410	3,742	18,483		24,045	5,525	1,715	766
1979	4,948	15	888	5,998	2,887	40,992		17,920	6,281	598	700
1980	2,632	260	957	2,310	4,087	43,664		15,069	7,265	1,052	548
1981	2,656	512	438	5,013	3,467	32,158		11,670	7,131	472	477
1982	4,275	572	1,205	4,158	4,252	26,824		9,585	5,898	1,200	889
1983	3,257	447	2,108	3,778	9,102	59,784		15,594	10,643	1,769	1,254
1984	1,659	629	4,458	7,498	10,971	39,636		26,330	10,970	2,498	1,859
1985	2,896	768	2,634	11,134	8,067	48,566		38,787	6,163	1,774	1,563
1986	2,651	1,632	2,474	7,290	7,275	71,562	3,230	32,266	6,508	3,212	1,815
1987	2,191	1,475	1,788	9,911	5,470	137,419	3,427	21,212	6,300	3,468	1,498
1988	4,435	1,283	1,252	10,488	8,069	72,528	3,294	20,620	5,203	2,270	575
1989	4,329	480	2,434	3,697	8,413	65,524	3,531	19,214	10,929	2,850	2,613
1990	3,383	879	1,558	6,548	11,594	56,000	2,520	37,712	13,383	3,376	1,194
1991	3,020	534	1,328	3,041	7,253	63,000	690	21,000	8,500	1,704	2,081
1992	2,917	345	3,391	8,587	5,377	61,300	536	26,600	14,670	5,208	2,755
1993	3,363	603	1,972	2,956	4,516	68,300	687	26,800	11,400	2,600	2,267
1994	2,298	640	1,738	3,222	3,316	77,800	753	28,600	9,730	2,500	2,100
1995	2,509	156	1,461	3,207	4,737	42,290	1,066	33,100	6,051	1,153	1,916
1996	2,170	249	1,171	4,740	4,424	67,900	391	32,600	7,700	2,700	2,330
1997	1,132	189	2,028	5,222	4,405	73,430	180	37,600	6,180	2,700	1,350
1998	875	160	1,100	5,560	3,338	83,050	607	34,400	4,848	-	1,510
1999	628	450	2,180	4,300	6,040	71,000	333	20,300	7,950	-	1,720
2000	1,113	653	780	4,170	6,660	75,540	974	23,000	6,360	-	910
Mean 95–99	1,463	241	1,588	4,606	4,589	67,534	515	31,600	6,546	2,184	1,765

[1]Mark recapture estimate from 1994

Continued…

Table 3.4.3.1 Cont'd. Wild adult counts to various rivers in the North East Atlantic area (Russia and UK).

Year	Russia	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (NI)	UK (NI)	UK (NI)	UK (NI)
	Umba	Frome	Test	Itchen	Kent	Leven	Tamar	Dee	Lune	Caldew	Roe	Bush	Faughan	Mourne
	Total trap	Counter	Counter + catch	Counter + catch	Counter	Counter	Counter	Counter + catch	Counter + catch	Trap	Counter	Total trap	Counter	Counter
1966													6,792	15,112
1967													1,723	7,087
1968													1,657	2,147
1969	2,030												1,195	1,569
1970	1,316												3,214	5,050
1971	288												1,758	4,401
1972	548												1,020	1,453
1973	2,536											2,614	1,885	2,959
1974	2,692											3,483	2,709	3,630
1975	5,432											3,366	1,617	1,742
1976	1,926											3,124	2,040	2,259
1977	3,692											1,775	2,625	2,419
1978	3,308											1,621	2,587	5,057
1979	3,772											1,820	3,262	2,226
1980	5,924											2,863	3,288	3,146
1981	6,252											1,539	3,772	2,399
1982	8,690											1,571	2,909	4,755
1983	7,850											1,030	2,410	1,271
1984	6,326											6,721	2,116	1,877
1985	12,190											2,443	9,077	8,149
1986	8,568											2,930	4,915	6,295
1987	10,040											2,530	907	2,322
1988	8,455	4,093	1,507	1,336								2,832	3,228	7,572
1989	12,029	3,186	1,730	791	1,137				8,785			1,029	8,287	9,497
1990	9,040	1,880	790	367	2,216				8,261			1,850	6,458	11,541
1991	6,400	805	538	152	1,736				7,591			2,341	4,301	7,987
1992	8,400	900	614	357	1,816			4,643	4,066			2,546	7,375	7,420
1993	8,500	1,182	1,155	852	1,526	101		9,757	7,883			3,235	8,655	17,855
1994	6,800	1,078	775	375	2,072	102	6,359	8,285	6,254	1,590		2,010	7,439	19,908
1995	7,340	1,016	647	880	1,396	123	5,637	5,703	4,589	1,417		1,521	5,838	7,547
1996	6,450	1,353	623	433	1,219	155	3,988	4,931	4,739	1,289		1,097	13,297	5,475
1997	6,200	1,157	361	246	491	41	2,989	5,495	3,121	889		1,677	4,500	6,979
1998	6,440	1,210	898	453	800	39	4,176	6,661	7,457	1,106	2,600	2,995	n/a	6,077
1999	6,850	n/a	867	213	1,018	98	3,588	3,664	4,936	1,022	n/a	959	n/a	8,500
2000	6,780	n/a	583	208	2,354	322	3,539	3,751	8,383	1,566	3,643	950	2,551	4,690
Mean 95–99	6,656	1,184	679	445	985	91	4,076	5,291	4,968	1,145	-	1,650	7,878	6,916

Table 3.4.3.1 Cont'd. Wild adult counts to various rivers in the North East Atlantic area (UK, France, Norway and Ireland).

	UK(Scotl.)	UK(Scotl.)	UK(Scotl.)	UK(Scotl.)	France	France	France	France	Norway	Norway	Norway	Ireland
Year	N. Esk	West Water	Girnock	Baddoch	Nivelle	Oir	Scorff	Bresle	Halselva	Imsa	Orkla	Burrishoole
	Counter	Counter	Total trap Females	Total trap Females	Trap est.	Trap est.	Trap est.	Trap est.	Total trap	Total trap	Counter	Total trap
1966			156									
1967			115									
1968			111									
1969			31									
1970			34									
1971			61									
1972			79									
1973			127									
1974			105									
1975			65									
1976			90									
1977			49									
1978			16									
1979			49									
1980			121									832
1981	9,025		41									348
1982	8,121		43							66		510
1983	8,972		26							14		602
1984	7,007		58		33	307		110		32		319
1985	9,912		30		61	296		135		31		567
1986	6,987		75		204	216		210		22		495
1987	7,014		110		138	180		200	52	9		468
1988	11,243		112	47	130	235		105	77	44		458
1989	11,026		43	67	263	235		220	64	83		662
1990	4,762		29	52	291	84		125	68	67		231
1991	9,127	2,962	57	46	184	47		215	89	43		547
1992	10,795	2,809	35	32	234	60		225	35	70		360
1993	10,887	2,699	21	27	472	176		75	18	39		528
1994	11,341	2,976	37	40	317	155	694[1]	105	29	30	4,305	516
1995	9,864	2,391	71	16	195	128	982	80	9	1	-	561
1996	7,993	2,656	41	26	214	196	756	40	25	2	4,405	405
1997	11,315	2,926	9	9	126	67	542	45	77	9	2,509	538
1998	10,474	2,422	11	10	160	189	551	270	38	20	4,171	516
1999	11,789	2,312	22	22	160	257	353	62	14	36	2,827	508
2000	8,353	2,092	27	9	151	490	n/a	35	25	8	7,719	574
Mean 95–99	10,287	2,541	31	17	171	167	637	99	33	14	3,478	506

Table 3.4.4.1 Estimated survival of wild smolts (%) to return to homewaters (prior to coastal fisheries) for various monitored rivers in the NE Atlantic area.

Smolt	Iceland[1]					Ireland		UK (N.Ireland)[8]	Norway[2]		UK (Scotland)[2]			France	
migration	Ellidaar	R.Vesturdalsa[4]		R.Midfjardara[4]		River Corrib	River Corrib	R. Bush	R. Imsa		North Esk			Nivelle[6]	Bresle
year	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW[3]	1SW	2SW	1SW	2SW	3SW	All ages	All ages
1975	20.8														
1980						14.3	0.5								
1981						10.0	3.0		17.3	4.0	13.7	6.9	0.3		
1982						16.7	2.7		5.3	1.2	12.6	5.4	0.2		
1983		2.0				8.0	1.5		13.5	1.3	-	-	-		
1984						20.0	1.6		12.1	1.8	10.0	4.1	0.1		
1985	9.4					15.2	1.4		10.2	2.1	26.1	6.4	0.2		
1986						-	-	31.3	3.8	4.2	-	-	-	15.1	
1987				2.4	1.4	13.3	0.6	35.1	17.3	5.6	13.9	3.4	0.1	2.6	
1988	12.7			0.6	0.9	11.7	0.6	36.2	13.3	1.1	-	-	-	2.4	
1989	8.1	1.1	2.0	0.2	0.7	5.3	0.6	25.0	8.7	2.2	7.8	4.9	0.1	3.5	
1990	5.4	1.0	1.0	1.2	1.3	4.0	0.5	34.7	3.0	1.3	7.3	3.1	0.2	1.8	
1991	8.8	4.2	0.6	1.1	0.5	5.8	1.0	27.8	8.7	1.2	11.2	4.5	-	9.2	
1992	9.6	2.4	0.8	1.4	0.5	5.8	-	29.0	6.7	0.9	-	-	-	8.9	6.9[7]
1993	9.8	-	-	1.0	1.1	8.7	1.6	-	15.6		-	-	-	8.3[7]	10.3[7]
1994	9.0	-	-	1.4	0.6	7.8	1.1	27.1	-	-	17.2	2.3	0.1	7.2[7]	7.5[7]
1995	9.4	1.6	1.2	0.3	0.9	6.7	0.1	n/a	1.8	1.5	11.5	5.1	0.1	2.3	-
1996	4.6	1.4	0.3	1.2	0.7	5.1	0.9	31.0	3.5	0.9	10.7	3.5	0.2	4.4	-
1997	5.3	0.7	0.5	2.4	0.5	10.2	0.6	19.8	1.5	0.3	10.3	6.3	0.1	3.4	4.8
1998	5.3	1.0	1.0	1.3	-	4.4	0.8	13.4	7.2	1.1	-	-		2.6	-
1999	7.7	1.3		-		4.3		16.5	3.7		-			-	-
Mean															
(5-year)	6.7	1.2	0.7	1.3	0.8	6.8	0.9	22.8	3.5	0.9	12.4	4.3	0.1	3.2	4.8
(10-year)	7.5	1.7	0.9	1.2	0.8	6.4	0.8	26.0	6.3	1.2	10.9	4.2	0.1	4.5	4.8

[1] Microtags.

[2] Carlin tags, not corrected for tagging mortality.

[3] Microtags, corrected for tagging mortality.

[4] Assumes 50% exploitation in rod fishery.

[5] Minimum estimates.

[6] From 0+ stage in autumn.

[7] Incomplete returns.

[8] Assumes 30% exploitation in trap fishery.

Table 3.4.4.2 Estimated survival of hatchery smolts (%) to adult return to homewaters, (prior to coastal fisheries) for monitored rivers and experimental facilities in the NE Atlantic area.

Smolt year	Iceland[1] R. Midfjardara[3]		UK (N. Ireland)[1] R. Bush (1SW)		Norway[2] R. Imsa		Norway[2] R. Drammen		Sweden[2] R. Lagan	
	1SW	2SW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981					10.1	1.3				
1982					4.2	0.6				
1983	0.0	0.2	1.9	8.1	1.6	0.1				
1984	0.5	0.2	13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	0.4	0.1	15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	0.4	0.7	2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	2.7	0.7	6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988	0.7	0.2	4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	0.7	0.4	8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	1.9	0.5	5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	1.8	0.2	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	1.3	0.2	6.0	7.8	3.8	0.7	0.4	0.6	1.5	0.4
1993	0.5	0.2	1.1	5.8	6.5	0.5	3.0	1.0	2.6	0.9
1994	1.0	0.2	1.6	-	6.2	0.6	1.2	0.9	4.0	1.2
1995	0.8	0.1	3.1	2.4	0.4	0.0	0.7	0.3	3.9	0.6
1996	0.1	0.0	2.0	2.3	2.1	0.2	0.3	0.2	3.5	0.5
1997	0.9	0.0	no release	4.1	0.9	0.0	0.4	0.1	0.6	0.5
1998	no release	no release	2.3	4.5	2.4	0.1	1.9	0.6	1.6	0.9
1999	no release		2.7	5.8	6.0		1.7		2.1	
Mean										
(5-year)	1.1	0.3	4.1	8.3	4.3	0.7	1.4	0.8	4.0	1.2
(10-year)	1.0	0.2	3.9	7.2	3.1	0.6	1.0	0.5	3.2	1.0

[1]Microtagged.

[2] Carlin tagged, not corrected for tagging mortality.

Table 3.4.4.2 Cont'd. Estimated survival of hatchery smolts (%) to 1SW adult return to homewaters, (prior to coastal fisheries) for monitored rivers and experimental facilities in Ireland.

Smolt year	R. Shannon	R. Screebe	R. Burrishoole[1]	R. Delphi	R. Bunowen	R. Lee	R. Corrib Cong. 2	R. Corrib Galway 2	R. Erne
1980	8.6					10.8	0.9		
1981	2.8		9.1			2	1.2		
1982	4.1		9.9			16.3	2.7	16.1	
1983	3.9		4.3			2	1.7	4.1	
1984	4.9	10.4	26.9			0.1	5.2	13.2	9.3
1985	4.8	12.3	27.9			17.7	1.4	14.4	9.9
1986	9.1	0.4	8.8			16.3	-	7.6	10.1
1987	4.7	8.3	13.8			8.6	-	2.2	6.9
1988	4.9	9.2	17.1			5.5	4.2	-	2.6
1989	5.0	1.6	10.1			1.7	6	4.9	1.2
1990	1.3	0.0	12.1			2.5	0.2	2.3	1.3
1991	4.1	0.2	12.8	10.8		0.8	3.5	4	1.3
1992	4.3	1.3	7.1	10.0	4.2	-	0.9	0.6	-
1993	2.9	2.2	14.0	14.3	5.4	-	1	-	-
1994	5.1	1.9	13.1	7.6	8.1	-	-	5.3	-
1995	3.6	4.1	8.5	2.5	3.4	-	2.4	-	-
1996	2.9	1.8	5.5	9.9	3.3	-	-	-	-
1997	6.0	0.4	13.3	10.8	5.1	6.9	-	-	5.9
1998	2.8	1.3	4.9	5.9	2.6	4.6	3.3	2.9	1.9
1999	0.5	2.5	8.6	7.8	1.4	-	-	3.2	3.5
Mean									
(5-year)	4.1	1.9	9.1	7.3	4.5	5.8	2.9	4.1	3.9
(10-year)	3.8	1.5	10.1	9.0	4.6	3.3	2.5	3.3	2.3

[1] Return rates to rod fishery with constant effort.

[2] Different release sites

Table 3.5.1 Assessment of the effects of the suspension of commercial fishing at Faroes on the numbers of salmon returning to home waters.

		Fishing season								
		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
NASCO quota (t) for the calender year if fishery operated [a]		550	550	550	550	470	425	380	330	300
Expected No. fish **landed** if quota had been taken [b]		147,048	162,850	182,027	172,931	142,037	128,438	140,927	122,384	111,258
Discard rate		8.8%	9.4%	14.4%	15.1%	11.9% [c]	11.9% [c]	16.9%	16.9% [g]	16.9% [g]
Discard mortality		80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80%	80%	80%
Expected No. fish killed if fishery operated		158,399	176,367	206,524	197,536	157,422	142,350	163,855	142,295	129,359
No. fish **killed** in research fishery		9,350	9,099	3,035	4,187	282	0	1465	0	2967 [h]
Total number of fish saved per year		149,049	167,268	203,489	193,349	157,140	142,350	162,390	142,295	126,392
Proportion of farmed fish in catch		37.0%	27.0%	17.0%	19.0%	19.0%	19.0%	19.0%	19.0% [f]	19.0% [f]
Number farm escapees spared		55,148	45,162	34,593	36,736	29,857	27,046	30,854	27,036	24,015
Number of wild fish spared		93,901	122,106	168,896	156,613	127,283	115,303	131,536	115,259	102,378
Sea age composition of wild fish:	1SW	4.0%	12.0%	16.0%	10.6%	10.7% [d]	10.7% [d]	19.2%	19.2%	19.2%
	2SW	83.0%	61.0%	64.0%	80.8%	72.2% [d]	72.2% [d]	74.6%	74.6%	74.6%
	2SW+	13.0%	27.0%	20.0%	8.6%	17.2% [d]	17.2% [d]	6.2%	6.2%	6.2%
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Additional salmon	**1SW**	**2,842**	**11,429**	**21,078**	**12,949**	**10,573**	**9,578**	**19,699**	**17,261**	**15,332**
expected to have returned:	**MSW**	**70,809**	**106,307**	**134,159**	**138,533**	**122,196**	**105,368**	**103,169**	**99,130**	**87,726**
Estimated **1SW** returns to ~~all European~~ homewaters: [e]		2,071,416	1,976,751	2,349,998	1,906,497	1,574,717	1,407,466	1752513	1241462	1661995
% 1SW returns derived from suspension of commerial fishing at Faroes:		0%	1%	1%	1%	1%	1%	1%	1%	1%
Estimated **MSW** returns to ~~all European~~ homewaters: [e]		990,822	1,002,492	1,134,800	1,034,176	953,108	708,513	755788	751153	919223
% MSW returns derived from suspension of commerial fishing at Faroes:		7%	11%	12%	13%	13%	15%	14%	13%	10%
Estimated **1SW** returns to ~~Northern European~~ homewaters: [e]		718,658	660,583	851,641	596,837	512,841	551,205	668824	614962	842672
% 1SW returns derived from suspension of commerial fishing at Faroes: (Assuming 65% from N. Europe)		0%	1%	2%	1%	1%	1%	2%	2%	1%
Estimated **MSW** returns to ~~Northern European~~ homewaters: [e]		457,004	506,992	489,097	445,638	484,430	365,885	396970	443141	582598
% MSW returns derived from suspension of commerial fishing at Faroes: (Assuming 65% from N. Europe)		10%	14%	18%	20%	16%	19%	17%	15%	10%

a. NASCO quota agreed for the calender year in the latter part of the fishing season.

b. Expected no. landed in year y calculated from quota: Sum(p_i/w_i)*Quota$_y$, p_i is proportion of age group i, i = 1; 2 and 2+SW, and w_i is mean weight of sea age i.

c. No data, estimated from mean discard rate 1992-95.

d. No data, mean values from 1992-95 data.

e. Includes farmed escapees.

f. Data not yet available, mean value from 1994-1996 data

g. Taken from 1997/98 research fishery

h. In 1999/2000 a commercial fishery operated instead of a research fishery

Table 3.5.2. Reduction in gear units over the period 1991-2000 for countries where such information is available.

Country	Type of gear units	% Change in gear units over 1991 to 2000
UK (England & Wales)	Gillnet Sweepnet Hand-held net Fixed engine	-45 -46 -43 -58
UK (Scotland)	Fixed engine Net and coble	-84 -71
UK (N. Ireland)	Driftnet Draftnet Bagnets and boxes	-7 -44 -44
Norway	Bagnet Bendnet	-33 -73
Ireland	Driftnet Draftnet Other nets	23 -3 -13
France[a]	Commercial nets in freshwater Commercial nets in estuary	-81 -14

a *Information on the number of gear units deployed in France for 2000 are not available. The % change in gear units presented covers the period 1991-1999.*

Table 3.6.2.1 Estimated number of RETURNING 1SW salmon by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	7,769	63,237	548,639	123,242	11,868	**754,754**	76,957	53,427	1,070,447	167,317	186,420	1,168,002	**2,645,613**	203,843	**3,400,367**	217,886
1972	12,058	64,211	706,255	135,241	9,546	**927,311**	98,959	105,359	1,164,565	186,085	161,965	1,073,691	**2,691,664**	192,790	**3,618,976**	216,704
1973	18,278	66,016	783,174	227,366	11,712	**1,106,546**	109,210	64,211	1,256,423	177,264	144,386	1,260,818	**2,903,101**	212,604	**4,009,648**	239,013
1974	16,906	46,644	736,277	207,967	17,307	**1,025,101**	105,314	30,123	1,379,752	174,495	156,802	1,317,677	**3,058,849**	232,899	**4,083,950**	255,603
1975	16,819	63,731	686,855	222,157	18,386	**1,007,948**	98,045	60,740	1,429,273	200,739	127,179	1,080,391	**2,898,323**	212,167	**3,906,270**	233,726
1976	14,490	53,341	684,807	167,519	10,434	**930,591**	98,129	55,623	1,007,550	125,363	87,787	935,194	**2,211,517**	180,113	**3,142,107**	205,109
1977	13,094	63,767	671,580	141,326	4,888	**894,654**	96,686	43,066	890,183	143,303	86,806	1,011,664	**2,175,022**	184,478	**3,069,676**	208,279
1978	9,552	77,629	724,892	153,472	5,766	**971,310**	101,399	43,785	795,426	141,288	112,183	1,102,254	**2,194,935**	198,692	**3,166,245**	223,070
1979	9,876	68,943	821,339	175,948	5,927	**1,082,032**	115,874	49,724	709,136	109,888	79,918	947,027	**1,895,693**	159,198	**2,977,725**	196,903
1980	9,737	35,260	824,362	115,940	7,378	**992,677**	114,246	104,147	543,181	139,614	102,394	589,955	**1,479,291**	107,608	**2,471,968**	156,945
1981	9,008	49,585	569,815	83,525	13,250	**725,184**	78,770	82,959	373,334	170,141	80,557	738,379	**1,445,370**	118,351	**2,170,554**	142,168
1982	6,446	32,731	415,943	127,541	11,852	**594,513**	58,571	51,006	669,910	101,354	115,640	1,029,799	**1,967,709**	170,176	**2,562,222**	179,973
1983	9,765	51,748	690,376	185,222	15,598	**952,710**	61,855	55,263	1,100,043	137,806	162,074	1,105,092	**2,560,278**	193,541	**3,512,988**	203,185
1984	12,223	32,817	872,447	175,950	22,290	**1,115,727**	76,051	90,802	524,866	117,621	63,674	1,130,608	**1,927,570**	182,348	**3,043,298**	197,572
1985	15,411	57,435	916,774	231,986	26,626	**1,248,231**	83,554	33,478	1,052,958	124,252	82,531	852,558	**2,145,776**	158,062	**3,394,008**	178,787
1986	15,369	83,403	767,763	203,397	28,737	**1,098,669**	70,456	62,226	1,013,536	153,746	92,030	1,062,355	**2,383,893**	184,946	**3,482,562**	197,911
1987	21,650	59,728	624,036	328,405	22,860	**1,056,679**	62,772	106,499	672,988	134,485	51,375	914,859	**1,880,207**	170,002	**2,936,885**	181,220
1988	14,740	108,987	554,480	180,242	19,053	**877,501**	50,244	37,584	1,040,039	177,532	119,759	906,598	**2,281,512**	185,870	**3,159,014**	192,541
1989	21,661	59,418	678,024	264,132	6,151	**1,029,386**	70,353	19,523	592,805	107,185	115,892	973,506	**1,808,911**	164,041	**2,838,297**	178,491
1990	21,302	55,516	555,477	238,818	14,448	**885,561**	56,432	35,159	439,885	76,456	96,011	495,498	**1,143,009**	93,336	**2,028,570**	109,069
1991	19,325	62,425	517,861	230,468	17,744	**847,823**	54,255	25,344	310,608	74,896	52,434	471,484	**934,766**	90,794	**1,782,589**	105,769
1992	31,462	79,113	396,871	192,028	19,185	**718,658**	43,557	45,949	496,569	74,984	107,403	627,853	**1,352,759**	119,120	**2,071,416**	126,833
1993	23,321	73,143	385,618	158,505	19,996	**660,583**	38,443	64,356	352,244	146,609	128,281	624,678	**1,316,168**	122,148	**1,976,751**	128,054
1994	15,698	50,695	593,827	174,288	17,134	**851,641**	53,830	50,491	496,896	204,480	85,743	660,748	**1,498,358**	129,716	**2,349,998**	140,442
1995	16,242	72,501	326,990	156,236	24,868	**596,837**	33,220	15,355	492,798	102,818	79,952	618,738	**1,309,660**	113,463	**1,906,497**	118,227
1996	26,796	54,588	224,768	191,239	15,450	**512,841**	29,440	19,103	431,085	84,459	82,572	444,657	**1,061,876**	87,589	**1,574,717**	92,404
1997	23,655	47,196	294,110	179,313	6,932	**551,205**	30,812	9,867	325,064	75,517	99,092	346,721	**856,261**	66,241	**1,407,466**	73,056
1998	28,452	70,799	369,612	195,926	4,036	**668,824**	33,467	19,163	372,024	85,090	213,314	394,098	**1,083,688**	77,128	**1,752,513**	84,076
1999	35,197	46,706	392,098	134,992	5,969	**614,962**	31,273	6,350	284,962	74,815	55,256	205,117	**626,500**	42,006	**1,241,462**	52,369
2000	36,828	37,300	600,701	155,941	11,901	**842,672**	51,296	16,861	361,341	119,103	80,468	241,550	**819,323**	54,887	**1,661,995**	75,126
10yr Av.	25,697	59,447	410,246	176,894	14,322	**686,605**	39,959	27,284	392,359	104,277	98,452	463,564	**1,085,936**	90,309	**1,772,540**	99,636

Table 3.6.2.2 Estimated number of RETURNING MSW salmon by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	**Est.**	SD
1971	7,296	37,018	343,756	204,481	865	**593,416**	53,746	11,255	174,511	107,660	15,679	526,864	**835,970**	68,716	**1,429,385**	87,238
1972	11,427	50,486	451,014	170,890	638	**684,455**	64,955	22,527	193,118	119,592	13,834	713,746	**1,062,817**	91,833	**1,747,271**	112,483
1973	17,421	52,932	492,614	285,191	2,043	**850,203**	78,742	13,851	206,349	110,051	12,032	789,053	**1,131,337**	101,633	**1,981,540**	128,567
1974	16,780	44,392	467,159	262,834	1,348	**792,513**	73,842	6,404	227,862	107,255	13,214	649,748	**1,004,483**	83,845	**1,796,997**	111,726
1975	16,432	50,875	440,399	330,259	326	**838,289**	73,364	12,711	237,614	121,472	10,822	717,402	**1,100,022**	95,753	**1,938,311**	120,628
1976	14,423	43,811	438,028	281,788	963	**779,013**	72,832	9,430	167,206	74,382	7,606	423,289	**681,913**	58,949	**1,460,926**	93,698
1977	13,135	50,659	425,060	211,489	745	**701,089**	65,681	7,321	146,713	81,360	7,293	513,504	**756,191**	67,036	**1,457,281**	93,850
1978	8,112	63,675	299,213	145,620	594	**517,215**	43,594	7,428	131,382	78,467	9,555	614,894	**841,726**	78,816	**1,358,941**	90,069
1979	6,459	41,087	519,467	160,929	1,680	**729,623**	76,810	8,437	116,739	59,017	6,775	506,675	**697,643**	65,505	**1,427,266**	100,949
1980	8,757	51,254	521,520	244,931	3,005	**829,467**	75,741	17,648	131,154	73,055	8,450	598,932	**829,239**	74,613	**1,658,706**	106,320
1981	13,703	27,068	547,026	133,546	865	**722,208**	78,673	12,367	92,108	86,425	6,673	634,358	**831,930**	79,662	**1,554,139**	111,962
1982	15,188	28,741	443,278	134,848	3,000	**625,054**	64,627	7,660	37,130	50,146	9,696	482,494	**587,125**	59,812	**1,212,180**	88,058
1983	16,905	33,537	429,326	217,029	2,032	**698,828**	48,078	8,147	97,458	66,396	13,646	583,971	**769,618**	71,687	**1,468,446**	86,316
1984	13,482	29,308	523,878	231,544	2,977	**801,188**	54,824	13,692	95,400	55,780	5,289	447,273	**617,434**	56,471	**1,418,622**	78,706
1985	13,775	22,855	465,102	257,068	1,171	**759,971**	55,410	10,080	87,521	57,762	6,885	499,786	**662,034**	64,502	**1,422,005**	85,034
1986	9,164	40,398	611,906	286,548	1,202	**949,218**	65,049	10,392	126,751	69,619	7,829	643,717	**858,308**	83,580	**1,807,526**	105,911
1987	12,799	30,982	441,595	133,956	3,602	**622,934**	42,549	5,506	104,979	75,617	4,032	469,756	**659,889**	63,594	**1,282,823**	76,516
1988	10,065	23,982	334,589	148,545	3,540	**520,721**	36,704	15,552	114,818	93,642	11,058	545,254	**780,323**	76,027	**1,301,044**	84,423
1989	12,421	21,834	242,252	180,902	9,644	**467,054**	42,590	7,094	76,214	68,179	8,906	475,958	**636,351**	64,660	**1,103,405**	77,427
1990	12,979	22,534	313,769	174,451	6,596	**530,329**	39,686	7,043	55,603	83,438	8,266	414,633	**568,983**	58,075	**1,099,312**	70,340
1991	14,581	20,209	265,964	150,390	7,524	**458,668**	32,937	6,399	39,531	36,014	4,122	323,069	**409,135**	45,312	**867,804**	56,018
1992	14,479	27,074	267,747	137,774	9,930	**457,004**	31,341	8,203	64,602	26,459	9,448	425,106	**533,818**	61,223	**990,822**	68,779
1993	18,787	22,241	248,269	204,507	13,187	**506,992**	40,237	3,921	43,427	41,284	23,036	383,831	**495,500**	55,511	**1,002,492**	68,560
1994	14,361	23,979	263,973	176,742	10,042	**489,097**	33,252	7,937	78,348	73,492	7,894	478,032	**645,703**	73,450	**1,134,800**	80,627
1995	12,410	18,615	279,735	128,620	6,257	**445,638**	30,712	3,799	78,320	48,095	6,617	451,708	**588,538**	69,586	**1,034,176**	76,062
1996	7,692	17,972	247,714	203,258	7,795	**484,430**	50,732	6,740	52,347	54,800	7,475	347,315	**468,678**	56,805	**953,108**	76,162
1997	12,108	14,576	169,798	164,279	5,124	**365,885**	40,443	3,480	34,973	33,681	9,126	261,367	**342,628**	44,625	**708,513**	60,225
1998	10,725	13,683	206,078	163,633	2,850	**396,970**	40,292	2,955	42,716	21,447	13,135	278,565	**358,819**	49,183	**755,788**	63,581
1999	9,645	22,034	246,263	162,808	2,392	**443,141**	40,226	6,389	31,823	40,507	5,850	223,443	**308,012**	40,301	**751,153**	56,941
2000	21,825	8,557	325,987	220,879	5,350	**582,598**	55,715	4,463	40,406	43,178	7,728	240,851	**336,624**	44,577	**919,223**	71,353
10yr Av.	13,661	18,894	252,153	171,289	7,045	**463,042**	39,589	5,428	50,649	41,896	9,443	341,329	**448,746**	54,058	**911,788**	67,831

Table 3.6.2.3 Estimated pre-fishery abundance of MATURING 1SW salmon (potential 1SW returns) by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	8,555	68,540	595,454	133,849	13,004	**819,402**	84,740	58,032	1,160,467	181,621	201,954	1,262,769	**2,864,842**	224,166	**3,684,244**	239,648
1972	13,209	69,599	766,284	146,873	10,493	**1,006,458**	108,662	114,289	1,262,444	201,983	175,472	1,160,483	**2,914,670**	212,370	**3,921,128**	238,555
1973	19,971	71,561	849,952	246,793	12,865	**1,201,142**	121,453	69,751	1,362,219	192,504	156,504	1,362,357	**3,143,336**	234,037	**4,344,478**	263,674
1974	18,440	50,556	798,805	225,642	18,876	**1,112,318**	116,893	32,775	1,495,777	189,376	169,880	1,423,777	**3,311,585**	255,914	**4,423,903**	281,347
1975	18,369	69,075	745,485	241,092	20,077	**1,094,097**	109,278	65,944	1,549,605	217,897	137,855	1,167,850	**3,139,151**	234,605	**4,233,249**	258,807
1976	15,800	57,812	742,753	181,749	11,400	**1,009,514**	107,725	60,388	1,092,174	136,057	95,151	1,011,217	**2,394,986**	197,654	**3,404,500**	225,104
1977	14,256	69,105	728,229	153,289	5,367	**970,246**	106,015	46,734	964,895	155,424	94,063	1,093,431	**2,354,547**	201,232	**3,324,793**	227,450
1978	10,401	84,138	786,092	166,448	6,303	**1,053,382**	112,601	47,487	862,292	153,254	121,473	1,191,559	**2,376,064**	217,114	**3,429,446**	244,576
1979	10,793	74,719	890,685	190,866	6,518	**1,173,581**	126,939	53,982	768,743	119,268	86,631	1,023,396	**2,052,020**	174,127	**3,225,601**	215,485
1980	10,785	38,216	894,905	126,126	8,238	**1,078,269**	126,081	113,101	589,195	151,787	111,163	638,362	**1,603,610**	118,156	**2,681,879**	172,793
1981	10,143	53,745	619,880	91,294	14,755	**789,817**	86,854	90,260	405,400	185,179	87,741	799,075	**1,567,656**	128,929	**2,357,473**	155,455
1982	7,337	35,477	452,987	138,948	13,198	**647,947**	65,063	55,626	726,841	110,569	125,702	1,113,661	**2,132,400**	185,169	**2,780,346**	196,267
1983	10,973	56,086	749,857	201,532	17,304	**1,035,751**	68,539	60,263	1,193,027	150,140	175,983	1,195,733	**2,775,147**	212,602	**3,810,898**	223,377
1984	13,441	35,569	945,864	191,098	24,367	**1,210,339**	84,688	98,591	569,280	127,880	69,192	1,222,602	**2,087,546**	199,781	**3,297,885**	216,990
1985	16,850	62,259	993,557	251,776	29,023	**1,353,466**	92,460	36,429	1,141,531	134,982	89,538	921,675	**2,324,155**	174,199	**3,677,621**	197,216
1986	16,849	90,393	832,162	220,832	31,367	**1,191,602**	76,786	67,656	1,098,947	167,027	99,879	1,148,032	**2,581,542**	202,850	**3,773,144**	216,897
1987	23,622	64,725	676,312	356,207	24,954	**1,145,819**	68,117	115,541	729,702	146,059	55,830	988,938	**2,036,070**	185,476	**3,181,889**	197,588
1988	16,149	118,113	601,178	195,683	20,845	**951,968**	54,601	40,900	1,127,516	192,738	129,862	980,405	**2,471,422**	203,319	**3,423,390**	210,523
1989	23,587	64,397	734,752	286,500	6,788	**1,116,024**	77,167	21,262	642,728	116,400	125,627	1,052,198	**1,958,215**	178,566	**3,074,239**	194,527
1990	23,170	60,170	601,683	259,016	15,753	**959,791**	61,124	38,172	476,938	83,041	104,026	535,772	**1,237,949**	101,933	**2,197,740**	118,855
1991	20,993	67,660	560,807	249,868	19,302	**918,630**	59,123	27,520	336,708	81,268	56,820	509,870	**1,012,186**	98,803	**1,930,816**	115,142
1992	34,116	85,763	429,806	208,204	20,833	**778,722**	47,946	49,800	538,275	81,333	116,269	678,610	**1,464,287**	130,142	**2,243,009**	138,693
1993	25,296	79,278	417,606	171,833	21,703	**715,717**	42,349	69,809	381,796	158,921	138,864	675,103	**1,424,494**	132,927	**2,140,211**	139,510
1994	17,033	54,948	643,007	188,947	18,591	**922,526**	59,475	54,734	538,583	221,668	92,830	713,908	**1,621,723**	141,363	**2,544,248**	153,365
1995	17,628	78,573	354,108	169,380	26,978	**646,668**	36,239	16,666	534,157	111,481	86,562	668,484	**1,417,349**	123,241	**2,064,017**	128,459
1996	29,057	59,170	243,609	207,326	16,779	**555,940**	33,029	20,719	467,261	91,596	89,415	480,362	**1,149,354**	95,770	**1,705,293**	101,305
1997	25,632	51,160	318,409	194,373	7,519	**597,093**	34,240	10,692	352,341	81,868	107,241	374,631	**926,772**	72,714	**1,523,866**	80,372
1998	30,833	76,730	400,155	212,347	4,380	**724,445**	37,035	20,761	403,206	92,224	230,849	425,708	**1,172,748**	84,270	**1,897,193**	92,049
1999	38,140	50,618	424,487	146,306	6,473	**666,023**	34,749	6,880	308,851	81,079	59,806	221,592	**678,208**	46,272	**1,344,231**	57,867
2000	39,914	40,425	650,043	169,009	12,906	**912,297**	55,036	18,278	391,618	129,087	87,080	260,984	**887,048**	60,316	**1,799,345**	81,651
10yr Av.	27,864	64,432	444,204	191,759	15,546	**743,806**	43,922	29,586	425,280	113,052	106,574	500,925	**1,175,417**	98,582	**1,919,223**	108,841

Table 3.6.2.4 Estimated pre-fishery abundance of NON-MATURING 1SW salmon (potential MSW returns) by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	14,088	68,540	548,639	123,242	11,868	**766,377**	79,972	40,798	312,903	223,928	16,394	1,054,004	**1,648,028**	101,101	**2,414,405**	128,907
1972	24,988	69,599	706,255	135,241	9,546	**945,629**	87,414	26,541	307,809	190,913	14,246	1,100,654	**1,640,164**	112,952	**2,585,793**	142,827
1973	23,274	71,561	783,174	227,366	11,712	**1,117,087**	83,846	16,804	326,455	181,741	15,641	913,330	**1,453,970**	90,464	**2,571,056**	123,345
1974	23,313	50,556	736,277	207,967	17,307	**1,035,419**	79,134	23,891	337,147	197,185	12,835	996,096	**1,567,154**	110,307	**2,602,573**	135,756
1975	20,274	69,075	686,855	222,157	18,386	**1,016,747**	78,263	21,874	261,485	150,052	9,008	656,130	**1,098,549**	61,180	**2,115,296**	99,338
1976	17,678	57,812	684,807	167,519	10,434	**938,250**	76,317	15,037	212,149	133,975	8,641	705,172	**1,074,974**	73,343	**2,013,224**	105,847
1977	11,467	69,105	671,580	141,326	4,888	**898,364**	50,840	16,086	198,131	135,267	11,317	833,365	**1,194,166**	90,700	**2,092,530**	103,977
1978	9,904	84,138	724,892	153,472	5,766	**978,172**	91,331	14,650	168,043	98,039	8,022	681,071	**969,825**	76,088	**1,947,996**	118,873
1979	15,576	74,719	821,339	175,948	5,927	**1,093,508**	87,494	27,811	203,931	129,841	10,008	850,845	**1,222,435**	92,224	**2,315,944**	127,124
1980	24,376	38,216	824,362	115,940	7,378	**1,010,272**	96,396	21,029	162,225	146,040	7,904	923,147	**1,260,345**	95,330	**2,270,617**	135,573
1981	25,588	53,745	569,815	83,525	13,250	**745,923**	77,631	14,463	90,592	96,785	11,483	724,774	**938,097**	70,458	**1,684,020**	104,837
1982	26,048	35,477	415,943	127,541	11,852	**616,860**	46,162	13,998	152,954	109,055	16,169	815,518	**1,107,694**	81,858	**1,724,555**	93,977
1983	20,032	56,086	690,376	185,222	15,598	**967,315**	55,115	18,222	133,454	81,608	6,264	603,617	**843,166**	62,287	**1,810,480**	83,171
1984	20,401	35,569	872,447	175,950	22,290	**1,126,657**	47,336	13,540	122,029	81,789	8,155	662,061	**887,573**	68,353	**2,014,230**	83,143
1985	15,568	62,259	916,774	231,986	26,626	**1,253,213**	61,571	17,286	187,665	114,919	9,273	877,484	**1,206,627**	93,626	**2,459,839**	112,057
1986	19,731	90,393	767,763	203,397	28,737	**1,110,021**	46,934	11,002	159,016	119,408	4,777	662,991	**957,193**	68,051	**2,067,214**	82,666
1987	14,655	64,725	624,036	328,405	22,860	**1,054,680**	36,761	22,576	164,306	137,277	13,095	727,119	**1,064,373**	75,695	**2,119,053**	84,150
1988	18,242	118,113	554,480	180,242	19,053	**890,129**	26,444	13,679	126,311	113,699	10,550	665,920	**930,157**	66,930	**1,820,286**	71,964
1989	18,468	64,397	678,024	264,132	6,151	**1,031,172**	34,490	10,056	82,370	112,302	9,786	549,856	**764,372**	61,055	**1,795,544**	70,123
1990	18,618	60,170	555,477	238,818	14,448	**887,532**	28,867	8,431	54,496	49,021	4,883	410,251	**527,083**	47,080	**1,414,614**	55,226
1991	17,962	67,660	517,861	230,468	17,744	**851,694**	27,964	11,795	89,195	43,581	11,189	538,287	**694,046**	64,463	**1,545,741**	70,267
1992	22,911	85,763	396,871	192,028	19,185	**716,757**	27,116	5,930	59,707	57,055	27,286	479,045	**629,023**	59,183	**1,345,780**	65,099
1993	17,596	79,278	385,618	158,505	19,996	**660,994**	22,234	9,441	94,509	88,852	9,352	577,555	**779,709**	79,297	**1,440,702**	82,355
1994	15,358	54,948	593,827	174,288	17,134	**855,554**	27,532	4,529	94,634	58,377	7,834	547,025	**712,399**	79,293	**1,567,953**	83,937
1995	9,749	78,573	326,990	156,236	24,868	**596,416**	25,437	8,346	65,442	68,209	8,856	425,597	**576,449**	62,187	**1,172,865**	67,188
1996	14,447	59,170	224,768	191,239	15,450	**505,075**	17,509	4,433	43,255	42,089	10,806	315,978	**416,561**	48,592	**921,636**	51,650
1997	12,786	51,160	294,110	179,313	6,932	**544,300**	20,964	3,658	51,597	26,572	15,562	334,549	**431,938**	51,043	**976,239**	55,181
1998	11,463	76,730	369,612	195,926	4,036	**657,767**	25,068	7,611	37,960	48,756	6,926	267,167	**368,421**	44,133	**1,026,187**	50,756
1999	25,943	50,618	392,098	134,992	5,969	**609,619**	30,379	5,333	48,269	52,035	9,155	288,260	**403,052**	45,888	**1,012,671**	55,033
10yr Av.	16,683	66,407	405,723	185,181	14,576	**688,571**	25,307	6,951	63,906	53,455	11,185	418,371	**553,868**	58,116	**1,242,439**	63,669

Table 3.6.2.5 Estimated number of 1SW SPAWNERS by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
eggs/F	5,000	4,500	4,500	4,500	3,000	**4403**		3,450	3,400	3,000	3,400	5,000	**4490**		**2623**	
% Fem	12%	45%	45%	45%	50%	**47%**		77%	60%	45%	60%	40%	**45%**		**27%**	
1971	3,618	32,155	112,989	62,664	2,159	**181,431**	57,145	51,687	302,707	114,127	38,082	807,337	**1,313,940**	194,913	**1,527,527**	203,118
1972	5,557	32,456	143,226	68,357	1,688	**218,827**	74,199	101,879	325,211	126,427	32,455	730,071	**1,316,042**	182,173	**1,567,325**	196,703
1973	8,399	33,444	159,750	115,174	2,059	**285,382**	82,176	62,081	351,827	120,585	29,833	859,635	**1,423,961**	201,376	**1,742,788**	217,498
1974	7,821	23,570	149,441	105,098	3,170	**265,529**	80,102	29,133	385,428	118,519	31,248	920,399	**1,484,727**	220,848	**1,773,826**	234,925
1975	7,825	32,227	139,390	112,326	3,394	**262,935**	74,029	58,760	399,322	136,379	25,682	773,116	**1,393,259**	198,582	**1,688,420**	211,932
1976	6,722	26,890	138,127	84,457	1,817	**231,123**	74,024	53,803	280,702	84,108	17,515	674,066	**1,110,194**	171,875	**1,368,208**	187,138
1977	6,096	32,466	138,958	71,963	949	**217,967**	72,729	41,666	250,728	95,835	17,817	742,353	**1,148,400**	177,887	**1,398,833**	192,180
1978	4,429	39,193	146,808	77,491	1,065	**229,795**	77,269	42,350	221,977	92,900	22,361	818,144	**1,197,733**	193,991	**1,466,721**	208,814
1979	4,553	34,956	167,840	89,202	1,065	**262,660**	85,832	48,079	198,718	71,700	16,087	690,183	**1,024,767**	153,981	**1,322,383**	176,287
1980	4,501	17,879	168,590	58,791	1,294	**233,176**	85,198	100,717	144,168	86,829	20,707	439,025	**791,446**	103,586	**1,042,501**	134,122
1981	4,173	25,322	118,454	42,648	2,318	**167,594**	58,119	80,239	93,324	105,282	16,279	551,670	**846,794**	116,182	**1,039,710**	129,908
1982	2,979	16,654	85,668	77,861	2,150	**168,657**	44,755	49,326	171,802	61,874	23,589	771,854	**1,078,445**	166,208	**1,263,756**	172,128
1983	4,539	26,259	162,735	112,832	2,826	**282,931**	48,218	53,463	293,850	83,093	32,493	843,788	**1,306,686**	184,626	**1,615,877**	190,818
1984	5,685	16,617	200,604	106,996	4,035	**317,320**	60,257	87,842	133,372	69,424	12,769	864,860	**1,168,267**	179,900	**1,502,203**	189,723
1985	7,137	29,040	217,418	140,906	4,912	**370,373**	67,222	32,378	252,505	72,085	16,445	656,429	**1,029,841**	147,641	**1,429,254**	162,224
1986	7,175	42,066	181,692	123,248	5,322	**317,437**	56,299	58,826	210,026	88,803	18,203	811,736	**1,187,593**	175,625	**1,547,097**	184,428
1987	10,019	30,199	153,372	206,629	4,318	**374,339**	53,869	100,499	156,203	78,058	16,189	709,864	**1,060,813**	164,133	**1,465,350**	172,747
1988	6,820	55,225	136,877	113,569	3,400	**260,667**	43,060	35,484	231,810	103,905	42,575	720,005	**1,133,781**	173,429	**1,449,673**	178,695
1989	7,787	30,138	232,306	166,498	1,143	**407,735**	63,774	18,423	153,411	60,382	13,500	774,626	**1,020,341**	159,641	**1,458,214**	171,908
1990	7,804	28,175	196,060	150,593	2,676	**357,134**	50,560	33,259	147,612	42,586	37,160	402,882	**663,500**	90,258	**1,048,809**	103,454
1991	7,010	31,783	177,050	162,266	3,317	**349,644**	48,184	23,944	107,278	42,536	18,913	386,876	**579,547**	89,118	**960,974**	101,310
1992	11,433	40,257	132,172	135,177	3,577	**282,359**	39,692	43,449	180,065	42,990	47,904	511,838	**826,246**	116,188	**1,148,863**	122,781
1993	8,430	37,256	131,235	111,613	3,277	**254,555**	35,803	60,756	100,868	90,941	76,071	516,622	**845,258**	120,252	**1,137,069**	125,469
1994	5,699	25,817	209,147	122,714	4,769	**342,329**	48,689	47,691	137,626	128,803	26,177	547,649	**887,946**	126,123	**1,256,091**	135,194
1995	5,852	36,774	112,737	109,835	9,711	**238,136**	30,700	13,686	128,585	66,256	26,713	516,477	**751,717**	109,746	**1,026,627**	113,959
1996	12,435	27,777	71,852	134,604	6,036	**224,929**	27,615	17,040	121,123	57,641	35,757	369,417	**600,977**	84,197	**853,683**	88,610
1997	10,997	23,899	110,598	125,987	2,589	**250,171**	29,360	8,807	96,019	52,301	40,592	293,228	**490,947**	65,742	**765,018**	72,000
1998	13,201	35,743	134,949	137,515	1,164	**286,830**	31,163	17,098	112,674	60,350	160,340	333,459	**683,921**	76,595	**1,006,494**	82,692
1999	12,688	23,724	145,123	94,955	1,763	**254,530**	28,289	5,660	88,681	55,532	20,481	176,536	**346,890**	41,474	**625,144**	50,204
2000	13,463	18,960	220,993	109,725	3,564	**347,745**	46,961	15,069	113,004	89,767	33,905	210,858	**462,603**	54,216	**829,309**	71,727
10yr.av.	9,065	31,762	150,811	135,680	3,826	**299,382**		28,415	128,526	64,479	48,313	465,307	**735,040**		**1,066,184**	

Table 3.6.2.6 Estimated number of MSW SPAWNERS by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
eggs/F	13,000	10,500	10,500	10,500	6,000			6,900	7,000	6,000	6,000	10,000				
% Fem	77%	80%	80%	80%	70%			77%	85%	70%	85%	60%				
1971	3,083	14,956	69,680	103,303	211	**176,276**	43,246	7,195	85,589	79,157	7,842	304,255	**484,038**	66,554	**675,270**	79,370
1972	4,835	20,436	91,802	86,456	174	**183,268**	50,153	14,407	95,038	87,985	6,966	413,329	**617,724**	89,149	**821,428**	102,288
1973	7,422	21,392	100,055	144,145	462	**252,084**	64,271	8,881	101,497	80,978	6,035	462,306	**659,697**	98,689	**933,172**	117,772
1974	7,100	18,024	95,746	133,315	341	**236,502**	59,258	4,094	112,261	79,069	6,619	390,423	**592,467**	81,268	**846,993**	100,578
1975	6,875	20,663	90,273	167,537	79	**264,764**	60,469	8,091	117,075	89,530	5,440	432,568	**652,704**	93,069	**938,131**	110,988
1976	6,149	17,819	89,963	143,134	221	**239,468**	58,900	6,050	82,403	54,439	3,825	264,760	**411,476**	57,414	**668,763**	82,253
1977	5,672	20,599	87,322	107,395	189	**200,578**	51,771	4,721	72,311	58,997	3,634	322,646	**462,309**	65,367	**683,486**	83,385
1978	3,455	25,733	60,530	73,555	159	**137,700**	33,326	4,763	64,593	56,167	4,772	391,081	**521,376**	77,123	**684,809**	84,016
1979	3,396	16,549	104,838	81,104	417	**189,756**	58,787	5,382	57,364	41,834	3,411	324,813	**432,805**	64,082	**639,110**	86,962
1980	4,617	20,717	105,602	123,751	789	**234,758**	58,340	11,278	64,488	49,860	4,226	386,333	**516,185**	73,657	**771,660**	93,962
1981	7,191	10,994	112,054	67,750	216	**187,210**	58,913	8,287	37,881	58,672	3,354	418,227	**526,420**	78,778	**724,625**	98,371
1982	7,983	11,566	88,985	81,640	752	**179,359**	49,433	5,140	16,295	33,573	4,848	323,695	**383,551**	59,328	**574,476**	77,223
1983	8,837	13,536	96,805	131,593	487	**237,722**	40,613	5,447	48,243	44,126	6,865	402,830	**507,511**	71,014	**758,769**	81,807
1984	7,177	11,928	122,965	141,157	802	**272,101**	47,439	9,252	62,092	36,658	2,635	314,096	**424,734**	56,041	**708,762**	73,423
1985	7,219	9,286	107,235	156,615	271	**271,341**	49,028	6,750	54,563	37,468	3,438	357,543	**459,761**	64,091	**740,388**	80,693
1986	4,840	16,419	151,054	174,572	302	**330,767**	56,783	6,992	79,083	45,091	3,935	460,343	**595,443**	83,001	**942,629**	100,566
1987	6,766	12,608	109,054	81,709	894	**198,423**	35,835	3,706	63,679	49,139	2,204	340,943	**459,671**	63,137	**670,701**	72,598
1988	5,391	9,640	80,955	89,868	912	**177,126**	32,260	10,552	68,853	60,666	7,072	405,363	**552,506**	75,539	**739,271**	82,139
1989	5,303	8,823	82,075	141,562	2,344	**231,285**	41,131	4,794	38,875	42,945	3,578	357,786	**447,979**	64,409	**688,087**	76,422
1990	5,506	9,110	107,176	140,193	1,655	**254,530**	36,914	4,743	30,729	52,075	5,161	314,981	**407,689**	57,890	**671,330**	68,657
1991	6,155	8,209	91,101	120,994	1,824	**220,074**	30,529	4,299	22,321	22,836	2,362	248,852	**300,669**	45,213	**528,952**	54,555
1992	6,092	10,980	90,336	110,798	2,467	**209,692**	29,151	5,503	37,713	16,894	6,327	330,991	**397,429**	61,095	**618,102**	67,693
1993	7,845	9,012	82,114	164,447	3,179	**257,585**	38,747	2,621	20,414	28,087	20,286	302,609	**374,016**	55,368	**640,613**	67,579
1994	6,038	9,786	88,637	142,345	2,662	**239,682**	31,775	5,637	45,581	50,794	4,746	381,179	**487,937**	73,222	**737,405**	79,819
1995	5,258	7,558	95,188	103,469	1,880	**205,795**	28,630	2,704	45,258	33,887	3,816	363,192	**448,857**	69,445	**662,211**	75,115
1996	4,065	7,288	84,037	173,972	2,241	**264,314**	49,947	4,798	28,023	40,370	5,015	281,922	**360,129**	56,757	**631,731**	75,605
1997	6,413	5,884	61,359	140,456	1,574	**209,803**	39,926	2,479	16,374	25,120	6,062	215,611	**265,646**	44,601	**481,333**	59,861
1998	5,710	5,554	76,111	140,054	833	**222,708**	39,595	2,109	21,658	16,396	10,350	233,888	**284,401**	49,163	**512,663**	63,125
1999	4,506	8,938	88,503	139,284	676	**232,969**	39,106	4,558	15,822	32,233	4,011	188,843	**245,467**	40,283	**487,374**	56,143
2000	10,202	3,471	117,750	189,057	1,544	**318,552**	54,619	3,186	20,131	34,390	5,267	207,119	**270,092**	44,562	**592,115**	70,491
10yr.av.	6,228	7,668	87,514	142,488	1,888	**238,117**		3,789	27,329	30,101	6,824	275,421	**343,464**		**589,250**	

Table 3.6.6.1 **Effects of taking account of fish farm escapees in Norwegian PFA assessment.**

Year	Numbers estimated from PFA and CL analysis					
	Maturing 1SW recruits	Non-mat. 1SW recruits	Total 1SW recruits	1SW spawners	MSW spawners	National CL
NOT taking account of farmed fish	510,398	341,371	851,770	185,741	104,690	191,000
Taking account of farm fish	464,109	290,096	754,206	182,359	100,588	183,000
Difference	46,289	51,275	97,564	3,382	4,103	8,000
% difference	10%	18%	13%	2%	4%	4%

Table 3.6.7.1 Sensitivity of Pre-Fishery Abundance estimates for 1SW and MSW stocks in Northern and Southern Europe to changes in input data to run-reconstruction model. [Based upon input data used in 2001 assessment]

Country	Sea age	Catch	Non-rep' rate	Exploit'n rate	Extra catch	Time	Recruits (PFA)	Effect of changing:- Non-rep' rate by by adding	Exp'n rate by by adding	Time by by adding	Effect of changing: Non-rep' rate by multiplying	Exploit'n rate by multiplying	Time by multiplying
		Input data for 2001 assessment						0.1	0.1	2.0	1.2	1.2	1.2
Northern European Stock Complex - 1SW													
Iceland 1	1SW	11,894	0.02	0.50		8.0	26,295	0.3%	-0.5%	0.1%	0.0%	-0.5%	0.0%
Iceland 2	1SW	6,081	0.02	0.50		8.0	13,444	0.2%	-0.2%	0.0%	0.0%	-0.2%	0.0%
Finland	1SW	17,499	0.25	0.65		8.0	38,885	0.7%	-0.6%	0.1%	0.3%	-0.7%	0.1%
Norway-N	1SW	77,121	0.35	0.70		8.0	183,614	3.6%	-2.5%	0.4%	2.4%	-3.3%	0.3%
Norway-M	1SW	85,179	0.35	0.60		8.0	236,598	4.7%	-3.7%	0.5%	3.1%	-4.3%	0.4%
Norway-S	1SW	85,179	0.35	0.60		8.0	236,598	4.7%	-3.7%	0.5%	3.1%	-4.3%	0.4%
Sweden	1SW	7,103	0.15	0.73		8.0	12,486	0.2%	-0.2%	0.0%	0.0%	-0.2%	0.0%
Russia	1SW	27,702	0.40	0.30		8.0	166,718	3.6%	-4.6%	0.4%	2.8%	-3.0%	0.3%
Faroes	1SW	225	0.15	1.00		0.5	266	-	-	-	-	-	-
Total Northern Area - 1SW:							914,904						
Northern European Stock Complex -MSW													
Iceland 1	MSW	2,358	0.02	0.60		17.0	4,753	0.1%	-0.1%	0.0%	0.0%	-0.1%	0.0%
Iceland 2	MSW	2,624	0.02	0.60		17.0	5,290	0.1%	-0.1%	0.0%	0.0%	-0.1%	0.0%
Finland	MSW	8,698	0.25	0.55		17.0	24,993	0.6%	-0.6%	0.1%	0.3%	-0.6%	0.1%
Norway-N	MSW	57,286	0.35	0.70		17.0	149,234	4.0%	-2.8%	0.4%	2.7%	-3.7%	0.8%
Norway-M	MSW	38,204	0.35	0.60		17.0	116,111	3.1%	-2.5%	0.3%	2.1%	-2.9%	0.6%
Norway-S	MSW	38,204	0.35	0.60		17.0	116,111	3.1%	-2.5%	0.3%	2.1%	-2.9%	0.6%
Sweden	MSW	3,196	0.15	0.73		17.0	6,147	0.1%	-0.1%	0.0%	0.0%	-0.2%	0.0%
Russia	MSW	9,413	0.70	0.15		17.0	247,939	18.4%	-14.8%	0.7%	32.3%	-6.1%	1.3%
Faroes	MSW	1,765	0.00	1.00		1.5	1,792	-	-	-	-	-	-
Total Northern Area - MSW:							672,371						
Southern European Stock Complex - 1SW													
France	1SW	1,792	0.00	0.13		8.0	15,530	0.2%	-0.8%	0.0%	0.0%	-0.3%	0.0%
Ireland	1SW	211,035	0.15	0.66		8.0	405,419	6.1%	-6.0%	0.9%	1.7%	-7.6%	0.7%
UK(Eng&Wales)	1SW	23,461	0.20	0.26		8.0	122,187	2.0%	-3.8%	0.3%	0.7%	-2.3%	0.2%
UK(N Ireland) 1	1SW	31,038	0.10	0.58		8.0	64,412	0.9%	-1.1%	0.1%	0.2%	-1.2%	0.1%
UK(N Ireland) 2	1SW	10,826	0.10	0.58		8.0	22,467	0.3%	-0.4%	0.1%	0.1%	-0.4%	0.0%
UK(Scotland) E	1SW	21,328	0.10	0.17	34,666	7.5	187,622	2.1%	-6.3%	0.4%	0.4%	-2.8%	0.3%
UK(Scotland) W	1SW	5,568	0.20	0.11		8.0	68,543	1.1%	-3.7%	0.2%	0.4%	-1.3%	0.1%
Greenland	1SW	0	0.00	1.00		7.5	0	-	-	-	-	-	-
Total Southern Area - 1SW:							886,179						
Southern European Stock Complex - MSW													
France	MSW	1,277	0.00	0.30		17.0	5,045	0.1%	-0.3%	0.0%	0.0%	-0.2%	0.0%
Ireland	MSW	17,185	0.15	0.51		17.0	46,910	1.5%	-1.8%	0.2%	0.4%	-1.9%	0.4%
UK(Eng&Wales)	MSW	7,008	0.20	0.22		18.0	47,671	1.6%	-3.5%	0.2%	0.6%	-1.9%	0.4%
UK(N Ireland) 1	MSW	1,634	0.10	0.33		17.0	6,621	0.2%	-0.4%	0.0%	0.0%	-0.3%	0.1%
UK(N Ireland) 2	MSW	570	0.10	0.33		17.0	2,310	0.1%	-0.1%	0.0%	0.0%	-0.1%	0.0%
UK(Scotland) E	MSW	25,287	0.10	0.17	34,666	17.5	238,178	5.8%	-17.3%	1.1%	1.1%	-7.8%	2.0%
UK(Scotland) W	MSW	4,487	0.20	0.11		17.0	60,437	2.0%	-6.8%	0.3%	0.8%	-2.4%	0.5%
Greenland	MSW	8,171	0.40	1.00		9.0	14,901	-	-	-	-	-	-
Total Southern Area - MSW:							422,074						

M 0.01

Table 3.7.3.1 **Conservation limit options for NEAC stock groups estimated from national lagged lagged egg deposition model and from of river specific values (where available)**

	National model CLs		River specific CLs		Conservation Limit used	
	1SW	**MSW**	**1SW**	**MSW**	**1SW**	**MSW**
Northern Europe						
Finland	9,112	5,607	-	-	9,112	5,607
Iceland	28,093	7,200	-	-	28,093	7,200
Norway	131,246	79,857	-	-	131,246	79,857
Russia	75,479	80,808	-	-	75,479	80,808
Swed'n	-	-	2,720	830	2,720	830
				Conservation Limit:	**246,650**	**174,302**
				Spawner escapement reserve:	**267,192**	**206,601**
Southern Europe						
France	-	-	17,400	5,100	17,400	5,100
Ireland	187,338	43,172	-	-	187,338	43,172
UK(EW)	-	-	53,000	17,500	53,000	17,500
UK(NI)	16,592	2,309	-	-	16,592	2,309
UK(Sc)	614,363	433,364	-	-	614,363	433,364
				Conservation Limit:	**888,692**	**501,445**
				Spawner escapement reserve:	**957,907**	**594,365**

Table 3.9.1. Cruises with surface trawling (flotation on trawl wings) in 2000, captures of post-smolts and adult salmon and smolt catch per unit of effort (trawl hours, CPUE)

Year and Cruise	Gear	Dates	Total number of surface hauls	% hauls with post-smolt captures	Number of post-smolts captured	Number of salmon captured	CPUE	Area
2000- 1 [2]	*Harstad* [C]*; Fish lift*	*06 - 28.05*	*50*	*n.a*	*n.a.*	*n.a.*	*n.a.*	*Selected fjords SW-Norway (Salmon lice investigatons)*
2000- 2 [2]	*Firkløver trawl* [B]*; Fish lift*	*10 - 31.05*	*93*	*42*	*291*	*7*	*2.2*	*Norwegian coastal current, Fjords SW – Mid Norway.*
2000- 3 [2]	Åkra trawl [A]; Fish lift	*10 - 20.06*	*14*	*64*	*268*	*6*	*9*	*Norwegian Sea , Voering plateau*
2000- 4	*Åkra trawl* [A]	*24 - 28.06*	*2*	*0*	*0*	*0*	*0*	*The Halten Bank, Norwegian Sea*
2000- 5 [2]	*Firkløver trawl* [B]*; Fish lift*	*28.06 - 24.07*	*106*	*30*	*202*	*13*	*1.22*	*Selected fjords N-Norway and S- Barents Sea (special salmon cruise)*
2000- 6	*Åkra trawl* [A]	*21.07 - 16.08*	*26*	*12*	*5*	*0*	*0.38*	*Norwegian Sea*
2000- 7	*Harstad 25 x 25m float- trawl*	*17.08 - 07.09*	*3*	*n.a*	*0*	*1*[1]	*0*	*Western Barents Sea*
TOTAL	2000		294		766	38		

[A] Dimensions of the Åkra trawl opening 25 x 25 m
[B] Dimensions of the Firkløver trawl opening 18.5 x 18.5 m
[C] Dimensions of the Harstad float trawl opening 14 x 14 m

[1] The salmon was captured in a sub-surface trawl (haul)
[2] Cruises dedicated to salmon investigations

Figure 3.3.3.1 Percent changes in gear units licened or authorised for net fishery in the NEAC are since 1996 (5-year period).

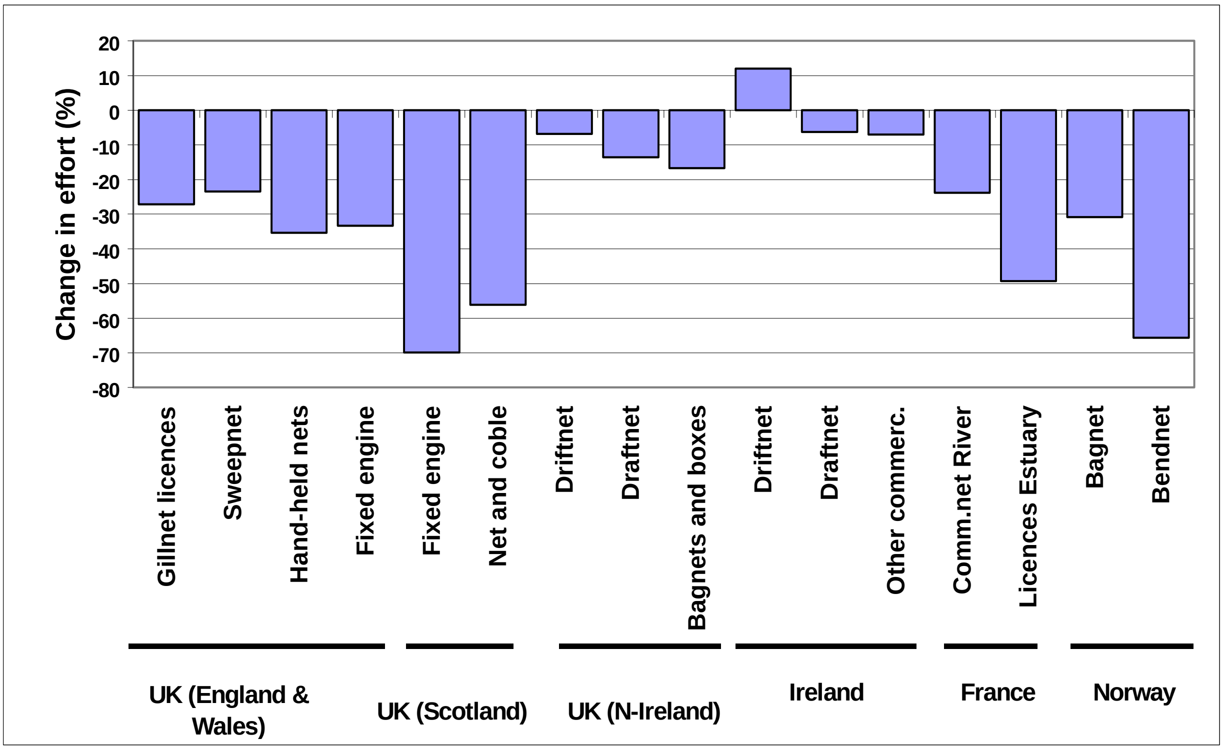
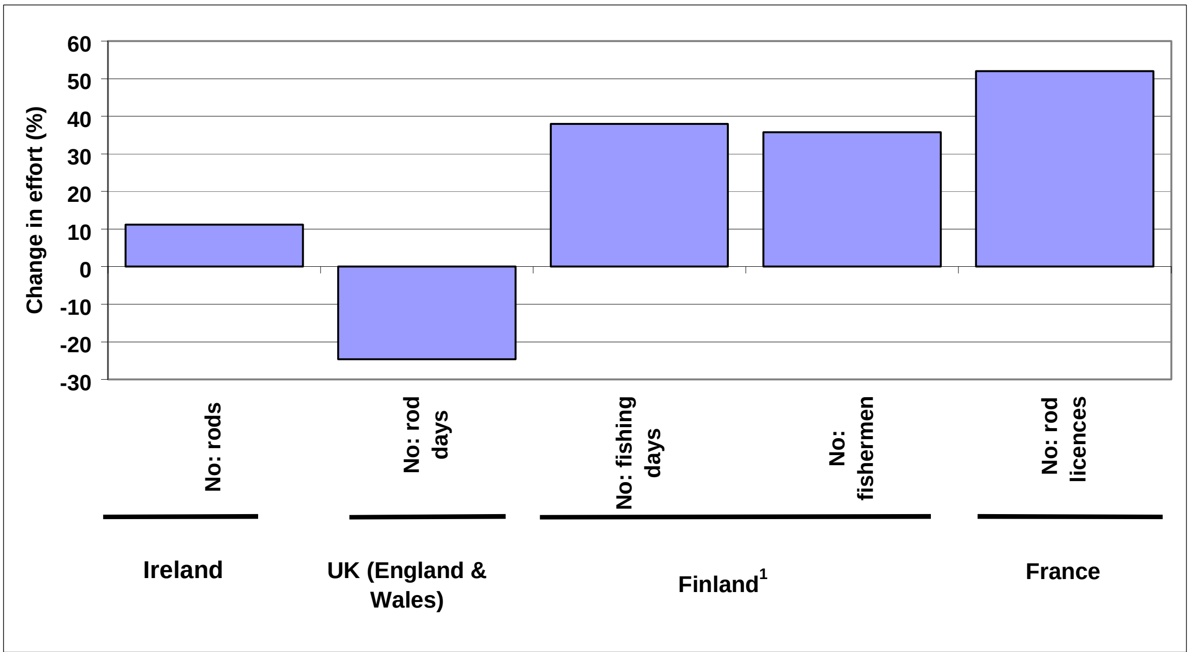


Figure 3.3.3.2 Percent changes in number of rod days, or rods licened or authorised in the NEAC are since 1996 (5-year period).



1 The number of fishermen and fishing days for River Teno and River Naatamo are combined.

Figure 3.3.4.1 Nominal catches of salmon in the NEAC area in year 2000 relative to mean catches in the preceeding 10-year and 5-year period. Countries are ordered after size of change.

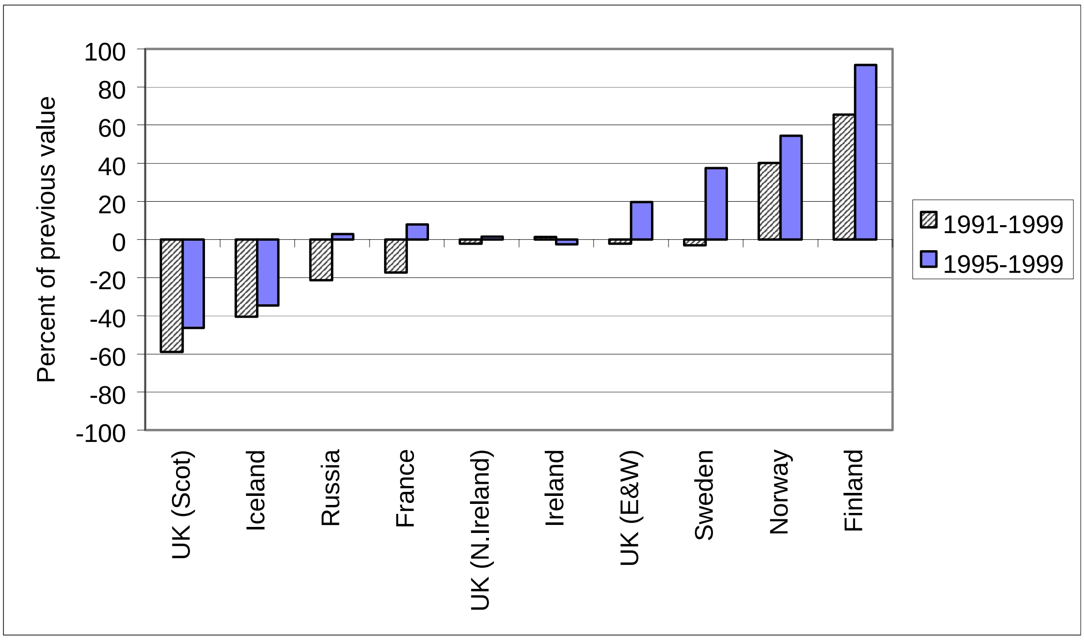
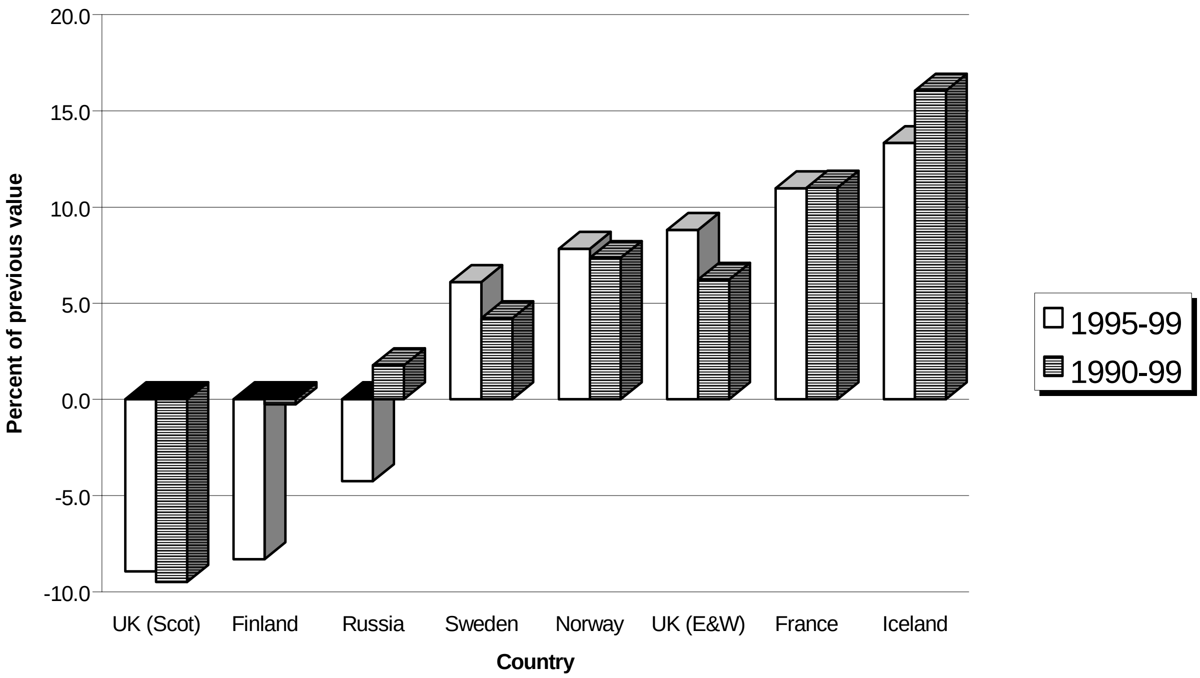


Figure 3.3.6.1. The proportions of 1SW salmon in the NEAC catches in 2000 relative to previous indices



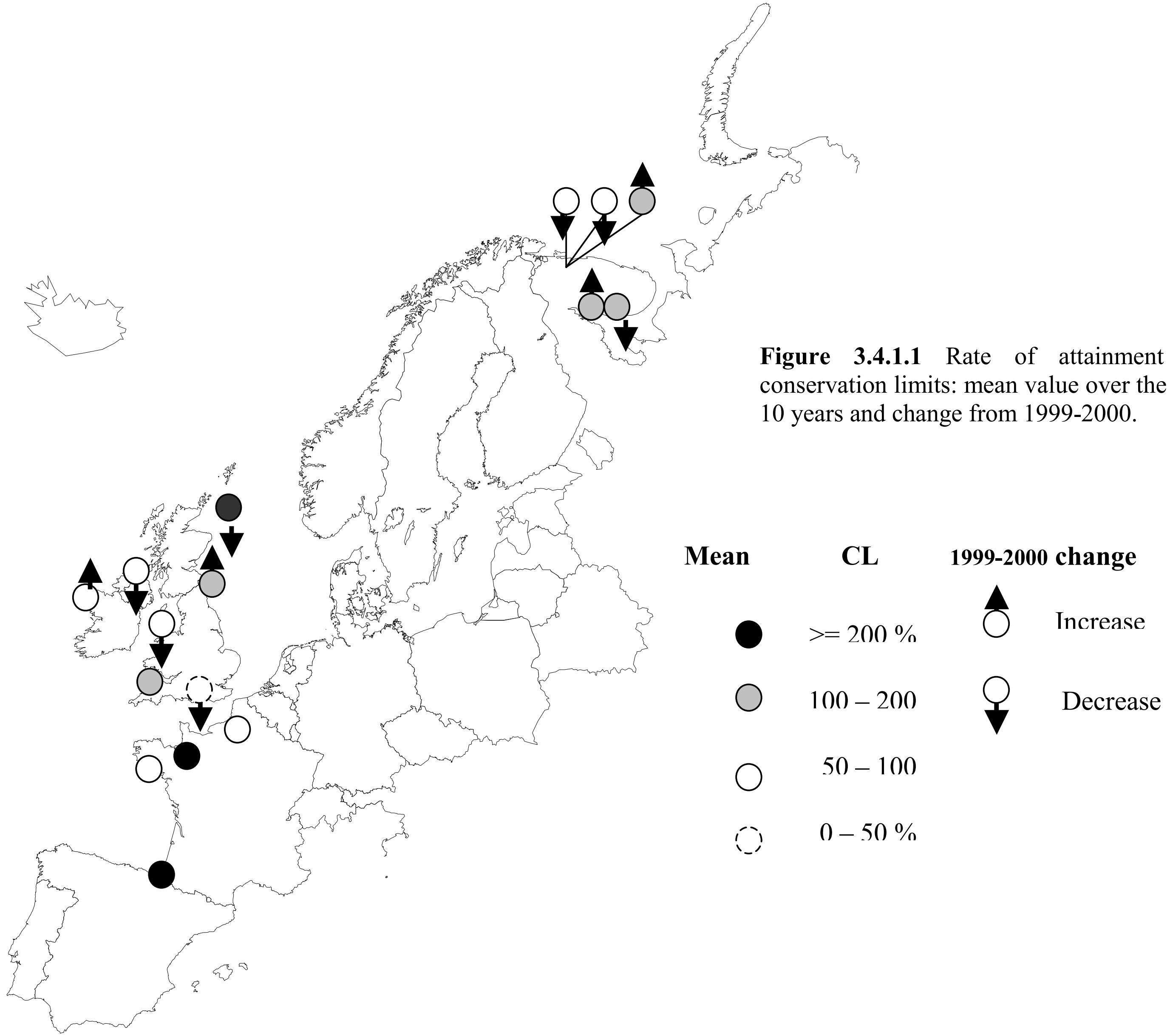


Figure 3.4.1.1 Rate of attainment of conservation limits: mean value over the last 10 years and change from 1999-2000.

Fig. 3.4.1.2. Conservation limit (CL) attainment (egg deposition/conservation limit, %) for index rivers having a mean egg deposition below (Type A), around (Type B) or above (Types C&D) the CL over the 10 previous years
the CL over the 10 previous years.

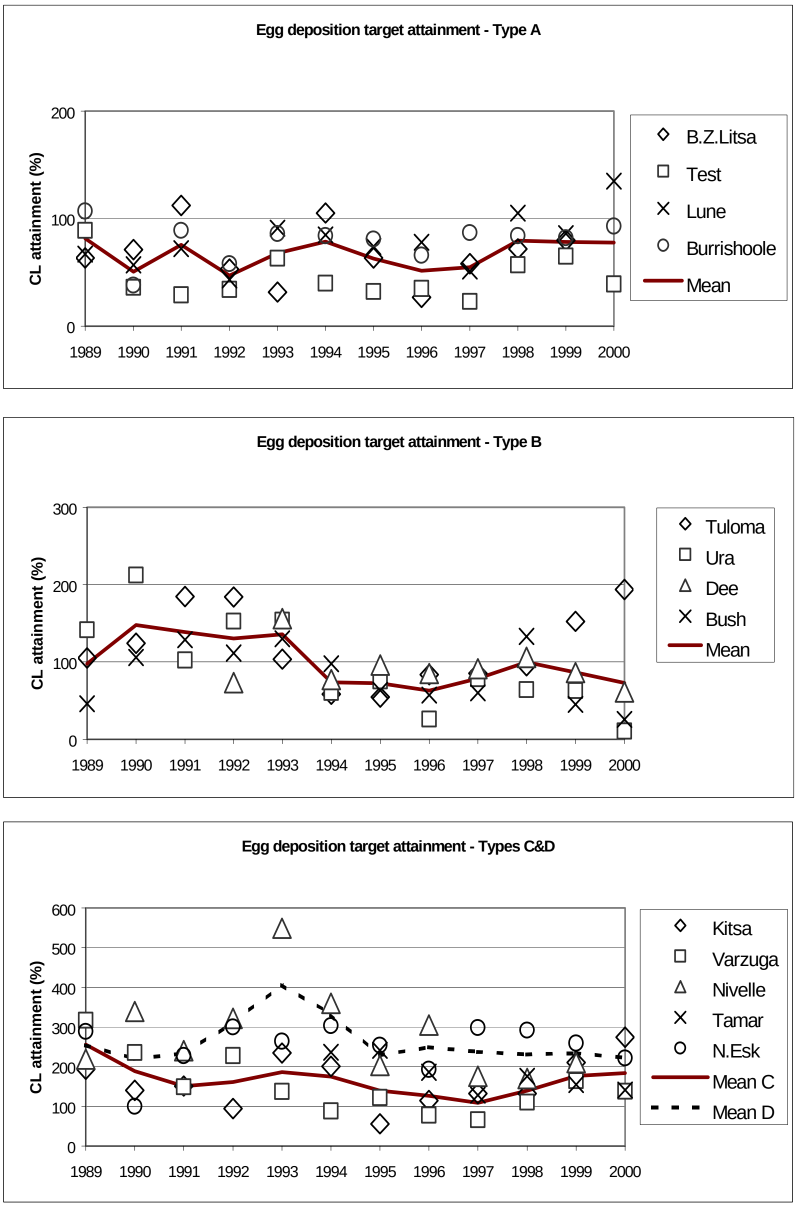
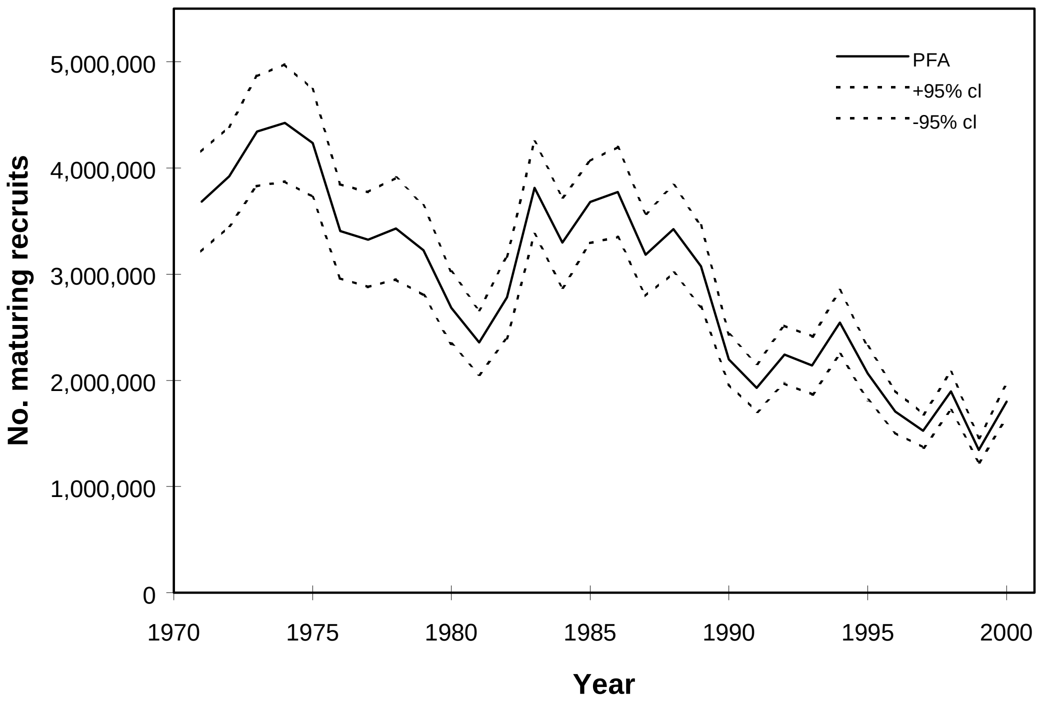


Figure 3.6.4.1 Estimated recruitment (PFA) in the NEAC Area, 1970-2000

a) Maturing 1SW recruits (potential 1SW returns)

(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)

(Recruits in Year N become spawners in Year N+1)

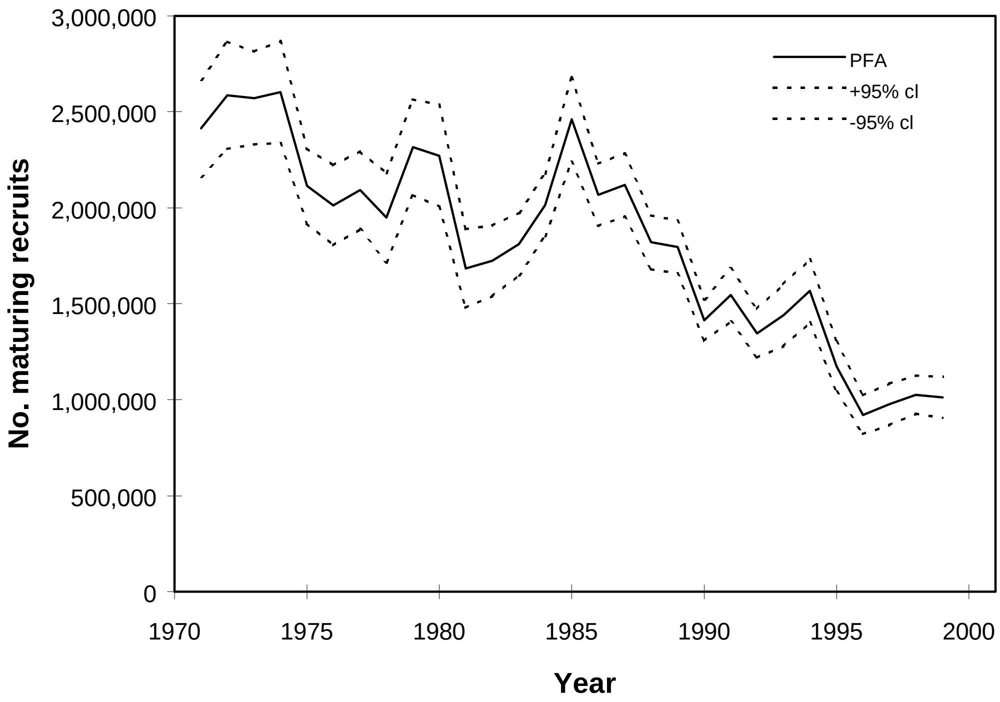
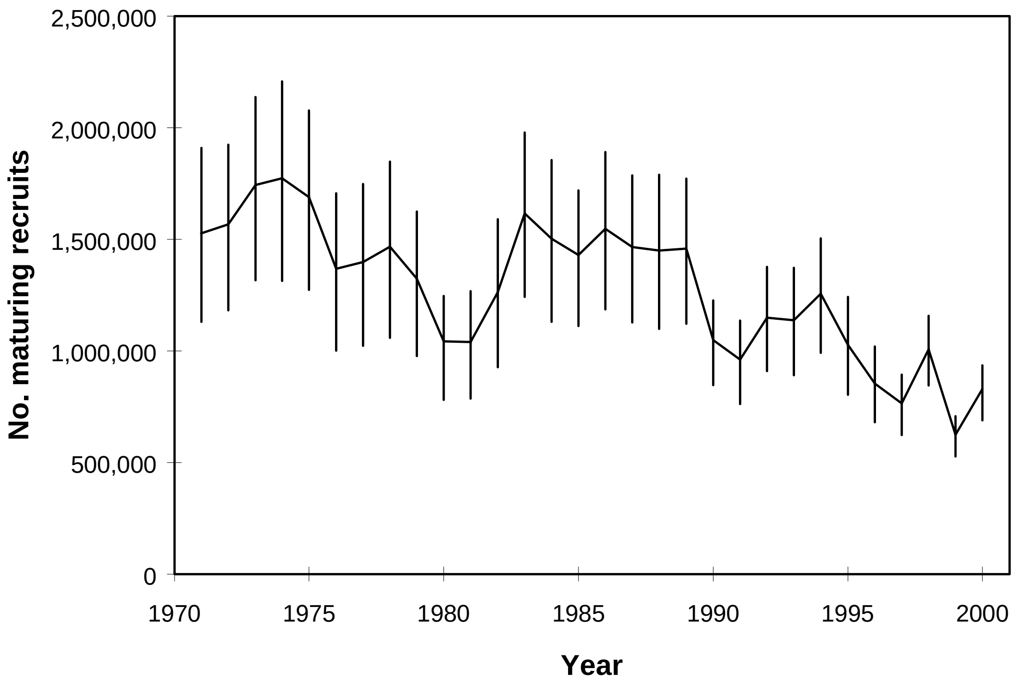


Figure 3.6.4.2 Estimated spawning escapement in the NEAC Area, 1970-2000

a) 1SW spawners (and 95% confidence limits)



b) MSW spawners (and 95% confidenance limits)

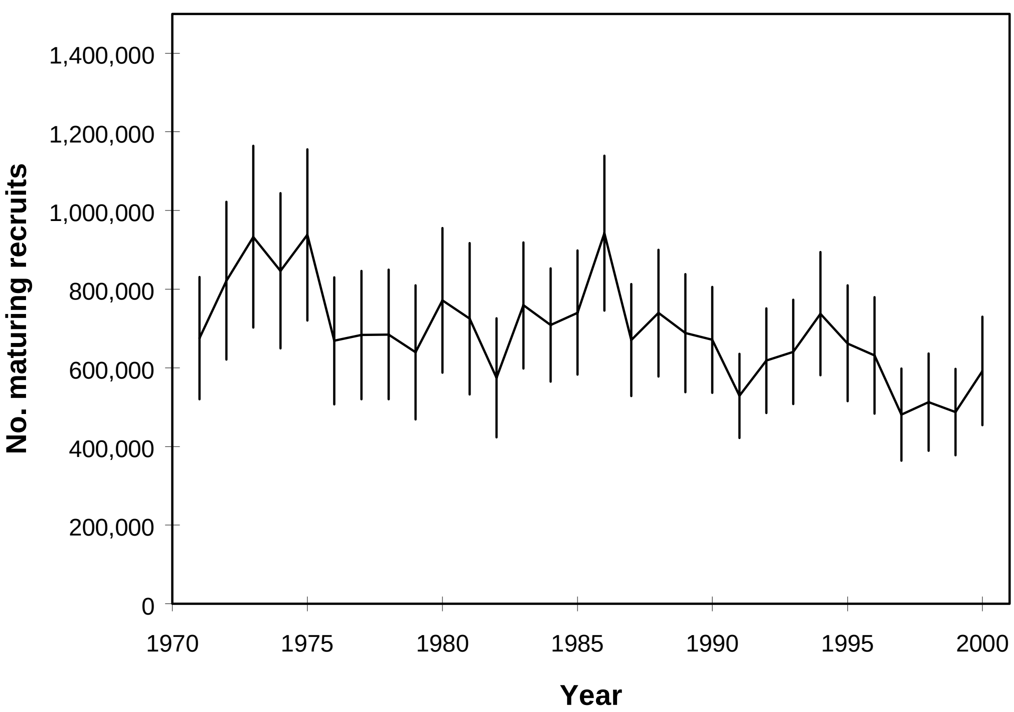
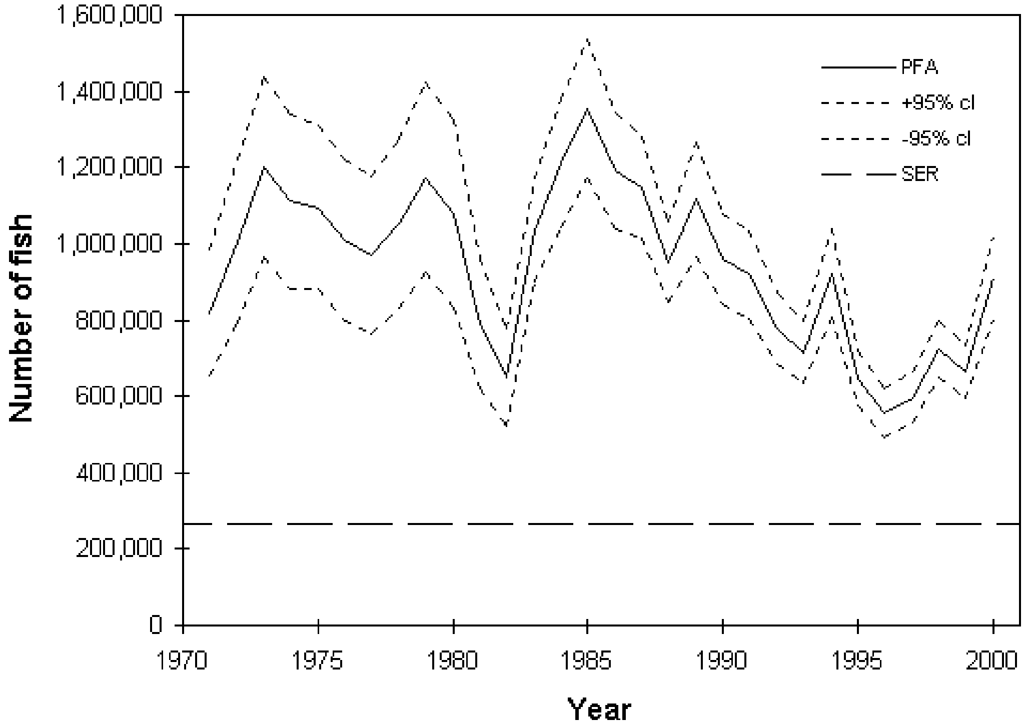


Figure 3.6.4.3 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Northern Europe, 1971-2000.

a) Maturing 1SW recruits (potential 1SW returns)

(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)

(Recruits in Year N become spawners in Year N+1)

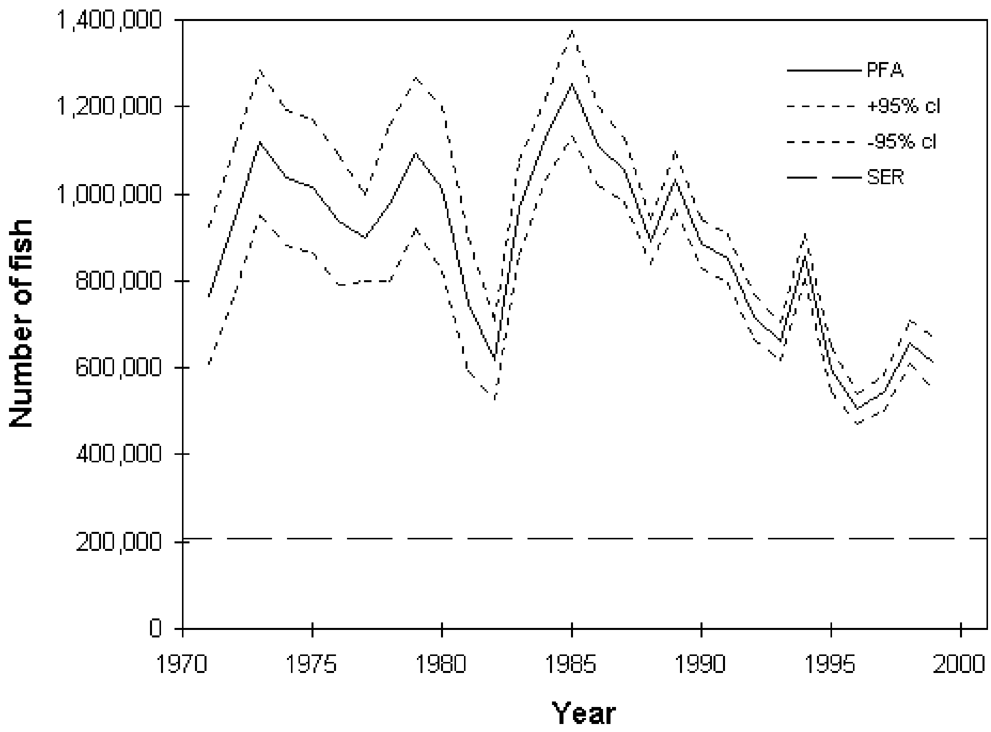
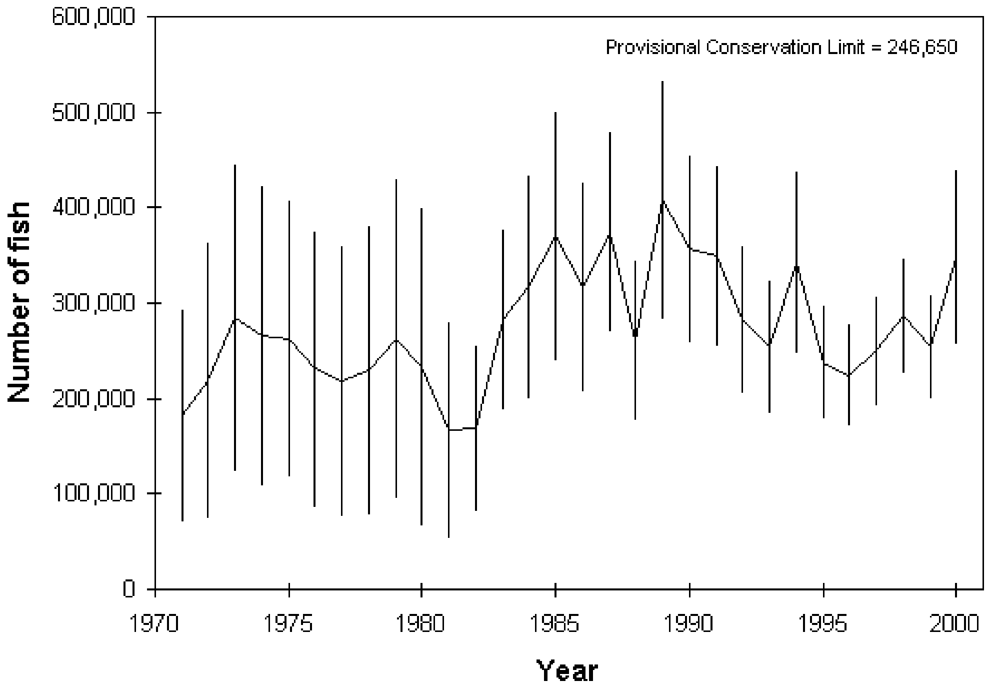


Figure 3.6.4.4 Estimated spawning escapement of maturing and non-maturing salmon in Northern Europe, 1971-2000.

a) 1SW spawners (and 95% confidence limits)



b) MSW spawners (and 95% confidence limits)

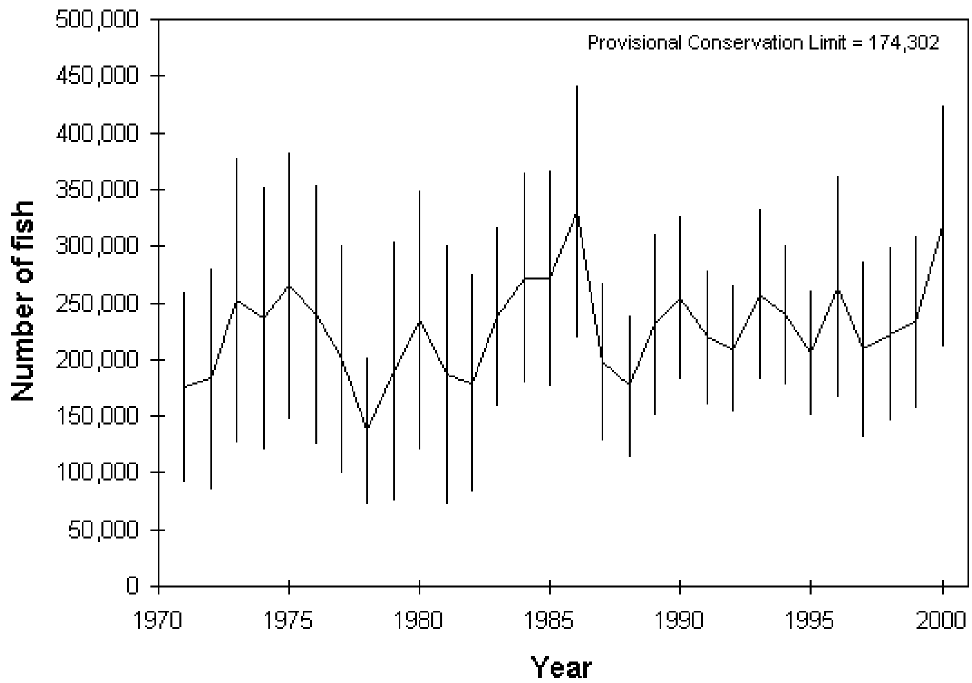
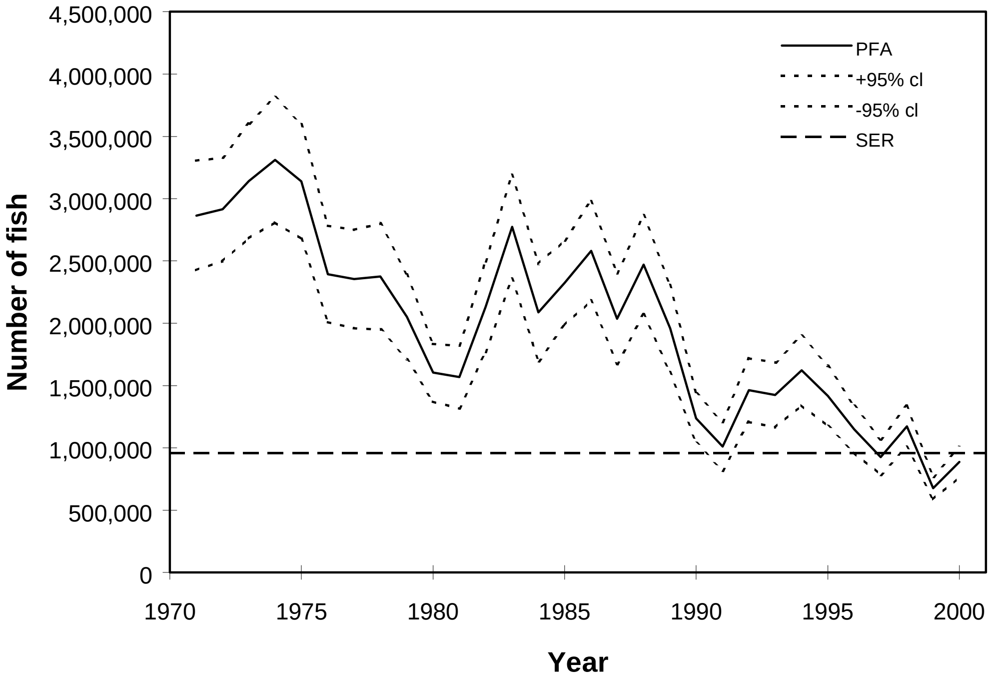


Figure 3.6.4.5 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Southern Europe, 1971-2000.

a) Maturing 1SW recruits (PFA) (potential 1SW returns)
(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)
(Recruits in Year N become spawners in Year N+1)

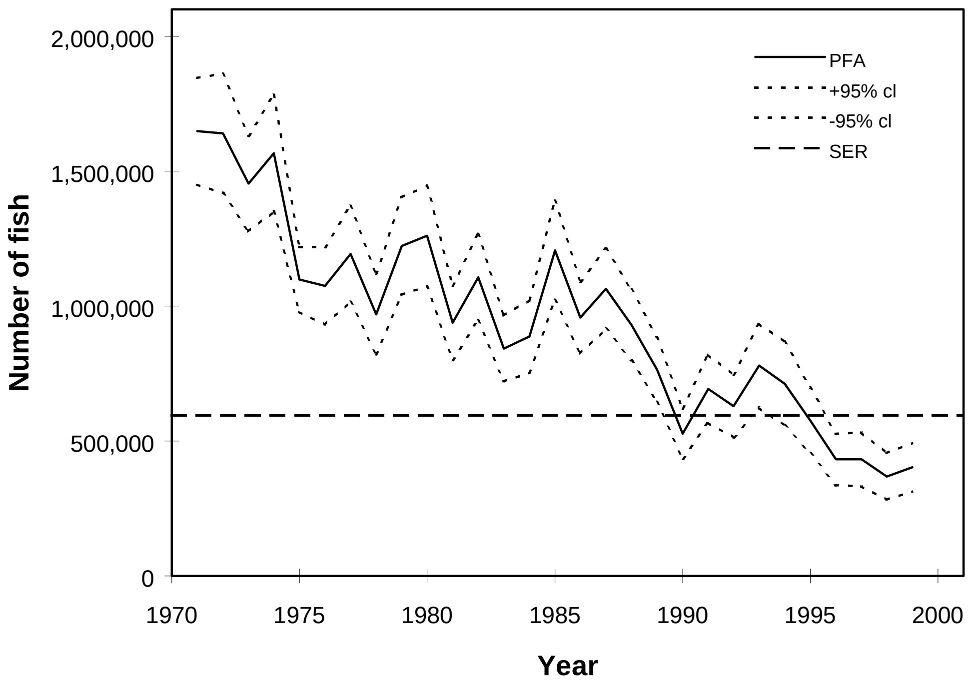
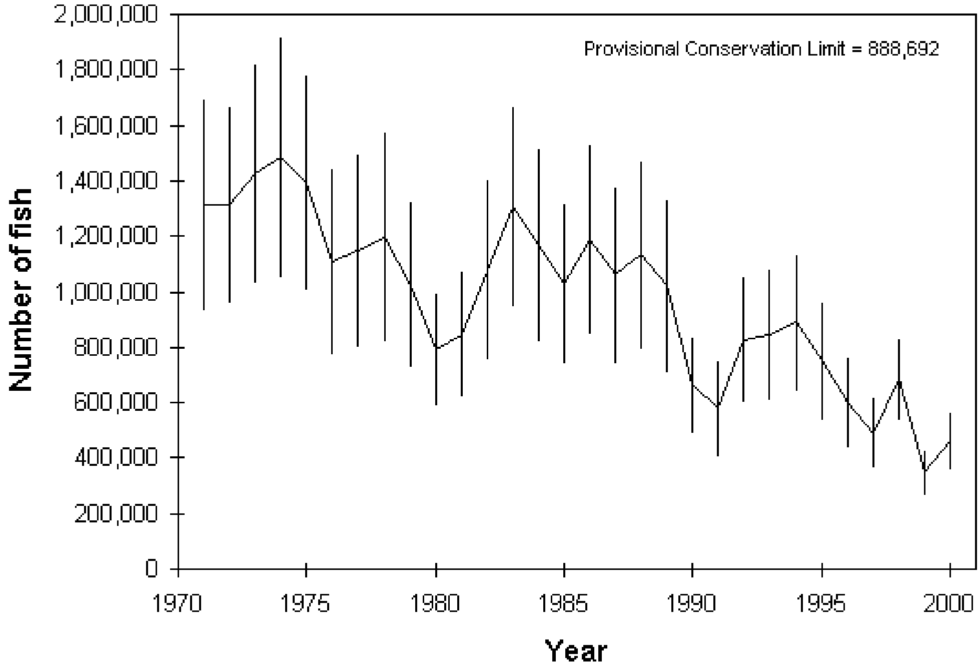


Figure 3.6.4.6 Estimated spawning escapement of maturing and non-maturing salmon in Southern Europe, 1971-2000.

a) 1SW spawners (and 95% confidence limits)



b) MSW spawners (and 95% confidence limits)

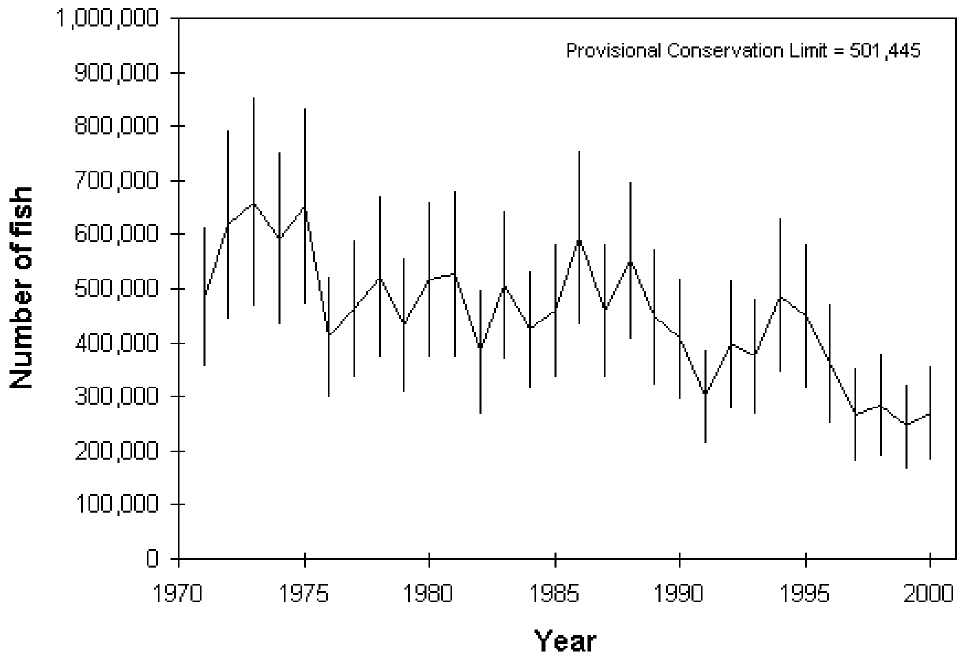


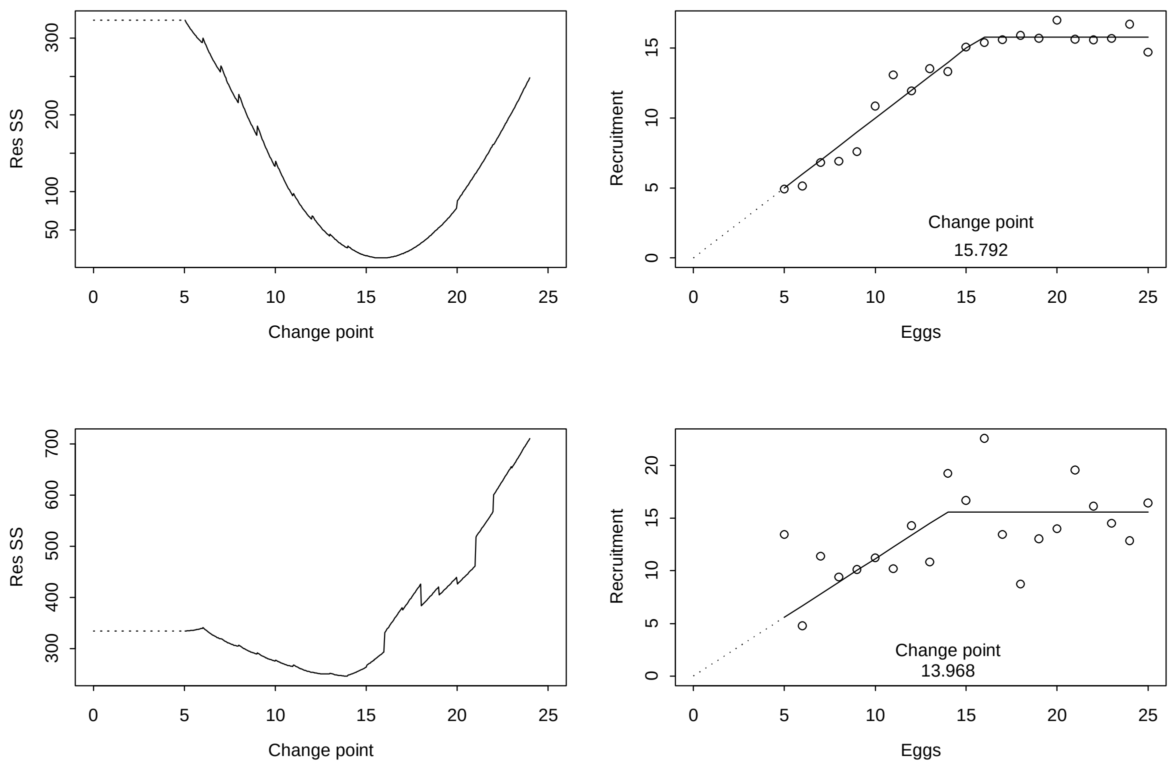
Figure 3.7.2.1 Demonstration of the simple model for establishing conservation limits

Top right: Simulated stock recruitment data with little variability

Top left: Model output for low variability data - residual sum of squares against change points

Bottom right: Simulated data with large variability

Bottom left: Model output for high variability data - Residual sum of squares against change points



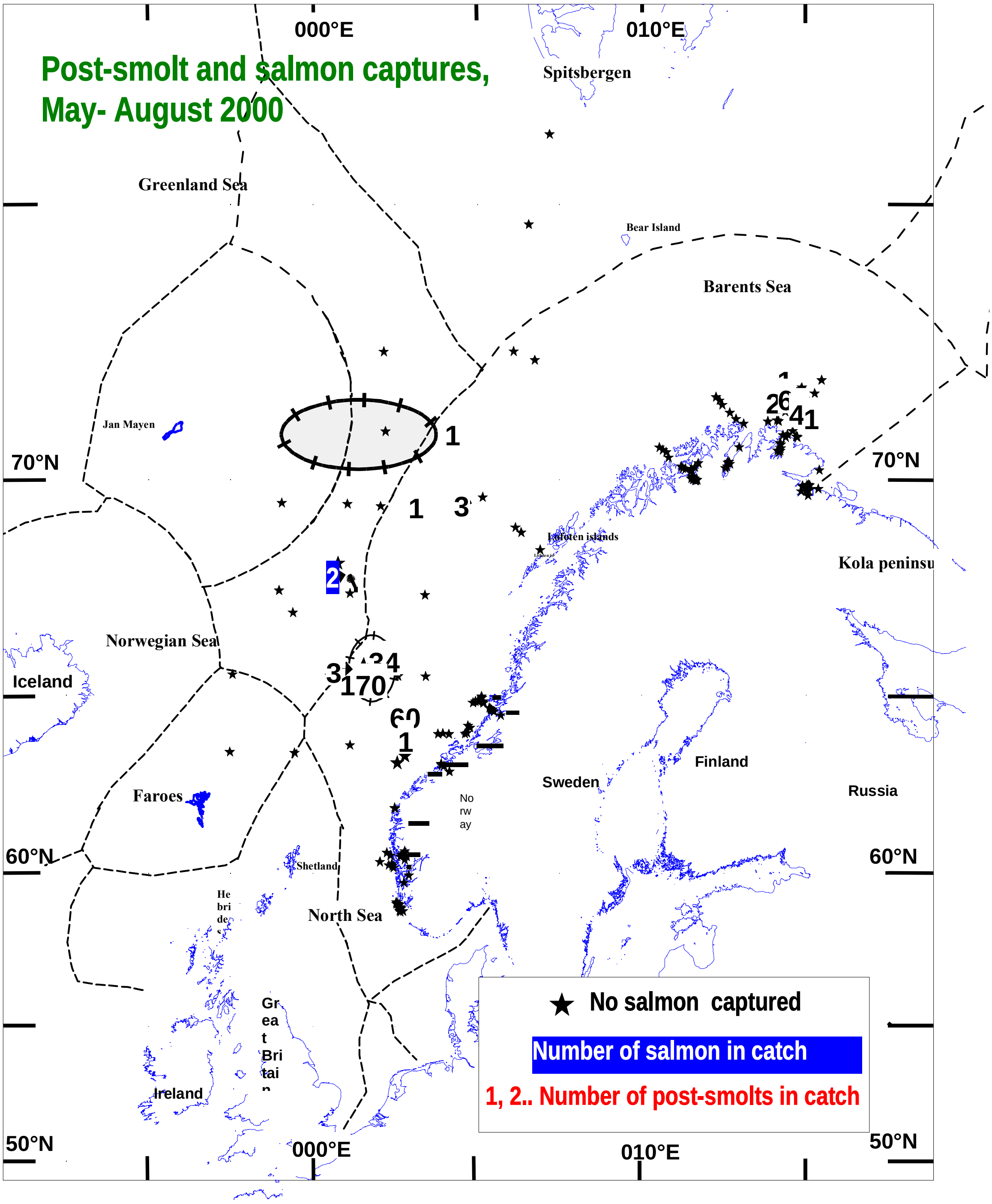


Figure 3.9.1 Post-smolt and salmon captures in surface trawl hauls in 2000 (legends in figure). Area of captures at special salmon survey in June, and sites of capture of micro-tagged and Carlin-tagged fish encircled. Shaded circle further north indicates area of captures of micro-tagged fish in July/ August 1995 – 97. EEZs of countries bordering the NE-Atlantic are drawn as dashed lines.

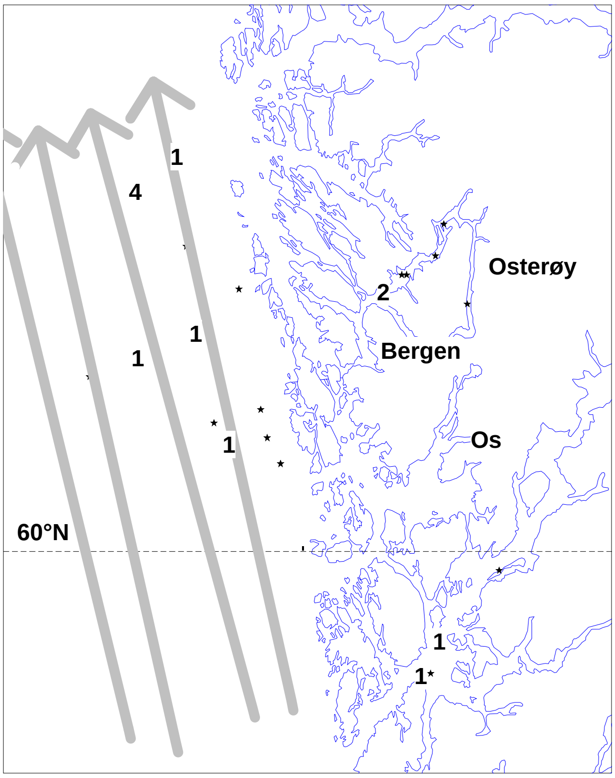


Figure 3.9.2 Surface trawl captures of post-smolts at the coast in the Norwegian Coastal Current (drawn as grey arrows). Stars mark trawl hauls with no salmon, numbers mark post-smolts in the catch

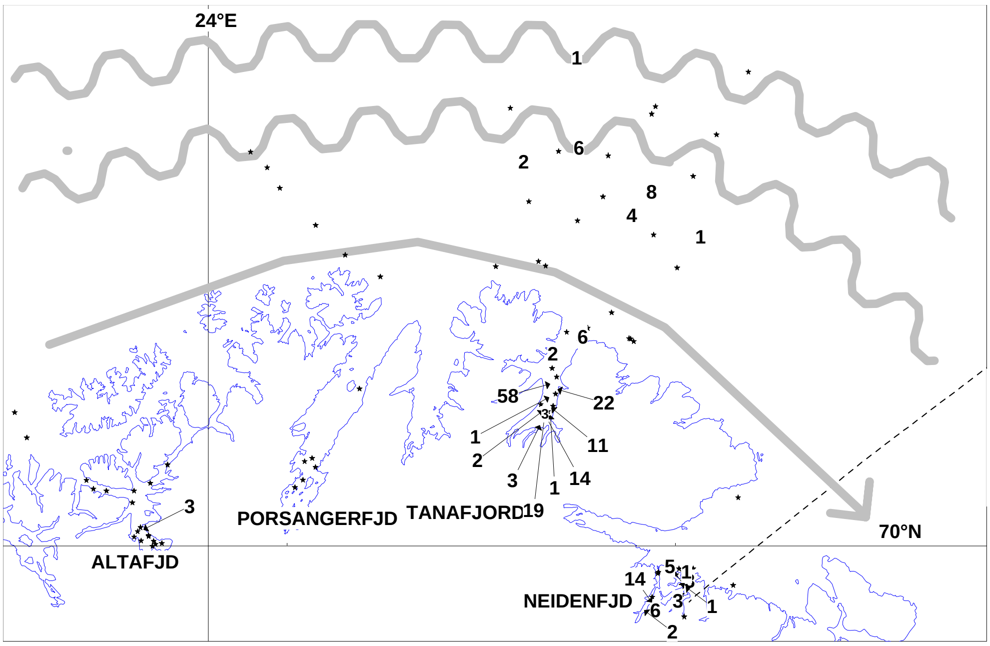


Figure 3.9.3 Surface trawl surveys in four fjords in northern Norway 28 June – 24.July. Catch legends as in figure 3.9.2. The coastal current is presented as a grey arrow, while the warmer more saline Atlantic current is presented as undulating lines

4 FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA

4.1 Description of Fisheries

4.1.1 Gear and effort

Canada

The 23 areas for which the Department and Fisheries and Oceans (DFO) manages the salmon fisheries are called Salmon Fishing Areas (SFAs); for Québec, the management is delegated to the Société de la Faune et des Parcs du Québec and the fishing areas are designated by Q1 through Q11 (Figure 4.1.1.1). Harvest (fish which are killed and retained) and catches (including harvests and fish caught-and-released in recreational fisheries) are categorized in two size groups: small and large. Small salmon in the recreational fisheries refer to salmon less than 63 cm fork length, whereas in commercial fisheries, it refers to salmon less than 2.7 kg whole weight. Large salmon in recreational fisheries are greater than or equal to 63 cm fork length and in commercial fisheries refer to salmon greater than or equal to 2.7 kg whole weight.

Three user groups exploited salmon in Canada in 2000: Native peoples, residents fishing for food in Labrador and recreational fishers. Commercial fisheries in Québec which operated in 1999 in zone Q9 were closed and licenses bought back in 2000. Commercial quotas normally fished by Native peoples in Ungava Bay (zone Q11) remained closed. Hence there were no commercial fisheries in Canada in 2000.

The following management measures were in effect in 2000:

<u>Native peoples' food fisheries</u>: In Québec, Native peoples' food fisheries took place subject to agreements or through permits issued to the bands. There are 10 bands with subsistence fisheries in addition to the fishing activities of the Inuit in Ungava (Q11), who fished in estuaries or within rivers. The permits generally stipulate gear, season and catch limits. Catches for subsistence fisheries have to be reported collectively by each native user group. However, if reports are not available, the catches are estimated. In the Maritimes and Newfoundland (SFAs 1 to 23), food fishery harvest agreements were signed with several Native peoples groups (mostly First Nations) in 2000. The signed agreements often included allocations of small and large salmon. Harvests which occurred both within and outside agreements were obtained directly from the Native peoples. Harvest by Native peoples with recreational or commercial licenses are reported under the recreational and commercial harvest categories.

<u>Residents food fisheries in Labrador</u>: In the Lake Melville (SFA 1) and the coastal southern Labrador (SFA 2) areas, DFO allowed a food fishery for local residents. Residents who requested a license were permitted to retain a maximum of four (4) salmon of any size while fishing for trout and charr; 4 salmon tags accompanied each license. The license restricted the fishing gear to a gillnet of 15 fathoms (27.4 m) and 3.5 in (89 mm) mesh. The seasons were June 15-July 2 and July 24-August 19 in SFA 1 and July 15-August 31 in SFA 2. All licensees were to complete logbooks. A total of 970 licenses were issued.

<u>Recreational fisheries</u>: Recreational fisheries management in 2000 varied by area (Figure 4.1.1.2). Except in Québec and Labrador (SFA 1 and 2), only small salmon could be retained in the recreational fisheries.

The seasonal bag limits in the recreational fishery remained at eight small salmon in New Brunswick and in Nova Scotia. In SFA 16 and in Nepisiquit River (SFA 15) of New Brunswick, the small salmon daily retention limit remained at one fish. In the remainder of SFA 15 and in Nova Scotia (SFA 18), the daily retention limits were two small salmon. The maximum daily catch limit was four fish daily. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. Catch-and-release fishing only for all sizes of Atlantic salmon was in effect in SFA 19 of Nova Scotia. SFAs 20-23 of Nova Scotia and New Brunswick were closed to all salmon angling, except for five acid-impacted rivers on the Atlantic coast of Nova Scotia, where retention of small salmon, mostly of hatchery origin, was allowed.

For insular Newfoundland (SFAs 3 to 14A) and the Strait of Belle Isle shore of Labrador (SFA 14B), the second year of a three year management plan was continued for the recreational fishery which allowed differing seasonal retention limits based on the status of the salmon stocks in the rivers. Retention limits ranged from a seasonal limit of 6 fish on Class I rivers, to no retention and catch-and-release only on Class IV rivers (five rivers in 2000). Some rivers were closed to all angling and were not assigned a class number. The river classification scheme rated individual rivers as Class I (highest) to Class IV (lowest) according to their ability to sustain angling activities as follows:

Class I – large rivers with a seasonal bag limit of 6 fish,

Class II – smaller rivers with a season bag limit of 4 fish,

Class III – rivers with a season bag limit of 2 fish,

Class IV – rivers with catch and release only.

Special class – with various management plans.

In SFAs 1 and 2 of Labrador, there was a seasonal limit of four fish, only one of which could be a large salmon.

In Québec, management rules were set before the season opening as a way to reach conservation limits on each river. Fishing licenses allowed a total landing of 7 salmon for the year. The northern zones (Q8, Q9 and Q11) include 44 rivers which were managed mainly on a zonal basis. Sport fishing was permitted on all rivers except one and retention of both small and large salmon was allowed throughout the northern zones. The daily limit was three fish in Q9, two in Q8 and one in zone Q11. Release of large salmon occurred mainly on a voluntary basis. The 74 rivers of the southern zones were managed river by river. Fishing was not allowed on nine rivers, retention of small salmon only was in force on 34 rivers and retention of small and large was allowed on 31 rivers. On these rivers, fishing for the day would end if the first fish caught was a large salmon. If the first fish was a small salmon, then fishing could continue on most rivers until the second fish, small or large was caught. Seven additional rivers were restricted to retention of small salmon only after mid-season reviews as an insufficient numbers of spawners were detected by this time in the rivers. (Figure 4.1.1.2).

USA

There was no fishery for Atlantic salmon in the USA in 2000; in 1999, hook-and-release fishing only was permitted in some rivers.

France (Islands of Saint-Pierre and Miquelon)

For the Saint-Pierre and Miquelon fisheries in 2000, there were 8 professional and 35 recreational gillnet licenses issued. The number of professional fishermen has increased by one license from 1999 and the number of recreational licenses decreased by five licenses since 1999.

Year	Number of Professional Fishermen	Number of Recreational Licenses
1995	12	42
1996	12	42
1997	6	36
1998	9	42
1999	7	40
2000	8	35

4.1.2 Catch and catch per unit effort (CPUE)

Canada

The provisional harvest of salmon in 2000 by all users was 150 t, similar to the 1999 harvest of 152 t (Table 2.1.1.1; Figure 4.1.2.1). The 2000 harvest was 50,108 small salmon and 11,458 large salmon, about the same as the 1999 harvests for both (Table 4.1.2.1). The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort, the closure of the insular Newfoundland commercial fishery in 1992, the closure of the Labrador commercial fishery in 1998 and the closure of theQuébec commercial fishery in 2000 (Figure 4.1.2.1). These reductions were introduced as a result of declining abundance of salmon.

The 2000 harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and the fish-size group exploited (Table 4.1.2.1). Newfoundland reported the largest proportion of the total harvest of small salmon and Québec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in each province, accounting for 79% of the total small salmon harvests in eastern Canada. Unlike years previous to 1999 when commercial fisheries took the largest share of large salmon, food fisheries (including the Labrador resident food fishery) accounted for the largest share in 2000 (60% by number).

Native peoples' food fisheries. Harvests in 2000 (by weight) were up 10% from 1999 and 18% above the previous 5-year average harvest. In some cases, particularly in the Maritime provinces, Native peoples' food fisheries harvests in 2000 were less than the allocations.

Native peoples' food fisheries			
		% large	
Year	**Harvest (t)**	**by weight**	**by number**
1990	31.9	78	
1991	29.1	87	
1992	34.2	83	
1993	42.6	83	
1994	41.7	83	58
1995	32.8	82	56
1996	47.9	87	65
1997	39.4	91	74
1998	47.9	83	63
1999	45.9	73	49
2000	50.3	69	43

Residents Fishing for Food in Labrador: A total of 633 logbooks have been processed for this fishery. The estimated catch for the entire fishery in 2000 was 5.6 t, about 2,300 fish (79% small salmon by number).

Recreational fisheries: Harvest in recreational fisheries in 2000 totaled 44,412 small and large salmon, 20% below the previous 5-year average and 8% below the 1999 harvest level (Figure 4.1.2.2). The small salmon harvest of 39,785 fish was a decrease of 19% from the previous 5-year mean. The large salmon harvest of 4,627 fish was a 32% decline from the previous five-year mean. Small and large salmon harvests were down 9% and 4% from 1999, respectively. The small salmon size group has contributed 87% on average of the total harvests since the imposition of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland (SFA 3 to 14B, 15 to 23) in 1984 (Figure 4.1.2.2).

Recreational catches (including retained and released fish) of small salmon in 2000 were similar or above the 1984 to 1991 mean in some fishing areas of Québec (Q1,Q2,Q3,Q5), and the north-east coast and northern peninsula of Newfoundland and throughout Labrador (Figure 4.1.2.3). Small salmon catches were among the lowest observed in the majority of the Maritimes. Large salmon catches were among the lowest observed throughout mainland Canada but were among the highest in the west coast of Newfoundland, (SFA 13, 14A) and Labrador (SFAs 1,2, and 14B).

In 1984, anglers were required to release all large salmon in the Maritime provinces and insular Newfoundland. Changes in the management of the recreational fisheries since 1984 have compromised the use of angling catches as indices of abundance. Therefore, the interpretation of trends in abundance relies mostly on rivers where returns have been estimated or completely enumerated. Caught-and-released fish are not considered equivalent to retained fish and their inclusion in catch statistics further compromises the reliability of interpretation of trends. In more recent years, anglers have been required to release all salmon on some rivers for conservation reasons and, on others, they are voluntarily releasing angled fish. In addition, numerous areas in the Maritimes Region in 2000 were closed to retention of all sizes of salmon (Figure 4.1.1.2).

Hook-and-released salmon fisheries: In 2000, about 49,700 salmon (about 20,700 large and 29,000 small) were caught and released (Table 4.1.2.2), representing about 51% of the total number caught, including retained fish. This was a 1% increase from the number released in 1999. Most of the fish released were in New Brunswick (44%), followed by Newfoundland (43%), Québec (9%), Nova Scotia (3%) and Prince Edward Island (0.3%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, Nova Scotia released the highest percentage (84%), followed by New Brunswick (57%), Newfoundland (56%), Prince Edward Island (49%) and Québec (31%).

Commercial fisheries: All commercial fisheries for Atlantic salmon were closed in Canada in 2000 and the catch therefore was 0. Catches have decreased from a peak in 1980 of almost 2,500 t to 0 currently as a result of effort reductions, low abundance of stocks and closures of fisheries (Figure 4.1.2.4).

Unreported catches: Canada's unreported catch estimate for 2000 is about 124 t, compared to 133 t in 1999. Estimates were included for all provinces (but not for all areas within the provinces) and were provided mainly by scientific staff. In the many cases where enforcement staff did not respond to requests for estimates, values previously provided by them were assumed for 2000. An exception to this was Labrador where the unreported catch estimate for 1999 was 6.3 t. No new estimate was provided for 2000 and it was determined to be inappropriate to use the 1999 estimate as most of the unreported catch in 1999 was ascribed to fisheries that are now included in the reported catch. In all areas, most unreported catch arises from illegal fishing or illegal retention of bycatch of salmon.

By stock groupings used for Canadian stocks throughout the report, the unreported catch estimates for 2000 were:

Stock Area	Unreported Catch (t)
Labrador	No estimate
Newfoundland	65
Gulf	39
Scotia-Fundy	< 1
Québec	19
Total	124

USA

All fisheries (commercial and recreational) for sea-run Atlantic salmon within the USA are now closed, including rivers previously open to catch-and-release fishing. Thus, there was no harvest of sea-run Atlantic salmon in the USA in 2000. Incidental catch was four Atlantic salmon, caught and released as the result of angling for other species (three on the Penobscot River and one on the Narraguagus River). As in 1999, unreported catches in the USA were estimated to be 0 t.

France (Islands of Saint-Pierre and Miquelon)

The harvest in 2000 was reported to be 2.3 t, the same as in 1998 and 1999, split about equally between professional and recreational fishermen in 2000 (Table 2.1.1.1). There was no estimate made of unreported catch for 2000.

4.1.3 Origin and composition of catches

In the past, salmon from both Canada and USA have been taken in the commercial fisheries of eastern Canada. These fisheries have since been closed. The remaining Native 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 in 2000. The fisheries of Saint Pierre and Miquelon catch salmon of both Canadian and US origin. Little sampling occurs in these remaining fisheries and often the best information on stock origins comes from sampling of the returns to rivers, rather than the fisheries.

Fish designated as being of wild origin are defined as the progeny of fish where mate selection occurred naturally (eggs not stripped and fertilised artificially) and whose life cycle is completed in the natural environment (ICES 1997/Assess:10). Hatchery-origin fish, designated as fish introduced into the rivers regardless of life stage, were identified on the basis of the presence of an adipose clip, from fin deformations, and/or from scale characteristics. Not all hatchery fish could be identified as such in the returns because of stocking in the early life stages. Aquaculture escapees were identified from hatchery fish on the basis of fin erosion (especially of the tail) and from scale characteristics.

The returns 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 (Figure 4.1.3.1). 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 present in the returns to four rivers of the Bay of Fundy and the coast of Maine (St. Croix, Magaguadavic, Union and Dennys) in 2000.

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to almost 32,000 t in 2000 (Table 2.2.1.1). Escapes of Atlantic salmon have occurred annually. In 1994, escapes of Atlantic salmon in the Bay of Fundy area were estimated at 20,000 to 40,000 salmon, an amount greater than the total returns of wild and hatchery origin salmon (both small and large) (13,000 to 21,000 fish) to the entire Bay of Fundy and Atlantic coast of Nova Scotia area (SFA 19 to 23) in the same year. The documented minimum numbers of farmed salmon that escaped in 1999 and 2000 from the North American east coast industry (Canada and USA combined) were 50,000 and 118,000 respectively (see Section 2.4.2).

The proportion of the run that are aquaculture escapees has been high (greater than 50%) since 1994 in the Magaguadavic River (SFA 23; Table 4.1.3.1) which is in close proximity to the centre of the aquaculture production area (Figure 4.1.3.2). Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of the total counts at the fishway. Aquaculture escapees comprised between 13% and 64% of the total run of salmon to the St. Croix River during 1994 to 2000 (Table 4.1.3.1). In addition to the St. Croix River, three other rivers in Maine were monitored for the occurrence of farmed salmon in 2000, the Union, Dennys and Narraguagus. Percentages of returns which were of farmed origin were 60, 94 and 0%, respectively.

4.1.4 Exploitation rates in Canadian and USA fisheries

Canada

In Newfoundland, exploitation rates were available for seven rivers in 2000. For those rivers with retention of small salmon, exploitation rates ranged from 6% to 28%. In Labrador, exploitation rates were available for two rivers; exploitation rates for small salmon range from 2% to 9% and 0 to 2% for large salmon.

In Québec, exploitation rates were estimated using mid-point estimates of returns and recreational landings. Exploitation rates for small salmon were18% and for large salmon, 10%.

In previous years, overall Canadian exploitation rates were calculated as the harvest of salmon divided by the estimated returns to North America. No estimates of returns to Labrador are possible for 1998, 1999 and 2000, as there was no commercial fishery and there was insufficient information collected on freshwater escapements to extrapolate to other Labrador rivers. For this reason, exploitation rates cannot be calculated for 1998 - 2000. Harvests in 2000 of 50,108 small and 11,458 large salmon were less than those of 1997, substantially in the case of large salmon. Exploitation rates in 1997 were estimated to be between 0.14 and 0.26 for small and 0.15 and 0.25 for large salmon.

USA

There was no exploitation of USA salmon in homewaters and no salmon of USA origin were reported in Canadian fisheries in 2000.

4.2 Status of Stocks in the North American Commission Area

There are approximately 550 Atlantic salmon rivers in eastern Canada and 21 rivers in eastern USA each of which could contain at least one population of salmon. Assessments are prepared for a limited number of specific rivers, because they compose significant fractions of the salmon resource or are indicators of patterns within a region, or because of the demands by user groups, or as a result of requests for biological advice from fisheries management. The status is evaluated by examining trends in returns and escapement relative to the conservation requirements.

4.2.1 Measures of abundance in monitored rivers

Canada

The returns represent the size of the population before any in-river and estuarine removals. Spawning escapement is determined by subtracting all the known removals, including food fisheries, recreational harvests, broodstock collections, and scientific samples from the total returns.

A total of 72 rivers were assessed in eastern Canada in 2000. Estimates of total returns of small and large salmon were obtained using various techniques: 37 were derived from counts at fishways and counting fences; 4 were obtained using mark and recapture experiments; 24 using visual counts by snorkeling or from shore; and 7 from angling catches, and redd counts.

2000 compared to 1999 adult returns: Of the 72 stocks for which returns of salmon were determined in 2000, comparable data were available for 68 of these in 1999. For 51 of these rivers, returns were estimated by small salmon and large salmon size groups separately in both years (Table 4.2.1.1). For both size groups combined, returns in 2000 were less than 50% of the 1999 returns in seven of the rivers assessed (10%), between 50% and 90% of 1999 returns in 28 (41%) of the rivers and were 90% or greater than 1999 returns in 33 (49%) of the rivers. The Newfoundland rivers showed the highest number of improvements in returns.

Large salmon returns in 2000 decreased from 1999 in rivers throughout the Maritime provinces (63%) and in Québec (85%). Lower proportions of the rivers were down or improved in Newfoundland (52%) (Table 4.2.1.1; Figure 4.2.1.1). In most of the rivers of Newfoundland, except for rivers of the south-west coast (SFA 13), large salmon are mostly repeat-spawning 1SW fish.

Small salmon returns in 2000 relative to 1999 were generally reduced throughout eastern Canada in the majority of their monitored rivers except in Québec (23%) (Table 4.2.1.1, Figure 4.2.1.1). Returns were similar to or improved (>90% in 2000 relative to 1999) in about half (53%) of the assessed rivers but decrease to 45% excluding Québec's rivers.

1985-2000 patterns of adult returns: Annual returns of salmon by size group are available for 26 rivers in eastern Canada since 1985. These returns do not account for commercial fisheries removals in Newfoundland, Labrador, Québec and Greenland and in some rivers include returns from hatchery stocking. Peak return years differed for regions within eastern Canada (Figure 4.2.1.2). The returns during the Newfoundland commercial fishery moratorium years (1992 to 2000) for all areas except Newfoundland are lower than returns in 1986 to 1988 when there were commercial fisheries in Newfoundland, Labrador, Québec and Greenland harvesting mainland Canada origin salmon. The total returns to seven Newfoundland rivers doubled during 1993 to 2000 from the low levels observed during 1989 to 1991 (Figure 4.2.1.2).

The returns for 2000 of large salmon in all areas except Newfoundland were among the lowest observed during the last 15 years and decreased in all regions except for the Gulf (Table 4.2.1.1, Figure 4.2.1.2). The returns of large salmon in 2000 were the lowest of the time series for the Nova Scotia and Bay of Fundy with a decrease of 68%. Returns of large salmon to ten rivers of Québec in 2000 were the second lowest since 1985. Returns of small salmon in Québec and Gulf rivers in 2000 increased from 1999. Returns to the rivers of the Atlantic coast (Nova Scotia and Bay of Fundy) and Newfoundland decreased for small salmon by 8 and 35% respectively.

Smolt and juvenile abundance: Counts of smolts provide direct measurements of the outputs from the freshwater habitat. Previous reports have documented the high annual variability in the annual smolt output: in tributaries, smolt output can vary by five times but in the counts for entire rivers, annual smolt output has generally varied in magnitude by a factor of two. Wild smolt production has been estimated in 11 rivers of eastern Canada, although only nine rivers have several years of data (Figure 4.2.1.3). In other rivers, juvenile abundance surveys have been conducted.

In 2000, smolt production from the two monitored rivers in Québec was among the lowest of the time series and about half of the 1990-95 average (Figure 4.2.1.4). In Newfoundland, smolt production in 2000 remained at or just above the 1990 to 1995 average but lower than recent years in three of the five rivers (Figure 4.2.1.4).

Juvenile salmon abundance has been monitored annually since 1971 in the Miramichi (SFA 16) and Restigouche (SFA 15) rivers and for shorter and variable time periods in other rivers (Figure 4.2.1.5). In the rivers of the southern Gulf (SFAs 15,16 and 18), densities of young-of-the-year (fry) and parr (juveniles of one or more years old) have increased since 1985 in response to increased spawning escapements (Figure 4.2.1.5). Densities of parr in 2000 increased to record values in the Restigouche River. In the Miramichi River, both fry and parr densities remained high in 2000 but dropped to near-mean values for 1985-1999. High densities of juveniles have also been reported from Nova Scotia rivers along the Gulf of St. Lawrence (SFA 18) and in several Cape Breton Island streams (SFA 19).

Rivers of SFAs 20 and 21 along the Atlantic coast of Nova Scotia are generally organic stained, of lower productivity, and, when combined with acid precipitation, can result in acidic conditions toxic to salmon. Prognoses for salmon populations in 47 of 65 of these rivers indicate that 40 populations are now likely to be extirpated. In the low-acidified St. Mary's River, fry (age 0^+) densities remain at moderate abundance while total parr (age-1^+ and older) densities are the lowest since 1993 (Figure 4.2.1.5). Juvenile densities in the outer Bay of Fundy (SFA 23) Saint John River and its tributaries, the Nashwaak, Hammond and Kennebecasis rivers, have declined since 1984 as a result of reduced spawning escapement.

Juvenile densities from inner Bay of Fundy rivers (SFA22 and a portion of SFA 23) are critically low and contribute to evidence for possible listing of these stocks pending the passage of the Species at Risk Act. In 2000, densities of parr in 33 electrofishing stations of the Stewiacke River were at a record low (Figure 4.2.1.5); no fry were found.

It is not possible to measure the total smolt production from the rivers of Atlantic Canada for any given year. However, juvenile abundance indices were considered as surrogates of smolt production from eastern Canada. To allow for the combined analysis of smolt counts and juvenile abundance surveys from all the rivers, the individual river surveys were standardized to a common period, 1995 to 1998.

Ind_{ij} = $Abund_{ij}$ / $Average_j$

where Ind_{ij} = Adjusted index of juvenile or smolt abundance for year *i* and river *j*

$Abund_{ij}$ = Measured abundance of juvenile or smolts for year *i* and river *j*

$Average_j$ = Average abundance for years 1995 to 1998 in river *j*

This adjustment places all the rivers on a common scale and provides a measure of the temporal variability in the smolt and juvenile measures. Juvenile measures were age 1 and older parr and were lagged forward one year to correspond to the smolt migration year.

The index of smolts from North America was obtained by weighting the annual river indices by the relative proportion of the conservation egg requirements (O'Connell *et al.* 1997) of the SFA or Zone to the total conservation egg requirements of the zones under consideration (Table 4.2.1.2). An alternative weighting incorporated the relative contribution to the 2SW spawner requirements of the areas or zones within North America. This allows indices of smolt production from all areas of North America to be used but attributes weights to the area indices according to the expected contribution to 2SW abundance.

The longest time series are from Western Arm Brook (SFA 14A) in Newfoundland and the Miramichi and Restigouche rivers in the Gulf (SFAs 15 and 16). The number of rivers with available data has increased from two in 1971 to greater than 25 rivers since 1995 (Table 4.2.1.3). The proportion of the indexed areas represented by the index rivers has increased from 11% in 1971 to more than 25% since 1993 (Table 4.2.1.3).

The relative index of smolt production, weighted by the area-index factor, indicates relative smolt production at three levels since 1971: at about one-third the 1995 to 1998 average between 1971 and 1979, at about 60% of the average during 1980 to 1989 and at about average since 1991 (Figure 4.2.1.6). The relative index for 2SW recruitment (calculated by excluding the Newfoundland areas which do not produce 2SW salmon, SFA 3-12, 14A or by weighting all areas according to the 2SW spawner requirements by area) suggests an overall similar trend.

Estimates of the relative smolt index in the four geographic areas correspond to the previously documented status of rivers (Figure 4.2.1.7). Smolt production from Newfoundland rivers has approximately doubled over the 1971 to 2000 time period (Figure 4.2.1.7). The Gulf smolt index is at its highest level in the 1990s. TheQuébec smolt index has declined between 1984 and 2000, driven by de la Trinité time series which forQuébec has a large area-index weight (Table 4.2.1.2). The relative index for Scotia-Fundy has essentially remained unchanged.

USA

The documented returns of Atlantic salmon to rivers in New England in 2000 was 803 fish. Returns of 1SW salmon were 270 compared to 358 in 1998 and 386 in 1999, while MSW returns decreased to 533. MSW returns were over 1,000 in the two previous years. Total salmon returns to the rivers of New England continued the downward trend that began in the mid-1980s, and were lower than the previous 5-year and 10-year averages. Documented Atlantic salmon returns to USA rivers since 1967 are shown in Figure 4.2.1.8. These are minimal estimates, since many rivers in Maine do not contain fish counting facilities, and where counting facilities exist, they do not count 100% of the returns.

The majority of the returns in 2000 were recorded in the rivers of Maine, with the Penobscot River accounting for nearly 67% of the total New England returns. The Connecticut River adult returns accounted for about 10% of the New England total and 46% of the adult returns outside of Maine. Overall, 34% of the adult returns to New England were 1SW salmon and 66% were MSW salmon. Most (72%) of these fish were of hatchery smolt origin. Of the total returns, approximately 28% were from natural reproduction and stocked fry.

4.2.2 Estimates of total abundance by geographic area

For assessment purposes, the following regions were considered: Labrador (SFA 1, 2, & 14B), Newfoundland (SFA 3−14A), Québec (Q1-Q11), Gulf of St. Lawrence (SFA 15-18), Scotia-Fundy (SFA 19-23) and USA. Returns of 1SW and 2SW salmon to each region (Tables 4.2.2.1 and 4.2.2.2; Figures 4.2.2.1 and 4.2.2.2; and Appendix 5) were estimated by updating the methods and variables used by Rago *et al.* (1993b) and reported in ICES 1993/Assess:10. The returns for both sea-age groups were derived using a variety of methods using data available for individual river systems and management areas. These methods included counts of salmon at monitoring facilities, population estimates from mark-recapture studies, and the application of angling and commercial catch statistics, angling exploitation rates, and measurements of freshwater habitat (Appendix 5). The 2SW component of the MSW returns was determined using the sea-age composition of one or more indicator stocks.

In the context used here "returns" are the number of salmon that returned to the geographic region, including homewater commercial fisheries, except in the case of Newfoundland and Labrador regions where returns do not include commercial fisheries. This was done to avoid double counting of fish when commercial catches in Newfoundland and Labrador are added to returns of all geographic areas in North America to create the PFA of North American salmon.

<u>Labrador</u>: 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. Catch and effort data from the angling fishery were collected by DFO enforcement staff in conjunction with angling reports submitted by fish camp operators and processed by DFO Science Branch personnel. In 1997 for SFA 14B, the angling catch statistics were derived from a licence stub system similar to insular Newfoundland while in SFAs 1 & 2 the camp statistics data were used. Commercial catch data were collected by DFO enforcement staff from fish plant landing slips and processed by DFO Statistics and Informatics Branch personnel.

In 1998-2000, there was no commercial fishery in Labrador and although counting projects took place in 2000 on two small Labrador rivers, out of about 100 salmon rivers that exist, it is not possible to extrapolate from these rivers to unsurveyed ones. For Labrador, returns were previously estimated from commercial catches and exploitation rates. As there was no commercial fishery since 1998, it was not possible to estimate the returns or spawners to Labrador for these years.

<u>Newfoundland</u>: The estimates of 1SW and 2SW returns and spawners for insular Newfoundland (SFAs 3−12 & 14A) are updated for the entire time series. Prior to 1999, they are derived from exploitation rates estimated from rivers with counting facilities which are subsequently applied to angling catches of small salmon, adjusted for the proportions of large:small salmon at counting facilities, and finally the proportion of large salmon that are 2SW. Exploitation rates for small salmon (retained only) were calculated by dividing the total count and the catch (retained) from rivers with enumeration facilities. In 1997, for SFAs 3−14A, angling catch data was derived from the license stub return system (O'Connell *et al.* 1997) while in previous years angling catch data was collected by DFO Fishery Officers and Guardian staff. For SFA 13, returns and spawners come from four assessment facilities expanded to the entire drainage area based on their proportionate contribution. The time series of ratios of large:small salmon were updated to include counts for some rivers not previously available. In last years report, a precision index was developed for Newfoundland based on known counts at enumeration facilities. It was noted that in some instances the index for the minimum value was higher than one, indicating that for some years, more salmon were counted than estimated. In order to correct this, exploitation rates were revised based on a weighted average of those rates available for assessed rivers. The new exploitation rates are:

Year	95^{th}.C.I.	5^{th}.C.I.
1995	0.1460	0.0674
1996	0.1500	0.0624
1997	0.1906	0.1149
1998	0.1360	0.0758

The dramatic changes to estimates of returns of both 1SW and 2SW salmon that occurred in 1995 and 1996 were due to lower exploitation rates for the three largest rivers in Newfoundland compared to the smaller ones (Figure 4.2.2.3). Therefore, when averages were weighted to the size of the returns to the rivers and were used instead of unweighted, the lower exploitation rate resulted in higher population estimates. The weighted averages were considered to be more appropriate than unweighted ones as the larger rivers have higher returns which would not have been as well estimated with the higher unweighted exploitation rates.

Beginning in 1999, the method used in previous years was modified to take into consideration the changes implemented in the 1999-2001 Salmon Management Plan. The Management Plan introduced, for the first time, a river classification scheme with different season limits for each of classes I-IV and, in addition, some other rivers were placed in a special class with a different management plan for each river. Since the intent of the Management Plan was to alter exploitation for rivers in the various classes, it would be better to model the estimation procedure for returns and spawners individually for each of them. However, there are too few rivers in each class to do so, there only being ten rivers available in 1999 and seven in 2000 with which to estimate parameter values for three river classes separately. The 95th confidence intervals of bootstrap estimates of unweighted exploitation rates and ratios of large:small salmon were generated from the assessment rivers with retention angling fisheries. The unweighted averages were used as large rivers are now being dealt with independently. Population estimates for all rivers with counting facilities were included from their assessment information. In order to avoid double counting, the catches of rivers whose populations were included from assessments were subtracted from the total catch. In 1999, most of the Class IV rivers were in Bay St. George area of SFA 13 and the entire area returns and spawners were estimated based on assessments for 8 rivers expanded to the total drainage based on their proportionate contribution. In 2000, the rivers in Bay St. George were in three separate classes and were dealt with independently.

The mid-point of the estimated returns (184,100) of 1SW salmon to Newfoundland rivers in 2000 is 4% lower than 1999 and 8% higher than the average 1SW returns (170,300) for the period 1992–95 (Figure 4.2.2.1, Appendix 5). The 1992–95 1SW returns are higher than the returns in 1989-91, but similar to the returns to the rivers between 1971 and 1988. The mid-point (9,300) of the estimated 2SW returns to Newfoundland rivers in 2000 remained the same as in 1999 (Figure 4.2.2.2, Appendix 5).

Québec: The mid-point (30,800) of the estimated returns of 1SW salmon to Québec in 2000 remained the same as the returns observed in 1999 and about the same as the 1995-99 average of 30,759 (Figure 4.2.2.1, Appendix 5).

The mid-point (29,600) of the estimated returns of 2SW salmon in Québec in 2000 is about the same as the returns observed for 1999 and a 21% decrease from the average of the years 1995-99 of 37,566 (Figure 4.2.2.2). Within the 1971-2000 time series, the 2000 value is the third lowest estimated and continues to decline from the high of 98,000 2SW salmon in 1980.

Gulf of St. Lawrence, SFAs 15–18: The mid-point (51,900) of the estimated returns in 2000 of 1SW salmon returning to the Gulf of St. Lawrence was a 27% increase from 1999 and it is the third lowest value since 1984. The low values noted in 1997 through 2000 are low relative to the high value of about 189,000 in 1992 (Figure 4.2.2.1, Appendix 5).

The mid-point (22,000) of the estimate of 2SW returns in 2000 is 5% higher than the estimate for 1999 and the fourth lowest of the time series (Figure 4.2.2.1, Appendix 5), the lowest being 1979 at 11,500. Returns of 2SW salmon have declined since 1995 with only slight improvement shown in 1999 and 2000.

Scotia-Fundy, SFAs 19-23: The mid-point (14,700) of the estimate of the 1SW returns in 2000 to the Scotia-Fundy Region was a 7% increase from the 1999 estimate, and the fifth lowest value in the time series, 1971-2000. Returns have generally been low since 1990 (Figure 4.2.2.1, Appendix 5).

The mid-point (3,600) of the 2SW returns in 2000 is 52% lower than the returns in 1999 and the lowest value in the time series, 1971–2000 (Figure 4.2.2.2, Appendix 5). A declining trend in returns has been observed from 1985 to 2000.

USA: Total salmon returns and spawners for USA rivers in 2000 were based on trap and weir catches (documented returns. Although some Maine rivers do not have fish counting facilities, a large portion of the total adult returns are documented and a method of estimating spawning escapement (and variance) in smaller Maine rivers based on redd counts is being developed. However, for 2000 the number of USA spawners was considered to be the same as the returns. The 1SW returns and spawners to USA rivers in 2000 were 270 fish. This was below the 1999 estimate and the previous 5-year and 10-year averages. The 2SW returns and spawners to USA rivers in 2000 were 515 fish. This was also below the 1999 estimate and below the 5-year and 10-year averages. There were also 18 3SW and repeat spawners in the USA returns.

4.2.3 Pre-fishery abundance estimates of non-maturing and maturing 1SW North American salmon

4.2.3.1 North American run-reconstruction model

The Working Group has 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 have been updated from those used in ICES 2000/ACFM:13 (Table 4.2.3.1). The North American run-reconstruction model has also been used to estimate the fishery exploitation rates for West Greenland and in homewaters.

4.2.3.2 Non-maturing 1SW salmon

The non-maturing component of 1SW fish, destined to be 2SW returns (excludes 3SW and previous spawners) is represented by the pre-fishery abundance estimator for year i designated as [NN1(i)]. Definitions of the variables are given in Table 4.2.3.2. It is constructed by summing 2SW returns in year i+1 [NR2(i+1)], 2SW salmon catches in commercial and native peoples' food fisheries in Canada [NC2(i+1)] and catches in year i from fisheries on non-maturing 1SW salmon in Canada [NC1(i)] and Greenland [NG1(i)]. In Labrador, native peoples' food harvests of small (AH_s) and large salmon (AH_l) were included in the reported catches for 1999-2000. Because harvests occurred in both Lake Melville and coastal areas of northern Labrador, the fraction of these catches that are immature was labeled as af_imm. This was necessary because non-maturing salmon do not occur in Lake Melville where approximately half the catch originated. However, non-maturing salmon may occur in coastal marine areas in the remainder of northern Labrador. Consequently, af_imm for the fraction of native peoples' harvests that were non-maturing was set at 0.05 to 0.1 which is half of f_imm from commercial fishery samples. The equations used to calculate NC1 and NC2 are as follows:

Eq. 4.2.3.1 $NC1(i) = [(H\_s(i)_{\{1\text{-}7,14b\}} + H\_l(i)_{\{1\text{-}7,14b\}} * q) * f\_imm]$

$+ [(AH\_s(i) + AH\_l(i) * q) * af\_imm]$, and

Eq. 4.2.3.2 $NC2(i+1) = [H\_l(i+1)_{\{1\text{-}7,14b\}} * (1\text{-}q)] + [AH\_l(i+1) * (1\text{-}q)]$

Similar to 1998 and 1999, the commercial fishery in Labrador remained closed in 2000. In past reports, salmon returns and spawners for Labrador which make up one of the six geographical areas contributing to NR2 for Canada were based on commercial fishery data. Since the commercial fishery was closed in Labrador in 1998, the time series also ended. However, in order to estimate pre-fishery abundance it was still necessary to include Labrador returns for 1998-2000. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time series of Labrador recruit estimates and pre-fishery abundance data from 1971-97. The raising factor (RFL2) to estimate returns to Labrador for 1998-2000 for 2SW salmon was set to the low and high range of values in the time series which was 1.05 to 1.27. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the numbers between the salmon fisheries on the 1SW and 2SW salmon (10 months) and between the fishery on 2SW salmon and returns to the rivers (1 month) as shown below:

Eq. 4.2.3.3 $NN1(i) = [RFL2*((NR2(i+1) / S1 + NC2(i+1))/S2 + NC1(i)] + NG1(i)$

where the parameters S1 and S2 are defined as exp(-M *1) and exp(-M *10), respectively. A detailed explanation of the model used to determine pre-fishery abundance is given in Rago *et al.* (1993a).

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for some of the fisheries harvesting potential or actual 2SW salmon. Commercial catches were not included in the run-reconstruction model for the West Greenland fishery (1993 and 1994), Newfoundland fishery (1992–2000) and Labrador fishery (1998-2000) as these fisheries were closed.

As the pre-fishery abundance estimates for potential 2SW salmon requires estimates of returns to rivers, the most recent year for which an estimate is available is 1999. This is because pre-fishery abundance estimates for 2000 require 2SW returns to rivers in North America in the year 2001 which of course are as of yet unavailable. The minimum and maximum values of the catches and returns for the 2SW cohort are summarized in Table 4.2.3.3. The 1999 abundance estimates ranged between 57,800 and 130,436 salmon. The mid-point of this range (94,118) is 2% higher than the 1998 value (92,479) and is the 2nd lowest in the 28-year time series (Figure 4.2.3.1). The most recent three years are shown with hollow symbols as no Labrador values were estimated for these years and the raising factor described previously was used. The results indicate a slight levelling off of the general decline from 807,000 in 1975. The Working Group expressed concern about the continued decline in the pre-fishery abundance and its impact on spawner levels.

4.2.3.3 Maturing 1SW salmon

Estimation of an aggregate measure of abundance has utility for identifying trends, evaluating management measures, and investigating the influence of the marine environment on survival, distribution, and abundance of salmon. Maturing 1SW salmon are in some areas a major component of salmon stocks and measuring their abundance is thought to be important to provide measures of abundance of the entire cohort from a specific smolt class.

For the commercial catches in Newfoundland and Labrador, all small salmon are assumed to be 1SW fish based on catch samples which show the percentage of 1SW salmon to be in excess of 95%. Large salmon are primarily MSW salmon but some maturing and non-maturing 1SW are also present in commercial catches in SFAs 1–7, 14B. Estimates of fractions of non-maturing salmon present in the Newfoundland and Labrador catch were presented in ICES 1991/Assess:12. The “large” category in SFAs 1–7 and 14B consists of 0.1–0.3 1SW salmon (Rago *et al.* 1993a; ICES 1993/Assess:10). Salmon catches in SFAs 8–14A are mainly maturing salmon (Idler *et al.* 1981). These values were assumed to apply to the Aboriginal food fishery catches in marine coastal areas of northern Labrador.

Similar to calculations to determine non-maturing 1SW salmon, a raising factor was also required to include Labrador returns in the maturing component of pre-fishery abundance necessitated by the closure of the commercial fishery in Labrador in 1998. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time series of Labrador recruit estimates and pre-fishery abundance data from 1971-97. The raising factor (RFL1) to estimate returns to Labrador for 1998-2000 for 1SW salmon was set to the low and high range of values in the time series which were 1.04 to 1.59.

The maturing 1SW component is represented by the pre-fishery abundance estimator for year i [MN1(i)]. It is constructed by summing maturing 1SW returns in year i [MR1(i)] in Canada and the USA and catches in year i from commercial and food fisheries on maturing 1SW salmon in Newfoundland and Labrador [MC1(i)]. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the numbers between the fishery on 1SW salmon and returns to the rivers (1 month) as shown below:

Eq. 4.2.3.4 $\quad MN1(i) = [MR1(i) / S1 + MC1(i)] * RFL1$

where the parameter S1 is defined as exp(-M * 1).

Eq. 4.2.3.5 $\quad MC1(i) = [(1\text{-}f\_imm)(H\_s(i)_{\{1\text{-}7,14b\}} + q*H\_l(i)_{\{1\text{-}7,14b\}})] + H\_s(i)_{\{8\text{–}14a\}}$

$$+ [(1\text{-}af\_imm)(AH\_s(i) + q*AH\_l(i))]$$

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for the fisheries harvesting 1SW salmon. Thus, catches used in the run-reconstruction model for the Newfoundland commercial fishery were set to zero for 1992–2000 and for Labrador for 1998-2000 to remain consistent with catches used in other years in these areas (see Section 4.1.1).

The minimum and maximum values of the catches and returns for the 1SW cohort are summarized in Table 4.2.3.4 and the mid-point values are shown in Figure 4.2.3.1. The most recent three years are shown with hollow symbols as no Labrador values were estimated for these years and the raising factor described previously was used. The mid-point of the range of pre-fishery abundance estimates for 2000 (404,724) is 5% higher than in 1999 (385,949) which had increased considerably from the low 1997 value of 325,433 which was the lowest estimated in the time series 1971-2000. The reduced values observed in 1978 and 1983–84 and 1994 were followed by large increases in pre-fishery abundance.

4.2.3.4 Total 1SW recruits (maturing and non-maturing)

Figure 4.2.3.1 shows the pre-fishery abundance of 1SW maturing and 1SW non-maturing salmon from North America for the period 1971 to 1999 and Figure 4.2.3.2 shows these data combined to give the total 1SW recruits. While maturing 1SW salmon in 1998-2000 have increased over the lowest value achieved in 1997, the non-maturing portion of these cohorts remained unchanged since 1997. Because the prefishery abundance has been consistently well below its conservation requirements, this situation is considered to be very serious. The decline in recruits in the time series is alarming. Although the declining trend appears common to both maturing and non-maturing portions of the cohort, non-maturing 1SW salmon have declined further. The Working Group expressed concerns about these stock trends and recommended further investigation into their causes.

4.2.4 Spawning escapement and egg deposition

4.2.4.1 Egg depositions in rivers

On rivers not under colonization or rehabilitation, egg depositions in 2000 exceeded or equaled the river specific conservation requirements in 23 of the 54 assessed rivers (43%) and were less than 50% of conservation in 18 other rivers (33%) (Figure 4.2.4.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 11 rivers assessed (91%) had egg depositions which were less than 50% of conservation requirements. Proportionally fewer rivers in Gulf (27%) and Québec (0%) had egg depositions less than 50% of conservation. Only 27% of the Gulf rivers and 69% of the Québec rivers had egg depositions that equaled or exceeded conservation (Figure 4.2.4.1). In Newfoundland, 57% of the rivers assessed met or exceeded the conservation egg requirements and half of the others (21%) had egg depositions that were less than 50% of requirement. The deficits occurred in the east and southwest rivers of Newfoundland (SFA 13) and in Labrador (Figure 4.2.4.1).

Fourteen rivers in Newfoundland (3) and Québec (11) are under rehabilitation or colonization programs where in recent years salmon have gained access to previously inaccessible habitat or to re-establish the wild production (Figure 4.2.4.1). Five of these rivers in Québec met or exceeded 90% of the conservation requirements in 2000. Egg depositions in 43% of these rivers were less than 50% of requirements. One international border river and four rivers in the USA are under rehabilitation. All of them had egg depositions less than 5% of conservation requirements.

Escapements over time relative to conservation requirements have improved in Newfoundland and decreased in all other areas of eastern Canada (Figure 4.2.4.2). The status of three Bay of Fundy/Atlantic coast of Nova Scotia rivers has severely declined, especially since 1991. The proportion of the conservation requirements achieved in 2000 was the lowest of the time series. For the Québec rivers, spawning escapements declined continually from a peak median value in 1988 with a slight recovery in 1995 and a similar increase in 1999. In almost all years inQuébec, the median proportion of conservation requirements achieved has exceeded the requirements. However, in 2000, the median proportion was the lowest value of the time series with 98% of the conservation requirement. The eight rivers of the Gulf of St. Lawrence have also been quite consistent in equalling or exceeding the conservation requirements but the median escapements were below conservation requirements in three of the last five years. Again in 2000, it was the lowest value (75%) of the last fifteen years. Newfoundland rivers have shown the greatest improvement in the proportion of the spawning requirement achieved as a direct result of the commercial salmon and groundfish moratoria initiated in 1992. There was a decline in 1997 relative to 1996 but escapements increased again in 1998 (highest median values since the 1992), decreased only slightly in 1999 and were unchanged in 2000.

4.2.4.2 Run-reconstruction estimates of spawning escapement

Updated estimates for 2SW spawners were derived for the six geographic regions referenced in Section 4.2.2 (Table 4.2.4.1). Estimates of 1SW spawners, 1971-2000 are provided in Table 4.2.4.2. These estimates were derived by subtracting the in-river removals from the estimates of returns to rivers. A comparison between the numbers of spawners, returns and spawning requirements for 1SW and 2SW salmon are shown in Figures 4.2.2.1 and 4.2.2.2 respectively (there are no spawning requirements defined specifically for 1SW salmon).

<u>Labrador:</u> As previously explained, it was not possible to estimate spawners in Labrador in 1998 - 2000 due to lack of assessment information.

<u>Newfoundland:</u> The mid-point of the estimated numbers of 2SW spawners (9,000) in 2000 is about the same as that estimated in 1999 (9,100) and is 224% of the total 2SW spawner requirements for all rivers. The 2SW spawner requirement has been met or exceeded in seven years since 1984 (Figure 4.2.2.2). The 1SW spawners (167,200) in 2000 was about the same as the 169,700 in 1999 to 206,900 in 1999. The 1992–93, 1995-96 and 1998-2000 1SW spawners are higher than the spawners in 1989–91 and similar to levels in the late 1970s and 1980s (Figure 4.2.2.1). The spawning level in 1997 however was the third lowest in the data series, with 1989 and 1991 being lower. There had been a general increase in both 2SW and 1SW spawners during the period 1992–96 and 1998-2000 and this is consistent with the closure of the commercial fisheries in Newfoundland. For 1997, decreases occurred most strongly in the 1SW spawners.

<u>Québec:</u> The mid-point of the estimated numbers of 2SW spawners (19,700) in 2000 is 4% lower than that estimated in 1999 and is about 67% of the total 2SW spawner requirements for all rivers (Figure 4.2.2.2). The spawning escapement in 2000 is the seventh lowest in the time series (1971-2000). Estimates of the numbers of spawners approximated the spawner requirement from 1971 to 1990 however they have been below requirements since 1990. The mid-point of the estimated 1SW spawners in 2000 (22,100) was about 7% lower than 1999 (Figure 4.2.2.1). Spawning escapement of 1SW fish has generally been higher since the early 1980s than it was before this period.

Gulf of St. Lawrence: The mid-point of the estimated numbers of 2SW spawners (19,800) in 2000 is about the same as that estimated in 1999 (19,400) and is about 65% of the total 2SW spawner requirements for all rivers in this region (Figure 4.2.2.2). This is the fifth time in ten years that these rivers have not exceeded their 2SW spawner requirements. The mid-point of the estimated spawning escapement of 1SW salmon (34,800) increased by 28% from 1999 and is the ninth lowest in the time series, 1971–2000. The abundance remains low relative to the peak observed in 1992 (Figure 4.2.2.1). Spawning escapement has on average been higher in the mid-1980s than it was before and after this period.

Scotia-Fundy: The mid-point of the estimated numbers of 2SW spawners (3,400) in 2000 is a 31% decrease from 1999 and is about 14% of the total 2SW spawner requirements for rivers in this region (Figure 4.2.2.2). Neither the spawner estimates nor the spawner requirements include rivers of the inner Bay of Fundy (SFA 22 and part of SFA 23) as these rivers do not contribute to distant water fisheries and spawning escapements are extremely low. The 2SW spawning escapement in the rest of the area has been generally declining since 1985 and the 3,400 in 2000 is the lowest in the time series, 1971-2000. The mid-point of the estimated 1SW spawners (14,300) in 2000 is a 7% increase from 1999 and is the eighth lowest in the time series, 1971-2000. There has been a general downward trend in 1SW spawners since 1990 (Figure 4.2.2.1).

USA:All age classes of spawners (1SW, 2SW, 3SW, and repeat) in 2000 (803 salmon) represented less than 2% of the 2SW spawner requirements for all USA rivers. Spawning escapement of 2SW salmon by river expressed as the percentage of conservation requirement was: 5% in the Penobscot, 2% in the Merrimack, and less than 1% in the Connecticut, Paucatuck, and other Maine rivers.

4.2.4.3 Escapement variability in North America

The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of the pre-fishery abundance taking into consideration the 11 months of natural mortality at 1% per month. These values, termed potential 2SW recruits, along with total North American 2SW returns, spawners and requirements are shown in Figure 4.2.4.3 and indicate that the overall North American spawner requirement could have been met, in the absence of all fisheries prior to, but not since 1994. The difference between the potential 2SW recruits and actual 2SW returns reflect the extent to which mixed stock fisheries at West Greenland and in SFAs 1–14 have reduced the populations.

Similarly, the impact of the Greenland fishery can be considered by subtracting the non-maturing 1SW salmon (accounting for natural mortality) harvested there from the total potential 2SW recruits. These values, termed 2SW recruits to North America, are also shown in Figure 4.2.4.3. The difference between the 2SW recruits to North America and the 2SW returns reflects the impact of removals by the commercial fisheries of Newfoundland and Labrador when they were open and the Labrador food fisheries since reports began in 1998. The 2SW recruits to North America indicate that, even if there had not been a West Greenland commercial fishery, spawner requirements could not have been met since 1992. The difference between the actual 2SW returns and the spawner numbers reflects in-river removals throughout North America and coastal removals in Québec, Gulf and Scotia Fundy regions.

Following on the technique outlined in previous reports (ICES 1994/Assess:16, ICES 1995/Assess:14), the spawners in each geographic area were allocated (weighted forward) to the year of the non-maturing 1SW component in the Northwest Atlantic using the weighted smolt age proportions from each area (Table 4.2.4.3). The total spawners for a given recruitment year in each area is the sum of the lagged spawners. Because the smolt age distributions in North America range from one to six years and the time series of estimated 2SW spawners to North America begins in 1971, the first recruiting year for which the total spawning stock size can be estimated is 1979 (although a value for 1978 was obtained by leaving out the 6-year old smolt contribution which represents 4% of the Labrador stock complex (Table 4.2.4.3)). Since the 1999 2SW spawners to North America (except for Labrador) are known, the spawning stock contributing to the pre-fishery abundance up to 2002 is known for North America and up to 2003 except for Labrador (Figure 4.2.4.4, Table 4.2.4.4).

Spawning escapement of 2SW salmon to several stock complexes has been below the spawner requirement (Labrador, Québec, Scotia-Fundy, USA) since at least the 1980s (Figure 4.2.4.4). In the last four years, lagged spawner abundance has been increasing in Labrador and Newfoundland but decreasing in all other areas.

The relative contributions of the stocks from geographic area to the total spawning escapement of 2SW salmon has varied over time (Figure 4.2.4.5). The reduced potential contribution of Scotia-Fundy stocks and the increased proportion of the spawning stock from the Gulf of St. Lawrence and recently Labrador rivers to future recruitment is most evident. Thus production of non-maturing 1SW salmon would not be expected to increase dramatically from most areas of North America even if the sea survival improves. Only the Newfoundland stock complex has received spawning escapements which have exceeded the area requirements, all other complexes were below requirement and some declined further in 2000.

4.2.5 Survival indices

Counts of smolts and adult salmon returns enable the estimation of indices of natural survival at sea, particularly following the closure of most northwest Atlantic commercial salmon fisheries in 1992. These estimates are potentially influenced by annual variation in size, age and sex composition of smolts leaving freshwater and possibly, annual variation in sea-age at maturity. There is information from 18 rivers in North America with smolt counts and corresponding adult counts. Data available in 2000 were from 10 wild and five hatchery populations distributed between Newfoundland (SFAs 4, 9, 11, 13, and 14a),Québec (Q2 and Q7), Nova Scotia (SFAs 20 and 21), New Brunswick (SFA 23) and Maine (USA).

Plots of survival rates over time (Figures 4.2.5.1 to 4.2.5.4) provide some insight into the impact of changes in management measures and possible changes in marine survival of wild and hatchery 1SW and 2SW stocks. In general the plots suggest:

- data sets that predate the commercial closures in 1992 and 1984 exhibit values that exceed those derived since fisheries closures, i.e., survival of North America stocks to home waters has not increased as expected
- 1SW survival greatly exceeds that of 2SW fish, and
- survival of wild stocks exceeds that of hatchery stocks

Survival indices for 8 of 15 stocks returning 1SW fish in 2000 exceeded indices for 1SW fish in 1999. Six indices for 1SW fish decreased from 1999. None of the survival indices for nine stocks returning 2SW fish in 2000 increased from values in 1999. There have been no significant increasing trends ($p \leq 0.05$) in survival indices of any of the stock components since commercial closures in 1992.

		Number of stocks					
Sea-age		Relative to 1999			9-Year Trend		
&stock	Province/region	⇧	⇔	⇩	⇧	⇔	⇩
1SW Wild	West & North Nfld	1		2		3	
	South Nfld	3				3	
	Québec		1	1		2	
	NS/NB	1		1		1	
Hatchery	Québec			1		1	
	NS	2				1	1
	NB			1		1	
	Maine	1				1	
	Total	8	1	6		13	1
2SW Wild	South Nfld		1			1	
	Québec		1	1		1	1
	NS			1			
Hatchery	Québec		1			1	
	NS		1	1		1	1
	NB			1		1	
	Maine			1			1
	Total		4	5		5	3

4.2.6 Evaluation of the potential bias involved by including fish farm escapees in stock assessments

Catch advice is based on estimates of returns and spawners in home rivers and harvests in commercial fisheries (see Sections 4.2.2, 4.2.3, and 4.2.4). Escaped-farmed salmon have been most frequently found close to the principal salmon farming area of Passamaquoddy and Cobscook bays of the Bay of Fundy, although a few other farm sites occur in Nova Scotia and Newfoundland. (Figure 4.1.3.2).

The principal salmon farming industry in Bay the Fundy has grown extensively since 1984 since the closure of local commercial salmon fisheries. Estimates of returns and spawners in this area are based on assessments of wild and hatchery fish at counting facilities where escapes are identified on the basis of external characteristics and scale analysis and excluded from both the assessment and from ascending the rivers. Counts of wild/hatchery salmon in all the principal impacted rivers, (Table 4.1.3.1) generally total less than 200 fish in any year since 1990. Misclassification of many of the hatchery fish would be of little consequence to catch advice at even a regional scale.

Catch advice is not provided for inner Bay of Fundy rivers where some escapes have been observed. The occasional escape noted in other rivers of Nova Scotia and Newfoundland allows the possibility that escapes could influence angler harvests used to derive returns in some Salmon Fishing Areas. However the numbers of these fish must be of minor consequence to assessments. The occurrence of escapes in the West Greenland catch, the North American proportion of which is included in the total of North American production, has been investigated by Hansen et. al. (1997) and found to be less than one percent.

4.2.7 Summary of status of stocks in the North American Commission Area

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, and the abundance recorded in 1993–2000 was the lowest in the time series (Figure 4.2.3.2). During 1993 to 2000, the total population of 1SW and 2SW Atlantic salmon was about one-half million fish, 45% of the average abundance during 1972 to 1990. The decline has been more severe for the 2SW salmon component than for the small salmon (maturing as 1SW salmon) age group.

In most regions the returns of 2SW fish are at or near the lower end of the 30-year time series (1971-2000) except Newfoundland where they are at the second highest level but are a minor age group component of the stocks in this area. Returns of 1SW salmon were at the lower end of the time series in Gulf, Scotia-Fundy, and USA and at about at the mid-point in Québec and Newfoundland.

The rank of the estimated returns in 2000 in the 1971–2000 time series for six regions in North America is shown below:

Region	Rank of 2000 returns in 1971-2000 time series (1=highest)		Mid-point estimate of 2SW spawners as proportion of escapement requirement
	1SW	2SW	(%)
Labrador	Unknown	Unknown	unknown
Newfoundland	12	2	224
Québec	13	28	67
Gulf	22	27	65
Scotia-Fundy	24	30	14
USA	19	30	2

Trends in abundance of small salmon and large salmon within the geographic areas show a general synchronicity among the rivers. Returns of large salmon were generally decreased or were about the same as 1999 and among the lowest observed since 1987 while small salmon returns improved marginally for stocks in some areas. For the rivers of Newfoundland, large salmon returns were among the highest in the last 12 years but large salmon returns in the other areas were among the lowest. Large salmon in Newfoundland are predominantly repeat-spawning 1SW salmon while in other areas of eastern Canada, 2SW and 3SW salmon make up varying proportions of the returns.

On rivers not under colonization or rehabilitation, egg depositions in 2000 exceeded or equaled the river specific conservation requirements in 23 of the 54 assessed rivers (43%) and were less than 50% of conservation in 18 other rivers (33%) (Figure 4.2.4.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 11 rivers assessed (91%) had egg depositions which were less than 50% of conservation requirements. In 2000, the overall spawning escapement requirements for 2SW salmon were not met in any area except Newfoundland. The overall 2SW spawning escapement requirement for Canada could have been met or exceeded in only nine (1974-78, 1980-82 and 1986) of the past 28 years (considering the mid-points of the estimates) by reduction of terminal fisheries (Figures 4.2.2.2 and 4.2.4.3). In the remaining years, spawning requirements could not have been met even if all terminal harvests had been eliminated. It is only within the last few years that Québec and the Gulf areas have failed to achieve their overall 2SW salmon spawning requirements.

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 since commercial closures in 1992.

Substantive increases in spawning escapements in recent years in northeast coast Newfoundland rivers and high smolt and juvenile production in many rivers, in conjunction with suitable ocean climate indices were suggestive of the potential for improved adult salmon returns for 1998 through 2000. Colder oceanic conditions both nearshore and in the Labrador Sea in the early 1990s are thought to have contributed to lower survival of salmon stocks in eastern Canada during that period. It was expected that increased marine water temperatures in 1994 to 1998 would have favoured marine survival and subsequent adult salmon production. Low returns of 2SW salmon in 1998 were consistent with the low 1SW returns of 1997.

Based on 1SW returns in 2000, no significant improvements in most areas, and further declines in some areas, are expected for large salmon in 2001. An additional concern is the low abundance levels which currently describe many salmon stocks in rivers in eastern Canada, particularly in the Bay of Fundy and 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 areas and many populations are currently threatened with extirpation.

Fish passage efficiency, both upstream and downstream, limit populations at hydropower facilities such as on the Saint John, St. Croix, and Penobscot rivers. Aquaculture has continued to increase. Salmon populations of the Southern Upland of Nova Scotia have fallen to critically low levels in acid-impacted areas. Populations of Maine's downeast rivers are listed under the US Endangered Species Act and are suspected of having been adversely affected by freshwater habitat conditions and agriculture.

4.3 Effects on US and Canadian Stocks and Fisheries of Quota Management and Closure after 1991 in Canadian Commercial Salmon Fisheries, with special emphasis on the Newfoundland stocks

The Working Group previously considered the impact of the closure of the Newfoundland commercial fishery in 1992 on the Newfoundland stocks (ICES 1997/Assess:10).

Dempson *et al.* (1997) developed an index of salmon returns to illustrate the impact of the commercial salmon fishery moratorium on Newfoundland stocks. It is based on the difference between the returns prior to the moratorium (1984-91) when there was a commercial fishery to those in the years since the commercial fishery closed (1992-97). By averaging among rivers with counting facilities this provides an estimate of commercial fishing mortality which can then be used to estimate what returns would have been if the commercial fishery had not closed. The method assumes that natural mortality during the commercial fishery years remained at the same levels on average after the commercial fishery was closed. Average commercial fishing exploitation rate was 44% on small salmon and 75% on large. These exploitation rates should be regarded as a minimum values because it is evident that the natural component of marine survival has declined in recent years.

For 2SW salmon, if the commercial fishery had remained open during this period then, on average, from 1,942 to 6,821 fewer 2SW fish would have spawned. For 1SW salmon, had the commercial fishery remained open then, on average, from 37,672 to 96,655 fewer 1SW salmon would have spawned. For 2SW salmon, in the years since the moratorium, spawner requirements have never been achieved if one uses the minimum estimates or have always been achieved using the maximum estimate. If the commercial fishery had not closed, then 2SW spawners would never have achieved spawning requirements even at maximum estimates.

Within Newfoundland, the commercial fishery closure has resulted in increased escapements of both small and large salmon to rivers, higher catches of large salmon (which were subsequently released) in the recreational fishery, and increased spawning escapements of both size groups. These increased spawning escapements have not however always resulted in increased smolt production. Some areas of Newfoundland, particularly the south coast, did not see increases in escapement as was expected from the closure of the commercial fishery.

4.4 Update of Age-Specific Stock Conservation Limits

There are no changes recommended in the 2SW spawner requirements from those recommended previously. Spawner requirements for 2SW salmon for Canada now total 123,349 and for the USA, 29,199 for a combined total of 152,548 (Table 4.4.1). The Working Group again recommends that these requirements be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

4.5 Catch Options or Alternative Management Advice and Assessment of Risks Relative to the Objective of Exceeding Stock Conservation Limits

Overview

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.

Catch histories of salmon which could have been available to the Greenland fishery, 1972-99, are provided in Tables 4.5.1 and 4.5.2. and expressed as 2SW salmon equivalents. The Newfoundland-Labrador commercial fisheries historically harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. The harvest in these fisheries of repeat spawners and older sea-ages was not considered in the run reconstructions. Harvests of 1SW non-maturing salmon in Newfoundland-Labrador commercial fisheries have been adjusted by natural mortalities of 1% per month for 11 months and 2SW harvests in these same fisheries have been adjusted by one month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. Starting in 1998, the Labrador commercial fishery was closed. A Native Peoples' fishery occurred in 1998 - 2000 which may have harvested, to some degree, mixed stocks and catches for this fishery have been included in Tables 4.5.1 and 4.5.2. As well, a resident's food fishery in Labrador is included for the first time in 2000. Mortalities (principally in fisheries) in mixed stock and terminal fisheries areas in Canada are summed with those of USA to estimate total 2SW equivalent mortalities in North America (Table 4.5.1). Mortalities within North America peaked at about 382,000 in 1976 and are now about 14,400 2SW salmon equivalents. In the most recent two years estimated (that is those since the closure of the Labrador commercial fishery), those taken as non-maturing fish in Labrador comprise 2%, or less, of the total in North America.

Of the North American fisheries on the cohort destined to be 2SW salmon, 90% of the catch comes from terminal fisheries in the most recent year. This value has ranged from as low as 19% in 1973, 1976 and 1987 to values of 76-91% in 1996-2000 fisheries (Table 4.5.1). The percentage increased significantly with the reduction and closures of the Newfoundland and Labrador commercial fisheries, particularly since 1992.

Table 4.5.2 shows the mortalities expressed as 2SW equivalents in Canada, USA and Greenland for 1972–2000. Harvests within the USA of the total within North America approached 0.6% on a few occasions in the time series and as recently as in 1990. As well as these harvests in the USA, USA-origin salmon were also harvested in Canada during the time period indicated. The percentage of the total 2SW equivalents that has been taken in North American waters has ranged from 43-100%, with the most recent year estimated at 75%. The two years when 100% of the mortality occurred in North America were the years when the Greenland commercial fishery did not operate.

It is possible to provide catch advice for the North American Commission area for two years. The revised forecast for 2001 for 2SW maturing fish is based on a new forecast of the 2000 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2000 as 1SW non-maturing fish. The second is a new estimate for 2002 based on the pre-fishery abundance forecast for 2001 from Section 5.6. A consequence of these annual revisions is that the catch options for 2SW equivalents in North America may change compared to the options developed the year before.

4.5.1 Catch advice for 2001 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 2000 is provided in Table 5.6.1.1. This value of 225,708 is higher than the value forecast last year at this time of 179,897 (See Section 5.2 for more detailed derivation of the models used, etc.). A pre-fishery abundance of 225,708 in 2000 can be expressed as 2SW equivalents by considering natural mortality of 1% per month for 10 months (a factor of 0.904837), resulting in 204,229 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 2000 for both the Labrador (421) and Greenland (5,041) fisheries (Tables 4.5.1 and 4.5.2) for a total of 5,462 2SW salmon equivalents already harvested, when the mortality factor is considered.

Table 4.5.1.1 uses the probability density projections for the revised pre-fishery abundance estimate of 225,708 (at 50% probability) and subtracts the spawning reserve (170,286) and the harvests in Greenland and Labrador of 1SW non-maturing fish in 2000,and converts the remainder to 2SW salmon equivalents. The calculation is as follows:

[PFA_i - spawning reserve - harvest in Greenland and Labrador in 2000 of 1SW non-maturing fish] x exp - (0.01 *10 months)]

where PFA_i = values from 25–75%

spawning reserve = 170,286

From Table 4.5.1.1, there are some harvest possibilities at forecasted levels which would be considered risk-neutral or risk-averse, that is, at probability levels of 50% and below down to about 14,000 fish at the 40% probability level. Any probability levels below this would suggest no harvest. The numbers provided for catch options 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 are no biological reasons to restrict the harvest.

To validate the forecasts provided by the PFA model, the Working Group considered historic information available on the returns of small and large salmon. Appropriate data were available for 20 rivers in Québec, six rivers of the Gulf, and three rivers of the Scotia-Fundy geographic area for the period 1991-1992 to 1999-2000, during which most commercial salmon fisheries were closed. The relationships between small salmon in year i and large salmon in year i+1 were significant for Québec and Scotia-Fundy (Figure 4.5.1). Forecasts of large salmon from the low returns of small salmon in 2000 (arrow on plots) indicate that there are no expectations for significant increases in large salmon in 2001.

There is no significant relationship between small and large salmon returns in the 'Gulf' rivers. However, the increasing proximity of recent data to the origin (Figure 4.5.1) and the low numbers of small salmon returns in 2000 also suggest low expectations for important increases in large salmon returns to the 'Gulf' in 2001. The evidence for each of the three geographic areas suggests that the PFA forecast of approximately 225,000 non-maturing fish in Greenland in 2000, i.e., triple the PFA value for the previous year and double the average PFA values of the previous 5 years, is highly unlikely.

Regional assessments in some areas of eastern North America provide a more detailed consideration of expectations for 2001, taking into consideration the contribution of all sea ages of salmon to the spawning population. By area, these are:

Labrador: Salmon returns in the year 2001 will be from a higher number of spawners than in recent years but the lack of long-term monitoring facilities makes it difficult to describe stock status or provide current expectations.

Newfoundland: The number of spawners has been relatively high in recent years, however, smolt output from all monitored rivers (with the exception of Highlands and Northeast Brook (Trepassey) in SFA 13) has declined in each of the past three years. In the absence of any improvement in marine survival rates, returns of small salmon in 2001 could be lower.

Québec : Returns of large salmon are expected to be adequate for the attainment of conservation requirements in 43 of the 44 salmon rivers in northern part of Québec; one river will remain closed. On the 74 salmon rivers in southern part of Québec, nine rivers will remained closed to fishing. Returns of large salmon are expected to be insufficient for attainment of conservation requirement on 34 rivers and consequently, only the retention of small salmon will be permitted on those rivers. Six other rivers are also under consideration for grilse-only retention.

Gulf: In SFA 15, returns in 2001 should approximate conservation requirements as they have in the last 5 years. Current levels of harvest have not been limiting the attainment of stock conservation. In SFA 16, neither large salmon nor eggs from small and large fish are expected to meet the conservation requirements in the Northwest and Southwest Miramichi, the Miramichi River overall, or the Buctouche River. It is expected, however that conservation requirements will be met or exceeded on the Tabusintac River. In SFA 18, Northumberland Strait and Cape Breton rivers, the Margaree, River Philip, and Sutherlands rivers are expected to meet or exceed conservation requirements. Stocks of the East River (Pictou), West River (Antigonish) and Wallace rivers are not expected to meet conservation requirements.

Scotia-Fundy: In SFAs 20-23, both large and small salmon returns, including hatchery supplements, are not expected to be adequate to meet conservation requirements. Many stocks are extirpated or at risk of extirpation and most rivers are closed to even hook-and-release fishing. Few stocks of eastern Cape Breton (SFA 19) are expected to meet conservation requirements but are anticipated to be subjected to hook-and-release fishing.

USA: Salmon returns (both large and small) in 2000 are not expected to be sufficient to meet conservation requirements in any river, including those receiving hatchery stocking.

4.5.2 Catch advice for 2002 fisheries on 2SW maturing salmon

Most catches (93%) 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 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 prefishery abundance forecast for 2001 (295,678 at the 50% probability level) would apply principally to North American fisheries in 2002 and hence the level of fisheries in 2001 need to be accounted for before providing these catch options. Assuming probability values between 25 and 75%, accounting for mortality and the spawning requirement and considering an allocation of 60% of the surplus to North America, would yield catch options in 2SW salmon equivalents of 77,000 to 138,000 fish. The numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management will be necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

4.6 Data Deficiencies and Research Needs in the North American Commission Area

Some progress was made on research needs identified last year. The Working Group reiterates many of last year's recommendations and suggests some further ones. Relevant sections of this year's report are identified in parentheses.

1. Estimates of total returns to Labrador no longer exist. There is a critical need to develop alternate methods to derive estimates of salmon returns and develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava regions of Québec. (4.2.2; 4.2.4)

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, 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. (4.2.2; 4.2.3; 4.4)

3. There is a requirement for additional smolt-to-adult survival rates for wild salmon. As well, sea survival rates of wild salmon from rivers stocked with hatchery smolts should be examined to determine if hatchery return rates can be used as an index of sea survival of wild salmon elsewhere. (4.2.5)

4. 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. (4.2.3; 4.2.5)

5. Return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that do contribute to distant fisheries should be developed and, when these are available, the SFA 22 spawning requirements for these rivers (476 fish) be included in the total.(4.4)

6. A consistent approach to estimating returns is needed, to incorporate broodstock, if offspring from such broodstock are stocked back into the management area from which their parents originated. (4.1.3)

Accounting of escaped-farmed salmon from North America indicates a high but undocumented mortality. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farmed salmon. In order to substantiate this conclusion farmed-salmon need to be included in background genetic analysis and the data re-examined for the presence of escaped-farmed salmon of North American origin.

Table 4.1.2.1. Percentages by user group and province of small and large salmon harvested (by number) in the Atlantic salmon fisheries of eastern Canada during 2000.

	% of Provincial Harvest			% of	
	Native peoples' food fisheries	Recreational fisheries	Resident food fisheries	eastern Canada	Number of fish
Small salmon					
Newfoundland / Labrador	17.5	74.4	8.1	45.5	22,813
Québec	15.3	84.7	0.0	13.1	6,588
New Brunswick	16.6	83.4	0.0	40.2	20,135
P.E.I.	15.6	84.4	0.0	0.4	179
Nova Scotia	27.0	73.0	0.0	0.8	393
Large salmon					
Newfoundland / Labrador	53.7	21.3	25.0	17.1	1,961
Québec	48.9	51.1	0.0	71.9	8,241
New Brunswick	100.0	0.0	0.0	9.1	1,047
P.E.I.	-	-	-	0.0	0
Nova Scotia	100.0	0.0	0.0	1.8	209
Eastern Canada		**% by User Group**			
Small salmon	16.9	79.4	3.7		50,108
Large salmon	55.3	40.4	4.3		11,458

Table 4.1.2.2. Hook-and-released Atlantic salmon caught by recreational fishermen in Canada, 1984 – 2000.

Year	Newfoundland			Nova Scotia			New Brunswick					Prince Edward Island			Quebec			CANADA*		
	Small	Large	Total	Small	Large	Total	Small Kelt	Small Bright	Large Kelt	Large Bright	Total	Small	Large	Total	Small	Large	Total	**SMALL**	**LARGE**	**TOTAL**
1984				939	1,655	2,594	661	851	1,020	14,479	17,011							**2,451**	**17,154**	**19,605**
1985		315	315	1,323	6,346	7,669	1,098	3,963	3,809	17,815	26,685			67				**6,384**	**28,285**	**34,669**
1986		798	798	1,463	10,750	12,213	5,217	9,333	6,941	25,316	46,807							**16,013**	**43,805**	**59,818**
1987		410	410	1,311	6,339	7,650	7,269	10,597	5,723	20,295	43,884							**19,177**	**32,767**	**51,944**
1988		600	600	1,146	6,795	7,941	6,703	10,503	7,182	19,442	43,830	767	256	1,023				**19,119**	**34,275**	**53,394**
1989		183	183	1,562	6,960	8,522	9,566	8,518	7,756	22,127	47,967							**19,646**	**37,026**	**56,672**
1990		503	503	1,782	5,504	7,286	4,435	7,346	6,067	16,231	34,079			1,066				**13,563**	**28,305**	**41,868**
1991		336	336	908	5,482	6,390	3,161	3,501	3,169	10,650	20,481	1,103	187	1,290				**8,673**	**19,824**	**28,497**
1992	5,893	1,423	7,316	737	5,093	5,830	2,966	8,349	5,681	16,308	33,304			1,250				**17,945**	**28,505**	**46,450**
1993	18,196	1,731	19,927	1,076	3,998	5,074	4,422	7,276	4,624	12,526	28,848							**30,970**	**22,879**	**53,849**
1994	11,105	2,343	13,448	796	2,894	3,690	4,153	7,443	4,790	11,556	27,942	577	147	724				**24,074**	**21,730**	**45,804**
1995	12,383	2,588	14,971	979	2,861	3,840	770	4,260	880	5,220	11,130	209	139	348		922	922	**18,601**	**12,610**	**31,211**
1996	22,227	3,092	25,319	3,526	5,661	9,187						472	238	710		1,718	1,718	**26,225**	**10,709**	**36,934**
1997	17,362	3,810	21,172	717	3,358	4,075	3,457	4,870	3,786	8,874	20,987	210	118	328	182	1,643	1,825	**26,798**	**21,589**	**48,387**
1998	25,314	4,351	29,665	687	2,520	3,207	3,154	5,760	3,452	8,298	20,664	233	114	347	297	2,680	2,977	**35,445**	**21,415**	**56,860**
1999	18,119	4,534	22,653	591	2,161	2,752	3,155	5,631	3,456	8,281	20,523	192	157	349	298	2,693	2,991	**27,986**	**21,282**	**49,268**
2000	18,292	3,376	21,668	335	1,146	1,481	3,154	6,689	3,455	8,690	21,988	101	46	147	445	4,008	4,453	**29,016**	**20,721**	**49,737**

* totals for all years prior to 1997 are incomplete and are considered minimal estimates
blank cells indicate no information available

Table 4.1.3.1. Counts of salmon and percentage of the counts which were identified as aquaculture escapes (% Aqua') at the counting facilities of the Magaguadavic River (SFA 23, Canada) and in rivers of eastern Maine, USA.

Magaguadavic River (SFA 23, Canada)						
Year	1SW	% Aqua'	MSW	% Aqua'	Total	% Aqua'
1983	303	-	637	-	940	-
1984	249	-	534	-	783	-
1985	169	-	466	-	635	-
1988	291	-	398	-	689	-
1992	238	35	201	31	439	33
1993	208	46	177	29	385	38
1994	1064	94	228	73	1292	90
1995	540	90	198	85	738	89
1996	195	89	68	29	263	74
1997	94	63	47	49	141	58
1998	247	89	6	50	253	88
1999	74	74	29	83	103	77
2000	41	68	3	67	44	68

Rivers of eastern Maine								
Year	Union		St. Croix		Dennys		Narraguagus	
	Total Run	% Aqua'	Total run	% Aqua'	Total run	% Aqua'	Total run	% Aqua'
1994	-	-	181	54	47	89	52	2
1995[1]	-	-	60	22	9	44	56	0
1996	-	-	152	13	31	68	64	22
1997	-	-	70	39	2[2]	100	37	0
1998	-	-	65	37	1[2]	100	22	0
1999	72	91	36	64	-	Unk	35	8
2000	5	40	50	60	30	97	23	0

[1] High flows in 1995 may have affected accuracy of counts in all three rivers, especially the Dennys River

[2] Incomplete count of total run

Table 4.2.1.1. Comparison of returns of small salmon, large salmon, and size groups combined to assessed rivers of eastern Canada in 2000 relative to returns in 1999 and to returns in 1990 to 2000.

	Number of rivers in each category			
		Returns in 2000 relative to returns in 1999		
Size group	Total	<50%	50% to 90%	>= 90%
Bay of Fundy and Atlantic Coast of Nova Scotia (SFA 19 to 23)				
Small	9	0	5	4
Large	9	4	2	3
Small & Large	9	0	6	3
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	10	5	1	4
Large	10	3	3	4
Small & Large	10	5	1	4
Quebec (Zones Q1 to Q11)				
Small	13	0	3	10
Large	13	0	11	2
Small & Large	28	1	14	13
Newfoundland and Labrador (SFA 1 to 14)				
Small	21	2	8	11
Large	21	5	6	10
Small & Large	21	1	7	13

		Rank of 2000 within the 1990 to 2000 period (Rank 1 = highest)		
Size group	Number of rivers	Best	Median	Worst
Bay of Fundy and Atlantic coast of Nova Scotia (SFA 19 to 23)				
Small	3	9	10	10
Large	4	9	11	11
Small & Large	4	9	10	10
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	6	6	10.5	11
Large	6	6	10.5	11
Small & Large	6	5	10.5	11
Quebec (Zones Q1 to Q11)				
Small	11	2	6	11
Large	11	6	11	11
Small & Large	25	1	9	11
Newfoundland and Labrador (SFA 1 to 14)				
Small	8	2	6	9
Large	9	2	4	8
Small & Large	8	2	6	8

Table 4.2.1.2. Index rivers in eastern North America with available juvenile abundance or smolt abundance estimates for 1971 to 2000. The index area refers to the SFAs or Zones which are assumed to be represented by the index rivers surveyed in those zones. River locations are shown in Figure 4.2.1.3.

				Egg requirement (millions)				
Geographic Area	SFA, Zone	Index river	Abundance Type	SFA, Zone	Index river	Index river / all index rivers	River relative to SFA, Zone	River as % of Total
Labrador	1							
	2							
	14B							
Newfoundland	3							
	4	Campbellton	Smolts	158.6	2.9	0.9%	1.8%	0.3%
	5			37.9				
	6							
	7							
	8							
	9	NE Trepassey	Smolts	16.2	0.1	0.0%	0.6%	0.0%
		Rocky	Smolts		3.4	1.0%	14.2%	0.3%
	10			7.8				
	11	Conne	Smolts	41.1	7.8	2.3%	19.0%	0.7%
		Little	Smolts		0.3	0.1%	0.8%	0.0%
	12							
	13	Highlands	Smolts	75.4	1.5	0.4%	2.0%	0.1%
	14A	WAB	Smolts	19.1	0.9	0.3%	4.8%	0.1%
Gulf	15	Restigouche	Juveniles	71.9	53.6	15.8%	74.5%	5.1%
		Nepisiguit	Juveniles		9.5	2.8%	13.2%	0.9%
	16	Miramichi	Juveniles	143.5	131.0	38.6%	91.3%	12.4%
		Buctouche	Juveniles		1.6	0.5%	1.1%	0.2%
	18	Margaree	Juveniles	23.1	6.7	2.0%	29.0%	0.6%
		R. Philip	Juveniles		2.3	0.7%	10.0%	0.2%
		Wallace	Juveniles		1.5	0.4%	6.4%	0.1%
		East Pict	Juveniles		1.8	0.5%	7.6%	0.2%
		West	Juveniles		0.8	0.2%	3.5%	0.1%
Scotia-Fundy	19	Middle	Juveniles	21.2	2.1	0.6%	9.8%	0.2%
		Baddeck	Juveniles		2.0	0.6%	9.4%	0.2%
		North	Juveniles		0.9	0.3%	4.0%	0.1%
		Grand	Juveniles		1.1	0.3%	5.2%	0.1%
		Inhabitants	Juveniles		1.4	0.4%	6.6%	0.1%
	20	St. Marys	Juveniles	55.2	9.6	2.8%	17.3%	0.9%
	21	LaHave	Juveniles	77.6	12.2	3.6%	15.7%	1.2%
	22			21.2				
	23	Saint John	Juveniles	90.6	32.3	9.5%	35.7%	3.1%
		Nashwaak	Juveniles		13.7	4.0%	15.1%	1.3%
		Kennebecasis	Juveniles		5.0	1.5%	5.5%	0.5%
		Hammond	Juveniles		4.0	1.2%	4.4%	0.4%
Quebec	Q1			24.8				
	Q2	Saint-Jean	Smolts	11.1	1.9	0.6%	16.9%	0.2%
	Q3			11.3				
	Q4							
	Q5			6.1				
	Q6			5.6				
	Q7	de la Trinité	Smolts	14.1	1.6	0.5%	11.2%	0.2%
		Moisie	Smolts		20.4	6.0%	145.1%	1.9%
	Q8			80.8				
	Q9			25.9				0.0%
	Q10	Bec-scie	Smolts	7.5	0.1	0.0%	1.9%	0.0%
U.S.	Maine		Juveniles	5.5	5.5	1.6%		0.5%
North America	Subtotal			1063.0	339.4	100.0%		32.2%

Table 4.2.1.3. Number of rivers and percent of total zonal area represented by the indexed rivers in 1971 to 2000.

Year	Rivers Monitored	River Area as % of Total Indexed Area
1971	2	11.5%
1972	3	16.3%
1973	3	16.3%
1974	3	16.3%
1975	4	16.9%
1976	4	16.9%
1977	5	17.1%
1978	8	17.4%
1979	6	18.1%
1980	6	17.7%
1981	10	20.9%
1982	11	21.1%
1983	9	20.8%
1984	11	21.1%
1985	11	20.9%
1986	12	20.9%
1987	13	21.8%
1988	12	21.2%
1989	12	20.5%
1990	16	22.7%
1991	18	23.3%
1992	19	23.5%
1993	23	26.8%
1994	24	26.8%
1995	28	29.2%
1996	26	28.1%
1997	29	29.3%
1998	30	29.7%
1999	27	27.6%
2000	26	26.6%

Table 4.2.2.1 Estimated numbers of 1SW returns in North America by geographic regions, 1971 – 2000.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	32,966	115,382	112,644	226,129	14,969	22,453	33,118	57,973	11,515	19,525	32	205,245	441,495	323,370
1972	24,675	86,362	109,282	219,412	12,470	18,704	42,202	73,711	9,522	16,915	18	198,169	415,122	306,645
1973	5,399	18,897	144,267	289,447	16,585	24,877	43,681	77,102	14,766	24,823	23	224,721	435,169	329,945
1974	27,034	94,619	85,216	170,748	16,791	25,186	65,673	114,083	26,723	44,336	55	221,491	449,026	335,259
1975	53,660	187,809	112,272	225,165	18,071	27,106	58,613	101,887	25,940	36,316	84	268,639	578,367	423,503
1976	37,540	131,391	115,034	230,595	19,959	29,938	90,308	155,693	36,931	55,937	186	299,958	603,740	451,849
1977	33,409	116,931	110,114	220,501	18,190	27,285	31,322	56,088	30,860	48,387	75	223,971	469,268	346,619
1978	16,155	56,542	97,375	195,048	16,971	25,456	26,008	45,413	12,457	16,587	155	169,121	339,201	254,161
1979	21,943	76,800	107,402	215,160	21,683	32,524	50,872	93,340	30,875	49,052	250	233,025	467,126	350,075
1980	49,670	173,845	121,038	242,499	29,791	44,686	45,716	81,737	49,925	73,560	818	296,958	617,145	457,051
1981	55,046	192,662	157,425	315,347	41,667	62,501	70,238	128,658	37,371	62,083	1,130	362,877	762,381	562,629
1982	38,136	133,474	141,247	283,002	23,699	35,549	79,874	143,543	23,839	38,208	334	307,129	634,111	470,620
1983	23,732	83,061	109,934	220,216	17,987	26,981	25,337	43,922	15,553	23,775	295	192,838	398,250	295,544
1984	12,283	42,991	130,836	262,061	21,566	30,894	37,696	63,943	27,954	47,493	598	230,933	447,980	339,456
1985	22,732	79,563	121,731	243,727	22,771	33,262	61,255	110,580	29,410	51,983	392	258,290	519,507	388,899
1986	34,270	119,945	125,329	251,033	33,758	46,937	114,718	204,455	30,935	54,678	758	339,768	677,807	508,787
1987	42,938	150,283	128,578	257,473	37,816	54,034	86,564	156,086	31,746	55,564	1,128	328,770	674,567	501,668
1988	39,892	139,623	133,237	266,895	43,943	62,193	123,578	223,368	32,992	56,935	992	374,635	750,007	562,321
1989	27,113	94,896	60,260	120,661	34,568	48,407	72,944	129,515	34,957	59,662	1,258	231,101	454,400	342,750
1990	15,853	55,485	99,543	199,416	39,962	54,792	83,670	159,455	33,939	60,828	687	273,654	530,664	402,159
1991	12,849	44,970	64,552	129,308	31,488	42,755	59,721	113,722	19,759	31,555	310	188,679	362,619	275,649
1992	17,993	62,094	118,778	237,811	35,257	48,742	146,539	231,291	22,832	37,340	1,194	342,594	618,473	480,533
1993	25,186	80,938	134,150	268,550	30,645	42,156	89,934	146,977	16,714	27,539	466	297,095	566,627	431,861
1994	18,159	56,888	95,981	192,138	29,667	40,170	55,639	117,549	8,216	11,583	436	208,098	418,763	313,430
1995	25,022	76,453	202,739	435,153	23,851	32,368	26,019	96,871	14,239	21,822	213	292,082	662,880	477,481
1996	51,867	153,553	257,215	559,079	32,008	42,558	50,313	99,615	22,795	36,047	651	414,848	891,504	653,176
1997	66,812	155,963	99,029	146,050	24,300	33,018	27,515	54,511	7,173	10,467	365	225,194	400,374	312,784
1998	-	-	146,371	247,035	24,029	33,524	38,029	69,155	16,770	26,481	403	-	-	-
1999	-	-	156,740	224,959	25,639	36,296	28,867	53,244	10,556	16,901	419	-	-	-
2000	-	-	116,167	252,102	25,216	36,309	40,215	63,624	10,997	18,343	270	-	-	-

Labrador : SFAs 1,2&14B
Newfoundland: SFAs 3-14A
Gulf of St. Lawrence: SFAs 15-18
Scotia-Fundy: SFAs 19-23 (SFA 22 is not included as it does not produce 2SW salmon)
Quebec: Q1-Q11

Table 4.2.2.2 Estimated numbers of 2SW returns in North America by geographic regions, 1971 – 2000.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	4,312	29,279	2,388	8,923	34,568	51,852	29,483	46,831	11,187	16,410	653	81,937	153,295	117,616
1972	3,706	25,168	2,511	9,003	45,094	67,642	35,640	59,937	14,028	19,731	1,383	102,364	182,865	142,614
1973	5,183	35,196	2,995	11,527	49,765	74,647	34,911	59,550	10,359	14,793	1,427	104,641	197,140	150,890
1974	5,003	34,148	1,940	6,596	66,762	100,143	49,081	83,402	21,902	29,071	1,394	146,082	254,754	200,418
1975	4,772	32,392	2,305	7,725	56,695	85,042	31,175	51,864	23,944	31,496	2,331	121,222	210,851	166,036
1976	5,519	37,401	2,334	7,698	56,365	84,547	29,266	51,427	21,768	29,837	1,317	116,569	212,228	164,398
1977	4,867	33,051	1,845	6,247	66,442	99,663	58,822	100,766	28,606	39,215	1,998	162,581	280,941	221,761
1978	3,864	26,147	1,991	6,396	59,826	89,739	30,465	51,481	16,946	22,561	4,208	117,301	200,531	158,916
1979	2,231	15,058	1,088	3,644	32,994	49,491	8,671	14,324	8,962	12,968	1,942	55,888	97,427	76,658
1980	5,190	35,259	2,432	7,778	78,447	117,670	43,407	73,841	31,897	44,823	5,796	167,169	285,167	226,168
1981	4,734	32,051	3,451	12,035	61,633	92,449	17,743	29,594	19,030	28,169	5,601	112,192	199,900	156,046
1982	3,491	23,662	2,914	9,012	54,655	81,982	31,652	51,128	17,516	24,182	6,056	116,284	196,022	156,153
1983	2,538	17,181	2,586	8,225	44,886	67,329	29,038	46,874	14,310	20,753	2,155	95,513	162,517	129,015
1984	1,806	12,252	2,233	7,060	44,661	59,160	20,478	34,131	17,938	27,899	3,222	90,339	143,724	117,031
1985	1,448	9,779	958	3,059	45,916	61,460	23,106	43,533	22,841	38,784	5,529	99,798	162,144	130,971
1986	2,470	16,720	1,606	5,245	55,159	72,560	36,214	70,921	18,102	33,101	6,176	119,727	204,723	162,225
1987	3,289	22,341	1,336	4,433	52,699	68,365	22,668	47,919	11,529	20,679	3,081	94,602	166,818	130,710
1988	2,068	14,037	1,563	5,068	56,870	75,387	26,140	49,956	10,370	19,830	3,286	100,297	167,564	133,930
1989	2,018	13,653	697	2,299	51,656	67,066	17,311	35,338	11,939	21,818	3,197	86,819	143,371	115,095
1990	1,148	7,790	1,347	4,401	50,261	66,352	24,616	53,110	10,248	18,871	5,051	92,671	155,576	124,123
1991	548	3,740	1,054	3,429	46,841	60,724	20,983	44,446	10,613	17,884	2,647	82,687	132,871	107,779
1992	2,515	15,548	3,111	10,554	46,917	61,285	29,101	61,122	9,777	16,456	2,459	93,880	167,425	130,652
1993	3,858	18,234	1,499	5,094	37,023	46,484	25,753	51,793	6,764	11,087	2,231	77,128	134,924	106,026
1994	5,653	24,396	1,902	6,174	37,703	47,180	22,097	57,055	4,379	6,908	1,346	73,080	143,058	108,069
1995	12,368	44,205	3,635	12,592	43,755	54,186	24,276	62,950	4,985	8,317	1,748	90,767	183,998	137,382
1996	9,113	32,759	4,457	14,159	39,413	49,846	20,380	42,964	7,227	12,054	2,407	82,996	154,188	118,592
1997	9,384	23,833	3,887	8,355	32,443	41,017	17,563	37,804	3,645	5,922	1,611	68,533	118,542	93,537
1998	-	-	5,322	12,453	24,295	31,726	8,260	19,498	2,728	6,003	1,526	-	-	-
1999	-	-	4,254	14,262	25,362	33,622	12,389	29,399	3,482	7,107	1,168	-	-	-
2000	-	-	2,218	16,360	24,695	34,543	14,052	29,955	2,038	5,079	533	-	-	-

Labrador : SFAs 1,2&14B
Newfoundland: SFAs 3-14A
Gulf of St. Lawrence: SFAs 15-18
Scotia-Fundy: SFAs 19-23 (SFA 22 is not included as it does not produce 2SW salmon)
Quebec: Q1-Q11

Table 4.2.3.1 Run reconstruction data inputs for harvests used to estimate pre-fishery abundance of maturing and non-maturing 1SW salmon of North American origin (terms defined in Table 4.2.3.2).

	{1}			{1-7, 14b}		{8-14a}		{1-7, 14b}
1SW Year (i)	AH_Small (i)	AH_Large (i+1)	AH_Large (i)	H_Small (i)	H_Large (i)	H_Small (i)	H_Large (i+1)	H_Large (i+1)
1971	0	0	0	158896	199176	70936	42861	144496
1972	0	0	0	143232	144496	111141	43627	227779
1973	0	0	0	188725	227779	176907	85714	196726
1974	0	0	0	192195	196726	153278	72814	215025
1975	0	0	0	302348	215025	91935	95714	210858
1976	0	0	0	221766	210858	118779	63449	231393
1977	0	0	0	220093	231393	57472	37653	155546
1978	0	0	0	102403	155546	38180	29122	82174
1979	0	0	0	186558	82174	62622	54307	211896
1980	0	0	0	290127	211896	94291	38663	211006
1981	0	0	0	288902	211006	60668	35055	129319
1982	0	0	0	222894	129319	77017	28215	108430
1983	0	0	0	166033	108430	55683	15135	87742
1984	0	0	0	123774	87742	52813	24383	70970
1985	0	0	0	178719	70970	79275	22036	107561
1986	0	0	0	222671	107561	91912	19241	146242
1987	0	0	0	281762	146242	82401	14763	86047
1988	0	0	0	198484	86047	74620	15577	85319
1989	0	0	0	172861	85319	60884	11639	59334
1990	0	0	0	104788	59334	46053	10259	39257
1991	0	0	0	89099	39257	42721	0	32341
1992	0	0	0	24249	32341	0	0	17096
1993	0	0	0	17074	17096	0	0	15377
1994	0	0	0	8640	15377	0	0	11176
1995	0	0	0	7980	11176	0	0	7272
1996	0	0	0	7849	7272	0	0	6943
1997	0	2269	0	9753	6943	0	0	0
1998	2988	1084	2269	0	0	0	0	0
1999	2739	1545	1084	0	0	0	0	0
2000	5842	0	1545	0	0	0	0	0

Table 4.2.3.2 Definitions of key variables used in continental run-reconstruction models for North American salmon.

Variable	Definition
i	Year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.01 per month)
t1	Time between the mid-point of the Canadian fishery and return to river = 2 months
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp(-M t1)}
H_s(i)	Number of "Small" salmon caught in Canada in year i; fish <2.7 kg
H_l(i)	Number of "Large" salmon caught in Canada in year i; fish >=2.7 kg
AH_s	Aboriginal and resident food harvests of small salmon in northern Labrador
AH_l	Aboriginal and resident food harvest of large salmon in northern Labrador
f_imm	Fraction of 1SW salmon that are immature, i.e. non-maturing: range = 0.1 to 0.2
af_imm	Fraction of 1SW salmon that are immature in native and resident food fisheries in N Labrador
q	Fraction of 1SW salmon present in the large size market category; range = 0.1 to 0.3
MC1(i)	Harvest of maturing 1SW salmon in Newfoundland and Labrador in year i
i+1	Year of fishery on 2SW salmon in Canada
MR1(i)	Return estimates of maturing 1SW salmon in Atlantic Canada in year i
NN1(i)	Pre-fishery abundance of non-maturing 1SW + maturing 2SW salmon in year i
NR(i)	Return estimates of non-maturing + maturing 2SW salmon in year i
NR2(i+1)	Return estimates of maturing 2SW salmon in Canada
NC1(i)	Harvest of non-maturing 1SW salmon in Nfld + Labrador in year i
NC2(i+1)	Harvest of maturing 2SW salmon in Canada
NG(i)	Catch of 1SW North American origin salmon at Greenland
S2	Survival of 2SW salmon between Greenland and homewater fisheries
MN1(i)	Pre-fishery abundance of maturing 1SW salmon in year I
RFL1	Labrador raising factor for 1SW used to adjust pre-fishery abundance
RFL2	Labrador raising factor for 2SW used to adjust pre-fishery abundance

Table 4.2.3.3 Run reconstruction data inputs used to estimate pre-fishery abundance of non-maturing (NN1) 1SW salmon of North American origin (terms defined in Table 4.2.3.2).

1SW Year (i)	NG1 (i)	NC1 min (i)	max (i)	NC2 min (i+1)	max (i+1)	NR2 min (i+1)	max (i+1)	NN1 min (i)	max (i)	mid-point (i)
1971	287672	17881	43730	144008	172907	102364	182865	578974	726622	652798
1972	200784	15768	37316	203072	248628	104641	197140	557790	732940	645365
1973	241493	21150	51412	223422	262767	146082	254754	672631	867684	770157
1974	220584	21187	50243	223332	266337	121222	210851	623907	800542	712224
1975	278839	32385	73371	243315	285486	116569	212228	710252	904626	807439
1976	155896	24285	57005	225424	271703	162581	280941	610799	826787	718793
1977	189709	24323	57902	146535	177644	117301	200531	506919	667787	587353
1978	118853	11796	29813	86644	103079	55888	97427	288792	371342	330067
1979	200061	19478	42242	202634	245013	167169	285167	630091	831411	730751
1980	187999	31132	70739	186367	228568	112192	199900	550336	734489	642412
1981	227727	31000	70441	125578	151442	116284	196022	527318	684352	605835
1982	194715	23583	52338	104116	125802	95513	162517	439982	567499	503741
1983	33240	17688	39712	76554	94103	90339	143724	236377	337388	286882
1984	38916	13255	30019	74062	88256	99798	162144	245424	347471	296448
1985	139233	18582	40002	97329	118841	119727	204723	399028	539102	469065
1986	171745	23343	50988	121610	150859	94602	166818	435090	575673	505381
1987	173687	29639	65127	74996	92205	100297	167564	398168	527764	462966
1988	116767	20709	44860	75300	92364	86819	143371	317609	423746	370678
1989	60693	18139	39691	53173	65040	92671	155576	241044	345930	293487
1990	73109	11072	24518	37739	45590	82687	132871	218191	296332	257262
1991	110680	9302	20175	22639	29107	93880	167425	249798	349917	299857
1992	41855	2748	6790	11967	15386	77128	134924	143925	216262	180094
1993	0	1878	4441	10764	13839	73080	143058	95352	179428	137390
1994	0	1018	2651	7823	10058	90767	183998	110985	219159	165072
1995	21341	910	2267	5090	6545	82996	154188	120523	202958	161740
1996	21944	858	2006	4860	6249	68533	118542	104675	163182	133928
1997	16814	1045	2367	1588	2269	42131	71205	69083	123311	96197
1998	3026	161	367	759	1084	46654	85558	58751	126207	92479
1999	5374	142	306	1082	1545	43536	86471	57800	130436	94118
2000	5571	300	631	0	0	0	0	5871	6202	6036

Table 4.2.3.4 Run reconstruction data inputs and estimated pre-fishery abundance for maturing (MN1) 1SW salmon (grilse) of North American origin (terms defined in Table 4.2.3.2).

1SW Year (i)	MC1 min (i)	max (i)	MR1 min (i)	max (i)	MN1 min (i)	max (i)	mid-point (i)
1971	213987	267720	205245	441495	421294	713652	567473
1972	237286	279064	198169	415122	437446	698358	567902
1973	346109	408260	224721	435169	573089	847803	710446
1974	322772	379370	221491	449026	546489	832909	689699
1975	351015	422105	268639	578367	622355	1006285	814320
1976	313060	375300	299958	603740	616033	985108	800571
1977	252058	318032	223971	469268	478280	792016	635148
1978	132546	172340	169121	339201	303367	514951	409159
1979	218442	252711	233025	467126	453809	724532	589171
1980	343344	412617	296958	617145	643287	1035964	839625
1981	308670	377651	362877	762381	675194	1147695	911444
1982	265678	312538	307129	634111	575893	953022	764458
1983	197184	234389	192838	398250	391960	636641	514300
1984	158852	187900	230933	447980	392105	640382	516244
1985	227928	259284	258290	519507	488814	784012	636413
1986	278654	321357	339768	677807	621836	1005976	813906
1987	319510	375472	328770	674567	651584	1056819	854201
1988	240291	276488	374635	750007	618691	1034033	826362
1989	205998	239495	231101	454400	439422	698461	568941
1990	134630	156382	273654	530664	411034	692380	551707
1991	117141	133509	188679	362619	307716	499773	403745
1992	21986	30556	342594	618473	368023	655245	511634
1993	15027	19983	297095	566627	315107	592304	453706
1994	8142	11928	208098	418763	218331	434899	326615
1995	7278	10200	292082	662880	302296	679741	491019
1996	6861	9028	414848	891504	425878	909491	667685
1997	8358	10652	225194	400374	235816	415050	325433
1998	3054	3302	225603	376598	240161	608110	424136
1999	2705	2758	222221	331819	236245	535653	385949
2000	5697	5675	192865	370647	208520	600927	404724

Table 4.2.4.1 Estimated numbers of 2SW spawners in North America by geographic regions, 1971-2000.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	4,012	28,882	1,817	8,055	11,822	17,733	4,303	8,237	4,496	9,032	490	26,940	72,429	49,684
1972	3,435	24,812	2,008	8,240	23,160	34,741	17,803	32,996	7,459	12,699	1,038	54,903	114,525	84,714
1973	4,565	34,376	2,283	10,449	23,564	35,346	20,505	38,126	3,949	7,844	1,100	55,966	127,240	91,603
1974	4,490	33,475	1,510	5,942	28,657	42,985	31,702	57,923	9,526	15,979	1,147	77,032	157,451	117,242
1975	4,564	32,119	1,888	7,086	23,818	35,726	18,477	33,210	11,861	18,830	1,942	62,549	128,913	95,731
1976	4,984	36,701	2,011	7,198	22,653	33,980	14,821	29,694	11,045	18,337	1,126	56,641	127,035	91,838
1977	4,042	31,969	1,114	5,088	32,602	48,902	32,535	60,188	13,578	23,119	643	84,512	169,909	127,211
1978	3,361	25,490	1,557	5,712	29,889	44,834	11,511	22,829	6,517	11,428	3,314	56,150	113,608	84,879
1979	1,823	14,528	980	3,463	12,807	19,210	3,575	6,823	4,683	8,234	1,509	25,376	53,767	39,572
1980	4,633	34,525	1,888	6,925	35,594	53,390	19,947	37,645	14,270	25,628	4,263	80,596	162,375	121,486
1981	4,403	31,615	3,074	11,442	26,132	39,199	4,657	10,028	5,870	13,353	4,334	48,470	109,971	79,221
1982	3,081	23,127	2,579	8,481	26,492	39,738	11,036	20,330	5,656	11,335	4,643	53,486	107,655	80,571
1983	2,267	16,824	2,244	7,677	17,308	25,963	7,436	14,288	1,505	6,529	1,769	32,529	73,050	52,790
1984	1,478	11,822	2,063	6,800	22,345	32,659	15,332	27,195	14,245	23,650	2,547	58,011	104,673	81,342
1985	1,258	9,530	946	3,042	20,668	31,742	21,168	39,982	18,185	33,580	4,884	67,108	122,759	94,934
1986	2,177	16,334	1,575	5,198	24,088	35,939	32,991	64,980	15,435	30,120	5,570	81,836	158,141	119,988
1987	2,895	21,821	1,320	4,409	21,723	31,727	19,877	43,120	10,235	19,233	2,781	58,831	123,091	90,961
1988	1,625	13,452	1,540	5,033	25,390	38,343	23,392	44,859	9,074	18,381	3,038	64,059	123,106	93,582
1989	1,727	13,270	690	2,289	25,016	35,905	14,758	30,866	11,689	21,539	2,800	56,680	106,668	81,674
1990	923	7,493	1,327	4,372	24,422	36,219	22,554	49,478	9,688	18,245	4,356	63,269	120,163	91,716
1991	491	3,665	1,041	3,410	19,959	29,052	19,590	41,956	9,356	16,479	2,416	52,854	96,978	74,916
1992	2,012	14,889	3,057	10,474	19,337	28,833	27,448	54,168	8,725	15,280	2,292	62,871	125,936	94,403
1993	3,624	17,922	1,449	5,017	15,774	21,428	25,218	46,308	5,710	9,921	2,065	53,839	102,661	78,250
1994	5,339	23,981	1,840	6,077	15,631	21,147	20,315	54,101	3,682	6,093	1,344	48,152	112,743	80,447
1995	12,006	43,726	3,563	12,481	22,575	28,703	22,634	60,511	4,672	7,971	1,748	67,198	155,140	111,169
1996	8,838	32,395	4,372	14,028	19,010	25,421	18,416	39,757	6,507	11,242	2,407	59,550	125,250	92,400
1997	9,221	23,646	3,780	8,190	15,531	20,780	15,832	35,144	3,095	5,311	1,611	49,070	94,682	71,876
1998	-	-	5,222	12,295	14,176	19,333	6,568	16,742	2,424	5,663	1,526	-	-	-
1999	-	-	4,169	14,126	17,198	23,723	11,372	27,406	3,041	6,648	1,168	-	-	-
2000	-	-	1,975	16,021	16,067	23,365	12,262	27,339	1,855	4,877	533	-	-	-

Labrador : SFAs 1,2&14B
Newfoundland: SFAs 3-14A
Gulf of St. Lawrence: SFAs 15-18
Scotia-Fundy: SFAs 19-23 (SFA 22 is not included as it does not produce 2SW salmon)
Quebec: Q1-Q11

Table 4.2.4.2 Estimated numbers of 1SW spawners in North America by geographic regions, 1971-2000.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	29,032	111,448	85,978	199,463	9,338	14,007	19,874	35,534	4,800	12,810	29	149,051	373,291	261,171
1972	21,728	83,415	84,880	195,010	8,213	12,320	24,319	43,318	2,992	10,385	17	142,149	344,465	243,307
1973	0	11,405	108,785	253,965	10,987	16,480	28,105	51,257	8,658	18,715	13	156,548	351,834	254,191
1974	24,533	92,118	58,731	144,263	10,067	15,100	48,343	84,685	16,209	33,822	40	157,922	370,028	263,975
1975	49,688	183,837	78,882	191,775	11,606	17,409	42,668	74,920	18,232	28,608	67	201,143	496,615	348,879
1976	31,814	125,665	80,571	196,132	12,979	19,469	56,021	99,810	24,589	43,595	151	206,125	484,822	345,474
1977	28,815	112,337	75,762	186,149	12,004	18,006	14,045	27,585	16,704	34,231	54	147,385	378,364	262,874
1978	13,464	53,851	68,756	166,429	11,447	17,170	13,768	25,474	5,678	9,808	127	113,240	272,859	193,049
1979	17,825	72,682	76,233	183,991	15,863	23,795	29,764	57,382	18,577	36,754	247	158,508	374,850	266,679
1980	45,870	170,045	85,189	206,650	20,817	31,226	26,450	50,297	28,878	52,513	722	207,926	511,453	359,690
1981	49,855	187,471	110,755	268,677	30,952	46,428	39,421	77,501	18,236	42,948	1,009	250,228	624,035	437,132
1982	34,032	129,370	99,376	241,131	16,877	25,316	52,020	97,071	12,179	26,548	290	214,774	519,727	367,250
1983	19,360	78,689	77,514	187,796	12,030	18,045	13,611	24,683	7,747	15,969	255	130,517	325,436	227,976
1984	9,348	40,056	91,505	222,730	16,316	24,957	17,990	33,657	17,964	37,503	540	153,663	359,444	256,554
1985	19,631	76,462	85,179	207,175	15,608	25,140	39,514	73,906	18,158	40,731	363	178,454	423,778	301,116
1986	30,806	116,481	87,833	213,537	22,230	33,855	82,122	149,587	21,204	44,947	660	244,854	559,067	401,960
1987	37,572	144,917	104,096	232,991	25,789	40,481	59,330	110,335	21,589	45,407	1,087	249,463	575,217	412,340
1988	34,369	134,100	93,396	227,054	28,582	44,815	85,644	159,916	23,288	47,231	923	266,203	614,039	440,121
1989	22,429	90,212	41,798	102,199	24,710	37,319	44,715	81,719	23,873	48,578	1,080	158,605	361,108	259,857
1990	12,544	52,176	69,576	169,449	26,594	39,826	56,161	113,442	22,753	49,642	617	188,245	425,153	306,699
1991	10,526	42,647	44,023	108,779	20,582	30,433	44,350	87,876	13,814	25,610	235	133,530	295,580	214,555
1992	15,229	59,331	95,096	214,129	21,754	33,583	118,723	189,260	15,125	29,633	1,124	267,051	527,060	397,056
1993	22,499	78,251	107,816	242,217	17,493	27,444	70,969	118,119	11,539	22,252	444	230,760	488,726	359,743
1994	15,228	53,958	66,185	162,342	16,758	25,642	32,651	90,339	6,918	10,218	427	138,167	342,925	240,546
1995	22,144	73,575	172,727	405,141	14,409	21,548	15,407	61,251	12,114	19,697	213	237,014	581,424	409,219
1996	48,362	150,048	218,639	520,504	18,923	27,805	24,411	70,260	19,253	32,472	651	330,240	801,740	565,990
1997	64,049	153,200	80,096	127,116	14,724	22,210	12,699	36,748	6,143	9,428	365	178,076	349,068	263,572
1998	-	-	124,551	225,216	16,277	24,954	23,580	46,609	16,342	26,028	403	-	-	-
1999	-	-	135,561	203,780	18,785	28,502	18,212	36,304	10,177	16,516	419	-	-	-
2000	-	-	99,743	234,572	17,137	27,096	25,968	43,558	10,656	17,977	270	-	-	-

Labrador : SFAs 1,2&14B
Newfoundland: SFAs 3-14A
Gulf of St. Lawrence: SFAs 15-18
Scotia-Fundy: SFAs 19-23 (SFA 22 is not included as it does not produce 2SW salmon)
Quebec: Q1-Q11

Table 4.2.4.3. Smolt age distributions in six stock areas of North America used to weight forward the spawning escapement in the current year to the year of the non-maturing 1SW component in the Northwest Atlantic.

	Smolt age (years)					
Stock area	1	2	3	4	5	6
Labrador	0.0	0.0	0.077	0.542	0.341	0.040
Newfoundland	0.0	0.041	0.598	0.324	0.038	0.0
Québec	0.0	0.058	0.464	0.378	0.089	0.010
Gulf of St. Lawrence	0.0	0.398	0.573	0.029	0.0	0.0
Scotia-Fundy	0.0	0.600	0.394	0.006	0.0	0.0
USA	0.377	0.520	0.103	0.0	0.0	0.0

Table 4.2.4.4 The mid-point of 2SW spawners and lagged spawners for North America and to each of the geographic areas. Lagged refers to the allocation of spawners to the year in which they would have contributed to the year of prefishery abundance.

	North America		Prefishery	Recruits/	Labrador (L)		Newfoundland (N)		Quebec (Q)		Gulf of St. Lawrence (G)		Scotia-Fundy (S)		USA (US)	
	Total 2SW	Lagged 2SW	abundance	2SW lagged												
Year	spawners	spawners	recruits	spawner	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged
1971	49684		652827		16447		4936		14777		6270		6764		490	
1972	84714		645486		14124		5124		28951		25399		10079		1038	
1973	91603		770200		19470		6366		29455		29316		5896		1100	
1974	117242		712403		18982		3726		35821		44813		12752		1147	
1975	95731		807391		18341		4487		29772		25844		15345		1942	
1976	91838		718805		20842		4605		28316		22258		14691		1126	
1977	127211		587326		18006		3101		40752		46361		18348		643	
1978	84879	95423	330077	3.46	14425	14759	3635	5802	37362	28016	17170	35371	8973	10034	3314	1442
1979	39572	107023	730725	6.83	8175	17486	2221	4664	16008	32232	5199	36818	6459	14270	1509	1553
1980	121486	96095	639192	6.65	19579	18903	4406	4316	44492	31940	28796	24971	19949	14937	4263	1029
1981	79221	104076	605935	5.82	18009	18795	7258	4472	32666	30266	7342	31955	9612	16888	4334	1699
1982	80571	107284	503481	4.69	13104	19695	5530	3661	33115	34821	15683	34049	8496	12699	4643	2358
1983	52790	82182	286891	3.49	9546	18710	4961	3440	21636	36526	10862	13258	4017	7514	1769	2733
1984	81342	79799	296450	3.71	6650	15422	4432	2801	27502	28065	21264	14937	18947	14569	2547	4006
1985	94934	85408	468776	5.49	5394	11576	1994	3786	26205	32359	30575	19576	25882	13668	4884	4443
1986	119988	80977	505066	6.24	9255	15361	3386	6075	30013	35728	48985	11286	22777	8998	5570	3528
1987	90961	78610	462953	5.89	12358	17772	2865	6023	26725	33119	31498	13524	14734	5813	2781	2359
1988	93582	79001	370526	4.69	7538	14762	3287	5209	31866	27538	34125	15142	13728	13002	3038	3347
1989	81674	93776	293057	3.13	7498	10875	1490	4544	30461	25762	22812	24668	16614	23026	2800	4901
1990	91716	103388	256969	2.49	4208	7799	2850	2951	30320	26580	36016	37632	13966	23978	4356	4449
1991	74916	99937	299086	2.99	2078	6285	2225	2953	24506	28072	30773	41497	12917	17965	2416	3166
1992	94403	89467	179755	2.01	8451	8072	6765	3018	24085	28227	40808	33056	12002	14173	2292	2922
1993	78250	91771	137134	1.49	10773	10649	3233	3080	18601	29616	35763	29551	7816	15464	2065	3410
1994	80447	88940	161214	1.81	14660	9247	3958	2178	18389	30646	37208	28397	4888	15007	1344	3464
1995	111169	89461	156490	1.75	27866	7453	8022	2400	25639	30138	41572	33549	6322	13350	1748	2570
1996	92400	84687	126588	1.49	20617	5299	9200	2585	22216	27289	29086	34922	8875	12373	2407	2219
1997	71876	82888	97899	1.18	16434	3511	5985	5004	18155	24550	25488	38513	4203	9493	1611	1817
1998		76104				6285	8758	4368	16754	21312	11655	36488	4044	6080	1526	1571
1999		80008				9930	9148	3994	20460	19459	19389	38906	4845	5764	1168	1954
2000		89093				14098		6574		22055		36481		7845		2039
2001		89243				22118		8490		22898		28021		6056		1661
2002		75646				22527		7215		20281		20091		4133		1400
2003		-						7892		18078		15136		4525		2908

Spawners lagged by:
Labrador = 0.0768 x i-5 spawners + 0.542 x i-6 + 0.341 x i-7 + 0.0401 x i-8
Newfoundland = 0.0408 x i-4 spawners + 0.5979 x i-5 + 0.3237 x i-6 + 0.0375 x i-7
Quebec = 0.0577 x i-4 spawners + 0.4644 x i-5 + 0.3783 x i-6 + 0.0892 x i-7 + 0.0104 x i-8
Gulf = 0.3979 x i-4 spawners + 0.5731 x i-5 + 0.0291 x i-6
Scotia-Fundy = 0.6002 x i-4 spawners + 0.3942 x i-5 + 0.0055 x i-6
USA = 0.3767 x i-3 spawners + 0.520 x i-4 + 0.1033 x i-5.

Table 4.4.1. 2SW spawning requirements for North America by country, management zone and overall. Management zones are shown in Figure 4.1.1.1.

Country	Stock Area	Management zone	2SW spawner requirement	
Canada	Labrador	SFA 1	7,992	
		SFA 2	25,369	
		SFA 14B	1,390	
	Subtotal			34,746
	Newfoundland	SFA 3	240	
		SFA 4	488	
		SFA 5	233	
		SFA 6 to 8	13	
		SFA 9 to 12	212	
		SFA 13	2,544	
		SFA 14A	292	
	Subtotal			4,022
	Gulf of St. Lawrence	SFA 15	5,656	
		SFA 16	21,050	
		SFA 17	537	
		SFA 18	3,187	
	Subtotal			30,430
	Québec	Q1	2,532	
		Q2	1,797	
		Q3	1,788	
		Q5	948	
		Q6	818	
		Q7	2,021	
		Q8	11,195	
		Q9	3,378	
		Q10	1,582	
		Q11	3,387	
	Subtotal		29,446	
	Scotia-Fundy	SFA 19	3,138	
		SFA 20	2,691	
		SFA 21	5,817	
		SFA 22	0	
		SFA 23	13,059	
	Subtotal		24,705	
Total			123,349	
USA	Connecticut		9,727	
	Merrimack		2,599	
	Penobscot		6,838	
	Other Maine rivers		9,668	
	Paucatuck		367	
Total			29,199	
North American Total			152,548	

Table 4.5.1 Fishing mortalities of 2SW salmon equivalents by North American fisheries, 1972-2000.
Only mid-points of the estimated values have been used.

Year	CANADA: MIXED STOCK: NF-LAB Comm 1SW (Yr i-1) (b)	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) (b)	NF-Lab comm total	TERMINAL FISHERIES IN YEAR i: Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	USA: Year i	Total	Terminal Fisheries as a % of Total
1972	27,874	11	156,881	184,755	314	633	27,417	22,389	6,801	242,310	346	242,656	24
1973	24,016	8	223,603	247,619	719	895	32,751	17,915	6,680	306,580	327	306,907	19
1974	32,828	9	240,676	273,504	593	542	47,631	21,429	12,734	356,434	247	356,681	23
1975	32,316	9	242,398	274,714	241	528	41,097	15,675	12,375	344,629	389	345,018	20
1976	47,846	13	261,770	309,616	618	412	42,139	18,088	11,111	381,985	191	382,176	19
1977	36,777	10	246,090	282,867	954	946	42,301	33,433	15,562	376,062	1,355	377,418	25
1978	37,200	14	160,477	197,677	580	559	37,421	23,803	10,781	270,821	894	271,714	27
1979	18,825	13	93,917	112,742	469	144	25,234	6,299	4,506	149,395	433	149,828	25
1980	27,923	8	221,597	249,520	646	699	53,567	29,828	18,411	352,670	1,533	354,202	30
1981	46,088	14	205,403	251,492	384	485	44,375	16,326	13,988	327,050	1,267	328,317	23
1982	45,894	18	137,132	183,026	473	433	35,204	25,707	12,353	257,195	1,413	258,608	29
1983	34,348	15	113,815	148,163	313	445	34,472	27,094	13,515	224,002	386	224,388	34
1984	25,969	18	84,480	110,448	379	215	24,408	6,041	3,971	145,464	675	146,138	24
1985	19,578	14	80,351	99,929	219	15	27,483	2,745	4,930	135,322	645	135,967	27
1986	26,504	15	107,009	133,514	340	39	33,846	4,582	2,824	175,145	606	175,750	24
1987	33,629	16	134,879	168,508	457	20	33,807	3,795	1,370	207,956	300	208,256	19
1988	42,874	26	82,769	125,642	514	29	34,262	3,922	1,373	165,743	248	165,990	24
1989	29,664	20	82,998	112,662	337	9	28,901	3,513	265	145,686	397	146,083	23
1990	26,164	22	58,518	84,682	261	24	27,986	2,847	593	116,394	696	117,089	28
1991	16,101	18	41,250	57,352	66	16	29,277	1,942	1,331	89,984	231	90,215	36
1992	13,336	18	25,615	38,952	581	67	30,016	4,303	1,114	75,033	167	75,201	48
1993	4,315	9	13,541	17,856	273	63	23,153	3,010	1,110	45,466	166	45,632	61
1994	2,859	7	12,179	15,038	365	80	24,052	2,368	756	42,659	1	42,660	65
1995	1,660	5	8,852	10,511	420	92	23,331	2,041	330	36,725	0	36,725	71
1996	1,437	4	5,760	7,197	320	108	22,413	2,586	766	33,389	0	33,389	78
1997	1,296	5	5,499	6,795	175	136	18,574	2,196	581	28,456	0	28,456	76
1998	1,544	9	1,909	3,453	268	129	11,256	2,224	322	17,651	0	17,651	80
1999	239	2	912	1,151	268	111	9,032	1,504	450	12,515	0	12,515	91
2000	203	1	1,300	1,503	268	291	9,903	2,203	193	14,361	0	14,361	90
2001	421	-	-	-	-	-	-	-		-	-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.904837
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.99005
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 1998-2000 and resident food fishery harvest in 2000

Table 4.5.1.1. Catch options for 2001 North American fisheries

Catch Options for 2001 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability Level	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	145,125	0
30	160,214	0
35	175,591	0
40	191,502	14,255
45	208,016	29,127
50	225,708	45,206
55	244,830	62,508
60	265,996	81,660
65	289,541	102,964
70	316,274	127,153
75	347,994	155,855

Table 4.5.2 History of fishing-related mortalities of North American salmon as 2SW equivalents, 1972-2000.

Year	Canadian total	USA total	North America Grand Total	% USA of Total North American	Greenland total	NW Atlantic Total	Harvest in homewaters as % of total NW Atlantic
1972	242,310	346	242,656	0.14	260,296	502,952	48
1973	306,580	327	306,907	0.11	181,677	488,584	63
1974	356,434	247	356,681	0.07	218,512	575,193	62
1975	344,629	389	345,018	0.11	199,593	544,611	63
1976	381,985	191	382,176	0.05	252,304	634,479	60
1977	376,062	1,355	377,418	0.36	141,060	518,478	73
1978	270,821	894	271,714	0.33	171,656	443,370	61
1979	149,395	433	149,828	0.29	107,543	257,370	58
1980	352,670	1,533	354,202	0.43	181,023	535,225	66
1981	327,050	1,267	328,317	0.39	170,108	498,425	66
1982	257,195	1,413	258,608	0.55	206,056	464,664	56
1983	224,002	386	224,388	0.17	176,185	400,574	56
1984	145,464	675	146,138	0.46	30,077	176,215	83
1985	135,322	645	135,967	0.47	35,213	171,179	79
1986	175,145	606	175,750	0.34	125,983	301,734	58
1987	207,956	300	208,256	0.14	155,401	363,658	57
1988	165,743	248	165,990	0.15	157,158	323,149	51
1989	145,686	397	146,083	0.27	105,655	251,738	58
1990	116,394	696	117,089	0.59	54,917	172,007	68
1991	89,984	231	90,215	0.26	66,152	156,366	58
1992	75,033	167	75,201	0.22	100,147	175,348	43
1993	45,466	166	45,632	0.36	37,872	83,504	55
1994	42,659	1	42,660	0.00	0	42,660	100
1995	36,725	0	36,725	0.00	0	36,725	100
1996	33,389	0	33,389	0.00	19,310	52,699	63
1997	28,456	0	28,456	0.00	19,856	48,312	59
1998	17,651	0	17,651	0.00	15,214	32,865	54
1999	12,515	0	12,515	0.00	2,738	15,253	82
2000	14,361	0	14,361	0.00	4,863	19,223	75
2001	-	-	-	-	5,041	-	-

Greenland harvest of 2SW equivalents = NG1 * 0.904837

Figure 4.1.1.1. Map of Salmon Fishing Areas (SFAs) and Quebec Management Zones (Qs) in Canada.

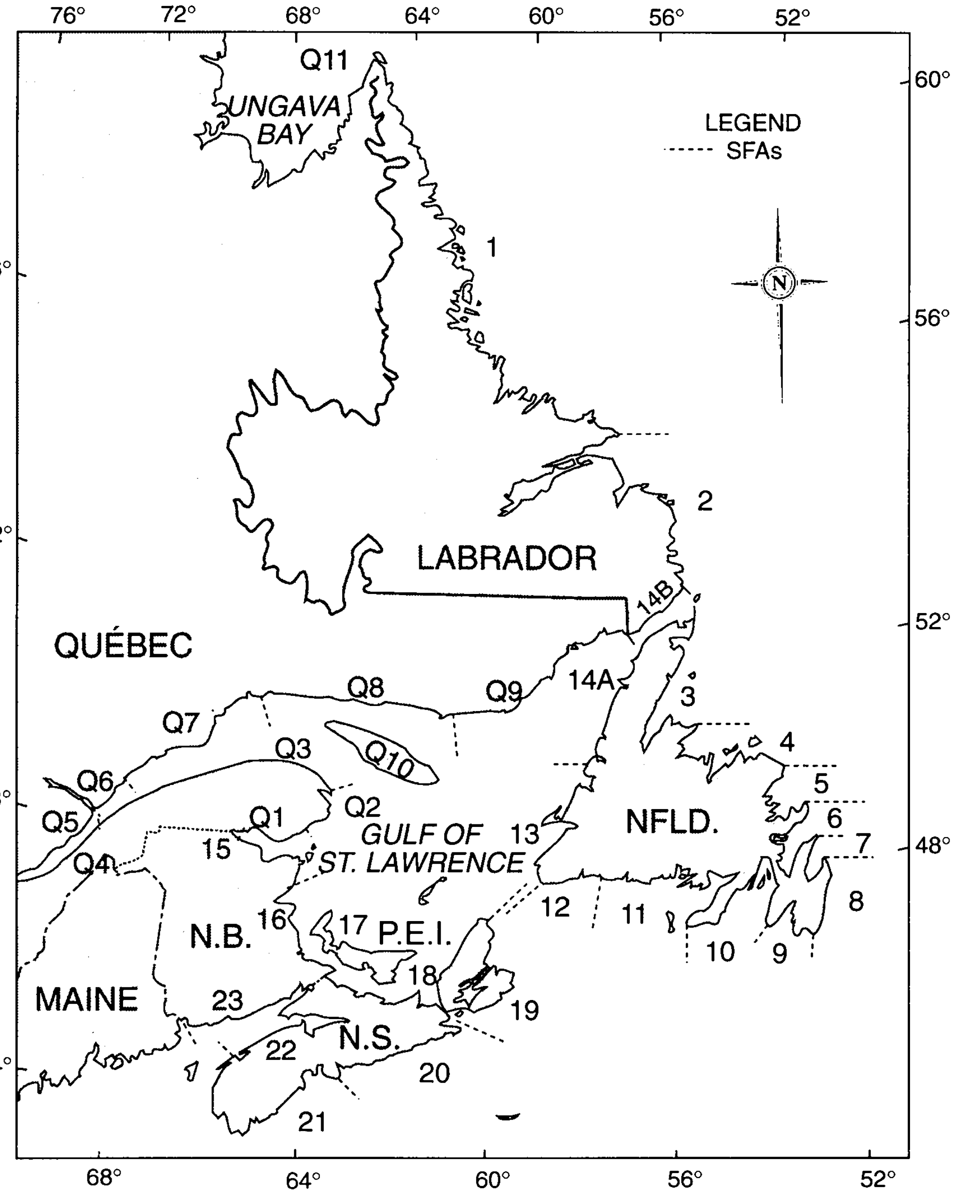


Figure 4.1.1.2. Summary of recreational fisheries management in eastern Canada and Maine (U.S.A.) during 2000.

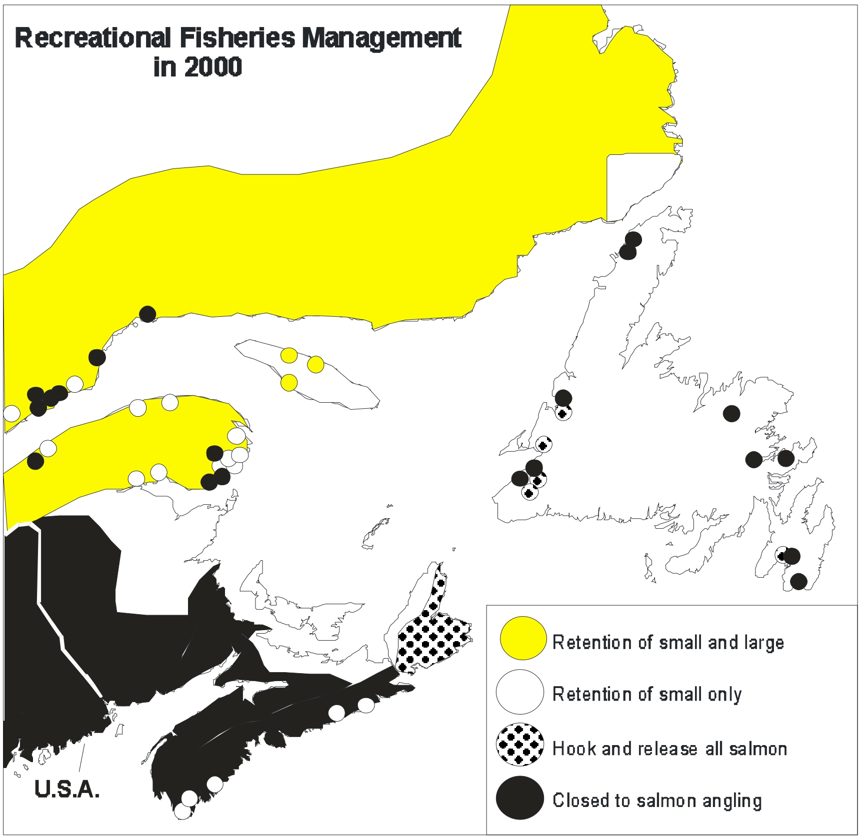


Figure 4.1.2.1. Harvest (t) of small salmon, large salmon, and combined in Canada, 1960-2000 by all users.

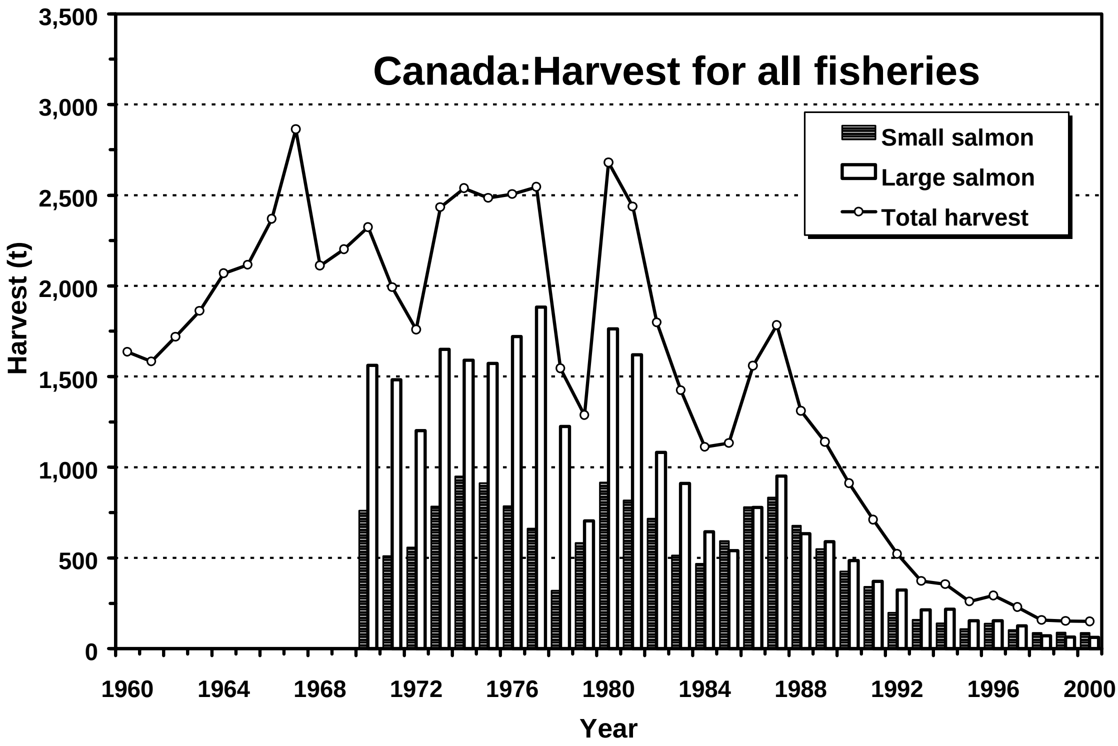


Figure 4.1.2.2. Harvest (number) of small and large salmon and both sizes combined in the recreational fisheries of Canada, 1974 to 2000.

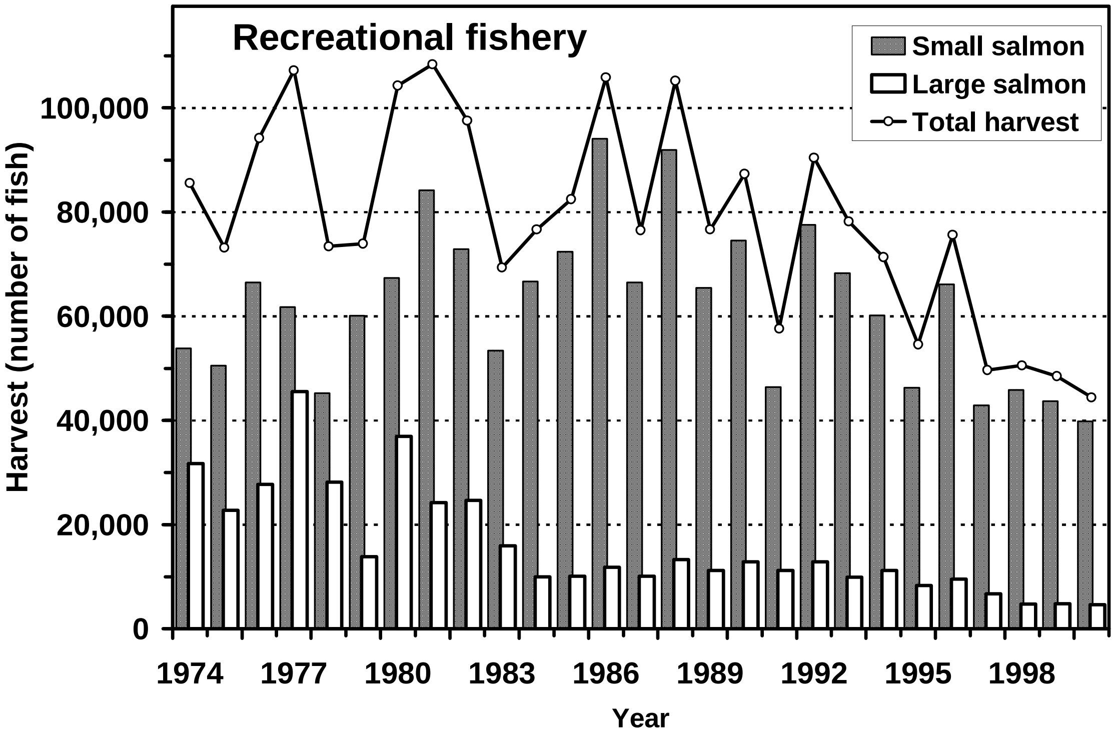


Figure 4.1.2.3. Angling catches (including kept and released fish) of small and large salmon by management area in 2000 (black square) expressed as a proportion of the average catches for the period 1984 to 1991. The vertical lines represent the minimum to maximum range. The 1984 to 1991 standard period was selected to represent the period of no commercial fisheries in SFAs 15 to 23 and Zones Q1 to Q6 and before the commercial salmon moratorium in Newfoundland SFAs 3 to 14A introduced in 1992. There were no estimates available for releaseed salmon in Newfoundland SFAs 3 to 11 for the years 1984 to 1991. The angling data for SFA 16 in 2000 are not available.

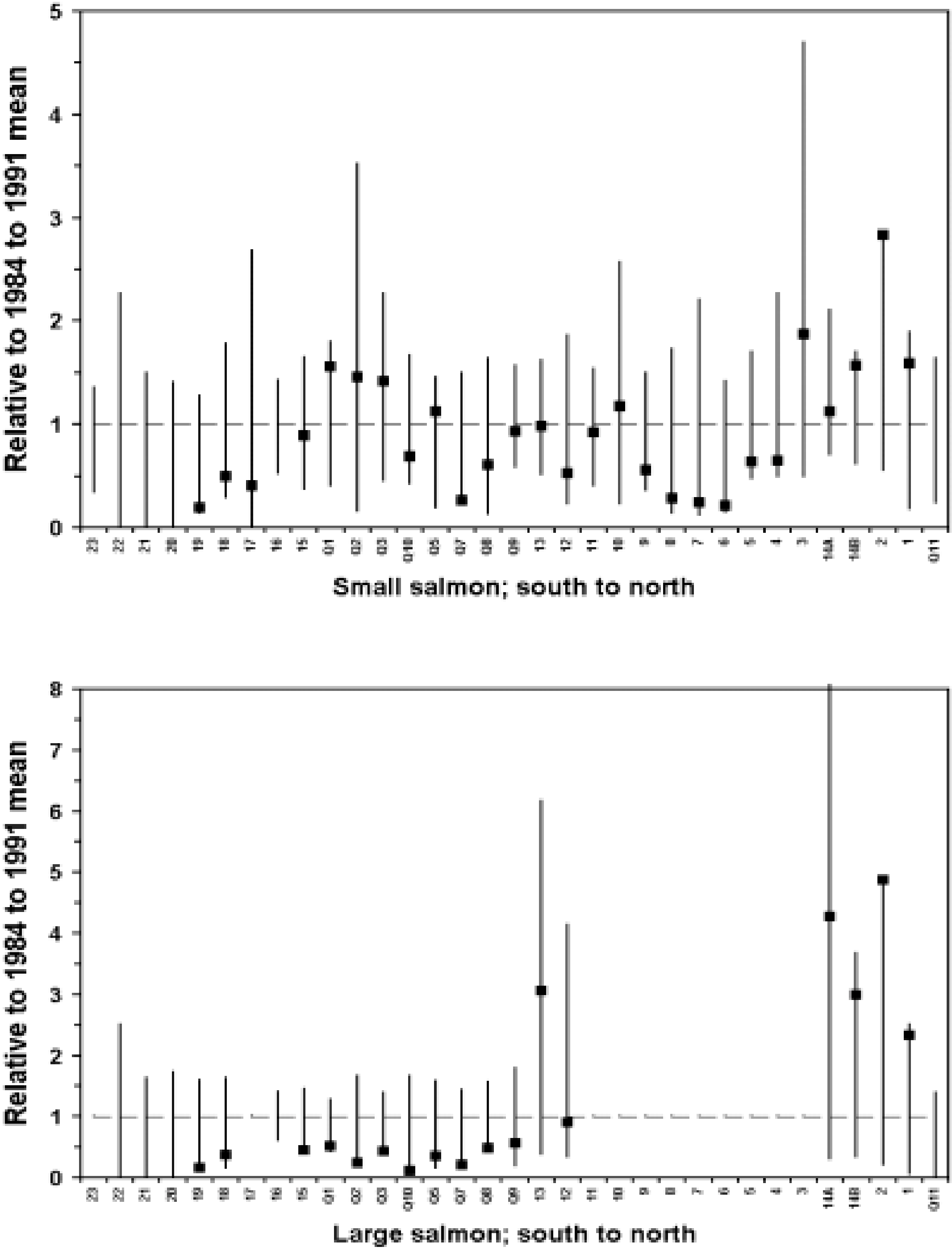


Figure 4.1.2.4. Harvest (t) of small salmon and large salmon and both size groups combined in the commercial fisheries of Canada, 1974 to 2000. All commercial fisheries were closed in 2000.

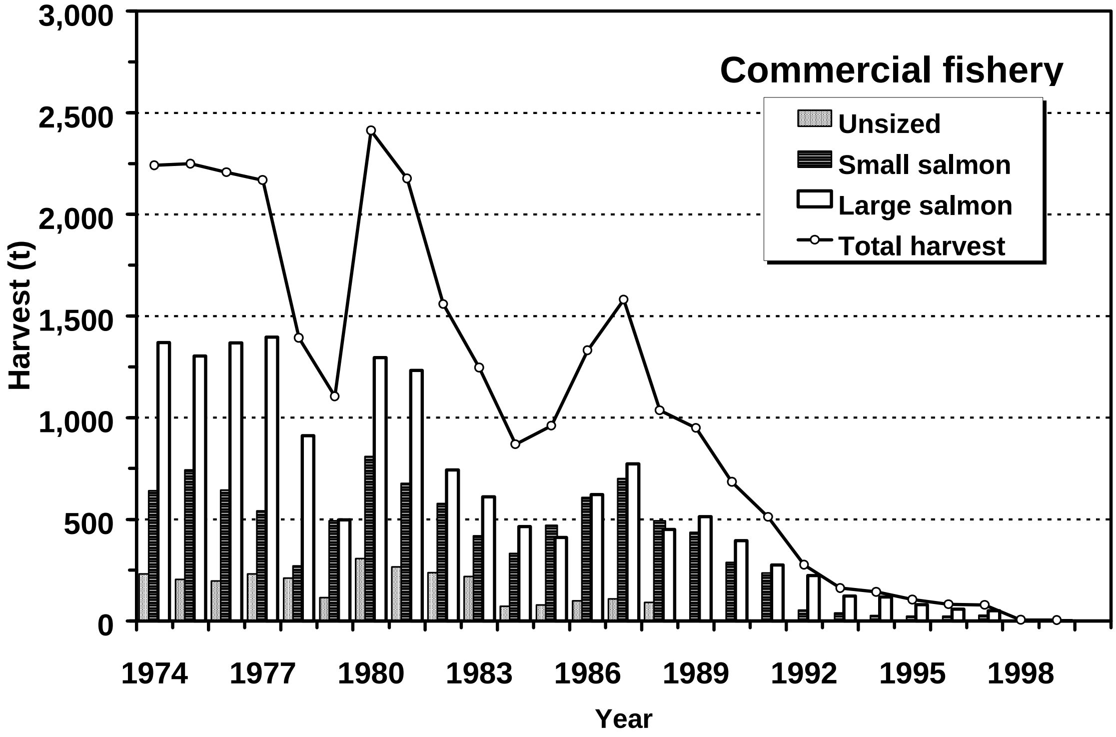


Figure 4.1.3.1. Origin (wild, hatchery, aquaculture) of Atlantic salmon returning to monitored rivers of eastern North America in 2000. Only rivers in which more than one origin type was expected are indicated.

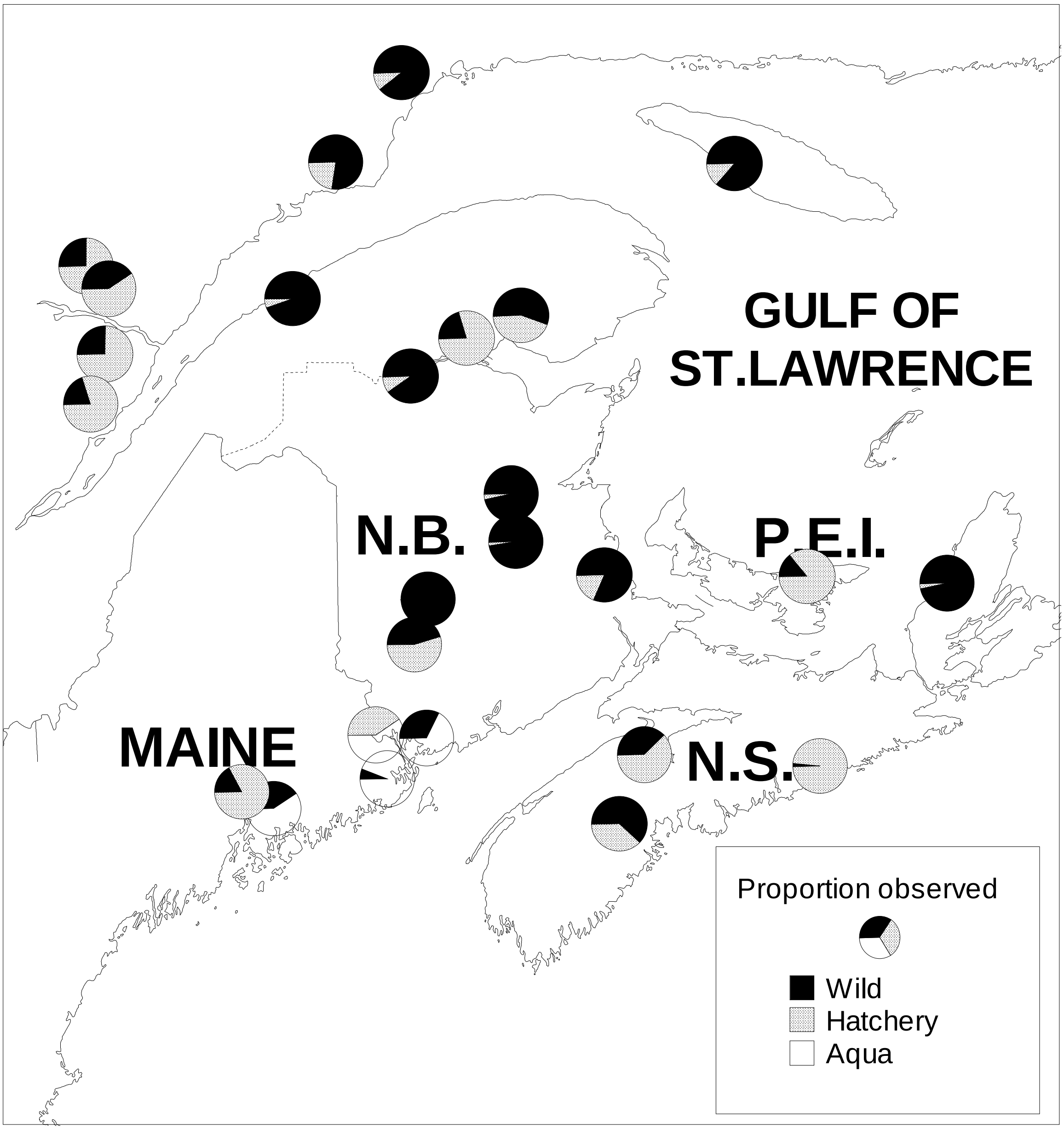


Figure 4.1.3.2. Location of Atlantic salmon marine grow-out sites in eastern North America (upper panel) and distribution of rivers with observed juvenile or adult aquaculture escaped Atlantic salmon since 1992 (lower panel).

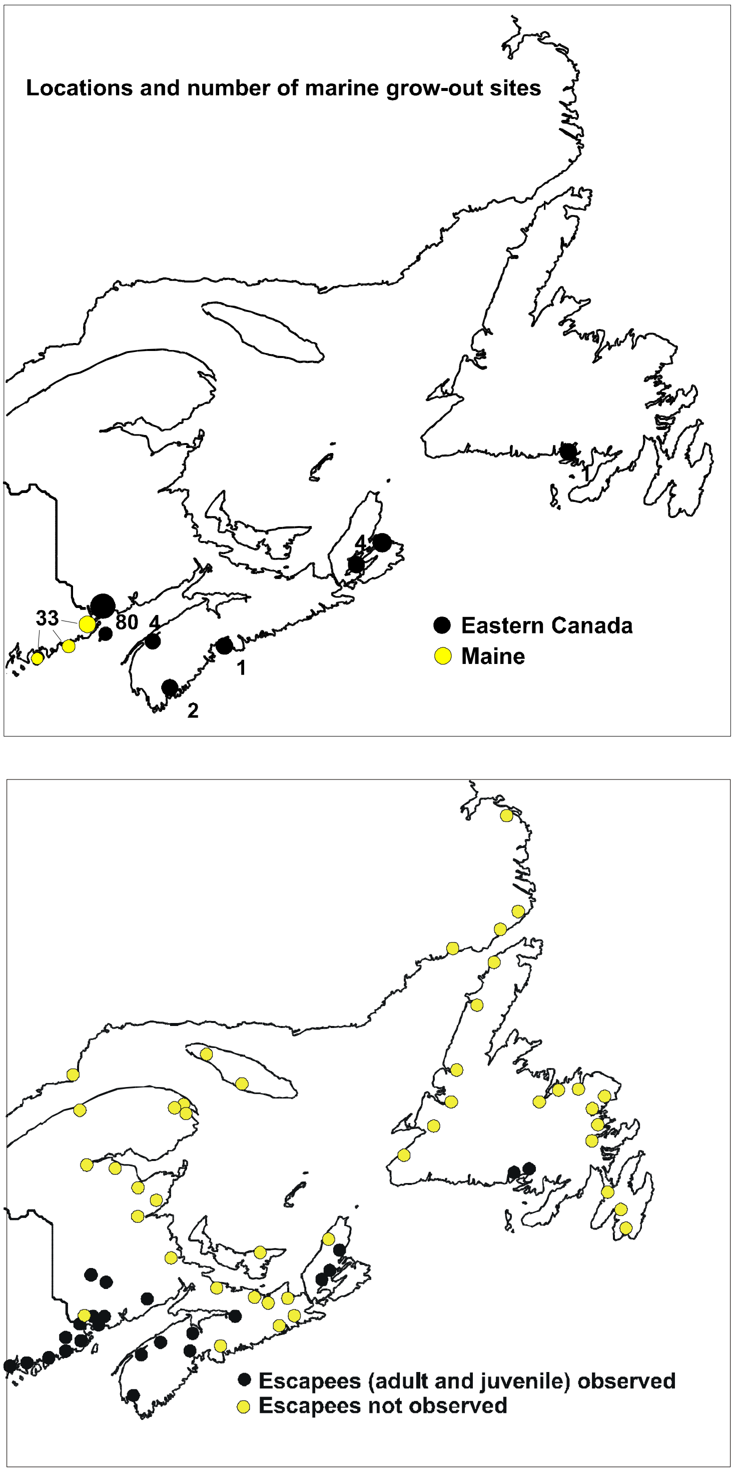
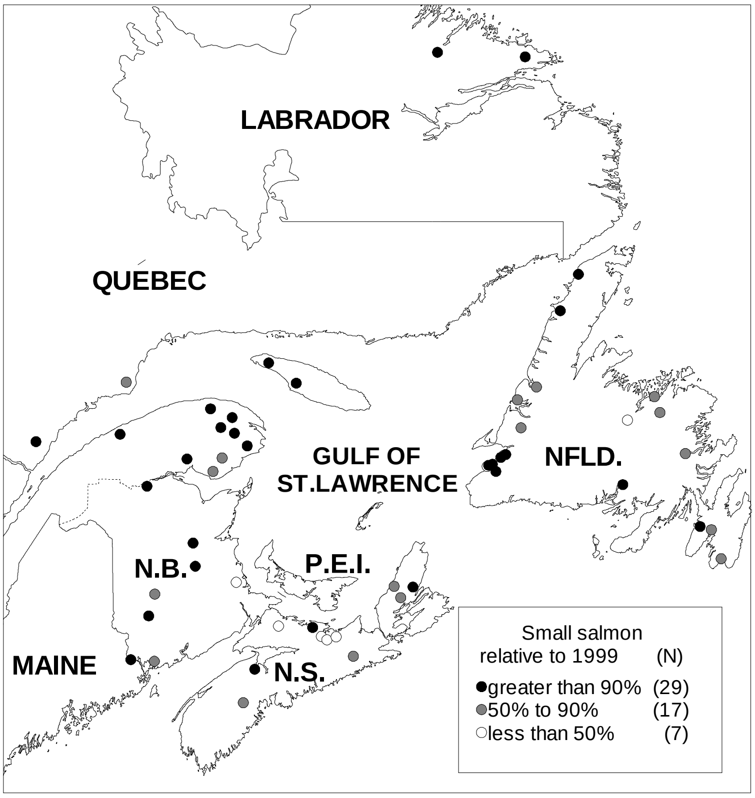


Figure 4.2.1.1. In-river returns of small salmon and large salmon for 53 monitored rivers of eastern Canada in 2000 relative to 1999.



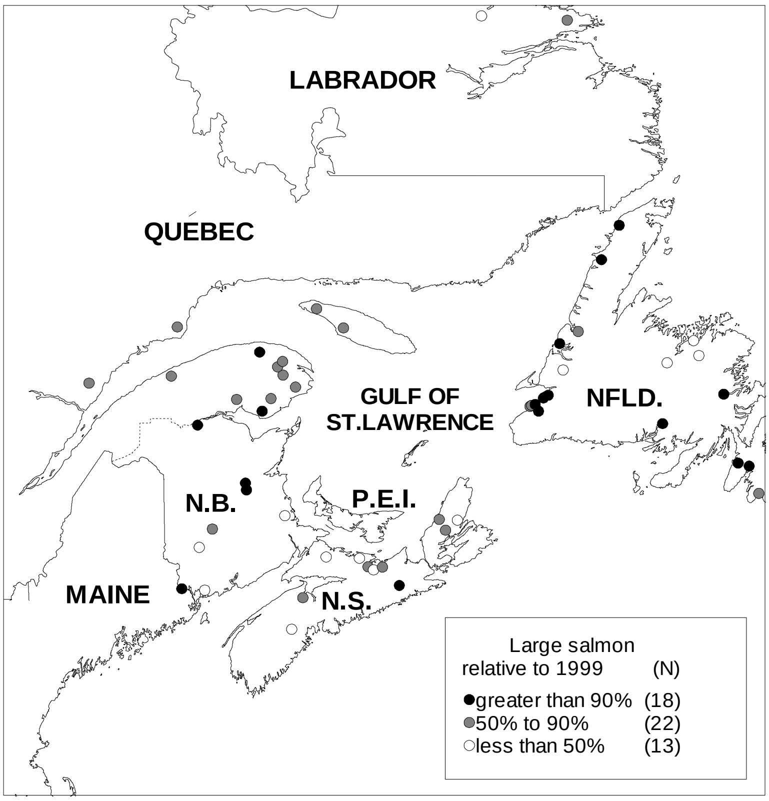


Figure 4.2.1.2. In-river returns of small salmon and large salmon for 26 monitored rivers in four geographic areas of eastern Canada from 1985 to 2000. The in-river returns do not account for removals in marine fisheries. Rivers by area are: Newfoundland (Conne, Exploits, Middle Brook, Northeast Trepassey, Northeast Brook, Torrent, Western Arm Brook), Québec (Bonaventure, Cascapédia, Port-Daniel Nord, Grande Rivière, St-Jean, York, Darmouth, Madeleine, Matane, de la Trinité), Gulf (Restigouche, Miramichi, Philip, East Pictou, West Antigonish, Margaree), and Scotia-Fundy (Liscomb, LaHave, Saint John at Mactaquac).

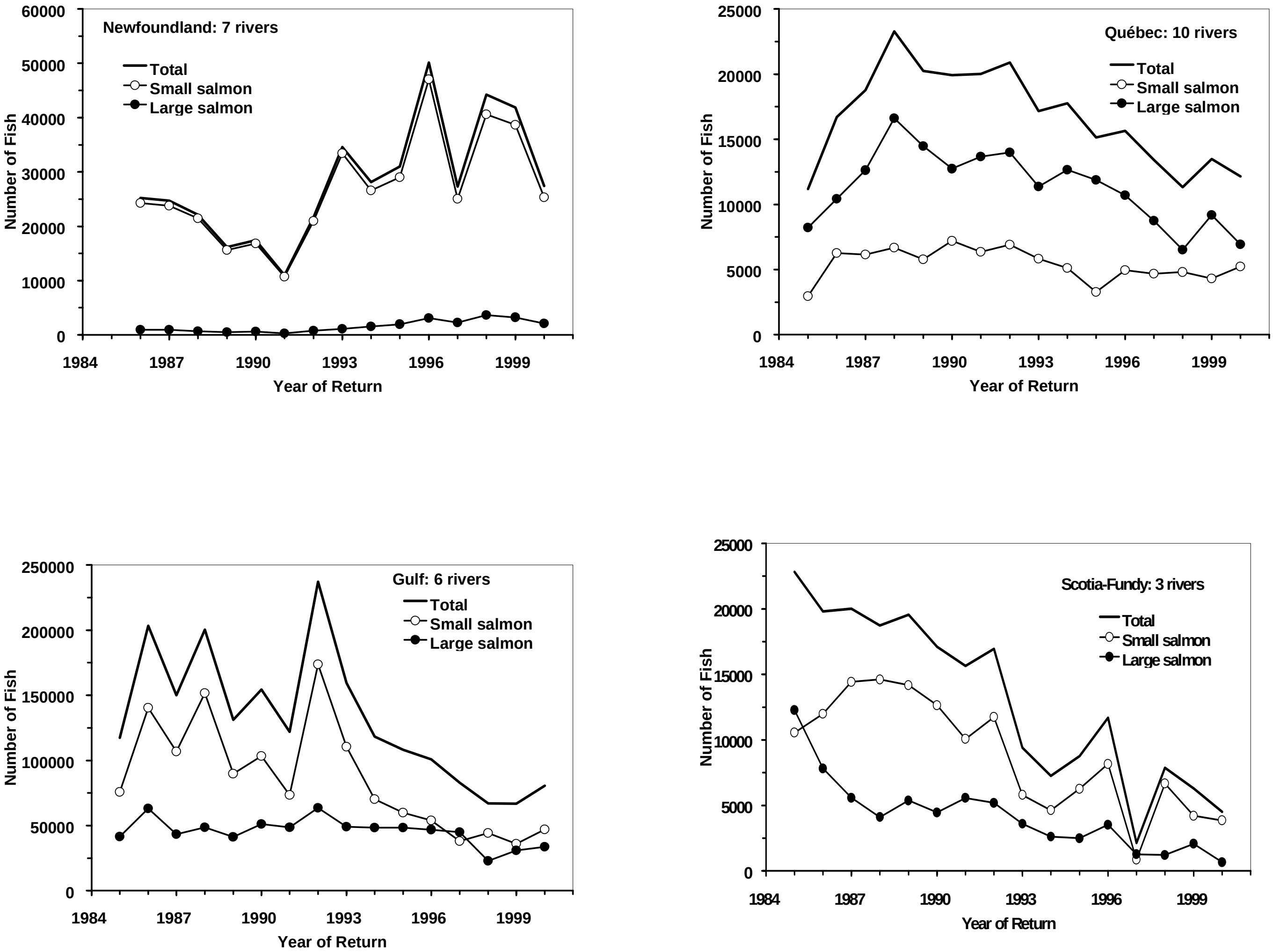


Figure 4.2.1.3. Rivers with smolt and juvenile monitoring programs in eastern Canada and U.S. used in the analysis for estimating a relative juvenile abundance index.

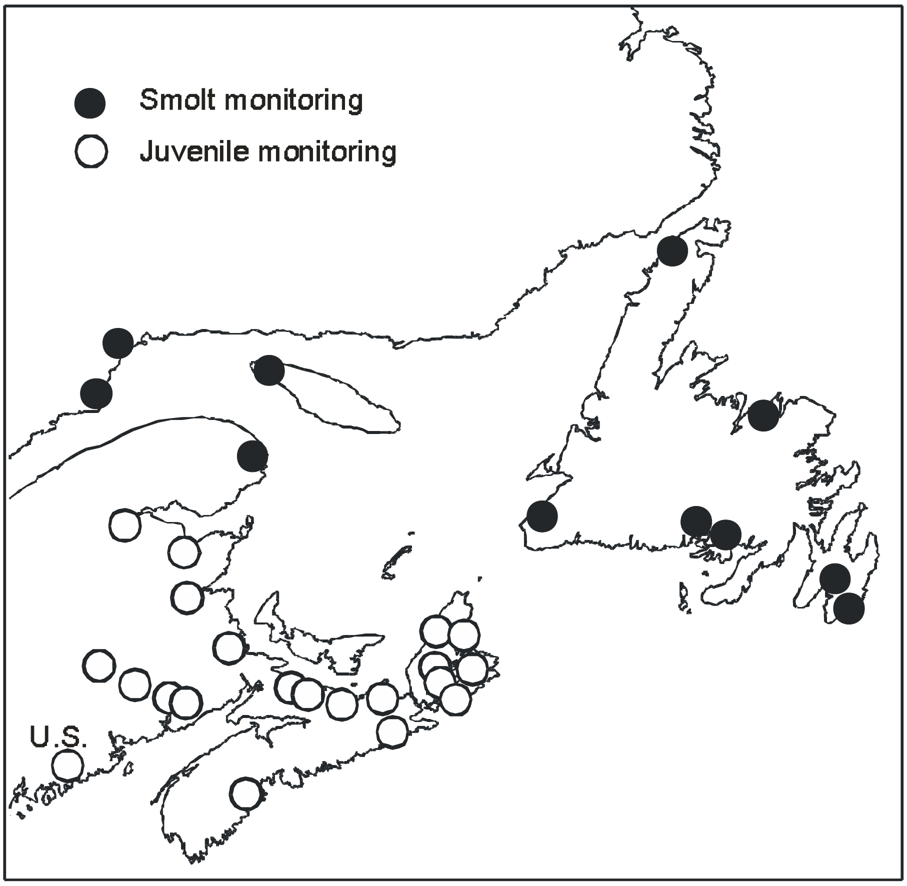


Figure 4.2.1.4. Variability in the wild smolt output from nine rivers of eastern Canada in 1971 to 2000 relative to the average smolt output (by individual river) for the 1990 to 1995 period.

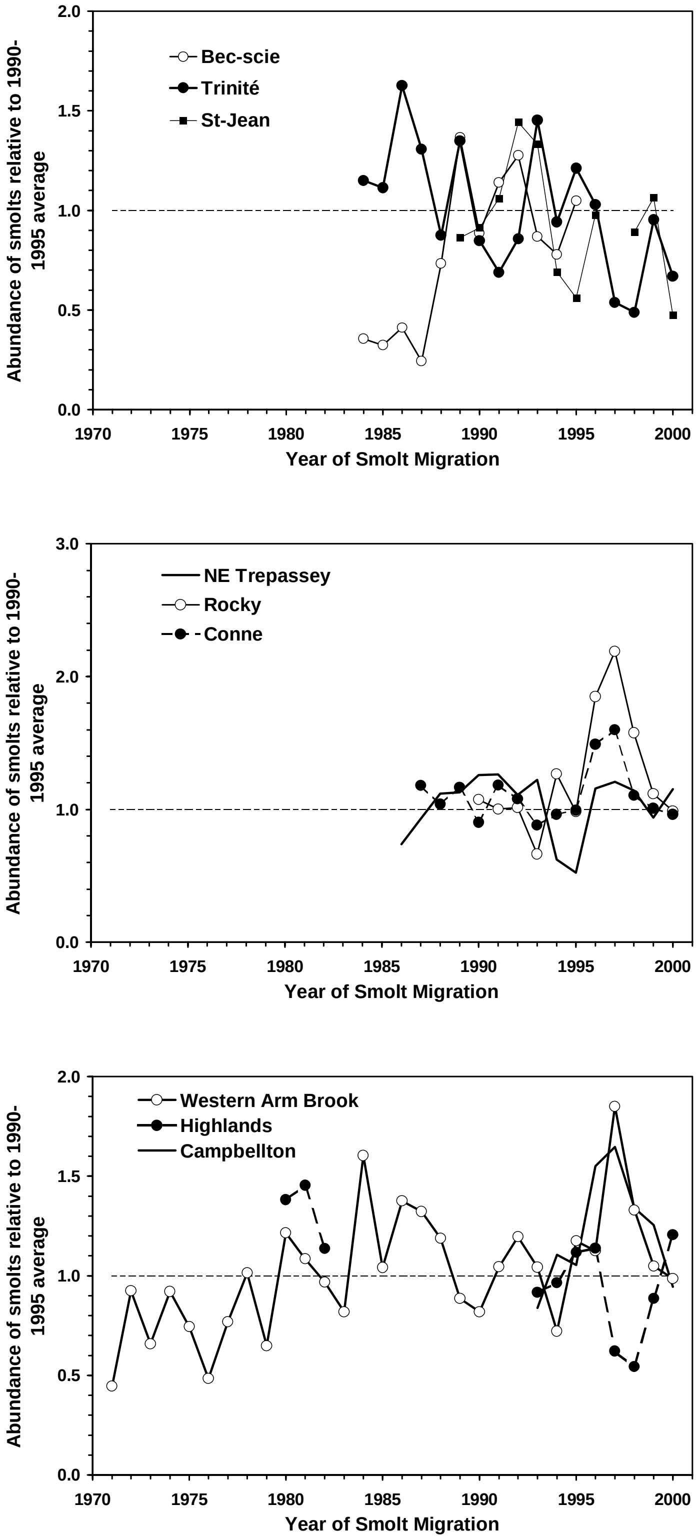


Figure 4.2.1.5. Atlantic salmon juvenile densities in eight rivers of the Maritime provinces (Restigouche SFA 15; Miramichi SFA 16; St. Mary's SFA 20, Stewiacke SFA 22, Nashwaak, Hammond, Kennebecasis and Saint John upriver of Mactaquac SFA 23).

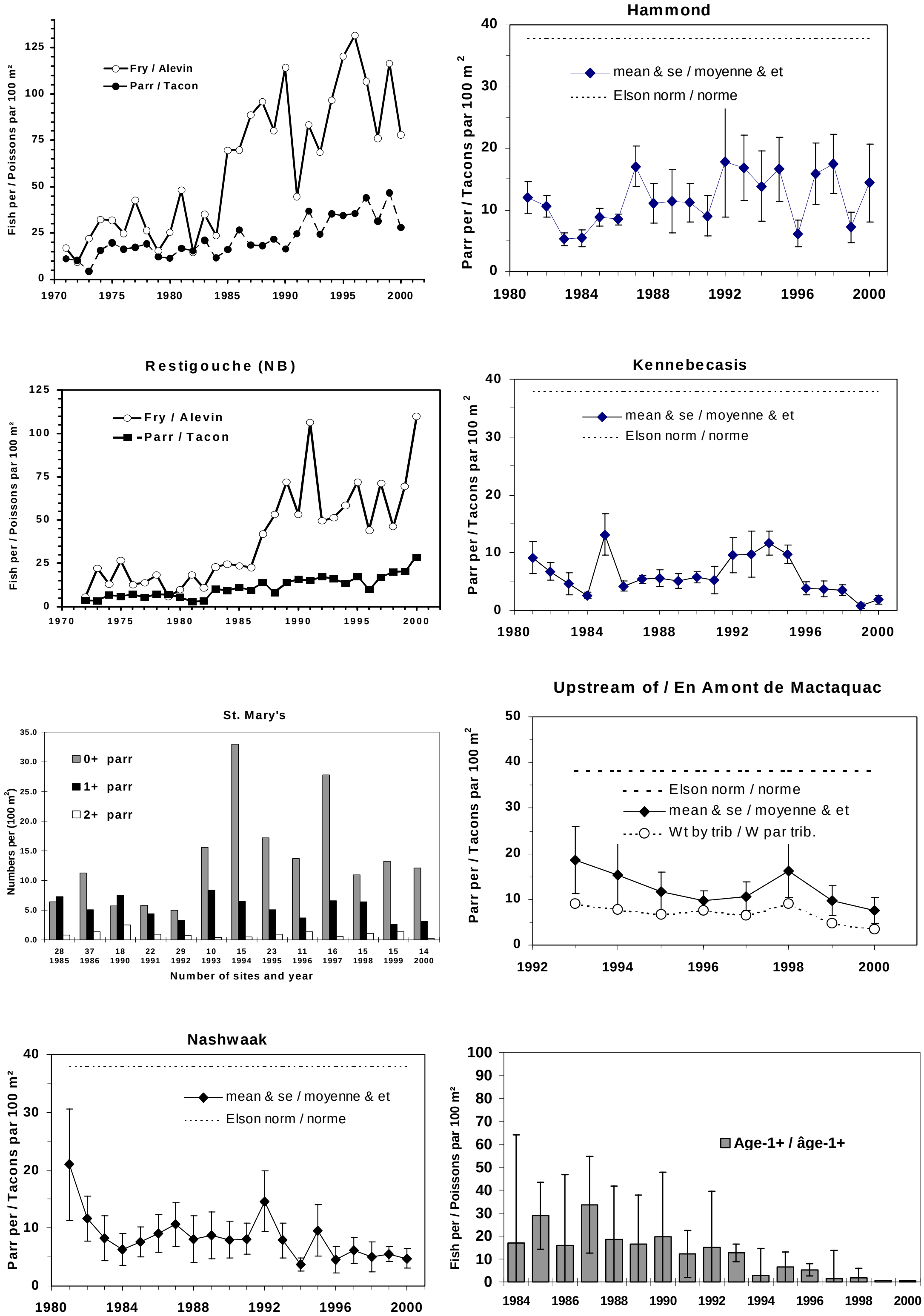


Figure 4.2.1.6. Relative index of smolt production in eastern North America. Index-area weighted refers to weighting corresponding to the size of the zone or Salmon Fishing Area. The other two indices consider relative smolt production which would contribute to potential 2SW recruitment.

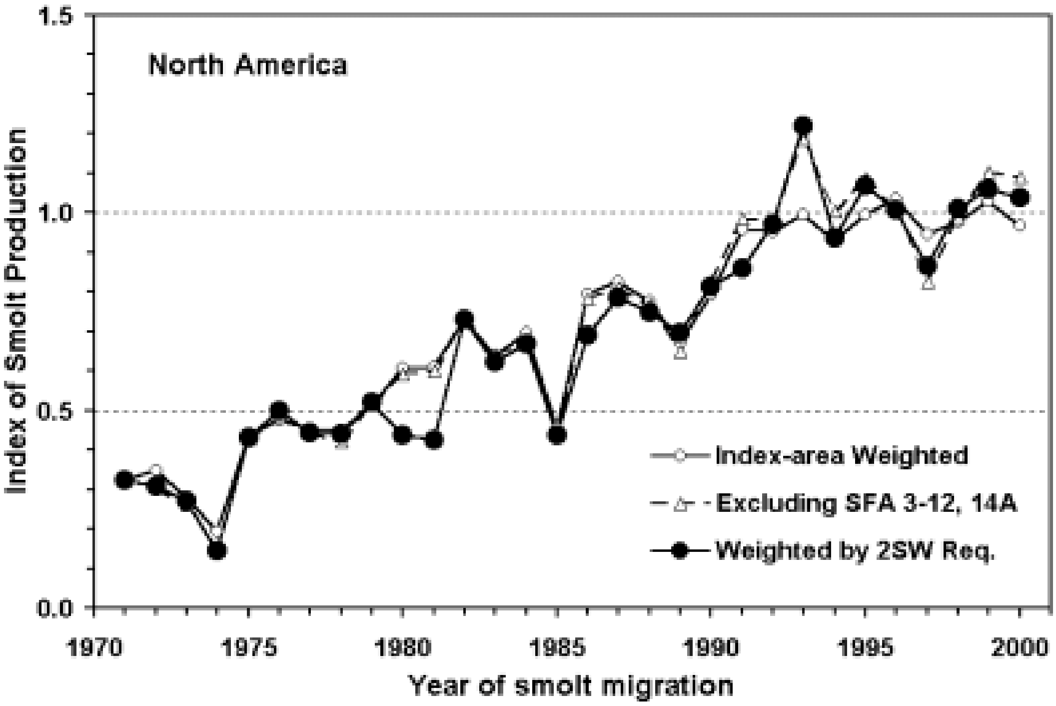


Figure 4.2.1.7. Relative index of smolt production in four areas of Canada. Relative indices are derived by weighting index river series by corresponding Salmon Fishing Area or Zone size (defined by conservation egg requirements). The Newfoundland and Quebec indices are derived from direct smolt counts. The Gulf and Scotia-Fundy estimates are based on juvenile abundances.

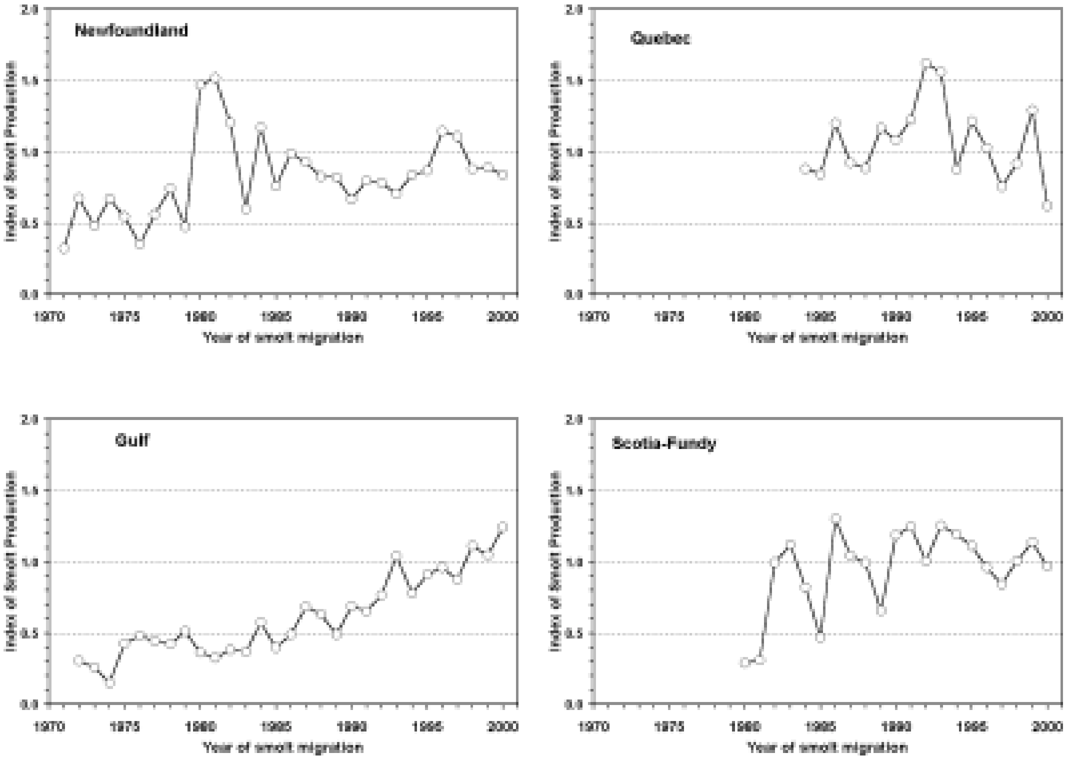


Figure 4.2.1.8. Documented returns of Atlantic salmon to USA rivers, 1967-2000.

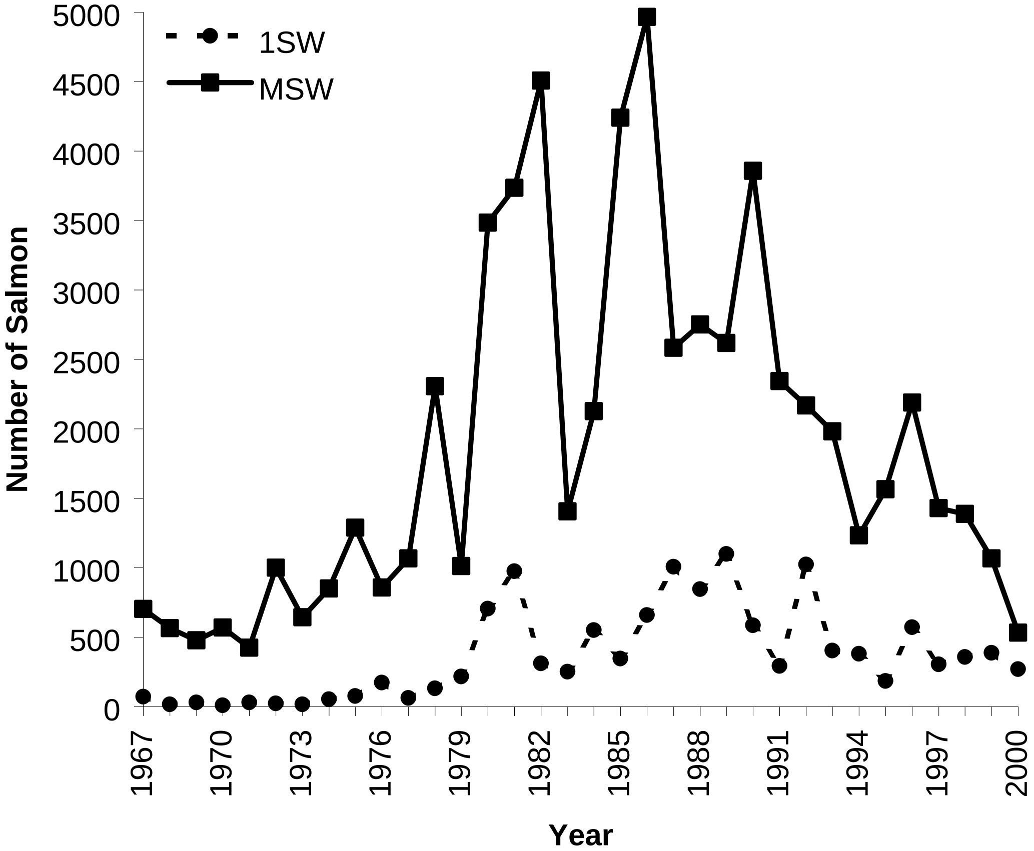


Figure 4.2.2.1. Comparison of estimated mid-points of 1SW returns to and 1SW spawners in rivers of six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

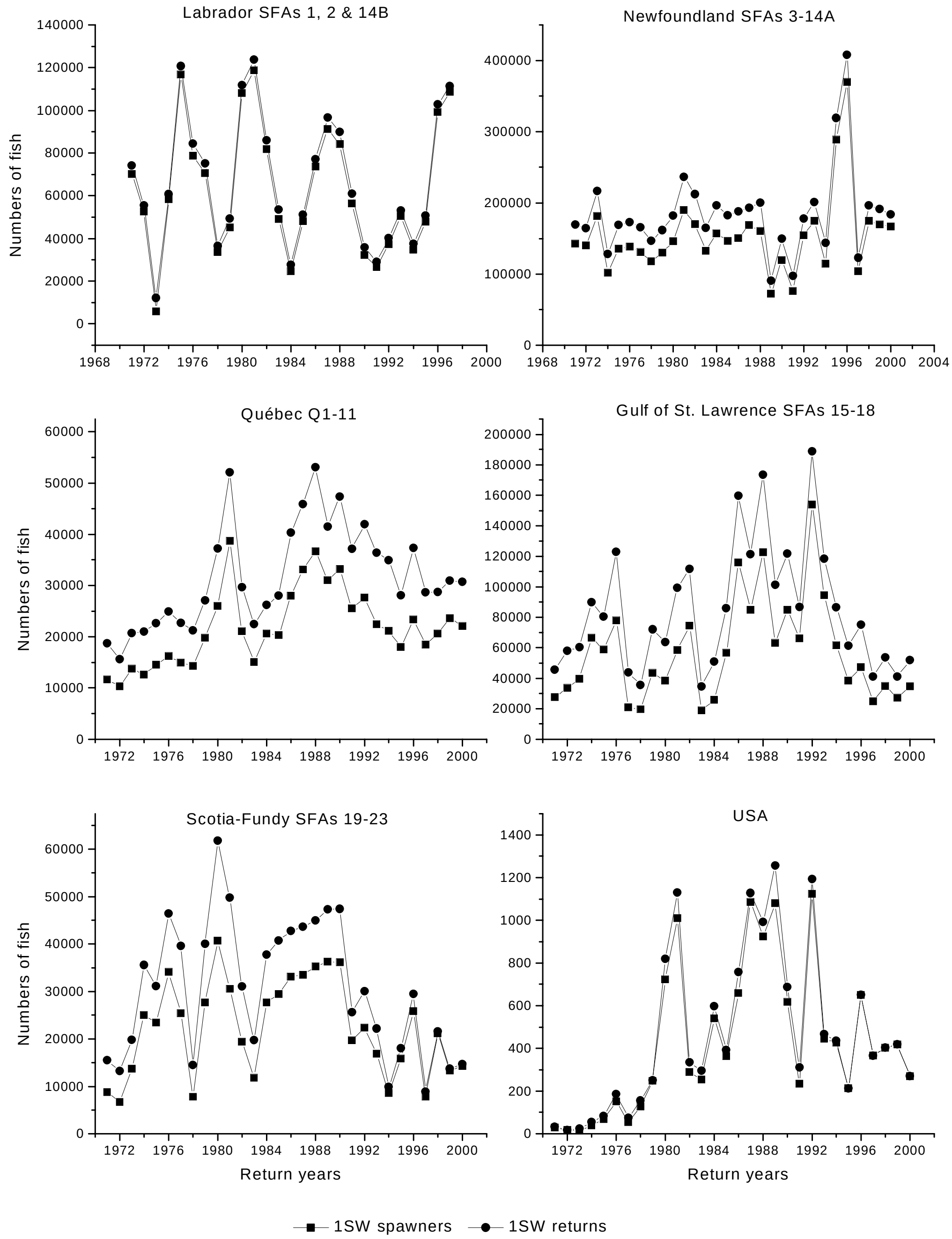


Figure 4.2.2.2. Comparison of estimated mid-points of 2SW returns, 2SW spawners, and 2SW conservation requirements for six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

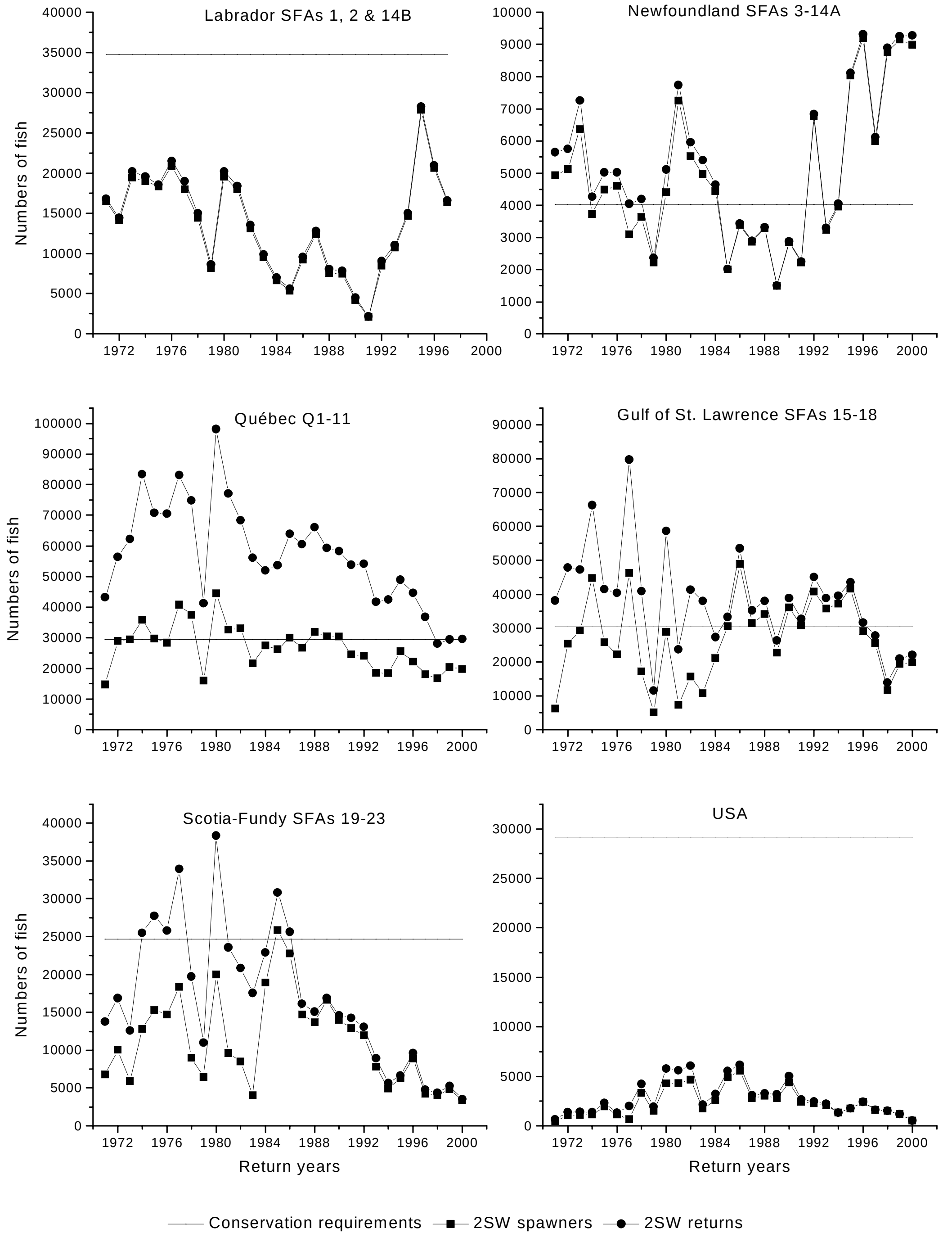


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Figure 4.2.2.3. Comparison of 1SW and 2SW return estimates for insular Newfoundland using previous method and updated method.

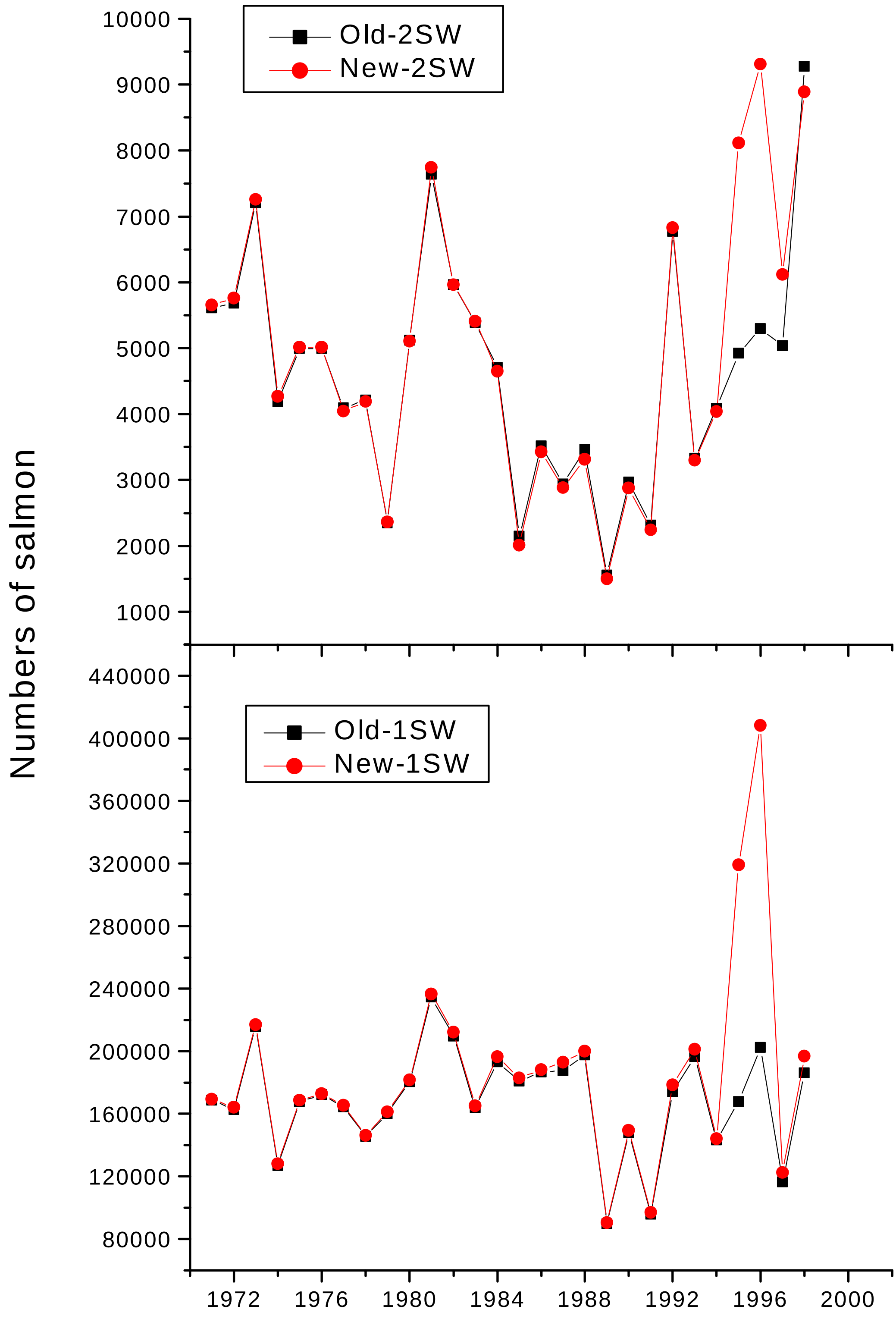


Fig. 4.2.3.1. Prefishery abundance estimate of maturing and non-maturing salmon in North America. Open circles are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America.

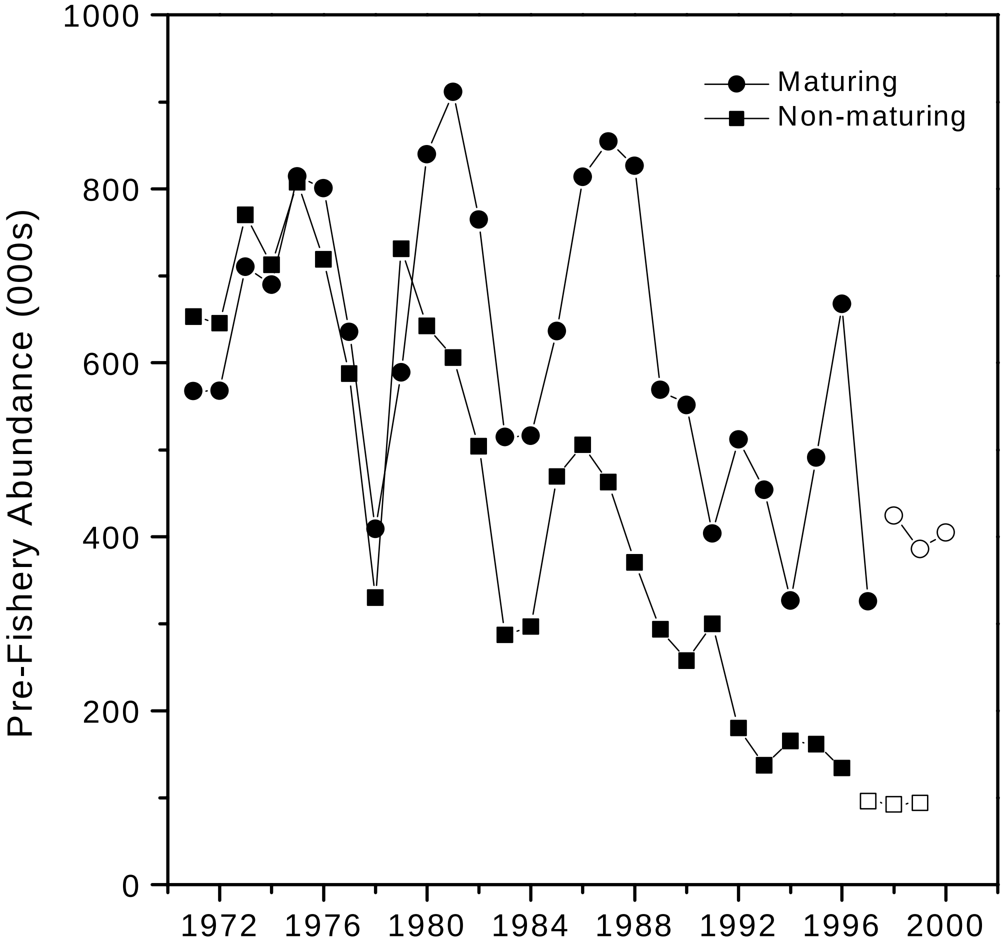


Fig. 4.2.3.2. Total 1SW recruits (non-maturing and maturing) originating in North America

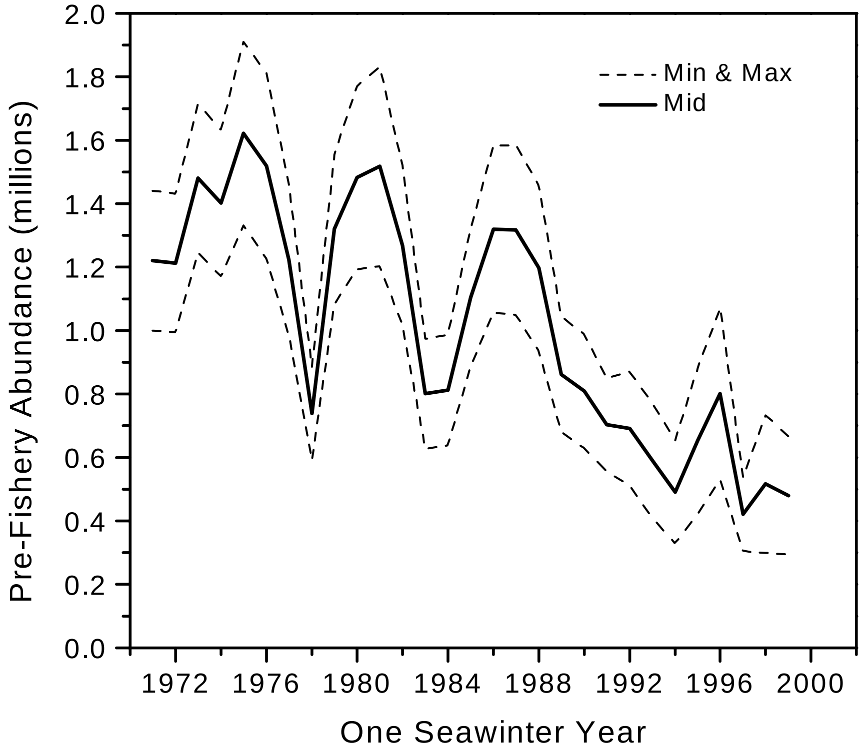
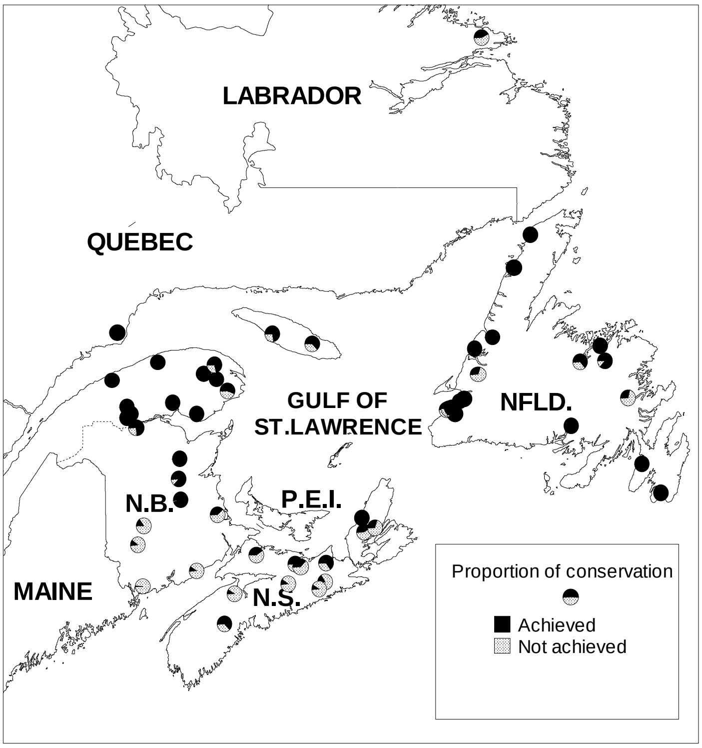


Figure 4.2.4.1. Egg depositions in 2000 relative to conservation requirements in 54 rivers (upper panel) and for 19 rivers of eastern Canada and five rivers of U.S. under colonization or rehabilitation (left panel). The black slice represents the proportion of the conservation requirement achieved in 2000. A solid black circle indicates the egg deposition requirement was attained or exceeded.



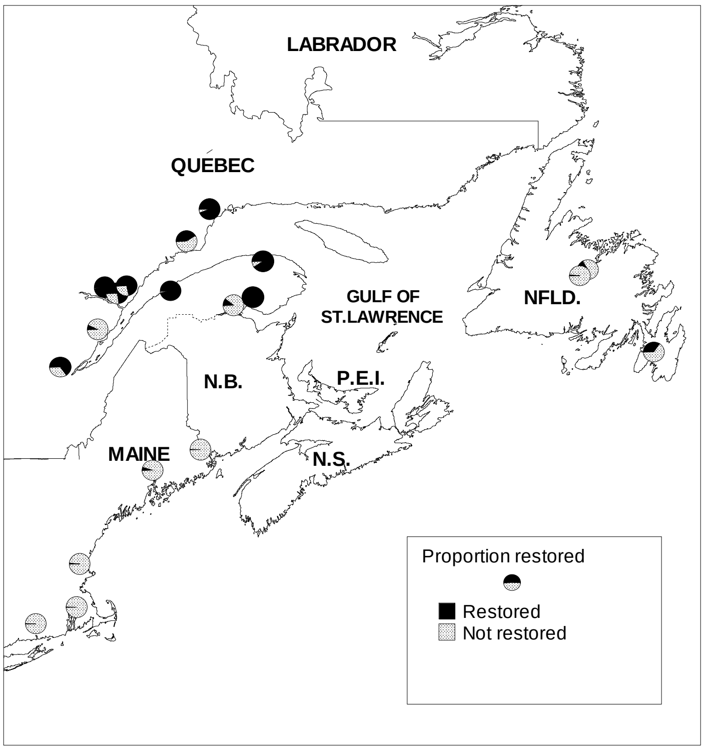


Figure 4.2.4.2. Proportion of the conservation requirements met in monitored rivers in four geographic areas of eastern Canada, 1984 to 2000. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion. The range of the number of rivers included in the annual summary was 7-8 for Newfoundland, 5-8 for the Gulf, 2-3 for Scotia-Fundy and 9 for Québec.

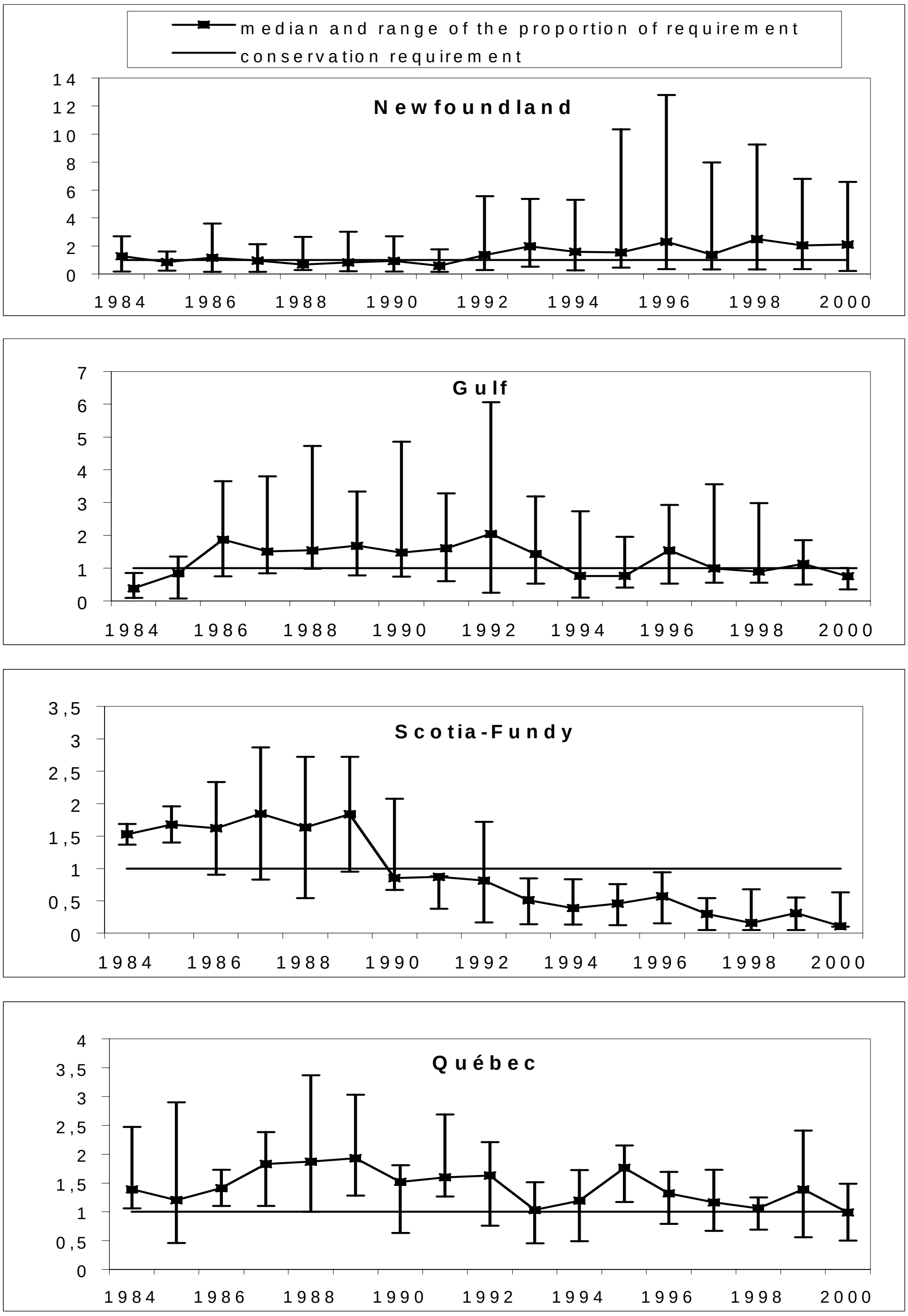


Figure 4.2.4.3. Top panel: comparison of estimated potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971-2000 and 2SW returns and spawners for 1971-97, as 1998-2000 data for Labrador are unavailable. The horizontal line indicates the2SW spawner requirements. Bottom panel: comparison of potential maturing 1SW recruits, 1971-2000 and returns and 1SW spawners for 1971-97 return years as Labrador data for 1998-2000 are unavailable.

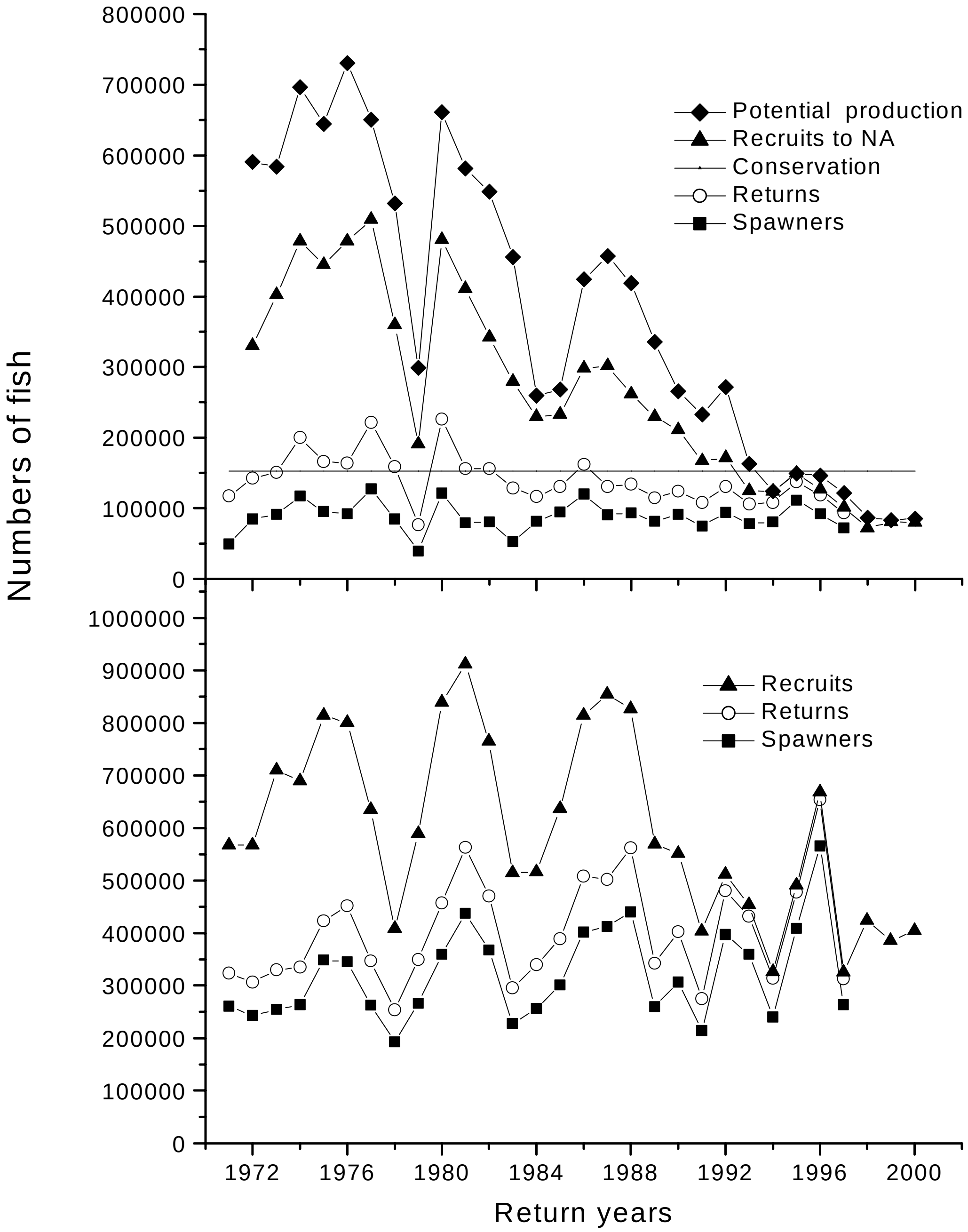


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Fig. 4.2.4.4. Midpoints of lagged spawners (solid circles) and estimated annual spawners (open circles) as contribution to potential recruitment in the year of prefishery abundance (PFA) for six geographic areas of North America. The horizontal line represents the spawning requirement (in terms of 2SW fish) in each geographic area.

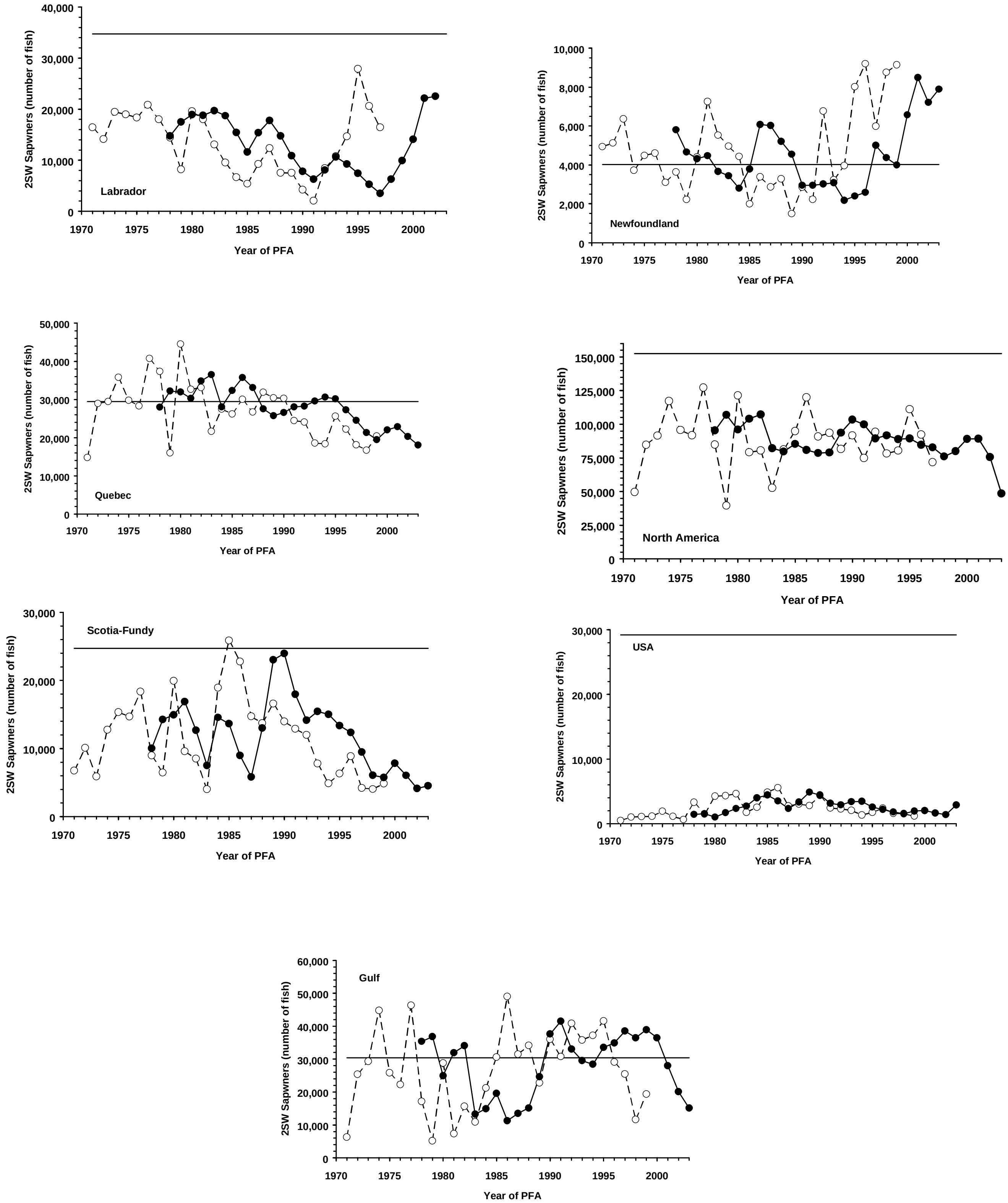


Fig. 4.2.4.5. Proportion of spawners (mid-points) lagged to year of PFA (solid circles) and as returns to rivers (open circles) in six geographic areas of North America relative to the total lagged spawner or annual spawning escapement to North America. The horizontal line represents the theoretical spawner proportions for each area based on the 2SW spawner requirement for North America

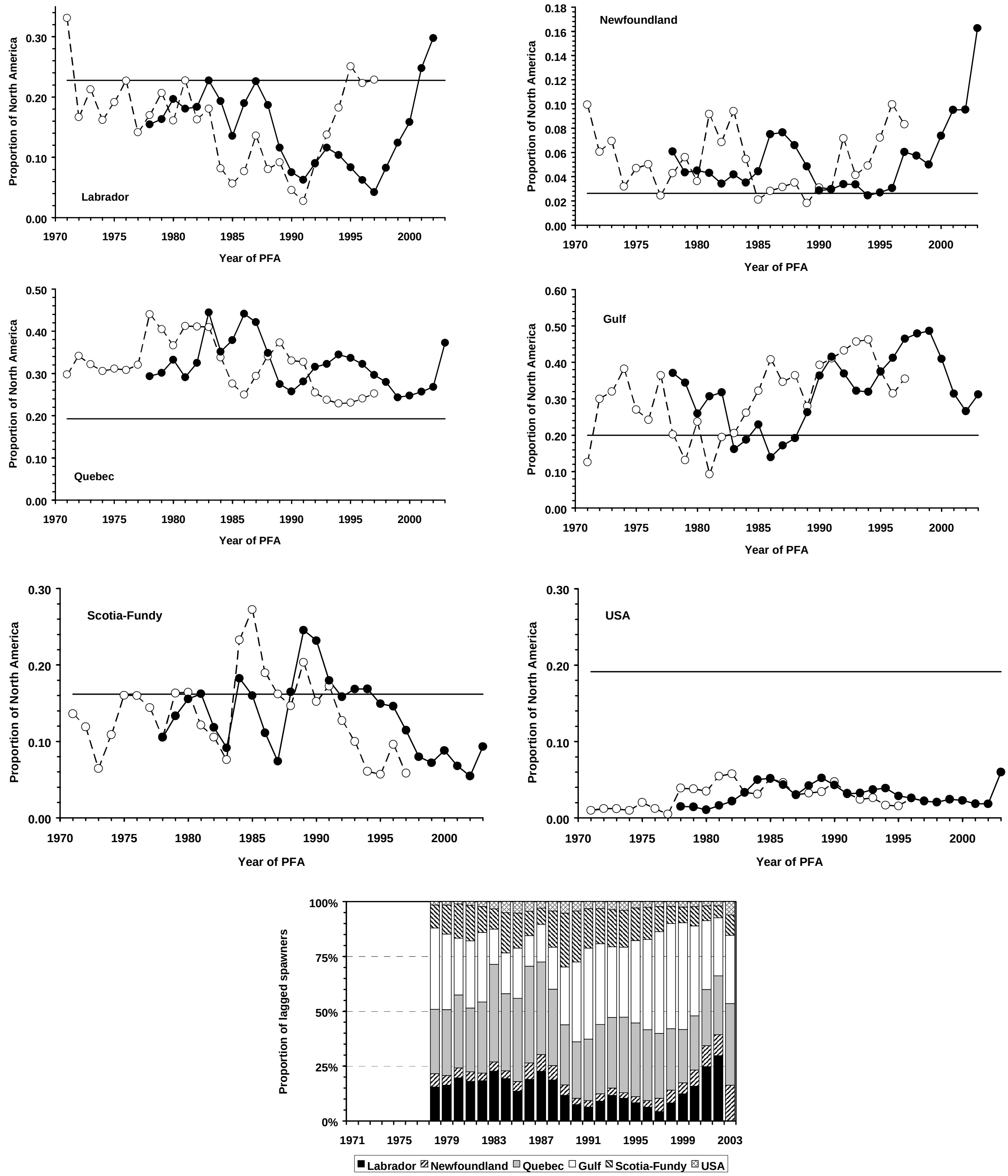
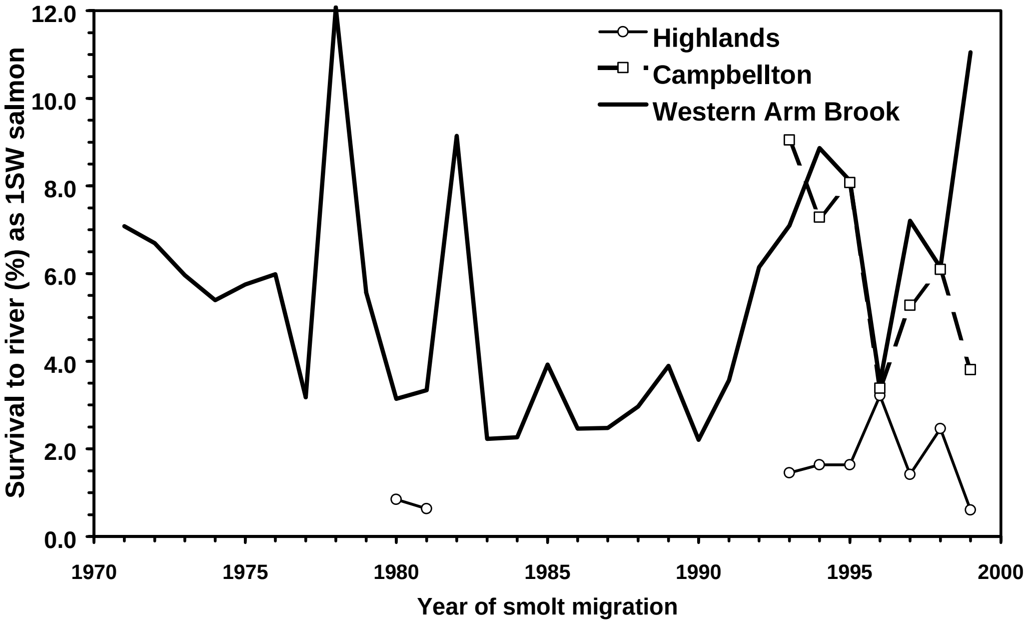


Figure 4.2.5.1. Survival rates (%) of wild smolts as 1SW salmon from the rivers in west and north Newfoundland (Highlands, SFA 13, Western Arm Brook, SFA 14A and Campbellton, SFA 4) and south Newfoundland (NE Trepassey, SFA 9; Rocky, SFA 9; and Conne, SFA 10).



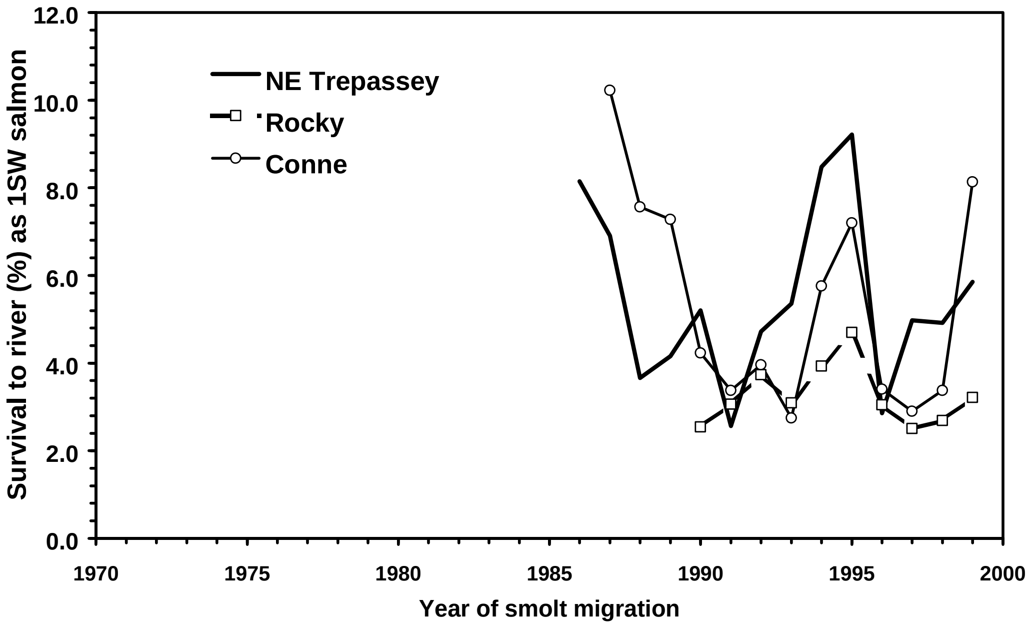
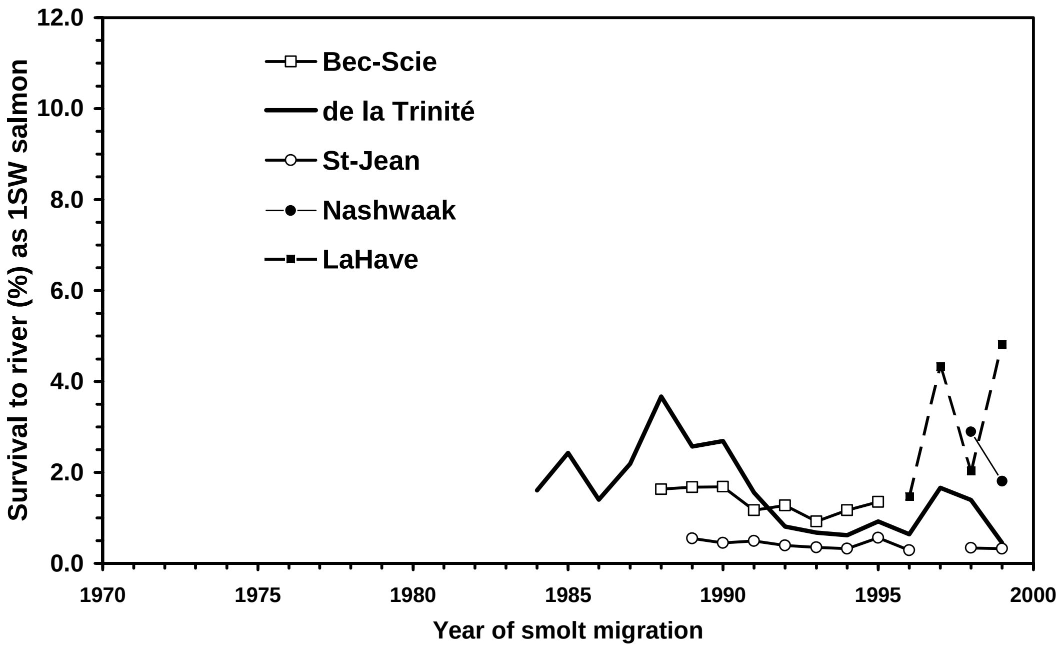


Figure 4.2.5.2. Survival rates (%) of wild smolts as 1SW and 2SW salmon from the rivers in Quebec (Bec-Scie Q10, de la Trinité, Q7 and Saint-Jean, Q2), Nova Scotia (LaHave, SFA 21) and New Brunswick (Nashwaak, SFA 23).



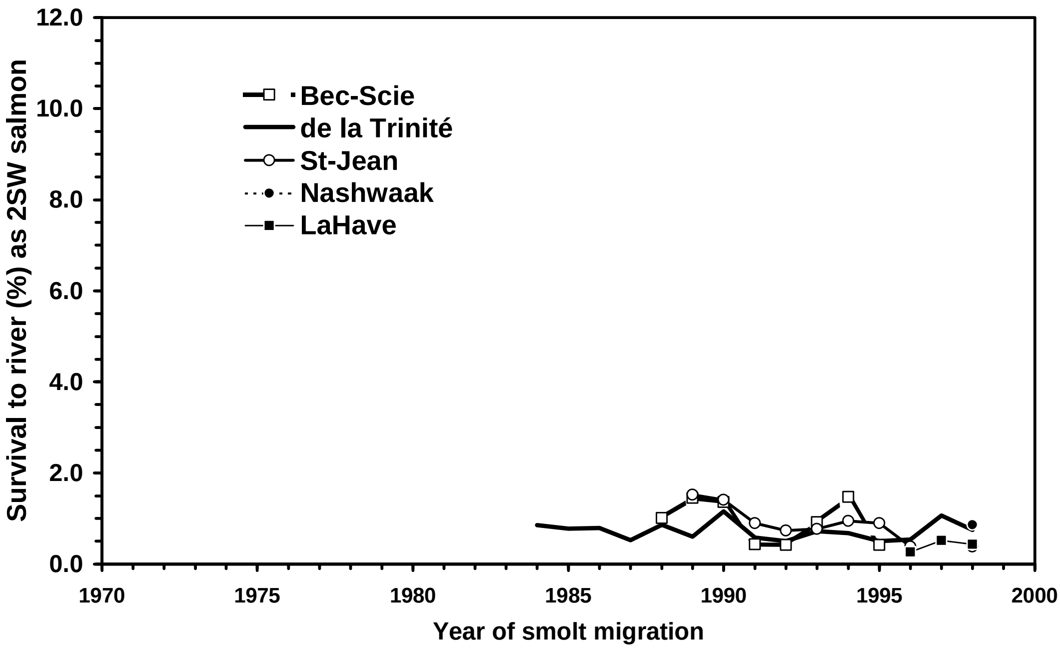
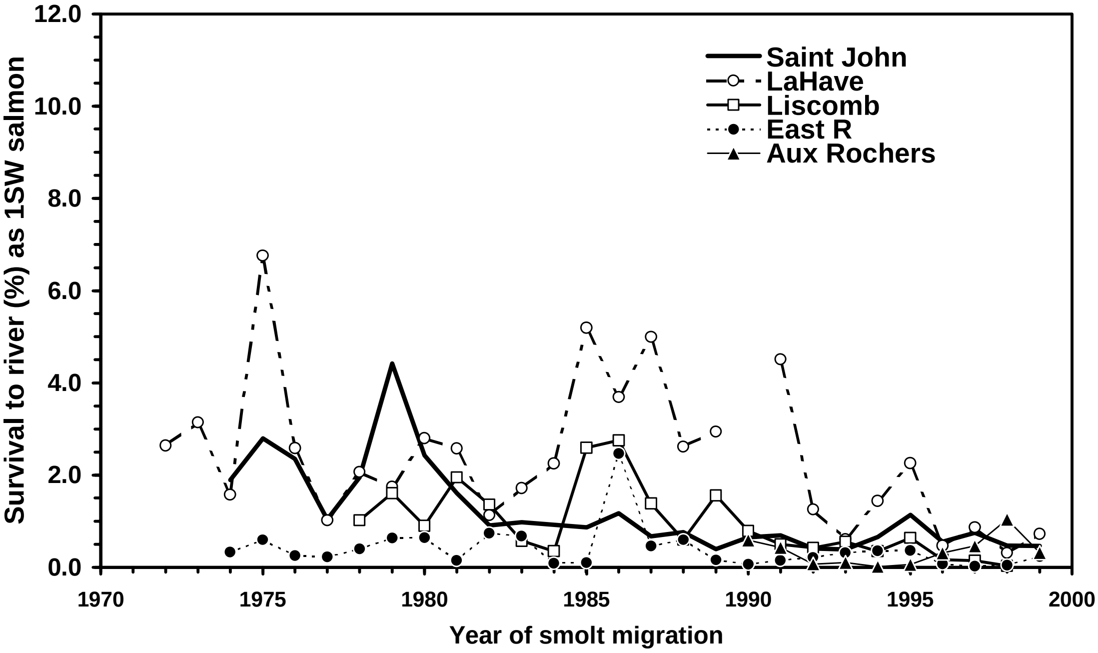


Figure 4.2.5.3. Survival rates (%) of hatchery released smolts from the Saint John River (SFA 23), LaHave River (SFA 21), Liscomb and East rivers (SFA 20), and Aux Rochers River (Q7) as 1SW, 2SW returns to the river.



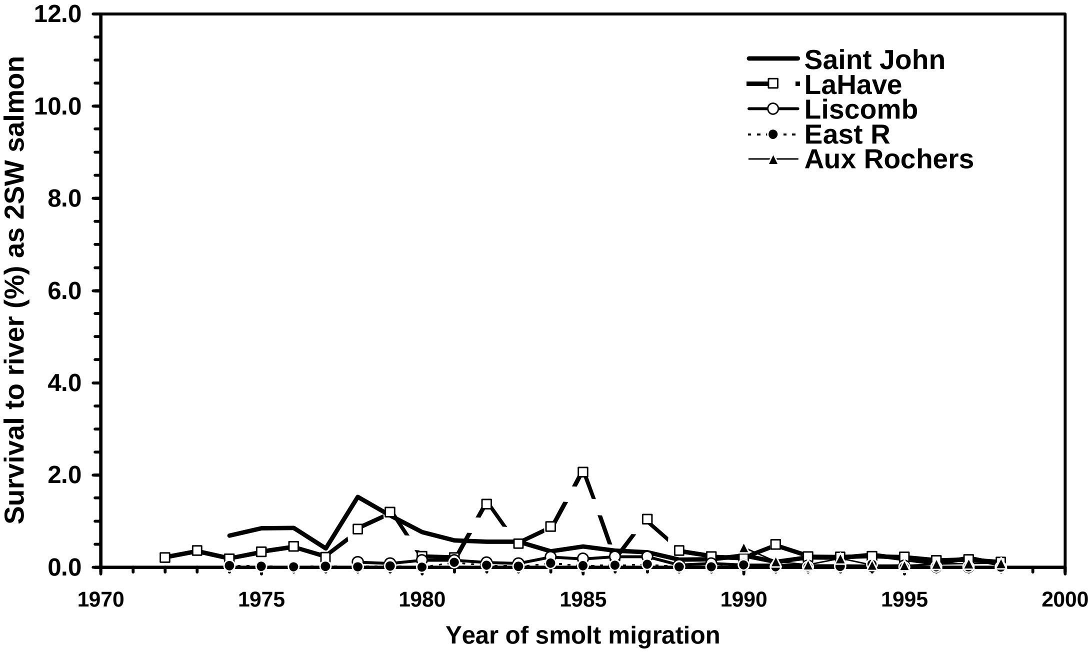


Figure 4.2.5.4. Survival rates (%) of hatchery released smolts from the Penobscot River (Maine, USA) as 1SW and 2SW returns to the river. Inset is higher resolution of data.

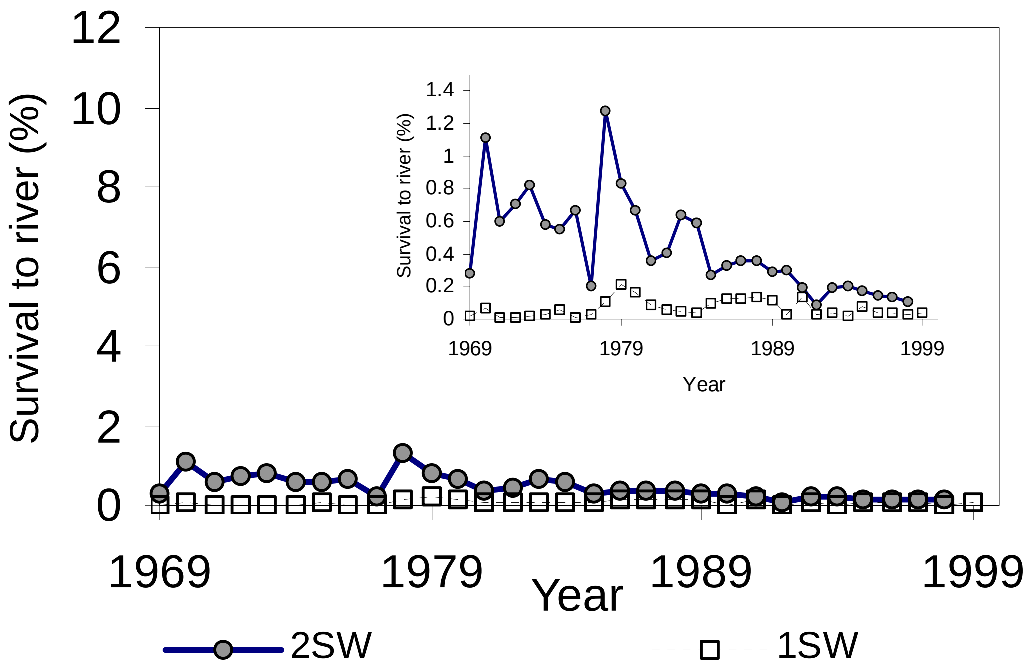
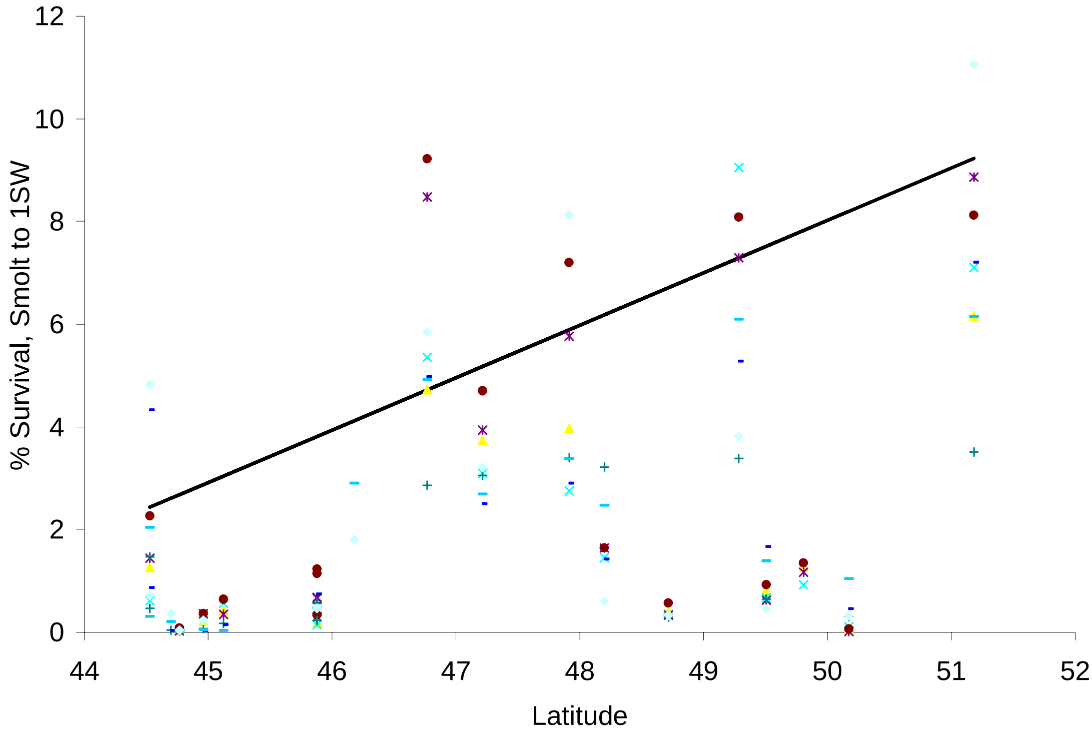


Figure 4.2.5.5. Relationship between latitude and the survival of hatchery and wild smolts to 2SW (a) and 1SW (b) returns in North America (1991 to 2000). The lines are predicted values from the 90th quantile least absolute difference regressions (2SW Survival = -43.051 + 1.021 * Latitude) and (1SW Survival = -8.345 + 0.197 * Latitude).



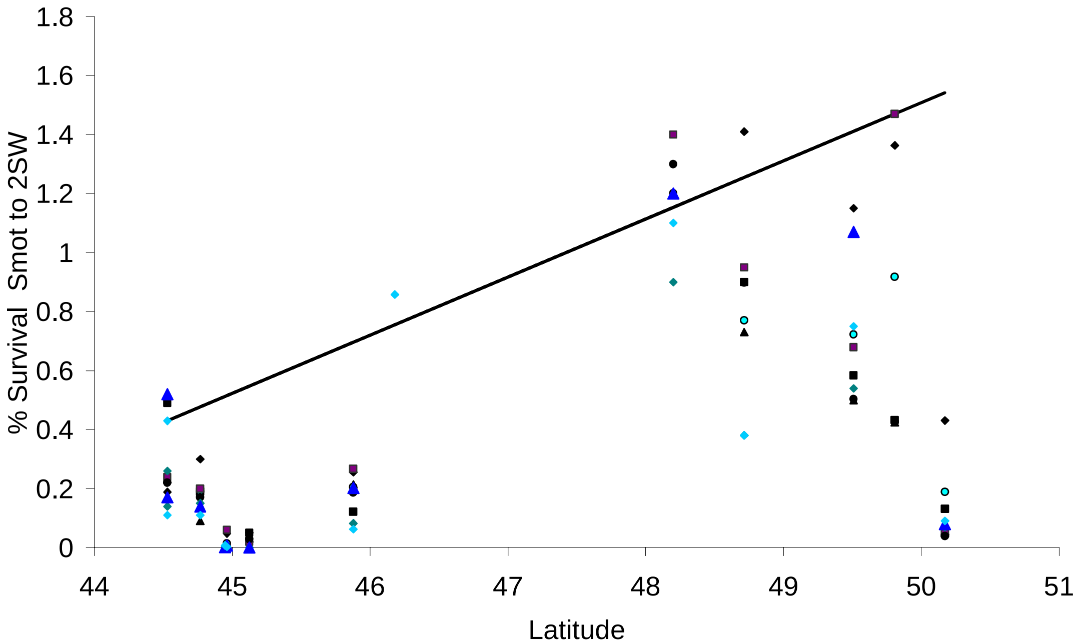
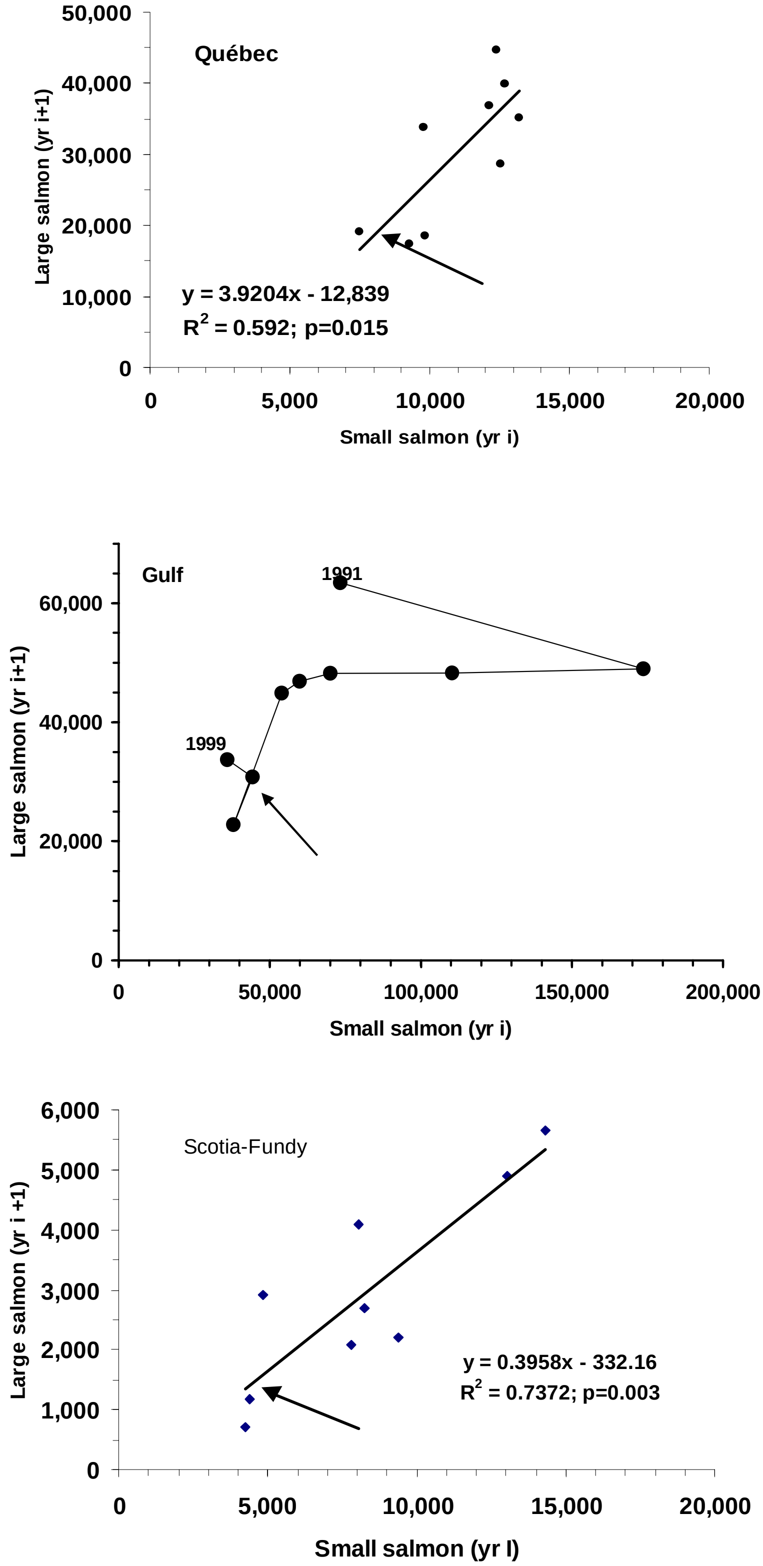


Figure 4.5.1. Relationships between small salmon returns in year i and large salmon (all ages) returns in year i+1 for 20 rivers in Québec (upper), 6 rivers of the 'Gulf' (middle), and 3 rivers of the Scotia-Fundy (lower) regions. Arrows indicate expectations of large salmon in 2001 based on small salmon returns in 2000.



Advisory Committee on Fishery Management **ICES CM 2001/ACFM:15**

REPORT OF THE

WORKING GROUP ON NORTH ATLANTIC SALMON

Part two

Aberdeen, Scotland

2–11 April 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION AREA

5.1 Description of fishery at West Greenland

5.1.1 Catch and effort in 2000

At its annual meeting in 1999 the West Greenland Commission of NASCO agreed on a multi-year approach for conservation of the salmon stocks occurring in Greenland. This agreement specified that the catch at West Greenland in 1999 and 2000 should be restricted to that amount used for internal consumption in Greenland, which in the past has been estimated at 20 t. The Greenland authorities subsequently set this amount as total allowable catch.

The fishery was opened on August 14 and was quickly closed by the authorities four days later (August 18) as the reported catch rapidly approached the total allowable catch. The total reported catches in round fresh weight amounted to 20.5 t (Table 5.1.1.1). The geographical distribution of catches by Greenland vessels is given in Table 5.1.1.2 for the years 1977-2000. Compared to previous years, a higher proportion of catch occurred in southern Greenland with 65% taken in NAFO Division 1F.

By regulation, all catches including landings to local markets, privately purchased salmon, and salmon caught by food fishermen, were reported on a daily basis to the Fishery Licence Office. A private company was given permission to buy salmon from fishermen, and biological samples were purchased from this company.

Licences for the salmon fishery have been issued to fishermen fishing for the local markets, hotels, hospitals etc., while fishing for personal use was permitted without licence for residents of Greenland. In total, 179 licences were issued, however only 45 licensed and 1 unlicensed fishermen reported landings. Due to the arrangement with the purchasing company and the extremely short season only few landings to local markets were observed. Despite the early closure of the fishing season and the considerably increased efficiency of reporting and enforcement system, a relatively large part (one third) of the total fishery is still considered to remain unreported. The unreported catches are estimated to be approximately 10 t in 2000.

5.1.2 Origin of catches at West Greenland

Tissue and biological samples were collected from the mixed population at West Greenland caught for local consumption in 2000. A sample of 491 salmon was purchased from the local purchasing company. In 2000 all samples were obtained through the purchasing company that received most of the landed salmon. The sampled salmon were measured, scales were removed for aging, and gutted weight recorded.

A tissue sample was removed and preserved for DNA analysis. Twelve microsatellite loci were screened in all fish. For Atlantic salmon, these loci have been shown to provide 100% correct assignment to their continent of origin, and 83% correct classification to country or province of origin (King et al. 1999).

A total 490 tissue samples were collected for DNA analysis from the following areas, 250 from NAFO Div. 1D, and 241 from NAFO Div. 1F. No precise information on the date of landing could be obtained because samples were taken after landing and transporting of the fish. By assuming August 16 (mid-point of the fishing season) as the landed date, there is a maximum error of +/- 2 days.

Based on DNA analysis in NAFO Div. 1D 89.2 % of the 250 salmon were of North American origin and 10.8 % of European origin. Of 240 salmon taken in NAFO Div. 1F 50.4 % were classified as North American while 49.6 % were European. The combined total for the two NAFO divisions sampled is 344 salmon (70.2 %) of North American origin and 146 salmon (29.8 %) of European origin (Table 5.1.2.1, Figure 5.1.2.1). Preliminary attempts to achieve a finer level of resolution of origin indicates that Canadian origin fish dominated the North American component of the catch and Southern European stocks dominated the European component of the catch.

The Working Group noted that the significant increase in proportion of North American origin salmon at West Greenland in 1995-1999 was concordant with the reduction in the number caught (Table 5.1.2.2). This increase is possibly related to the declining number of non-maturing salmon especially in the Southern European countries. The proportion of North American origin salmon estimated for 2000 is similar to that observed during the mid-1980s.

Applying the results of the above analysis to the reported catch indicated that 12.6 t (5,100 salmon) of North American origin and 7.6 t (2,700 salmon) of European origin were landed in West Greenland in 2000. Quota reductions have resulted in a reduction in the numbers of North American salmon landed at West Greenland from 1996-1999. The number of North American salmon remained about the same as that from 1999 to 2000. The number of landed salmon of European origin was similarly reduced from 1995 to 1999, but increased in 2000 due to a higher proportion of European salmon in the Division 1F. The data for 1982 to 2000 (no data for 1993-94) are summarised in Table 5.1.2.2.

5.1.3 Biological characteristics of the catches

Biological characteristics (length, weight, and age) were recorded from 491 fish in catches from NAFO Div. 1D and 1F in 2000 and presented in Tables 5.1.3.1 to 5.1.3.3 together with corresponding data from sampling in Greenland since 1968.

The general downward trend in mean length and weight of both European and North American 1SW salmon observed from 1969 –1995 reversed in 1996 when mean lengths and weights increased (Table 5.1.3.1, Figure 5.1.3.1). From 1996 to 1998 the mean lengths and weights were relatively stable but increased significantly in 1999. In 2000, a decrease was observed, and the mean lengths and weights were among the lowest observed in the time series (Table 5.1.3.1, Figure 5.1.3.1). The Working Group noted that all catches in 2000 were taken relatively early in the traditional fishing season (mid August), i.e. also early in the feeding season in which period the weight increase is known to be 2-3 % per week. The working group noted that the samples in 2000 could be biased towards smaller (younger) fish, as some sorting might have taken place before landing to the purchasing company.

Distribution of the catch by river age in 1968-2000 as determined from scale samples is shown in Table 5.1.3.2. The proportion of the European origin salmon that were river age 1 fish has been quite variable through the later years with relatively high values in 1998-2000 (28.6, 27.7 and 36.5 %, respectively), the 2000 value being the highest on record. A high proportion of this group suggests a high contribution from Southern European stocks. In 1998 and 1999 low proportions of 7.6 and 7.2 %, respectively, of river age 3 were observed, the lowest on record. Some increase from 1999 to 2000 (to 13.1 %) was observed, close to the overall mean of 16.2 %. The proportion of river age 2 salmon of North American origin declined somewhat from 1998, which was close to the overall mean value of 34.8 %, to 23.5 and 26.6 % in 1999 and 2000, respectively.

The sea-age composition of the samples collected from the West Greenland fishery showed no significant changes in the proportions in the North American component of fish from 1998 to 2000 (Table 5.1.3.3), the 1SW proportion being among the highest in the time series. The proportion of 1SW salmon in the European component has been very high since 1997 (99.3 %), and was in 1999 and 2000 estimated at 100 %. Samples (6% in weight of the total landings) were representative in time and space of catches in the fishery, but may have been biased if culling of fish occurred prior to purchase for sampling purposes. In addition, the short time period of the fishery may have produced landings that were not representative of the population in the Greenland area in 2000.

5.2 Status of the stocks in the West Greenland area

The salmon caught in the West Greenland fishery are non-maturing 1SW or older salmon, nearly all of which would return to home waters in Europe or North America as MSW fish if they survived. While non-maturing 1SW salmon make up more than 90% of the catch there are also 2SW salmon and repeat spawners including salmon that had originally spawned for the first time after 1-sea-winter. 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. For North American MSW salmon, the most abundant stocks in West Greenland are thought to originate in the southern area of the range.

For the Northeast Commission Area, a Run-reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing 1SW salmon (Table 3.6.2.4). The main contributor to the abundance of the European component of the West Greenland stock complex is non-maturing 1SW salmon from the southern areas of Europe. These stocks appear to have declined for most of the past 30 years.

Conservation limits and the time series of spawners have been provided for 16 rivers in the NEAC area. Only 6 of the 16 rivers had egg depositions above their conservation limits in the later years. Improvements in egg deposition are indicated for the rivers that were above their conservation limits, while other rivers, which remain near or under their conservation limits on average show a slight decrease (Section 3.4). In general, there seemed to be no indication of recovery from low escapement levels.

In most areas marine survival was lower than the previous 5-year and 10-year mean for 1SW and 2SW fish. Marine survival rates for 6 hatchery stocks showed a downward trend in survival to home waters for 1SW and 2SW salmon for the past 10-year period.

In general, there has been no significant change in smolt production in the Northeast Atlantic. Returns of salmon to most European rivers showed a significant downward trend for the last ten years period both for southern and northern rivers, but no trend was detected for the last five years.

The Working Group has 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 1999 abundance estimates ranged between 57,800 and 130,436 salmon. The mid-point of this range (94,118) is 2% higher than the 1998 value (92,479) and is the 2nd lowest in the 30-year time series (Figure 4.2.3.1). The Working Group expressed concern about the continued decline in the pre-fishery abundance and its impact on spawner levels. While maturing 1SW salmon in 1998-2000 have increased over the lowest value achieved in 1997, the non-maturing portion of these cohorts has increased only slightly from the lowest value recorded in 1998. Because the pre-fishery abundance has been consistently well below its conservation requirements, this situation is considered to be very serious.

The estimate of the total number of 2SW salmon returning to Newfoundland rivers and coastal waters of other areas of North America in 2000 was close to the number in 1999, but was about 26 % lower than the estimate for 1997 and lower than the average of the previous years (1971-96). The estimates for 1998-2000 are the lowest observed in the past 10 years and among the lowest in the 30 year time series, 1971-2000 (Table 4.2.2.2). The estimates of returns are quite variable over the time series with no trends indicated. Returns have declined from a peak of 226,000 in 1980 to 94,000 in 1999.

In most regions apart from Newfoundland, the returns of 2SW fish in 2000 are near the lower end of the thirty-year time series. However, returns of 2SW salmon to Labrador in 1995 and 1996 were the best in the time series. The estimated returns decreased again in 1997. Closure of the commercial fishery in Labrador after 1997 eliminated the basis for the return and spawner model, and returns could not be estimated for 1998-2000.

The majority of the USA returns were recorded in the rivers of Maine. The estimated 2SW returns and spawners to USA rivers have declined since 1996, and were in 2000 66 % and 73 % below the previous 5-year and 10-year averages, respectively. Returns to most USA rivers are hatchery-dependent. Spawning escapements decreased further from 5 % in 1999 to 1.8 % in 2000 compared to conservation requirements.

Egg depositions exceeded or equalled the specific conservation requirements in 23 of the 54 rivers (43 %) assessed in Canada and were less than 50 % of requirements in 18 other rivers (33 %). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 11 rivers assessed (91 %) had egg depositions that were less than 50 % of conservation requirements (Figure 4.2.4.1).

North American salmon stocks remain at low levels relative to the 1970s. The 1SW non-maturing component continues to be low with river returns and total production amongst the lowest recorded. The 1999 pre-fishery abundance estimates ranged between 57,800 and 130,436 salmon. The mid-point of this range (94,118) is 2% higher than the 1998 value (92,479) and is the 2nd lowest in the 28-year time series. In addition, small salmon returns in 2000 relative to 1999 were generally reduced throughout eastern Canada in the majority of their monitored rivers except in Québec. Returns were similar to or improved (>90% in 2000 relative to 1999) in about half (53%) of the assessed rivers but this percentage decreased to 45% without Québec's rivers. Given recent downward trends in returns, improvement in 2SW salmon returns and spawners in 2001 would represent a significant reversal from recently observed trends. Only the Newfoundland stock complex has observed spawning escapements, which have exceeded the area requirements, all other region complexes were below requirement and some declined further in 2000 (Section 4.2.4).

Despite some improvements in the annual returns to some rivers, both in European and North American areas, the overall status of stocks contributing to the West Greenland fishery remains poor, and as a result, the status of stocks within the West Greenland area is thought to be low compared to earlier (historical) levels.

5.3 Changes in the continent of origin of salmon captured at West Greenland including changes in migration patterns

The Working Group noted the considerable increase in proportion of North American origin salmon in the fishery at West Greenland in recent years. The proportion of North American origin salmon has changed dramatically over the period of observation, 1969-1999, from below 40 % to a record high level of 90 % in 1999. The proportion of North American origin salmon declined in 2000 fishery samples; however, this may have been due to the early opening and short duration of the fishery. Thus, the catch samples while being descriptive of the fishery may not be a good representation of the salmon population at Greenland. The biological explanation(s) for these changes in North American and European salmon will continue to allude us due to incomplete knowledge of migration of the various components contributing to the West Greenland fishery and more importantly the relative contributions of various stock groupings. Previous tagging studies including tagging at West Greenland had shown that the southern European stock group contributed more heavily to Greenland than did the northern group. Within North America, it has been shown that stocks in the Gulf of St. Lawrence contributed more heavily than others to Greenland. The DNA analysis in 2000 showed that that annual variations in proportional contributions do occur. Exploratory work into more detailed discrimination of origin of salmon captured at West Greenland will lead to a greater understanding of the mixed stock fishery.

The Working Group examined an analysis of the North American proportions from 1987 to 1999. The year 2000 samples were not included because of the short time scale and geographical distribution of the catch and samples.

Analysis of Variance for North American proportion at West Greenland

Dependent Variable: Arcsine transformed proportions of North American salmon (ARC_NA)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	10638.13621	343.16568	9.71	<.0001
Error	50	1766.25203	35.32504		
Corrected Total	81	12404.38824			

R-Square	Coeff Var	Root MSE	ARC_NA Mean
0.857611	10.59370	5.943487	56.10399

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	10	4485.666311	448.566631	12.70	<.0001
NAFO	4	1931.648511	482.912128	13.67	<.0001
Year*NAFO	17	1263.145243	74.302661	2.10	0.0215

The results of the analysis of variance indicate that the North American proportion varies over year, between NAFO Divisions and that there is a significant interaction effect between year and the various NAFO Divisions. In terms of NAFO Divisions, the North American proportion increased from NAFO Div. 1B to 1C then declined from 1D to 1E and 1F (Figure 5.3.1). The North American proportion has increased significantly from 1987 to 1999. The reasons for the varying North American proportions between NAFO Divisions and years is not completely known. However, it possibly results from different migration patterns and arrival at Greenland of the various stock components.

To learn more about the reasons behind the increasing North American proportion in Greenland a new variable was created by summing the pre-fishery abundances of North American and European non-maturing Atlantic salmon. Examination of the trends in North American proportion at Greenland and in the total pre-fishery abundance of North American plus southern European salmon indicates that the latter is actually declining ($r=-0.69$, $P<0.0001$) at the same time that the North American proportion at Greenland is increasing ($r=0.87$, $P<0.0001$) (Figure 5.3.2). This can only occur if the proportion of southern European salmon migrating to Greenland is declining or if the proportion of North American salmon migrating to Greenland is increasing ($r=-0.52$, $P<0.004$). However, given current trends the former is more likely the case.

5.4 Evaluation of the effects on European and North American stocks of the West Greenland management measures since 1993

There have been three significant changes in the management regime at West Greenland since 1993. First, NASCO adopted a new management model (Anon., 1993) based upon ICES' assessment of the PFA of non-maturing 1SW North American salmon and the spawner escapement requirements for these stocks. This resulted in a substantial reduction in the TAC agreed to by NASCO from 840 t in 1991 to 258 t in 1992, and further reductions in subsequent years. The second change in management was the suspension of fishing in 1993 and 1994 following the agreement of compensation payments by the North Atlantic Salmon Fund. Due to the closure of the fishery in the two years no sampling could be carried out in Greenland, and no biological data were collected. The third change in management was a multi-year agreement in 1999 restricting the annual catch to that amount used for internal consumption in Greenland, which in the past has been estimated at 20 t.

To calculate a possible TAC for those years according to the agreed quota allocation model (Anon., 1993) biological parameters from sampling in 1992 were used (Table 5.4.1). The variables given in the table (proportion of origin, mean weights, and proportion of 1SW fish) are those used in the analyses, see Sections 5.1 and 5.7.

The numbers of fish spared by the 1993-1994 closure are shown in Table 5.4.1. The potential catches in the years 1993 and 1994 of 89 and 137 t, respectively correspond to the TACs calculated in accordance with the quota allocation computation model that was agreed by NASCO at its annual meeting in 1993. For the successive years nominal catch figures are used. The table shows the number of salmon returning to home waters provided no fishing of the given magnitude took place in Greenland. The biological parameters given in the table represent the annual sampling data.

The mean number for 1993-2000 of potentially returning fish per ton caught at Greenland is calculated to 208 and 106 salmon for North America and Europe, respectively.

In the years 1972-92 exploitation rates in Greenland of the North American component of the salmon stock fluctuated between 10 and 45 % around an average of 34 % (Figure 5.4.1). The management measures in force since 1993 resulted in an average exploitation rate of this component of 13 %, for the period 1995-97, about one third of its previous level after reopening of the fishery in 1995. After the 1999 agreement the exploitation rates decreased to about 5 %.

In the current analysis the effects of the management measures taken at West Greenland have been examined in terms of numbers of fish only. Thus it has been difficult to show direct benefits to homewater stocks from these measures. The Working Group recommends that other indices of change, i.e. changes in age composition, size at age and sea survival, should also be included in this evaluation.

5.5 Age-Specific Stock Conservation Limits for All Stocks in the West Greenland Commission Area

Sampling of the fishery at West Greenland (Table 5.1.3.3) since 1985 has shown that both European and North American stocks harvested are primarily (greater than 90%) 1SW non-maturing salmon that would mature as either 2 or 3 SW salmon, if surviving to spawn. Usually less than 1% of the harvest are salmon which have previously spawned and a few percent are 2 SW salmon which would mature as 3SW or older salmon, if surviving to spawn. For example, in 1999, 96.8% of the sampled catch of North American origin and 100% of the sampled catch of European origin were 1SW salmon. For this reason, conservation limits defined previously for North American stocks have been limited to this cohort (2SW salmon on their return to homewaters) that may have been at Greenland as 1SW non-maturing fish. These numbers have been documented previously by the Working Group and are revised this year in Section 4.4. From Table 4.4.1, the 2SW spawning requirements of salmon stocks from North America which may be present in the West Greenland Commission Area total 152,548 fish, with 123,349 and 29,199 required in Canadian and USA rivers, respectively.

The conservation limits were 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 groups, and tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern group. The currently estimated conservation limit for southern European MSW stocks is approximately 595,000 fish (Table 3.7.3.1). There is still considerable uncertainty in the conservation limits for European stocks. The above value has been increased from 530,000 in the 2000 report. To date, the conservation limits for MSW salmon in Europe have not been incorporated into the modelling of catch options for West Greenland.

5.6 Catch Options with Assessment of Risks Relative to the Objective of Achieving Conservation Limits

5.6.1 Overview of provision of catch advice

The Working Group was asked to advise on catch levels based upon maintaining adequate spawning escapements sufficient to achieve conservation limits. Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed-stock fisheries are still relevant. In principle, adjustments in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mean mortality on the contributing populations. However, benefits that might result for particular stocks would be difficult to demonstrate, in the same way that damage to individual stocks would be difficult to identify.

In 1993, the Working Group considered how the predictive measures of abundance could be used to give annual catch advice (ICES 1993/Assess:10; Sections 5.3 and 5.4). The aim of management would be to limit catches to a level that would facilitate achieving overall spawning escapement reflecting the spawning requirements in individual North American and European rivers (when the latter have been defined). In order to achieve the desired level of exploitation for a given level of predicted abundance, a TAC could be fixed or some form of effort adjustment introduced. Such an assessment would also depend on a forecast of prefishery abundance for both North American and European salmon stocks.

To date, 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. Gill net fisheries in Greenland and Labrador harvest one-sea-winter (1SW) salmon about one year before they mature and return to spawn in North American rivers. This component was also harvested on their return as 2SW salmon in commercial fisheries in eastern Canada, angling and native fisheries throughout eastern Canada and angling fisheries in the northeastern USA. The fishery in Greenland harvests salmon which would not mature until the following year while the fishery in Labrador (closed in 1998) harvested a mix from the non-maturing component as well as maturing 1SW and MSW salmon. The commercial fisheries in Québec and the Maritime provinces of Canada harvested maturing 1SW and MSW salmon.

The Working Group has advocated models based on thermal habitat in the northwest Atlantic and spawning stock indices to forecast pre-fishery abundance and provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, the models themselves have varied slightly over the years. The changes have been made to these models in attempts to improve the biological basis and predictive capability. In particular, the models since 1996 have used a spawning stock surrogate variable (lagged spawners) in an attempt to describe the variations in parental stock size of the non-maturing 1SW component (PFA). The models of previous years included the following predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; 1995 -thermal habitat in January, February, and March; and 1996-2000 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada.

The Working Group noted that because the method of estimating spawning escapement for Labrador was based on commercial catches and exploitation rates ended in 1997, lagged spawner values will have missing components in year 2003. An alternative index of salmon abundance will be required in the future. Preliminary investigations into the development of a juvenile abundance index as an alternative index of salmon abundance were reported in 2000, and continued in the current report (Section 5.8).

North American run-reconstruction model

The Working Group has used the North American run-reconstruction model to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West Greenland fishery (See Section 4.2.3). Region-specific estimates of 2SW returns are listed in Table 4.2.2.2. Estimates of 2SW returns prior to 1998 in Labrador are derived from estimated 2SW catches in the fishery using a range of assumptions regarding exploitation rates and origin of the catch. With the closure of the Labrador fishery, 1998-2000 returns were estimated as a proportion of the total for other areas based on historical data (Section 4.2.3).

Update of thermal habitat index

The Working Group has been using the relationship between marine habitat, 2SW lagged spawners and estimated pre-fishery abundance to forecast pre-fishery abundance in the year of interest (ICES 1993/Assess:10; 1994/Assess:16; 1995/Assess:14; 1996/Assess:11, 1997/Assess:10; 1998/ACFM:15, 1999/ACFM:14; and 2000/ACFM:13). Marine habitat is measured as a relative index of the area suitable for salmon at sea, termed thermal habitat, and was derived from sea surface temperature (SST) data obtained from the National Meteorological Center of the National Ocean &

Atmospheric Administration and previously published catch rates for salmon from research vessels fishing in the northwest Atlantic (Reddin *et al.* 1993 and ICES 1995/Assess:14). The SST data were determined by optimally interpolating SSTs from ships of opportunity, earth observation satellites (AVHRR), and sea ice cover data. The area used to determine available salmon habitat encompassed the northwest Atlantic north of 41°N latitude and west of 29°W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland.

Thermal habitat index has been updated to include data for 2000 and January and February 2001 year data. Two periods of decline are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 5.6.1.1 and Figure 5.6.1.1). The habitat index for February increased slightly (3%) in 2001 from 1,634 to 1,685. The 2001 February value is close to the long-term mean of 1,653.

The lagged spawner variable used in the model is an estimate of the 2SW parental stock of the PFA. The calculation procedure is described in Section 4.2.4. Previous analyses indicated that the sum of lagged spawner components from Labrador, Newfoundland, Québec, and Scotia-Fundy and excluding Gulf and U.S. was the strongest explanatory variable for the model. Inclusion of the Gulf spawning component reduced the explanatory power of the variable.

The Working Group recognized the problems inherent in the exclusion of a major component of the spawning stock contributing to the PFA. As well, spawning escapement estimates for Labrador are not available for the years 1998-2000. The previously formulated lagged spawner variable will therefore not be available beyond 2002.

5.6.2 Forecast model for pre-fishery abundance of North America 2SW salmon

The model used to forecast pre-fishery abundance for 2001 was revised and results presented in Section 5.6 are based on this model. Changes to the model in 2001 and a comparison in 2001 results produced by each model are provided in Section 5.7. The 2001 forecast of pre-fishery abundance was based on an alternative modelling approach that takes into consideration that habitat acts on PFA through survival rather than on absolute abundance. The adopted model takes the following form:

$$PFA = \text{Spawners} * \exp^{-(\alpha + B*\text{Habitat} + \xi)}$$

This model relates directly to a survival relationship of the form: $N_t = N_0 e^{-Z}$.

In the case of the PFA model, the survival rate of salmon (PFA / Spawners) has a mean survival level which is modified by the habitat environmental variable. A linear form of the model fits the natural log of PFA relative to the natural log of spawners and habitat variables:

$$Ln(PFA) = Ln(\text{Spawners}) + \text{Habitat} + \text{intercept} + \xi$$

The basis for the model is the same two predictor variables as were used from 1999 to 2000: thermal habitat for February (term H2) and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Quebec, term SLNQ) (ICES 1996/Assess:11). This was justified on the basis of studies showing that salmon stocks over wide geographic areas tend to have synchronous survival rates and that the winter period may be the critical stage for post-smolt survival and maturation (Scarnecchia 1989; Reddin and Shearer 1987; Friedland *et al.* 1993; Friedland *et al.* 1998). Consequently, the input data used in 2000 was updated to reflect the inclusion of the additional value and the refinement of other parameters to the time series of pre-fishery abundance estimates.

There was a significant linear relationship between the estimate PFA values and predicted values (log transformed model; $F_{2,18}$ =70.52; r^2 = 0.88). All model parameters were significant at less than the 5% level (Table 5.6.2.1). Individually, the two predictor variables are also significantly related to pre-fishery abundance. February habitat accounted for approximately 10% of the total sum of squares and SLNQ spawners was approximately 80% (Table 5.6.2.1). The jackknife and simulated predicted values for pre-fishery abundance for 1978-2001 are shown in Table 5.6.1.1 and Figure 5.6.2.1. The predicted values are shown to fit the observed data quite well except in the late 1980s and 1990s when abundance was low and there are low positive residuals at the end of the time series (Figure 5.6.2.1). The forecasted estimate by simulation of pre-fishery abundance for 2001 using the February thermal habitat and lagged spawner model is about 295,700 at the 50% probability level (Table 5.6.1.1).

The model continues to be influenced primarily by the spawning stock level in the predictive relationship for pre-fishery abundance (Table 5.6.2.1). Thus, the prediction of pre-fishery abundance would be moderated during periods of high levels of habitat and low levels of spawning stock. The alternate case would be an increase in predicted pre-fishery abundance when spawning stocks were high and thermal habitat was low. The former has occurred with the predicted values for 1998 and 1999, as thermal habitat has increased considerably, the predicted pre-fishery abundance in recent years was low due to the large decline in spawners producing them (Figure 5.6.1.1). However, two-sea-winter spawners contributing to returns have improved in the year 2001 which is contributing substantially to the increase in forecasted prefishery abundance.

Using this model to estimate the 2000 pre-fishery abundance yields a value of 225,700, which is about 25% higher than the previously reported value of 179,900. Note that the previously reported value was based on the additive model without errors in the lagged spawners. The inclusion of errors in the lagged spawners has been shown to increase the median value and to widen the distribution of the forecast (ICES CM 2000/ACFM:13). The change is also in part due to the addition of 1999 prefishery abundance which was not included last year as it was unavailable. This value is on the mid- to low end of the distribution of prefishery abundance. Also due to the time lag between forecasted and estimated prefishery abundance there is a delay of two years before comparison of estimated and forecasted values can be made. Consequently, any developing trend in high positive or negative residuals indicating a poor fit to recent data will be hard to detect until after the fishery. It should be noted that deterministic and simulated forecast values will show differences due to the method of calculation.

In Section 4.5.1, the relationship between the available 2SW to 1SW data from several rivers in Eastern Canada indicated that the 2000 forecast of prefishery abundances, i.e returns of 2SW salmon to North America in 2001, is unlikely to be achieved. Consequently, there is considerable uncertainty regarding the projected reversal of the declining trend in prefishery abundance forecasted by the model

Stochastic Analyses

Although the exact error bounds for the estimates of prefishery abundance (NN1(i)) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods, implemented in the software package SAS (SAS Institute, 1996), were used to generate the probability density function of NN1(i). This was done as a seven-step procedure as follows:

Step 1: Annual values (1978–99) of pre-fishery abundance (NN1) were generated assuming a uniform distribution of the minimum to maximum values of input parameters NC1, NC2, and NR2.

Step 2: Annual values (1978-99) of lagged spawners (SLNQ) were generated assuming a uniform distribution of the minimum to maximum values of SLNQ

Step 3: The parameter values of the regression model of pre-fishery abundance on the February thermal habitat (H2) variable and the lagged spawners (SLNQ) variable were estimated from the data set generated in steps 1 and 2.

Step 4: A single pre-fishery forecast value for 2001 was obtained by drawing at random from a normal distribution defined by the mean forecast value and the mean square error of the estimate (for a single prediction) from the regression statistics. The normal distribution was used because the error structure of the regression (after log transforamtion) is assumed to be normal.

Step 5: Step 4 was repeated 1,000 times to generate a vector of forecast values from an individual regression fit.

Step 6: Steps 1 to 5 were repeated 1,000 times to generate 1,000,000 predictions (1,000 times 1,000) of pre-fishery abundance. This resampling incorporates the uncertainty of the input parameters (step 1 and 2) and the unexplained variance in pre-fishery abundance from the regression (step 5).

Step 7: The probability profile of these stochastic realizations (in 5% intervals) of the pre-fishery abundance forecast was generated from the vector of pre-fishery abundance forecast values obtained in step 6 (Table 5.6.2.2).

These estimates will be used to develop risk analysis and catch advice presented in Section 5.6.3 and 5.6.4. Managers may use this information to determine the relative risks borne by the stock (i.e., not meeting spawning requirements) versus the fishery (e.g., reduced short-term catches).

5.6.3 Development of catch options for 2001

Atlantic salmon are managed with the objective of ensuring adequate numbers of spawners in individual rivers. A composite spawning requirement for the North American 2SW stock complex was developed by summing the spawning requirements of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawning requirements are provided in (ICES 1996/Assess:11) and in Section 4.4 of this report. With these data, it is possible to compute an allowable harvest. This procedure is unchanged from the previous assessment. Previously, NASCO considered all salmon above the conservation requirement as being available for harvest.

The fishery allocation for West Greenland is for 1SW fisheries in 2001, whereas the allocation for North America can be harvested in fisheries on 1SW salmon in 2001 and/or in fisheries on 2SW salmon in 2002. To achieve spawning requirements, a pool of fish must be set aside prior to fishery allocation in order to meet spawning requirements and allow for natural mortality in the intervening months between the fishery and return to river. Thus, 170,286 pre-fishery abundance fish must be reserved (152,548/exp$^{(-.01*11)}$) to ensure achievement of the requirement after natural mortality.

Quota computation for the 2001 fishery requires an estimate of pre-fishery abundance [NN1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea-age composition of the total landings [ACF]. Exponentially smoothed values utilising data collected during the 1995-99 fisheries are summarised below.

Parameter	**Value**
PropNA	0.779
WT1SWNA	2.954
WT1SWE	2.990
ACF	1.049

Greenland quota options are presented for the 25% and 75% cumulative probability levels of PFA (Table 5.6.2.2, Table 5.6.3.1, Appendix 6). The probability distribution provides a measure of the chance that the PFA value would be lower than the value considered. Between the 25% and 75% probability level and at the Fna of 0.4 quota options range from 28 to 467 t with a median value of 200 t.

Growth of salmon through the fishing season can significantly affect the total number of fish harvested under a fixed quota. A sensitivity analysis was conducted to evaluate the effect of salmon growth in August and September on the total number of fish harvested under a theoretical 200 mt quota (Figure 5.6.3.1). This analysis shows that the number of fish harvested under a fixed quota declines significantly as the median date of the fishery is delayed through August and September.

5.6.4 Risk assessment of catch options for 2001

The provision of catch advice in a risk framework involves the incorporation of the uncertainty in all the factors used to develop the catch options. The method is described in more detail in Section 2.3.1 and 2.3.3. Annual variations in uncertainty result in differing assessments and differing levels of precision. The risk analysis plots are calculated for consideration of the 2001 fishery in West Greenland.

The pre-fishery abundance of salmon in 2001 is predicted to be moderate relative to historic levels (Figure 5.6.4.1). The risk analysis results suggest a moderate risk that the returns of 2SW salmon to North America in 2002 will be below the conservation requirement, even in the absence of any fisheries on this age group in Greenland in 2001 (Figure 5.6.4.2).

The risk analysis performed considers the most optimistic scenario of equal production rates in all six stock areas of North America. The reality is that the stock status differs greatly within North America and that the expected returns of salmon to the USA and Scotia Fundy areas will be severely below their respective conservation requirements of this area. In the USA, the escapement for the entire area has never been above 3000 spawners since 1992, no better than 10% of the requirement (Table 4.2.4.1). Similarly, the Scotia-Fundy area lagged spawners have been less than 10,000 fish over the last ten years (Table 4.2.4.4). If all stocks were at their spawner requirements, the U.S.A. stocks would be expected to produce almost 20% of the 2SW production from North America while the Scotia-Fundy stock is expected to produce just over 16% of the total (Figure 4.2.4.5). Under the current levels of spawning escapement, recruitment to USA. rivers are not expected to be more than 2% of the total PFA, and Scotia-Fundy no better than 10% of the present PFA (Figure 4.2.4.5). The majority of the non-maturing 1SW salmon in the Northwest Atlantic in 2001 are expected to return principally to the other areas, Quebec, Gulf, Labrador and Newfoundland (Figure 4.2.4.5). With this consideration, the risk analysis applies more appropriately to these four areas while the probability of the Scotia-Fundy area meeting its conservation requirement is very likely near zero and is zero for the USA stocks. These differences in anticipated relative production should be considered in the risk analysis for the coming years in an attempt to provide a more realistic evaluation and useful analysis for guiding fisheries management.

The Working Group concludes that the North American stock complex of non-maturing salmon remains in tenuous condition. Increased spawning escapements to rivers of some areas of eastern North America resulted in improved abundance of the juvenile life stages, and perhaps now at adult life stages. Despite the closure of Canadian and West Greenland 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. Associations between 1SW returns in year i and 2SW returns in year i+1 observed in several rivers in eastern Canada suggest that abundance of 2SW salmon in 2001 in eastern Canada will be similar to or less than recent years (Sections 4.5.1). Smolt production in 1999 and 2000 in monitored rivers of eastern Canada were similar to or below the average of the last five years and unless sea survival improves, the abundance of non-maturing 1SW salmon in the Northwest Atlantic is not expected to improve above the levels of the last five years.

There is little information available to confirm the possibility of an improvement in prefishery abundance in 2000 and 2001 as forecasted through modelling. Two sea winter adult returns in 2001 will provide initial indications regarding the overall abundance of non-maturing 1SW salmon in 2000. The adoption of risk neutral quota options on the basis of predicted sharp increases in pre-fishery abundance in 2000 and 2001 provide the potential for significant overexploitation if increases in prefishery abundance are not realized. Extreme caution is urged regarding harvest decisions for 2001, and adoption of conservative harvest levels is warranted until projected increases can be confirmed. The increasing advantage associated with each additional spawner in under-seeded river systems makes a strong case for a conservative management strategy.

5.7 Changes to and Critical Assessment of the 'Model' Used to Provide Catch Advice and Impacts of Changes on the Calculated Quota

5.7.1 Changes from the 2000 assessment

The models used to predict pre-fishery abundance of the North American non-maturing stock complex and subsequent quota levels for West Greenland were revised based on exploratory work conducted by the Working Group and reported in the 1999 and 2000 reports. For the past several years, models used to predict the PFA hypothesized a linear effect of SLNQ and habitat on salmon abundance.

$$PFA = \alpha + \beta * SLNQ + \gamma * Habitat + \xi$$

An alternative approach, adopted in the 2001 assessment takes into consideration that habitat acts on PFA by mediating survival rather than on absolute abundance. The adopted model takes the following form:

$$PFA = \beta * SLNQ * \exp^{-(\alpha + \gamma * Habitat + \xi)}$$

This model relates directly to a survival relationship of the form:

$$N_t = N_0 e^{-Z}$$

where

- N_t is the abundance at time t (PFA)
- N_0 is the abundance at time 0 (SLNQ)
- Z is the instantaneous mortality rate (at a mean level with an environmental modification)

A linear form of the model fits the natural log of PFA relative to the natural log of spawners and habitat variables:

$$\ln(PFA) = \alpha + \beta' * Ln(SLNQ) + \gamma * Habitat + \xi$$

where

- ξ is assumed $N(0,\sigma)$

Note that under the back-transformed model, the error structure is assumed lognormal.

The basis for the multiplicative model is two predictor variables: thermal habitat for February (term H2) and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Quebec, term SLNQ; ICES 1996/Assess:11), which are unchanged from the 2000 assessment.

In addition, the uncertainty in the lagged spawner and PFA variables were incorporated in the model simulations. A triangular distribution centered at the midpoints and defined by the minimum and maximum values was assumed for the uncertainty in the PFA and lagged spawner variables. Values were drawn randomly and independently for each variable, each year in the simulations. A total of 1,000 simulations were performed to generate the posterior predictive probability distributions of the PFA in year 2000. When predicting the PFA, the uncertainty in the lagged spawners for the year 2000 was also considered in the same way as for the predictor variables.

There is an important difference in distribution between the additive model used in the 2000 assessment and multiplicative models (adopted in 2001) with the latter being skewed to the origin and long tailed towards large values. Because of the underlying lognormal distribution of errors, the predicted abundance is always greater than 0, contrary to what is given by the additive model. There is a greater cumulative probability for lower PFA levels with the multiplicative model but the distribution suggests that there is insufficient information in the data to fix an upper bound on the PFA. Adoption of the multiplicative model resolves issues related to the biological logic of the model and the prediction of unreasonable PFA values, less than 0, generated by the additive model in previous assessments.

The multiplicative model has improved statistical fit to the two predictor variables used in previous assessments. Figure 5.7.1.1 provides a comparison of the residuals and pre-fishery abundance estimates for the additive model used in the 2000 assessment and the multiplicative model adopted in 2001. Each model provides similar estimates of pre-fishery abundance and associated residuals. The primary changes in performance of the multiplicative model adopted for 2001 relate to changes in pre-fishery abundance forecasts and characterization of uncertainty about these forecasts.

5.7.2 Impact of changes on the catch advice

Adopting the multiplicative model does result in changes to the catch advice generated. Table 5.7.2.1 provides the probability levels of the pre-fishery abundance estimates for the additive model used in the 2000 assessment. The additive model provides 2001 forecasts of 312,000 and 425,000 salmon at 25% and 75% probability levels, respectively. The multiplicative model generates prefishery abundance forecasts for 2001 of 187,700 and 463,000 salmon at the 25% and 75% probability levels, respectively (Table 5.6.2.2). The distribution of PFA forecasts generated by the multiplicative model is centered at a lower median and has a broader distribution of probability values, particularly in the end of PFA.

Table 5.7.2.2 provides quota options for 2001 at West Greenland based on results from the pre-fishery abundance estimates generated by the additive model used in the 2000 assessment. The additive model used in the 2000 assessment provides a pre-fishery abundance forecast for non-maturing 1SW salmon in 2001 of 368,685, while the multiplicative model adopted in 2001 provides a lower forecast of 295,678 (approximately 20% lower). In comparing quota options generated by the multiplicative and additive models for a 40% portion of the surplus fishery abundance to West Greenland at a 50% probability level, the multiplicative model provides a quota option of 200 t (Table 5.6.3.1), while the additive model provides a quota option of 317 t (Table 5.7.2.2).

Alternative Spawning Stock Variable

As an alternative to the lagged spawner variable, juvenile abundance indices were considered as surrogates of potential smolt production from eastern Canada as described in Section 4.2.1. The adjustment (annual value divided by the average value of 1994 to 1998) places all the rivers on a common relative scale, temporally. The information from various rivers with juvenile surveys or smolt counts is combined into an index of smolt production reflecting the temporal variability in the juvenile production (Section 4.2.1).

The index of smolts from North America was obtained by weighting the annual river indices by the relative proportion of the conservation egg requirements (O'Connell et al. 1997) of the SFA or Zone to the total conservation egg requirements of the zones under consideration (Table 4.2.1.2). An alternative weighting incorporated the relative contribution to the 2SW spawner requirements of the six main areas within North America. This allows indices of smolt production from all areas of North America to be used but attributes weights to the area indices according to the expected contribution to 2SW abundance.

The relative indices using alternative weighting factors all show the same general pattern of freshwater production: at about one-third the recent (1995 to 1998) average between 1971 and 1979, at about 60% of the average during 1980 to 1985 and at about average since 1986 (Figure 4.2.1.6).

A model identical to that described in sections 5.6 and 5.7 was fitted after substituting the juvenile index for the lagged spawner variable (SLNQ). The juvenile index was advanced one year to correspond to the year of PFA (i.e. the PFA of year i corresponded to the juvenile index of year i-1 which was a combination of smolt indices of year i-1 and the parr indices of year i-2).

The modeled relationship between juvenile index and PFA is negative indicating that as the juvenile index increases, PFA decreases (Figure 5.8.1). There has not been any temporal contrast in juvenile index and PFA values such that a generally increasing trend in juveniles corresponds to the generally decreasing trend in PFA over the time series examined.

In terms of the predictions for the PFA, the 2000 value has a median estimate of 120,000 fish, 50% lower than the value derived from the lagged spawner model without errors in spawners (Figure 5.8.2) (ICES CM 2000/ACFM:13). For 2001, the model provides the following predictions of PFA; median = 122,000 fish with a 10th to 90th percentile range of 71,000 to 216,000 fish (Figure 5.8.2).

5.8 Concerns regarding the juvenile index

A juvenile index model is conceptually more attractive as juveniles represent a stage closer to the PFA than the lagged spawner variable used previously. Consequently, some of the noise corresponding to the stochasticity of the recruitment process between the spawner and the juveniles is removed, favoring a more direct link between the predictors and the PFA.

This point needs to be addressed because in many cases (especially until the mid 1980s) the index is based on only a few rivers, and the rivers monitored never represented more than 35% of the total area potentially producing juveniles. The number of sampling stations by river is also limited, whereas juvenile abundance is know to show small-scale spatial variations and the measurement made on each station is an estimate with an uncertainty associated with it. As a first step, a sensitivity analysis of the PFS forecast to measurement errors in juvenile indices is required before applying the index in a predictive framework for PFA abundance.

The rivers monitored for juveniles are assumed to represent the relative production levels within a broader geographic area. This assumption should be tested by examining trends in abundance where several rivers are available from a zone.

The juvenile index also assumes that parr to smolt translations are equivalent in all areas. This should also be examined where parr and smolt data sets from the same river are available. Parr size-at-age has been shown to vary annually in the Miramichi River (Section 2.4.7) and size has been shown to be an important determinant of smoltification. Consequently, increased juvenile densities may not translate directly into smolts especially where overwinter survival of large parr has been shown to be in some rivers limiting smolt production

As with the other indices of spawning stock, there is an assumption of stationarity over time in parr to smolt dynamics. Again, where data sets exist, this should be examined.

5.8.1 Alternative modelling approaches

All the models examined to date assume that the habitat, spawning stock indicators and PFA estimates are temporally independent. In reality, all these data sets are time series with autocorrelation (as evidenced in residual patterns). Models to treat time series data should be examined.

There is also the potential problem of non-stationarity in the data sets being examined. Examples from both sides of the Atlantic provide evidence of shifts in marine survival over the few decades of observations available. Models such as dynamic linear modeling would permit the integration of this information sequentially through time. It would be useful for the Working Group to review these approaches in the near future to address the various problems identified with the modeling approaches to date.

5.9 Data Deficiencies and Research Needs in the WGC area

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

2. The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme be continued and closely coordinated with fishery harvest plan to be executed annually in West Greenland.

~~3.~~ The catch options for the West Greenland fishery are based almost entirely upon data taken from North American stocks (with the current exclusion of Labrador, see Section 4.6). In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible.

4. Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses) to provide some index of plausibility of the quantitative forecasts.

5. Further basic research is needed on the spatial/temporal distribution and migration patterns of salmon and their predators at sea to assist in explaining variability in survival rates.

6. Samples should be obtained for DNA analysis from rivers in North America and Europe.

The status of the six stock areas should be incorporated into the analysis of risk of catch options.

Table 5.1.1. Nominal catches of salmon, West Greenland 1960-2000 (metric tons round fresh weight).

Year	Norway	Faroes	Sweden	Denmark	Greenland[1]	Total	Quota[2]
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1539	1539	-
1965	-[3]	36	-	-	825	861	-
1966	32	87	-	-	1251	1370	-
1967	78	155	-	85	1283	1601	-
1968	138	134	4	272	579	1127	-
1969	250	215	30	355	1360	2210	-
1970	270	259	8	358	1244	2146[4]	-
1971	340	255	-	645	1449	2689	-
1972	158	144	-	401	1410	2113	1100
1973	200	171	-	385	1585	2341	1100
1974	140	110	-	505	1162	1917	1191
1975	217	260	-	382	1171	2030	1191
1976	-	-	-	-	1175	1175	1191
1977	-	-	-	-	1420	1420	1191
1978	-	-	-	-	984	984	1191
1979	-	-	-	-	1395	1395	1191
1980	-	-	-	-	1194	1194	1191
1981	-	-	-	-	1264	1264	1265[6]
1982	-	-	-	-	1077	1077	1253[6]
1983	-	-	-	-	310	310	1191
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	-[7]
1989	-	-	-	-	337	337	-[7]
1990	-	-	-	-	274	274	-[7]
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237	237	258[8]
1993	-	-	-	-	0[5]	0[5]	89[9]
1994	-	-	-	-	0[5]	0[5]	137[9]
1995	-	-	-	-	83	83	77
1996	-	-	-	-	92	92	174[8]
1997	-	-	-	-	58	58	57
1998	-	-	-	-	11	11	20[10]
1999	-	-	-	-	19	19	20[10]
2000	-	-	-	-	21	21	20[10]

[1] For Greenland vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non-Greenland catches 1969-75 were taken with drift nets.
[2] Quota figures apply to Greenland fishery only.
[3] Figures not available, but catch is known to be less than Faroese catch.
[4] Including 7 t caught on longline by one of two Greenland vessels in the Labrador Sea early in 1970.
[5] The fishery was suspended.
[6] Quota corresponding to specific opening dates of the fishery.
[7] Quota for 1988-90 was 2,520 t with an opening date of 1 August and annual catches not to exceed the annual average (840 t) by more than 10%. Quota adjusted to 900 t in 1989 and 924 t in 1990 for later opening dates.
[8] Set by Greenland authorities.
[9] Quotas were bought out.
[10] Fishery restricted to catches used for internal consumption in Greenland.

Table 5.1.1.2. Distribution of nominal catches (metric tons), Greenland vessels.

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

[1]) The fishery was suspended

+) Small catches <0.5 t

-) No commercial landings

Table 5.1.2.1. Size of biological samples and percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82), from commercial samples (1978-92 and 1995-97), and from local consumption samples (1998-2000).

		Sample size		Continent of origin (%)			
Source	Year	Length	Scales	NA	(95%CI)[1]	E	(95%CI)[1]
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(75,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3488	3488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977	-	-	45	-	55	-
	1978[2]	606	606	38	(41,34)	62	(66,59)
	1978[3]	49	49	55	(69,41)	45	(59,31)
	1979	328	328	47	(52,41)	53	(59,48)
	1980	617	617	58	(62,54)	42	(46,38)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1653	1653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4570	1930	59	(61,58)	41	(42,39)
	1982	1949	414	62	(64,60)	38	(40,36)
	1983	4896	1815	40	(41,38)	60	(62,59)
	1984	7282	2720	50	(53,47)	50	(53,47)
	1985	13272	2917	50	(53,46)	50	(54,47)
	1986	20394	3509	57	(66,48)	43	(52,34)
	1987	13425	2960	59	(63,54)	41	(46,37)
	1988	11047	2562	43	(49,38)	57	(62,51)
	1989	9366	2227	56	(60,52)	44	(48,40)
	1990	4897	1208	75	(79,70)	25	(30,21)
	1991	5005	1347	65	(69,61)	35	(39,31)
	1992	6348	1648	54	(57,50)	46	(50,43)
	1995	2045	2045	68	(72,65)	32	(35,28)
	1996	3341	1297	73	(76,71)	27	(29,24)
	1997	794	282	80	(84,75)	20	(25,16)
Local cons.	1998	540	406	79	(84,73)	21	(27,16)
	1999	532	532	90	(97,84)	10	(16,3)
	2000	491	491	70		30	

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

[2] During Fishery.

[3] Research samples after fishery closed.

Table 5.1.2.2. The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2000. Numbers are rounded to the nearest hundred fish.

	Proportion weighted by catch in number		Numbers of Salmon caught	
Year	NA	E	NA	E
1982	57	43	192200	143800
1983	40	60	39500	60500
1984	54	46	48800	41200
1985	47	53	143500	161500
1986	59	41	188300	131900
1987	59	41	171900	126400
1988	43	57	125500	168800
1989	55	45	65000	52700
1990	74	26	62400	21700
1991	63	37	111700	65400
1992	45	55	46900	38500
1993	-	-	-	-
1994	-	-	-	-
1995	67	33	21400	10700
1996	73	27	22400	9700
1997	85	15	18000	3300
1998	79	21	3100	900
1999	91	9	5700	600
2000	65	35	5100	2700

Table 5.1.3.1. Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-1992 and 1995-2000. Fork length (cm); whole weight (kg). NA = North America; E = Europe.

	Whole weight (kg)									Fork length (cm)					
	Sea age & origin									Sea age & origin					
	1SW		2SW		PS		All sea ages		TOTAL	1SW		2SW		PS	
Year	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.69	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.42	2.54	5.82	6.23	5.15	5.09	2.57	2.79	2.65	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.54	2.66	6.49	6.01	4.09	5.28	2.86	2.74	2.81	62.3	63.2	83.4	81.1	77.4	82.7
1995	2.37	2.67	6.09	5.88	3.71	4.98	2.45	2.75	2.56	61.0	63.2	81.3	81.0	70.9	81.3
1996	2.63	2.86	6.50	6.30	4.98	5.44	2.83	2.90	2.88	62.8	64.0	81.4	81.1	77.1	79.4
1997	2.57	2.82	7.95	6.11	4.82	6.90	2.63	2.84	2.71	62.3	63.6	85.7	84.0	79.4	87.0
1998	2.72	2.83	6.44	-	3.28	4.77	2.76	2.84	2.78	62.0	62.7	84.0	-	66.3	76.0
1999	3.02	3.03	7.59	-	4.20	-	3.09	3.03	3.08	63.8	63.5	86.6	-	70.9	-
2000	2.47	2.81	-	-	2.58	-	2.47	2.81	2.57	60.7	63.2	-	-	64.7	-

Table 5.1.3.2. River age distribution (%) for all North American and European origin salmon caught at West Greenland, 1968-1992 and 1995-2000.

	River age							
Year	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0.0
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0.0
1992	6.7	36.7	34.1	19.1	3.2	0.3	0.0	0.0
1995	2.4	19.0	45.4	22.6	8.8	1.8	0.1	0.0
1996	1.7	18.7	46.0	23.8	8.8	0.8	0.1	0.0
1997	1.3	16.4	48.4	17.6	15.1	1.3	0.0	0.0
1998	4.0	35.1	37.0	16.5	6.1	1.1	0.1	0.0
1999	2.7	23.5	50.6	20.3	2.9	0.0	0.0	0.0
2000	3.2	26.6	38.6	23.4	7.6	0.6	0.0	0.0
Mean	3.9	34.8	37.3	16.7	6.1	1.1	0.1	0.0

Table 5.1.3.2. Continued

European				River age				
Year	1	2	3	4	5	6	7	8
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0
1988	18.4	61.6	17.3	2.3	0.5	0.0	0.0	0.0
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0
1990	15.9	56.3	23.0	4.4	0.2	0.2	0.0	0.0
1991	20.9	47.4	26.3	4.2	1.2	0.0	0.0	0.0
1992	11.8	38.2	42.8	6.5	0.6	0.0	0.0	0.0
1995	14.8	67.3	17.2	0.6	0.0	0.0	0.0	0.0
1996	15.8	71.1	12.2	0.9	0.0	0.0	0.0	0.0
1997	4.1	58.1	37.8	0.0	0.0	0.0	0.0	0.0
1998	28.6	60.0	7.6	2.9	0.0	1.0	0.0	0.0
1999	27.7	65.1	7.2	0.0	0.0	0.0	0.0	0.0
2000	36.5	46.7	13.1	2.9	0.7	0.0	0.0	0.0
Mean	20.2	60.9	16.2	2.4	0.3	0.0	0.0	0.0

Table 5.1.3.3. Sea-age composition (%) of samples from commercial catches at West Greenland, 1985-2000.

Year	North American			European		
	1SW	2SW	Previous Spawners	1SW	2SW	Previous spawners
1985	92.5	7.2	0.3	95.0	4.7	0.4
1986	95.1	3.9	1.0	97.5	1.9	0.6
1987	96.3	2.3	1.4	98.0	1.7	0.3
1988	96.7	2.0	1.2	98.1	1.3	0.5
1989	92.3	5.2	2.4	95.5	3.8	0.6
1990	95.7	3.4	0.9	96.3	3.0	0.7
1991	95.6	4.1	0.4	93.4	6.5	0.2
1992	91.9	8.0	0.1	97.5	2.1	0.4
1993	-	-	-	-	-	-
1994	-	-	-	-	-	-
1995	96.8	1.5	1.7	97.3	2.2	0.5
1996	94.1	3.8	2.1	96.1	2.7	1.2
1997	98.2	0.6	1.2	99.3	0.4	0.4
1998[1]	96.8	0.5	2.7	99.4	0.0	0.6
1999[1]	96.8	1.2	2.0	100.0	0.0	0.0
2000[1]	97.4	0.0	2.6	100.0	0.0	0.0

[1] Catches for local consumption only.

Table 5.4.1. Numbers of salmon returning to home waters provided no fishing took place at Greenland. The average number of potentially returning salmon per ton caught in Greenland is also given.

Year	1993	1994	1995	1996	1997	1998	1999	2000
Nominal catch at Greenland (tons) [1]:	89	137	83	92	58	11	19	21
Proportion of NA fish in catch (PropNA):	0.540	0.540	0.680	0.732	0.796	0.785	0.900	0.700
Proportion of EU fish in catch (PropEU):	0.460	0.460	0.320	0.268	0.204	0.215	0.100	0.300
Mean weight, NA fish, all sea ages (kg):	2.655	2.655	2.450	2.830	2.630	2.760	3.090	3.020
Mean weight, EU fish, all sea ages (kg):	2.745	2.745	2.750	2.900	2.840	2.840	3.030	2.992
Mean weight of all sea ages (NA+EU fish):	2.696	2.696	2.546	2.849	2.673	2.777	3.084	3.012
Proportion of 1SW fish in catch:	0.919	0.919	0.968	0.941	0.982	0.968	0.968	0.968
Catch of 1SW NA fish:	16635	25607	22300	22392	17238	3029	5357	4712
Catch of 1SW EU fish:	13706	21098	9349	8000	4091	806	607	2038
Natural mortality during migration:	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Additional fish if no fishery at Greenland:								
2SW fish returning to NA (numbers):	**15052**	**23171**	**20177**	**20262**	**15598**	**2740**	**4847**	**4263**
2SW fish returning to EU (numbers):	**12402**	**19091**	**8459**	**7239**	**3702**	**729**	**549**	**1844**

Average number of salmon potentially returning to home waters per ton caught in Greenland:	
2SW fish returning to NA (numbers per ton, average of 1993-2000):	**208**
2SW fish returning to EU (numbers per ton, average of 1993-2000):	**106**

[1]) Figures for 1993 and 1994 correspond to calculated quotas.

Table 5.6.1.1. Pre-fishery abundance estimates, thermal habitat index for February based on sea surface temperature (H2), lagged spawner index for North America excluding Gulf and US spawners (SLNQ), results of a jacknife cross-validation of the multiplicative forecast model, and simulated forecasts.

	Pre-fishery abundance			Thermal Habitat	Lagged spawners (SLNQ)			Jacknife Cross-validation	
Year	Low	High	Mid-point	February (H2)	Low	High	Mid-point	Prediction	Residuals
1971	578,974	726,622	652,798	2,011	.	.	.	.	.
1972	557,790	732,940	645,365	1,990	.	.	.	.	.
1973	672,631	867,684	770,157	1,708	.	.	.	.	.
1974	623,907	800,542	712,224	1,862	.	.	.	.	.
1975	710,252	904,626	807,439	1,827	.	.	.	.	.
1976	610,799	826,787	718,793	1,676	.	.	.	.	.
1977	506,919	667,787	587,353	1,915	.	.	.	.	.
1978	288,792	371,342	330,067	1,951	35,453	81,767	58,610	389,220	-59,153
1979	630,091	831,411	730,751	2,058	42,626	94,677	68,652	664,772	65,978
1980	550,336	734,489	642,412	1,823	43,173	97,017	70,095	590,190	52,222
1981	527,318	684,352	605,835	1,912	43,268	97,575	70,421	658,224	-52,389
1982	439,982	567,499	503,741	1,703	43,381	98,372	70,876	563,713	-59,972
1983	236,377	337,388	286,882	1,416	40,413	91,967	66,190	364,762	-77,880
1984	245,424	347,471	296,448	1,257	37,647	84,066	60,856	233,165	63,283
1985	399,028	539,102	469,065	1,410	39,344	83,435	61,389	248,799	220,266
1986	435,090	575,673	505,381	1,688	40,567	91,757	66,162	442,148	63,233
1987	398,168	527,764	462,966	1,627	36,636	88,818	62,727	353,451	109,515
1988	317,609	423,746	370,678	1,698	37,131	83,891	60,511	339,966	30,712
1989	241,044	345,930	293,487	1,642	41,955	86,459	64,207	400,432	-106,945
1990	218,191	296,332	257,262	1,503	40,948	81,667	61,307	304,340	-47,078
1991	249,798	349,917	299,857	1,357	37,582	72,966	55,274	178,975	120,882
1992	143,925	216,262	180,094	1,381	35,596	71,384	53,490	179,100	994
1993	95,352	179,428	137,390	1,252	38,387	79,232	58,810	244,899	-107,509
1994	110,985	219,159	165,072	1,329	38,395	75,762	57,079	215,540	-50,467
1995	120,523	202,958	161,740	1,311	36,740	69,943	53,342	168,198	-6,458
1996	104,675	163,182	133,928	1,470	33,492	61,600	47,546	134,001	-72
1997	69,083	123,311	96,197	1,594	29,876	55,241	42,558	107,109	-10,912
1998	58,751	126,207	92,479	1,849	25,629	50,461	38,045	91,858	621
1999	57,800	130,436	94,118	1,741	25,658	52,637	39,147	91,254	2,864
2000	.	.	.	1,634	32,960	68,185	50,572	*225,708* [1]	
2001	.	.	.	1,685	37,414	81,709	59,561	*295,678* [1]	

[1] Simulated forecast values.

Table 5.6.2.1 Results of analysis of prefishery abundance (NN1) on February thermal habitat (H2) and North American spawners (SLNQ) from the multiplicative model, 1978-99.

General Linear Models Procedure

Dependent Variable: LNN1

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	2	7.83182436	3.91591218	70.52	<.0001
Error	19	1.05498117	0.05552532		
Corrected Total	21	8.88680553			

	R-Square	**C.V.**	**Root MSE**	**NN1 Mean**
	0.881287	1.884988	0.235638	12.50077

Source	**DF**	**Type I SS**	**Mean Square**	**F Value**	**Pr > F**
H2	1	1.32987051	1.32987051	23.95	0.0001
LN(SLNQ)	1	6.50195385	6.50195385	117.10	<.0001

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
H2	1	0.80611073	0.80611073	14.52	0.0012
LN(SLNQ)	1	6.50195385	6.50195385	117.10	<.0001

Regression statistics

Parameter	**Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
INTERCEPT	-22.69738188	3.11673567	-7.28	<.0001
H2	0.00082736	0.00021714	3.81	0.0012
LN(SLNQ)	3.09084662	0.28562819	10.82	<.0001

Table 5.6.2.2 Estimate of pre-fishery abundance in 2001. forecasted by H2-SLNQ multiplicative model of probability levels between 25 and 75%.

Cumulative Density Function %	Forecast
25	187,700
30	207,784
35	228,189
40	249,433
45	271,859
50	295,678
55	321,537
60	350,175
65	382,308
70	418,919
75	462,797

Table 5.6.3.1 Quota options (mt) for 2001 at West Greenland based on H2-SLNQ multiplicative forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	7	14	21	28	35	42	49	56	63	69
30	0	15	30	45	60	75	90	105	120	135	150
35	0	23	46	69	92	116	139	162	185	208	231
40	0	32	63	95	126	158	190	221	253	284	316
45	0	41	81	122	162	203	243	284	324	365	405
50	0	50	100	150	200	250	300	350	400	450	500
55	0	60	121	181	241	302	362	423	483	543	604
60	0	72	144	215	287	359	431	503	574	646	718
65	0	85	169	254	338	423	508	592	677	761	846
70	0	99	198	298	397	496	595	695	794	893	992
75	0	117	233	350	467	584	700	817	934	1,051	1,167

Sp. res =	170,286
Prop NA =	0.779
WT1SWNA =	2.954
WT1SWE =	2.990
ACF =	1.049

Table 5.7.2.1 Estimate of pre-fishery abundance in 2001. forecasted by H2-SLNQ additive model of probability levels between 25 and 75%.

Cumulative Density Function %	Forecast
25	312,426
30	324,966
35	336,579
40	347,550
45	358,165
50	368,685
55	379,156
60	389,811
65	400,880
70	412,467
75	424,968

Table 5.7.2.2 Quota options (mt) for 2001 at West Greenland based on H2-SLNQ additive model forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	57	113	170	227	284	340	397	454	511	567
30	0	62	123	185	247	309	370	432	494	556	617
35	0	66	133	199	265	332	398	465	531	597	664
40	0	71	141	212	283	354	424	495	566	637	707
45	0	75	150	225	300	375	450	525	600	675	750
50	0	79	158	238	317	396	475	554	633	713	792
55	0	83	167	250	333	417	500	583	667	750	834
60	0	88	175	263	350	438	526	613	701	788	876
65	0	92	184	276	368	460	552	644	736	828	920
70	0	97	193	290	387	483	580	677	773	870	966
75	0	102	203	305	407	508	610	711	813	915	1,016

Sp. res =	170,286
Prop NA =	0.779
WT1SWNA =	2.954
WT1SWE =	2.990
ACF =	1.049

Figure 5.1.2.1 Numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2000.

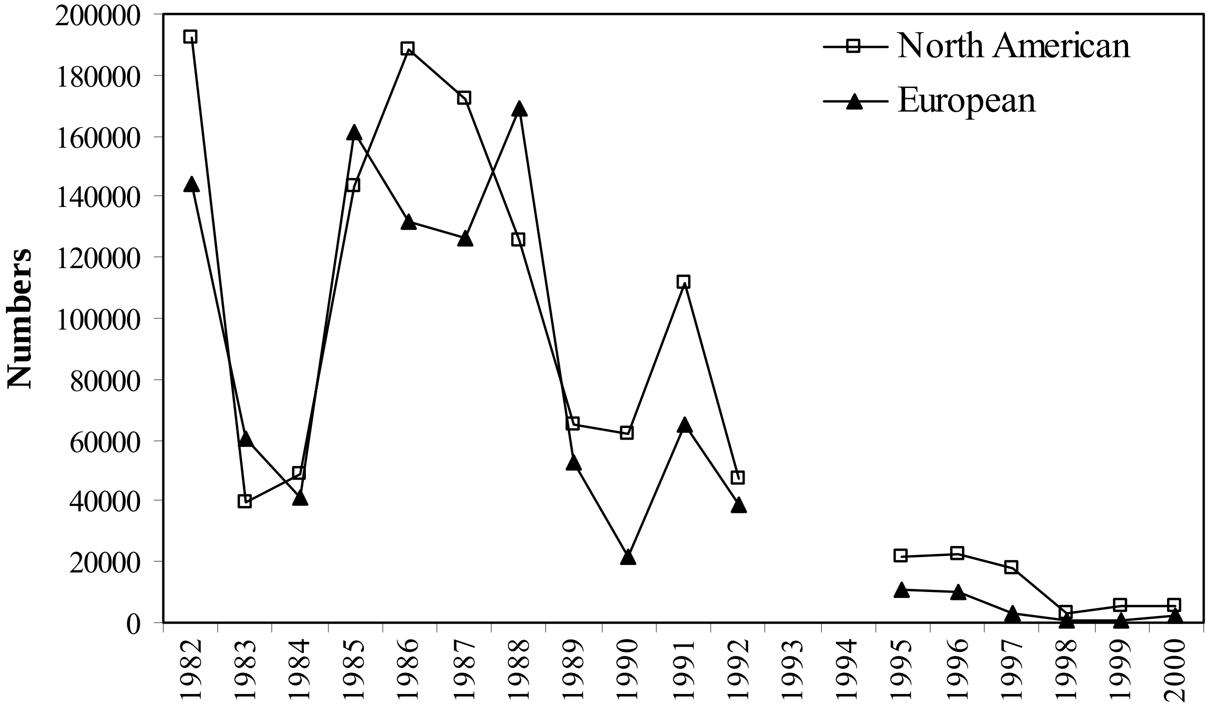

Figure 5.1.3.1. Mean weight (kg, fresh round weight) of 1 SW Atlantic salmon of North American and European origin sampled at West Greenland from 1969 to 2000

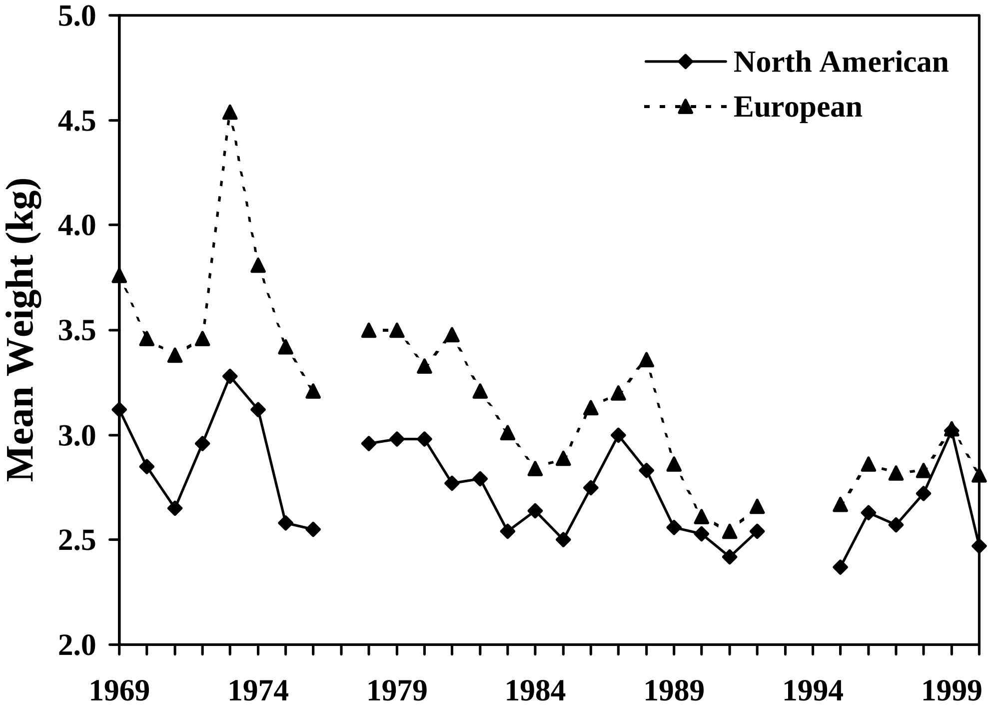

Figure 5.3.1. The proportion (with confidence intervals) of North American salmon for (A) NAFO Divisions and (B) for years 1987-1999.

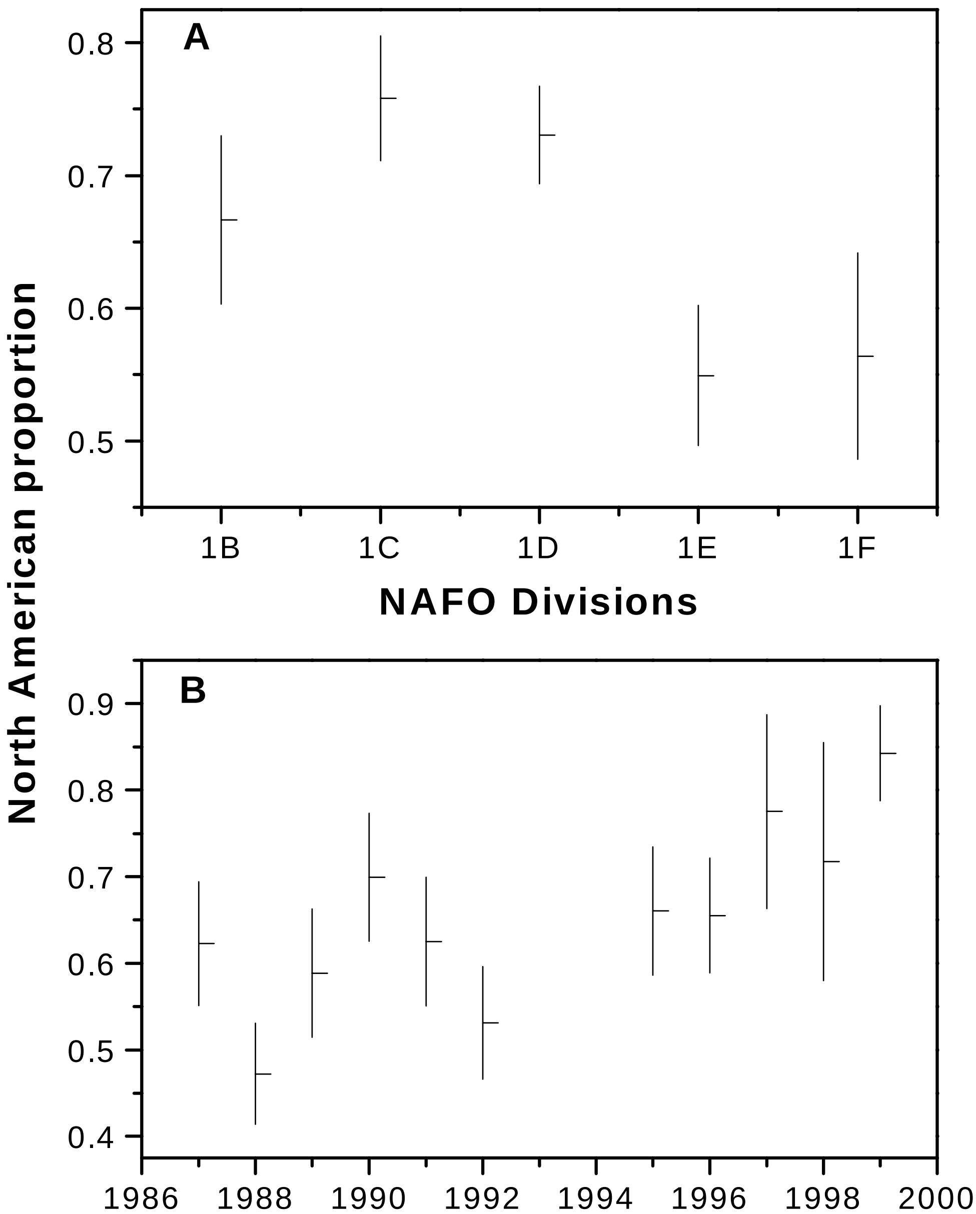

Figure 5.3.2. The proportions of North American salmon in samples at West Greenland and in the total pre-fishery abundance of North American and southern European 1SW non-maturing salmon, 1971-1999.

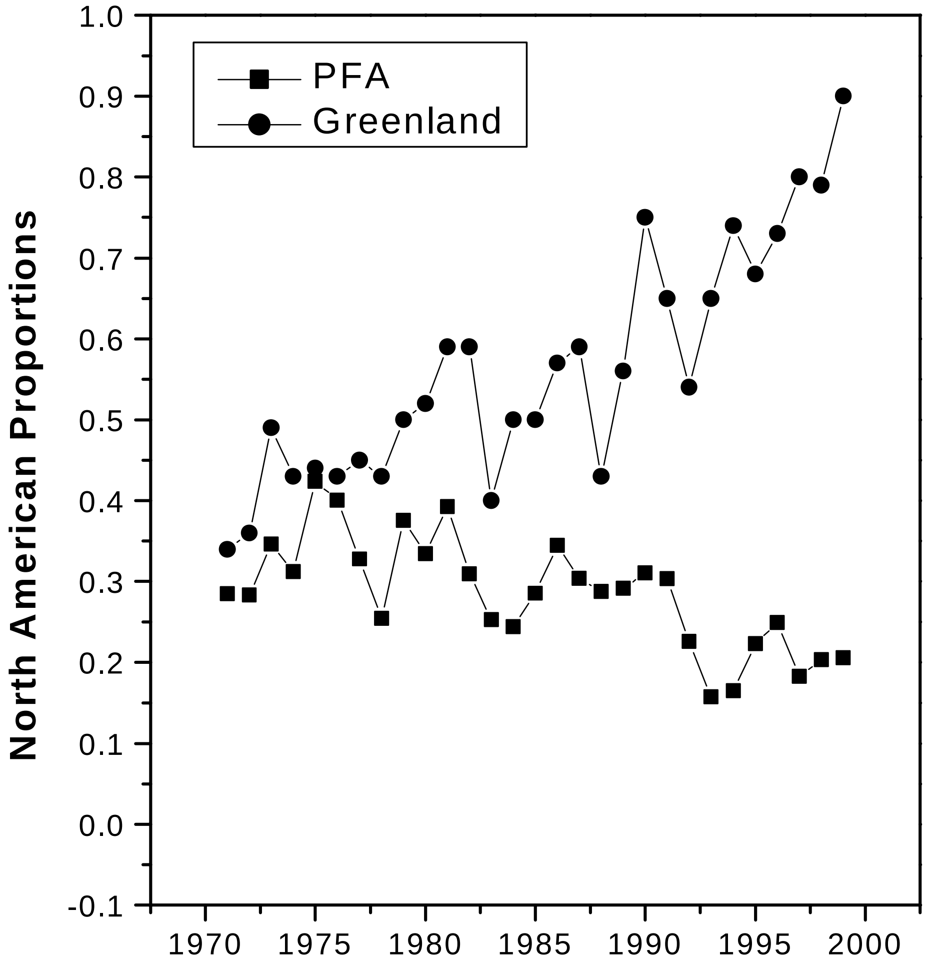

Figure 5.4.1 Extant exploitation of the non-maturing component of North American salmon as 1SW salmon in North America and Greenland from the run reconstruction statistics.

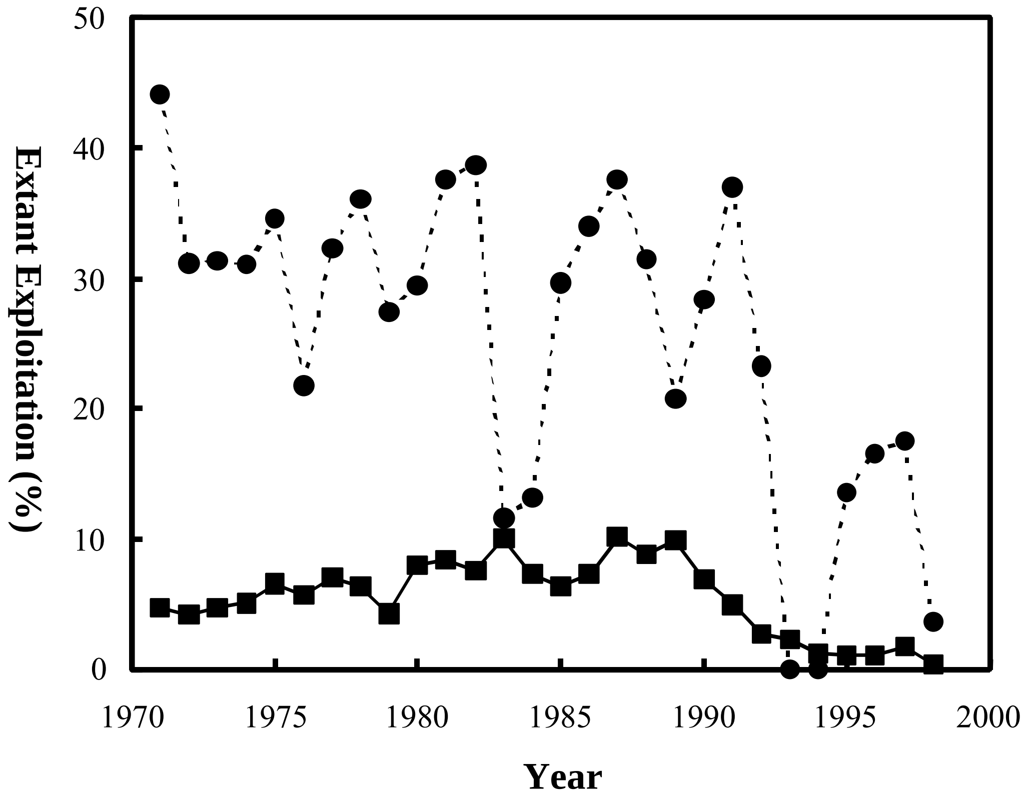

Fig. 5.6.1.1. Thermal habitat index for Frebruary (H2) and lagged spawners (SLNQ).

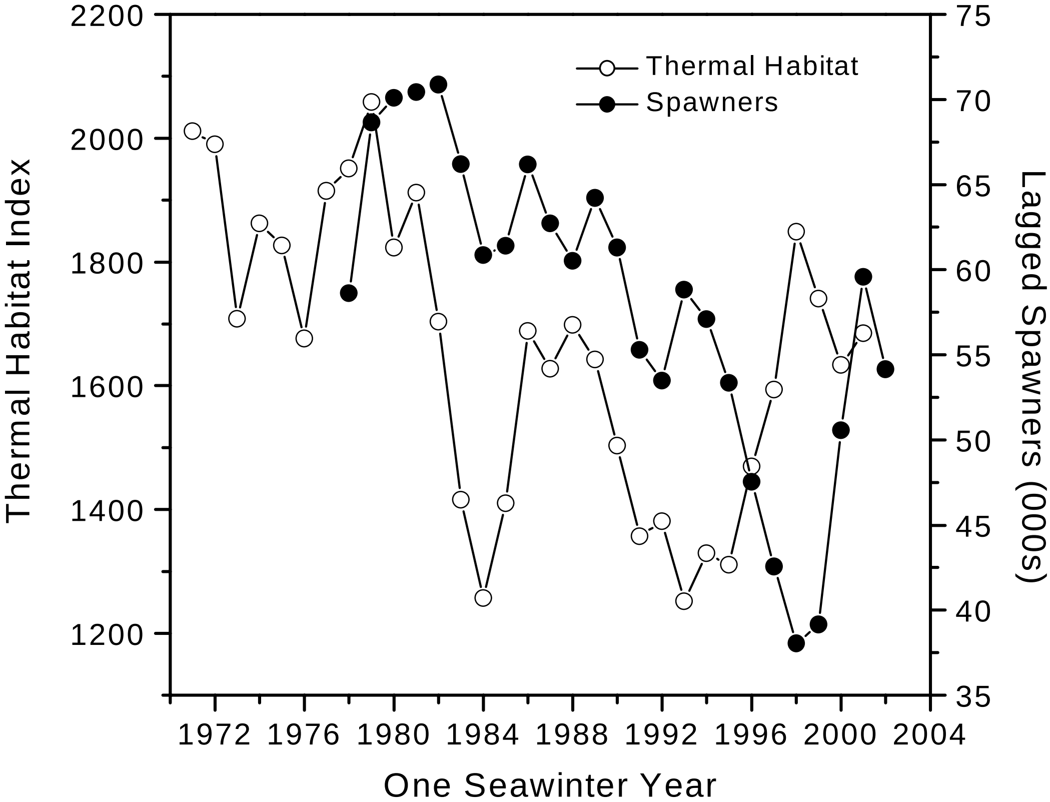

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Figure 5.6.2.1. Observed estimates, jackknifed historical predictions, and deterministic forecasts (upper Panel A) of prefishery abundance from the multiplicative model. The residual pattern from the jackknifed predictions is shown in the lower panel (Panel B).

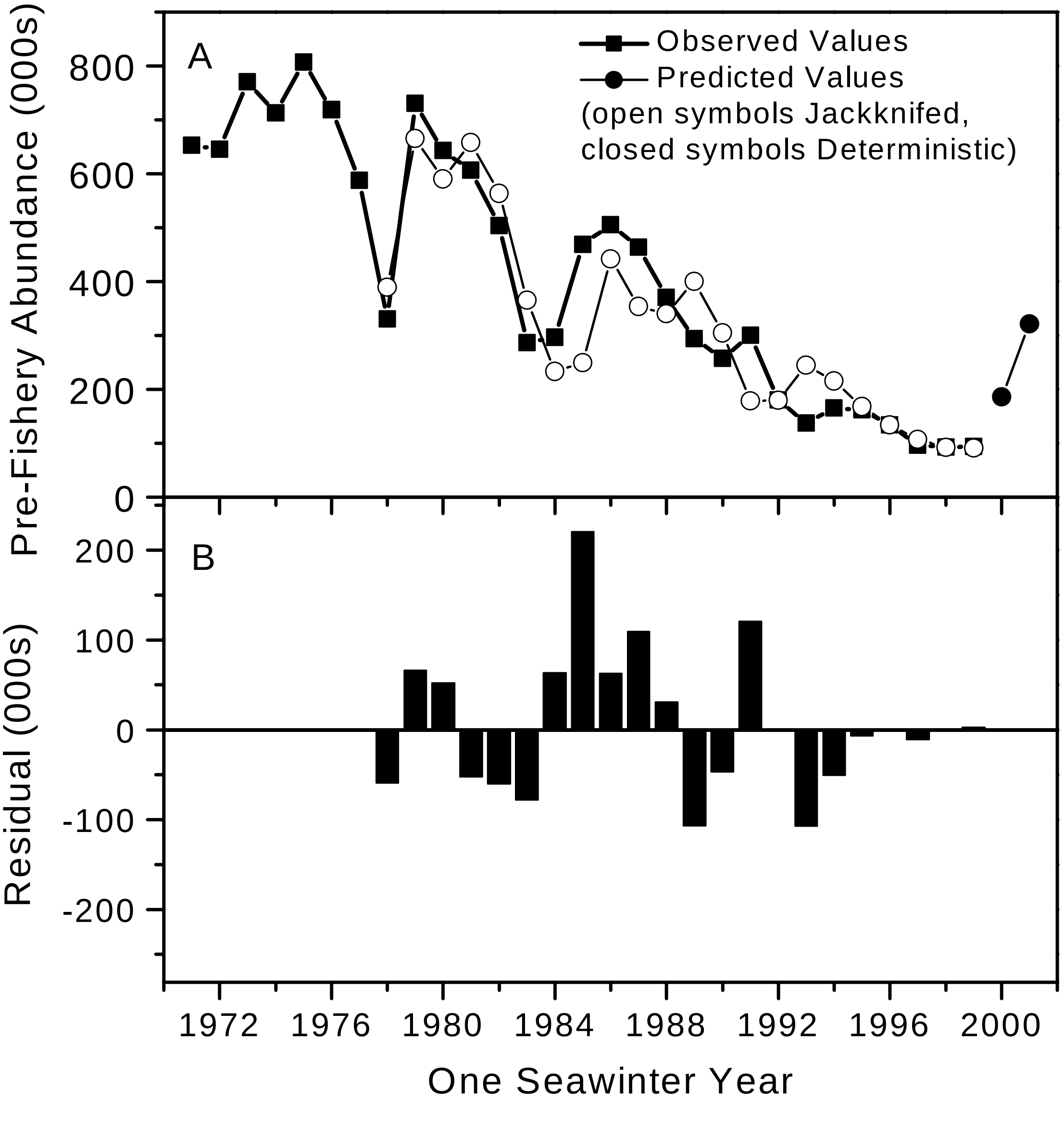


Figure 5.6.3.1. Number of fish yielding a 200 mt quota, relative to changes in the median date of the fishery and associated changes in mean weight of fish harvested. Equations presented by Jensen (1990) were used to calculate daily changes in mean weight.

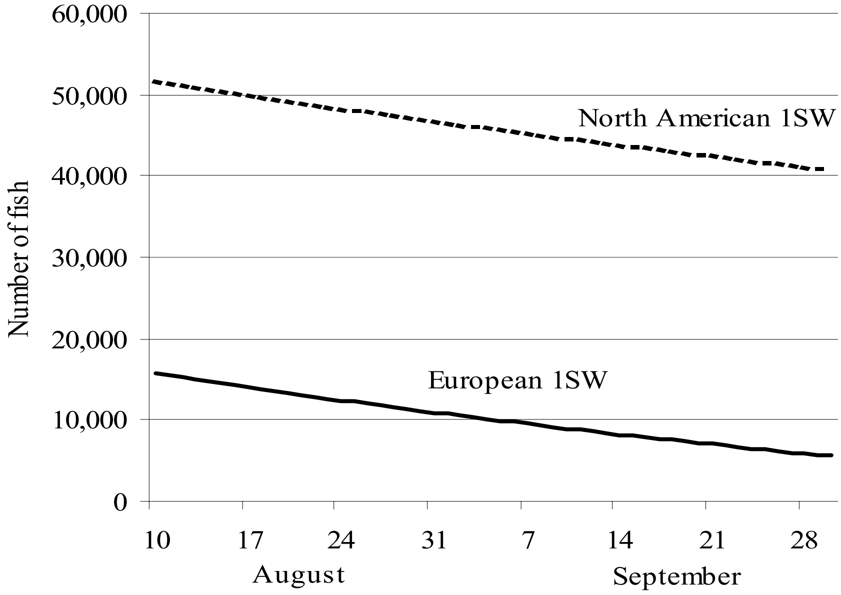


Figure 5.6.4.1. Exact (upper) and cumulative (lower) posterior predicted probability distributions of the PFA in year 2001 based on the multiplicative model of survival with errors in the PFA and SNLQ variables. The distributions were generated from 50,000 Monte Carlo simulations.

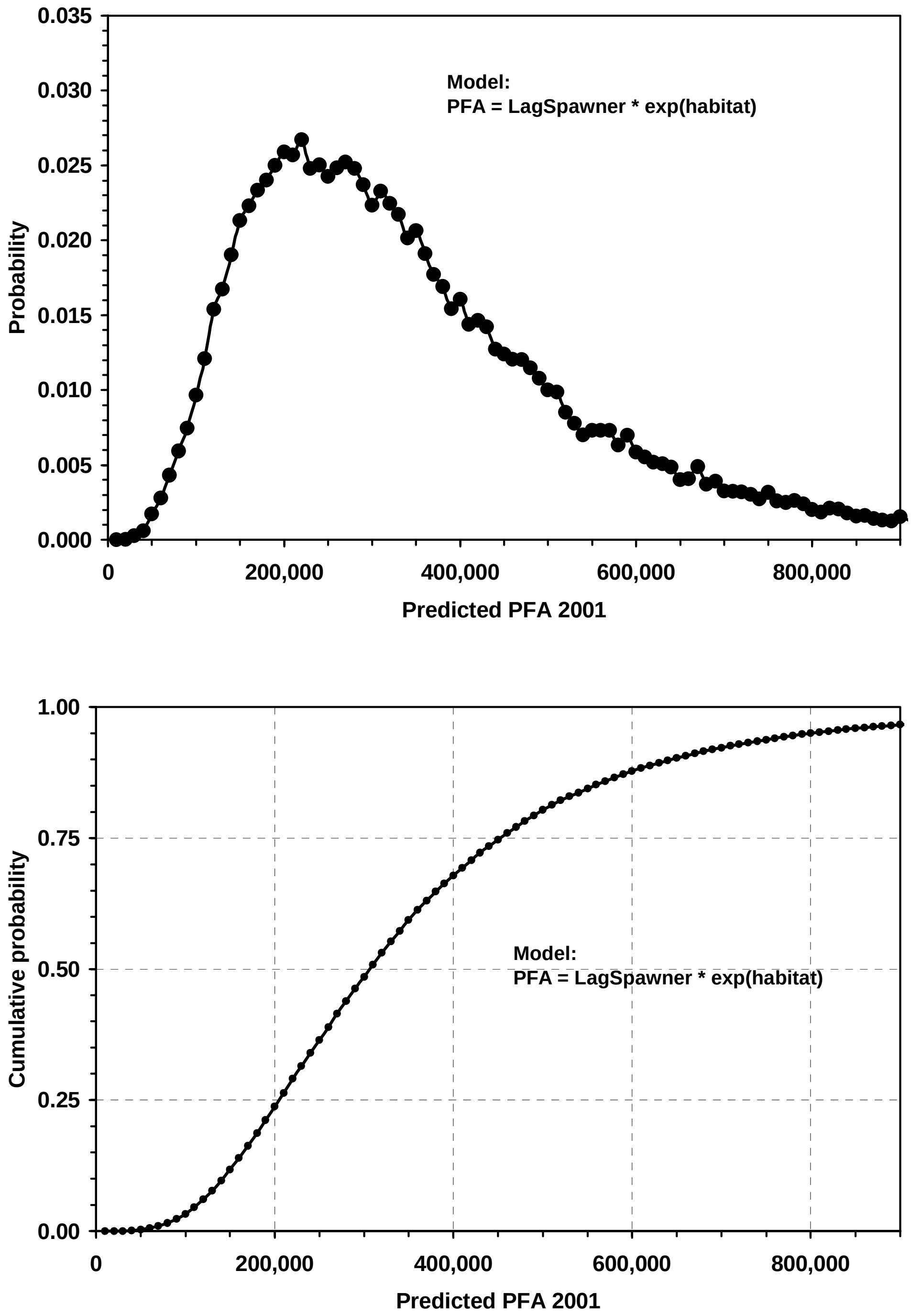


Figure 5.6.4.2. Risk analysis (probability of meeting the conservation requirement simultaneously in the six stock areas in North America) of catch options on the prefishery 1SW non-maturing salmon component in 2001.

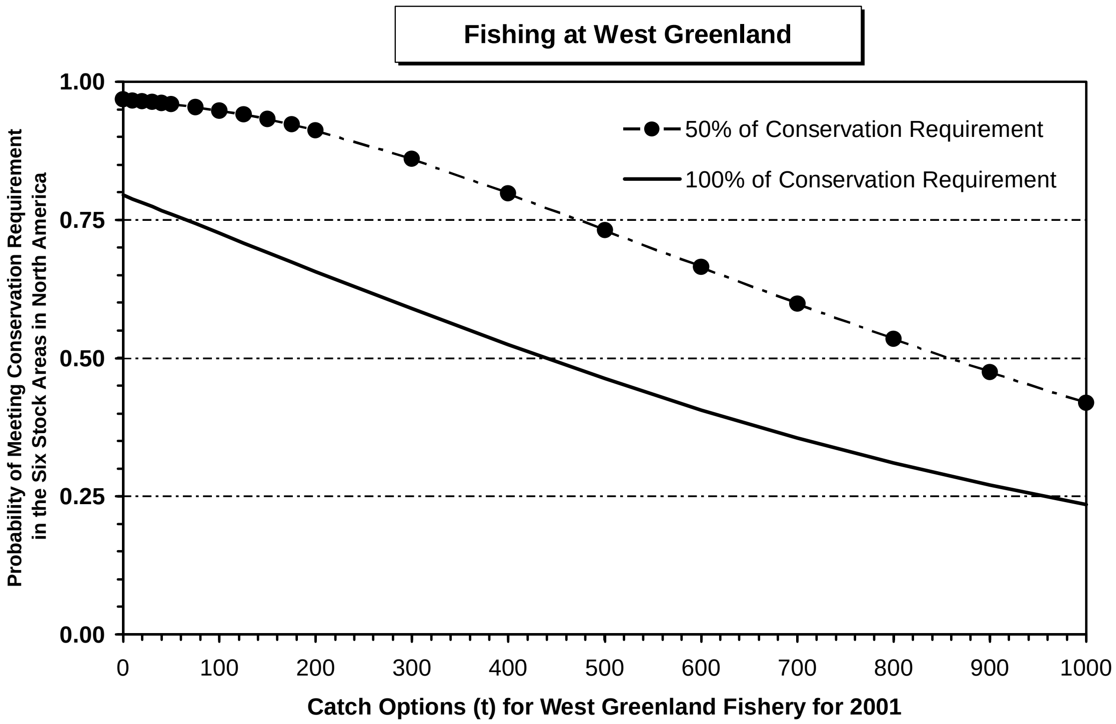


Figure 5.7.1.1. Observed estimates, jacknifed historical predictions (upper panel) of pre-fishery abundance. The residual pattern for the additive and multiplicative forecast models is shown in the lower panel.

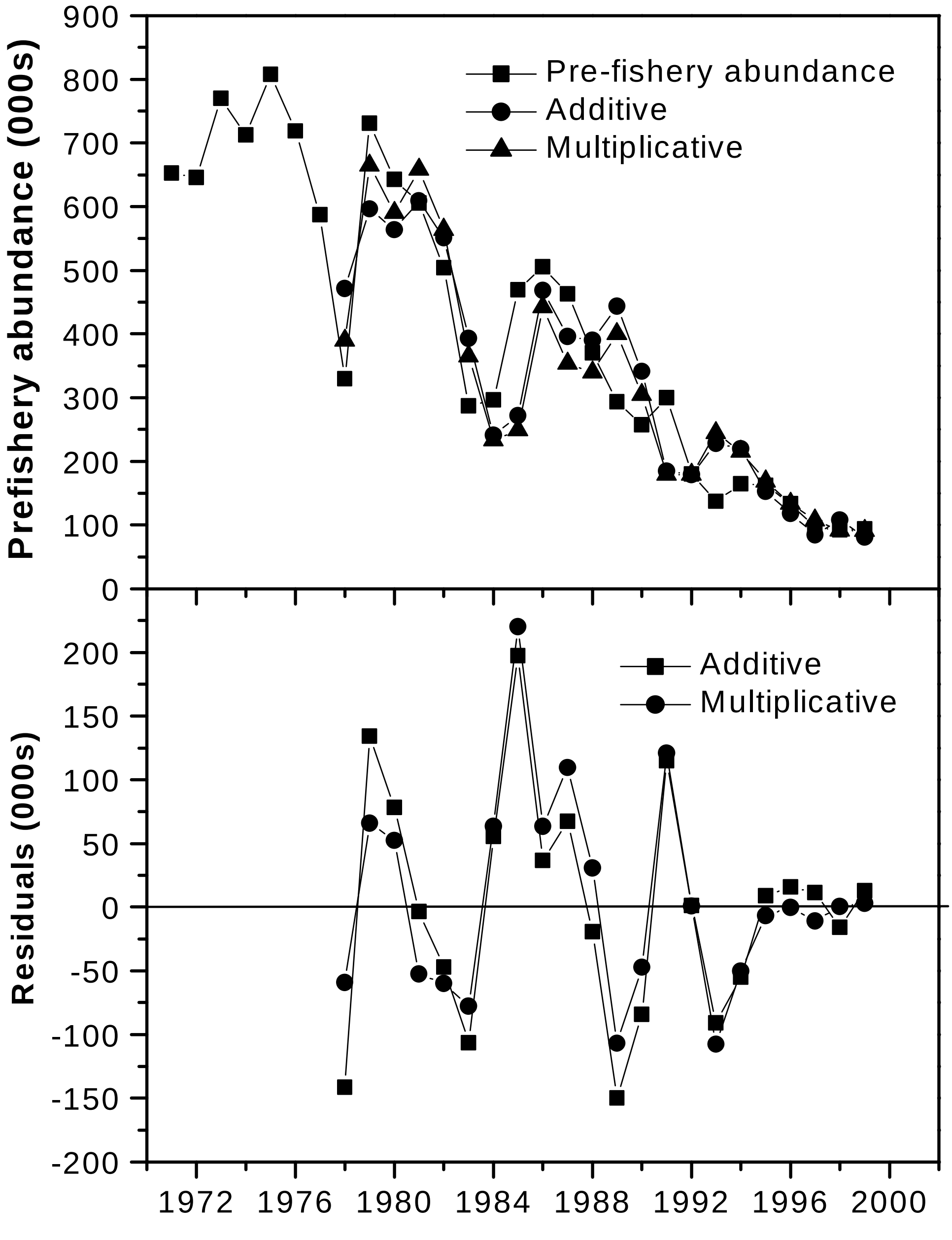


Figure 5.8.1. Association between the juvenile index and the estimated PFA for North America, 1978 to 1999.

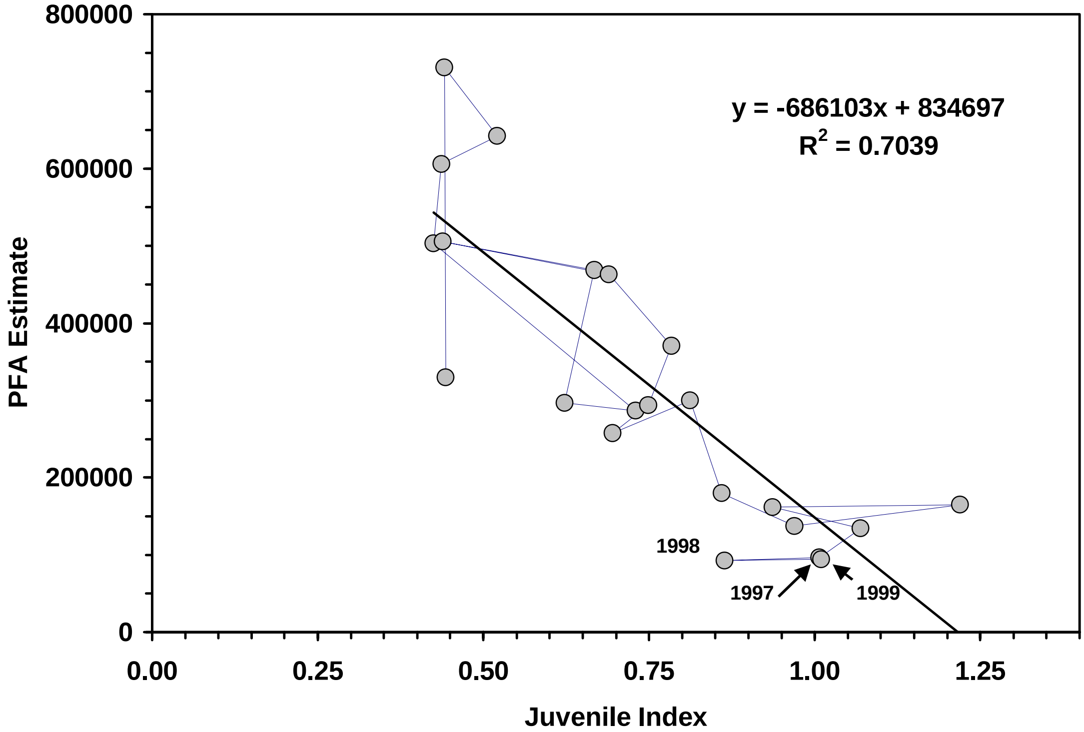
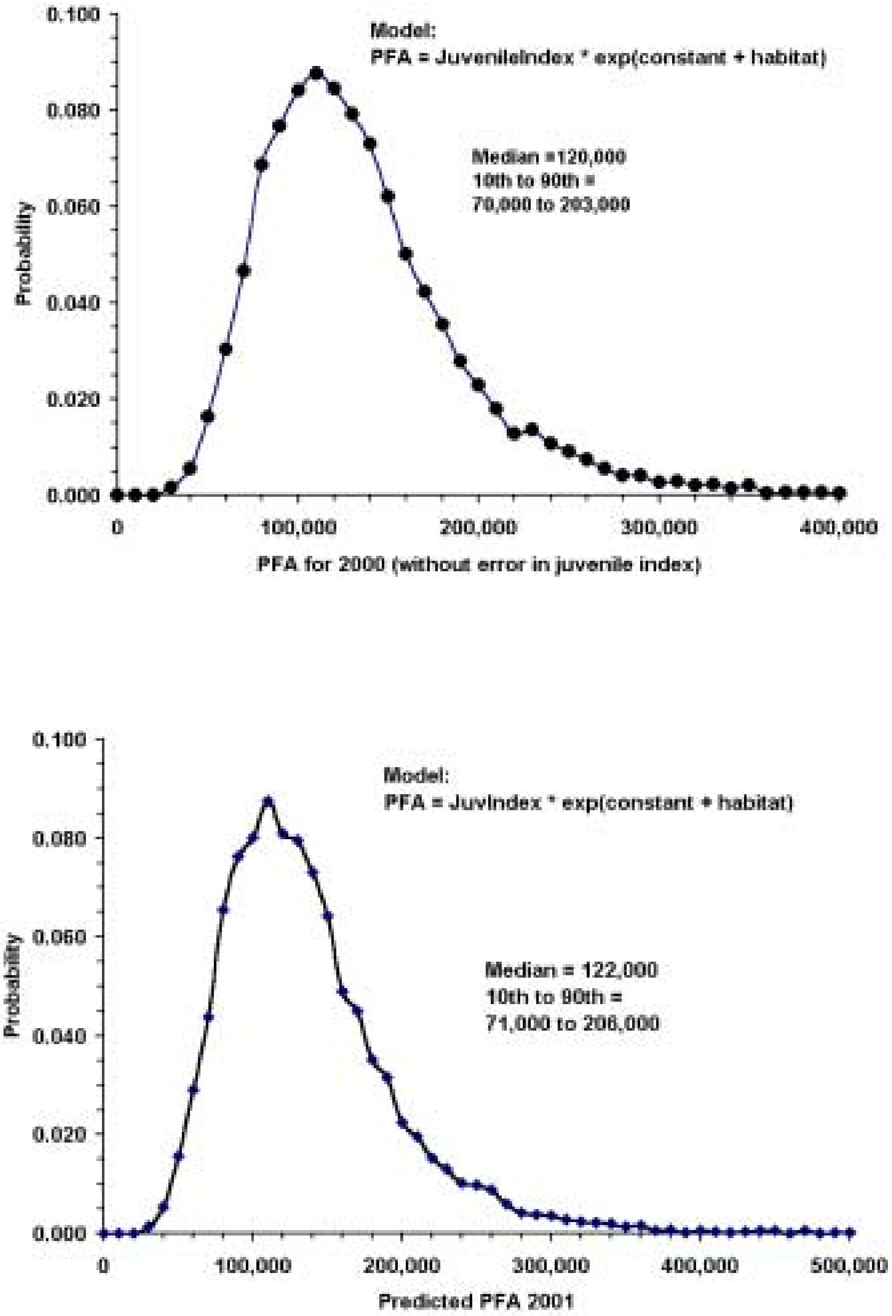


Figure 5.8.2. PFA predictions from the juvenile index model for 2000 (upper) and 2001 (lower).



6 RECOMMENDATIONS

6.1 General recommendations

The Working Group recommends that it should meet in 2002 to address questions posed by ACFM, including those posed by NASCO. No invitation to host the meeting was proposed to the Working Group. Therefore, the Working Group should convene from the 3rd to the 13th of April 2002 in Copenhagen, Denmark. It is strongly recommended by the Working Group that this period is adhered in order to provide sufficient time to adequately review and complete the report

The Working Group recognises the problems with long meetings is considering solutions to increase the efficiency and reduce the length of the meeting. A large amount of time is spent updating tables and figures from the previous year's report. It suggested that ICES establish a WGNAS web site giving the opportunity for all subgroups (NEAC, NAC, West Greenland) to update as much as possible (tables, figures and the texts associated to them) prior to the working group meeting. The Chairman would provide directions for the updating process each year. It is also suggested that the overall size of the report be shortened by removing some long series of historical data, appendices, etc, which could be more efficiently held and made available on the web. This process should be carried out concurrently with the present arrangements recommended for the Working group meeting above. Subsequently, the overall length of the meeting can be shortened based on the time being saved by adopting the web-site procedure.

6.2 Data deficiencies and research needs.

Recommendations from Section 2- Atlantic salmon in the North Atlantic Area:

1. Investigate the by-catch issue to assess the possible impact on post-smolt survival in pelagic fisheries (2.4.4.1).

2. Survey and investigat infestation rates of salmon lice and their influence on subsequent returns rates. (2.4.4.2).

3. Evaluation of the maturity schedule method particularly as it relates to the sensitivities of the survival estimates to the sex ratio values of the smolts and the assumption of equal survival of male and female salmon (2.4.6).

Recommendations from Section 3- Fisheries and Stocks from the North East Atlantic Commission Area:

1. More research into the biology of salmon in the marine phase is required. This includes the need to monitor trends in marine mortality for a wider range of stocks than at present, and identify causes for mortality. It should also include the examination of relationships between postsmolt growth and marine mortality. The use of data storage tags will significantly improve the information on the marine life history of salmon. (2.4, 3.9)

2. Research on postsmolts in the early marine phase should be continued and expanded. This should include studies of interactions with parasites and assessments of the impact of sea lice on postsmolts. (2.4, 3.9)

3. A Study Group is required to quantitatively assess the level of bycatches of postsmolts in pelagic fisheries. It is recommended that such a group should comprise both those with information relating to postsmolt distribution and those who can provide information on the activity and distribution of pelagic fisheries. (2.4, 3.9)

4. A coordinated programme of tagging and release of farmed salmon should be undertaken to improve knowledge on the marine survival and migratory behaviour of these fish (2.4)

5. If the commercial fishery at Faroes recommences, it is recommended that biological samples from the salmon caught should be collected. Historical sample from this fishery information should continue to be analysed.(3.1)

Recommendations from Section 4- Fisheries and Stocks from the North American Commission Area:

1. Estimates of total returns to Labrador no longer exist. There is a critical need to develop alternate methods to derive estimates of salmon returns and develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava regions of Québec. (4.2.2; 4.2.4)

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks of Canadian and US rivers, and the harvest in aboriginal 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. (4.2.2; 4.2.3; 4.4)

3. There is a requirement for additional smolt-to-adult survival rates for wild salmon. As well, sea survival rates of wild salmon from rivers stocked with hatchery smolts should be examined to determine if hatchery return rates can be used as an index of sea survival of wild salmon elsewhere. (4.2.5)

4. 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. (4.2.3; 4.2.5)

5. Return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that do contribute to distant fisheries should be developed and, when these are available, the SFA 22 spawning requirements for these rivers (476 fish) be included in the total.(4.4)

6. A consistent approach to estimating returns is needed, to incorporate broodstock, if offspring from such broodstock are stocked back into the management area from which their parents originated. (4.1.3)

7. Accounting of escaped-farmed salmon from North America indicates a high but undocumented mortality. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farmed salmon. In order to substantiate this conclusion farmed-salmon need to be included in background genetic analysis and the data re-examined for the presence of escaped-farmed salmon of North American origin.

<u>Recommendations from Section 5- Atlantic Salmon in the West Greenland Commission Area:</u>

7. Continued efforts should be made to improve the estimates of the annual catches of salmon taken for local consumption in Greenland. (5.1)

8. The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme be continued and closely coordinated with fishery harvest plan to be executed in West Greenland. (5.6)

9. The Working Group recommends that other indices of change, i.e. changes in age composition, size at age and sea survival, should also be included in the evaluation of the effects on European and North American stocks of the West Greenlandic management measures since 1993. (5.4)

10. The catch options for the West Greenland fishery are based almost entirely upon data taken from North American stocks (with the current exclusion of Labrador, see Section 4.6). In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible. (5.4, 3.8)

11. The Working Group recommends that an evaluation be conducted on the present reliability of the PFA estimate. An initial approach is to determine what fraction of the PFA estimate is directly based on catches and assessed returns (hard data), and what fraction results from less certain information such as scaling factors for potential productive habitat. (5.7)

12. Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses) to provide some index of plausibility of the quantitative forecasts. (5.6)

Further basic research is needed on the spatial/temporal distribution and migration patterns of salmon in relation to sea surface temperature and their predators at sea to assist in explaining variability in survival rates. (5.6)

REPORT OF THE

WORKING GROUP ON NORTH ATLANTIC SALMON

Part three - Appendices

Aberdeen, Scotland

2–11 April 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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APPENDIX 2

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APPENDIX 3

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APPENDIX 4

Example of SAS program to calculate Atlantic salmon pre-fishery abundance with an estimate of precision based on empirically derived distributions of observed patterns of pre-fishery abundance.

```
FILENAME CATCH DDE 'EXCEL | Years78-01 ! R4C1:R27C14';
OPTIONS NOCENTER LINESIZE = 80;
*... DATA FOR CATCH ADVICE FOR 2001 FROM RISKVAR01.XLS ;
*<><><><><  UPDATE COLUMNS BY ONE IN FILENAME STATEMENT <><><>;
DATA CATCH;
   INFILE CATCH;
   INPUT  YEAR  NG1  NC1_L  NC1_H  NC2_L  NC2_H  NR2_L  NR2_H  NN1_L  NN1_H  NN1_M  H2  GUS_L
GUS_H ;
GUS_M=(GUS_L+GUS_H)/2;
LN_NN1_M=LOG(NN1_M);
LN_GUS=LOG(GUS_M);
PROC PRINT;
PROC REG;
MODEL LN_NN1_M = H2 LN_GUS/P R;
•   <<<  In 2001, we changed to risk model with varying spawner and PFA inputs >>>;
•   * <<<  also switched to multiplicative model for logged PFA and spawners  >>>;
DATA D2;  SET CATCH;
    SEED = 0;
DO SIM = 1 TO 1000;
 RAN_C1  = NC1_L + ((NC1_H - NC1_L) * RANUNI(SEED));
 RAN_C2  = NC2_L + ((NC2_H - NC2_L) * RANUNI(SEED));
 RAN_R2  = NR2_L + ((NR2_H - NR2_L) * RANUNI(SEED));
 RAN_PFA = LOG((((RAN_R2/.99005) + RAN_C2)/.90483) + RAN_C1 + NG1);
 RAN_SP  = GUS_L + ((GUS_H - GUS_L) * RANUNI(SEED));
OUTPUT;
END;
PROC SORT; BY SIM;
PROC REG NOPRINT;
 BY SIM;
 ID YEAR;
 MODEL RAN_PFA = H2 LN_GUS/ P R;
 output out=predic p=pran_pfa stdi=stdi_pfa;
*<><><><><  REMEMBER TO CHANGE THE YEAR BELOW  <><><><><><>;
data univ;
  set predic;
  if year=2001;
  do i=1 to 1000;
    new_pfa=pran_pfa+((stdi_pfa)*rannor(0));
    output;
  end;
run;
PROC UNIVARIATE  DATA = UNIV;
    VAR NEW_PFA;
    OUTPUT OUT=D4 PCTLNAME=
   MEAN=M STD=S
   PCTLPRE=PFA
       PCTLPTS=5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95;
proc print;
run;
```

Appendix 5(i). Estimated numbers of 1SW salmon recruits, returns and spawners for Labrador.

	Commercial catches of small salmon			Grilse Recruits		Grilse to rivers		Labrador grilse spawners Angling catch subtracted	
Year	SFA 1	SFA 2	SFA 14B	SFA 1,2&14B+Nfld		SFA 1,2&14B		SFA 1,2&14B	
				Min	Max	Min	Max	Min	Max
*1969	10774	21627	6321	48912	122280	18587	65053	15476	61942
*1970	14666	29441	8605	66584	166459	25302	88556	21289	84543
*1971	19109	38359	11212	86754	216884	32966	115382	29032	111448
*1972	14303	28711	8392	64934	162335	24675	86362	21728	83415
*1973	3130	6282	1836	14208	35520	5399	18897	0	11405
1974	9848	37145	9328	71142	177856	27034	94619	24533	92118
1975	34937	57560	19294	141210	353024	53660	187809	49688	183837
1976	17589	47468	13152	98790	246976	37540	131391	31814	125665
1977	17796	40539	11267	87918	219796	33409	116931	28815	112337
1978	17095	12535	4026	42513	106282	16155	56542	13464	53851
1979	9712	28808	7194	57744	144360	21943	76800	17825	72682
1980	22501	72485	8493	130710	326776	49670	173845	45870	170045
1981	21596	86426	6658	144859	362147	55046	192662	49855	187471
1982	18478	53592	7379	100357	250892	38136	133474	34032	129370
1983	15964	30185	3292	62452	156129	23732	83061	19360	78689
1984	11474	11695	2421	32324	80811	12283	42991	9348	40056
1985	15400	24499	7460	59822	149555	22732	79563	19631	76462
1986	17779	45321	8296	90184	225461	34270	119945	30806	116481
1987	13714	64351	11389	112995	282486	42938	150283	37572	144917
1988	19641	56381	7087	104980	262449	39892	139623	34369	134100
1989	13233	34200	9053	71351	178377	27113	94896	22429	90212
1990	8736	20699	3592	41718	104296	15853	55485	12544	52176
1991	1410	20055	5303	33812	84531	12849	44970	10526	42647
1992	9588	13336	1325	29632	79554	17993	62094	15229	59331
1993	3893	12037	1144	33382	93231	25186	80938	22499	78251
1994	3303	4535	802	22306	63109	18159	56888	15228	53958
1995	3202	4561	217	28852	82199	25022	76453	22144	73575
1996	1676	5308	865	55634	159204	51867	153553	48362	150048
1997	1728	8025		72138	162610	66812	155963	64049	153200

Estimates are based on:

EST SMALL RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8, SFA 1:0.36-0.42&SFA 2:0.75-0.85(97)
EXP RATE-SFAs1,2&14B=.3-.5(69-91),.22-.39(92),.13-.25(93),
- .10-.19(94),.07-.13(95),.04-.07(96), SFA 1:0.07-0.14&SFA 2:0.04-0.07 (97)
EST GRILSE RETURNS CORRECTED FOR NON-MATURING 1SW - (SMALL RET*PROP GRILSE), PROP GRILSE SFAs1,2&14B=0.8-0.9
EST RET TO FRESHWATER - (EST GRILSE RET-GRILSE CATCHES)
EST GRILSE SPAWNERS = EST GRILSE RETURNS TO FRESHWATER - GRILSE ANGLING CATCHES
*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.
Furthermore small catches in 1973 were adjusted by ratio of large:small in 1972&74 (SFA 1-1.4591, SFA 2-2.2225, SFA 14B-1.5506).

Appendix 5(ii). Estimated numbers of 2SW salmon recruits, returns and spawners for Labrador salmon stocks including west Greenland.

Year	Commercial catches of large salmon SFA 1	SFA 2	SFA 14B	Labrador 2SW Recruits,NF & Greenland SFAs 1,2 &14B Min	Max	Labrador at Greenland	Labrador salmon Total+NF+WG Min	Max	Labrador 2SW to rivers SFAs 1,2 &14B Min	Max	Labrador 2SW spawners SFAs 1,2 &14B Angling catch subtracted Min	Max
*1969	18929	48822	10300	32483	69198	34280	80636	133032	3248	20760	2890	20287
*1970	17633	45479	9595	30258	68490	56379	99561	154121	3026	20547	2676	20085
*1971	25127	64806	13673	43117	97596	24299	85831	163577	4312	29279	4012	28882
*1972	21599	55708	11753	37064	83895	59203	112096	178927	3706	25168	3435	24812
*1973	30204	77902	16436	51830	117319	22348	96314	189771	5183	35196	4565	34376
1974	13866	93036	15863	50030	113827	38035	109433	200476	5003	34148	4490	33475
1975	28601	71168	14752	47715	107974	40919	109012	195006	4772	32392	4564	32119
1976	38555	77796	15189	55186	124671	67730	146485	245646	5519	37401	4984	36701
1977	28158	70158	18664	48669	110171	28482	97937	185706	4867	33051	4042	31969
1978	30824	48934	11715	38644	87155	32668	87816	157045	3864	26147	3361	25490
1979	21291	27073	3874	22315	50194	18636	50481	90267	2231	15058	1823	14528
1980	28750	87067	9138	51899	117530	21426	95490	189152	5190	35259	4633	34525
1981	36147	68581	7606	47343	106836	32768	100331	185233	4734	32051	4403	31615
1982	24192	53085	5966	34910	78873	43678	93497	156236	3491	23662	3081	23127
1983	19403	33320	7489	25378	57268	30804	67021	112531	2538	17181	2267	16824
1984	11726	25258	6218	18063	40839	4026	29802	62306	1806	12252	1478	11822
1985	13252	16789	3954	14481	32596	3977	24644	50494	1448	9779	1258	9530
1986	19152	34071	5342	24703	55734	17738	52991	97275	2470	16720	2177	16334
1987	18257	49799	11114	32885	74471	29695	76625	135970	3289	22341	2895	21821
1988	12621	32386	4591	20681	46789	27842	57355	94614	2068	14037	1625	13452
1989	16261	26836	4646	20181	45509	26728	55528	91673	2018	13653	1727	13270
1990	7313	17316	2858	11482	25967	9771	26158	46828	1148	7790	923	7493
1991	1369	7679	4417	5477	12467	7779	15596	25571	548	3740	491	3665
1992	9981	19608	2752	14756	37045	13713	28469	50758	2515	15548	2012	14889
1993	3825	9651	3620	10242	29482	6592	16834	36074	3858	18234	3624	17922
1994	3464	11056	857	11396	34514	0	11396	34514	5653	24396	5339	23981
1995	2150	8714	312	16520	51530	0	16520	51530	12368	44205	12006	43726
1996	1375	5479	418	11814	37523	4312	16126	41835	9113	32759	8838	32395
1997	1393	5550		13167	28647	3806	16973	32453	9384	23833	9221	23646

Estimates are based on:

EST LARGE RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8,SFA 1: 0.64-0.72 & SFA 2 0.88-0.95 (97);
EXP RATE-SFAs1,2&14B=.7-.9(69-91),.58-.83(92),.38-.62(93),.29-.50(94), .15-.26(95), .13-.23(96),
- SFA 1: 0.22-0.40, SFA 2: 0.16-0.28 (97)
EST 2SW RETURNS - (EST LARGE RETURNS*PROP 2SW), PROP 2SW SFA 1=.7-.9,SFAs 2&14B=.6-.8
WG - are North American 1SW salmon of river age 4 and older of which 70% are Labrador origin
EST RET TO FRESHWATER - (EST 2SW RET-2SW CATCHES)
EST 2SW SPAWNERS = EST 2SW RETURNS TO FRESHWATER - 2SW ANGLING CATCHES
*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

Appendix 5(iii). Atlantic salmon returns to freshwater, total recruits prior to the commercial fishery and spawners summed for Salmon Fishing Area 3-14A, insular Newfoundland, 1969-2000.

	Small catch	Small retns to river		Small recruits		Small spawners		Large retns to river		Large recruits		Large catch	Large spawners		2SW retns to river		2SW spawners		2SW recruits	
Year	Retained	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Min	Max	Min	Max	Min	Max	Min	Max
1969	34944	109580	219669	219160	732230	74636	184725	10634	25631	35446	256307	2310	8324	23321	2193	8995	1383	7760	7311	89953
1970	30437	140194	281466	280388	938221	109757	251030	12731	29313	42435	293127	2138	10593	27175	3135	11517	2359	10340	10450	115168
1971	26666	112644	226129	225288	753763	85978	199463	9999	23221	33330	232208	1602	8397	21619	2388	8923	1817	8055	7959	89230
1972	24402	109282	219412	218564	731374	84880	195010	10368	23434	34560	234343	1380	8988	22054	2511	9003	2008	8240	8371	90031
1973	35482	144267	289447	288534	964822	108785	253965	13489	31645	44964	316451	1923	11566	29722	2995	11527	2283	10449	9985	115268
1974	26485	85216	170748	170431	569159	58731	144263	10541	21113	35137	211133	1213	9328	19900	1940	6596	1510	5942	6465	65964
1975	33390	112272	225165	224544	750550	78882	191775	11605	23260	38682	232596	1241	10364	22019	2305	7725	1888	7086	7684	77247
1976	34463	115034	230595	230068	768650	80571	196132	10863	21768	36211	217677	1051	9812	20717	2334	7698	2011	7198	7781	76982
1977	34352	110114	220501	220229	735004	75762	186149	9795	19624	32650	196237	2755	7040	16869	1845	6247	1114	5088	6151	62470
1978	28619	97375	195048	194751	650159	68756	166429	7892	15841	26307	158411	1563	6329	14278	1991	6396	1557	5712	6637	63959
1979	31169	107402	215160	214803	717199	76233	183991	5469	10962	18230	109619	561	4908	10401	1088	3644	980	3463	3625	36437
1980	35849	121038	242499	242076	808330	85189	206650	9400	18866	31335	188656	1922	7478	16944	2432	7778	1888	6925	8108	77784
1981	46670	157425	315347	314850	1051158	110755	268677	21022	42096	70074	420961	1369	19653	40727	3451	12035	3074	11442	11502	120353
1982	41871	141247	283002	282494	943342	99376	241131	9060	18174	30198	181736	1248	7812	16926	2914	9012	2579	8481	9714	90117
1983	32420	109934	220216	219868	734053	77514	187796	9717	19490	32391	194903	1382	8335	18108	2586	8225	2244	7677	8620	82253
1984	39331	130836	262061	261673	873537	91505	222730	8115	16268	27052	162684	511	7604	15757	2233	7060	2063	6800	7445	70602
1985	36552	121731	243727	243461	812424	85179	207175	3672	7370	12240	73702	0	3641	7339	958	3059	946	3042	3193	30593
1986	37496	125329	251033	250657	836778	87833	213537	7052	14140	23505	141400	0	6972	14060	1606	5245	1575	5198	5353	52445
1987	24482	128578	257473	257157	858244	104096	232991	6394	12817	21313	128170	0	6353	12776	1336	4433	1320	4409	4453	44329
1988	39841	133237	266895	266474	889652	93396	227054	6572	13183	21908	131832	0	6512	13123	1563	5068	1540	5033	5211	50681
1989	18462	60260	120661	120520	402203	41798	102199	3234	6482	10780	64815	0	3216	6463	697	2299	690	2289	2325	22992
1990	29967	99543	199416	199086	664721	69576	169449	5939	11909	19798	119093	0	5889	11859	1347	4401	1327	4372	4489	44011
1991	20529	64552	129308	129105	431027	44023	108779	4534	9090	15112	90896	0	4500	9056	1054	3429	1041	3410	3514	34291
1992	23118	118778	237811	118778	237811	95096	214129	16705	33463	16705	33463	0	16564	33322	3111	10554	3057	10474	3111	10554
1993	24693	134150	268550	134150	268550	107816	242217	8121	16267	8121	16267	0	7957	16103	1499	5094	1449	5017	1499	5094
1994	28959	95981	192138	95981	192138	66185	162342	8089	16216	8089	16216	0	7884	16010	1902	6174	1840	6077	1902	6174
1995	29055	202739	435153	202739	435153	172727	405141	16175	34633	16175	34633	0	15956	34414	3635	12592	3563	12481	3635	12592
1996	36715	257215	559079	257215	559079	218639	520504	21957	46706	21957	46706	0	21693	46442	4457	14159	4372	14028	4457	14159
1997	17388	99029	146050	99029	146050	80096	127116	15318	22183	15318	22183	0	14985	21850	3887	8355	3780	8190	3887	8355
1998	19672	146371	247035	146371	247035	124551	225216	23032	36266	23032	36266	0	22672	35906	5322	12453	5222	12295	5322	12453
1999	19960	156740	224959	156740	224959	135561	203780	21198	41674	21198	41674	0	20853	41329	4254	14262	4169	14126	4254	14262
2000	14709	116167	252102	116167	252102	99743	234572	11126	55412	11126	55412	0	10901	55187	2218	16360	1975	16021	2218	16360

SRR (Small returns to river) are the sum of Bay St. George small returns (Reddin & Mullins 1996) plus Humber R small returns (Mullins & Reddin 1996) plus small returns in SFAs 3-12 & 14A
SSR (Small recruits) = SRR/(1-Exploitation rate commercial (ERC)) where ERC=0.5-0.7, 1969-91 & ERC=0, 1992-98.
SS (Small spawners) = SSR-(SC+(SR*0.1))
SC = small salmon catch retained
SR = small salmon catch released with assumed mortalities at 10%
RL (RATIO large:small) are from counting facilities in SFAs 3-11, 13 & 14A, angling catches in SFA 12.
LRR (Large returns to river) = SRR * RL
LR (Large recruits) = LRR*(1-Exploitation rate large (ERL)), where ERL=0.7-0.9, 1969-91; & ERL=0, 1992-98.
LS (Large spawners) = LRR-large catch retained (LC)-(0.1*large catch released)
2SW-RR (2SW returns to river)= LRR*proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-S (2SW spawners) = LS * proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-R (2SW recruits) = LR * proportion 2SW of 0.4-0.6 for SFAs 12-14A& 0.1-0.2 for SFAs 3-11.

Appendix 5(iv). Small, large, and 2SW return and spawner estimates for SFA 15

Year	Small salmon Returns Min.	Small salmon Returns Max.	Small salmon Spawners Min.	Small salmon Spawners Max.	Large salmon Returns Min.	Large salmon Returns Max.	Large salmon Spawners Min.	Large salmon Spawners Max.	Proportion 2SW in large salmon	2SW salmon Returns Min.	2SW salmon Returns Max.	2SW salmon Spawners Min.	2SW salmon Spawners Max.
1970	3513	7505	1497	4418	24955	36452	1917	5548	0.65	16221	23694	1246	3606
1971	2629	5566	1116	3246	12096	17412	846	2335	0.65	7863	11318	550	1518
1972	2603	5537	1092	3236	10621	21963	4323	12085	0.59	6266	12958	2550	7130
1973	5146	9852	1589	4720	10588	21653	4184	11686	0.74	7835	16023	3096	8648
1974	2869	6007	1159	3422	13102	27363	5345	15221	0.73	9564	19968	3902	11112
1975	3150	6567	1262	3717	7229	13894	2413	6660	0.79	5711	10976	1906	5261
1976	11884	20582	2619	7647	12318	25396	5005	14313	0.76	9362	19301	3804	10878
1977	7438	14652	2606	7527	14011	28399	5728	15988	0.83	11629	23571	4754	13270
1978	5215	9595	1477	4244	9716	19224	3768	9917	0.75	7287	14418	2826	7437
1979	5451	11163	2223	6260	3655	6267	1114	2602	0.51	1864	3196	568	1327
1980	9692	18781	3164	9285	11473	22537	4577	11997	0.81	9294	18255	3708	9717
1981	11367	21188	3362	9669	12078	21265	3163	8305	0.47	5677	9995	1487	3903
1982	8889	16834	2736	7978	9431	15011	1810	4599	0.59	5565	8856	1068	2713
1983	3621	6207	799	2268	9281	14864	1654	4489	0.59	5476	8770	976	2648
1984	11861	18589	1646	4732	6924	12237	3603	7403	0.79	5470	9667	2847	5848
1985	8525	18272	3639	10801	9802	20224	7600	16096	0.63	6175	12741	4788	10140
1986	12895	27635	5490	16311	13324	27128	10333	21470	0.76	10126	20617	7853	16317
1987	11708	24768	4930	14408	9627	19058	6932	14401	0.64	6161	12197	4437	9217
1988	16037	34159	6796	20027	12796	26222	9932	20804	0.72	9213	18880	7151	14979
1989	7673	16088	3185	9249	9905	19797	7319	15185	0.57	5646	11284	4172	8655
1990	9527	19902	3975	11418	8125	16280	6066	12636	0.68	5525	11070	4125	8592
1991	5276	10962	2219	6270	6185	12207	4621	9388	0.50	3092	6104	2311	4694
1992	10529	22220	4462	12930	9530	19257	7125	14911	0.54	5146	10399	3848	8052
1993	6578	13541	2739	7643	4407	8742	3156	6647	0.40	1763	3497	1262	2659
1994	10446	21861	4390	12580	8493	17143	6379	13317	0.60	5096	10286	3828	7990
1995	3310	6832	1344	3830	5590	10880	3977	8132	0.65	3636	7077	2587	5290
1996	7468	15529	3259	9043	7796	15745	5902	12275	0.65	5067	10234	3836	7979
1997	7666	16238	3672	9898	5302	10602	4008	8295	0.65	3446	6891	2605	5392
1998	7657	18381	3710	12036	2871	7562	600	3976	0.65	1866	4916	390	2584
1999	5712	12785	3096	8614	3423	7360	2511	5706	0.65	2225	4778	1632	3709
2000	7659	12983	4581	9160	4782	7193	2805	4838	0.65	3108	4676	1823	3145

Return and spawner estimates for SFA 15 are based on Restigouche River data, scaled up for SFA 15 using angling data.
Restigouche stock assessment is based on angling catch with assumed exploitation rates between 50% (min.) and 30% (max).
The proportion of 2SW in large salmon numbers is based on aged scale samples from angling, trapnets, and broodstock.
No scale samples were available for 1970-71, 1995-96: the mean value of 0.65 is used here.
Salmon in the Quebec portions of the Restigouche River were subtracted from the total for the watershed.
The returns and spawners estimates thus derived for the SFA 15 portion of the Restigouche were then multiplied by the minumum (1.117) and maximum (1.465) ratios of angling catch in SFA15:SFA 15 portion of Restigouche catch to obtain estimates for SFA 15.

Appendix 5(v)a. Returns and spawners of large salmon and 2SW salmon to SFA 16.

	2SW returns to SFA 16		Returns to the Miramichi River						Returns of large salmon to SFA 16	
			Large	0.8	1.33	Prop.	2SW Returns			
Year	Min.	Max.	returns	Min.	Max.	2SW	Min	Max	Min	Max
1971	19697	32746	24407	19526	32461	0.918	17924	29799	21457	35672
1972	24645	40972	29049	23239	38635	0.965	22427	37284	25538	42456
1973	22896	38065	27192	21754	36165	0.958	20836	34639	23905	39742
1974	33999	56523	42592	34074	56647	0.908	30939	51436	37444	62250
1975	21990	36558	28817	23054	38327	0.868	20011	33267	25334	42117
1976	17118	28459	22801	18241	30325	0.854	15578	25898	20045	33325
1977	43160	71753	51842	41474	68950	0.947	39275	65296	45575	75769
1978	18539	30822	24493	19594	32576	0.861	16871	28048	21532	35797
1979	5484	9117	9054	7243	12042	0.689	4991	8297	7960	13233
1980	30332	50426	36318	29054	48303	0.95	27602	45888	31928	53080
1981	9489	15775	16182	12946	21522	0.667	8635	14355	14226	23651
1982	21875	36368	30758	24606	40908	0.809	19907	33095	27040	44954
1983	19762	32854	27924	22339	37139	0.805	17983	29897	24549	40812
1984	12562	20884	15137	12110	20132	0.944	11431	19005	13307	22123
1985	15861	26369	20738	16590	27582	0.87	14434	23996	18231	30309
1986	23460	39003	31285	25028	41609	0.853	21349	35493	27503	45724
1987	13590	22594	19421	15537	25830	0.796	12367	20561	17073	28385
1988	15599	25933	21745	17396	28921	0.816	14195	23599	19116	31781
1989	9880	16426	17211	13769	22891	0.653	8991	14948	15131	25155
1990	15474	25725	28574	22859	38003	0.616	14081	23410	25120	41762
1991	15929	26482	29949	23959	39832	0.605	14495	24098	26329	43772
1992	19191	31905	37000	29600	49210	0.590	17464	29034	32527	54077
1993	21662	36012	35200	28160	46816	0.7	19712	32771	30945	51446
1994	14582	37515	27450	18278	47023	0.726	13270	34139	20086	51674
1995	18879	48135	32627	19747	50348	0.87	17180	43803	21700	55327
1996	13034	24328	24812	17443	32557	0.68	11861	22139	19168	35777
1997	10957	20049	18422	14183	25953	0.703	9971	18245	15586	28520
1998	4129	6882	9500	7500	12500	0.501	3758	6263	8242	13736
1999	8762	19805	16200	11900	26900	0.67	7973	18023	13077	29560
2000	9938	21895	18200	13300	29300	0.68	9044	19924	14615	32198

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.
For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.
For 1994 to 2000, min and max are 5th and 95th percentiles from the assessment.
Prop. 2SW are from scale ageing.
Miramichi makes up 91% of total rearing area of SFA 16.
Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 2SW returns to Miramichi / 0.91

Appendix 5(v)b. Returns and spawners of large salmon and 2SW salmon to SFA 16.
Same procedure as for returns (Appendix 5(v)b)

	2SW spawners in SFA 16		Large Salmon Spawners to the Miramichi River						Spawners of large salmon in SFA 16	
			Large	0.8	1.33	Prop.	2SW Spawners			
Year	Min.	Max.	spawners	Min.	Max.	2SW	Min	Max	Min	Max
1971	3508	5832	4347	3478	5782	0.918	3192	5307	3822	6353
1972	14992	24924	17671	14137	23502	0.965	13643	22681	15535	25827
1973	17134	28486	20349	16279	27064	0.958	15592	25922	17889	29741
1974	27495	45711	34445	27556	45812	0.908	25021	41597	30281	50343
1975	16366	27209	21448	17158	28526	0.868	14893	24760	18855	31347
1976	10760	17889	14332	11466	19062	0.854	9792	16279	12600	20947
1977	27404	45560	32917	26334	43780	0.947	24938	41459	28938	48109
1978	8197	13627	10829	8663	14403	0.861	7459	12401	9520	15827
1979	2751	4573	4541	3633	6040	0.689	2503	4161	3992	6637
1980	15762	26204	18873	15098	25101	0.95	14343	23846	16592	27584
1981	2702	4492	4608	3686	6129	0.667	2459	4088	4051	6735
1982	9429	15676	13258	10606	17633	0.809	8581	14265	11655	19377
1983	5986	9951	8458	6766	11249	0.805	5447	9056	7436	12362
1984	12189	20264	14687	11750	19534	0.944	11092	18440	12912	21466
1985	15390	25586	20122	16098	26762	0.87	14005	23283	17690	29409
1986	22659	37670	30216	24173	40187	0.853	20619	34280	26564	44162
1987	12635	21006	18056	14445	24014	0.796	11498	19116	15873	26390
1988	15050	25021	20980	16784	27903	0.816	13696	22769	18444	30663
1989	8921	14831	15540	12432	20668	0.653	8118	13496	13662	22712
1990	14940	24838	27588	22070	36692	0.616	13595	22602	24253	40321
1991	15472	25721	29089	23271	38688	0.605	14079	23406	25573	42515
1992	18984	27603	35927	29281	42573	0.590	17275	25118	32176	46784
1993	21755	31632	34702	28282	41122	0.7	19797	28785	31079	45189
1994	14207	37140	27147	17808	46553	0.726	12929	33797	19569	51157
1995	18345	47600	32093	19188	49789	0.87	16694	43316	21086	54713
1996	12510	23804	23478	16741	31855	0.68	11384	21661	18397	35005
1997	10319	19411	17596	13357	25127	0.703	9390	17664	14678	27612
1998	4077	6795	9215	7275	12125	0.51	3710	6184	7995	13324
1999	8499	19211	15714	11543	26093	0.67	7734	17482	12685	28674
2000	9640	21238	17654	12901	28421	0.68	8773	19326	14177	31232

Appendix 5(v)c. Returns of small salmon and 1SW salmon to SFA 16

	1SW returns to SFA 16		Returns to the Miramichi River			1SW Returns to Miramichi	
				0.8	1.33	0.97	1.00
Year	Min.	Max.	Small	Min.	Max.	Min	Max
1971	30420	52137	35673	28538	47445	27682	47445
1972	39461	67633	46275	37020	61546	35909	61546
1973	37986	65104	44545	35636	59245	34567	59245
1974	62607	107303	73418	58734	97646	56972	97646
1975	55345	94857	64902	51922	86320	50364	86320
1976	78095	133848	91580	73264	121801	71066	121801
1977	23658	40547	27743	22194	36898	21529	36898
1978	20711	35496	24287	19430	32302	18847	32302
1979	43460	74487	50965	40772	67783	39549	67783
1980	35464	60782	41588	33270	55312	32272	55312
1981	55661	95399	65273	52218	86813	50652	86813
1982	68543	117477	80379	64303	106904	62374	106904
1983	21476	36807	25184	20147	33495	19543	33495
1984	25333	43418	29707	23766	39510	23053	39510
1985	51847	88862	60800	48640	80864	47181	80864
1986	100240	171802	117549	94039	156340	91218	156340
1987	72327	123962	84816	67853	112805	65817	112805
1988	103966	178189	121919	97535	162152	94609	162152
1989	64153	109953	75231	60185	100057	58379	100057
1990	71160	121962	83448	66758	110986	64756	110986
1991	51906	88962	60869	48695	80956	47234	80956
1992	132610	198777	152647	124407	180887	120675	180887
1993	80271	120323	92400	75306	109494	73047	109494
1994	44288	92257	56929	41549	83954	40303	83954
1995	20998	85127	54145	19699	77466	19108	77466
1996	40133	73318	44377	37651	66719	36521	66719
1997	18980	33143	22565	17806	30160	17272	30160
1998	29313	45055	33000	27500	41000	26675	41000
1999	22385	35275	25700	21000	32100	20370	32100
2000	31978	46264	35800	30000	42100	29100	42100

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.
For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.
For 1994 to 1999, min and max are 5th and 95th percentiles from the assessment.
Prop. 1SW are from scale ageing. Proportions vary from 0.97 to 1.00. Ref. Moore et al. 1995.
Miramichi makes up 91% of total rearing area of SFA 16.
Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 1SW returns to Miramichi / 0.91

Appendix 5(v)d. Spawners of small salmon and 1SW salmon to SFA 16

	1SW spawners to SFA 16		Spawners to the Miramichi River			1SW Spawners to Miramichi	
				0.8	1.33	0.97	1.00
Year	Min.	Max.	Small	Min.	Max.	Min	Max
1971	18714	32075	21946	17557	29188	17030	29188
1972	23139	39659	27135	21708	36090	21057	36090
1973	26169	44852	30688	24550	40815	23814	40815
1974	47060	80656	55186	44149	73397	42824	73397
1975	41332	70839	48469	38775	64464	37612	64464
1976	53194	91171	62380	49904	82965	48407	82965
1977	11296	19361	13247	10598	17619	10280	17619
1978	12239	20977	14353	11482	19089	11138	19089
1979	26306	45086	30848	24678	41028	23938	41028
1980	22934	39307	26894	21515	35769	20870	35769
1981	34049	58358	39929	31943	53106	30985	53106
1982	47754	81846	56000	44800	74480	43456	74480
1983	12662	21702	14849	11879	19749	11523	19749
1984	16142	27665	18929	15143	25176	14689	25176
1985	35658	61114	41815	33452	55614	32448	55614
1986	76234	130659	89398	71518	118899	69373	118899
1987	53533	91751	62777	50222	83493	48715	83493
1988	76984	131945	90278	72222	120070	70056	120070
1989	41260	70717	48385	38708	64352	37547	64352
1990	50759	86997	59524	47619	79167	46191	79167
1991	41161	70547	48269	38615	64198	37457	64198
1992	112317	168359	129288	105370	153206	102209	153206
1993	66385	99509	76416	62279	90553	60411	90553
1994	27829	75289	42479	26108	68513	25325	68513
1995	13079	53561	34084	12270	48740	11902	48740
1996	19278	51818	24812	18086	47154	17543	47154
1997	8762	22609	12979	8220	20574	7973	20574
1998	19347	29736	21780	18150	27060	17606	27060
1999	14774	23281	16962	13860	21186	13444	21186
2000	21105	30534	23496	19800	27786	19206	27786

Same procedure for escapements as used to calculate returns.
Assumes exploitation rates of 3% for large and 34% for small salmon for the years 1998 to 2000. These are average rates for 1993 to 1997 as per assessment.
For 1999, native removals = 2526.

Appendix 5(vi). Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1970-2000.
PEI commercial landings are also given.

	Small recruits		Small spawners		Large recruits		Large spawners		2SW recruits		2SW spawners		PEI comm.
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	catch (nos.)
1970	0	0	0	0	0	0	0	0	0	0	0	0	
1971	0	0	0	0	0	0	0	0	0	0	0	0	29
1972	0	0	0	0	0	0	0	0	0	0	0	0	385
1973	5	9	3	7	0	0	0	0	0	0	0	0	206
1974	0	0	0	0	0	0	0	0	0	0	0	0	386
1975	0	0	0	0	0	0	0	0	0	0	0	0	345
1976	14	28	8	22	2	5	1	4	2	5	1	4	573
1977	0	0	0	0	0	0	0	0	0	0	0	0	606
1978	0	0	0	0	0	0	0	0	0	0	0	0	N/A
1979	2	5	1	4	5	9	3	7	5	9	3	7	454
1980	12	23	7	18	2	5	1	4	2	5	1	4	1697
1981	259	498	151	390	40	77	36	73	40	77	36	73	217
1982	175	336	102	263	16	31	8	23	16	31	8	23	416
1983	17	32	10	25	17	32	15	30	17	32	15	30	326
1984	17	32	10	25	13	26	13	26	13	26	13	26	46
1985	113	217	66	170	8	15	8	15	8	15	8	15	
1986	566	1088	330	852	5	11	5	11	5	11	5	11	
1987	1141	2194	665	1718	66	128	66	128	66	128	66	128	
1988	1542	2963	899	2320	96	185	96	185	96	185	96	185	
1989	400	770	233	603	149	287	149	287	149	287	149	287	
1990	1842	3539	1074	2771	284	545	284	545	284	545	284	545	
1991	1576	3028	919	2371	188	361	188	361	188	361	188	361	
1992	1873	3599	1092	2818	95	183	95	183	95	183	95	183	
1993	1277	2454	745	1922	22	43	22	43	22	43	22	43	
1994	209	383	117	291	168	309	165	306	168	309	165	306	
1995	1058	1914	585	1441	85	154	81	151	85	154	81	151	
1996	1161	2576	738	2154	158	351	154	347	158	351	154	347	
1997	485	932	283	730	31	59	30	58	31	59	30	58	
1998	635	1221	370	956	79	151	76	149	79	151	76	149	
1999	379	728	221	570	23	45	20	41	23	45	20	41	
2000	307	591	179	463	57	109	56	108	57	109	56	108	
70-89 X	213	410	124	321	21	40	20	40	21	40	20	40	
90-00 X	982	1906	575	1499	108	210	106	208	108	210	106	208	

Notes

Number of small retained salmon in 1993 was not recorded. The number given is the mean for 1986-1992

For 1970-1980, percent small is calculated from numbers of small and large salmon in the retained catch in each year. For 1981-1997 and 1999, percent small is calculated from numbers of small and large salmon taken at the Leard's Pond trap. For 1998 and 2000, percent small is taken from seining catches at Mooneys Pool.

Small recruits are calculated as small retained salmon/exploitation rate. Angler exploitation was calculated as 0.34, 0.347, and 0.264 of estimated returns in 1994, 1995, and 1996, respectively. For other years the mean of these values is used. The min and max max numbers of small recruits are calculated using exploitation + or - 0.1; e.g. 0.34 + or - 0.1 gives 0.24 and 0.44.

Small spawners = number of small recruits - number of small retained

Large recruits = (number of small recruits/(0.01*percent small))-number of small recruits

Large spawners = number of large recruits - number of large retained

It is asssumed that large salmon and 2SW salmon are equivalent

Appendix 5(viia). Total 2SW returns and spawners to SFA 18, 1070-2000.

	LARGE RETURNS						***Commercial catches***			***TOTAL 2SW***		***LARGE SPAWNERS***				***TOTAL 2SW***	
	Margaree		SFA 18		***2SW RETURNS***			*2SW ctch*		***RETURNS***		*Margaree*		*SFA 18*		***SPAWNERS***	
	Large salmon		1.24	2.28	0.77	0.87	Zone 6	0.77	0.87	(inc. comm.)				1.24	2.28	0.77	0.87
Year	MIN	MAX	MIN	MAX	MIN	MAX	(kg)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	581	1,000	723	2,285	556	1,988	30,440	4,262	4,815	4,818	6,803	657	1,145	817	2,616	629	2,276
1971	254	437	316	999	243	869	12,001	1,680	1,898	1,923	2,767	256	446	318	1,019	245	887
1972	284	488	353	1,116	272	971	31,840	4,458	5,037	4,729	6,007	272	474	338	1,083	261	942
1973	316	544	393	1,243	303	1,082	27,694	3,877	4,381	4,180	5,462	287	499	356	1,141	274	993
1974	289	498	360	1,137	277	989	37,437	5,241	5,922	5,518	6,911	318	554	396	1,265	305	1,101
1975	173	298	215	681	166	592	23,631	3,308	3,738	3,474	4,330	214	372	266	850	205	740
1976	222	381	276	871	213	757	18,361	2,571	2,904	2,783	3,662	267	465	332	1,062	256	924
1977	378	651	470	1,487	362	1,294	26,221	3,671	4,148	4,033	5,442	393	683	488	1,561	376	1,358
1978	427	735	531	1,679	409	1,461	30,216	4,230	4,780	4,639	6,241	510	888	635	2,028	489	1,765
1979	219	377	272	861	210	749	7,917	1,108	1,252	1,318	2,002	265	461	330	1,053	254	916
1980	378	651	470	1,487	362	1,294	24,412	3,418	3,862	3,780	5,156	497	865	618	1,976	476	1,719
1981	375	647	466	1,478	359	1,286	15,562	2,179	2,462	2,538	3,748	451	785	561	1,793	432	1,560
1982	484	833	602	1,903	463	1,656	26,664	3,733	4,218	4,196	5,874	555	965	690	2,205	531	1,919
1983	402	693	500	1,583	385	1,378	24,280	3,399	3,841	3,784	5,218	480	834	596	1,906	459	1,659
1984	327	583	407	1,332	313	1,159	15,140	2,120	2,395	2,433	3,554	296	532	368	1,216	283	1,058
1985	1,109	2,217	1,379	5,065	1,062	4,407		0	0	1,062	4,407	1,025	2,133	1,275	4,874	981	4,240
1986	2,738	5,680	3,405	12,978	2,622	11,291		0	0	2,622	11,291	2,583	5,525	3,212	12,624	2,473	10,983
1987	2,976	6,540	3,701	14,943	2,850	13,000		0	0	2,850	13,000	2,860	6,424	3,557	14,678	2,739	12,770
1988	1,286	2,494	1,599	5,698	1,231	4,958		0	0	1,231	4,958	1,143	2,351	1,421	5,372	1,094	4,673
1989	1,708	3,693	2,124	8,438	1,635	7,341		0	0	1,635	7,341	1,583	3,568	1,969	8,152	1,516	7,092
1990	3,481	7,933	4,329	18,126	3,333	15,769		0	0	3,333	15,769	3,347	7,799	4,162	17,819	3,205	15,503
1991	1,853	5,785	2,304	13,218	1,774	11,499		0	0	1,774	11,499	1,692	5,624	2,104	12,850	1,620	11,179
1992	4,875	9,375	6,062	21,420	4,668	18,636		0	0	4,668	18,636	4,722	9,222	5,872	21,071	4,522	18,332
1993	2,408	6,158	2,995	14,070	2,306	12,241		0	0	2,306	12,241	2,274	6,024	2,828	13,764	2,177	11,975
1994	2,350	4,500	2,922	10,282	2,250	8,945		0	0	2,250	8,945	2,209	4,359	2,747	9,960	2,115	8,665
1995	1,750	3,815	2,176	8,717	1,676	7,583		0	0	1,676	7,583	1,693	3,758	2,105	8,586	1,621	7,470
1996	2,214	4,050	2,753	9,254	2,120	8,051		0	0	2,120	8,051	2,001	3,837	2,488	8,767	1,916	7,627
1997	3,268	5,435	4,064	12,418	3,129	10,804		0	0	3,129	10,804	3,006	5,173	3,738	11,819	2,878	10,283
1998	2,283	3,798	2,839	8,678	2,186	7,550		0	0	2,186	7,550	2,114	3,629	2,629	8,292	2,024	7,214
1999	1,440	2,400	1,791	5,484	1,379	4,771		0	0	1,379	4,771	1,276	2,236	1,587	5,109	1,222	4,445
2000	991	1648	1,232	3,765	949	3,276		0	0	949	3,276	776	1,433	965	3,274	743	2,849

Yr	SFA 18.00	Marg-aree	Ratio
84	449	305	1.47
85	1706	1215	1.40
86	4448	2636	1.69
87	3012	1857	1.62
88	3078	1932	1.59
89	3206	1570	2.04
90	2391	1507	1.59
91	3470	1757	1.97
92	3315	1938	1.71
93	2372	1102	2.15
94	2043	1479	1.38
95	1633	1060	1.54
96	3921	1864	2.10
97	2609	2098	1.24
98	2,163	1,327	1.63
99	1,853	811	2.28
0	959	636	1.51
		Min	1.244
		Max	2.285

Margaree returns, 1970-84, equal catch /min (0.215) or max (0.37) exploitation rate.

Return of large salmon (MIN) and (MAX) to all SFA 18 equals Margaree returns * ratio Margaree catch to SFA 18 catch.

Margaree returns 1984-00 based on various Margaree CAFSAC , DFO Atl. Res and CSAS Res. Docs.

Margaree catch to SFA 18 catch; MIN _MAX 2SW based on the ratio 0.77-0.87 2SW fish among MSW fish.

Margaree escapements 1970-83 = returns minus removals; 1984-1999 from various Margaree CAFSAC, DFO Atl. Fish. and CSAS Res.
Docs e.g., Marshall et al. (MS 1997) where 2SW equal 0.77-0.87 of MSW fish; Margaree raised to SFA by respective ratios in recreational catch.

Appendix 5(viib). Total 1SW returns and spawners to SFA 18, 1970-2000.

	RETURNS				SPAWNERS			
	Margaree		SFA 18		Margaree		SFA 18	
	0.37	0.21	1.214	2.768			1.214	2.768
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	230	395	279	1,094	145	310	176	859
1971	57	98	69	270	36	77	43	212
1972	114	195	138	541	72	153	87	424
1973	449	772	545	2,137	283	606	343	1,678
1974	162	279	197	772	102	219	124	606
1975	97	167	118	463	61	131	74	364
1976	259	447	315	1,236	163	351	198	970
1977	186	321	226	888	117	252	143	697
1978	68	116	82	322	43	91	52	253
1979	1,614	2,777	1,959	7,685	1,017	2,180	1,234	6,033
1980	451	777	548	2,150	284	610	345	1,688
1981	2,430	4,181	2,950	11,573	1,531	3,282	1,859	9,085
1982	1,868	3,214	2,267	8,896	1,177	2,523	1,429	6,983
1983	184	316	223	875	116	248	141	687
1984	400	688	486	1,904	158	446	192	1,234
1985	634	1,167	770	3,230	125	658	152	1,821
1986	838	1,420	1,017	3,930	56	638	68	1,766
1987	1,143	1,865	1,388	5,162	166	888	202	2,458
1988	1,674	2,911	2,032	8,057	795	2,032	965	5,624
1989	591	977	718	2,704	30	416	36	1,151
1990	940	5,077	1,141	14,052	291	4,428	353	12,256
1991	794	3,891	964	10,770	42	3,139	51	8,688
1992	1,258	2,419	1,527	6,695	701	1,862	851	5,154
1993	1,489	3,851	1,808	10,659	906	3,268	1,100	9,045
1994	573	1,101	696	3,047	259	787	314	2,178
1995	538	1,083	653	2,998	329	874	399	2,419
1996	1,277	2,960	1,550	8,193	935	2,618	1,135	7,246
1997	316	1,517	384	4,199	68	1,269	83	3,512
1998	349	1,625	424	4,498	126	1,402	153	3,880
1999	323	1,610	392	4,456	100	1,387	121	3,839
2000	223	1,368	271	3,786	84	1,229	102	3,402

Recreational ctch:

Year	SFA 18	Marg-aree	Ratio
1984	298	242	1.23
1985	618	509	1.21
1986	1,180	782	1.51
1987	1,289	977	1.32
1988	1,349	879	1.53
1989	928	561	1.65
1990	1,206	649	1.86
1991	1,262	752	1.68
1992	1,242	678	1.83
1993	1,216	777	1.56
1994	659	429	1.54
1995	711	333	2.14
1996	2,022	918	2.20
1997	558	316	1.77
1998	829	349	2.38
1999	894	323	2.77
2000	**467**	**223**	2.09

Min	1.214
Max	2.768

Margaree returns, 1970-1983, equal catch divided by MIN (0.37) and MAX (0.215) exploitation rate.
Return of small salmon to all SFA 18 equals Margaree returns * MIN and MAX ratio of
Margaree catch to SFA 18 catch. Margaree returns, 1984-2000, based on annual assessments
in CAFSAC and DFO Atl. Fish. and CSAS Res. Docs, eg., Marshall et al. (MS 1997).
Spawners for 1970-1983 equal returns minus removals; 1984-2000 from various Margaree CAFSAC,
Atl. Res. and CSAS Res Doc. series.

Appendix 5(viii). Total 1SW returns and spawners, SFAs 19, 20, 21 and 23, 1970-2000.

	RETURNS						***TOTAL RETURNS***		***SPAWNERS***						***TOTAL SPAWNERS***	
	River returns SFA 19-21		Comm-ercial	SFA 23			SFAs 19,20,21,23		angled	Spawners 19-21		SFA 23 H+W rtns		Harvest	19,20,21,23	
Year	MIN	MAX	19-21	Wild MIN	Wild MAX	Hatch	MIN	MAX	19-21	MIN	MAX	MIN	MAX		MIN	MAX
1970	8,236	16,868	3,189	5,206	7,421	100	16,731	27,578	3,609	4,627	13,259	5,306	7,521	1,420	8,513	19,360
1971	6,345	13,062	1,922	2,883	4,176	365	11,515	19,525	2,761	3,584	10,301	3,248	4,541	2,032	4,800	12,810
1972	6,636	13,354	1,055	1,546	2,221	285	9,522	16,915	2,917	3,719	10,437	1,831	2,506	2,558	2,992	10,385
1973	8,225	16,744	1,067	3,509	5,047	1,965	14,766	24,823	3,604	4,621	13,140	5,474	7,012	1,437	8,658	18,715
1974	14,478	29,385	2,050	6,204	8,910	3,991	26,723	44,336	6,340	8,138	23,045	10,195	12,901	2,124	16,209	33,822
1975	5,096	10,393	2,822	11,648	16,727	6,374	25,940	36,316	2,227	2,869	8,166	18,022	23,101	2,659	18,232	28,608
1976	12,421	25,398	1,675	13,761	19,790	9,074	36,931	55,937	5,404	7,017	19,994	22,835	28,864	5,263	24,589	43,595
1977	13,349	27,943	3,773	6,746	9,679	6,992	30,860	48,387	5,841	7,508	22,102	13,738	16,671	4,542	16,704	34,231
1978	2,535	5,241	3,651	3,227	4,651	3,044	12,457	16,587	1,113	1,422	4,128	6,271	7,695	2,015	5,678	9,808
1979	12,365	25,381	3,154	11,529	16,690	3,827	30,875	49,052	5,428	6,937	19,953	15,356	20,517	3,716	18,577	36,754
1980	16,534	33,825	8,252	14,346	20,690	10,793	49,925	73,560	7,253	9,281	26,572	25,139	31,483	5,542	28,878	52,513
1981	18,594	38,329	1,951	11,199	16,176	5,627	37,371	62,083	8,163	10,431	30,166	16,826	21,803	9,021	18,236	42,948
1982	10,008	20,552	2,020	8,773	12,598	3,038	23,839	38,208	4,361	5,647	16,191	11,811	15,636	5,279	12,179	26,548
1983	4,662	9,562	1,621	7,706	11,028	1,564	15,553	23,775	2,047	2,615	7,515	9,270	12,592	4,138	7,747	15,969
1984	12,398	25,815	0	14,105	20,227	1,451	27,954	47,493	4,724	7,674	21,091	15,556	21,678	5,266	17,964	37,503
1985	16,354	34,055	0	11,038	15,910	2,018	29,410	51,983	6,360	9,994	27,695	13,056	17,928	4,892	18,158	40,731
1986	16,661	34,495	0	13,412	19,321	862	30,935	54,678	6,182	10,479	28,313	14,274	20,183	3,549	21,204	44,947
1987	18,388	37,902	0	10,030	14,334	3,328	31,746	55,564	7,056	11,332	30,846	13,358	17,662	3,101	21,589	45,407
1988	16,611	33,851	0	15,131	21,834	1,250	32,992	56,935	6,384	10,227	27,467	16,381	23,084	3,320	23,288	47,231
1989	17,378	35,141	0	16,240	23,182	1,339	34,957	59,662	6,629	10,749	28,512	17,579	24,521	4,455	23,873	48,578
1990	20,119	41,652	0	12,287	17,643	1,533	33,939	60,828	7,391	12,728	34,261	13,820	19,176	3,795	22,753	49,642
1991	6,718	13,870	0	10,602	15,246	2,439	19,759	31,555	2,399	4,319	11,471	13,041	17,685	3,546	13,814	25,610
1992	9,269	18,936	0	11,340	16,181	2,223	22,832	37,340	3,629	5,640	15,307	13,563	18,404	4,078	15,125	29,633
1993	9,104	18,711	0	7,610	8,828	foot-	16,714	27,539	3,327	5,777	15,384	5,762	6,868	foot-	11,539	22,252
1994	2,446	4,973	0	5,770	6,610	note:"a"	8,216	11,583	493	1,953	4,480	4,965	5,738	note:"a"	6,918	10,218
1995	5,974	12,364	0	8,265	9,458		14,239	21,822	1,885	4,089	10,479	8,025	9,218		12,114	19,697
1996	9,888	20,791	0	12,907	15,256		22,795	36,047	2,211	7,677	18,580	11,576	13,892		19,253	32,472
1997	2,665	5,488	0	4,508	4,979		7,173	10,467	493	2,172	4,995	3,971	4,433		6,143	9,428
1998	7,567	15,680	0	9,203	10,801		16,770	26,481	0	7,567	15,680	8,775	10,348		16,342	26,028
1999	5,048	10,535	0	5,508	6,366		10,556	16,901	67	4,981	10,468	5,196	6,048		10,177	16,516
2000	6,201	12,890	0	4,796	5,453		10,997	18,343	0	6,201	12,890	4,455	5,087		10,656	17,977

SFAs 19, 20, 21: Returns, 1970-1997, estimated as run size (1SW recreational catch / expl. rate [0.2 t0 0.45]; where MIN and MAX selected as 5th and 95th percentile values from 1,000 monte carlo estimates) + estimated 1SW fish in commercial landings 1970-1983 (Cutting MS 1984). For 1998-2000, see "a" below.

SFA 22: Inner Fundy stocks and inner-Fundy SFA 23 (primarily 1SW fish) do not go to the North Atlantic.

SFA 23: For 1970-'97, similar to SFAs 19-21 except that estimated wild 1SW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch and estimated proportions that production above Mactaquac is of the total (0.4-0.6) river replaced exploitataion rates (commercial harvest, bi-catch etc., incl. in estimated returns); hatchery returns attributed to above Mactaquac only; 1SW production in rest of SFA (outer Fundy) omitted.

"a"- Revision of method, SFA 23, 1993-2000, estimated returns to Nashwaak fence raised by proportion of area below Mactaquac (0.21-0.30) and added to total estimated returns originating upriver of Mactaquac (Marshall et al. 1998); MIN and MAX removals below Mactaquac based on Nashwaak losses, Mactaquac losses are a single value and together summed and removed from returns to establish estimate of spawners. SFAs 19-21, estimate of returns 1998-2000 based on regression of LaHave wild counts on MIN and MAX estimates of total SFA 19-21 returns, 1984-1997, because there was no (1998 and 2000) & little (1999) angling in SFAs 20-21.

Appendix 5(ixa). Total 2SW returns to SFAs 19, 20, 21 and 23, 1970-2000.

	SFA 19		**SFA 20**		**SFA 21**		Total	**SFA 23**				**TOTAL RETURNS**	
							Comm-	Wild	Wild	Htch	Htch	**SFAs 19,20,21,23**	
	MIN	MAX	MIN	MAX	MIN	MAX	ercial	MIN	MAX	MIN	MAX		
	2SW=0.7-0.9		2SW=0.6-0.9		2SW=0.5-0.9		19-21	2SW= 0.85-0.95		2SW= 0.85-0.95			
Year	Exp. rate=0.2-0.45		Exp. rate=0.2-0.45		Exp. rate=0.2-0.45			p. abv= 0.4-0.6				MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	2,644	8,540	12,674	0	0	13,609	20,915
1971	600	1,266	344	802	481	1,199	2,607	7,089	10,463	66	73	11,187	16,410
1972	735	1,614	421	1,002	454	1,198	4,549	7,362	10,809	507	559	14,028	19,731
1973	726	1,571	665	1,532	546	1,437	4,217	3,773	5,559	432	477	10,359	14,793
1974	1,035	2,225	691	1,588	548	1,397	8,873	8,766	12,790	1,989	2,198	21,902	29,071
1975	376	824	149	343	882	2,321	9,430	11,217	16,490	1,890	2,088	23,944	31,496
1976	791	1,672	346	822	441	1,146	5,916	12,304	18,106	1,970	2,175	21,768	29,837
1977	999	2,152	660	1,509	873	2,354	9,205	14,539	21,420	2,330	2,575	28,606	39,215
1978	810	1,739	429	995	655	1,706	6,827	6,059	8,903	2,166	2,391	16,946	22,561
1979	532	1,169	431	978	508	1,288	2,326	4,149	6,084	1,016	1,123	8,962	12,968
1980	1,408	3,051	746	1,714	1,483	3,989	9,204	16,500	24,041	2,556	2,824	31,897	44,823
1981	886	1,856	926	2,133	1,754	4,475	4,438	8,696	12,690	2,330	2,577	19,030	28,169
1982	917	1,990	316	746	682	1,756	5,819	8,266	12,198	1,516	1,673	17,516	24,182
1983	477	1,030	641	1,475	552	1,434	2,978	8,718	12,793	944	1,043	14,310	20,753
1984	828	1,768	638	1,500	766	2,004	0	14,753	21,573	953	1,054	17,938	27,899
1985	1,495	3,132	2,703	6,355	2,102	5,469	0	15,793	23,002	748	826	22,841	38,784
1986	3,500	7,541	2,561	5,987	2,150	5,312	0	9,210	13,507	681	754	18,102	33,101
1987	2,427	5,237	1,066	2,527	1,114	2,872	0	6,512	9,590	410	453	11,529	20,679
1988	2,635	5,724	1,914	4,464	1,105	2,945	0	3,936	5,836	780	861	10,370	19,830
1989	2,236	4,810	1,512	3,485	1,631	4,086	0	6,159	8,994	401	443	11,939	21,818
1990	2,406	5,178	1,085	2,515	1,271	3,260	0	4,994	7,375	492	543	10,248	18,871
1991	1,890	4,050	965	2,200	421	1,071	0	6,739	9,902	598	661	10,613	17,884
1992	1,788	3,923	631	1,488	480	1,236	0	6,213	9,074	665	735	9,777	16,456
1993	876	1,897	1,006	2,321	564	1,498	0	4,318	5,371	foot-		6,764	11,087
1994	833	1,845	242	561	305	773	0	2,999	3,729	note:"a"		4,379	6,908
1995	759	1,582	666	1,565	518	1,339	0	3,042	3,831			4,985	8,317
1996	1,231	2,692	604	1,404	894	2,293	0	4,498	5,665			7,227	12,054
1997	607	1,299	170	387	301	1,026	0	2,567	3,210			3,645	5,922
1998	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,103	3,888	0	1,625	2,115			2,728	6,003
1999	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,230	4,324	0	2,252	2,783			3,482	7,107
2000	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,086	3,816	0	952	1,263			2,038	5,079

SFAs 19, 20, 21: Returns, 1970-'97 estimated as run size (MSW recreational catch * prop. 2SW [range of values]/ expl. rate [range of values]; where MIN and MAX selected as 5th and 95th percentile values from 1,000 monte carlo estimates) + estimated 2SW fish in commercial landings 1970-1983 (Cutting MS 1984). For 1998-2000 see "a" below.

SFA 22: Inner Fundy stocks do not go to north Atlantic.

SFA 23: For 1970-1997 Similar approach as for SFAs 19-21 except that estimated wild MSW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch; and estimated proportions that production above Mactaquac is of the total river replaced exploitation rates (commercial harvest, bi-catch etc., incl. in estimated returns) + est. 0.85-0.95* MSW hatchery returns to Mactaquac; 2SW production in rest of SFA omitted.

"a": Revsion of method, SFA 23, 1993-2000, estimated MSW returns to Nashwaak fence raised by prop. of area below Mactaquac (0.21-0.30) * prop. 2SW (0.7 & 0.9) and added to estimated MSW hatchery and wild returns * (Marshall et al. MS 1998) (0.85-0.95; 2SW) originating upriver of Mactaquac. MIN & MAX removals below Mactaquac based on Nashwaak losses: Mactaquac losses were a single value and together summed and removed from MSW returns (prevously) to estimate spawners. SFAs 19-21, estimate of 2SW returns for 1998-'00, based on regression of LaHave wild counts on MIN and MAX estimates of total SFA 19-21 MSW returns and 5th and 95th percentile values of MIN-MAX (0.5 & 0.9 2SW fish among MSW salmon).

Appendix 5(ixb). Total 2SW spawners in SFAs 19, 20, 21 and 23, 1970-2000.

	RETURNS						REMOVALS		SPAWNERS		SFA 23					
	SFA 19		SFA 20		SFA 21		angled (19-21)		SFAs (19-21)		RETURNS		REMOVALS		TOTAL SPAWNERS	
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	941	1,375	1,485	4,222	8,540	12,674	7,004	7,828	3,021	9,068
1971	600	1,266	344	802	481	1,199	541	812	884	2,455	7,155	10,536	3,543	3,960	4,496	9,032
1972	735	1,614	421	1,002	454	1,198	623	922	987	2,892	7,869	11,368	1,397	1,562	7,459	12,699
1973	726	1,571	665	1,532	546	1,437	740	1,108	1,197	3,432	4,205	6,036	1,454	1,625	3,949	7,844
1974	1,035	2,225	691	1,588	548	1,397	871	1,277	1,404	3,933	10,755	14,988	2,632	2,942	9,526	15,979
1975	376	824	149	343	882	2,321	534	867	874	2,621	13,107	18,578	2,120	2,369	11,861	18,830
1976	791	1,672	346	822	441	1,146	603	887	975	2,754	14,274	20,281	4,203	4,698	11,045	18,337
1977	999	2,152	660	1,509	873	2,354	967	1,463	1,565	4,552	16,869	23,995	4,856	5,427	13,578	23,119
1978	810	1,739	429	995	655	1,706	723	1,088	1,171	3,352	8,225	11,294	2,879	3,218	6,517	11,428
1979	532	1,169	431	978	508	1,288	560	851	911	2,585	5,165	7,207	1,393	1,557	4,683	8,234
1980	1,408	3,051	746	1,714	1,483	3,989	1,390	2,131	2,247	6,623	19,056	26,865	7,033	7,860	14,270	25,628
1981	886	1,856	926	2,133	1,754	4,475	1,338	2,125	2,228	6,339	11,026	15,267	7,384	8,253	5,870	13,353
1982	917	1,990	316	746	682	1,756	734	1,096	1,181	3,396	9,782	13,871	5,307	5,932	5,656	11,335
1983	477	1,030	641	1,475	552	1,434	633	971	1,037	2,968	9,662	13,836	9,194	10,275	1,505	6,529
1984	828	1,768	638	1,500	766	2,004	267	419	1,965	4,853	15,706	22,627	3,426	3,829	14,245	23,650
1985	1,495	3,132	2,703	6,355	2,102	5,469			6,300	14,956	16,541	23,828	4,656	5,204	18,185	33,580
1986	3,500	7,541	2,561	5,987	2,150	5,312			8,211	18,840	9,891	14,261	2,667	2,981	15,435	30,120
1987	2,427	5,237	1,066	2,527	1,114	2,872			4,607	10,636	6,922	10,043	1,294	1,446	10,235	19,233
1988	2,635	5,724	1,914	4,464	1,105	2,945			5,654	13,133	4,716	6,697	1,296	1,449	9,074	18,381
1989	2,236	4,810	1,512	3,485	1,631	4,086			5,379	12,381	6,560	9,437	250	279	11,689	21,539
1990	2,406	5,178	1,085	2,515	1,271	3,260			4,762	10,953	5,486	7,918	560	626	9,688	18,245
1991	1,890	4,050	965	2,200	421	1,071			3,276	7,321	7,337	10,563	1,257	1,405	9,356	16,479
1992	1,788	3,923	631	1,488	480	1,236			2,899	6,647	6,878	9,809	1,052	1,176	8,725	15,280
1993	876	1,897	1,006	2,321	564	1,498			2,446	5,716	4,318	5,371	1,054	1,166	5,710	9,921
1994	833	1,845	242	561	305	773			1,380	3,179	2,999	3,729	697	815	3,682	6,093
1995	759	1,582	666	1,565	518	1,339			1,943	4,486	3,042	3,831	313	346	4,672	7,971
1996	1,231	2,692	604	1,404	894	2,293			2,729	6,389	4,498	5,665	720	812	6,507	11,242
1997	607	1,299	170	387	301	1,026			1,078	2,712	2,567	3,210	550	611	3,095	5,311
1998	>>>>>>>>>>>>>>>>>>>>>>>>>>				1,103	3,888			1,103	3,888	1,625	2,115	304	340	2,424	5,663
1999	>>>>>>>>>>>>>>>>>>>>>>>>>>				1,230	4,324			1,230	4,324	2,252	2,783	441	459	3,041	6,648
2000	>>>>>>>>>>>>>>>>>>>>>>>>>>				1,086	3,816			1,086	3,816	952	1,263	183	202	1,855	4,877

Spawners = returns minus removals where "returns" are from previous Appendix as are outlines of revisions to methods for SFAs 19-21, 1998-2000, and SFA 23, 1993-2000.
"Removals" of 2SW fish in SFAs 19-21 have been few, largely illegal and unascribed since the catch-and-release angling regulations in 1985; removals in SFA 23, 1985-1997, had been in total, the assessed losses to stocks originating above Mactaquac. The revised method, 1993-2000, incorporates 5th and 95th percentile values for losses noted on the Nashwaak raised to the total production area downstream of Mactaquac as well as the previously assessed and used values for stocks upstream of Mactaquac.

Appendix 5(x). Estimated numbers of salmons recruits and spawners for Québec, 1969-2000.

	Recruit of small salmon			Recruit of large salmon			Spawner of small salmon			Spawner of large salmon		
Year	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
1969	25 355	31 694	38 032	74 653	93 316	111 979	16 313	20 392	24 470	25 532	31 915	38 299
1970	18 904	23 630	28 356	82 680	103 350	124 020	11 045	13 806	16 568	31 292	39 115	46 937
1971	14 969	18 711	22 453	47 354	59 192	71 031	9 338	11 672	14 007	16 194	20 243	24 292
1972	12 470	15 587	18 704	61 773	77 217	92 660	8 213	10 267	12 320	31 727	39 658	47 590
1973	16 585	20 731	24 877	68 171	85 214	102 256	10 987	13 734	16 480	32 279	40 349	48 419
1974	16 791	20 988	25 186	91 455	114 319	137 182	10 067	12 583	15 100	39 256	49 070	58 884
1975	18 071	22 589	27 106	77 664	97 080	116 497	11 606	14 507	17 409	32 627	40 784	48 940
1976	19 959	24 948	29 938	77 212	96 515	115 818	12 979	16 224	19 469	31 032	38 790	46 548
1977	18 190	22 737	27 285	91 017	113 771	136 525	12 004	15 005	18 006	44 660	55 825	66 990
1978	16 971	21 214	25 456	81 953	102 441	122 930	11 447	14 309	17 170	40 944	51 180	61 416
1979	21 683	27 103	32 524	45 197	56 497	67 796	15 863	19 829	23 795	17 543	21 929	26 315
1980	29 791	37 239	44 686	107 461	134 327	161 192	20 817	26 021	31 226	48 758	60 948	73 137
1981	41 667	52 084	62 501	84 428	105 535	126 642	30 952	38 690	46 428	35 798	44 747	53 697
1982	23 699	29 624	35 549	74 870	93 587	112 305	16 877	21 096	25 316	36 290	45 363	54 435
1983	17 987	22 484	26 981	61 488	76 860	92 232	12 030	15 038	18 045	23 710	29 638	35 565
1984	21 566	26 230	30 894	61 180	71 110	81 041	16 316	20 636	24 957	30 610	37 674	44 739
1985	22 771	28 016	33 262	62 899	73 545	84 192	15 608	20 374	25 140	28 312	35 897	43 482
1986	33 758	40 347	46 937	75 561	87 479	99 397	22 230	28 042	33 855	32 997	41 114	49 232
1987	37 816	45 925	54 034	72 190	82 920	93 650	25 789	33 135	40 481	29 758	36 610	43 462
1988	43 943	53 068	62 193	77 904	90 587	103 269	28 582	36 699	44 815	34 781	43 653	52 524
1989	34 568	41 488	48 407	70 762	81 316	91 871	24 710	31 015	37 319	34 268	41 727	49 185
1990	39 962	47 377	54 792	68 851	79 872	90 893	26 594	33 210	39 826	33 454	41 535	49 615
1991	31 488	37 121	42 755	64 166	73 675	83 184	20 582	25 508	30 433	27 341	33 569	39 797
1992	35 257	42 000	48 742	64 271	74 112	83 953	21 754	27 668	33 583	26 489	32 993	39 497
1993	30 645	36 400	42 156	50 717	57 197	63 677	17 493	22 469	27 444	21 609	25 481	29 353
1994	29 667	34 918	40 170	51 649	58 139	64 630	16 758	21 200	25 642	21 413	25 191	28 968
1995	23 851	28 109	32 368	59 939	67 083	74 227	14 409	17 978	21 548	30 925	35 122	39 320
1996	32 008	37 283	42 558	53 990	61 136	68 282	18 923	23 364	27 805	26 042	30 433	34 824
1997	24 300	28 659	33 018	44 442	50 315	56 187	14 724	18 467	22 210	21 275	24 871	28 466
1998	24 029	28 777	33 524	33 280	38 370	43 460	16 277	20 615	24 954	19 419	22 951	26 483
1999	25 639	30 967	36 296	34 742	40 400	46 058	18 785	23 643	28 502	23 559	28 028	32 497
2000	25 216	30 762	36 309	33 829	40 574	47 320	17 137	22 116	27 096	22 009	27 008	32 007
Mean 95-99	**25 965**	**30 759**	**35 553**	**45 279**	**51 461**	**57 643**	**16 624**	**20 814**	**25 004**	**24 244**	**28 281**	**32 318**
2000 vs 1999		**-1**			**0**			**-6**			**-4**	
1995-1999		**0**			**-21**			**6**			**-5**	

APPENDIX 6

Computation of Catch Advice for West Greenland

The North American Spawning Reserve (SpT) for 2SW salmon of 152,548 fish remains the same as in 2000.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. SpR = SpT * (exp(11*M) (where M = 0.01)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. MAH = PFA - SpR

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. NA1SW = f_{NA} * MAH

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] [1]. Thus:

Eq. 4. E1SW = (NA1SW / PropNA) - NA1SW

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric tonnes, it is necessary to incorporate the mean weights (kg) of salmon for North America [WT1SWNA][1] and Europe [WT1SWE][1] and age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon [ACF][1] . The quota (in tonnes) at Greenland is then estimated as

Eq. 5. Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000

[1] Sampling data from the 1995-99 fishery at West Greenland were used to update the forecast values by exponential smoothing of the proportion of North American salmon in the catch (PropNA), weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF].

APPENDIX 7

Appendix 7a Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FINLAND

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	3,114	3,156	20	30	20	30	40	70	40	80
1972	4,865	4,932	20	30	20	30	40	70	40	80
1973	7,395	7,496	20	30	20	30	40	70	40	80
1974	6,803	7,253	20	30	20	30	40	70	40	80
1975	6,732	7,178	20	30	20	30	40	70	40	80
1976	5,817	6,202	20	30	20	30	40	70	40	80
1977	5,238	5,584	20	30	20	30	40	70	40	80
1978	3,832	3,481	20	30	20	30	40	70	40	80
1979	3,982	2,298	20	30	20	30	40	70	30	70
1980	3,920	3,093	20	30	20	30	40	70	30	70
1981	3,617	4,874	20	30	20	30	40	70	30	70
1982	2,598	5,408	20	30	20	30	40	70	30	70
1983	3,916	6,050	20	30	20	30	40	70	30	70
1984	4,899	4,726	20	30	20	30	40	70	30	70
1985	6,201	4,912	20	30	20	30	40	70	30	70
1986	6,131	3,244	20	30	20	30	40	70	30	70
1987	8,696	4,520	20	30	20	30	40	70	30	70
1988	5,926	3,495	20	30	20	30	40	70	30	70
1989	10,395	5,332	20	30	20	30	50	80	40	80
1990	10,084	5,600	20	30	20	30	50	80	40	80
1991	9,213	6,298	20	30	20	30	50	80	40	80
1992	15,017	6,284	20	30	20	30	50	80	40	80
1993	11,157	8,180	20	30	20	30	50	80	40	80
1994	7,493	6,230	20	30	20	30	50	80	40	80
1995	7,786	5,344	20	30	20	30	50	80	40	80
1996	10,726	2,717	20	30	20	30	40	70	30	70
1997	9,469	4,272	20	30	20	30	40	70	30	70
1998	11,410	3,749	20	30	20	30	40	70	30	70
1999	16,861	3,848	20	30	20	30	50	80	40	70
2000	17,499	8,698	20	30	20	30	50	80	40	70
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7b Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FRANCE

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
	Non-reporting included in exploitation rates									
1971	1,740	4,060	0	0	0	0	2	5	25	50
1972	3,480	8,120	0	0	0	0	2	5	25	50
1973	2,130	4,970	0	0	0	0	2	5	25	50
1974	990	2,310	0	0	0	0	2	5	25	50
1975	1,980	4,620	0	0	0	0	2	5	25	50
1976	1,820	3,380	0	0	0	0	2	5	25	50
1977	1,400	2,600	0	0	0	0	2	5	25	50
1978	1,435	2,665	0	0	0	0	2	5	25	50
1979	1,645	3,055	0	0	0	0	2	5	25	50
1980	3,430	6,370	0	0	0	0	2	5	25	50
1981	2,720	4,080	0	0	0	0	2	5	20	50
1982	1,680	2,520	0	0	0	0	2	5	20	50
1983	1,800	2,700	0	0	0	0	2	5	20	50
1984	2,960	4,440	0	0	0	0	2	5	20	50
1985	1,100	3,330	0	0	0	0	2	5	20	50
1986	3,400	3,400	0	0	0	0	2	12	20	50
1987	6,000	1,800	0	0	0	0	2	12	20	50
1988	2,100	5,000	0	0	0	0	2	12	20	50
1989	1,100	2,300	0	0	0	0	2	12	20	50
1990	1,900	2,300	0	0	0	0	2	12	20	50
1991	1,400	2,100	0	0	0	0	2	12	20	50
1992	2,500	2,700	0	0	0	0	2	12	20	50
1993	3,600	1,300	0	0	0	0	2	12	20	50
1994	2,800	2,300	0	0	0	0	2	12	20	40
1995	1,669	1,095	0	0	0	0	5	20	20	40
1996	2,063	1,942	0	0	0	0	5	20	20	40
1997	1,060	1,001	0	0	0	0	5	20	20	40
1998	2,065	846	0	0	0	0	5	20	20	40
1999	690	1,831	0	0	0	0	5	20	20	40
2000	1,792	1,277	0	0	0	0	5	20	20	40
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	W(min)	7	W(min)	16
M(max)=	0.015		1SW(max)	9	V(max)	18

Appendix 7c Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - ICELAND-1

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	25,746	15,429	1	3	1	3	40	60	50	70
1972	26,793	19,715	1	3	1	3	40	60	50	70
1973	26,105	18,847	1	3	1	3	40	60	50	70
1974	17,742	17,364	1	3	1	3	40	60	50	70
1975	24,541	19,695	1	3	1	3	40	60	50	70
1976	20,046	17,588	1	3	1	3	40	60	50	70
1977	21,394	17,636	1	3	1	3	40	60	50	70
1978	28,436	21,858	1	3	1	3	40	60	50	70
1979	24,508	14,099	1	3	1	3	40	60	50	70
1980	15,447	15,784	1	3	1	3	40	60	50	70
1981	16,666	10,785	1	3	1	3	40	60	50	70
1982	12,398	10,872	1	3	1	3	40	60	50	70
1983	20,397	15,348	1	3	1	3	40	60	50	70
1984	14,129	11,573	1	3	1	3	40	60	50	70
1985	17,595	9,900	1	3	1	3	40	60	50	70
1986	26,753	13,310	1	3	1	3	40	60	50	70
1987	20,697	8,366	1	3	1	3	40	60	50	70
1988	39,891	7,534	1	3	1	3	40	60	50	70
1989	22,050	7,168	1	3	1	3	40	60	50	70
1990	21,396	7,290	1	3	1	3	40	60	50	70
1991	21,438	7,206	1	3	1	3	40	60	50	70
1992	24,245	9,330	1	3	1	3	40	60	50	70
1993	23,818	6,040	1	3	1	3	40	60	50	70
1994	20,668	8,079	1	3	1	3	40	60	50	70
1995	25,517	7,122	1	3	1	3	40	60	50	70
1996	21,264	5,605	1	3	1	3	40	60	50	70
1997	15,470	5,565	1	3	1	3	40	60	50	70
1998	21,520	3,707	1	3	1	3	40	60	50	70
1999	16,622	5,757	1	3	1	3	40	60	50	70
2000	11,894	2,358	1	3	1	3	40	60	50	70
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7d Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - ICELAND-2

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	4,704	6,191	1	3	1	3	40	60	50	70
1972	4,334	9,728	1	3	1	3	40	60	50	70
1973	5,803	12,059	1	3	1	3	40	60	50	70
1974	4,867	8,475	1	3	1	3	40	60	50	70
1975	6,343	9,907	1	3	1	3	40	60	50	70
1976	5,880	7,883	1	3	1	3	40	60	50	70
1977	9,285	11,824	1	3	1	3	40	60	50	70
1978	9,232	15,323	1	3	1	3	40	60	50	70
1979	8,807	9,952	1	3	1	3	40	60	50	70
1980	1,586	14,140	1	3	1	3	40	60	50	70
1981	7,105	4,965	1	3	1	3	40	60	50	70
1982	3,358	5,956	1	3	1	3	40	60	50	70
1983	4,583	4,259	1	3	1	3	40	60	50	70
1984	1,742	5,460	1	3	1	3	40	60	50	70
1985	10,233	3,398	1	3	1	3	40	60	50	70
1986	13,745	10,189	1	3	1	3	40	60	50	70
1987	8,238	9,642	1	3	1	3	40	60	50	70
1988	12,776	6,519	1	3	1	3	40	60	50	70
1989	6,644	5,582	1	3	1	3	40	60	50	70
1990	5,403	5,866	1	3	1	3	40	60	50	70
1991	8,583	4,552	1	3	1	3	40	60	50	70
1992	13,831	6,440	1	3	1	3	40	60	50	70
1993	11,354	6,922	1	3	1	3	40	60	50	70
1994	3,712	5,828	1	3	1	3	40	60	50	70
1995	9,494	3,714	1	3	1	3	40	60	50	70
1996	5,007	4,865	1	3	1	3	40	60	50	70
1997	7,354	2,955	1	3	1	3	40	60	50	70
1998	12,822	4,261	1	3	1	3	40	60	50	70
1999	5,905	7,077	1	3	1	3	40	60	50	70
2000	6081	2624	1	3	1	3	40	60	50	70
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7e Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - All IRELAND.

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	475,839	52,871	30.00	45.00	30.00	50.00	66.00	78.00	47.00	55.00
1972	523,742	58,194	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1973	560,323	62,258	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1974	617,806	68,645	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1975	643,355	71,484	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1976	453,194	50,355	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1977	398,323	44,258	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1978	357,097	39,677	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1979	318,484	35,387	30.00	45.00	30.00	50.00	66.30	78.00	46.75	55.00
1980	248,333	39,608	30.00	45.00	30.00	50.00	65.87	81.67	46.75	55.00
1981	173,667	32,159	30.00	45.00	30.00	50.00	67.55	83.64	54.25	63.82
1982	310,000	12,353	30.00	45.00	30.00	50.00	66.81	82.77	51.53	60.62
1983	502,000	29,411	30.00	45.00	30.00	50.00	67.54	79.46	46.44	54.63
1984	242,666	19,804	30.00	45.00	30.00	50.00	68.68	80.80	32.19	37.87
1985	498,333	19,608	30.00	45.00	30.00	50.00	69.95	82.29	34.71	40.83
1986	498,125	28,335	30.00	45.00	30.00	50.00	72.87	85.73	34.66	40.78
1987	358,842	27,609	20.00	40.00	20.00	45.00	70.66	83.13	36.27	42.67
1988	559,297	30,599	20.00	40.00	20.00	45.00	71.56	84.19	36.76	43.24
1989	305,667	24,891	20.00	40.00	20.00	45.00	68.28	80.33	45.06	53.01
1990	203,955	16,608	20.00	40.00	20.00	45.00	61.21	72.02	41.15	48.42
1991	140,796	11,465	20.00	40.00	20.00	45.00	60.42	71.08	40.11	47.19
1992	219,942	17,910	20.00	40.00	20.00	45.00	58.82	69.20	38.34	45.11
1993	187,742	15,288	15.00	35.00	20.00	45.00	65.87	77.50	48.79	57.40
1994	267,928	21,818	15.00	35.00	20.00	45.00	66.73	78.50	38.59	45.40
1995	271,497	22,108	15.00	35.00	20.00	45.00	68.08	80.10	41.60	42.83
1996	230,826	18,797	15.00	35.00	15.00	30.00	66.33	78.03	37.95	56.18435
1997	194,187	15,813	10.00	20.00	10.00	20.00	64.86	76.30	46.67	60.00
1998	219,767	17,896	10.00	20.00	10.00	20.00	64.12	75.43	40.00	60.00
1999	166,887	13,590	10.00	20.00	10.00	20.00	63.50	74.70	40.00	62.17
2000	211,035	17,185	10.00	20.00	10.00	20.00	63.00	75.00	40.00	62.00
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 7f Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-Total pre-1983

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	213,595	135,247	40	60	40	60	70	90	70	90
1972	279,249	176,818	40	60	40	60	70	90	70	90
1973	305,439	193,402	40	60	40	60	70	90	70	90
1974	288,982	182,981	40	60	40	60	70	90	70	90
1975	271,993	172,224	40	60	40	60	70	90	70	90
1976	270,754	171,439	40	60	40	60	70	90	70	90
1977	263,322	166,733	40	60	40	60	70	90	70	90
1978	285,812	117,655	40	60	40	60	70	90	70	90
1979	324,020	205,167	40	60	40	60	70	90	70	90
1980	323,843	205,055	40	60	40	60	70	90	70	90
1981	221,566	213,943	40	60	40	60	70	90	70	90
1982	163,120	174,229	40	60	40	60	70	90	70	90
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 7g Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-S (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	38,353	34,080	40	60	40	60	65	85	65	85
1984	86,583	66,580	40	60	40	60	65	85	65	85
1985	106,376	55,914	40	60	40	60	65	85	65	85
1986	98,525	76,517	40	60	40	60	65	85	65	85
1987	73,885	61,257	40	60	40	60	65	85	65	85
1988	72,751	45,278	40	60	40	60	65	85	65	85
1989	83,316	29,734	40	60	40	60	55	75	55	75
1990	66,477	38,353	40	60	40	60	55	75	55	75
1991	57,410	28,440	40	60	40	60	55	75	55	75
1992	40,380	30,691	40	60	40	60	55	75	55	75
1993	46,975	26,425	30	50	30	50	55	75	55	75
1994	95,265	31,392	30	50	30	50	55	75	55	75
1995	45,194	40,019	30	50	30	50	55	75	55	75
1996	22,110	29,417	30	50	30	50	55	75	55	75
1997	36,549	18,312	25	45	25	45	50	70	50	70
1998	47,909	23,533	25	45	25	45	50	70	50	70
1999	48,504	26,435	25	45	25	45	50	70	50	70
2000	85179	38204	25	45	25	45	50	70	50	70
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 7h Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-M (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	112,811	73,452	40	60	40	60	65	85	65	85
1984	86,583	66,580	40	60	40	60	65	85	65	85
1985	106,376	55,914	40	60	40	60	65	85	65	85
1986	98,525	76,517	40	60	40	60	65	85	65	85
1987	73,885	61,257	40	60	40	60	65	85	65	85
1988	72,751	45,278	40	60	40	60	65	85	65	85
1989	83,316	29,734	40	60	40	60	55	75	55	75
1990	66,477	38,353	40	60	40	60	55	75	55	75
1991	57,410	28,440	40	60	40	60	55	75	55	75
1992	40,380	30,691	40	60	40	60	55	75	55	75
1993	46,975	26,425	30	50	30	50	55	75	55	75
1994	95,265	31,392	30	50	30	50	55	75	55	75
1995	45,194	40,019	30	50	30	50	55	75	55	75
1996	22,110	29,417	30	50	30	50	55	75	55	75
1997	36,549	18,312	25	45	25	45	50	70	50	70
1998	47,909	23,533	25	45	25	45	50	70	50	70
1999	48,504	26,435	25	45	25	45	50	70	50	70
2000	85,179	38,204	25	45	25	45	50	70	50	70
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7i Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-N (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	107,749	56,994	40	60	40	60	70	90	70	90
1984	156,755	66,460	40	60	40	60	70	90	70	90
1985	125,469	65,800	40	60	40	60	70	90	70	90
1986	91,403	68,494	40	60	40	60	70	90	70	90
1987	82,236	40,394	40	60	40	60	70	90	70	90
1988	58,859	35,986	40	60	40	60	70	90	70	90
1989	53,009	20,466	40	60	40	60	60	80	60	80
1990	47,133	23,221	40	60	40	60	60	80	60	80
1991	52,442	30,245	40	60	40	60	60	80	60	80
1992	51,137	27,082	40	60	40	60	60	80	60	80
1993	56,382	45,669	30	50	30	50	60	80	60	80
1994	40,402	40,336	30	50	30	50	60	80	60	80
1995	36,706	30,337	30	50	30	50	60	80	60	80
1996	45,946	38,520	30	50	30	50	60	80	60	80
1997	43,413	32,701	25	45	25	45	60	80	60	80
1998	53,099	37,217	25	45	25	45	60	80	60	80
1999	64,531	49,320	25	45	25	45	60	80	60	80
2000	77,121	57,286	25	45	25	45	60	80	60	80
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7j Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA.

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	48,312	80,841	15	25	15	25	40	60	40	60
1972	53,525	67,407	15	25	15	25	40	60	40	60
1973	89,440	112,636	15	25	15	25	40	60	40	60
1974	82,141	103,444	15	25	15	25	40	60	40	60
1975	87,944	129,896	15	25	15	25	40	60	40	60
1976	66,447	110,756	15	25	15	25	40	60	40	60
1977	55,463	83,195	15	25	15	25	40	60	40	60
1978	60,737	57,564	15	25	15	25	40	60	40	60
1979	69,423	63,844	15	25	15	25	40	60	40	60
1980	45,673	96,795	15	25	15	25	40	60	40	60
1981	32,611	52,528	15	25	15	25	40	60	40	60
1982	39,702	42,471	15	25	15	25	30	50	30	50
1983	57,870	68,396	15	25	15	25	30	50	30	50
1984	54,991	72,228	15	25	15	25	30	50	30	50
1985	72,803	80,292	15	25	15	25	30	50	30	50
1986	63,926	89,465	15	25	15	25	30	50	30	50
1987	97,242	41,769	15	25	15	25	30	45	30	50
1988	53,158	46,848	15	25	15	25	30	45	30	50
1989	78,023	29,454	15	25	20	30	30	45	15	30
1990	70,595	25,663	15	25	20	30	30	45	15	25
1991	40,603	17,543	33	47	33	47	25	35	15	25
1992	34,021	13,431	35	45	45	55	25	35	15	25
1993	28,100	17,907	35	45	50	60	25	35	15	25
1994	30,877	13,668	35	45	55	65	25	35	15	25
1995	27,775	10,023	35	45	55	65	25	35	15	25
1996	33,878	8,708	35	45	65	75	25	35	10	20
1997	31,857	7,107	35	45	65	75	25	35	10	20
1998	34,870	7,024	35	45	65	75	25	35	10	20
1999	24,016	6,998	35	45	65	75	25	35	10	20
2000	27,702	9,413	35	45	65	75	25	35	10	20
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 7k Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - SWEDEN

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	6,330	420	20	50	20	50	70	95	55	100
1972	5,005	295	20	50	20	50	70	95	55	100
1973	6,210	1,025	20	50	20	50	70	95	55	100
1974	8,935	660	20	50	20	50	70	95	55	100
1975	9,620	160	20	50	20	50	70	95	55	100
1976	5,420	480	20	50	20	50	70	95	55	100
1977	2,555	360	20	50	20	50	70	95	55	100
1978	2,917	275	20	50	20	50	70	95	55	100
1979	3,080	800	20	50	20	50	70	95	55	100
1980	3,920	1,400	20	50	20	50	70	95	55	100
1981	7,095	407	20	50	20	50	70	95	55	100
1982	6,230	1,460	20	50	20	50	70	95	55	100
1983	8,290	1,005	20	50	20	50	70	95	55	100
1984	11,680	1,410	20	50	20	50	70	95	55	100
1985	13,890	590	20	50	20	50	70	95	55	100
1986	14,635	570	20	50	20	50	70	95	55	100
1987	11,860	1,700	20	50	20	50	70	95	55	100
1988	9,930	1,650	20	50	20	50	70	95	55	100
1989	3,180	4,610	20	50	20	50	70	95	55	100
1990	7,430	3,135	20	50	20	50	70	95	55	100
1991	8,990	3,620	20	50	20	50	70	95	55	100
1992	9,850	4,655	20	50	20	50	70	95	55	100
1993	10,540	6,370	20	50	20	50	70	95	55	100
1994	8,035	4,660	20	50	20	50	60	85	55	100
1995	9,761	2,770	20	50	20	50	50	75	55	90
1996	6,008	3,542	20	50	20	50	50	75	55	90
1997	2,747	2,307	20	50	20	50	50	75	55	90
1998	2,421	1,702	5	25	5	25	60	85	55	90
1999	3,573	1,460	5	25	5	25	55	90	55	90
2000	7,103	3,196	5	25	5	25	55	90	55	90
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 7l Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(England and Wales).

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	34,142	18,384	25	45	25	45	23	43	18	38
1972	38,630	20,347	25	45	25	45	23	43	18	38
1973	36,357	18,729	25	45	25	45	23	43	18	38
1974	36,048	18,159	25	45	25	45	23	43	18	38
1975	41,730	20,554	25	45	25	45	23	43	18	38
1976	26,686	12,849	25	45	25	45	24	44	18	38
1977	30,665	14,431	25	45	25	45	24	44	19	39
1978	31,253	14,372	25	45	25	45	25	45	19	39
1979	24,725	11,108	25	45	25	45	26	46	20	40
1980	34,066	14,950	25	45	25	45	29	49	23	43
1981	41,670	17,859	25	45	25	45	29	49	23	43
1982	25,480	10,662	25	45	25	45	30	50	24	44
1983	35,332	14,432	25	45	25	45	31	51	24	44
1984	30,943	12,334	25	45	25	45	32	52	25	45
1985	33,680	13,098	25	45	25	45	33	53	26	46
1986	41,700	15,817	25	45	25	45	33	53	26	46
1987	36,339	17,101	25	45	25	45	33	53	26	46
1988	47,242	21,225	25	45	25	45	32	52	26	46
1989	32,559	17,532	20	40	20	40	34	54	28	48
1990	23,635	21,817	20	40	20	40	35	55	28	48
1991	22,408	9,152	20	40	20	40	34	54	28	48
1992	22,233	6,641	20	40	20	40	34	54	27	47
1993	29,963	7,028	30	60	30	60	29	49	23	43
1994	40,610	12,130	30	60	30	60	28	48	22	42
1995	29,211	11,360	15	25	15	25	27	47	21	41
1996	21,415	11,531	15	25	15	25	23	43	18	38
1997	18,521	6,850	15	25	15	25	22	42	17	37
1998	19,726	4,040	15	25	15	25	20	40	15	35
1999	15,430	6,613	15	25	15	25	17	37	12	32
2000	23,461	7,008	15	25	15	25	16	36	12	32
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	17
M(max)=	0.015		1SW(max)	9	MSW(max)	19

Appendix 7m Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Northern Ireland)-1

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	79,715	4,196	10	33	10	33	75	85	45	55
1972	66,054	3,477	10	33	10	33	75	85	45	55
1973	58,705	3,090	10	33	10	33	75	85	45	55
1974	74,148	3,903	10	33	10	33	75	85	45	55
1975	52,159	2,745	10	33	10	33	75	85	45	55
1976	36,984	1,947	10	33	10	33	75	85	45	55
1977	37,295	1,963	10	33	10	33	75	85	45	55
1978	45,515	2,396	10	33	10	33	75	85	45	55
1979	35,153	1,850	10	33	10	33	75	85	45	55
1980	46,762	2,461	10	33	10	33	75	85	45	55
1981	33,042	1,739	10	33	10	33	75	85	45	55
1982	57,149	3,008	10	33	10	33	75	85	45	55
1983	79,089	4,163	10	33	10	33	75	85	45	55
1984	28,055	1,477	10	33	10	33	75	85	45	55
1985	38,495	2,026	10	33	10	33	75	85	45	55
1986	44,036	2,318	10	33	10	33	75	85	45	55
1987	17,559	924	10	33	10	33	62	76	41	51
1988	44,920	2,364	10	33	10	33	58	71	32	40
1989	61,585	3,241	10	37	10	37	80	98	54	66
1990	40,732	2,144	10	17	10	17	56	68	34	42
1991	22,176	1,167	10	17	10	17	58	71	39	47
1992	40,144	2,113	10	23	10	23	50	62	30	36
1993	36,127	1,901	10	17	10	17	37	45	11	13
1994	36,921	1,943	10	28	10	28	63	77	36	44
1995	34,116	1,796	10	17	10	17	60	74	38	46
1996	29,017	1,527	10	20	10	20	47	67	24	44
1997	41,765	2,198	5	15	5	15	50	70	24	44
1998	37,953	1,998	5	15	5	15	20	30	15	30
1999	22,126	1,165	5	15	5	15	58	68	25	40
2000	31,038	1,634	5	15	5	15	53	63	25	40
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7n Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Northern Ireland)-FCB area-(2)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	36,270	1,909	10	33	10	33	75	85	45	55
1972	35,293	1,858	10	33	10	33	75	85	45	55
1973	29,858	1,571	10	33	10	33	75	85	45	55
1974	22,787	1,199	10	33	10	33	75	85	45	55
1975	27,275	1,436	10	33	10	33	75	85	45	55
1976	18,270	962	10	33	10	33	75	85	45	55
1977	17,139	902	10	33	10	33	75	85	45	55
1978	25,391	1,336	10	33	10	33	75	85	45	55
1979	14,631	770	10	33	10	33	75	85	45	55
1980	16,310	858	10	33	10	33	75	85	45	55
1981	16,338	860	10	33	10	33	75	85	45	55
1982	14,370	756	10	33	10	33	75	85	45	55
1983	21,293	1,121	10	33	10	33	75	85	45	55
1984	11,348	597	10	33	10	33	75	85	45	55
1985	12,635	665	10	33	10	33	75	85	45	55
1986	13,443	708	10	33	10	33	75	85	45	55
1987	9,439	497	10	33	10	33	62	76	41	51
1988	14,628	770	10	33	10	33	58	71	32	40
1989	15,405	811	10	37	10	37	80	98	54	66
1990	10,215	538	10	17	10	17	56	68	34	42
1991	6,804	358	10	17	10	17	58	71	39	47
1992	9,534	502	10	23	10	23	50	62	30	36
1993	8,939	470	10	17	10	17	37	45	11	13
1994	11,146	587	10	28	10	28	63	77	36	44
1995	11,887	626	10	17	10	17	60	74	38	46
1996	10,606	558	10	20	10	20	47	67	24	44
1997	10,705	563	5	15	5	15	50	70	24	44
1998	9,577	504	5	15	5	15	20	30	15	30
1999	9,205	484	5	15	5	15	58	68	25	40
2000	10,826	570	5	15	5	15	53	63	25	40
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7o Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Scotland)-E.

Year	Catch (numbers)		Catch of Scottish fish in England	Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	(% 1SW)	min	max	min	max	min	max	min	max
			70%								
1971	216,873	135,527	57,335	15	35	15	35	30.0	50.0	40.0	60.0
1972	220,106	183,872	49,097	15	35	15	35	29.3	49.1	39.0	58.7
1973	259,773	204,825	59,700	15	35	15	35	28.7	48.1	38.0	57.4
1974	245,424	158,951	50,118	15	35	15	35	28.0	47.2	37.0	56.2
1975	181,940	180,828	50,778	15	35	15	35	27.4	46.3	36.0	54.9
1976	150,069	92,179	14,759	15	35	15	35	26.7	45.3	35.0	53.6
1977	154,306	118,645	49,186	15	35	15	35	26.1	44.4	34.0	52.3
1978	158,844	139,688	47,500	15	35	15	35	25.4	43.5	33.0	51.1
1979	160,791	116,514	39,552	15	35	15	35	24.8	42.6	32.0	49.8
1980	101,665	155,646	41,202	10	25	10	25	24.1	41.6	31.0	48.5
1981	129,690	156,683	61,511	10	25	10	25	23.4	40.7	30.0	47.2
1982	175,355	113,180	44,147	10	25	10	25	22.8	39.8	29.0	46.0
1983	170,843	126,104	67,231	10	25	10	25	22.1	38.8	28.0	44.7
1984	175,675	90,829	50,994	10	25	10	25	21.5	37.9	27.0	43.4
1985	133,073	95,012	48,753	10	25	10	25	20.8	37.0	26.0	42.1
1986	180,276	128,813	53,277	10	25	10	25	20.2	36.0	25.0	40.9
1987	139,252	88,519	29,999	10	25	10	25	19.5	35.1	24.0	39.6
1988	118,580	91,068	41,696	10	25	10	25	18.9	34.2	23.0	38.3
1989	142,992	85,348	33,577	5	15	5	15	18.2	33.2	22.0	37.0
1990	63,297	73,954	41,224	5	15	5	15	17.6	32.3	21.0	35.8
1991	53,835	53,676	20,343	5	15	5	15	16.9	31.4	20.0	34.5
1992	79,883	67,968	16,115	5	15	5	15	16.2	30.4	19.0	33.2
1993	73,396	60,496	33,440	5	15	5	15	15.6	29.5	18.0	31.9
1994	80,555	72,746	37,243	5	15	5	15	14.9	28.6	17.0	30.7
1995	72,986	69,115	42,568	5	15	5	15	14.3	27.7	16.0	29.4
1996	56,617	50,361	14,865	5	15	5	15	13.6	26.7	15.0	28.1
1997	37,465	34,841	17,538	5	15	5	15	13.0	25.8	14.0	26.8
1998	44,915	32,264	14,612	5	15	5	15	12.3	24.9	13.0	25.6
1999	20,840	26,979	21,466	5	15	5	15	11.7	23.9	12.0	24.3
2000	21,328	25,287	34,666	5	15	5	15	11.0	23.0	11.0	23.0
2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 17
M(max)= 0.015 1SW(max) 8 MSW(max) 18

Appendix 7p Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Scotland)-W.

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	45287	26074	25	45	25	45	10	30	20	40
1972	31359	34151	25	45	25	45	10	30	19	39
1973	33317	33095	25	45	25	45	10	29	19	38
1974	43992	29406	25	45	25	45	9	29	18	38
1975	40424	27150	25	45	25	45	9	28	18	37
1976	38423	22403	25	45	25	45	9	28	17	36
1977	39958	20342	25	45	25	45	9	27	17	35
1978	45626	23266	25	45	25	45	9	27	16	34
1979	26445	15995	25	45	25	45	9	26	16	34
1980	19776	16942	20	35	20	35	8	26	15	33
1981	21048	18038	20	35	20	35	8	26	15	32
1982	32706	15062	20	35	20	35	8	25	14	31
1983	38774	19857	20	35	20	35	8	25	14	30
1984	37404	16384	20	35	20	35	8	24	13	30
1985	24939	19636	20	35	20	35	8	24	13	29
1986	22579	19584	20	35	20	35	7	23	12	28
1987	25533	15475	20	35	20	35	7	23	12	27
1988	30518	21094	20	35	20	35	7	22	11	27
1989	31949	18538	15	25	15	25	7	22	11	26
1990	17797	13970	15	25	15	25	7	21	10	25
1991	19773	11517	15	25	15	25	7	21	10	24
1992	21793	14873	15	25	15	25	6	21	9	23
1993	21121	11230	15	25	15	25	6	20	9	23
1994	18904	12658	15	25	15	25	6	20	8	22
1995	16935	9337	15	25	15	25	6	19	8	21
1996	9796	7559	15	25	15	25	6	19	7	20
1997	9407	5586	15	25	15	25	6	18	7	19
1998	8532	6984	15	25	15	25	5	18	6	19
1999	4343	3672	15	25	15	25	5	17	6	18
2000	5568	4487	15	25	15	25	5	17	5	17
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 7q Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FAROES

Year n/n+1	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	2620	105796	5	15	0	0	100	100	100	100
1972	2754	111187	5	15	0	0	100	100	100	100
1973	3121	126012	5	15	0	0	100	100	100	100
1974	2186	88276	5	15	0	0	100	100	100	100
1975	2798	112984	5	15	0	0	100	100	100	100
1976	1830	73900	5	15	0	0	100	100	100	100
1977	1291	52112	5	15	0	0	100	100	100	100
1978	974	39309	5	15	0	0	100	100	100	100
1979	1736	70082	5	15	0	0	100	100	100	100
1980	4523	182616	5	15	0	0	100	100	100	100
1981	7443	300542	5	15	0	0	100	100	100	100
1982	6859	276957	5	15	0	0	100	100	100	100
1983	15861	215349	5	15	0	0	100	100	100	100
1984	5534	138227	5	15	0	0	100	100	100	100
1985	378	158103	5	15	0	0	100	100	100	100
1986	1979	180934	5	15	0	0	100	100	100	100
1987	90	166244	5	15	0	0	100	100	100	100
1988	8637	87629	5	15	0	0	100	100	100	100
1989	1788	121965	5	15	0	0	100	100	100	100
1990	1989	140054	5	15	0	0	100	100	100	100
1991	943	84935	5	15	0	0	100	100	100	100
1992	68	35700	5	15	0	0	100	100	100	100
1993	6	30023	5	15	0	0	100	100	100	100
1994	15	31672	5	15	0	0	100	100	100	100
1995	18	34662	5	15	0	0	100	100	100	100
1996	101	28381	5	15	0	0	100	100	100	100
1997	0	0	10	20	0	0	100	100	100	100
1998	339	1,424	10	20	0	0	100	100	100	100
1999	0	0	10	20	0	0	100	100	100	100
2000	225	1,765	10	20	0	0	100	100	100	100
2001	0	0	0	0	0	0	100	100	100	100
2002	0	0	0	0	0	0	100	100	100	100
2003	0	0	0	0	0	0	100	100	100	100
2004	0	0	0	0	0	0	100	100	100	100
2005	0	0	0	0	0	0	100	100	100	100

M(min)=	0.005	Return time (m)=	1SW(min)	0	MSW(min)	1
M(max)=	0.015		1SW(max)	1	MSW(max)	2

Prop'n 1SW returning as grilse = min 0.170

max 0.270

Appendix 7r Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - WEST GREENLAND.

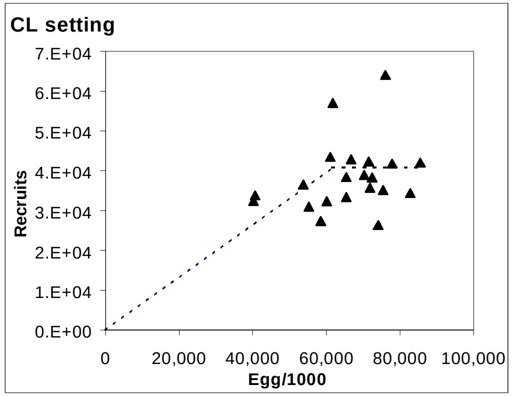
Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	856369	0	0	5	15	100	100	100	100
1972	0	614244	0	0	5	15	100	100	100	100
1973	0	560048	0	0	5	15	100	100	100	100
1974	0	535475	0	0	5	15	100	100	100	100
1975	0	650641	0	0	5	15	100	100	100	100
1976	0	386513	0	0	5	15	100	100	100	100
1977	0	442368	0	0	5	15	100	100	100	100
1978	0	293731	0	0	5	15	100	100	100	100
1979	0	417665	0	0	5	15	100	100	100	100
1980	0	370807	0	0	5	15	100	100	100	100
1981	0	398738	0	0	5	15	100	100	100	100
1982	0	346302	0	0	5	15	100	100	100	100
1983	0	100000	0	0	5	15	100	100	100	100
1984	0	95498	0	0	5	15	100	100	100	100
1985	0	301045	0	0	5	15	100	100	100	100
1986	0	316832	0	0	5	15	100	100	100	100
1987	0	305696	0	0	5	15	100	100	100	100
1988	0	280818	0	0	5	15	100	100	100	100
1989	0	117422	0	0	5	15	100	100	100	100
1990	0	101859	0	0	5	15	100	100	100	100
1991	0	178113	0	0	5	15	100	100	100	100
1992	0	84342	0	0	5	15	100	100	100	100
1993	0	2,000	0	0	-25	25	100	100	100	100
1994	0	2,000	0	0	-25	25	100	100	100	100
1995	0	32422	0	0	5	15	100	100	100	100
1996	0	31944	0	0	10	20	100	100	100	100
1997	0	21402	0	0	9	19	100	100	100	100
1998	0	3957	0	0	3	13	100	100	100	100
1999	0	6169	0	0	40	60	100	100	100	100
2000	0	8171	0	0	30	50	100	100	100	100
2001	0	0	0	0	0	0	100	100	100	100
2002	0	0	0	0	0	0	100	100	100	100
2003	0	0	0	0	0	0	100	100	100	100
2004	0	0	0	0	0	0	100	100	100	100
2005	0	0	0	0	0	0	100	100	100	100

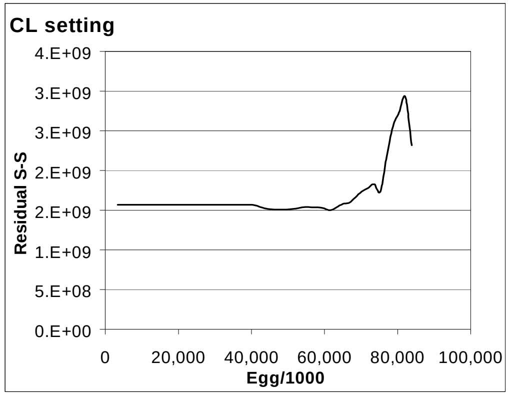
M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	8
M(max)=	0.015		1SW(max)	8	MSW(max)	10

APPENDIX 8

Appendix 8a Lagged egg deposition analysis and estimation of conservation limit options - FINLAND

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	5000	13000										
Fem	12%	77%		0.00	0.00	0.26	0.59	0.14	0.01			
1971	3,618	3,083	33,027							n/a	22,643	
1972	5,557	4,835	51,737							n/a	38,197	
1973	8,399	7,422	79,331							n/a	43,245	
1974	7,821	7,100	75,762	0						n/a	41,753	
1975	7,825	6,875	73,510	0	0					n/a	38,643	
1976	6,722	6,149	65,581	0	0	8,587				n/a	33,478	
1977	6,096	5,672	60,434	0	0	13,452	19,486			n/a	25,723	
1978	4,429	3,455	37,242	0	0	20,626	30,525	4,624		n/a	20,305	
1979	4,553	3,396	36,726	0	0	19,698	46,805	7,243	330	74,077	26,369	0.36
1980	4,501	4,617	48,919	0	0	19,113	44,699	11,106	517	75,436	35,161	0.47
1981	4,173	7,191	74,485	0	0	17,051	43,371	10,607	793	71,822	35,731	0.50
1982	2,979	7,983	81,700	0	0	15,713	38,693	10,291	758	65,455	33,385	0.51
1983	4,539	8,837	91,181	0	0	9,683	35,656	9,181	735	55,255	31,005	0.56
1984	5,685	7,177	75,252	0	0	9,549	21,973	8,461	656	40,638	33,843	0.83
1985	7,137	7,219	76,549	0	0	12,719	21,669	5,214	604	40,206	32,418	0.81
1986	7,175	4,840	52,756	0	0	19,366	28,862	5,142	372	53,742	36,580	0.68
1987	10,019	6,766	73,734	0	0	21,242	43,946	6,849	367	72,404	38,276	0.53
1988	6,820	5,391	58,052	0	0	23,707	48,203	10,428	489	82,827	34,390	0.42
1989	7,787	5,303	57,758	0	0	19,566	53,797	11,438	745	85,545	42,054	0.49
1990	7,804	5,506	59,798	0	0	19,903	44,399	12,765	817	77,884	41,788	0.54
1991	7,010	6,155	65,817	0	0	13,717	45,164	10,535	912	70,327	38,955	0.55
1992	11,433	6,092	67,837	0	0	19,171	31,126	10,717	753	61,766	57,028	0.92
1993	8,430	7,845	83,583	0	0	15,094	43,503	7,386	765	66,748	42,892	0.64
1994	5,699	6,038	63,855	0	0	15,017	34,251	10,323	528	60,118	32,391	0.54
1995	5,852	5,258	56,148	0	0	15,548	34,077	8,127	737	58,489	27,377	0.47
1996	12,435	4,065	48,149	0	0	17,112	35,281	8,086	581	61,060	43,504	0.71
1997	10,997	6,413	70,793	0	0	17,638	38,832	8,372	578	65,419	38,418	0.59
1998	13,201	5,710	65,078	0	0	21,732	40,024	9,214	598	71,568	42,296	0.59
1999	12,688	4,506	52,714	0	0	16,602	49,314	9,497	658	76,072	64,082	0.84
2000	13,463	10,202	110,199	0	0	14,598	37,674	11,702	678	64,653	39,935	0.62
2001	0	0	0	0	0	12,519	33,127	8,940	836	55,422	0	0.00
2002	0	0	0	0	0	18,406	28,408	7,861	639	55,314	0	0.00
2003	0	0	0	0	0	16,920	41,768	6,741	561	65,991	0	0.00
2004	0	0	0	0	0	13,706	38,396	9,911	481	62,494	0	0.00
2005	0	0	0	0	0	28,652	31,101	9,111	708	69,572	0	0.00
2006	0	0	0	0	0	0	65,017	7,380	651	73,048	0	0.00

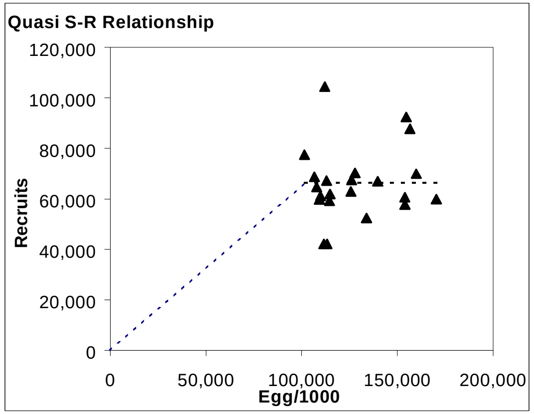


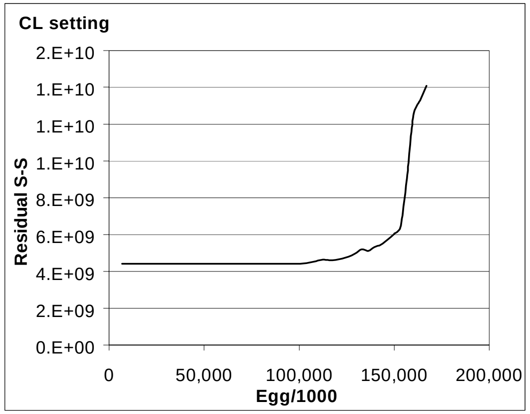


Conservation limit:			
Eggs /1000	1SW	MSW	Total salmon
61,593	9,112	5,607	14,718

Appendix 8b Lagged egg deposition analysis and estimation of conservation limit options - ICELAND-1

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	5725	10256										
Fem	56%	62%		0.08	0.49	0.35	0.08	0.00	0.00			
1971	27,188	10,673	155,031							n/a	98,732	
1972	27,937	13,684	176,579							n/a	98,849	
1973	27,362	13,045	170,672							n/a	94,442	
1974	18,496	12,112	136,317	12,247						n/a	80,407	
1975	25,608	13,748	169,517	13,950	76,585					n/a	91,258	
1976	20,791	12,304	144,894	13,483	87,230	54,726				n/a	81,010	
1977	22,640	12,331	150,995	10,769	84,312	62,332	11,627			n/a	92,914	
1978	29,587	15,128	191,051	13,392	67,340	60,247	13,243	465		154,688	92,428	0.60
1979	25,715	9,702	144,131	11,447	83,741	48,120	12,800	530	0	156,638	87,774	0.56
1980	16,215	10,927	121,469	11,929	71,578	59,840	10,224	512	0	154,082	57,749	0.37
1981	17,753	7,529	104,790	15,093	74,592	51,148	12,714	409	0	153,955	60,743	0.39
1982	13,105	7,472	89,527	11,386	94,379	53,301	10,867	509	0	170,443	59,890	0.35
1983	21,441	10,596	136,119	9,596	71,201	67,441	11,325	435	0	159,997	69,979	0.44
1984	14,792	8,104	98,957	8,278	60,005	50,878	14,329	453	0	133,944	52,401	0.39
1985	18,361	6,914	102,828	7,073	51,766	42,878	10,810	573	0	113,100	67,167	0.59
1986	27,789	9,300	148,226	10,753	44,226	36,991	9,110	432	0	101,513	77,415	0.76
1987	21,601	5,857	106,496	7,818	67,243	31,603	7,859	364	0	114,887	61,933	0.54
1988	41,829	5,168	166,964	8,123	48,885	48,050	6,715	314	0	112,087	104,517	0.93
1989	23,160	4,961	105,793	11,710	50,797	34,932	10,209	269	0	107,916	64,718	0.60
1990	22,495	5,048	104,218	8,413	73,223	36,298	7,422	408	0	125,765	62,920	0.50
1991	22,697	5,031	104,754	13,190	52,609	52,324	7,712	297	0	126,132	67,445	0.53
1992	25,634	6,496	123,490	8,358	82,480	37,593	11,117	308	0	139,856	67,000	0.48
1993	25,229	4,199	107,587	8,233	52,262	58,938	7,987	445	0	127,865	70,301	0.55
1994	21,886	5,685	106,315	8,276	51,484	37,345	12,522	319	0	109,946	61,186	0.56
1995	26,802	4,968	117,516	9,756	51,749	36,789	7,934	501	0	106,728	68,774	0.64
1996	22,483	3,902	96,889	8,499	61,004	36,978	7,816	317	0	114,615	59,207	0.52
1997	16,199	3,843	76,373	8,399	53,148	43,592	7,857	313	0	113,308	42,242	0.37
1998	22,398	2,583	88,236	9,284	52,520	37,978	9,262	314	0	109,358	59,821	0.55
1999	17,505	4,009	81,617	7,654	58,053	37,529	8,069	370	0	111,676	42,164	0.38
2000	12,546	1,643	50,670	6,033	47,863	41,483	7,974	323	0	103,677	26,753	0.26
2001	0	0	0	6,971	37,728	34,202	8,814	319	0	88,034	0	0.00
2002	0	0	0	6,448	43,589	26,960	7,267	353	0	84,615	0	0.00
2003	0	0	0	4,003	40,319	31,147	5,728	291	0	81,488	0	0.00
2004	0	0	0	0	25,031	28,811	6,618	229	0	60,688	0	0.00
2005	0	0	0	0	0	17,886	6,121	265	0	24,272	0	0.00



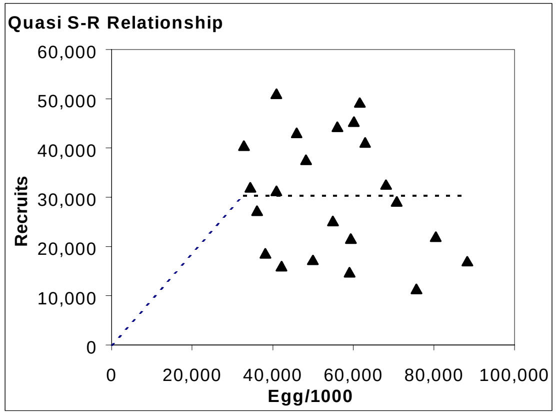


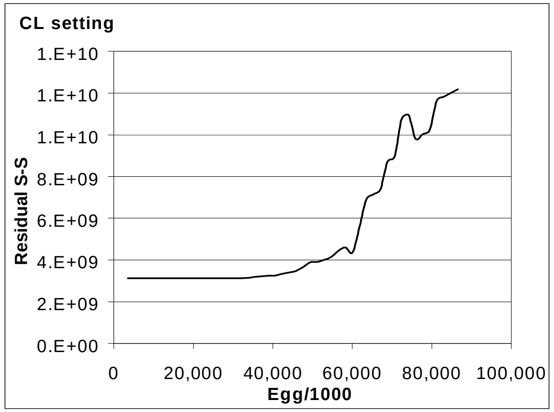
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
101,513	21,258	4,356	25,614

Appendix 8c Lagged egg deposition analysis and estimation of conservation limit options - ICELAND-2

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	5808	11776										
Fem	25%	66%		0.05	0.55	0.36	0.06	0.01	0.00			
1971	4,967	4,283	40,498							n/a	31,029	
1972	4,519	6,752	59,040							n/a	34,822	
1973	6,083	8,346	73,702							n/a	30,777	
1974	5,074	5,912	53,314	1,903						n/a	31,638	
1975	6,619	6,915	63,358	2,775	22,233					n/a	30,739	
1976	6,098	5,515	51,716	3,464	32,413	14,660				n/a	37,553	
1977	9,826	8,268	78,524	2,506	40,463	21,373	2,430			n/a	52,346	
1978	9,606	10,605	96,371	2,978	29,269	26,680	3,542	445		62,915	41,120	0.65
1979	9,241	6,848	66,640	2,431	34,784	19,300	4,422	649	0	61,586	49,219	0.80
1980	1,665	9,790	78,504	3,691	28,392	22,936	3,199	811	0	59,028	14,771	0.25
1981	7,569	3,466	37,926	4,529	43,110	18,721	3,801	586	0	70,748	29,155	0.41
1982	3,549	4,094	36,969	3,132	52,908	28,426	3,103	697	0	88,265	17,009	0.19
1983	4,818	2,940	29,847	3,690	36,585	34,886	4,711	569	0	80,442	21,981	0.27
1984	1,824	3,823	32,364	1,783	43,099	24,124	5,782	864	0	75,651	11,372	0.15
1985	10,679	2,373	33,948	1,738	20,821	28,418	3,998	1,060	0	56,036	44,325	0.79
1986	14,277	7,119	76,060	1,403	20,296	13,729	4,710	733	0	40,871	50,987	1.25
1987	8,598	6,750	64,949	1,521	16,386	13,383	2,276	864	0	34,429	32,007	0.93
1988	13,397	4,472	54,207	1,596	17,768	10,805	2,218	417	0	32,804	40,481	1.23
1989	6,979	3,863	40,155	3,575	18,637	11,716	1,791	407	0	36,125	27,248	0.75
1990	5,680	4,062	39,820	3,053	41,757	12,289	1,942	328	0	59,369	21,595	0.36
1991	9,087	3,178	37,894	2,548	35,657	27,534	2,037	356	0	68,131	32,580	0.48
1992	14,623	4,484	56,084	1,887	29,760	23,512	4,564	373	0	60,096	45,340	0.75
1993	12,027	4,813	54,867	1,872	22,045	19,623	3,897	837	0	48,273	37,598	0.78
1994	3,931	4,101	37,581	1,781	21,861	14,536	3,252	714	0	42,145	16,022	0.38
1995	9,972	2,591	34,615	2,636	20,804	14,415	2,409	596	0	40,860	31,305	0.77
1996	5,294	3,386	34,007	2,579	30,790	13,717	2,389	442	0	49,917	17,291	0.35
1997	7,700	2,041	27,043	1,766	30,122	20,302	2,274	438	0	54,902	25,181	0.46
1998	13,344	2,970	42,461	1,627	20,632	19,862	3,365	417	0	45,903	43,078	0.94
1999	6,219	4,929	47,339	1,598	19,004	13,604	3,292	617	0	38,115	18,626	0.49
2000	6,414	1,828	23,524	1,271	18,670	12,531	2,255	604	0	35,330	13,679	0.39
2001	0	0	0	1,996	14,847	12,311	2,077	413	0	31,643	0	0.00
2002	0	0	0	2,225	23,311	9,790	2,040	381	0	37,747	0	0.00
2003	0	0	0	1,106	25,989	15,371	1,623	374	0	44,463	0	0.00
2004	0	0	0	0	12,915	17,137	2,548	297	0	32,897	0	0.00
2005	0	0	0	0	0	8,516	2,840	467	0	11,823	0	0.00
2006	0	0	0	0	0	0	1,411	521	0	1,932	0	0.00



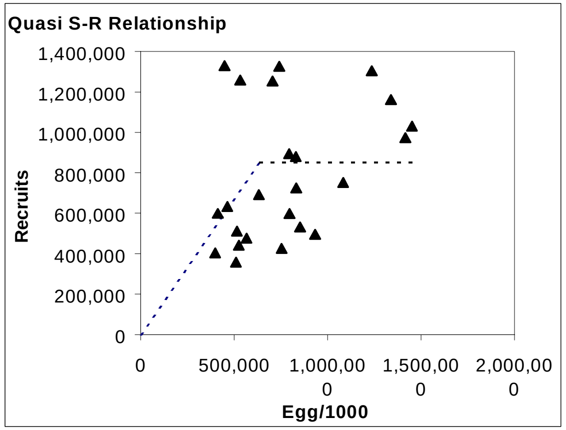


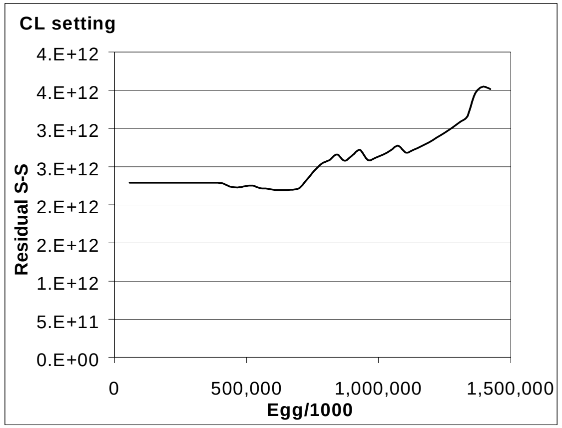
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
32,804	6,835	2,843	9,679

Appendix 8d   Lagged egg deposition analysis and estimation of conservation limit options - All IRELAND

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	3400	7000										
Fem	60%	85%		0.20	0.70	0.10	0.00	0.00	0.00			
1971	302,707	85,589	1,126,774							n/a	1,473,370	
1972	325,211	95,038	1,228,905							n/a	1,570,253	
1973	351,827	101,497	1,321,633							n/a	1,688,675	
1974	385,428	112,261	1,454,228	225,355						n/a	1,832,924	
1975	399,322	117,075	1,511,211	245,781	788,742					n/a	1,811,090	
1976	280,702	82,403	1,062,927	264,327	860,233	112,677				1,237,237	1,304,323	1.05
1977	250,728	72,311	941,739	290,846	925,143	122,890	0			1,338,879	1,163,026	0.87
1978	221,977	64,593	837,160	302,242	1,017,959	132,163	0	0		1,452,365	1,030,334	0.71
1979	198,718	57,364	746,703	212,585	1,057,848	145,423	0	0	0	1,415,856	972,673	0.69
1980	144,168	64,488	677,809	188,348	744,049	151,121	0	0	0	1,083,518	751,420	0.69
1981	93,324	37,881	415,771	167,432	659,217	106,293	0	0	0	932,942	495,993	0.53
1982	171,802	16,295	447,432	149,341	586,012	94,174	0	0	0	829,527	879,796	1.06
1983	293,850	48,243	886,500	135,562	522,692	83,716	0	0	0	741,970	1,326,481	1.79
1984	133,372	62,092	641,526	83,154	474,466	74,670	0	0	0	632,291	691,309	1.09
1985	252,505	54,563	839,761	89,486	291,040	67,781	0	0	0	448,307	1,329,195	2.96
1986	210,026	79,083	898,994	177,300	313,202	41,577	0	0	0	532,079	1,257,963	2.36
1987	156,203	63,679	697,543	128,305	620,550	44,743	0	0	0	793,598	894,008	1.13
1988	231,810	68,853	882,570	167,952	449,068	88,650	0	0	0	705,670	1,253,827	1.78
1989	153,411	38,875	544,263	179,799	587,833	64,153	0	0	0	831,784	725,099	0.87
1990	147,612	30,729	483,967	139,509	629,296	83,976	0	0	0	852,781	531,434	0.62
1991	107,278	22,321	351,655	176,514	488,280	89,899	0	0	0	754,693	425,903	0.56
1992	180,065	37,713	591,727	108,853	617,799	69,754	0	0	0	796,406	597,981	0.75
1993	100,868	20,414	327,233	96,793	380,984	88,257	0	0	0	566,035	476,305	0.84
1994	137,626	45,581	551,962	70,331	338,777	54,426	0	0	0	463,534	633,216	1.37
1995	128,585	45,258	531,598	118,345	246,158	48,397	0	0	0	412,901	599,599	1.45
1996	121,123	28,023	413,829	65,447	414,209	35,165	0	0	0	514,821	510,517	0.99
1997	96,019	16,374	293,303	110,392	229,063	59,173	0	0	0	398,628	403,938	1.01
1998	112,674	21,658	358,724	106,320	386,373	32,723	0	0	0	525,416	441,166	0.84
1999	88,681	15,822	275,051	82,766	372,118	55,196	0	0	0	510,080	357,119	0.70
2000	113,004	20,131	350,306	58,661	289,680	53,160	0	0	0	401,500	392,298	0.98
2001	0	0	0	71,745	205,312	41,383	0	0	0	318,440	0	0.00
2002	0	0	0	55,010	251,107	29,330	0	0	0	335,447	0	0.00
2003	0	0	0	70,061	192,535	35,872	0	0	0	298,469	0	0.00
2004	0	0	0	0	245,214	27,505	0	0	0	272,719	0	0.00
2005	0	0	0	0	0	35,031	0	0	0	35,031	0	0.00



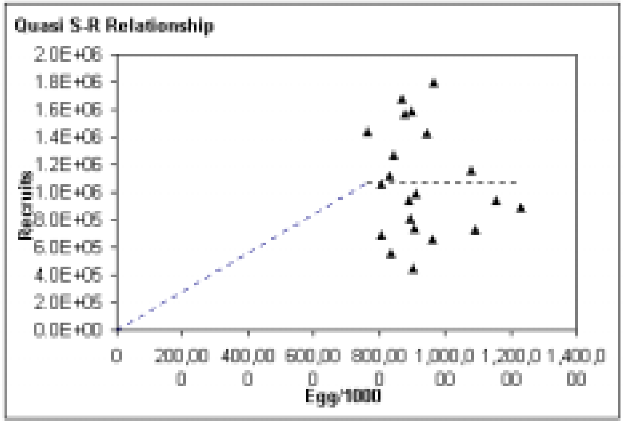


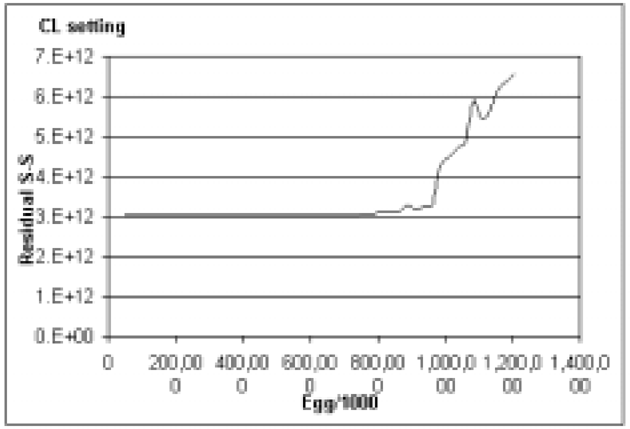
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
639,041	187,338	43,172	230,509

Appendix 8e Lagged egg deposition analysis and estimation of conservation limit options - NORWAY-Combined estimates

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	4500	10500										
Fem	45%	80%		0.00	0.10	0.70	0.20	0.00	0.00			
1971	112,989	69,680	659,878							n/a	1,193,884	
1972	143,226	91,802	861,494							n/a	1,415,936	
1973	159,750	100,065	944,045							n/a	1,454,014	
1974	149,441	96,746	898,591	0						n/a	1,379,396	
1975	139,390	90,273	845,108	0	98,982					n/a	1,309,892	
1976	138,127	89,963	841,112	0	129,224	316,741				n/a	1,277,479	
1977	138,968	87,322	823,263	0	141,607	413,517	191,365			n/a	1,108,516	
1978	146,808	60,530	641,361	0	134,789	453,141	249,833	46,191		n/a	1,436,889	
1979	167,840	104,838	989,813	0	126,766	431,324	273,773	60,305	6,599	898,766	1,592,653	1.77
1980	168,590	105,602	996,359	0	126,167	405,652	260,592	66,083	8,615	867,108	1,678,087	1.94
1981	118,454	112,054	972,622	0	123,489	403,734	245,081	62,901	9,440	844,647	1,271,561	1.51
1982	85,668	88,986	760,625	0	96,203	395,166	243,923	59,158	8,986	803,435	1,061,258	1.32
1983	162,735	96,806	924,827	0	148,472	307,848	238,746	58,878	8,451	762,396	1,438,781	1.89
1984	200,604	122,965	1,166,191	0	149,454	475,110	185,992	57,628	8,411	876,596	1,566,189	1.79
1985	217,418	107,235	1,076,479	0	145,893	478,252	287,046	44,895	8,233	964,318	1,796,358	1.86
1986	181,692	151,054	1,341,955	0	114,094	466,858	288,944	69,287	6,414	945,596	1,429,867	1.51
1987	153,372	109,054	999,911	0	104,052	365,100	282,060	69,745	9,898	830,856	1,116,128	1.34
1988	136,877	80,956	774,504	0	162,327	426,723	220,581	68,084	9,964	887,678	943,987	1.06
1989	232,306	82,075	916,170	0	149,412	552,786	316,140	53,244	9,726	1,081,288	1,157,534	1.07
1990	196,060	107,176	1,046,154	0	200,249	509,708	369,896	77,912	7,606	1,155,372	939,163	0.81
1991	177,060	91,101	903,800	0	155,967	652,898	332,798	91,202	0	1,232,865	889,417	0.72
1992	132,172	90,336	835,460	0	119,097	494,931	395,635	84,561	0	1,094,224	733,525	0.67
1993	131,235	82,114	774,951	0	144,712	381,222	285,501	93,173	0	904,808	739,878	0.82
1994	209,147	88,637	930,993	0	167,171	455,740	223,494	63,511	0	909,917	985,141	1.08
1995	112,737	96,188	843,189	0	128,495	622,810	269,106	50,691	0	961,103	658,282	0.68
1996	71,852	84,037	705,656	0	120,914	431,759	293,217	56,611	0	902,501	445,712	0.49
1997	110,598	61,359	696,622	0	94,938	401,781	275,219	62,966	0	834,893	563,513	0.67
1998	134,949	76,111	736,927	0	134,546	351,157	251,473	68,327	0	806,503	692,383	0.86
1999	145,123	88,903	840,396	0	129,166	447,480	266,936	61,292	0	894,874	811,780	0.91
2000	220,993	117,750	1,157,190	0	90,554	414,414	280,496	71,920	0	857,384	650,292	0.76
2001	0	0	0	0	78,558	324,889	243,991	68,471	0	715,910	0	0.00
2002	0	0	0	0	100,525	277,184	228,316	55,618	0	661,643	0	0.00
2003	0	0	0	0	108,177	346,735	190,294	61,896	0	707,102	0	0.00
2004	0	0	0	0	162,532	387,340	230,241	50,586	0	830,700	0	0.00
2005	0	0	0	0	0	550,323	271,455	59,426	0	881,203	0	0.00



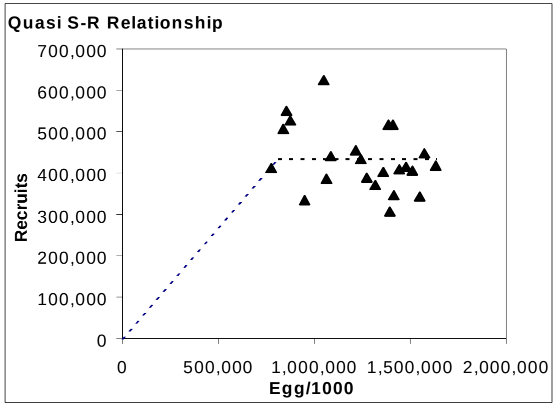


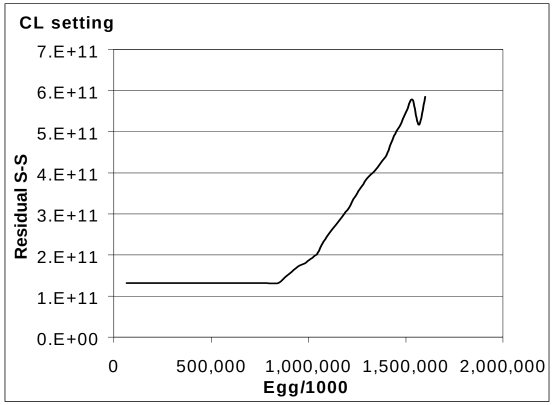
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
762,396	131,246	79,857	211,103

Appendix 8f Lagged egg deposition analysis and estimation of conservation limit options - RUSSIA

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	4500	10500										
Fem	45%	80%		0.00	0.10	0.70	0.20	0.00	0.00			
1971	62,664	103,303	994,638							n/a	359,283	
1972	68,357	86,456	864,652							n/a	510,861	
1973	115,174	144,145	1,444,044							n/a	577,404	
1974	105,098	133,315	1,332,668	0						n/a	640,415	
1975	112,326	167,537	1,634,772	0	99,464					n/a	591,223	
1976	84,457	143,134	1,373,355	0	86,465	696,246				n/a	443,811	
1977	71,963	107,395	1,047,847	0	144,404	605,256	198,928			948,588	334,401	0.35
1978	77,491	73,555	774,785	0	133,267	1,010,831	172,930	0		1,317,028	371,200	0.28
1979	89,202	81,104	861,908	0	163,477	932,868	288,809	0	0	1,385,154	516,834	0.37
1980	58,791	123,751	1,158,558	0	137,336	1,144,341	266,534	0	0	1,548,210	343,541	0.22
1981	42,648	67,750	655,460	0	104,785	961,349	326,954	0	0	1,393,088	306,874	0.22
1982	77,861	81,640	843,445	0	77,478	733,493	274,671	0	0	1,085,642	440,480	0.41
1983	112,832	131,593	1,333,865	0	86,191	542,349	209,569	0	0	838,110	506,854	0.60
1984	106,996	141,157	1,402,384	0	115,856	603,336	154,957	0	0	874,149	527,062	0.60
1985	140,906	156,615	1,600,901	0	65,546	810,991	172,382	0	0	1,048,918	624,926	0.60
1986	123,248	174,572	1,715,980	0	84,344	458,822	231,712	0	0	774,878	412,057	0.53
1987	206,629	81,709	1,104,782	0	133,386	590,411	131,092	0	0	854,890	550,474	0.64
1988	113,569	89,868	984,871	0	140,238	933,705	168,689	0	0	1,242,633	433,672	0.35
1989	166,498	141,562	1,526,284	0	160,090	981,669	266,773	0	0	1,408,532	516,470	0.37
1990	150,593	140,193	1,482,572	0	171,598	1,120,631	280,477	0	0	1,572,706	447,242	0.28
1991	162,266	120,994	1,344,938	0	110,478	1,201,186	320,180	0	0	1,631,845	417,715	0.26
1992	135,177	110,798	1,204,433	0	98,487	773,347	343,196	0	0	1,215,031	454,788	0.37
1993	111,613	164,447	1,607,370	0	152,628	689,410	220,956	0	0	1,062,994	386,103	0.36
1994	122,714	142,345	1,444,193	0	148,257	1,068,399	196,974	0	0	1,413,630	346,539	0.25
1995	109,835	103,469	1,091,554	0	134,494	1,037,800	305,257	0	0	1,477,551	415,331	0.28
1996	134,604	173,972	1,733,938	0	120,443	941,457	296,514	0	0	1,358,414	402,650	0.30
1997	125,987	140,456	1,434,957	0	160,737	843,103	268,988	0	0	1,272,828	388,905	0.31
1998	137,515	140,054	1,454,926	0	144,419	1,125,159	240,887	0	0	1,510,465	405,794	0.27
1999	94,955	139,284	1,362,269	0	109,155	1,010,935	321,474	0	0	1,441,565	408,886	0.28
2000	109,725	189,057	1,810,268	0	173,394	764,088	288,839	0	0	1,226,321	169,067	0.14
2001	0	0	0	0	143,496	1,213,756	218,311	0	0	1,575,563	0	0.00
2002	0	0	0	0	145,493	1,004,470	346,788	0	0	1,496,750	0	0.00
2003	0	0	0	0	136,227	1,018,448	286,991	0	0	1,441,666	0	0.00
2004	0	0	0	0	181,027	953,588	290,985	0	0	1,425,600	0	0.00
2005	0	0	0	0	0	1,267,188	272,454	0	0	1,539,641	0	0.00
2006	0	0	0	0	0	0	362,054	0	0	362,054	0	0.00





Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
815,922	75,479	80,808	156,287

Appendix 8g Lagged egg deposition analysis and estimation of conservation limit options - UK(Northern Ireland)-1

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition						Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	3400	6000		1 yr	2 yr	3 yr	4 yr	5 yr	6 yr			
Fem	60%	85%		20%	78%	2%	0%	0%	0%			
1971	25,959	5,410	80,546							n/a	148,818	
1972	21,015	4,539	66,019							n/a	123,149	
1973	19,914	3,957	60,806							n/a	115,871	
1974	23,788	5,051	74,287	16,109						n/a	138,122	
1975	16,910	3,560	52,652	13,204	62,826					n/a	96,870	
1976	11,756	2,576	37,121	12,161	51,495	1,611				65,267	69,660	
1977	12,156	2,466	37,378	14,857	47,429	1,320	0			63,607	71,624	1.13
1978	14,485	3,090	45,311	10,530	57,944	1,216	0	0		69,690	83,923	1.20
1979	11,317	2,416	35,408	7,424	41,068	1,486	0	0	0	49,978	68,410	1.37
1980	15,372	3,139	47,369	7,476	28,955	1,053	0	0	0	37,483	87,675	2.34
1981	10,852	2,246	33,594	9,062	29,155	742	0	0	0	38,960	67,936	1.74
1982	18,931	3,884	58,428	7,082	35,343	748	0	0	0	43,172	113,168	2.62
1983	25,556	5,455	79,955	9,474	27,618	906	0	0	0	37,998	143,044	3.76
1984	9,107	1,875	28,141	6,719	36,948	708	0	0	0	44,375	55,458	1.25
1985	12,298	2,593	38,311	11,686	26,204	947	0	0	0	38,837	74,227	1.91
1986	13,890	2,990	43,581	15,991	45,574	672	0	0	0	62,237	79,531	1.28
1987	10,490	1,440	28,744	5,628	62,365	1,169	0	0	0	69,162	46,233	0.67
1988	31,897	5,315	92,179	7,662	21,950	1,599	0	0	0	31,211	106,228	3.40
1989	10,929	2,873	36,946	8,716	29,883	563	0	0	0	39,162	108,571	2.77
1990	29,685	4,142	81,680	5,749	33,993	766	0	0	0	40,508	86,873	2.14
1991	14,517	1,807	38,832	18,436	22,420	872	0	0	0	41,728	52,544	1.26
1992	38,970	5,110	105,558	7,389	71,900	575	0	0	0	79,864	116,151	1.45
1993	61,047	16,293	207,630	16,336	28,818	1,844	0	0	0	46,997	118,551	2.52
1994	20,128	3,641	59,633	7,766	63,710	739	0	0	0	72,216	77,202	1.07
1995	19,803	2,815	54,758	21,112	30,289	1,634	0	0	0	53,034	70,647	1.33
1996	26,495	3,664	72,737	41,526	82,335	777	0	0	0	124,638	74,362	0.60
1997	32,276	4,788	90,264	11,927	161,952	2,111	0	0	0	175,989	97,708	0.56
1998	128,291	8,275	303,914	10,952	46,513	4,153	0	0	0	61,618	189,494	3.08
1999	14,445	2,869	44,101	14,547	42,711	1,193	0	0	0	58,451	49,070	0.84
2000	25,342	3,936	71,771	18,053	56,735	1,095	0	0	0	75,883	64,828	0.85
2001	0	0	0	60,783	70,406	1,455	0	0	0	132,643	0	0.00
2002	0	0	0	8,820	237,053	1,805	0	0	0	247,679	0	0.00
2003	0	0	0	14,354	34,399	6,078	0	0	0	54,831	0	0.00
2004	0	0	0	0	55,981	882	0	0	0	56,863	0	0.00
2005	0	0	0	0	0	1,435	0	0	0	1,435	0	0.00
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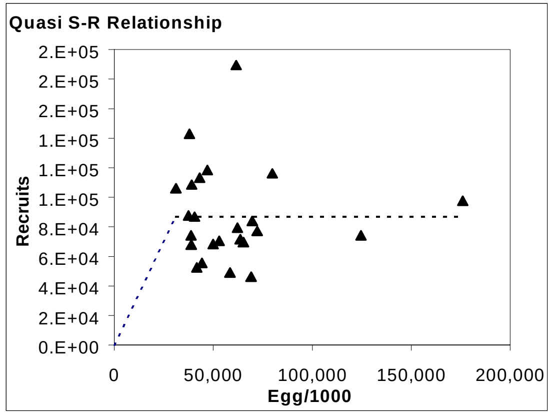

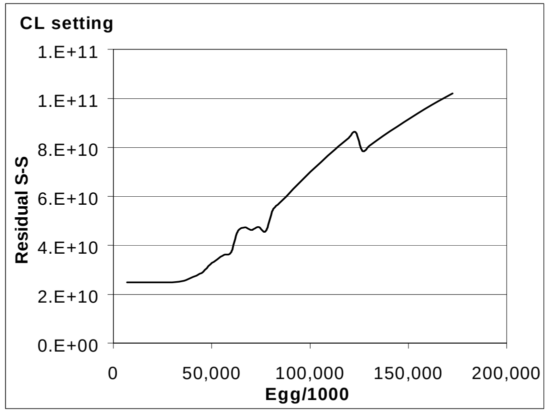

Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
31,211	12,156	1,683	13,839

Appendix 8h Lagged egg deposition analysis and estimation of conservation limit options - UK(Northern Ireland)-FCB area-(2)

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	3400	6000										
Fem	60%	85%		20%	78%	2%	0%	0%	0%			
1971	12,123	2,432	37,137							n/a	69,530	
1972	11,440	2,427	35,717							n/a	66,569	
1973	9,919	2,078	30,831							n/a	56,274	
1974	7,460	1,568	23,215	7,427						n/a	44,593	
1975	8,772	1,881	27,485	7,143	28,967					n/a	49,994	
1976	5,759	1,249	18,119	6,166	27,859	743				34,768	34,132	
1977	5,661	1,167	17,501	4,643	24,048	714	0			29,405	33,756	1.15
1978	7,876	1,682	24,645	5,497	18,107	617	0	0		24,221	45,572	1.88
1979	4,771	995	14,808	3,624	21,438	464	0	0	0	25,526	28,229	1.11
1980	5,335	1,086	16,424	3,500	14,133	550	0	0	0	18,183	31,392	1.73
1981	5,427	1,108	16,720	4,929	13,650	362	0	0	0	18,942	31,288	1.65
1982	4,658	964	14,420	2,962	19,223	350	0	0	0	22,535	28,703	1.27
1983	6,936	1,410	21,340	3,285	11,550	493	0	0	0	15,328	39,203	2.56
1984	3,662	760	11,350	3,344	12,811	296	0	0	0	16,451	21,889	1.33
1985	4,147	845	12,768	2,884	13,041	328	0	0	0	16,254	24,584	1.51
1986	4,313	945	13,618	4,268	11,247	334	0	0	0	15,850	25,125	1.59
1987	5,699	764	15,523	2,270	16,645	288	0	0	0	19,204	22,692	1.18
1988	10,678	1,756	30,740	2,554	8,853	427	0	0	0	11,833	34,184	2.89
1989	2,570	705	8,841	2,724	9,959	227	0	0	0	12,909	26,843	2.08
1990	7,476	1,020	20,450	3,105	10,622	255	0	0	0	13,982	22,035	1.58
1991	4,395	555	11,797	6,148	12,108	272	0	0	0	18,529	15,465	0.83
1992	8,935	1,218	24,437	1,768	23,977	310	0	0	0	26,056	27,404	1.05
1993	15,024	3,993	51,014	4,090	6,896	615	0	0	0	11,601	29,665	2.56
1994	6,049	1,105	17,975	2,359	15,951	177	0	0	0	18,488	23,463	1.27
1995	6,910	1,000	19,197	4,887	9,202	409	0	0	0	14,498	24,771	1.71
1996	9,262	1,351	25,784	10,203	19,061	236	0	0	0	29,500	25,860	0.88
1997	8,316	1,273	23,459	3,595	39,791	489	0	0	0	43,874	25,095	0.57
1998	32,049	2,075	75,962	3,839	14,020	1,020	0	0	0	18,880	48,281	2.56
1999	6,036	1,141	18,135	5,157	14,973	359	0	0	0	20,490	19,891	0.97
2000	8,563	1,331	24,256	4,692	20,111	384	0	0	0	25,187	22,252	0.88
2001	0	0	0	15,192	18,298	516	0	0	0	34,006	0	0.00
2002	0	0	0	3,627	59,251	469	0	0	0	63,347	0	0.00
2003	0	0	0	4,851	14,145	1,519	0	0	0	20,516	0	0.00
2004	0	0	0	0	18,920	363	0	0	0	19,282	0	0.00
2005	0	0	0	0	0	485	0	0	0	485	0	0.00
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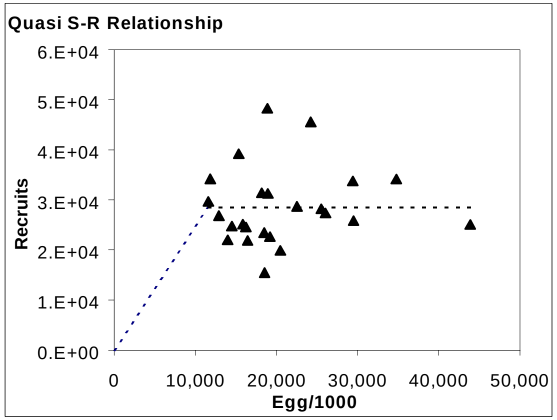
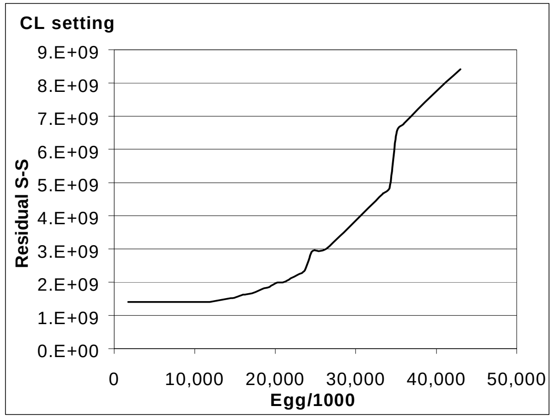


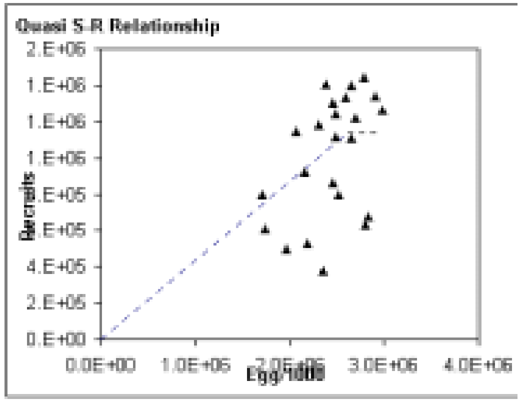


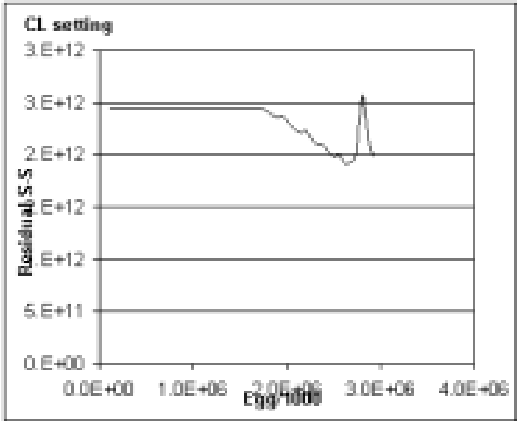
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
11,601	4,436	626	5,061

Appendix 8i Lagged egg deposition analysis and estimation of conservation limit options - UK(Scotland)-E

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10-3	Smolt age composition						Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	5000	10000		1 yr	2 yr	3 yr	4 yr	5 yr	6 yr			
Fem	40%	60%		5%	45%	45%	5%	0%	0%			
1971	492,226	205,749	2,218,946							n/a	1,653,885	
1972	510,308	279,165	2,695,609							n/a	1,725,582	
1973	618,764	328,952	3,211,243							n/a	1,739,243	
1974	598,360	267,075	2,799,153	110,947						n/a	1,784,339	
1975	468,774	314,692	2,825,697	134,780	998,526					n/a	1,249,059	
1976	383,046	163,692	1,748,246	160,562	1,213,024	998,526				n/a	1,175,918	
1977	431,596	228,365	2,233,380	139,958	1,445,069	1,213,024	110,947			2,908,988	1,341,951	0.46
1978	453,206	281,496	2,595,389	141,285	1,259,619	1,445,069	134,780	0		2,980,743	1,262,473	0.42
1979	473,856	244,970	2,417,533	87,412	1,271,564	1,259,619	160,562	0	0	2,779,157	1,441,499	0.52
1980	289,470	309,671	2,436,967	111,669	786,711	1,271,564	139,958	0	0	2,309,901	1,179,889	0.51
1981	367,233	333,247	2,773,949	129,769	1,005,021	786,711	141,285	0	0	2,062,786	1,145,083	0.56
1982	515,670	249,615	2,529,031	120,877	1,167,925	1,005,021	87,412	0	0	2,381,235	1,404,410	0.59
1983	538,420	300,683	2,880,940	121,848	1,087,890	1,167,925	111,669	0	0	2,489,333	1,245,286	0.50
1984	557,896	224,175	2,460,843	138,697	1,096,635	1,087,890	129,769	0	0	2,452,992	1,300,151	0.53
1985	449,518	246,160	2,375,996	126,452	1,248,277	1,096,635	120,877	0	0	2,592,240	1,334,446	0.51
1986	620,711	344,347	3,307,503	144,047	1,138,064	1,248,277	121,848	0	0	2,652,236	1,398,666	0.53
1987	486,190	245,391	2,444,723	123,042	1,296,423	1,138,064	138,697	0	0	2,696,227	1,221,715	0.45
1988	439,257	270,004	2,498,540	118,800	1,107,380	1,296,423	126,452	0	0	2,649,054	1,110,802	0.42
1989	504,840	244,587	2,477,204	165,375	1,069,198	1,107,380	144,047	0	0	2,486,000	1,118,908	0.45
1990	249,147	227,574	1,863,740	122,236	1,488,376	1,069,198	123,042	0	0	2,802,863	636,591	0.23
1991	209,720	170,703	1,443,662	124,927	1,100,125	1,488,376	118,800	0	0	2,832,228	677,342	0.24
1992	314,189	225,207	1,979,623	123,860	1,124,343	1,100,125	165,375	0	0	2,513,703	796,346	0.32
1993	315,811	220,887	1,966,942	93,187	1,114,742	1,124,343	122,236	0	0	2,454,508	864,898	0.35
1994	362,971	281,577	2,415,403	72,183	838,683	1,114,742	124,927	0	0	2,150,535	923,325	0.43
1995	348,742	264,829	2,406,457	98,981	649,648	838,683	123,860	0	0	1,711,172	794,800	0.46
1996	270,963	215,669	1,835,942	97,847	890,830	649,648	93,187	0	0	1,731,512	606,879	0.35
1997	194,392	164,386	1,375,101	120,770	880,624	890,830	72,183	0	0	1,964,407	496,838	0.25
1998	240,469	164,106	1,465,575	120,323	1,086,931	880,624	98,981	0	0	2,186,869	528,628	0.24
1999	127,896	149,801	1,154,596	91,797	1,082,906	1,086,931	97,847	0	0	2,359,481	382,989	0.16
2000	147,563	155,478	1,227,995	68,755	826,174	1,082,906	120,770	0	0	2,098,605	186,295	0.09
2001	0	0	0	73,279	618,795	826,174	120,323	0	0	1,638,571	0	0.00
2002	0	0	0	57,730	669,509	618,795	91,797	0	0	1,427,831	0	0.00
2003	0	0	0	61,400	519,569	669,509	68,755	0	0	1,309,233	0	0.00
2004	0	0	0	0	552,598	519,569	73,279	0	0	1,145,446	0	0.00
2005	0	0	0	0	0	552,598	57,730	0	0	610,327	0	0.00
2006	0	0	0	0	0	0	61,400	0	0	61,400	0	0.00



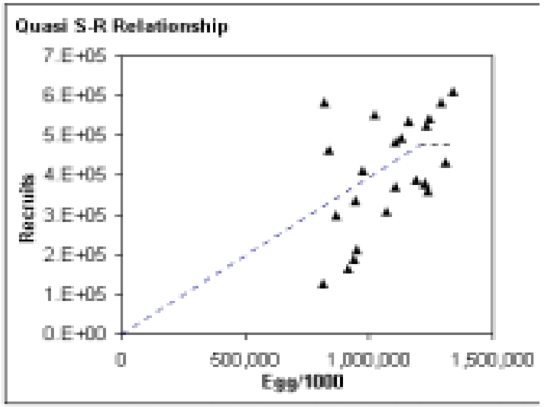


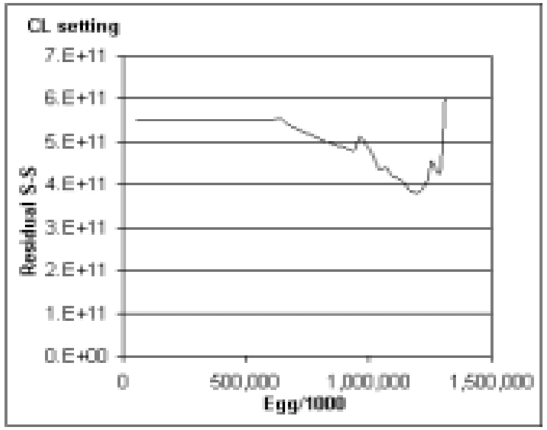
Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
2,623,054	384,875	308,884	693,759

Appendix 8j Lagged egg deposition analysis and estimation of conservation limit options - UK(Scotland)-W

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	5000	10000										
Fem	40%	60%		20%	50%	30%	0%	0%	0%			
1971	315,112	98,506	1,221,257							n/a	662,889	
1972	219,763	134,163	1,244,506							n/a	535,555	
1973	240,871	133,354	1,281,866							n/a	536,444	
1974	322,049	123,348	1,384,186	244,251						n/a	635,534	
1975	304,342	117,677	1,315,945	248,901	610,629					n/a	574,921	
1976	291,020	101,068	1,188,446	256,373	622,253	366,377				1,245,003	540,470	
1977	310,757	94,281	1,187,201	276,837	640,933	373,352	0			1,291,122	584,845	0.45
1978	364,938	109,584	1,387,383	263,189	692,093	384,560	0	0		1,339,842	610,157	0.46
1979	216,327	79,843	911,714	237,689	657,972	415,256	0	0	0	1,310,917	432,743	0.33
1980	149,556	76,662	759,082	237,440	594,223	394,783	0	0	0	1,226,446	381,620	0.31
1981	164,437	84,981	838,756	277,477	593,600	356,534	0	0	0	1,227,611	378,765	0.31
1982	256,184	74,080	956,846	182,343	693,692	356,180	0	0	0	1,232,195	524,768	0.43
1983	305,368	102,147	1,223,616	151,816	455,857	416,215	0	0	0	1,023,889	554,065	0.54
1984	306,963	89,921	1,153,454	167,751	379,541	273,514	0	0	0	820,807	584,512	0.71
1985	206,910	111,383	1,082,119	191,389	419,378	227,725	0	0	0	838,472	464,713	0.55
1986	191,025	115,996	1,078,024	244,723	478,423	251,627	0	0	0	974,773	412,357	0.42
1987	223,675	95,553	1,020,667	230,691	611,808	287,054	0	0	0	1,129,553	494,342	0.44
1988	280,748	135,359	1,373,650	216,424	576,727	367,085	0	0	0	1,160,236	535,523	0.46
1989	269,786	113,199	1,218,767	215,605	541,059	346,036	0	0	0	1,102,701	483,146	0.44
1990	153,736	87,406	831,908	204,133	539,012	324,636	0	0	0	1,067,781	310,432	0.29
1991	177,156	78,149	823,202	274,730	510,333	323,407	0	0	0	1,108,471	370,814	0.33
1992	197,649	105,784	1,030,001	243,753	686,825	306,200	0	0	0	1,236,779	361,309	0.29
1993	200,811	81,722	891,954	166,382	609,383	412,095	0	0	0	1,187,860	387,760	0.33
1994	184,678	99,602	966,970	164,640	415,954	365,630	0	0	0	946,224	337,609	0.36
1995	167,735	78,363	805,651	206,000	411,601	249,572	0	0	0	867,174	299,281	0.35
1996	98,454	66,253	594,425	178,391	515,001	246,961	0	0	0	940,362	189,460	0.20
1997	98,836	51,225	506,021	193,394	445,977	309,000	0	0	0	948,372	213,342	0.22
1998	92,991	69,782	604,673	161,130	483,485	267,586	0	0	0	912,202	164,248	0.18
1999	48,639	39,043	331,533	118,885	402,826	290,091	0	0	0	811,802	126,863	0.16
2000	63,295	51,641	436,433	101,004	297,213	241,695	0	0	0	639,912	76,231	0.12
2001	0	0	0	120,935	252,511	178,328	0	0	0	551,773	0	0.00
2002	0	0	0	66,307	302,336	151,506	0	0	0	520,150	0	0.00
2003	0	0	0	87,287	165,767	181,402	0	0	0	434,455	0	0.00
2004	0	0	0	0	218,216	99,460	0	0	0	317,676	0	0.00
2005	0	0	0	0	0	130,930	0	0	0	130,930	0	0.00
2006	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!





Conservation limit:

Eggs /1000	1SW	MSW	Total salmon
1,205,858	229,487	124,481	353,968

Appendix 8k Estimated numbers of fish killed and recruits from Monte Carlo simulation analysis - FAROES

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Est. mat. 1SW recruits mean	Variance	Est. non-mat. 1SW recruits mran	Variance	Total 1SW recruits means	SD	Prop'n wild
1971	12,358	9.08E+06	105,796	9.45E-08	2,717	5.27E+05	122,575	6.22E+06	125,292	2,598	1.00
1972	13,031	1.10E+07	111,187	1.36E-07	2,869	6.51E+05	138,149	7.32E+06	141,018	2,823	1.00
1973	14,802	1.37E+07	126,012	8.40E-08	3,263	8.53E+05	101,227	9.06E+06	104,490	3,148	1.00
1974	10,331	6.76E+06	88,276	7.88E-08	2,278	4.20E+05	122,803	4.53E+06	125,080	2,226	1.00
1975	13,210	1.07E+07	112,984	5.06E-08	2,908	6.39E+05	85,387	7.01E+06	88,296	2,766	1.00
1976	8,649	4.86E+06	73,900	2.34E-08	1,903	2.84E+05	59,691	3.17E+06	61,593	1,859	1.00
1977	6,110	2.23E+06	52,112	6.21E-09	1,342	1.28E+05	44,702	1.47E+06	46,045	1,264	1.00
1978	4,602	1.35E+06	39,309	1.07E-09	1,014	8.12E+04	74,756	9.72E+05	75,770	1,026	1.00
1979	8,152	4.41E+06	70,082	4.77E-10	1,796	2.69E+05	191,784	3.82E+06	193,580	2,022	1.00
1980	21,067	2.67E+07	182,617	1.20E-07	4,652	1.75E+06	321,621	1.87E+07	326,273	4,524	1.00
1981	35,317	7.72E+07	300,542	5.58E-07	7,778	4.73E+06	308,871	5.08E+07	316,649	7,453	0.98
1982	32,485	6.57E+07	276,957	6.49E-07	7,168	4.14E+06	244,092	4.25E+07	251,260	6,828	0.98
1983	36,381	4.51E+07	215,350	2.41E-07	8,020	3.28E+06	168,863	2.96E+07	176,883	5,737	0.98
1984	18,528	1.69E+07	138,227	8.97E-08	4,083	1.09E+06	175,039	1.15E+07	179,122	3,545	0.96
1985	14,816	2.04E+07	158,103	2.33E-07	3,264	1.17E+06	195,303	1.35E+07	198,567	3,834	0.92
1986	18,206	2.58E+07	180,934	2.16E-07	4,012	1.52E+06	183,050	1.69E+07	187,061	4,293	0.96
1987	15,123	2.28E+07	166,244	1.97E-07	3,334	1.29E+06	100,822	1.45E+07	104,155	3,973	0.97
1988	17,333	7.30E+06	87,629	4.92E-08	3,822	6.00E+05	137,412	5.07E+06	141,233	2,381	0.92
1989	12,865	1.31E+07	121,965	7.73E-08	2,834	7.68E+05	152,273	8.63E+06	155,107	3,065	0.82
1990	14,836	1.65E+07	140,054	1.05E-07	3,270	9.95E+05	97,862	1.06E+07	101,132	3,409	0.54
1991	8,584	6.09E+06	84,935	4.68E-08	1,892	3.52E+05	42,975	3.83E+06	44,867	2,046	0.54
1992	3,316	1.05E+06	35,700	7.04E-09	732	6.16E+04	33,079	6.81E+05	33,811	862	0.62
1993	2,690	7.29E+05	30,023	2.45E-09	594	4.23E+04	34,262	5.03E+05	34,856	738	0.69
1994	2,863	8.59E+05	31,672	5.85E-09	631	4.81E+04	37,434	5.75E+05	38,065	790	0.72
1995	3,130	1.00E+06	34,662	1.04E-08	688	5.45E+04	31,269	6.45E+05	31,957	837	0.80
1996	2,639	6.33E+05	28,381	6.03E-09	581	3.60E+04	2,071	3.98E+05	2,652	659	0.75
1997	0	0.00E+00	0	0.00E+00	0	0.00E+00	1,446	5.58E+01	1,446	7	0.80
1998	590	3.13E+03	1,424	1.75E-11	130	4.38E+02	463	2.18E+03	593	51	0.80
1999	0	0.00E+00	0	0.00E+00	0	0.00E+00	1,792	8.57E+01	1,792	9	0.80
2000	510	4.19E+03	1,765	3.10E-11	112	4.20E+02	400	2.77E+03	513	56	0.80
2001	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80
2002	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80
2003	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80
2004	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80
2005	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80

Stock composition	1SW	MSW
France	0.05	0
Finland	0.05	0
Iceland	0	0.006
Ireland	0.1	0.057
Norway	0.3	0.396
Russia	0.1	0.183
Sweden	0.05	0.023
UK(E&W)	0.1	0.023
UK(NI)	0.05	0
UK(Sc)	0.2	0.192
Other		0.122
Total	1	1.002

Appendix 8l   Estimated numbers of fish killed and recruits from Monte Carlo simulation analysis - WEST GREENLAND

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Estimated number 1SW recruits mean	Variance	Est. non-mat. 1SW recruits mean	Variance	Prop'n EU	European stock composition	MSW
1971	0	0.00E+00	951,713	9.69E+08	0	0.00E+00	1,040,849	1.89E+09	**0.50**	**France**	0.027
1972	0	0.00E+00	683,518	4.91E+08	0	0.00E+00	747,549	9.89E+08	**0.50**	**Finland**	0.001
1973	0	0.00E+00	623,043	4.02E+08	0	0.00E+00	681,415	8.21E+08	**0.50**	**Iceland**	0.001
1974	0	0.00E+00	595,929	3.70E+08	0	0.00E+00	651,746	7.34E+08	**0.50**	**Ireland**	0.147
1975	0	0.00E+00	723,169	5.53E+08	0	0.00E+00	790,896	1.08E+09	**0.50**	**Norway**	0.027
1976	0	0.00E+00	429,572	1.92E+08	0	0.00E+00	469,788	3.63E+08	**0.50**	**Russia**	0.000
1977	0	0.00E+00	492,205	2.52E+08	0	0.00E+00	538,302	4.96E+08	**0.50**	**Sweden**	0.003
1978	0	0.00E+00	326,682	1.04E+08	0	0.00E+00	357,281	2.14E+08	0.48	**UK(E&W)**	0.149
1979	0	0.00E+00	463,787	2.24E+08	0	0.00E+00	507,238	4.57E+08	0.50	**UK(NI)**	0.000
1980	0	0.00E+00	412,993	1.77E+08	0	0.00E+00	451,702	3.77E+08	0.52	**UK(Sc)**	0.645
1981	0	0.00E+00	443,665	2.01E+08	0	0.00E+00	485,228	4.10E+08	0.41		
1982	0	0.00E+00	385,618	1.54E+08	0	0.00E+00	421,732	3.03E+08	0.38	**Other**	
1983	0	0.00E+00	111,061	1.32E+07	0	0.00E+00	121,468	2.71E+07	0.60		
1984	0	0.00E+00	106,146	1.15E+07	0	0.00E+00	116,090	2.36E+07	0.50	**Total**	1.000
1985	0	0.00E+00	334,696	1.18E+08	0	0.00E+00	366,061	2.46E+08	0.50		
1986	0	0.00E+00	351,775	1.28E+08	0	0.00E+00	384,733	2.63E+08	0.43		
1987	0	0.00E+00	340,041	1.18E+08	0	0.00E+00	371,884	2.31E+08	0.41		
1988	0	0.00E+00	312,145	1.06E+08	0	0.00E+00	341,383	2.08E+08	0.57		
1989	0	0.00E+00	130,538	1.76E+07	0	0.00E+00	142,769	3.63E+07	0.44		
1990	0	0.00E+00	113,195	1.36E+07	0	0.00E+00	123,796	2.66E+07	0.25		
1991	0	0.00E+00	198,244	3.99E+07	0	0.00E+00	216,823	8.46E+07	0.35		
1992	0	0.00E+00	94,036	9.31E+06	0	0.00E+00	102,846	1.90E+07	0.46		
1993	0	0.00E+00	2,047	9.20E+04	0	0.00E+00	2,239	1.15E+05	**0.3**		
1994	0	0.00E+00	2,032	9.16E+04	0	0.00E+00	2,223	1.12E+05	**0.3**		
1995	0	0.00E+00	36,071	1.38E+06	0	0.00E+00	39,448	2.66E+06	0.32		
1996	0	0.00E+00	37,751	1.72E+06	0	0.00E+00	41,288	3.31E+06	0.27		
1997	0	0.00E+00	24,931	7.06E+05	0	0.00E+00	27,266	1.39E+06	0.20		
1998	0	0.00E+00	4,301	1.81E+04	0	0.00E+00	4,703	3.44E+04	0.21		
1999	0	0.00E+00	12,497	2.13E+06	0	0.00E+00	13,668	2.68E+06	0.10		
2000	0	0.00E+00	13,724	1.76E+06	0	0.00E+00	15,009	2.24E+06	0.30		
2001	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0.00		
2002	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0.00		
2003	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0.00		
2004	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0.00		
2005	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0.00		

APPENDIX 9

Data from Spain received after the Working Group meeting but included as an appendix for information

RIVER	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	X:1991-00	
BIDASOA	22	59	59	64	49	47	38	36	21	35	43	NAVARRA
PAS	453	86	16	77	36	106	30	12	19	7	84	CANTABRIA
NANSA	65	57	44	35	74	86	29	17	25	82	51	
ASON	101	226	75	76	86	66	48	16	32	48	77	
DEVA	2	66	20	5	23	209	46	8	7	95	48	
other	1	0	0	0	0	0	0	0	0	0	0	
DEVA-CARES	455	921	495	506	247	252	117	177	183	413	377	ASTURIAS
NARCEA	766	430	917	1038	836	401	270	365	394	643	606	
SELLA	297	543	423	581	219	192	130	259	447	440	353	
ESVA	204	169	331	201	175	142	55	66	64	102	151	
NAVIA	13	9	16	8	3	3	0	1	0	1	5	
EO	94	46	27	52	22	26	16	12	54	43	39	
other	3	6	21	7	5	9	6	4	1	18	8	
MASMA	84	32	24	22	5	13	3	2	2	6	19	GALICIA
MIÑO	29	38	3	17	12	18	8	0	0	0	13	
ULLA	33	21	1	4	1	2	1	0	0	0	6	
MANDEO	11	9	2	12	0	5	0	4	0	5	5	
other	3	7	16	9	0	2	0	2	0	0	5	
total catch Spain	2636	2725	2490	2714	1793	1579	797	979	1249	1938	1890	SPAIN