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Palægade 2–4 DK–1261 Copenhagen K Denmark

1 INTRODUCTION.. 1
1.1 Main Tasks.. 1
1.2 Participants.. 2

2 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA.. 3
2.1 Catches of North Atlantic Salmon.. 3
2.1.1 Nominal catches of salmon.. 3
2.1.2 Catch and release.. 3
2.1.3 Unreported catches.. 4
2.2 Farming and Sea Ranching of Atlantic Salmon.. 4
2.2.1 Production of farmed Atlantic salmon.. 4
2.2.2 Production of ranched Atlantic salmon.. 5
2.3 Update on the estimation of natural mortality at sea of Atlantic salmon.. 5
2.3.1 Methods and estimates of natural mortality (M) at sea.. 5
2.3.2 Calculation of marine mortality for two rivers in Quebec.. 6
2.4 Significant developments towards the management of salmon.. 6
2.4.1 Trends in sub-catchment populations of salmon in the River North Esk, UK (Scotland).. 6
2.4.2 Gyrodactylus salaris in Sweden.. 7
2.4.3 Considerations for examining the effects of fisheries on biological characteristics of Atlantic salmon stocks.. 8
2.4.4 Data Storage Tag (DST) tagging of pre-adult salmon.. 10
2.5 Long-term projections for stock rebuilding.. 11
2.5.1 Recovery trajectories for reductions in exploitation of Atlantic salmon across a range of stock recruitment functions and uncertainty.. 11
2.5.2 Atlantic salmon population viability analysis for Maine (USA) distinct population segment.. 12
2.5.3 Baltic Salmon Action Plan.. 13
2.6 Distribution, behaviour and migration of farmed salmon.. 14
2.6.1 Movements and distribution.. 14
2.6.2 Methodology to improve knowledge on the distribution and movements of escaped farmed salmon.. 15
2.6.3 Experimental tagging programme for investigating the behaviour of escaped farmed salmon.. 16
2.6.4 Sonic tracking of escapees in Maine (USA).. 16
2.7 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2002.. 17
2.7.1 Compilation of tag releases and finclip data for 2002.. 17

3 FISHERIES AND STOCKS IN THE NORTH-EAST ATLANTIC COMMISSION AREA.. 61
3.1 Fishing at Faroes in 2001/2002.. 61
3.2 Homewater fisheries in the NEAC area.. 61
3.2.1 Significant events in NEAC homewater fisheries in 2002.. 61
3.2.2 Gear.. 62
3.2.3 Effort.. 62
3.2.4 Catches.. 62
3.2.5 Catch per unit effort (CPUE).. 62
3.2.6 Age composition of catches.. 63
3.2.7 Farmed and ranched salmon in catches.. 63
3.2.8 National origin of catches.. 63
3.2.9 Summary of homewater fisheries in the NEAC Area.. 63
3.3 Status of stocks in the NEAC Area.. 64
3.3.1 Survival indices.. 64
3.3.2 The NEAC – PFA model.. 64
3.3.3 Sensitivity analysis of the PFA model.. 64
3.3.4 Grouping of national stocks.. 65
3.3.5 National input to the NEAC PFA model.. 65
3.3.6 Status of national stocks as derived from the PFA model.. 65
3.3.7 Summary of status of stocks.. 67
3.4 Development of Age-Specific Conservation Limits.. 67
3.4.1 Progress with setting river-specific Conservation Limits.. 67
3.4.2 Description of the national Conservation limits model.. 71
3.4.3 National Conservation Limits.. 71
3.5 Catch Options or Alternative Management Advice.. 72
3.5.1 Trends in the PFA for NEAC stocks.. 72

3.5.2 Forecasting the PFA for NEAC stocks ... 73
3.5.3 Management Advice ... 73
3.6 Evaluation of the effects on stocks and homewater fisheries of significant management measures introduced in the last 5 years ... 75
3.7 Estimate of by-catches of Post-Smolts in mackerel and other pelagic fisheries ... 76
3.7.1 Research surveys and distribution of salmon ... 76
3.7.2 By-catches of post-smolts and salmon ... 77
3.7.3 Description of mackerel and other commercial pelagic fisheries ... 79
3.8 Data deficiencies and research needs in the NEAC area ... 80
3.8.1 Salmon trawl [C]; Fish lift ... 124

4 NORTH AMERICAN COMMISSION ... 168
4.1 Description of Fisheries ... 168
4.1.1 Gear and effort ... 168
4.1.2 Catch and catch per unit effort (CPUE) ... 169
4.1.3 Origin and composition of catches ... 171
4.1.4 Exploitation rates in Canadian and USA fisheries ... 172
4.2 Status of Stocks in the North American Commission Area ... 173
4.2.1 Measures of abundance in monitored rivers ... 173
4.2.2 Estimates of total abundance by geographic area ... 174
4.2.3 Pre-fishery abundance estimates of non-maturing and maturing 1SW North American salmon .. 175
4.2.4 Spawning escapement and egg deposition ... 177
4.2.4.1 Egg depositions in rivers ... 177
4.2.4.2 Run-reconstruction estimates of spawning escapement ... 178
4.2.4.2 Escapement variability in North America ... 179
4.2.5 Survival Indices ... 180
4.2.6 Atlantic Salmon Recovery and Restoration Actions ... 181
4.2.7 Summary of status of stocks in the North American Commission Area ... 182
4.3 Evaluation of management measures ... 183
4.4 Update of age-specific stock conservation limits ... 184
4.5 Catch options or alternative management advice and assessment of risks relative to the objective of exceeding stock conservation limits ... 185
4.5.1 Catch advice for 2003 fisheries on 2SW maturing salmon ... 186
4.5.2 Catch advice for 2004 fisheries on 2SW maturing salmon ... 187
4.6 Biological sampling program for the Islands of Saint-Pierre and Miquelon ... 187
4.7 Data deficiencies and research needs in the North American Commission Area ... 188

5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION ... 228
5.1 Catch and effort in 2002 ... 228
5.1.1 Biological characteristics of the catches ... 228
5.1.2 Origin of catches at West Greenland ... 229
5.1.2.1 Continent of Origin ... 229
5.1.2.2 Origin of Atlantic salmon caught at West Greenland at a finer resolution than continent of origin ... 230
5.2 Status of the stocks in the West Greenland area ... 231
5.2.1 Southern European Stock ... 231
5.2.2 North American Stock ... 232
5.2.3 Evaluating Atlantic salmon biological data for phase shifts ... 232
5.3 Evaluation of the effects on European and North American stocks of the West Greenland management measures ... 234
5.4 Age-Specific Stock Conservation Limits for All Stocks in the West Greenland Commission Area ... 236
5.5 Catch Options with Assessment of Risks Relative to the Objective of Achieving Conservation Limits 236
5.5.1 Overview of provision of catch advice ... 236
5.5.2 Forecast models for pre-fishery abundance of 2SW salmon ... 238
5.5.3 Development and risk assessment of catch options for 2003 ... 240
5.5.3.1 Development of catch advice ... 240
5.5.3.2 Catch Advice for the NAC ... 242
5.5.3.3 Catch advice for combined NAC and NEAC PFA ... 243
5.6 Updates to and Critical Assessment of the 'Model' Used to Provide Catch Advice ... 243
5.7 Continuing Model Development ... 244
5.7.1 Juvenile Abundance Indices ... 244
5.8 Data Deficiencies and Research Needs in the WGC area ... 244

6 GENERAL RECOMMENDATIONS ... 280

6.1 Data deficiencies and research needs. ... 280
APPENDIX 1 ... 284
APPENDIX 2 ... 286
APPENDIX 3 ... 291
APPENDIX 4 ... 293
APPENDIX 5 ... 297

1 INTRODUCTION

1.1 Main Tasks

At its 2002 Statutory Meeting, ICES resolved (C. Res. 2002/2ACFM03) that the Working Group on North Atlantic Salmon [WGNAS] (Chair: Dr W Crozier, UK) will meet at ICES headquarters in Copenhagen, Denmark, from the 30 March-10 April 2003 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). 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 2002;	2.1 & 2.2
ii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.4
iii. provide long-term projections for stock rebuilding, focusing on trajectories for restoring stocks to target levels above conservation limits	2.5
iv. provide a compilation of tag releases by country in 2002.	2.7
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	Section
i. describe the events of the 2002 fisheries and the status of the stocks;	3.1-3.3
ii. evaluate the extent to which the objectives of any significant management measures introduced during the last five years have been achieved;	3.6
iii. further develop the age-specific stock conservation limits where possible based upon individual river-based stocks;	3.4
iv. provide catch options or alternative management advice, if possible based on a forecast of PFA, with an assessment of risks relative to the objective of exceeding stock conservation limits;	3.5
v. further refine the estimate of by-catch of salmon post-smolts in pelagic trawl fisheries for mackerel and provide estimates for other pelagic fisheries that may catch salmon;	3.7
vi. advise on an appropriate methodology to improve knowledge on the distribution and movements of escaped farmed salmon;	2.6
vii. identify relevant data deficiencies, monitoring needs and research requirements.	6
c) With respect to Atlantic salmon in the North American Commission area:	Section
i. describe the events of the 2002 fisheries and the status of the stocks;	4.1 & 4.2
ii. evaluate the extent to which the objectives of any significant management measures introduced during the last five years have been achieved;	4.3
iii. update age-specific stock conservation limits based on new information as available;	4.4
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	4.5
v. provide an analysis of existing biological and/or tag return data, and recommendations for required data collections, to identify the origin Atlantic salmon caught at St Pierre and Miquelon;	4.6
vi. identify relevant data deficiencies, monitoring needs and research requirements.	6

d) With respect to Atlantic salmon in the West Greenland Commission area:	Section
i. describe the events of the 2002 fisheries and the status of the stocks;	5.1 & 5.2
ii. evaluate the extent to which the objectives of any significant management measures introduced during the last five years have been achieved;;	5.3
iii. provide information on the origin of Atlantic salmon caught at West Greenland at a finer resolution than continent of origin (river stocks, country or stock complexes);	5.1
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	5.5
v. 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;	5.6 & 5.7
vii. identify relevant data deficiencies, monitoring needs and research requirements.	6
e) review the appropriateness, and possible development of, an experimental tagging programme for investigating the behaviour of escaped farmed salmon;	2.6

The Working Group considered 39 Working Documents submitted by participants (Appendix 1); other references cited in the report are given in Appendix 2.

1.2 Participants

Amiro, P.	Canada
Caron, F.	Canada
Chaput, G.	Canada
Crozier, W (Chair)	UK (Northern Ireland)
Erkinaro, J.	Finland
Fontaine, P.M.	Canada
Gudbergsson, G.	Iceland
Hansen, L.P.	Norway
Holm, M.	Norway
Jacobsen, J.A	Faroe Islands
Kanneworff, P.	Greenland
Karlsson, L.	Sweden
Legault, C.	USA
MacLean, J.	UK (Scotland)
Meerburg, D.J.	Canada
Ó Maoiléidigh, N.	Ireland
Prusov, S.	Russia
Reddin, D.G.	Canada
Russell, I.C.	UK (England & Wales)
Sheehan, T.	USA
Smith, G.W.	UK (Scotland)
Trial, J.	USA
Vauclin, V.	France
Whoriskey, F.	Canada

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 that are caught and retained. Total nominal catches of salmon reported by country in all fisheries for 1960-2002 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, relatively small numbers of ranched fish (see Section 2.2.2).

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

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

The provisional total nominal catch for 2002 was 2,625 tonnes, 439 t below the confirmed catch for 2001 (3,069 t). The 2002 catch was a little above the average of the last five years (2,598 t), but over 500 t below the average of the last 10 years (3,151 t). For the majority of countries, catches in 2002 were lower than those in 2001, although in five countries catches rose slightly on 2001. Catches were above the mean of the previous five years in nine countries, and in six of these countries catches were also above the 10-year mean.

Nominal catches in homewater fisheries split, where available, by sea-age or size category are presented in Table 2.1.1.2 (weight only) and Table 2.1.1.3 (numbers and weight). The data for 2002 are provisional and, as in Table 2.1.1.1, include both wild and reared salmon and fish farm escapees in some countries. Different countries use different methods to partition their catches by sea-age class and these are outlined 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 the nominal catch by country in homewater fisheries partitioned according to whether the catch was taken in coastal, estuarine or riverine areas. Overall, coastal fisheries accounted for 57% of catches in North East Atlantic countries in 2002, in-river fisheries 37% and estuarine fisheries 6%. In North America, coastal fisheries accounted for 10% of the catch in 2002, while in-river fisheries took 76% and estuarine fisheries 14%.

There is considerable variability in the percentage of the catch taken in different fisheries between individual countries. For some countries the entire catch is taken in freshwater, in other countries the majority of the catch is taken in coastal waters. Estuarine catches, where these occur, commonly comprise less than 25% of the nominal catch. Catch and release has become increasingly commonplace in some countries and these fish do not appear in the nominal catches. Data aggregated by region are presented in Figure 2.1.1.4. Overall in the NEAC northern area (Iceland, Norway, Russia, Finland and Sweden) around half the catch over the period 1995 to 2002 has been taken in estuarine waters and half in rivers; coastal catches comprise no more than 2% of the total. There is no trend over the period in the percentages taken in each area. In the NEAC southern area (France, Ireland, Spain, UK (N. Ireland), UK (Scotland) and UK (England & Wales)) estuarine fisheries have comprised a small (<20%) and relatively stable part of the catch. However, the percentage of the catch taken in coastal fisheries has increased over the period (50% in 1996 to 64% in 2002). This is thought to reflect increasing use of catch and release, since catches and effort in coastal fisheries has been reduced in many countries over the period. In North America, the majority of the catch has been taken in freshwater, and this has increased over the period (69 to 78%).

2.1.2 Catch and release

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

The nominal catches presented in Section 2.1.1 comprise fish which have been caught and retained and do not include salmon that have been caught and released. Table 2.1.2.1 presents catch-and-release information from 1991 to 2002 for six countries that have records; catch-and-release may also be practiced in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released: in 2002 this ranged from 16% in Iceland to 80% in Russia, reflecting varying management practices among these countries. Within countries, the percentage of fish released has tended to increase over time, and the rates in 2002 are the highest in the time series for three countries and among the highest for two other countries. There is also evidence from some countries that larger MSW fish are released in higher proportions than smaller fish.

Concerns have been expressed about the survival of fish following catch and release. However, various research studies have demonstrated that if fish are appropriately handled, mortality following capture is low and a large proportion of fish survive to spawn (Anon., 1998; Webb, 1998a and b; Whoriskey *et al.*, 2000; Dempson, *et al.*, 2002; Thorstad *et al.*, 2003). It is recognised, however, that fish are more likely to die when water temperatures are high (>20^{o}C) or if fish are 'played' for an extended period. In deriving river-specific conservation limits, Canada (various regions) and UK (England & Wales) make a small allowance for catch-and-release mortality. These correction factors vary: up to10% for Canadian Regions and 20% for UK (England & Wales).

2.1.3 Unreported catches

Unreported catches by year (1987-2002) 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 and updated for the NEAC Region in ICES 2002/ACFM:14. In practice, the estimation methods used by each country have remained relatively unchanged and thus comparisons over time may be appropriate. However, the estimation procedures vary markedly between countries. For example, some countries include only illegally caught fish in the unreported catch, while other countries include estimates of unreported catch by legal gear as well as illegal catches in their estimates. For France, the illegal catch is included in the nominal catch. Over recent years efforts have been made to reduce the level of unreported catch in a number of countries (e.g. through improved reporting procedures). The introduction of carcase tagging programmes in Ireland and UK (N. Ireland) in the last two years is also expected to lead to reductions in unreported catches.

The total unreported catch in NASCO areas in 2002 was estimated to be 1,039 t, a decrease of 12% on the estimate in 2001. The unreported catch in the North East Atlantic Commission Area in 2002 was estimated at 940 t, that for the North American Commission Area 83 t, with 10 t estimated for the West Greenland Commission Area. Figure 2.1.3.1 shows that the unreported catch has remained a relatively constant percentage of the total catch (~25-30%) since 1987.

Estimates for 2002 are presented by country in Table 2.1.3.2. Expressed as a percentage of the total North Atlantic catch (nominal and unreported), unreported catches for individual countries range from 0 to 15%. Relative to national catches, unreported catches range from 2% to 64% of country totals.

In the past, salmon fishing by non-contracting parties is known to have taken place in international waters to the north of the Faroe Islands. A total of 16 surveillance flights were made over the area in 2002, 14 by the Norwegian coastguard and 2 by the Icelandic coastguard. No sightings of vessels were made during these flights. However, none of the flights took place in the period from mid-September to late March, which is the period when previous salmon fishing has been reported. Nonetheless, there were no reports from ports in Norway, Faroes or elsewhere indicating that vessels fishing for salmon may be operating in international waters.

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 rose slightly in 2002 to 705,307 t a 1% increase on 2001 and a 15% increase on the mean of the previous 5 years (Table 2.2.1.1 and Figure 2.2.1.1). Most of the North Atlantic production took place in Norway (62%) and UK (Scotland) (23%). Production increased over the previous years in most countries, but fell by around a half in USA and Iceland.

World-wide, production of farmed Atlantic salmon in 2002 topped one million tonnes for the first time. Total production is estimated at 1,058,307 t, an increase of 30% on 2001 (Table 2.2.1.1 and Figure 2.2.1.1). Production outside the North Atlantic increased by 74% on 2001 to 353,000 t. The largest contribution to the farmed production outside the North Atlantic area was in Chile (273,000 t). World-wide production of farmed Atlantic salmon in 2002 was over 400 times the reported nominal catch of Atlantic salmon in the North Atlantic. Farmed salmon therefore dominate world markets.

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 can include fish collected for broodstock) (ICES 1994/Assess:16). The total production of ranched Atlantic salmon in countries bordering the North Atlantic in 2002 was 10 t, a reduction of 4 t on 2001 and the lowest value since 1980 (Table 2.2.2.1 and Figure 2.2.2.1). Salmon ranching (smolt releases) ceased in Iceland in 1998. Small catches of ranched fish were recorded in each of the three other countries reporting such fish (Ireland, UK(N. Ireland), and Norway). Production in these three countries includes catches in net, trap, and rod fisheries.

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

2.3.1 Methods and estimates of natural mortality (M) at sea

In 2002 the Working Group reviewed theoretical and empirical methods for estimating M for Atlantic salmon and applied the inverse-weight model to observations from the River Bush as well as to growth and abundance data of the River Trinité, LaHave River and Northwest Miramichi River (Canada) (ICES CM2002/ACFM: 14). The Working Group also considered a maturity schedule method to derive estimates of natural mortality at sea for stocks which mature at two or more different ages. Based on the analyses reviewed, the Working Group decided to continue use of the inverse-weight method as the basis of estimating M because the maturity schedule method yielded values of M that varied temporally and spatially, and it was not clear whether it was appropriate to apply values from this method to all stocks and the entire time series. However, the group determined that the most appropriate growth function for use with inverse-weight method was linear rather than the previously used exponential function. This change in growth function, plus analysis of data from additional rivers, resulted in the instantaneous monthly mortality rate used in the run-reconstruction model for the North American and NEAC areas to be changed from 0.01 to 0.03.

The Working Group reviewed an analysis of a more extensive data set from 5 rivers of the NEAC area and 6 rivers in the NAC area. The rivers with suitable data extended from the Scorff (France) to the North Esk (Scotland) and north to the Vesturdalsa River (Iceland). On the North American side, hatchery and wild stock data sets extended from the Scotia-Fundy region to the north shore of the St. Lawrence (Quebec) (Table 2.3.1.1). The time period analysed was from 1981 to 1999 in the NEAC area and 1970 to 1999 in the NAC area.

Both the inverse weight method and the maturity schedule method were applied to the sets with appropriate data. The analysis of the river-specific growth data supported the previous conclusion that a linear function characterized the observed weights at age in the marine phase better than the exponential function (Figure 2.3.1.1).

The results from the inverse-weight modelling using the linear growth function are summarized in Figure 2.3.1.2. The estimates of integrated monthly mortality in the second year at sea ranged from 1.4% to 4%, increasing from south (Scorff in France) to north (Vesturdalsa in Iceland). The mortality rate on the hatchery stock (Shannon River) was higher than on the wild stocks of the southern NEAC area.

For North America, the monthly mortality rates in the second year at sea ranged from 1.5% (de la Trinite River) to a high of just under 8% for the wild stocks but ranging to just under 10% for the hatchery stock of the LaHave River (Figure 2.3.1.2). The hatchery stock mortality rates were higher than the wild stock mortality rates.

The mortality rate estimates from the maturity schedule method were higher than those derived from the inverse-weight method. For the NEAC stocks, monthly mortality rates ranged between 5% and 19% in the second year at sea and for the NAC stocks, the mortality rates ranged from less than 1% to almost 22% per month (Figure 2.3.1.3). There is high interannual variation in the estimates.

Both the inverse-weight model and the maturity schedule model estimate mortality in the second year at sea based on the numbers of salmon alive at the 1SW and 2SW stages. If there are no fisheries on these age groups, then the mortality rates equate to M (natural mortality). If there are fisheries on the age groups and the removals are accounted for in the abundance at 1SW or 2SW, then the mortality estimates also equate to M. In cases where exploitation occurs in marine fisheries and the harvests are not accounted for, the mortality estimates equate to the total instantaneous mortality ($Z = F + M$). As an example, the estimates of Z for the Shannon River hatchery stock were derived using returns to the coast (factored from tag recoveries in the commercial fisheries) compared with returns to the hatchery in river (Table 2.3.1.2). The differences in the estimates represent the exploitation rate in the fishery. An analysis of changes in Z over time may provide an indication of the changes in F resulting from changes in exploitation if M is assumed to be constant over time.

The Working Group acknowledged that the additional analyses confirmed the previous conclusion that monthly mortality in the second year at sea was greater than 1% and distributed around 3%, at least for the wild fish. There are important differences among stocks and even regions which are not accounted for in the generalization over the entire NEAC and NAC areas. Exploration of the maturity schedule model for mortality requires inputs of abundance at sea by age of both males and females, a value which has to be frequently assumed for smolts and adult returns because of insufficient sampling. Adult sex ratios should generally be easy to obtain since these fish are exploited in fisheries. The sex ratio of smolts is more difficult to obtain because the research objective is to have the least impact on the population being monitored. However, hatchery stocking programs should at least attempt to confirm the sex ratio of the released smolts as this information will greatly enhance the exploration of trends in mortality at sea.

2.3.2 Calculation of marine mortality for two rivers in Quebec

The St-Jean and Trinité rivers provide information about smolt production and adult returns in Québec. This enables calculation of freshwater survival from egg to smolt , as well as marine survival from smolt to adult return.

A mark-recapture program has been used to estimate the smolt run. Annual smolt estimates have been available since 1989 (with the exception of 1997) on the St. Jean River and since 1984 on the Trinité River. Adult return is estimated by visual count in September on the St. Jean River and using a trap count on a fishladder on the Trinité River. Maiden spawners are 1SW or 2SW and, on the St-Jean River, a small proportion of 3SW.

Return rate of St. Jean River smolt varied from 2.1% in 1989 to 0.7% in 1996, for a mean value of 1.3% (Fig 2.3.2.1). Return rate of the year 2000 smolt cohort was 1.7%, higher than the average and the third highest value in the 11-year time series. Return rate of the 2001 cohort is known for 1SW returns. It was 0.5%, higher than the mean value of 0.4%.

On the Trinité River, smolt return rate at sea has fluctuated from 5.4% in 1988 to 0.7% in 2001 and shows a mean return rate of 2.5% (Figure 2.3.2.1). Return rate of the 2000 smolt cohort, the last one fully available, shows the lowest sea survival encountered in the 17-year time series, with a low of 0.4%. Sea return rate of the 2001 cohort is known for 1SW returns. It was 0.6%, two times higher than previous year, but only 40% of the mean value of 1.5%.

The downward trend observed with regard to return rate after the 1991 smolt year seems to be reversed in recent years on the St-Jean River but continues on the Trinité River, reaching a new low.

2.4 Significant developments towards the management of salmon

2.4.1 Trends in sub-catchment populations of salmon in the River North Esk, UK (Scotland)

Recent declines in nominal catches of salmon across the species range (ICES 2002/ACFM:14) have focused attention on current management practices and on the assessment methodologies which advise such practices. Ideally, management units should correspond to the way in which the salmon resource is structured. Our current understanding of the population structure of salmon returning to rivers in UK (Scotland) has been informed by a number of scientific investigations. Long term tagging studies associated with fish traps on upper catchment tributaries suggest that homing units, or populations, are spatially distributed over distances as small as ca. 10km (Youngson *et al*, 1994). Radio tracking studies of returning adult salmon have demonstrated that the time of entry into freshwater is related to spawning destination (Laughton and Smith, 1992; Webb 1998; Smith *et al,* 1998; Smith and Johnstone 1996; Webb, 1992; Walker and Walker, 1991) and that, within each sea age class, early running salmon tend to spawn in the upper areas of catchments while later running salmon, spawn in the lower reaches. This pattern is consistent among a range of river types (eg. large/small, complex/simple). Thus, run-timing is related to spawning destination, and furthermore, run timing has been shown to be a heritable attribute (Stewart *et al*, 2000).

The present study set out to investigate trends in stock size among particular sub-catchment groups within the river North Esk over the last 20 years, and the effects of recent local management initiatives aimed at protecting early running MSW salmon.

On the North Esk, a monitored river on the east coast of Scotland, a fish counter allows a direct count of adult fish past a particular point on the lower reaches of the river throughout the year. Such counts, together with the catch data from local fisheries allows estimates to be made of the fishery performance and stock levels at identifiable points within the lower river. Further, partitioning these counts and catches into seasonal components, permits such assessments to be made at sub-catchment scales. In the current study, trends in the fisheries and stock of the North Esk were assessed at a whole river level and for four age/seasonal run-timing components (early 1SW, late 1SW, early MSW and late MSW) for the period 1981-2001.

Analysis of annual count and catch data at whole river level shows that there has been a decreasing trend in the abundance of North Esk salmon to coastal waters, and similar decreasing trends in exploitation and catch, resulting in a stable number of salmon entering the river. Decreasing trends in in-river exploitation and catch have resulted in an increasing trend in potential spawners.

Although it was not possible to estimate the abundance of each seasonal component in coastal waters, analysis of the trends in abundance, exploitation and catch in the lower river for each of the four age/seasonal components of the stock suggest that there has been no trend in abundance over the study period (Table 2.4.1). However, the significance of the observed downward trends in lower river exploitation varies among the groups and as a result, increasing trends in the upper river abundance are significant for only the early 1SW and early MSW components. Due to the absence of any significant trends in exploitation and catch in the upper river, the increasing trends in lower abundance for the two early running components are also evident in the estimated abundance of potential spawners.

In summary, the results show that although the overall abundance of North Esk salmon returning to coastal waters has decreased, reduced exploitation has resulted in an increasing trend in the abundance of potential spawners. Further, local management actions to protect early running fish, the stock component thought to be most at rapidly declining (Youngson *et al*, 2002), appear to be having some effect. More generally, the analysis illustrates that trends in the abundance may vary among different stock components within a river system, as will the results of management measures that are implemented non-uniformly over a fishing season. There is thus a need to develop assessment methods that operate at scales that more closely mirror the population structure within river systems.

2.4.2 Gyrodactylus salaris in Sweden

The monogenean parasite *Gyrodactylus salaris* spread from the Baltic region to Norwegian rivers in the 1970s and its devastating impact on Norwegian wild salmon is well known (Johnsen and Jensen 1991). However, the effects of the parasite on Swedish west coast salmon have not been well described. The parasite was first found in this region in 1989 and since that time it has spread gradually. By autumn 2002, 11 out of a total of 23 wild salmon rivers harboured the parasite. These rivers are mainly located along the southern part of the west coast. A programme implemented to monitor the spread of the parasite to new rivers has been gradually improved, and parasite infestations in three infected rivers are also monitored annually.

Evidence that the parasite has had a negative impact on salmon in the region comes from trends in parr densities over time in infected and uninfected populations. In uninfected rivers, densities of older salmon parr, and to a smaller extent also 0+ parr, have generally been trending upwards between 1988 –2002, whereas in the same time period a number of infected rivers have had exhibited significant downward trends in parr densities. However, other factors such as low water discharges, may be partially responsible for the observed decreases.

Concurrent experimental infection trials were conducted in 2002 in both the laboratory (Veterinary Institute, Oslo) and in a streamside system using natural water and food from Sweden's Enningdalsälven River. Fish from a number of west coast populations were tested at both sites. Results from the Oslo work showed that while all the salmon were initially susceptible to the parasite, those from one system (Gullspångsälven) showed a decrease in infection levels with time. By contrast, in the streamside experiments, impacts of the infection were more varied. Initially, two groups showed high mortalities, but these may have been due to dramatic increases in temperature, low Flows, and the development of fungal infections. An increase in $\mathbf{F}_{low}$ rates eliminated the fungus and stopped the mortalities. Some of the fish from the Enningdalsälven River died from the infection later in the experiment, whereas others successfully fought it off. In addition, fish from the Rolfsån and Gullspångsälven systems did not show increased mortalities toward the end of the experiment, and 50% of the Gullspångsälven fish had freed themselves of the parasite by the time the trial terminated. The lesser impacts of the parasite under these more natural conditions may be due to water chemistry. One possible explanation is that the level of labile inorganic aluminium in the water used for the Swedish experiments was higher than that in the Oslo water (about 65 mg/l versus < 2 mg/l). Increased levels of inorganic aluminium have a negative impact on *G. salaris*, particularly at low pH (Soleng et al. 1999).

A large scale survey of the parasite in the Baltic river Torneälven in 2001 revealed that the parasite was common on salmon parr. This was in contrast to earlier investigations. The prevalence and intensity varied among different parts of the river (from 0% infected to 100% infected with up to 330 parasites per fish) which suggested that earlier studies on geographically limited scales studies may not have been able to adequately describe infestation levels. It is also possible that the abundance of the parasite has increased in recent years, when the parr densities in most Baltic rivers have increased dramatically, boosting the probability of transmission. It is not known if the parasite is also common in other Baltic salmon rivers.

Management approaches for *Gyrodactylus salaris* infestations in Sweden were similar to those adopted elsewhere in the Baltic region, where only few cases of negative impacts of the parasite have been described. In the last few years Sweden has begun to take the threat of the parasite more seriously, and infection with *Gyrodactylus salaris* became a notifiable disease in Sweden in 2002. There are also regulations concerning the release of fish in non-infected wild salmon rivers of the west coast. Releases of fish are allowed if they are from a hatchery free of the parasite. At this time it is also allowed to treat infected fish to kill the parasites before release, but this option is under debate and may be abolished.

2.4.3 Considerations for examining the effects of fisheries on biological characteristics of Atlantic salmon stocks

Fisheries are most frequently managed to ensure the achievement of spawning stock biomass or spawner objectives which are expected to ensure the long term sustainability of the resource. Fisheries can be selective for particular sizes of fish, because of the gear being used, or selective to particular run components because of restrictions in seasons. As a result responses to fisheries in addition to returns and spawners may be evident in other features of the salmon stock including:

- Increased juvenile abundance resulting from improved spawning escapement (which can be beneficial to future abundance)
- Variations in size of salmon (if sea fisheries are size selective, which may be beneficial to future abundance)
- Variations in proportions of age groups (if sea fisheries are age selective, which may be important for persistence)
- Variations in post-spawner and repeat spawner survival (which may be important for persistence)
- Variations in run-timing of fish into fresh water (which may benefit resource users, and benefit the resource).

The Working Group examined some examples of stock characteristics which could be used to evaluate the consequences of fisheries management, both in homewater and distant high seas fisheries. To address the issue of distant water fisheries which exploit primarily one maturing age group, a stock indicator (1SW-2SW relation) was presented which shows the benefits to home water returns of reductions in marine fisheries which may not be discernible by simply looking at abundance.

In 1984, the commercial fisheries of the Maritime provinces (Canada) were closed and anglers were prohibited from retaining large salmon (>= 63 cm fork length). The Newfoundland commercial fisheries were closed in 1992, in 1998 in Labrador, and by 2000 in all of eastern Canada.

Returns as indicators of stock responses to variations in fisheries exploitation:

A trends analysis of returns of small and large salmon to rivers of eastern Canada indicated that most of the rivers of Newfoundland showed an increasing trend in returns to rivers as a result of the commercial moratoria of 1992 but no such effect was evident in the Maritimes rivers where the local commercial fisheries had been closed since 1984 (Chaput and Prevost 1999). Returns of 1SW salmon and 2SW salmon did not improve in all rivers of the Maritimes after 1984. The closure of the remaining commercial fisheries in 1992 to 2000 did not result in increased returns to the rivers relative to the 1984-1991 period and in some cases, the abundance declined after 1992.

Egg depositions and juvenile abundance:

There were significant improvements in egg depositions in the Miramichi River but no improvements were observed in the Saint John River after the closure of the commercial fisheries in 1984 (Figure 2.4.3.1). The further closure of the remaining commercial fisheries post 1991 did not result in any improvements in egg depositions in the Miramichi but a significant decline in egg depositions was observed for the Saint John River post-1991 (Figure 2.4.3.1). The greatest increase in fry abundance occurred post 1991 in both the Northwest and Southwest Miramichi branches (Figure 2.4.3.1). Improvements in the parr abundance lagged those of fry and it wasn't until post-1991 that the average parr abundances increased in the Miramichi. Increased parr abundance was noted in the LaHave River through the 1972 to 1983 period but the juvenile abundance increased significantly after the closure of the commercial fisheries and imposition of mandatory catch and release (Figure 2.4.3.1). This contrasts with the Nashwaak River in which the parr densities declined after the 1984 closure and have since remained unchanged.

Increases in return rates of salmon to rivers:

Returns of adults adjusted for the number of smolts which produced them are the true indicators of benefits to stocks of reduced exploitation. Return rates of hatchery origin salmon were highest in the 1970s prior to the commercial fishery moratoria in the Maritimes of 1984 and the Newfoundland commercial fishery moratoria of 1992 (Figure 2.4.3.2). Had commercial fisheries been in operation, the return rates to rivers would have been lower still. In stocks where salmon mature at two sea ages, return rates alone are insufficient to infer levels of marine survival. In the Trinité River, survival in the first year at sea declined whereas measured survival in the second year at sea increased following the reductions and subsequently closure of the commercial fisheries in 1992 (Figure 2.4.3.2). This presents a different picture from that based on return rates which suggested that 2SW return rates were declining (Figure 2.4.3.2).

Increases in occurrence, abundance and return rates of repeat spawners:

Atlantic salmon returning to the Miramichi have been sampled during the entire spawning migration period at estuary trapnets from 1971 to 2002. After the closures of the commercial fisheries in 1984 and the mandatory release of all large salmon, the relative proportion and the absolute abundance of repeat spawners in the returns of large salmon have increased (Table 2.4.3.1). Since 1995, salmon with six previous spawnings have been observed in the returns to the Miramichi and salmon on the third to fifth spawnings are more abundant since 1992 (Table 2.4.3.1; Figure 2.4.3.3). There are fewer repeat spawner components in the Saint John River than in the Miramichi and there has not been any change in relative proportions over time as was seen in the Miramichi (Table 2.4.3.2). The post-spawner survival in the Saint John River is likely constrained by downstream fish passage through 2 to 3 hydro-generating facilities which cannot be managed like the fishing exploitation rates on the Miramichi stock. For the Saint John River, therefore, reduced fisheries exploitations have not resulted in improved post-spawner survivals.

Repeat spawner return rates for 2SW have been the highest during the 1992 to 2000 period whereas 1SW repeat spawner return rates have not increased significantly over the past 30 years (Figure 2.4.3.4). Since the return rates are relative to the abundance of maiden fish prior to in-river exploitation, return rates of 1SW salmon would be lower than on 2SW salmon because the former are still exploited in Native and recreational fisheries.

In addition to being more abundant in recent years, repeat spawners from the Miramichi grow substantially between spawning events and 1SW maiden salmon on their second spawning are as large as 2SW maiden fish and 2SW salmon are as large or larger than comparative 3SW salmon in other rivers (Figure 2.4.3.5). These larger fish of proportionally greater abundance in the river are of interest to the recreational fishermen, produce more eggs per fish than maiden spawners, and provide a buffer to the annual spawning escapement when smolt to maiden spawner survivals are low.

Change in size-at-age resulting from size-selective fishing:

Salmon fishing gears are potentially size-selective. In the Miramichi, the mean size of 2SW salmon increased in 1986. The 2SW salmon from 1999 to 2002 are the largest of the time series (Figure 2.4.3.6). The mean size of the 1SW salmon of the last four years is the largest of the time series and the change in size was also first observed in 1986 (Figure 2.4.3.6). An increase in mean size of 1SW salmon was observed in the Nashwaak River where mean size in 1972 and 1973 was 53-54 cm in contrast to the 56-58 cm mean size in the 1990s (Figure 2.4.3.6). In the Saint John River, the mean size of 1SW salmon averaged between 58 and 59 cm prior to 1986 and jumped to between 60 and 62 cm since (Figure 2.4.3.6). The change in mean size occurred in 1986 in both the Saint John and Miramichi samples when the commercial fisheries were supposedly closed in 1984. It is possible that exploitation with nets was still taking place on these stocks in 1984 and 1985.

Variations in run-timing:

Many historical commercial fisheries were prosecuted early in the season and frequently not in proportion to the timing of the fish entering the river. Evidence of the effect of fisheries exploitation in coastal waters relative to the time of entry of salmon to rivers is available from the Millbank index trapnet in the Miramichi River. The date of the 50th percentile of the count of large salmon at Millbank in the 1950 and 1960s was post Sept. 1 and it got rapidly earlier in 1970 to 1972 to the end of June or middle of July (Figure 2.4.3.7). Since 1984, the date of the median count has varied between the end of June and the end of August while in the 1990s, the median date oscillated around mid-August. Run-timing of both small and large salmon is currently bimodal with a peak in July and a second peak in late September.

Indications of homewater effects relative to variations in high seas exploitation:

The fishery at West Greenland exploits predominantly 1SW salmon destined to mature and return as 2SW salmon the following year. Significant associations between 1SW salmon returning to rivers in year and 2SW salmon returns in year+1 have been reported which suggests that there is an underlying stock-specific average maturation schedule for 1SW and 2SW age groups. Deviations from the relationship would result from disproportionate variations in first year and second year mortalities both natural and fisheries induced (because the fishery exploits one age group and not the other), variations in maturation profiles of males and females leading to deviations from average 1SW/2SW relationships (as influenced by the environment, for example). If a fishery exploits the 2SW age group but not the 1SW age group, then the 1SW/2SW ratio should be unnaturally high. If fisheries exploit 1SW age group preferentially, then the 1SW/2SW ratio would be unnaturally low. The absence of exploitation on one age group can be used to assess the relative impacts of the fishery on the other age group. Since 1992, there is essentially no exploitation on 1SW salmon in the marine environment. Variations in 2SW returns to eastern Canada, but specifically variations from the 1SW/2SW relationship, may be exaggerated by variations in fisheries harvests at West Greenland.

This effect was examined using data from the LaHave River, Saint John River at Mactaquac, and the Miramichi River. To assess whether there were any detectable effects on 2SW returns to rivers as harvests at Greenland varied, a covariance model was examined:

Ln(2SW returns in year+1) = Ln(1SW returns in year) + GN1
where GN1 = harvest of North American 1SW salmon at West Greenland in year

In both the LaHave and Southwest Miramichi relationships, the 2SW returns in 1993 are exceptionally low relative to the 1SW returns in 1992 (Figure 2.4.3.8). There is a negative association between the level of harvest at West Greenland and the difference from expected (based on the 1SW/2SW relationship) in the 2SW returns (Figure 2.4.3.9). For all rivers and stocks (wild, hatchery) examined, the correlation coefficient of GN1 was consistently negative.

For the Southwest Miramichi, Northwest Miramichi, and LaHave River wild salmon, including Greenland catch of North American origin 1SW salmon resulted in a reduction in the residuals of the 2SW prediction. For Nashwaak River and the hatchery salmon from the Saint John River, consideration of the Greenland harvest did not contribute to describing the variations in 2SW return corrected for variation in 1SW return the previous year (Figure 2.4.3.9). Variations in high seas exploitation at Greenland can be detected in the returns of 2SW salmon in home waters in the Maritimes, but only after correcting for the 1SW abundance of the same cohort.

Conclusions:

Characteristics other than returns should be considered when evaluating the effects of fisheries on salmon stocks. Responses in juvenile abundances and return rates to rivers provide direct indications of desired responses to stock management. In addition, life history features may also change including the relative and absolute abundances of repeat spawners, growth of salmon with repeat spawning events both of which provide additional spawners to the population and improved recreational fishing quality in rivers. Some commercial fisheries have been size-selective and focused on specific run components. Differential exploitation on faster growing fish or fish returning earlier may have genetic consequences. The examination of such characteristics is recommended since the conservation of Atlantic salmon involves more than maintenance of fish numbers.

The Working Group recommends that life history characteristics of salmon stocks including age structure, length at age, relative and absolute abundance of repeat spawners, run-timing and other such features be examined for Atlantic salmon stocks to ensure that conservation of salmon goes beyond considerations of abundance.

2.4.4 Data Storage Tag (DST) tagging of pre-adult salmon

Within the framework of a Nordic DST tagging programme started in 2002, a new salmon trawl design and a modified "Fish-lifter" (after Holst & McDonald 2000) was developed for the live capture of fish in post-smolt and mackerel investigations in the Norwegian Sea (Section 3.7.1). This was used by Norway, Faroes and Iceland to capture fish for tagging. The modified "Fish Lifter" allows most of the salmon to be taken with little or no external damage, making the catch fit for tagging and release. The new trawl design with lighter trawl doors gave a higher speed through the water (mean ~ 4.5 kt against ~ 3.5 kt previously). Possibly because of the higher trawling speed and maybe also due to lower sea temperatures, the Faroese and Icelandic research vessels captured an unprecedented number of large "autumn" post-smolts/ pre adults during late October 2002 to January 2003 (Table 2.4.4.1). In June –July while the Norwegian research vessel was fishing in the mid part of the Norwegian Sea, the catches of adult salmon stayed low, although a large number of post-smolts were taken. In the summer, however, the post-smolts were too small to be tagged with the DSTs available (38.4 x 12.5 mm)

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The tags were placed in the body cavity of the salmon through a small incision above the pelvic fins. Two types of tags were used, an "I- button" tag (Dallas Semiconductor) recording only temperature (memory capacity approx. 12,000 recordings) and a depth and temperature recording tag with a memory capacity of 21,738 measurements per parameter (Star Oddi "Micro"). The tags will record these parameters for two years during the time lapse from tagging to retrieval of the tags. The temperature regime encountered and the vertical migration patterns of the salmon can thus be followed for the marine feeding cycle, and in most cases also for the homing back to the river.

A total of 197 post-smolts, pre-adults (fish < 45 cm) and 26 adults were taken; 76 of these were tagged with the "Micro" tags, and 51 with "I-buttons" (Table 2.4.4.1). Figure 2.4.4.1 shows positions and numbers of fish taken in the areas where salmon were captured and released. About 50 % of the 17 adult salmon taken in the Norwegian cruise were fish farm escapees or maturing fish. This, together with the low number captured indicates that the areas around the Voering Plateau probably were surveyed too late to allow for sampling the densest cohorts of wild adult immature fish anticipated to be migrating northwards through these waters. One of the four fish tagged in the Norwegian Sea, turned up 18 days later in the bag net fishery in the Namsenfjord, Norway- a distance of ~ 480 km (Figure 2.4.4.1). The salmon taken in the Faroese tagging expedition were dominated by fish with 2 year smolt age, while 3 year and 1 year smolts made up ~ 20% and ~10 % respectively of the material analysed. In the Icelandic expedition, one fish carried an Irish microtag. All DST tagged fish were adipose fin clipped, but in the Icelandic expedition they were tagged with external tags (Floy tags) in addition. Once the fish are opened, the DST tags will be easily visible due to a fluorescent plastic tube attached to the tag body. The DSTs have a contact address and a reward announcement.

The results so far are a breakthrough in marine tagging of pre-adults and adults. Once the tags start to be returned expectedly starting with the fishing season in 2002, they will yield results of significance for the knowledge of the marine life cycle of the salmon. Records from retrieved tags will shed light on temperature regimes in the salmon habitats during the first and possibly the second winter, temperature preferences at different times of the year, and temperatures recorded may be related to individual growth. Vertical distribution in relation to temperature and diurnal vertical distribution and migrations can be detected. For the management of salmon the vertical distributions and temperature/growth relationships will be particularly valuable for assessing potential of salmon being intercepted by pelagic fisheries and for building predictive models.

2.5 Long-term projections for stock rebuilding

The term of reference (Aiii) to ICES was to "provide long-term projections for stock re-building, focusing on trajectories for restoring stocks to target levels above conservation limits". Trajectories for stock rebuilding depend on many parameters which are not known with certainty or which may change over time. It is not possible to establish generalised trajectories for all stocks contributing to national or continental stock complexes as the range of uncertainty, both presently and in the future would lead to spurious projections over time on these larger scales. This is because the rate at which a stock complex will recover depends on the existing productive capacity of each individual stock under the prevailing conditions e.g. of exploitation, marine survival and effective intervention. Therefore, in order to address this request the Working Group considered theoretical rebuilding trajectories for stocks with known stock and recruitment parameters (Section 2.5.1) and the probability of extinction under different circumstances for some stocks in the USA which are well below their conservation limits (Section 2.5.2). The programmes for rebuilding salmon stocks in North America are described separately in Section 4.2.6. An example of a large-scale international stock rebuilding programme for Baltic salmon stocks is provided to illustrate the rate of recovery of stocks currently undergoing restoration and rebuilding (Section 2.5.3). The difficulty in rebuilding salmon stocks which have fallen below S_{lim} is illustrated and the need to maintain all salmon stocks at or above this level is emphasised. The conditions under which stock rebuilding can be carried out are simulated and discussed.

2.5.1 Recovery trajectories for reductions in exploitation of Atlantic salmon across a range of stock recruitment functions and uncertainty

Stock and recruitment curves representing highly productive stocks through low productive stocks were applied to a forward projecting stochastic framework that could produce recovery trajectories for a variety of states and exploitations. The purpose of this exercise was to estimate recovery times and frequency of achieving conservation over a 50 year time frame under a range of exploitation.

Parameters for Ricker stock and recruitment functions were obtained from SALMODEL (Anon 2003, Table 4.2) for the rivers Bush, North Esk and Nivelle. Although no North American river examples are presented, the H' parameters (exploitation at optimum spawning stock abundance) were within the known range of 11 North American rivers. Similarly, the age structure of the River North Esk population is only out of phase by 1 age class compared to many North American stocks.

H' and R' (recruitment at optimum spawning stock) parameters were used to obtain the Ricker parameters alpha (α-productivity) and beta (β) for the formula:

$$R = \alpha * S * Exp(-\beta * S)$$

Alpha was calculated according to the formula:

$$\alpha = Exp(H'/(1-H'))$$

and Beta was calculated as:

$$\beta = H'/((1-H')*R')$$

Spawning stock at optimum recruitment (S_{lim}) was:

$$S_{\lim} = (1-H')*R'$$

Projections were dependent on partial recruitment vectors particular for the river i.e. age structure, relative fecundity and mortality. A fully recruited age structure (i.e. all age classes expected are present and in the correct proportion) is assumed prior to initialisation of the model. Therefore, obtaining recruits for 7 years (the longest period required to obtain complete recruitment) initializes projections at the selected starting stock size before accumulating recruits for any trajectory. Error in trajectories was introduced by selecting a new value of *alpha* and *beta* for each year from the normal distribution of H' and the log normal distribution of R' reported. The reported stock recruitment scale was eggs*m^{-2}. Preliminary exploration of the models indicated the need for an egg density cap to constrain depositions in the stochastic trajectories. This was accomplished by constraining alpha to values less than 20.

Starting spawning stock sizes were 10% of S_{lim} and 50% of S_{lim}. Projections were run using exploitations of 0% (no exploitation), 50% of the current river exploitation, at the current exploitation rate and at H'. Forward simulations were run 10,000 times in an @Risk© framework in Excel© and the aggregated output collected to produce a trajectory with mean and variance for each year. The number of years required to rebuild to S_{lim} as well as the number of years during the 50 year projection below the S_{lim} were recorded for each simulation.

The alpha determinations ranged from a high of 14.93 for the Bush River, 2.13 for the North Esk and a low of 1.85 for the Nivelle (Table 2.5.1.1). Projections typically resulted in occasional highs and lows in a single trajectory however the 90% range of values generally followed the deterministic function (Figure 2.5.1.1). The years to recovery ranged from 1 to 50 years, the limit of the projections (Table 2.5.1.2; Figure 2.5.1.2).

The proportion of years with values lower than S_{lim} ranged from 0.13 to 1 depending mostly on alpha and exploitation. This proportion for populations at less than S_{lim} and at H' was 0.49 for the high alpha, which is the expectation for a productive population managed at H' and based on well-defined parameters (Table 2.5.1.3). However, at lower alpha the frequencies were much greater (0.97 and 1) indicating high sensitivity of S_{lim} to variance in the parameters at low alpha values.

The number of years to recovery was unobtainable in fifty-year projections in a low productivity and possibly unobtainable in a moderate productivity river. This was because the recovery time in years was more dependent on the value of alpha (productivity) than the start point. The time to recovery and the proportion of annual recruitment less than the S_{lim} increased with lower productivity and the starting point. Recovery was particularly sensitive to increasing exploitation at lower alpha.

The data and analysis indicate that there is an increased probability of not achieving S_{lim} with increased exploitation and lower alpha. The model did not incorporate demographic stocasticity i.e. uncertainty in sex ratio, fecundity etc. or environmental stocasticity i.e. annual variations in survival that could eliminate a year class at low populations, that can lead to extirpations. Therefore while this model may not be a reliable indicator of population viability, it can provide reasonable indications of management actions concerning S_{lim} and exploitation. The analysis suggests that increased caution needs to be taken when assigning exploitation to low productivity stocks. It also suggests that current management strategies for mixed stock fisheries are likely to fail to protect "the weakest link" i.e. those stocks that are far below their S_{lim} and of low productivity. Similarly, expected contributions to rebuilding from restocking programmes may also be confounded by prevailing low levels of marine survival, high or variable exploitation rates and even negative interactions between hatchery reared fish and their wild counterparts (McGinnity et al, 1998, Ferguson et al, 2002).

2.5.2 Atlantic salmon population viability analysis for Maine (USA) distinct population segment

A population viability analysis (PVA) model has been developed for Atlantic salmon in Maine. This model incorporates uncertainty in juvenile and adult survival rates, direct and indirect linkages among populations in different rivers, and a number of potential human removals or stocking in a flexible, modular Fortran program named SalmonPVA. The structure of the model is based on a state-space approach with a detailed life history cycle. Multiple cohorts in multiple rivers progress through their life history based on stage specific survival rates and fecundity with limits imposed by riverine habitat capacity. The model projects the populations forward in time, usually 100 years, numerous times with stochastic variables selected based on a Monte Carlo approach to calculate the probability of extinction. This model is being developed with input from scientists and policy makers from NOAA Fisheries, US Fish and Wildlife Service, Atlantic Salmon Commission, and the University of Maine. Results from this model will form the basis for delisting criteria in the Recovery Plan for the Maine Distinct Population Segment which was listed as Endangered in 1999.

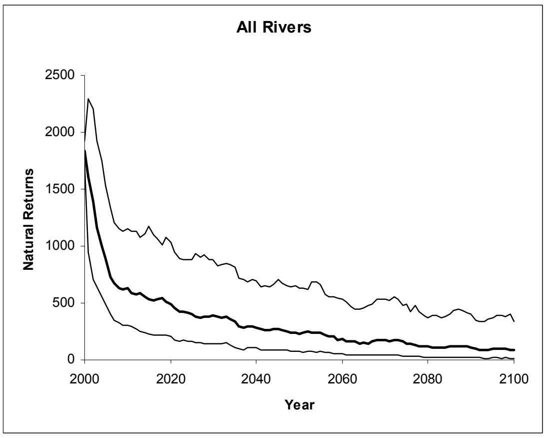
The SalmonPVA model is structured to represent Atlantic salmon life history characteristics in the US. For example, most fish spend two or three years in the river and two years at sea before returning to the river to spawn. However, there is the possibility to return from sea after one or three years and the model will soon be modified to allow five years in freshwater. Inputs to the model allow for a wide range of simulations. The number of rivers is a dynamic variable limited only by the computer running the program. The linkages among rivers are determined on input and allow for various straying hypotheses as well as linkages among juvenile survival rates due to year effects. The habitat capacity limits will soon be expanded to all juvenile life stages. This, combined with the approach used for fecundity, will produce a Beverton and Holt type spawner-recruitment relationship. This will underestimate the probability of extinction when populations are large relative to a Ricker type spawner-recruitment relationship. The populations are currently so low that this concern is minimized. A number of human removals from the populations are allowed, but not required, by the model including interception fisheries at sea, river fishing, and broodstock removals of either returning adults or parr. Stocking of any life stage during any year of the simulation is possible. These stocked fish are followed in a separate matrix in the program from the natural fish to allow for different survival rates or removals. The offspring from the hatchery matrix are added to the natural matrix so that hatchery populations disappear if stocking is discontinued. The model allows direct examination of specific simulations as well as summarizes results from the total number of simulations conducted. The probability of extinction is the most important output, but trends in adult returns can also be enlightening, especially when trends are detected. This is because a five percent chance of extinction in one hundred years has different implications if the overall trend for the population is increasing or decreasing over the projected time series.

The SalmonPVA model was run using example ranges of survival rates for all life stages under conditions of no stocking and initial population sizes set at the conservation spawning escapement levels (CSE) for the eight rivers in the Maine DPS. Assumptions were made regarding straying, fishing, broodstock removal, etc. to demonstrate the bottom line predictive power of the model. Projecting the populations for 100 years for 10,000 iterations produced a low probability (0.2%) of all eight rivers going extinct, with high probabilities (45-84%) of individual rivers becoming extinct (see text table below).

Probability of extinction when all rivers seeded with CSE levels of 2SW returns, no stocking occurs, and example ranges of survival by life stage are assumed.

Rivers : DE=Dennys, EM=East Machias, MC=Machias, PL=Pleasant, NG=Narraguagus, CB=Cove Brook, DT=Ducktrap, SHP=Sheepscot

River	Probability
DE	**18.2**
EM	**12.2**
MC	**6.1**
PL	**27.9**
NG	**6.7**
CB	**83.7**
DT	**44.7**
SHP	**18.3**
ALL	**0.2**



Although the probability of extinction for all eight rivers combined is low, examination of the time trend during the 100 year projection shows that the combined returns are continuing to decline and may go extinct if more years were projected (see panel above).

2.5.3 Baltic Salmon Action Plan

The Baltic Salmon Action Plan (SAP), launched by the International Baltic Sea Fishery Commission (IBSFC) in 1997, aims to prevent extinction of wild salmon populations, to increase the natural smolt production of wild Baltic salmon to a level of 50% of the estimated potential capacity in each salmon river selected for the programme by 2010, and to re-establish wild populations in potential salmon rivers (Ranke 2002, www.ibsfc.org). A central element of the SAP was the reduction of the annual TAC in accordance with the SAP objectives, from the level of 760 000 salmon in early 1990's to a range of 510-540,000 salmon since 1997. Other measures taken to reach the SAP targets include stocking programmes, freshwater habitat restoration and national fishery regulations.

Some national restrictions of fishing effort in the Gulf of Bothnia have been launched in both Sweden and Finland, but the most significant development has been since Finland introduced the new temporal regulations for the Gulf of Bothnia coastal trap net fishery in 1996. After this the wild salmon stocks of many of the northern wild salmon rivers in Sweden and Finland have improved substantially (Romakkaniemi et al. 2003). In a recent EU Study project, the effects of fishing mortality on the returning salmon were modelled and it was shown to have reduced substantially after the coastal fishery regulations were introduced (Anon. 2002). As an example, the salmon catch in the River Tornionjoki, a border river between Finland and Sweden, increased three-to fivefold in 1996-1997 compared to the levels of the early 1990's. As well as the increased catches, the juvenile salmon (0+) densities also showed a marked increase as the mean density in 1998 was 30-fold higher than in early 1990's. Wild smolt production (Ranke 2002), has also increased substantially, and the estimated smolt run in e.g. Rivers Tornionjoki and Simojoki (Finland) have exceeded the 50% SAP reference level during the past three years (2000-2002; Figure 2.5.3.1). The increase in the wild smolt production was thus detectable after only four years following the corresponding management actions taken. It should be emphasised that this fast recovery (Figure 2.5.3.1) was possible when the reduction in fishing mortality coincided with the return of the fish from the strong brood-year class of 1990 (Ranke 2002, Romakkaniemi et al. 2003).

The positive development in the Baltic salmon stocks has, however, been most pronounced in large, wild salmon rivers in the northern Gulf of Bothnia. Many potential salmon rivers in the Gulf of Bothnia have shown little or no signs of recovery. The status of many potential rivers prior to the SAP was very different from the wild salmon rivers, as the stocks were completely extinct and stock rebuilding started from introducing salmon from nearby stocks. The slow development in these rivers compared to that of the wild rivers can be attributed to several factors, ranging from genetic adaptation of the introduced stocks to smaller scale local problems in freshwater environment and fishery management (Erkinaro et al. 2003).

Direct extrapolation of the results from the Baltic SAP to Atlantic salmon situations would require more in-depth comparison of the underlying dynamics (i.e. mortality rates, exploitation rates and productivity) which may be very different. Despite this, it is clear that stock rebuilding is feasible and significant increases in wild stocks can be achieved over a short time frame provided the initial productivity is sufficiently high. Rebuilding from low productivity or even restoring extinct stocks appears to pose similar difficulties in both the Baltic and Atlantic areas. In this regard, the theoretical approaches presented in the previous two sections result in predictions which are consistent with the actual outcome from an ongoing stock rebuilding programme and illustrate the difficulties in rebuilding salmon stocks when stock levels fall below $S_{lim.}$ The Working Group therefore notes that in the provision of advice S_{lim} (MSY) point is the most appropriate limit reference for Atlantic salmon populations.

2.6 Distribution, behaviour and migration of farmed salmon

2.6.1 Movements and distribution

Salmon escape from fish farms at all life stages, to both fresh and salt water. They are caught in ocean fisheries, and should they mature will move to freshwater to spawn (e.g. Hansen et al. 1987; Gausen & Moen 1991; Webb and Youngson, 1992; Youngson et al. 1997; Crozier 1998; Carr et al. 1998; Whoriskey & Carr 2001).

Farmed salmon are taken in large numbers in Norwegian coastal commercial salmon fisheries (about 24% of total nominal catch in 2002). Their proportion is lower in fjord and freshwater catches, but increases in spawning populations. Tagging experiments have shown that farmed salmon from Norway are caught in the Faroes' fisheries (Hansen et al. 1987). The abundance of farmed salmon in oceanic areas at Faroes is high (Hansen et al. 1999). Farmed fish have been captured at much lower frequencies in fisheries in Scotland, Ireland and Northern Ireland, despite the presence of extensive salmon farm production in these regions (ICES CM 2001/ACFM:15). This may be due to differences compared to Norway in the siting of salmon farms in relation to the salmon rivers and fisheries, or it may be due to different dispersal patterns of the farmed fish after they escape.

Wild salmon smolts leave their home rivers in the spring and move quickly into oceanic areas. In the north east Atlantic zone, smolt tagging experiments and post-smolt surveys have strongly indicated that ocean currents are the vectors that force the fish northwards (Holm et al. 2000). Salmon smolts imprint, or learn cues sequentially on their way from the river to the sea, and use that information for homing on the return migration. The homeward migration may be divided in two phases, an oceanic phase with fast movement from the ocean to coastal areas, and a slower migration from coastal areas to the natal river (Hansen et al. 1993). Migration patterns of hatchery-reared salmon released as smolts in freshwater are similar to those of wild salmon. Hatchery smolts released on the coast also tend to return to the area where they were released, but apparently enter any river to spawn (e.g. Carlin 1969; Sutterlin et al. 1982). Hansen & Jacobsen (2000) who captured, tagged and then released wild and farmed salmon in the Northeast Atlantic Ocean north of the Faroes, got 18 recoveries from Norway and one from the west coast of Sweden. These authors speculated that the farmed fish may have escaped from Norwegian cages. The speculation was based on the assumption that farmed salmon return when sexually mature to the areas from where they escaped, and the fact that Norway as the most significant producer of farmed salmon in the Atlantic should contribute many of the escaped farmed salmon observed in that area.

Results from an experiment that released large salmon from two farms on the south and mid- Norwegian coast showed that salmon escaping in the autumn had lower survival rates than fish released in the winter/early spring ((ICES CM 2001/ACFM:15; Hansen 2002). The released fish were recaptured in the sea, as well as in freshwater north of their experimental "escape" point. Some of the fish from the southern farm moved to the southeast and entered freshwater in this area. The movements could be explained by the direction and strength of ocean currents. Assuming that fish entering freshwater had made their final decision on where to spawn, it could be concluded that these farmed salmon were not imprinted to any particular river or marine site, and could therefore be regarded as "homeless". This contradicts Hansen and Jacobsen's (2000) speculation that farmed homed to the area from which they escaped.

Ocean movements of the farmed salmon could be controlled by prevailing currents ((ICES CM 2001/ACFM:15; Hansen 2002). This may explain why so few of the fish released in the autumn in the previously described experiment were ever recovered. These fish could have been transported with the currents so far north that when they attained sexual maturity, they either were too far off route to find a river for spawning, or were simply lost in the cold Artic water. Fish that escape later in the year (closer to maturation) could have a higher probability of entering freshwater to spawn than early escapees, but the low recovery rates (less than 6%) of experimentally late released fish (Hansen 2002) suggest that significant numbers of them are also lost.

Based on the above, the following hypothesis is proposed: Farmed salmon escaping from cages in different countries are displaced with the currents, and any fish that become sexually mature when they are relatively close to the coast enter local fisheries and rivers. The signification of this is that escaped farmed salmon may spread into fisheries and rivers far away from where they escaped.

2.6.2 Methodology to improve knowledge on the distribution and movements of escaped farmed salmon

Farmed salmon that have escaped from sea cages can easily be identified in fisheries and stocks, but it is more difficult to detect fish that escaped as parr or smolt. Sampling and examination of salmon in marine areas at different times of the year, especially in areas that have not been sampled before, would improve the general knowledge of the spatial and temporal distribution of farmed salmon.

At present it is difficult to determine from which country or area farmed fish caught in the ocean originated from. To approach this problem, it would be feasible to tag farmed fish, conduct experimental "escapes", and determine the ultimate fate of the fish. Recoveries could come from existing fisheries, and planned scientific sampling programmes. A number of different tags and tagging procedures could be used, including:

1. External tags (Carlin, Lea, Floy, etc.)
2. Visible implant tags (including visual implant elastomers)
3. Coded wire tags (CWT)
4. Passive Integrated Transponder (PIT) tags
5. Sonic tags
6. Data storage tags (DST)
7. Genetic tags
8. Physiological tags (otholith marking, trace elements in bones and otoliths, fatty acids, etc.)

External tags can be reliably detected in fisheries and scientific sampling programmes. Visible implant tags can be recovered in sampling programmes, but may be difficult to detect for fishermen.

CWT tags are cheap, easy and quick to apply, and suitable for large numbers of fish. They can be easily detected providing an additional external mark is applied, but the removal of CWTs is time consuming. They are usually detected in scientific sampling programmes. In Iceland a mandatory 10 % of the farmed salmon released to coastal net pens are required to be CWT tagged.

PIT tags are easy to implant and detect, but have to be recovered in sampling programmes.

Sonic tags can be used to examine the behaviour of escaped farmed salmon following their escape providing the fish remain within receiver detection range. Fish can be actively tracked, or detected at fixed locations where receivers are moored, however detection ranges may be short (500m). Acoustic tags and equipment are very expensive, which limits the number of fish that can be marked and released.

Data storage tags are new technologies, and are still expensive. However, information on the behaviour (postion, environmental conditions, movements) of the recovered fish will be significant. Tagged fish can be recovered in sampling programmes or by fishermen.

Genetic and physiological tagging are new methods that can be used for mass marking. However, ”tagged” individuals have to be recovered in sampling programmes, and the marks are expensive to identify.

2.6.3 Experimental tagging programme for investigating the behaviour of escaped farmed salmon

To test the hypotheses that salmon escaping from fish farms in the Northeast Atlantic are homeless, transported with the currents, enter fisheries and rivers in other countries than the one they escaped from, or are lost in the Arctic, several tagging programmes using different tag types could be developed. Below a simple programme using individually numbered external tags that can be recovered both from fishermen and in sampling programmes is outlined, including a pilot project to be expanded to a main project. The programme is expected to give information on migration, distribution, survival and growth of escaped farmed salmon.

1. Pilot project

This should be carried out to compare migration and distribution of one single group (500-1000) of farmed salmon released in each of the countries producing farmed salmon (i.e. Ireland, Scotland, Faroes, Iceland and Norway). To maximise the probability for recaptures ((ICES CM 2001/ACFM:15; Hansen 2002) the farmed salmon to be released should be expected to be sexually mature the following autumn and should preferably be released in March/April. External tags of the same origin and type should be used, and the releases should be co-ordinated in time. The recovery information should be used for developing a detailed design of the main project.

2. Main project

Groups of externally tagged farmed salmon should be released sequentially over the year (e.g. monthly, bimonthly etc), or over periods when escapes from salmon farms are known to occur, usually during the winter. The fish should be released in the same countries as suggested above, and the numbers of tagged fish in each group should be optimised based on results from the pilot project. The releases should be coordinated and the same types of tags should be applied. This exercise is expected to give information on variation in migration, distribution, survival and growth of salmon escaping from fish farms at different times of the year.

Given the large numbers of farmed salmon escaping from cages in the Northeast Atlantic, the number of farmed salmon released for the purpose of this experiment will only be a small fraction of the total number of escaping salmon.

2.6.4 Sonic tracking of escapees in Maine (USA)

An experimental release of farmed salmon fitted with acoustic tags is planned to start in the Cobscook Bay region of Maine in autumn, 2003. This region produces the majority of the USA’s east coast farmed Atlantic salmon, and adjoins Canada’s Bay of Fundy region where the Canadian east coast industry is concentrated. The goals of the study are to:

- Document the residency time of “escaped” fish in the vicinity of the cages following the release.
- Track the directions and rates of any movements that the fish exhibit, and correlate them with tidal currents and other environmental cues.
- Based on histories of detection of the tagged fish on the receiver grid, attempt to determine their survival time at sea.
- Maintain a cross border detection grid in order to document the degree to which escapees stray between US and Canadian waters.
- Determine if the fish tend to move to particular rivers in the region at spawning time, presuming they survive for this long.

The project will provide short to medium term information about rates of dispersal of farmed fish, post-escape. Results should help with the development of recapture strategies, or if the program shows that the fish in this region are not likely to be recaptured, it will refocus efforts and scarce resources on ensuring containment.

2.7 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2002

2.7.1 Compilation of tag releases and finclip data for 2002

Data on releases of tagged, fin-clipped, and marked salmon in 2002 were provided by the Working Group and are compiled as a separate report. A summary of Atlantic salmon marked in 2002 is given in Table 2.7.1.1. About 4.1 million salmon were marked in 2002, an increase from the 3.88 million fish marked in 2001. 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). Tagging with data storage tags (DSTs) is not presently recorded on the database, but the Working Group will include these tags from 2004. 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 (3.1 million), with microtags (0.68 million) the next most used primary mark. Most marks were applied to hatchery-origin juveniles (4.0 million), while 64,445 wild juveniles and 13,843 adults were marked. The Working Group noted that a number of commercial fish farms are applying tags to fish placed in sea cages in some countries and hence these might appear in fisheries if escapes occurred. The Working Group recommended that state agencies should provide information on tag codes applied in these instances and this should be included in the tag compilation.

Table 2.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight of fish caught and retained), 1960-2002. (2002 figures include provisional data).

	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
Year	Canada (1)	USA	St. P. & M.	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch	Sweden (West)	Den.	Finland	Ireland (4,5)	UK (E & W)	UK (N.Irl.) (5,6)	UK (Scotl.)	France	Spain (7)	Faroes (8)	East Grld.	West Grld. (9)	Other (10)	Reported Nominal Catch	NASCO Areas	International waters (11)
1960	1636	1	-	1659	1100	100		40	-	-	743	283	139	1443	-	33	-	-	60	-	7237	-	-
1961	1583	1	-	1533	790	127		27	-	-	707	232	132	1185	-	20	-	-	127	-	6464	-	-
1962	1719	1	-	1935	710	125		45	-	-	1459	318	356	1738	-	23	-	-	244	-	8673	-	-
1963	1861	1	-	1786	480	145		23	-	-	1458	325	306	1725	-	28	-	-	466	-	8604	-	-
1964	2069	1	-	2147	590	135		36	-	-	1617	307	377	1907	-	34	-	-	1539	-	10759	-	-
1965	2116	1	-	2000	590	133		40	-	-	1457	320	281	1593	-	42	-	-	861	-	9434	-	-
1966	2369	1	-	1791	570	104	2	36	-	-	1238	387	287	1595	-	42	-	-	1370	-	9792	-	-
1967	2863	1	-	1980	883	144	2	25	-	-	1463	420	449	2117	-	43	-	-	1601	-	11991	-	-
1968	2111	1	-	1514	827	161	1	20	-	-	1413	282	312	1578	-	38	5	-	1127	403	9793	-	-
1969	2202	1	-	1383	360	131	2	22	-	-	1730	377	267	1955	-	54	7	-	2210	893	11594	-	-
1970	2323	1	-	1171	448	182	13	20	-	-	1787	527	297	1392	-	45	12	-	2146	922	11286	-	-
1971	1992	1	-	1207	417	196	8	18	-	-	1639	426	234	1421	-	16	-	-	2689	471	10735	-	-
1972	1759	1	-	1578	462	245	5	18	-	32	1804	442	210	1727	34	40	9	-	2113	486	10965	-	-
1973	2434	2.7	-	1726	772	148	8	23	-	50	1930	450	182	2006	12	24	28	-	2341	533	12670	-	-
1974	2539	0.9	-	1633	709	215	10	32	-	76	2128	383	184	1628	13	16	20	-	1917	373	11877	-	-
1975	2485	1.7	-	1537	811	145	21	26	-	76	2216	447	164	1621	25	27	28	-	2030	475	12136	-	-
1976	2506	0.8	2.5	1530	542	216	9	20	-	66	1561	208	113	1019	9	21	40	<1	1175	289	9327	-	-
1977	2545	2.4	-	1488	497	123	7	10	-	59	1372	345	110	1160	19	19	40	6	1420	192	9414	-	-
1978	1545	4.1	-	1050	476	285	6	10	-	37	1230	349	148	1323	20	32	37	8	984	138	7682	-	-
1979	1287	2.5	-	1831	455	219	6	12	-	26	1097	261	99	1076	10	29	119	<0,5	1395	193	8118	-	-
1980	2680	5.5	-	1830	664	241	8	17	-	34	947	360	122	1134	30	47	536	<0,5	1194	277	10127	-	-
1981	2437	6	-	1656	463	147	16	26	-	44	685	493	101	1233	20	25	1025	<0,5	1264	313	9954	-	-
1982	1798	6.4	-	1348	364	130	17	25	-	54	993	286	132	1092	20	10	606	<0,5	1077	437	8395	-	-
1983	1424	1.3	3	1550	507	166	32	28	-	58	1656	429	187	1221	16	23	678	<0,5	310	466	8755	-	-
1984	1112	2.2	3	1623	593	139	20	40	-	46	829	345	78	1013	25	18	628	<0,5	297	101	6912	-	-
1985	1133	2.1	3	1561	659	162	55	45	-	49	1595	361	98	913	22	13	566	7	864	-	8108	-	-
1986	1559	1.9	2.5	1598	608	232	59	54	-	37	1730	430	109	1271	28	27	530	19	960	-	9255	315	-
1987	1784	1.2	2	1385	564	181	40	47	-	49	1239	302	56	922	27	18	576	<0,5	966	-	8159	2788	-
1988	1310	0.9	2	1076	420	217	180	40	-	36	1874	395	114	882	32	18	243	4	893	-	7737	3248	-
1989	1139	1.7	2	905	364	141	136	29	-	52	1079	296	142	895	14	7	364	-	337	-	5904	2277	-
1990	911	2.4	1.9	930	313	146	280	33	13	60	567	338	94	624	15	7	315	-	274	-	4924	1890	180-350

Table 2.1.1.1 continued

Year	NAC Area			NEAC (N. Area)							NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
								Sweden				UK	UK	UK				East	West		Reported		
	Canada	USA	St. P.	Norway	Russia	Iceland		(West)	Den.	Finland	Ireland	(E & W)	(N.Irl.)	(Scotl.)	France	Spain	Faroes	Grld.	Grld.	Other	Nominal	NASCO	International
	(1)		& M.	(2)	(3)	Wild	Ranch				(4,5)		(5,6)			(7)	(8)		(9)	(10)	Catch	Areas	waters (11)
1991	711	0.8	1.2	876	215	130	345	38	3.3	70	404	200	55	462	13	11	95	4	472	-	4106	1682	25-100
1992	522	0.7	2.3	867	167	175	461	49	10	77	630	171	91	600	20	11	23	5	237	-	4119	1962	25-100
1993	373	0.6	2.9	923	139	160	496	56	9	70	541	248	83	547	16	8	23	-	-	-	3696	1644	25-100
1994	355	0	3.4	996	141	141	308	44	6	49	804	324	91	649	18	10	6	-	-	-	3945	1276	25-100
1995	260	0	0.8	839	128	150	298	37	3.1	48	790	295	83	588	9	9	5	2	83	-	3628	1060	-
1996	292	0	1.6	787	131	122	239	33	1.7	44	687	183	77	427	14	7	-	0.1	92	-	3138	1123	-
1997	229	0	1.5	630	111	106	50	19	1.3	45	570	142	93	296	8	3	-	1	58	-	2364	827	-
1998	157	0	2.3	740	131	130	34	15	1.3	48	624	123	78	283	9	4	6	0	11	-	2397	1210	-
1999	152	0	2.3	811	103	120	26	16	0.5	62	515	150	53	199	11	6	0	0.4	19	-	2246	1032	-
2000	153	0	2.3	1176	124	83	2	33	5.2	95	621	219	78	274	11	7	8	0	21	-	2913	1269	-
2001	148	0	2.2	1267	114	88	0	33	6.4	126	730	184	53	251	11	13	0	0	43	-	3069	1180	-
2002	148	0	3.6	1019	118	92	0	28	5.3	93	673	161	64	190	12	9	0	0	9	-	2625	1033	-
Average																							
1997-2001	168	0	2	925	117	105	22	23	3	75	612	164	71	261	10	7	4	0	30	-	2598	1104	-
1992-2001	264	0	2	904	129	128	191	33	4	66	651	204	78	411	13	8	9	1	71	-	3151	1258	-

Key:

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches taken in the recently developed recreational (rod) fishery.
4. From 1994, includes increased reporting of rod catches.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Not including angling catch (mainly 1SW).
7. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 to 1999 based on mean weight for R. Asturias.
8. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place, the commercial fishery resumed in 2000, but has not operated in 2001 or 2002.
9. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
10. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
11. Estimates refer to season ending in given year.

Table 2.1.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-2002. (2002 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

	NAC Area				NEAC (N. Area)											NEAC (S. Area)										
								Russia	Iceland		Sweden					Ireland			UK	UK(N.I.)					Spain	
Year	Canada (1)			USA	Norway (2)			(3)	Wild	Ranch	(West)	Denmark	Finland			(4,5)			(E&W)	(4,6)	UK(Scotland)			France	(7)	Total
	Lg	Sm	T	T	S	G	T	T	T	T	T	T	S	G	T	S	G	T	T	T	S	G	T	T	T	T
1960	-	-	1636	1	-	-	1659	1100	100	-	40	-	-	-	-	-	-	743	283	139	971	472	1443	-	33	7,177
1961	-	-	1583	1	-	-	1533	790	127	-	27	-	-	-	-	-	-	707	232	132	811	374	1185	-	20	6,337
1962	-	-	1719	1	-	-	1935	710	125	-	45	-	-	-	-	-	-	1459	318	356	1014	724	1738	-	23	8,429
1963	-	-	1861	1	-	-	1786	480	145	-	23	-	-	-	-	-	-	1458	325	306	1308	417	1725	-	28	8,138
1964	-	-	2069	1	-	-	2147	590	135	-	36	-	-	-	-	-	-	1617	307	377	1210	697	1907	-	34	9,220
1965	-	-	2116	1	-	-	2000	590	133	-	40	-	-	-	-	-	-	1457	320	281	1043	550	1593	-	42	8,573
1966	-	-	2369	1	-	-	1791	570	104	2	36	-	-	-	-	-	-	1238	387	287	1049	546	1595	-	42	8,422
1967	-	-	2863	1	-	-	1980	883	144	2	25	-	-	-	-	-	-	1463	420	449	1233	884	2117	-	43	10,390
1968	-	-	2111	1	-	-	1514	827	161	1	20	-	-	-	-	-	-	1413	282	312	1021	557	1578	-	38	8,258
1969	-	-	2202	1	801	582	1383	360	131	2	22	-	-	-	-	-	-	1730	377	267	997	958	1955	-	54	8,484
1970	1562	761	2323	1	815	356	1171	448	182	13	20	-	-	-	-	-	-	1787	527	297	775	617	1392	-	45	8,206
1971	1482	510	1992	1	771	436	1207	417	196	8	18	-	-	-	-	-	-	1639	426	234	719	702	1421	-	16	7,575
1972	1201	558	1759	1	1064	514	1578	462	245	5	18	-	-	-	32	200	1604	1804	442	210	1013	714	1727	34	40	8,357
1973	1651	783	2434	2.7	1220	506	1726	772	148	8	23	-	-	-	50	244	1686	1930	450	182	1158	848	2006	12	24	9,768
1974	1589	950	2539	0.9	1149	484	1633	709	215	10	32	-	-	-	76	170	1958	2128	383	184	912	716	1628	13	16	9,567
1975	1573	912	2485	1.7	1038	499	1537	811	145	21	26	-	-	-	76	274	1942	2216	447	164	1007	614	1621	25	27	9,603
1976	1721	785	2506	0.8	1063	467	1530	542	216	9	20	-	-	-	66	109	1452	1561	208	113	522	497	1019	9	21	7,821
1977	1883	662	2545	2.4	1018	470	1488	497	123	7	10	-	-	-	59	145	1227	1372	345	110	639	521	1160	19	19	7,756
1978	1225	320	1545	4.1	668	382	1050	476	285	6	10	-	-	-	37	147	1082	1229	349	148	781	542	1323	20	32	6,514
1979	705	582	1287	2.5	1150	681	1831	455	219	6	12	-	-	-	26	105	922	1027	261	99	598	478	1076	10	29	6,341
1980	1763	917	2680	5.5	1352	478	1830	664	241	8	17	-	-	-	34	202	745	947	360	122	851	283	1134	30	47	8,120
1981	1619	818	2437	6	1189	467	1656	463	147	16	26	-	-	-	44	164	521	685	493	101	844	389	1233	20	25	7,352
1982	1082	716	1798	6.4	985	363	1348	364	130	17	25	-	49	5	54	63	930	993	286	132	596	496	1092	20	10	6,275
1983	911	513	1424	1.3	957	593	1550	507	166	32	28	-	51	7	58	150	1506	1656	429	187	672	549	1221	16	23	7,298
1984	645	467	1112	2.2	995	628	1623	593	139	20	40	-	37	9	46	101	728	829	345	78	504	509	1013	25	18	5,883
1985	540	593	1133	2.1	923	638	1561	659	162	55	45	-	38	11	49	100	1495	1595	361	98	514	399	913	22	13	6,668
1986	779	780	1559	1.9	1042	556	1598	608	232	59	54	-	25	12	37	136	1594	1730	430	109	745	526	1271	28	27	7,744
1987	951	833	1784	1.2	894	491	1385	564	181	40	47	-	34	15	49	127	1112	1239	302	56	503	419	922	27	18	6,615
1988	633	677	1310	0.9	656	420	1076	420	217	180	40	-	27	9	36	141	1733	1874	395	114	501	381	882	32	18	6,595
1989	590	549	1139	1.7	469	436	905	364	141	136	29	-	33	19	52	132	947	1079	296	142	464	431	895	14	7	5,201
1990	486	425	911	2.4	545	385	930	313	146	280	33	13	41	19	60	-	-	567	338	94	423	201	624	15	7	4,333
1991	370	341	711	0.8	535	342	876	215	130	345	38	3.3	53	17	70	-	-	404	200	55	285	177	462	13	11	3,534
1992	323	199	522	0.7	566	301	867	167	175	461	49	10	49	28	77	-	-	630	171	91	361	238	599	20	11	3,851
1993	214	159	373	0.6	611	312	923	139	160	496	56	9	53	17	70	-	-	541	248	83	320	227	547	16	8	3,670
1994	216	139	355	0	581	415	996	141	141	308	44	6	38	11	49	-	-	804	324	91	400	248	648	18	10	3,935
1995	153	107	260	0	590	249	839	128	150	298	37	3.1	37	11	48	-	-	790	295	83	364	224	588	9	9	3,537
1996	154	138	292	0	571	215	787	131	122	239	33	1.7	24	20	44	-	-	687	183	77	267	160	427	14	7	3,045
1997	126	103	229	0	389	241	630	111	106	50	19	1.3	30	15	45	-	-	570	142	93	182	114	296	8	3	2,303
1998	70	87	157	0	445	296	740	131	130	34	15	1.3	29	19	48	-	-	624	123	78	162	121	283	9	4	2,377
1999	64	88	152	0	493	318	811	103	120	26	16	0.5	29	33	62	-	-	515	150	53	142	57	199	11	6	2,225
2000	58	95	153	0	673	504	1176	124	83	2	33	5.2	56	39	95	-	-	621	219	78	160	114	274	11	7	2,881
2001	61	86	148	0	850	417	1267	114	88	0	33	6.4	105	21	126	-	-	730	184	53	150	101	251	11	13	3,024
2002	49	99	148	0	770	249	1019	118	92	0	28	5.3	81	12	93	-	-	673	161	64	120	70	190	12	9	2,612
Average																										
1997-2001	76	92	168	0	570	355	925	117	105	22	23	3	50	25	75	-	-	612	164	71	159	101	261	10	7	2,562
1992-2001	144	120	264	0	577	327	904	129	128	191	34	4	45	21	66	-	-	651	204	78	251	160	411	13	8	3,085

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches of the recently developed recreational (rod) fishery.
4. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
5. From 1994, includes increased reporting of rod catches.
6. Not including angling catch (mainly 1SW).
7. Weights up to 1990 estimated from 1994 mean weight. Weights from 1990-99 based on mean wt. from R. Asturias.

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	496	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	355,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	320,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,855	526	-	-	-	-	-	-	-	-	148,397	745	-	-	351,252	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	599
	1993	94,517	227	-	-	-	-	-	-	-	-	71,726	320	-	-	166,243	547
	1994	99,459	248	-	-	-	-	-	-	-	-	85,404	400	-	-	184,863	648
	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	43,879	114	-	-	-	-	-	-	-	-	36,657	160	-	-	80,536	274
	2001	42,565	101	-	-	-	-	-	-	-	-	34,908	150	-	-	77,473	251
	2002	30,561	70	-	-	-	-	-	-	-	-	26,834	120	-	-	57,395	190
France	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	21
	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	-	-	-	-	-	-	-	-	2,764	9
	1996	2,063	5	1,891	9	52	0.4	-	-	-	-	-	-	-	-	4,006	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	1,792	4	1,253	6	24	0.2	-	-	-	-	-	-	-	-	3,069	11
	2001	1,544	4	1,464	7	25	0.2	-	-	-	-	-	-	-	-	3,033	11
	2002	2,424	6	1,023	5	41	0.3	-	-	-	-	-	-	-	-	3,488	12
Spain (2)	1993	1,589	-	827	-	75	-	-	-	-	-	-	-	-	-	2,491	8
	1994	1,658	-	1,042	-	14	-	-	-	-	-	-	-	-	-	2,714	10
	1995	389	-	1,373	-	30	-	-	-	-	-	-	-	-	-	1,792	9
	1996	351	-	1,219	-	9	-	-	-	-	-	-	-	-	-	1,579	7
	1997	172	-	604	-	21	-	-	-	-	-	-	-	-	-	797	3
	1998	486	-	486	-	8	-	-	-	-	-	-	-	-	-	980	4
	1999	160	-	1,047	-	42	-	-	-	-	-	-	-	-	-	1,249	6
	2000	1,223	-	705	-	10	-	-	-	-	-	-	-	-	-	1,938	7
	2001	1,138	-	1,913	-	111	-	-	-	-	-	-	-	-	-	3,162	13
	2002	655	-	1,266	-	39	-	-	-	-	-	-	-	-	-	1,960	9

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, 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; mis-classification may be very high in some years.
   In Norway, catches shown as 3SW refer to salmon of 3SW or greater.
2. Based on catches in Asturias (80-90% of total catch).

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	-	-	8,006	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	49
	1996	12,230	20	1,275	5	1,424	12	234	4	19	0.5	-	-	354	3	15,536	45
	1997	10,341	15	2,419	10	1,674	15	141	2	22	0.5	-	-	418	3	15,015	46
	1998	11,792	19	1,608	7	1,660	16	147	3	0	0	-	-	460	3	15,667	48
	1999	18,830	33	1,528	8	1,579	16	129	2	6	0.1	-	-	490	3	22,562	62
	2000	20,817	39	5,152	24	2,379	25	110	2	0	0	-	-	991	6	29,449	96
	2001	13,062	21	6,308	32	5,415	58	104	2	0	0	-	-	2,360	13	27,249	126
	2002	6,531	12	5,361	20	4,276	43	148	2	11	0.3	-	-	2,619	16	18,946	93
Iceland	1991	30,011	-	11,935	-	-	-	-	-	-	-	-	-	-	-	41,946	130
	1992	38,955	-	15,416	-	-	-	-	-	-	-	-	-	-	-	54,371	175
	1993	37,611	-	11,611	-	-	-	-	-	-	-	-	-	-	-	49,222	160
	1994	25,480	62	14,408	78	-	-	-	-	-	-	-	-	-	-	39,888	140
	1995	34,046	93	13,380	57	-	-	-	-	-	-	-	-	-	-	47,426	150
	1996	28,039	69	9,971	53	-	-	-	-	-	-	-	-	-	-	38,010	122
	1997	23,945	62	8,872	44	-	-	-	-	-	-	-	-	-	-	32,817	106
	1998	35,537	90	7,791	40	-	-	-	-	-	-	-	-	-	-	43,328	130
	1999	20,031	52	8,093	44	-	-	-	-	-	-	-	-	-	-	28,124	96
	2000	23,850	58	4,456	24	-	-	-	-	-	-	-	-	-	-	28,306	82
	2001	23,717	58	5,564	29	-	-	-	-	-	-	-	-	-	-	29,281	87
	2002	27,673	68	5,010	25	-	-	-	-	-	-	-	-	-	-	32,683	92
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	-	-	14,506	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,965	44
	1995	9,761	22	-	-	-	-	-	-	-	-	2,770	14	-	-	12,531	36
	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	-	-	-	-	-	-	-	-	3,196	15	-	-	10,299	33
	2001	4,634	12	-	-	-	-	-	-	-	-	3,853	21	-	-	8,487	33
	2002	4,733	12	-	-	-	-	-	-	-	-	2,826	16	-	-	7,559	28

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
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	-	-	449,422	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	-	-	283,937	930
	1991	171,041	342	-	-	-	-	-	-	-	-	92,214	535	-	-	263,255	877
	1992	151,291	301	-	-	-	-	-	-	-	-	92,717	566	-	-	244,008	867
	1993	153,407	312	62,403	284	35,147	327	-	-	-	-	-	-	-	-	250,957	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	786
	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	741
	1999	164,905	318	70,825	326	18,669	167	-	-	-	-	-	-	-	-	254,399	811
	2000	250,468	504	99,934	454	24,319	219	-	-	-	-	-	-	-	-	374,721	1,177
	2001	207,934	417	117,759	554	33,047	295	-	-	-	-	-	-	-	-	358,740	1,266
	2002	127,039	249	98,055	471	33,013	299									258,107	1,019
Russia	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	137,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,065	420
	1989	78,023	-	23,123	-	4,118	-	26	-	0	-	-	-	2,187	-	107,477	364
	1990	70,595	-	20,633	-	2,919	-	101	-	0	-	-	-	2,010	-	96,258	313
	1991	40,603	-	12,458	-	3,060	-	650	-	0	-	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	0	-	-	-	824	-	47,452	167
	1993	28,100	-	11,780	-	4,280	-	377	-	0	-	-	-	1,470	-	46,007	139
	1994	30,877	-	10,879	-	2,183	-	51	-	0	-	-	-	555	-	44,545	141
	1995	27,775	62	9,642	50	1,803	15	6	0	0	0	-	-	385	2	39,611	129
	1996	33,878	79	7,395	42	1,084	9	40	0.5	0	0	-	-	41	0.5	42,438	131
	1997	31,857	72	5,837	28	672	6	38	0.5	0	0	-	-	559	3	38,963	110
	1998	34,870	92	6,815	33	181	2	28	0.3	0	0	-	-	638	3	42,532	130
	1999	24,016	66	5,317	25	499	5	0	0	0	0	-	-	1,131	6	30,963	102
	2000	27,702	75	7,027	34	500	5	3	0.1	0	0	-	-	1,853	9	37,085	123
	2001	26,472	61	7,505	39	1,036	10	30	0.4	0	0	-	-	922	5	35,965	115
	2002	24,588	60	8,720	43	1,284	12	3	0	0	0	-	-	480	3	35,075	118

Table 2.1.1.3 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 2002 may be provisional.
Methods used for estimating age composition given in footnote

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	-	288,254	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,477	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,103	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,540	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1995	31,241	-	558	-	-	-	-	-	-	-	-	-	478	-	32,277	83
	1996	30,613	-	884	-	-	-	-	-	-	-	-	-	568	-	32,065	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	21	0	0	-	-	-	-	-	-	-	-	140	0.4	7,855	21
	2001	14,795	40	324	2	-	-	-	-	-	-	-	-	293	1.3	15,412	43
	2002	3,041	9	20	0.1									40	0.2	3,101	9
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	55,263	95	-	-	-	-	-	-	-	-	10,571	58	-	-	65,834	153
	2001	51,225	86	-	-	-	-	-	-	-	-	11,575	61	-	-	62,800	147
	2002	53,832	99	-	-	-	-	-	-	-	-	8,401	49	-	-	62,233	148

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
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1265	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	2	-	-	-	-	-	-	-	13	-	566	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	563	1.9
	1987	33	-	229	1	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	0	0	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	0	0	0	0	-	-	-	-	-	-	-	-	12	0.1
	1995	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1996	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1997	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1998	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1999	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2000	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2001	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2002	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,508	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,177	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	-	-	-	-	-	-	-	111,436	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,449	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	0	-	0	-	0	-	-	-	-	-	-	-	-	-	0	0
	2001/02	0	-	0	-	0	-	-	-	-	-	-	-	-	-	0	0
	2002/03	0	-	0	-	0	-	-	-	-	-	-	-	-	-	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
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	-	-	526,460	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
	2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	270,963	730
	2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	253,473	673
UK	1985	62,815	-	-	-	-	-	-	-	-	-	32,716	-	-	-	95,531	361
(England & Wales)	1986	68,759	-	-	-	-	-	-	-	-	-	42,035	-	-	-	110,794	430
	1987	56,739	-	-	-	-	-	-	-	-	-	26,700	-	-	-	83,439	302
	1988	76,012	-	-	-	-	-	-	-	-	-	34,151	-	-	-	110,163	395
	1989	54,384	-	-	-	-	-	-	-	-	-	29,284	-	-	-	83,668	296
	1990	45,072	-	-	-	-	-	-	-	-	-	41,604	-	-	-	86,676	338
	1991	36,671	-	-	-	-	-	-	-	-	-	14,978	-	-	-	51,649	200
	1992	34,331	-	-	-	-	-	-	-	-	-	10,255	-	-	-	44,586	171
	1993	56,033	-	-	-	-	-	-	-	-	-	13,144	-	-	-	69,177	248
	1994	67,853	-	-	-	-	-	-	-	-	-	20,268	-	-	-	88,121	324
	1995	57,944	-	-	-	-	-	-	-	-	-	22,534	-	-	-	80,478	295
	1996	30,352	-	-	-	-	-	-	-	-	-	16,344	-	-	-	46,696	183
	1997	30,203	-	-	-	-	-	-	-	-	-	11,171	-	-	-	41,374	142
	1998	30,641	-	-	-	-	-	-	-	-	-	6,276	-	-	-	36,917	123
	1999	28,766	-	-	-	-	-	-	-	-	-	12,328	-	-	-	41,094	150
	2000	48,153	-	-	-	-	-	-	-	-	-	12,800	-	-	-	60,953	219
	2001	38480	-	-	-	-	-	-	-	-	-	12827	-	-	-	51,307	184
	2002	34233	-	-	-	-	-	-	-	-	-	11411	-	-	-	45,644	161

Table 2.1.1.4 The weight (tonnes round fresh weight) and % 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
	2001	13	9	20	14	112	77	145
	2002	12	8	21	14	115	78	148
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	62	100	62
	2000	0	0	0	0	95	100	95
	2001	0	0	0	0	126	100	126
	2002	0	0	0	0	93	100	93
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
	2001	0	4	5	44	6	53	11
	2002	1	5	6	48	6	47	12
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	96	100	96
	2000	0	0	0	0	82	100	82
	2001	0	0	0	0	87	100	87
	2002	0	0	0	0	92	100	92
Ireland	1995	566	72	140	18	84	11	790
	1996	440	64	134	20	113	16	687
	1997	379	66	100	18	91	16	570
	1998	433	69	92	15	99	16	624
	1999	335	65	83	16	97	19	515
	2000	440	71	79	13	102	16	621
	2001	551	75	109	15	70	10	730
	2002	514	76	89	13	70	10	673
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
	2001	696	55	0	0	570	45	1266
	2002	596	58	0	0	423	42	1019
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
	2001	70	74	0	0	24	26	95
	2002	62	64	0	0	35	36	96

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	0	0	0	0	7	100	7
	2001	0	0	0	0	13	100	13
	2002	0	0	0	0	9	100	9
Sweden[5]	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
	2001	9	27	0	0	24	73	33
	2002	7	25	0	0	21	75	28
UK England & Wales	1995	200	68	45	15	49	17	295
	1996	83	45	42	23	58	31	183
	1997	81	57	27	19	35	24	142
	1998	65	53	19	16	38	31	123
	1999	101	67	23	15	26	17	150
	2000	157	72	25	12	37	17	219
	2001	129	70	24	13	31	17	184
	2002	108	67	24	15	29	18	161
UK N. Ireland[2]	1999	44	83	9	17	-	-	53
	2000	63	82	14	18	-	-	77
	2001	41	77	12	23	-	-	53
	2002	48	74	17	26	-	-	64
UK Scotland	1995	201	34	105	18	282	48	588
	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	11	141	71	199
	2000	76	28	41	15	157	57	274
	2001	77	30	22	9	153	61	251
	2002	43	23	23	12	124	65	189
Totals								
North East Atlantic[3]	2002	1378	57	158	6	901	37	2437
North America[4]	2002	16	10	21	14	115	76	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. 2001/2 catches from the illegal coastal net fishery in Lower Normandy are unknown.

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

[3] Data not available from Denmark

[4] Includes St Pierre et Miquelon.

[5] Estuarine catch included in coastal catch.

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, 1991-2002. Figures for 2002 are provisional.

Year	Canada [1]		Iceland		Russia		UK (E&W)		UK (Scotland)		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	28,497	33			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	53	2,826	7	12,776	81	5,365	31	13,455	18	273	100
1999	49,268	50	3,055	10	11,450	77	5,447	44	14,839	28	211	100
2000	62,106	55	2,918	11	12,914	74	7,470	42	21,068	32	0	-
2001	58,961	55	3,607	12	16,945	76	6,143	43	27,699	38	0	-
2002	54,425	54	5,576	16	25,248	80	7,632	50	25,352	41	0	-

1. Figures prior to 1997 are minimal estimates as not all areas have reported catch and release.

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, 1987-2002.

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
2001	1,089	81	10	1,180
2002	946	83	10	1,039
Mean 1997-2001	990	104	10	1104

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 American and West Greenland Commissions of NASCO, 2002.

2002 Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Denmark	6	0.2	53
NEAC	Finland	23	0.6	20
NEAC	Iceland	2	0.0	2
NEAC	Ireland	71	1.9	10
NEAC	Norway	549	15.0	35
NEAC	Russia	212	5.8	64
NEAC	Sweden	4	0.1	13
NEAC	UK (E & W)	31	0.8	16
NEAC	UK (N.Ireland)	3	0.1	5
NEAC	UK (Scotland)	45	1.2	19
NAC	Canada	83	2.3	36
NAC	USA	0	0.0	0
WGC	West Greenland	10	0.3	53
	Total Unreported Catch	1039	28.4	
	Total Reported Catch of North Atlantic salmon	2625		

Note: No unreported catch estimate for France, Spain & St. Pierre et Miquelon

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), 1980-2002.

Year	North Atlantic Area										Outside the North Atlantic Area							World-wide
	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	204,686	64,066	14,789	12,441	11,616	6,130	2,588	<100	0	316,316	34,077	5,000	16,100	5,000	1,000	800	61,977	378,293
1995	261,522	70,060	9,000	12,550	11,811	10,020	2,880	259	0	378,102	41,093	5,000	16,000	6,000	1,000	0	69,093	447,195
1996	297,557	83,121	18,600	17,715	14,025	10,010	2,772	338	0	444,138	69,960	5,200	17,000	7,500	1,000	600	101,260	545,398
1997	332,581	99,197	22,205	19,354	14,025	12,140	2,554	225	0	502,281	87,700	6,000	28,751	9,000	1,000	900	133,351	635,632
1998	361,879	110,784	20,362	16,418	14,860	13,166	2,686	114	0	540,269	125,000	3,000	33,057	7,068	1,000	400	169,525	709,794
1999	425,154	126,686	37,000	23,370	18,000	12,194	2,900	234	0	645,538	150,000	5,000	39,577	9,195	0	500	204,272	849,810
2000	440,861	128,959	32,000	29,095	17,648	16,400	2,600	250	0	667,813	176,000	5,670	40,000	10,906	0	500	233076	900,889
2001	436,103	138,519	46,014	37,606	23,312	13,230	2,645	250	0	697,679	200,000	5,443	58,000	11,500	0	500	275443	973,122
2002	436,103	159,060	45,150	34,190	22,294	6,810	1,450	250	0	705,307	273,000	5,000	63,000	11,000	0	1000	353000	1,058,307
Mean 1997-2001	399,316	120,829	31,516	25,169	17,569	13,426	2,677	215	0	610,716	147,740	5,023	39,877	9,534	400	560	203,133	813,849
% change on 1997-2001	+9	+32	+43	+36	+27	-49	-46	+16	0	+15	+85	0	+58	+15		+79	+74	+30

Notes: Data for 2002 are provisional for many countries.
Where production figures were not available for 2002, values for 2001 were used (Norway, UK (N.Ireland), Canada).
West Coast USA = Washington State
West Coast Canada = British Columbia
Australia = Tasmania
Source of production figures for non-Atlantic areas: miscellaneous fishing publications & Government reports.
'Other' includes South Korea & China.

Table 2.2.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight) as harvested at ranching facilities, 1980-2002.

Year	Iceland commercial ranching	Ireland [1]	UK(N.Ireland) River Bush [1]	Norway various facilities [1]	Total production
1980	8				8
1981	16				16
1982	17				17
1983	32				32
1984	20				20
1985	55	17.5	17.0		90
1986	59	22.9	22.0		104
1987	40	6.4	7.0		53
1988	180	11.5	12.0	4.0	208
1989	136	16.3	17.0	3.0	172
1990	280	5.7	5.0	6.2	297
1991	345	3.6	4.0	5.5	358
1992	460	9.4	11.0	10.3	491
1993	496	9.7	8.0	7.0	521
1994	308	15.2	0.4	10.0	334
1995	298	16.8	1.2	2.0	318
1996	239	18.5	3.0	8.0	269
1997	50	4.1	2.8	2.0	59
1998	34	11.0	1.0	1.0	46
1999	26	4.3	1.4	1.0	33
2000	2	4.5	3.5	1.0	11
2001	0	10.6	2.8	1.0	14
2002	0	6.7	2.4	1.0	10
Mean 1997-2001	22.4	6.9	2.3	1.2	32.5

[1] Total yield in homewater fisheries and rivers.

Table 2.3.1.1. Atlantic salmon smolt, 1SW and 2SW data sets from the NEAC and the NAC areas analysed using the inverse weight model and the maturity schedule model to estimate mortality in the second year at sea.

				Data available for		
River (country or region)	Origin of fish	Smolt cohorts	Number of years	Inverse-weight model	Growth data	Maturity schedule model
NEAC Area						
Scorff (France)	Wild	1995 - 1999	5	Yes	Scorff	Yes
Shannon[1] (Ireland)	Hatchery	1995 - 1999	9	Yes	Shannon	Yes
River Bush (UK N. Ireland)	Wild	1999	1	Yes	Bush	
North Esk (Scotland)	Wild	1981 - 1997	12	Yes	North Esk	Yes
Vesturdalsa (Iceland)	Wild	1989 - 1999	9	Yes	Verdustala	Yes
North America						
Saint John (Scotia Fundy)	Hatchery	1991 - 1999	10	Yes	Assumed	Yes
Nashwaak	Wild	1998 - 2000	3	Yes	Assumed	Yes
LaHave River (Scotia-Fundy)	Hatchery	1974 - 2000	27	Yes	Assumed	Yes
LaHave River (Scotia-Fundy)	Wild	1984 - 1998 1996 - 2000	15 5	Yes	Assumed	Yes
Miramichi	Wild	1969 - 1999	31	Yes	Assumed	Yes
Southwest Miramichi	Wild	1991 - 1999	10	Yes		Yes
Northwest Miramichi (Gulf)	Wild	1990 - 1999 1999 - 2000	10 22	Yes	Assumed	Yes
St. Jean (Quebec)	Wild	1989 – 1999	9	Yes	St. Jean	Yes
De la Trinite (Quebec)	Wild	1983 - 1999	17	Yes	De la Trinite	Yes

[1] Data courtesy of the National Universtiy of Ireland, Galway (Ireland)

Table 2.3.1.2. Differences in estimates of monthly mortality rate in the second year derived from returns to the coast relative to those derived from returns to the hatchery in-river (excluding harvests in marine fisheries). The differences in mortality rate represent the exploitation rate in the fishery.

Group	Smolt Year	Mortality rate (A%) returns in-river	returns to coast
Ordinary MSW	1998	4.6%	3.3%
All Female MSW	1998	4.1%	2.7%
Ordinary MSW	1999	4.6%	3.8%
All Female MSW	1999	4.5%	4.0%
Grilse line	1997	4.0%	2.4%
Grilse line	1995	4.5%	2.7%
All Female Grilse line	1995	4.6%	3.1%
Grilse line	1996	4.9%	3.1%
All Female Grilse line	1996	4.4%	2.8%

Table 2.4.1. Results of Spearman's rank correlations, and their associated significance levels, testing for associations between various abundance, exploitation and catch parameters with time for four age/seasonal components of the returning stock.

	Early 1SW	Late 1SW	Early MSW	Late MSW
Lower river abundance	$r = 0.329$ $p = ns$	$r = 0.109$ $p = ns$	$r = -0.136$ $p = ns$	$r = -0.268$ $p = ns$
Lower river exploitation	$r = -0.455$ $p < 0.05$	$r = -0.118$ $p = ns$	$r = -0.862$ $p < 0.01$	$r = -0.501$ $p < 0.05$
Lower river catch	$r = -0.252$ $p = ns$	$r = -0.051$ $p = ns$	$r = -0.842$ $p < 0.01$	$r = -0.604$ $p < 0.01$
Upper river abundance	$r = 0.478$ $p < 0.05$	$r = 0.160$ $p = ns$	$r = 0.508$ $p < 0.02$	$r = 0.010$ $p = ns$
Upper river exploitation	$r = 0.010$ $p = ns$	$r = 0.040$ $p = ns$	$r = -0.401$ $p = ns$	$r = 0.249$ $p = ns$
Upper river catch	$r = 0.244$ $p = ns$	$r = 0.056$ $p = ns$	$r = 0.059$ $p = ns$	$r = 0.239$ $p = ns$
Potential spawners	$r = 0.478$ $p < 0.05$	$r = 0.126$ $p = ns$	$r = 0.517$ $p < 0.02$	$r = -0.147$ $p = ns$

Table 2.4.3.1. Spawning histories of wild large (>=63 cm fork length) Atlantic salmon from the Miramichi River as interpreted from scale samples.

	Scale samples processed (%)							
	Previous spawnings							Total
Year	0	1	2	3	4	5	6	Samples
1971	94.2	5.4	0.3					313
1972	96.7	3.3						516
1973	98.2	1.8						729
1974	93.0	6.7	0.3					583
1975	88.0	11.4	0.6					341
1976	88.9	10.6	0.5					198
1977	94.0	5.4	0.6					519
1978	86.9	13.1						290
1979	75.5	20.4	4.1					98
1980	95.2	3.3	1.5					331
1981	73.1	21.2	5.8					52
1982	81.6	16.1	2.3					87
1983	85.1	14.9						74
1984	89.6	9.4		1.0				96
1985	88.4	8.8	2.8					181
1986	85.8	13.1	1.0					289
1987	81.8	16.7	1.5					66
1988	82.0	14.8	2.4	0.8				250
1989	66.7	30.0	2.9	0.5				210
1990	63.3	26.8	8.1	1.7				406
1991	61.4	23.7	11.4	3.5				342
1992	67.2	15.9	10.5	5.1	1.1	0.2		807
1993	70.8	14.9	9.0	4.7	0.6			511
1994	81.6	12.3	3.4	1.9	0.4	0.3		991
1995	86.0	10.2	2.4	1.1	0.2	0.1	0.1	1692
1996	70.4	21.0	6.1	2.0	0.2	0.3		992
1997	61.1	24.3	9.7	4.2	0.5	0.2	0.1	1252
1998	48.4	31.1	13.9	5.5	0.8	0.2	0.2	655
1999	61.0	21.9	10.5	5.0	1.2	0.3		721
2000	60.8	22.8	9.2	5.2	1.8	0.2	0.1	1167
2001	73.3	18.2	4.6	2.5	1.1	0.2	0.1	2686
2002	63.0	22.2	7.9	3.3	3.0	0.4	0.1	901

Table 2.4.3.2. Spawning histories of wild 1SW and 2SW maiden spawner Atlantic salmon from the Saint John River (at Mactaquac) as interpreted from scale samples.

Spawned first as 1SW					
	Scale samples processed (%)				
	Previous spawnings				Total
Year	0	1	2	3	Samples
1982	88.4%	10.7%	0.4%	0.4%	224
1983	99.1%	0.9%			337
1984	98.2%	1.8%			608
1985	97.2%	2.4%	0.4%		534
1986	95.0%	4.8%	0.2%		666
1987	91.6%	8.2%	0.2%		561
1988	97.1%	2.8%	0.1%		817
1989	97.8%	2.0%	0.2%		853
1990	92.2%	7.8%			658
1991	93.1%	6.7%	0.1%		682
1992	98.1%	1.9%			317
1993	98.0%	2.0%			256
1994	87.6%	12.4%			249
1995	97.1%	2.7%	0.2%		489
1996	92.8%	7.2%			180
1997	70.6%	29.4%			68
1998	87.8%	11.9%	0.4%		270
1999	98.1%	1.9%			362
2000	94.2%	5.8%			573
2001	98.6%	1.4%			354
2002	94.7%	5.3%			361

Spawned first as 2SW					
	Scale samples processed (%)				
	Previous spawnings				Total
Year	0	1	2	3	Samples
1982	90.4%	8.4%	1.1%		178
1983	96.4%	3.6%			138
1984	98.4%	1.6%			258
1985	99.2%	0.7%	0.1%		884
1986	93.8%	6.2%			565
1987	91.1%	8.9%			526
1988	93.9%	5.0%	1.1%		279
1989	93.5%	6.0%	0.4%		496
1990	97.8%	2.0%	0.2%		494
1991	96.7%	3.3%			575
1992	98.6%	1.4%			368
1993	96.8%	3.2%			443
1994	96.8%	3.2%			411
1995	97.8%	2.2%			453
1996	97.9%	2.1%			439
1997	96.4%	3.6%			357
1998	85.9%	14.1%			135
1999	98.6%	1.4%			636
2000	95.0%	5.0%			241
2001	97.4%	2.6%			387
2002	94.3%	4.9%	0.8%		123

Table 2.4.4.1 Summary of data from the Nordic DST expeditions in 2002-2003.

Cruise	Area	Date	Post-smolts/ salmon captured, no.	Star Oddi "Micro" (I- button tags), no.
Norway	Norwegian Sea	20 June- 05 July 2002	0 / 17	3 (1)
Faroes	Faroes EEZ, north	16- 23 Oct. 2002	172 / 6	62 (50)
Iceland	Icel. EEZ west & east	12 Nov. – 9 Dec. 2002	4 / 2	5 (0)
Iceland	Icel. EEZ east	10-23 January 2003	21 / 1	6 (0)
Total			197 / 26	76 (51)

Table 2.5.1.1. Stock and recruitment (Ricker) parameters and standard deviations of parameters for Atlantic salmon in 3 rivers of western Europe (Anon 2003).

River	H'	SDH'	R'	SDR'	Alpha	Beta	S_{lim}
Bush	0.73	0.07	13.64	11.57	14.93	0.20	3.6828
North Esk	0.43	0.17	27.51	29.44	2.13	0.03	15.6807
Nivelle	0.38	0.11	0.94	0.28	1.85	0.65	0.5828

Table 2.5.1.2. Mean number of years to attain recruitment of Atlantic salmon to S_{lim} with 90% confidence ranges in three rivers with high to low productivity (alpha) using their respective fitted stock and recruitment curves for two starting points and three fisheries exploitation scenarios.

River			Start at 0.1 of S_{lim}		Start at 0.5 of S_{lim}	
	Exploitation	Rate	Mean	5th - 95th	Mean	5th - 95th
Bush						
alpha	Zero	0	1.4	(1 - 4)	1.0	(1 - 1)
(14.93)	Half Current	0.2645	2.6	(1 - 5)	1.0	(1 - 1)
beta	Current	0.529	5.0	(4 - 7)	1.1	(1 - 2)
(0.20)	H'	0.73	8.6	(5 - 14)	2.5	(1 - 7)
North Esk						
alpha	Zero	0	13.6	(6 - 24)	5.2	(1 - 14)
(2.13)	Half Current	0.079	15.9	(6 - 28)	6.7	(1 - 18)
beta	Current	0.158	19.3	(7 - 37)	9.1	(1 - 25)
(0.03)	H'	0.430	41.1	(15 - 50)	29.1	(1 - 50)
Nivelle						
alpha	Zero	0	13.7	(9 - 18)	4.8	(1 - 8)
(1.85)	Half Current	0.011	14.1	(9 - 19)	5.0	(1 - 8)
beta	Current	0.022	14.5	(10 - 19)	5.2	(1 - 9)
(0.65)	H'	0.380	49.4	(50 - 50)	46.4	(16 - 50)

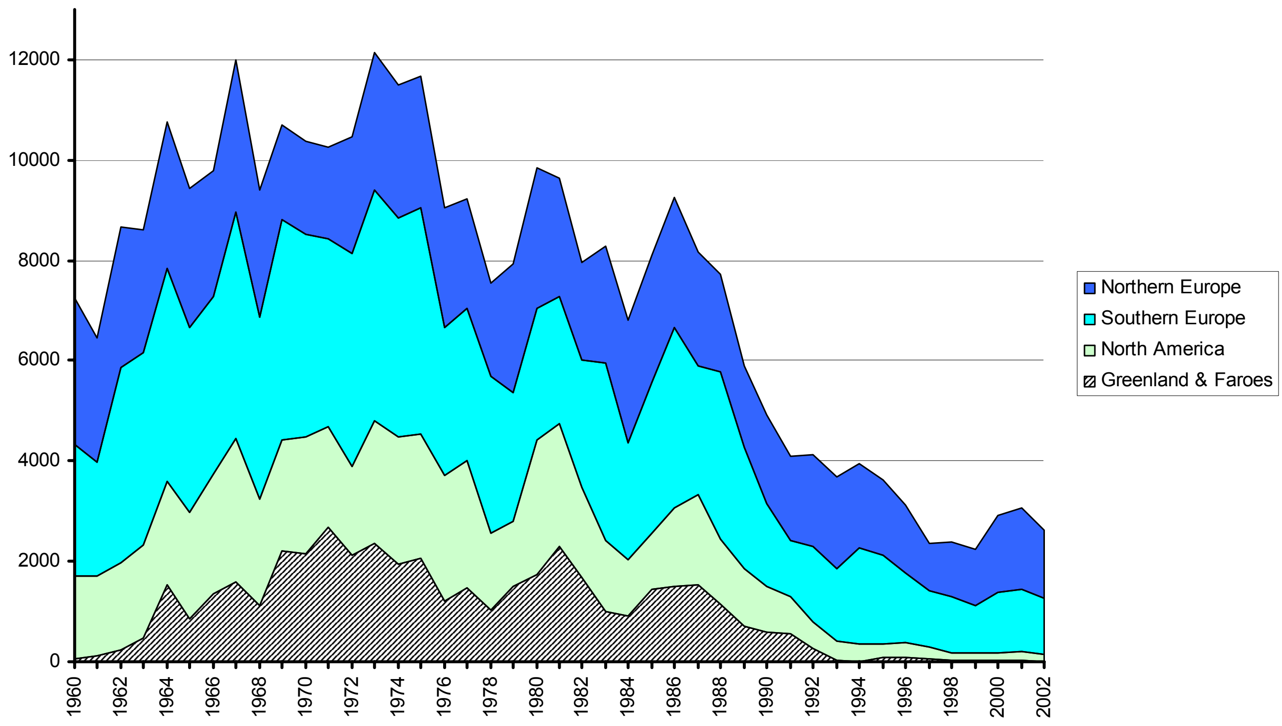
Table 2.5.1.3. Proportion of annual recruitment in 10,000 fifty year projections of Atlantic salmon that were below S_{lim} with 90% confidence ranges in three rivers with high to low productivity (alpha) using their respective fitted stock and recruitment curves for two starting points and three fisheries exploitation scenarios.

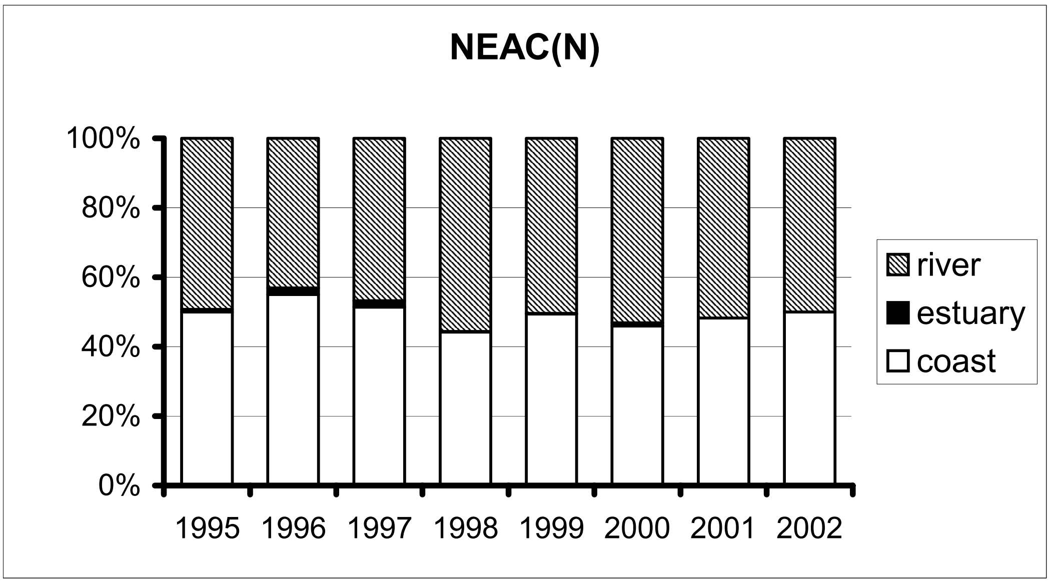
River			Start at 0.1 of S_{lim}		Start at 0.5 of S_{lim}	
	Exploitation	Rate	Mean	5th - 95th	Mean	5th - 95th
Bush						
alpha	Zero	0	0.14	(0.06 - 0.22)	0.13	(0.06 - 0.22)
(14.93)	Half Current	0.2645	0.18	(0.1 - 0.26)	0.14	(0.06 - 0.24)
beta	Current	0.529	0.25	(0.16 - 0.36)	0.19	(0.1 - 0.3)
(0.20)	H'	0.73	0.49	(0.32 - 0.66)	0.42	(0.26 - 0.58)
North Esk						
alpha	Zero	0	0.52	(0.32 - 0.74)	0.41	(0.2 - 0.66)
(2.13)	Half Current	0.079	0.62	(0.38 - 0.84)	0.52	(0.28 - 0.76)
beta	Current	0.158	0.73	(0.5 - 0.94)	0.64	(0.4 - 0.88)
(0.03)	H'	0.430	0.97	(0.88 - 1)	0.95	(0.84 - 1)
Nivelle						
alpha	Zero	0	0.27	(0.2 - 0.36)	0.10	(0.04 - 0.16)
(1.85)	Half Current	0.011	0.28	(0.2 - 0.38)	0.10	(0.04 - 0.18)
beta	Current	0.022	0.29	(0.2 - 0.38)	0.11	(0.04 - 0.18)
(0.65)	H'	0.380	1.00	(1 - 1)	1.00	(0.98 - 1)

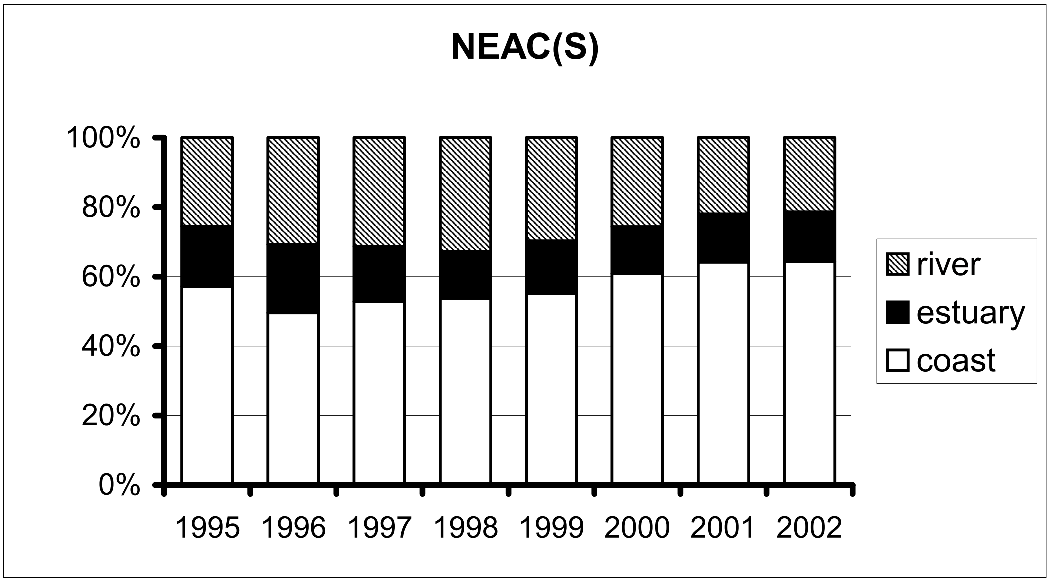
Table 2.7.1.1. Summary of Atlantic salmon tagged and marked in 2002. 'Hatchery' and 'Wild' refer to smolts or parr; 'Adult' refers to wild and hatchery fish. Data from Belgium were not available. Fish were not tagged in Finland or Denmark. PIT tags were not included.

		Primary Tag or Mark			
Country	Origin	Microtag	External mark	Adipose clip	Total
Canada	Hatchery	0	45,346	2,328,471	2,373,817
	Wild	0	28,194	501	28,695
	Adult	0	5,777	0	5,777
	Total	0	79,317	2,328,972	2,408,289
Spain	Hatchery	18,150	0	67,700	85,850
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	18,150	0	67,700	85,850
France	Hatchery	0	39,950	405,482	445,432
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	0	39,950	405,482	445,432
Iceland	Hatchery	142,777	0	0	142,777
	Wild	1,218	0	0	1,218
	Adult	0	355	0	355
	Total	143,995	355	0	144,350
Ireland	Hatchery	348,949	0	0	348,949
	Wild	3,610	0	0	3,610
	Adult	0	0	0	0
	Total	352,559	0	0	352,559
Norway	Hatchery	41,308	48,714	0	90,022
	Wild	0	5,038	0	5,038
	Adult	0	178	0	178
	Total	41,308	53,930	0	95,238
Russia	Hatchery	0	2,000	130,400	132,400
	Wild	0	0	0	0
	Adult	0	2,208	0	2,208
	Total	0	4,208	130,400	134,608
Sweden	Hatchery	0	4,966	24,994	29,960
	Wild	0	497	0	497
	Adult	0	0	0	0
	Total	0	5,463	24,994	30,457
UK (England & Wales)	Hatchery	57,056	4,304	119,081	180,441
	Wild	6,082	0	1,515	7,597
	Adult	0	1,418	0	1,418
	Total	63,138	5,722	120,596	189,456
UK (N. Ireland)	Hatchery	28,035	0	18,128	46,163
	Wild	1,043	0	0	1,043
	Adult	0	0	0	0
	Total	29,078	0	18,128	47,206
UK (Scotland)	Hatchery	17,045	0	0	17,045
	Wild	15,974	0	0	15,974
	Adult	0	1,120	0	1,120
	Total	33,019	1,120	0	34,139
USA	Hatchery	0	137,920	0	137,920
	Wild	0	1,280	0	1,280
	Adult	0	2,787	0	2,787
	Total	0	141,987	0	141,987
All Countries	Hatchery	653,320	283,697	3,094,256	4,030,776
	Wild	27,927	34,512	2,016	64,952
	Adult	0	13,843	0	13,843
	Total	681,247	332,052	3,096,272	4,109,571

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions, 1960-2002.







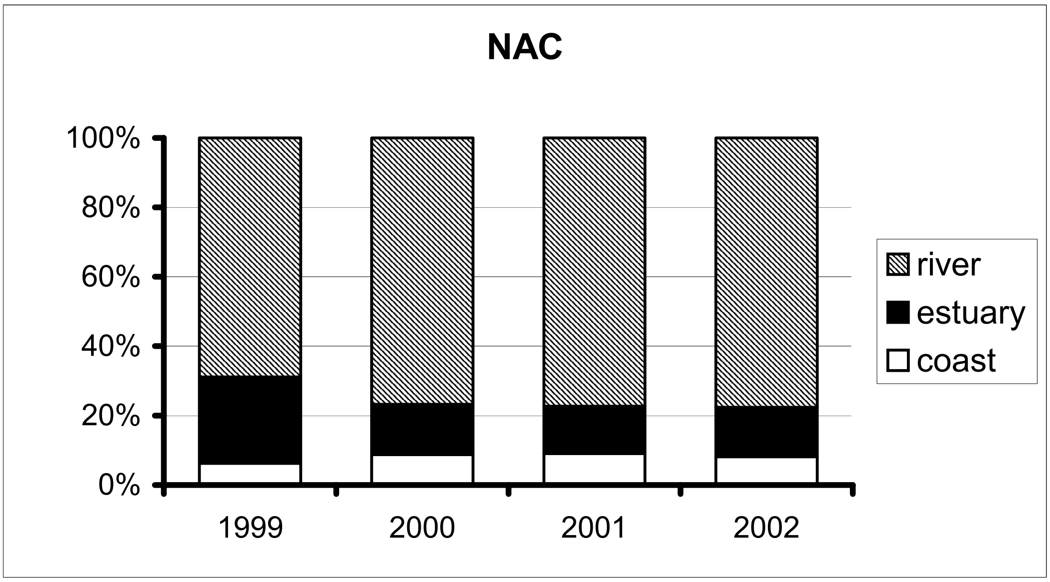
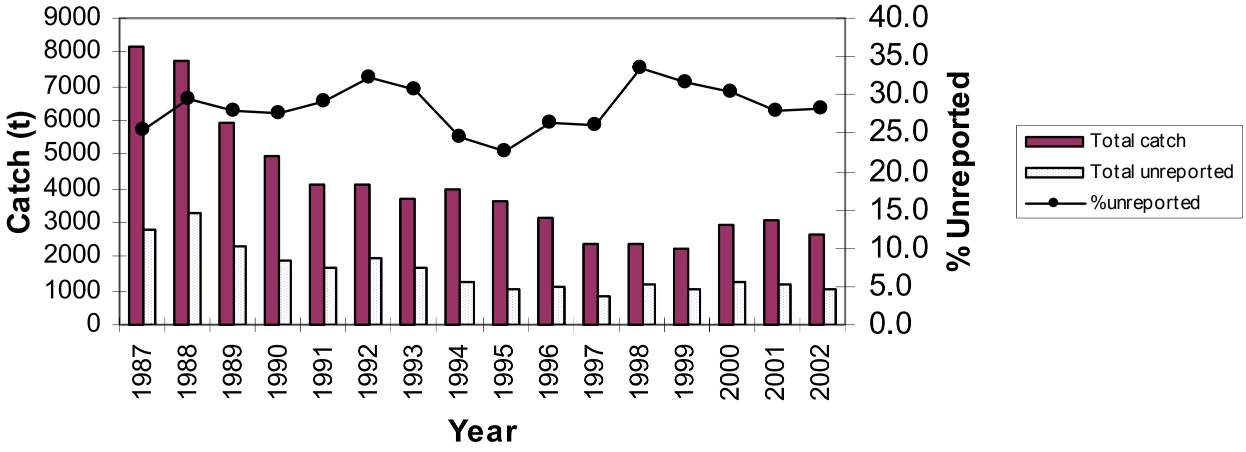


Figure 2.1.1.4 Percentages of nominal catch taken in coastal, estuarine and riverine fisheries for NEAC northern and southen areas (1995-2002) and for the NAC area (1999-2002).

Figure 2.1.3.1 Total reported catch, unreported catch and percentage unreported (expressed as % of total catch) in NASCO Areas, 1987-2002.



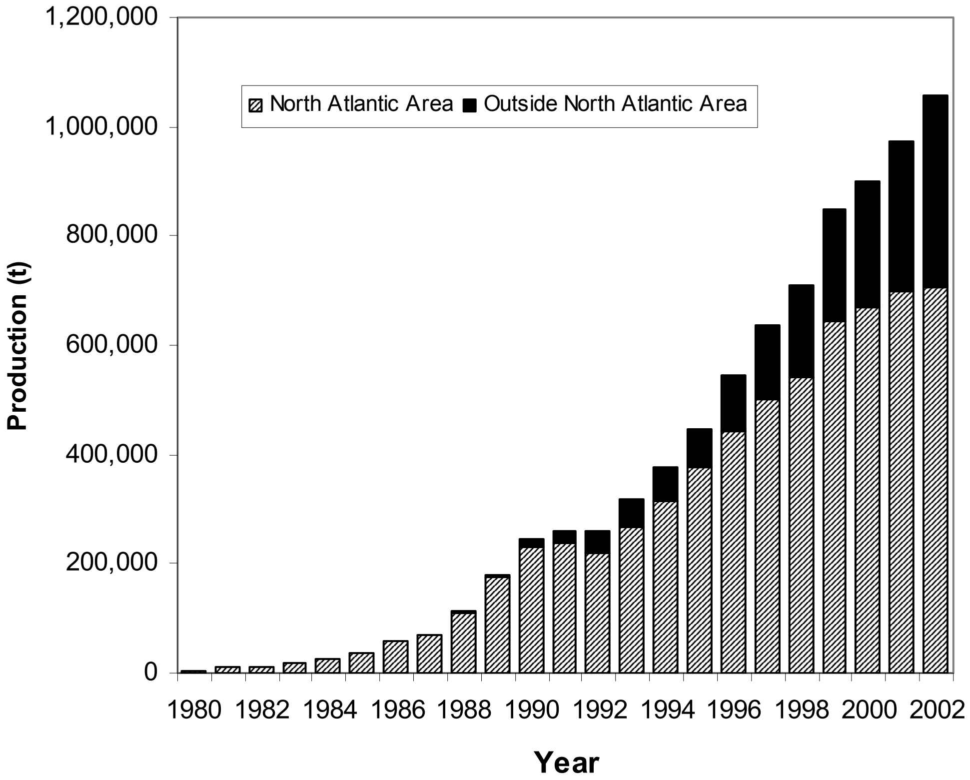


Figure 2.2.1.1. World-wide farmed Atlantic salmon production, 1980-2002.

Figure 2.2.2.1 Production of ranched salmon in the North Atlantic, 1980-2002.

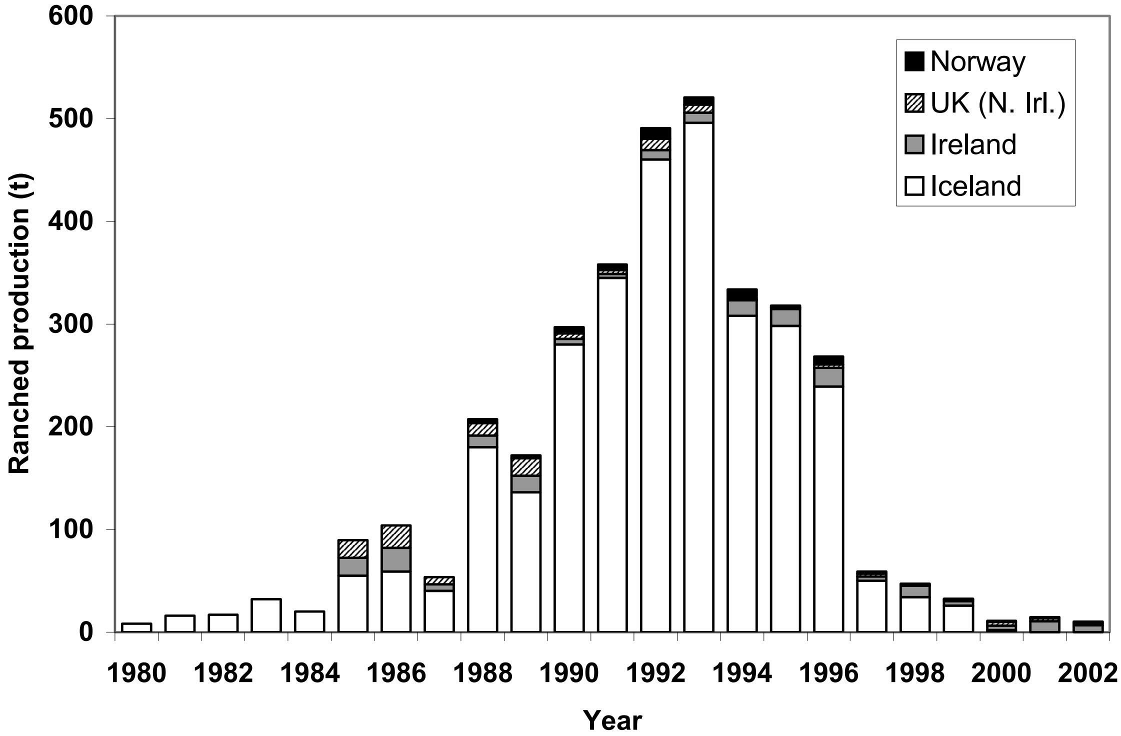


Figure 2.3.1.1. Growth trajectories of Atlantic salmon based on average weight (kg) of outmigrating smolts, returning 1SW and 2SW salmon from NEAC and NAC rivers.

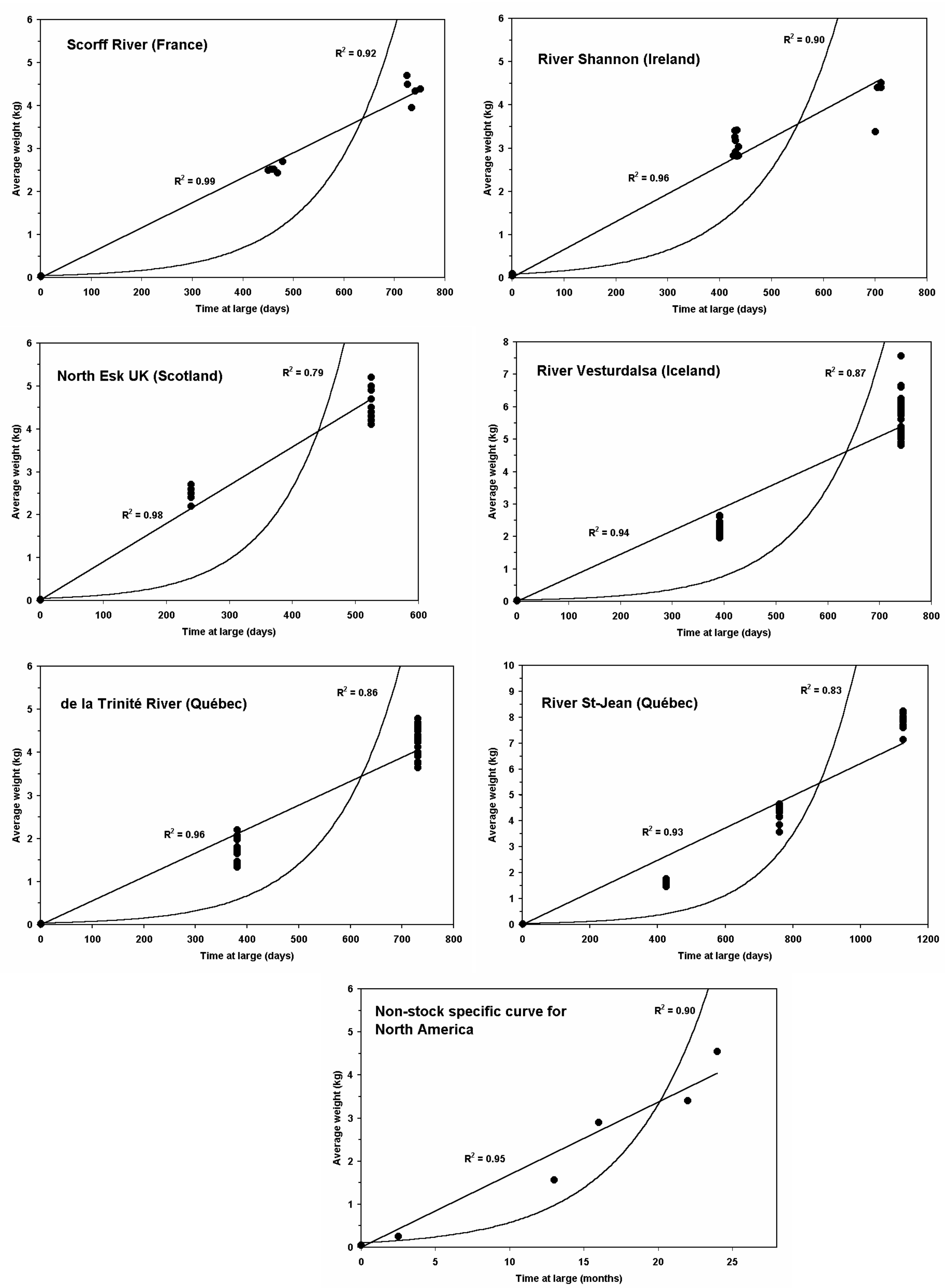
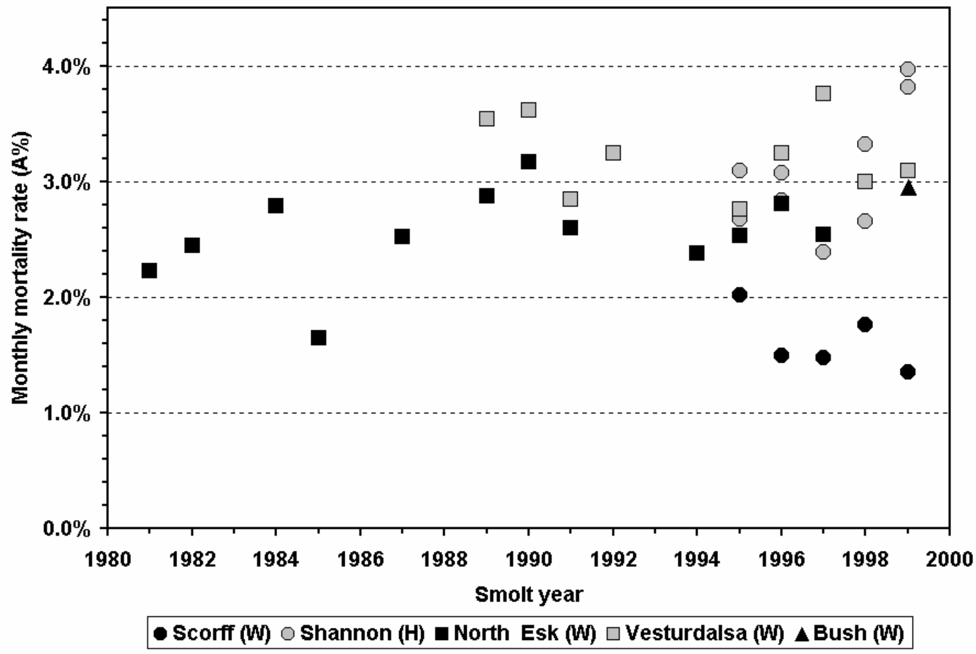


Figure 2.3.1.2. Monthly mortality (A%) estimates in the second year at sea derived from the inverse-weight model assuming a linear growth function for NEAC stocks (upper panel) and for NAC stocks (lower panel).



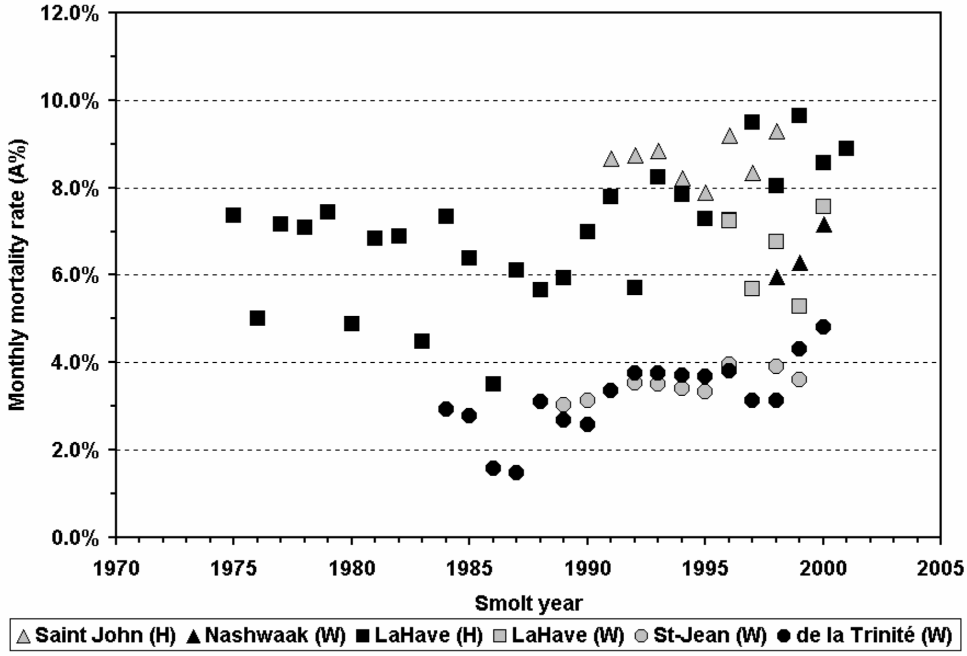
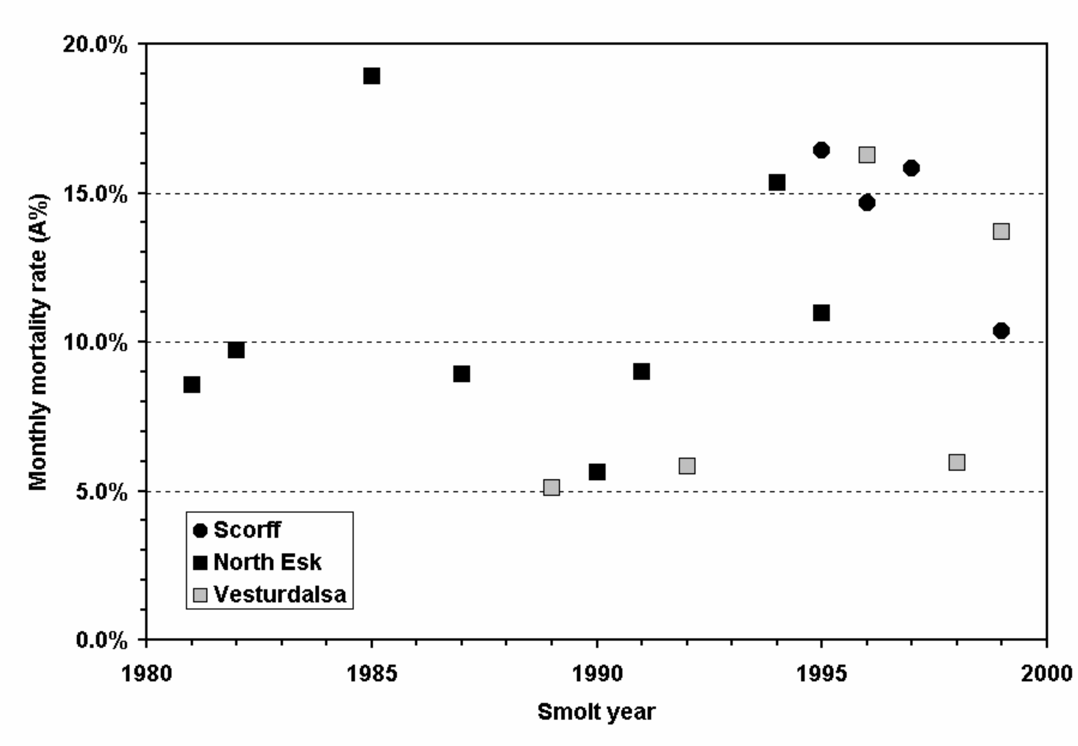


Figure 2.3.1.3. Monthly mortality (A%) estimates in the second year at sea derived from the maturity schedule model for NEAC stocks (upper panel) and for NAC stocks (lower panel).



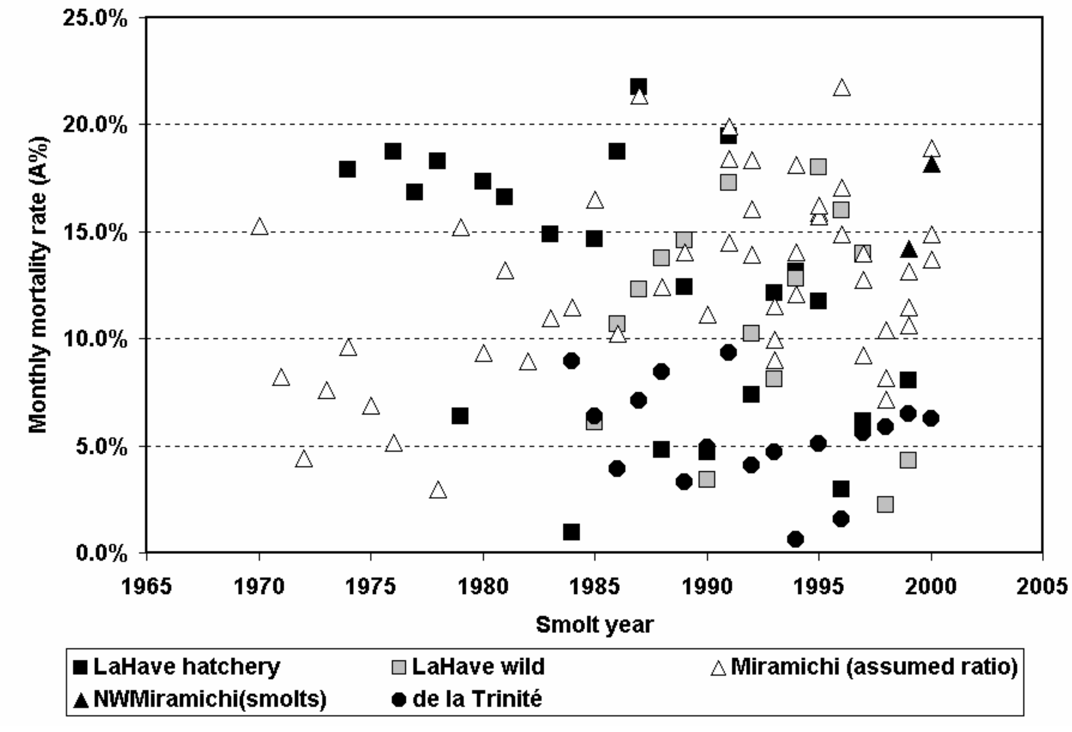


Figure 2.3.2.1. Return rates of wild Atlantic salmon smolts from the St- Jean River (upper panel) and de la Trinité River (lower), Québec, for the smolt year.

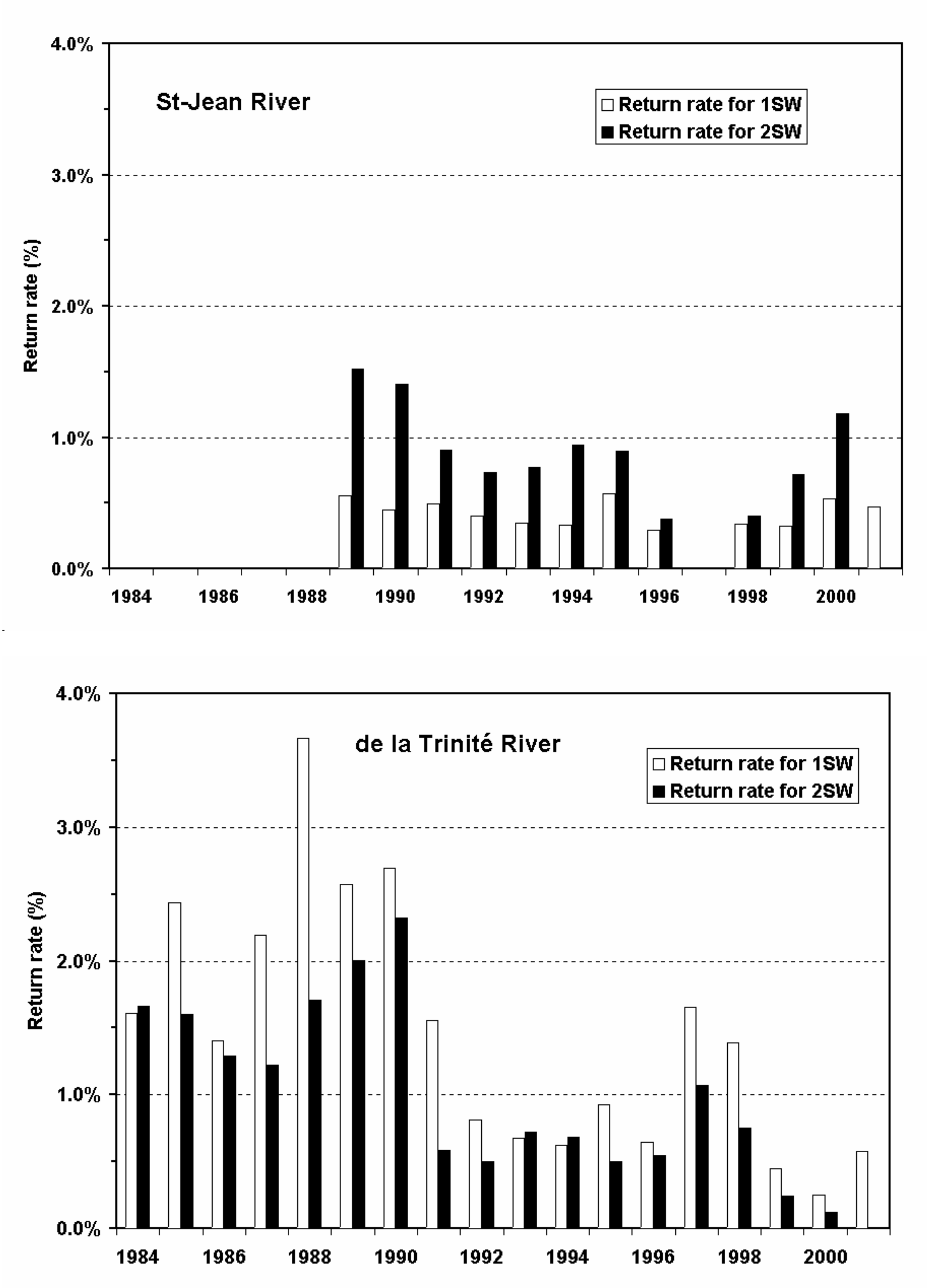


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Figure 2.4.3.1. Average egg depositions and average juvenile densities in rivers of the Maritime provinces within the management periods encompassing important variations in commercial and recreational fisheries exploitation.

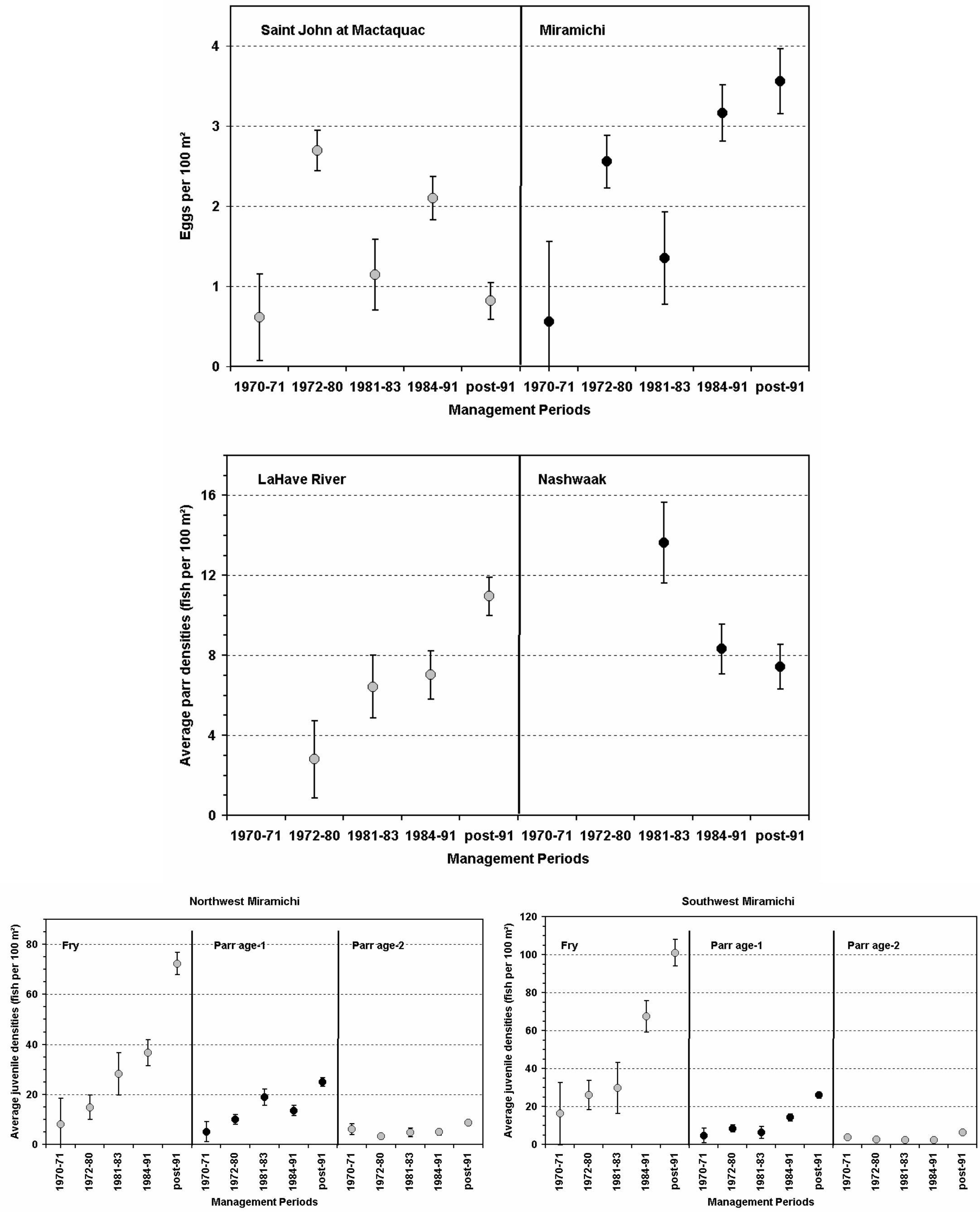


Figure 2.4.3.2. Returns rates of hatchery 1SW salmon (left upper panel) and 2SW salmon (right upper panel), return rates of wild smolts to 1SW salmon (left middle panel) and 2SW salmon (right middle panel), and estimates of survivals in the first year and second year at sea for salmon smolts from the Trinité River (bottom panel).

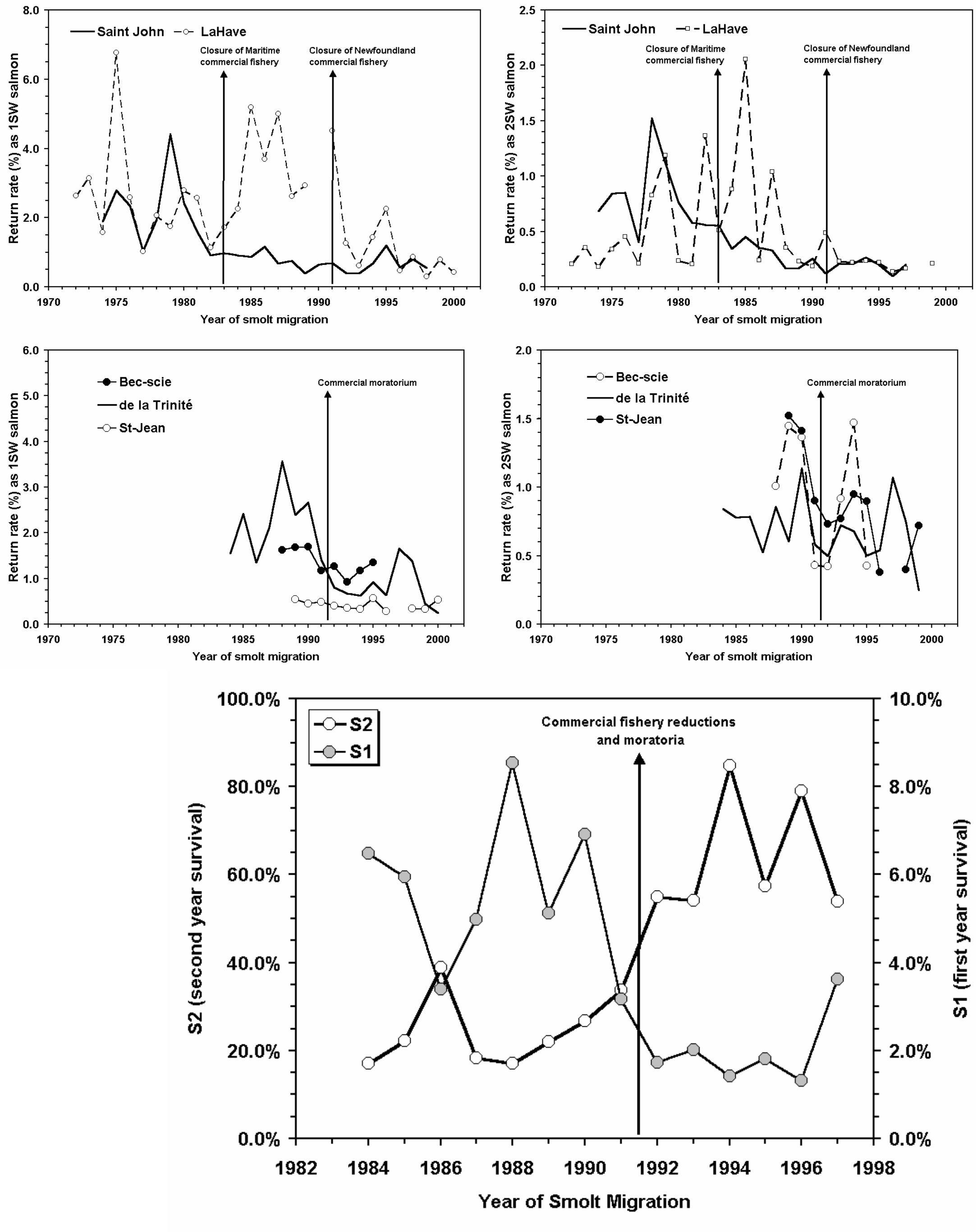


Figure 2.4.3.3. Relative abundance of maiden and repeat spawning large salmon (upper panel) and estimates of absolute abundance (lower panel) of repeat spawning large salmon by spawning history returning to the Miramichi River, 1971 to 2002.

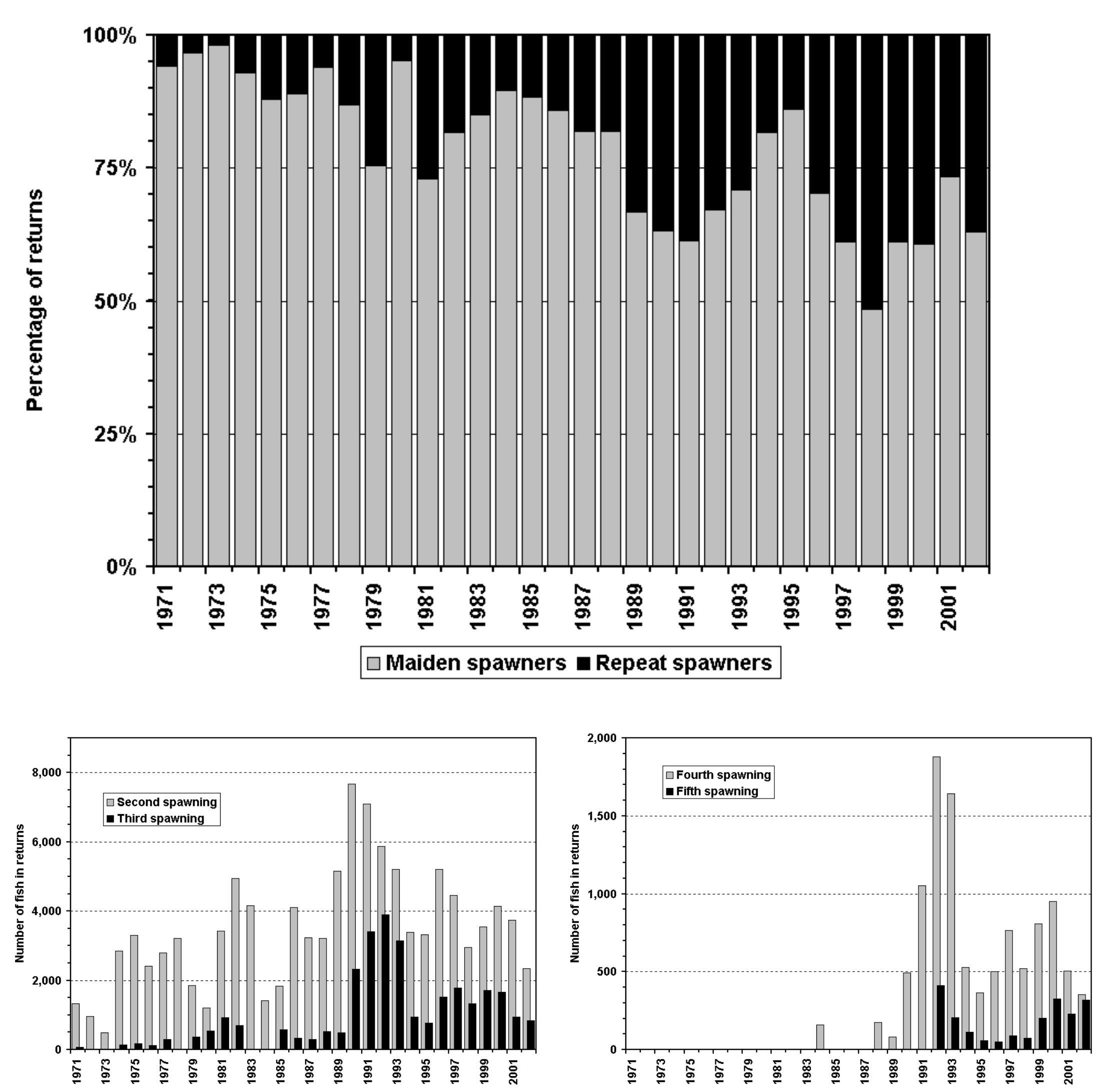


Figure 2.4.3.4. Average return rates to a second spawning as either consecutive or alternate spawners by 2SW salmon and 1SW salmon (upper panel) for significant management periods and annual return rates of 2SW maiden (middle panel) and 1SW salmon (lower panel) for the Miramichi River, 1971 to 2002. Return rates are the quotient of returns at life history stage and returns at maiden age.

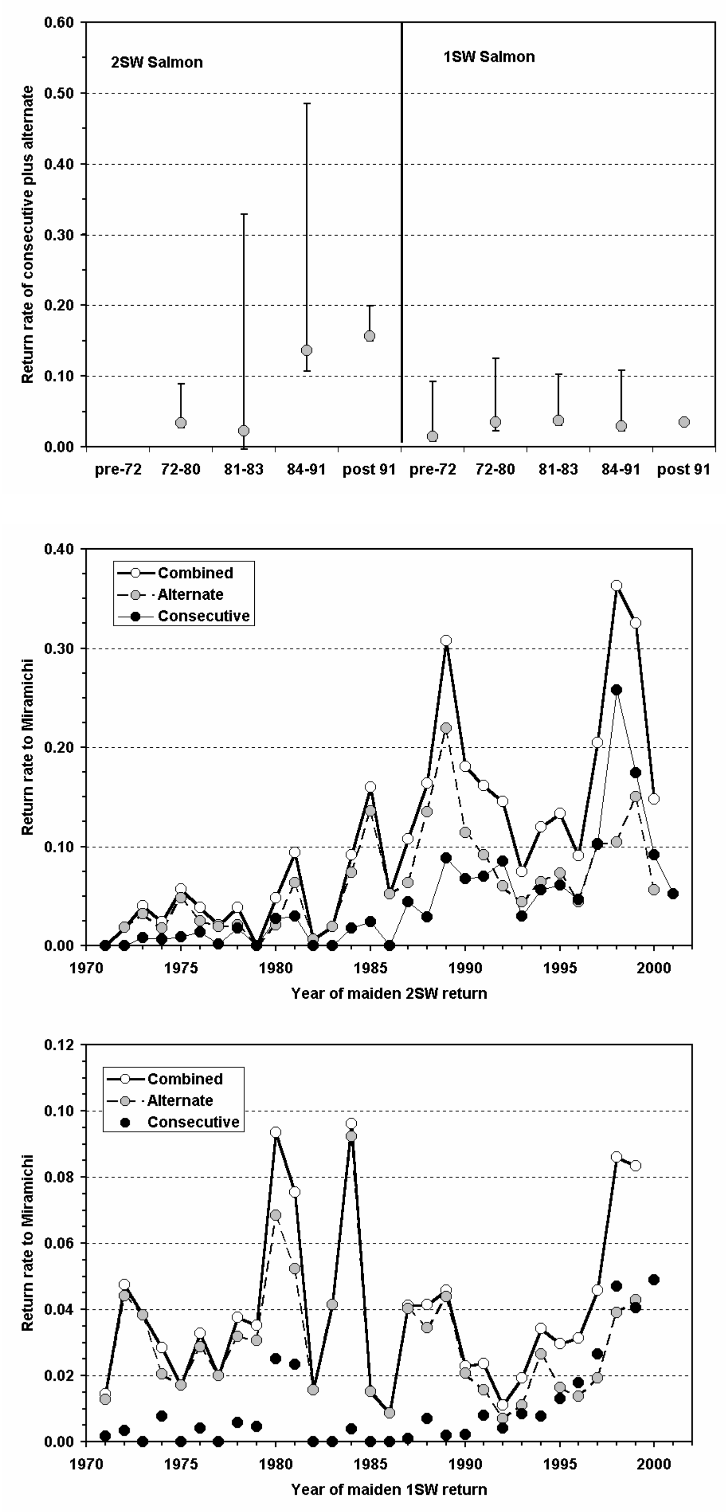
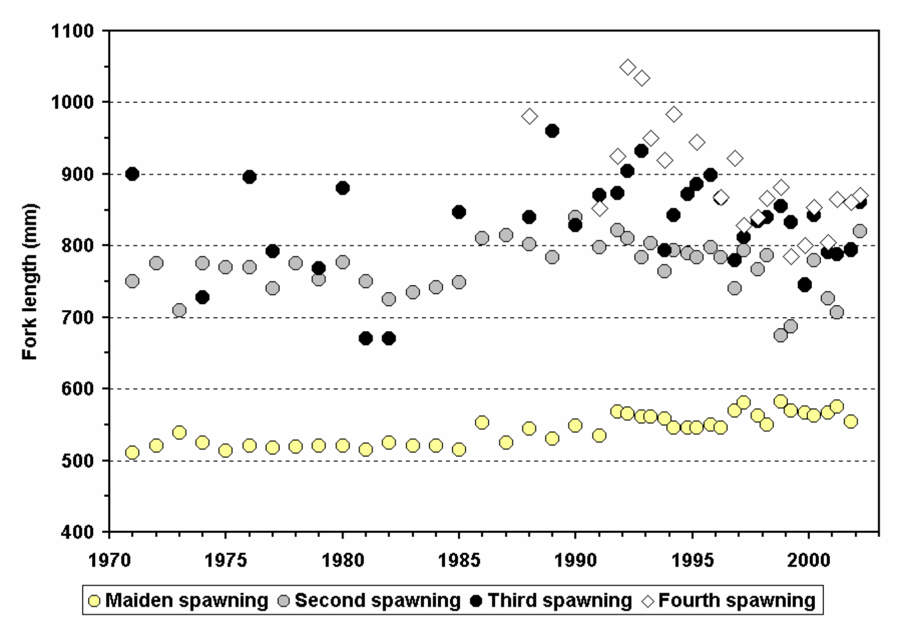


Figure 2.4.3.5. Median fork length of maiden and repeat spawning salmon if the maiden age of spawning was 1SW (upper panel) and 2SW (lower panel).



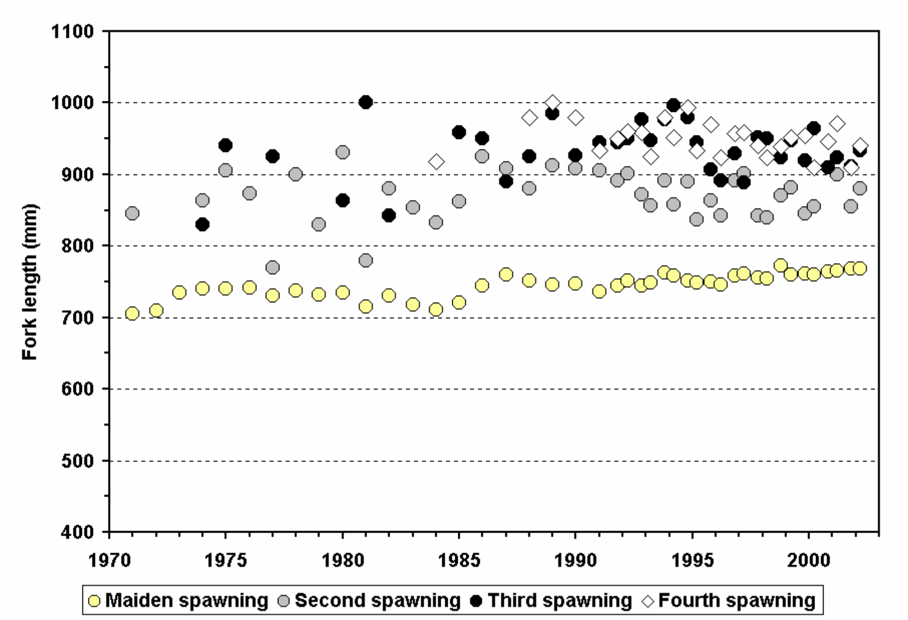


Figure 2.4.3.6. Adjusted mean length at age of wild 1SW salmon (left panels) and 2SW salmon (right panels) from the Saint John River and Nashwaak River (upper panel) and Miramichi River (lower panel), 1971 to 2002.

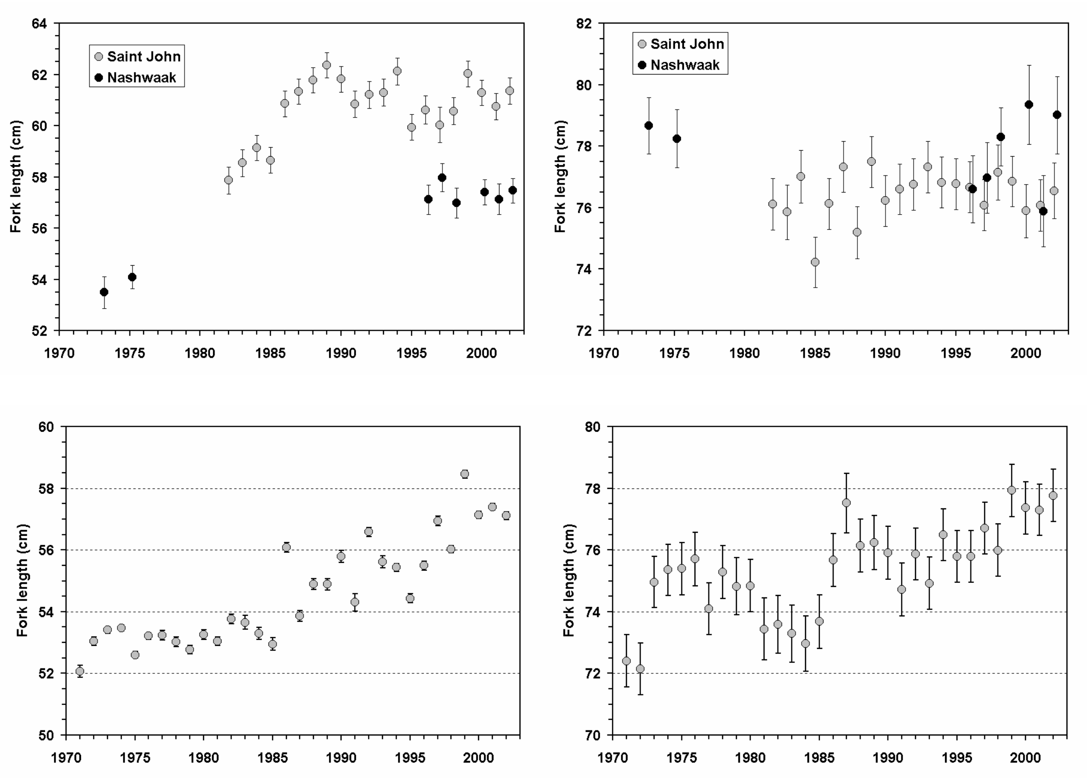


Figure 2.4.3.7. Run-timing of large salmon (upper panel) and small salmon (lower panel) as observed at the Millbank estuary trap net in the Miramichi River, 1952 to 1992. Arrows and letters identify management periods. A – commercial fishery in the Gulf of St. Lawrence; B – closure of drift net fisheries and commercial fisheries in Maritimes (by-catch of salmon in non-salmon commercial gear could be retained); C – reopening of Maritimes commercial fishery with restrictions; D – moratoria in Newfoundland commercial fishery.

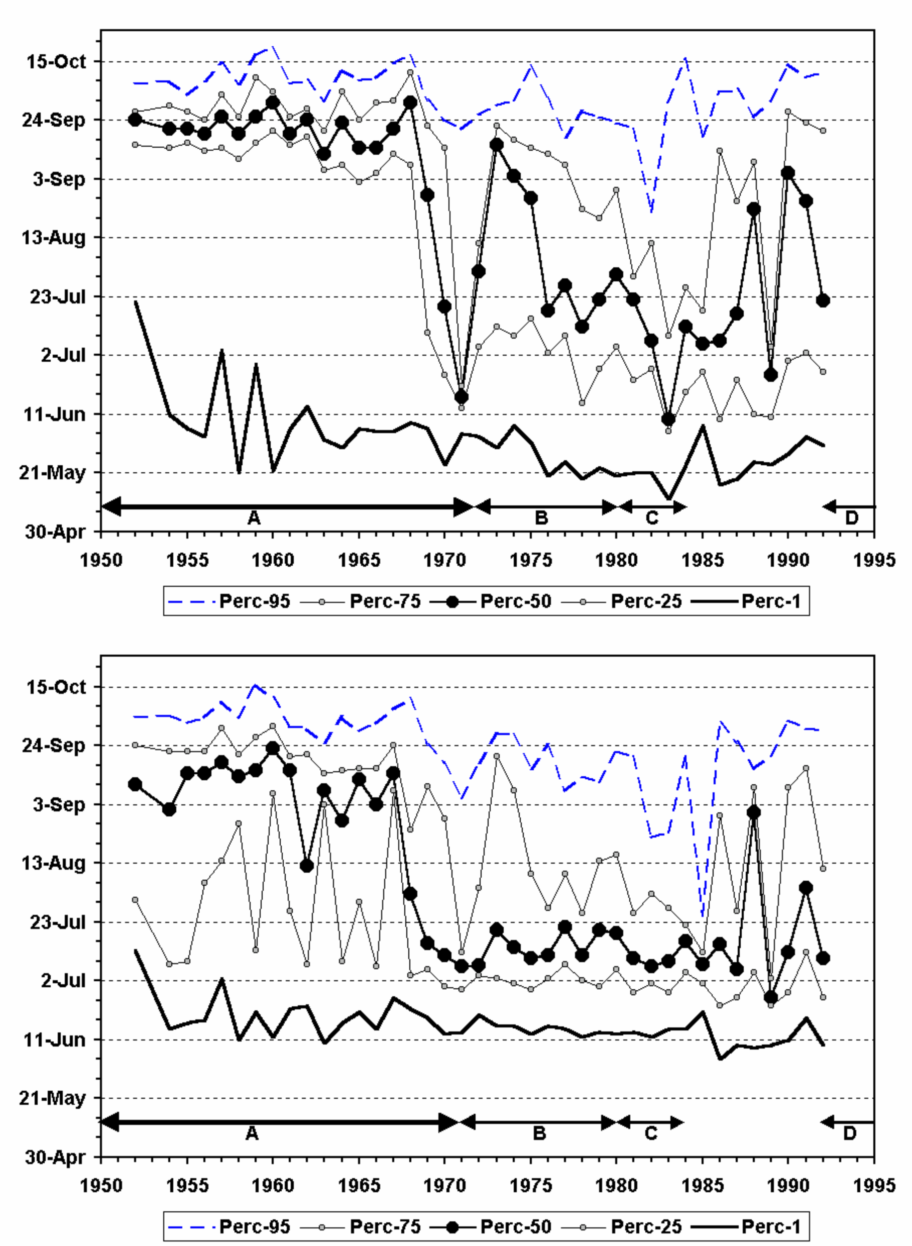


Figure 2.4.3.8. 1SW/2SW relationships for Northwest Miramichi, the Southwest Miramichi (upper row panels), hatchery salmon and wild salmon from the LaHave River (second row panels), hatchery salmon and wild salmon from the Saint John River (third row panels), and wild salmon from the Nashwaak River (bottom panel).

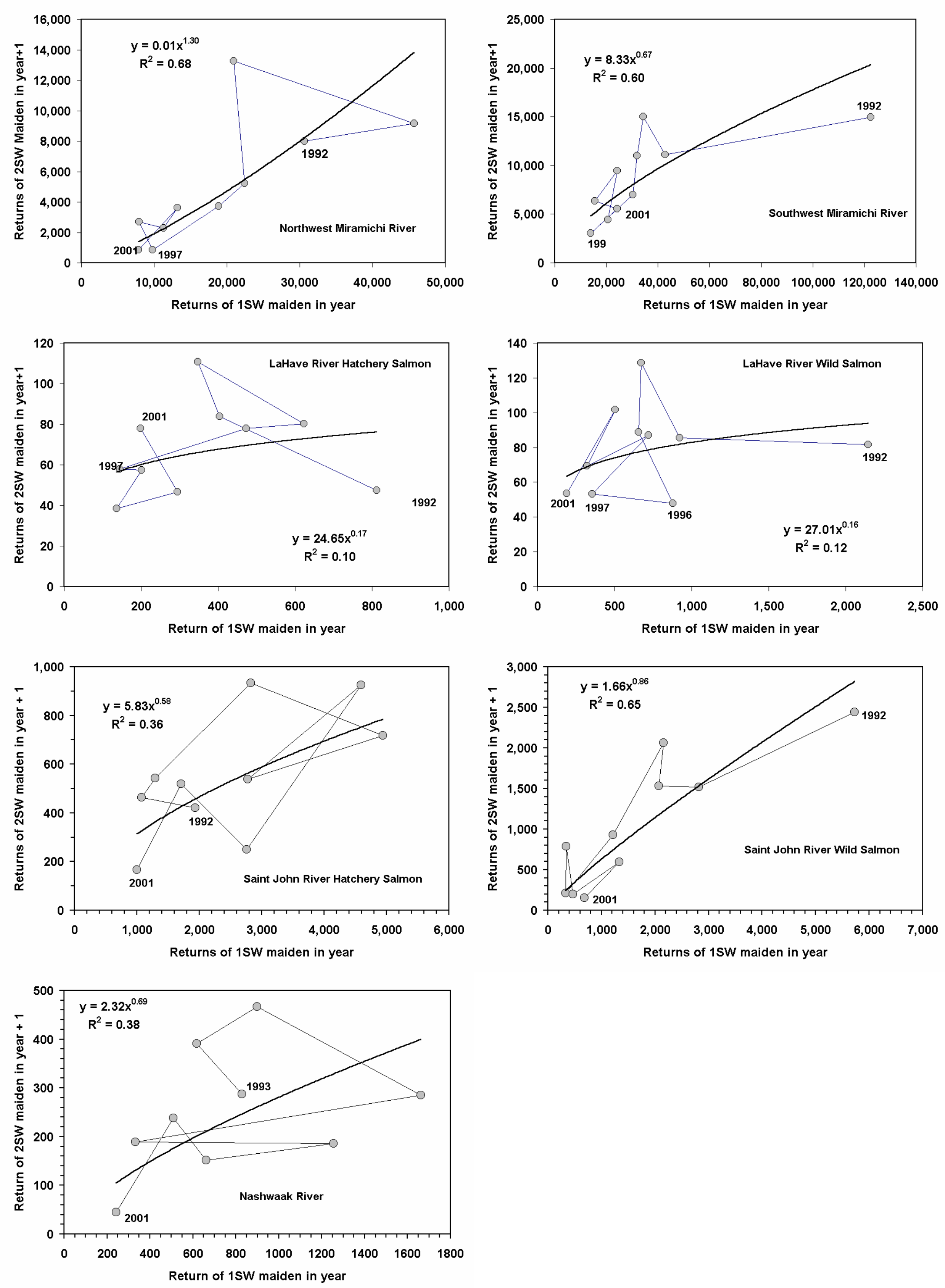


Figure 2.4.3.9. Linear association between residuals from the 1SW/2SW association and harvest of 1SW salmon at Greenland for Southwest Miramichi (upper left panel) and relative error [(obs. – pred.) / obs.] of predicted 2SW return when Greenland harvest of North American 1SW salmon is excluded or included in the 1SW/2SW association for the Southwest Miramichi (upper right panel), LaHave River wild salmon (lower left panel) and Saint John wild salmon (lower right panel).

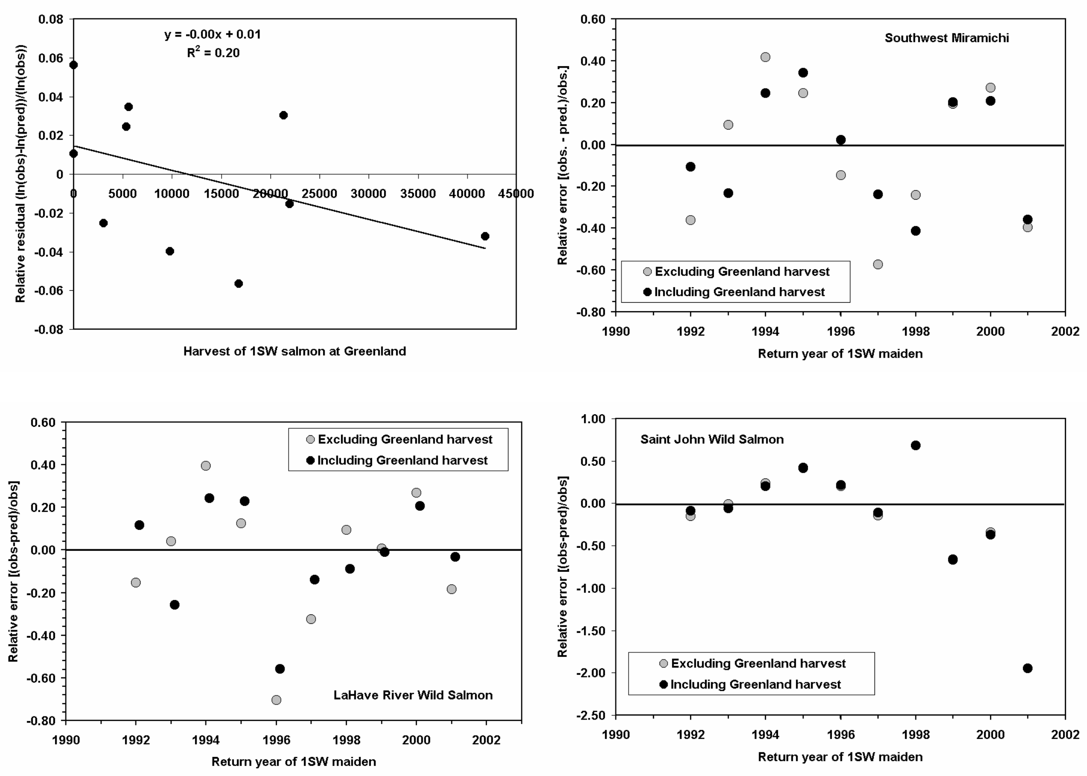


Figure 2.4.4.1. Postitions and numbers of large post-smolts and salmon captured in surface trawl hauls for DST tagging in a Nordic project. During the Norwegian survey, 21 June – 5 July 2002 west of the Vøring plateau, in addition to a few salmon large numbers of post-smolts were caught. These were too small for tagging. Hence, in that area, the stars (see legend in figure) may mark both "no salmon" and small post-smolts. Late autumn/ early winter the post-smolts captured north of the Faroes and east of Iceland were mostly sufficiently large to be tagged. The sites of release and recapture of one salmon, and its possible migration path are marked with open circles and dashed line. The boundaries of the various EEZs are marked with dotted lines.

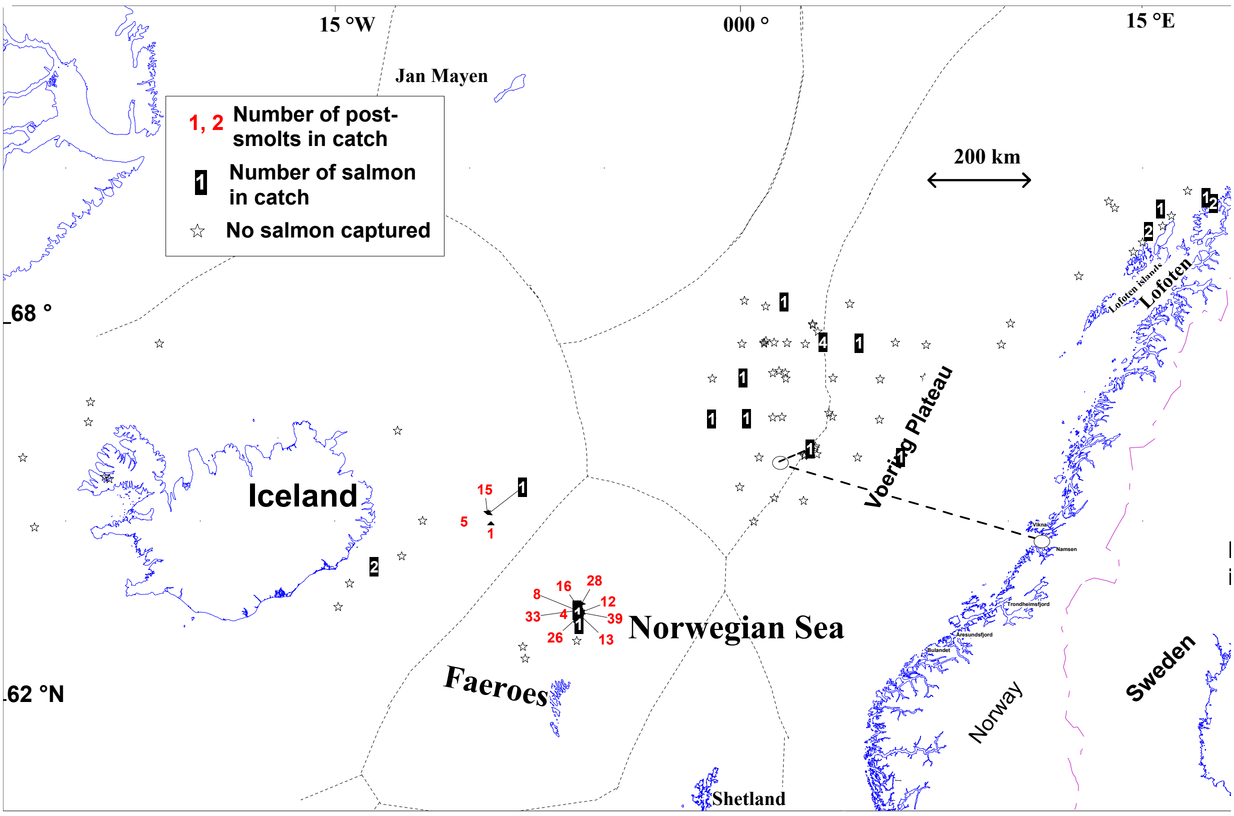


Figure 2.5.1.1. Typical single run trajectory and 90% range of 10,000 simulations of an expected stock and recruitment curve in relation to its conservation requirement S_{lim}.

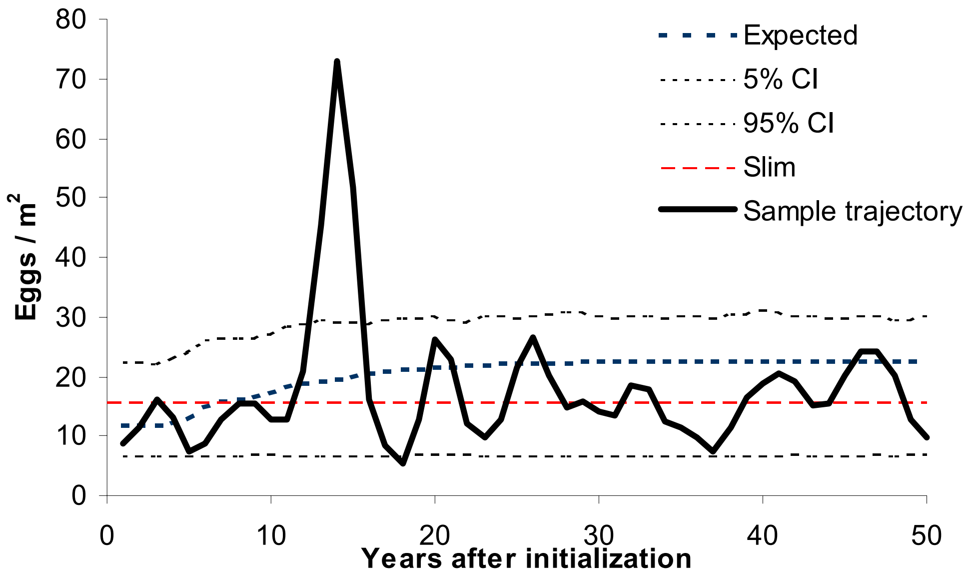


Figure 2.5.1.2. Number of years to attain S_{lim} in 50 years for High (14.93), Medium (2.13) and Low (1.85) alpha values in a Ricker stock and recruitment function over 10,000 simulations with uncertain parameters.

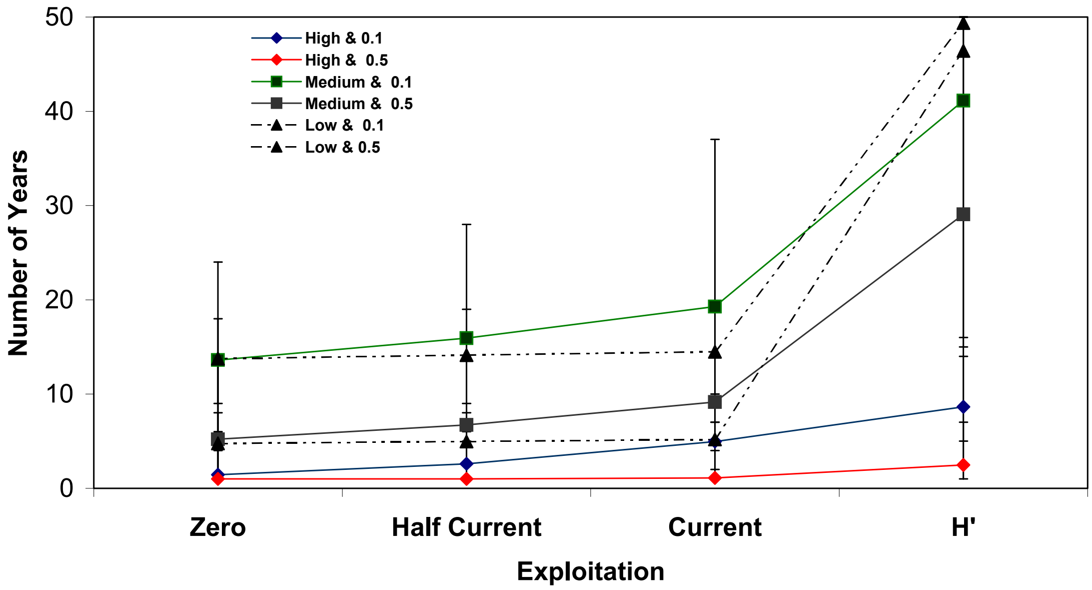
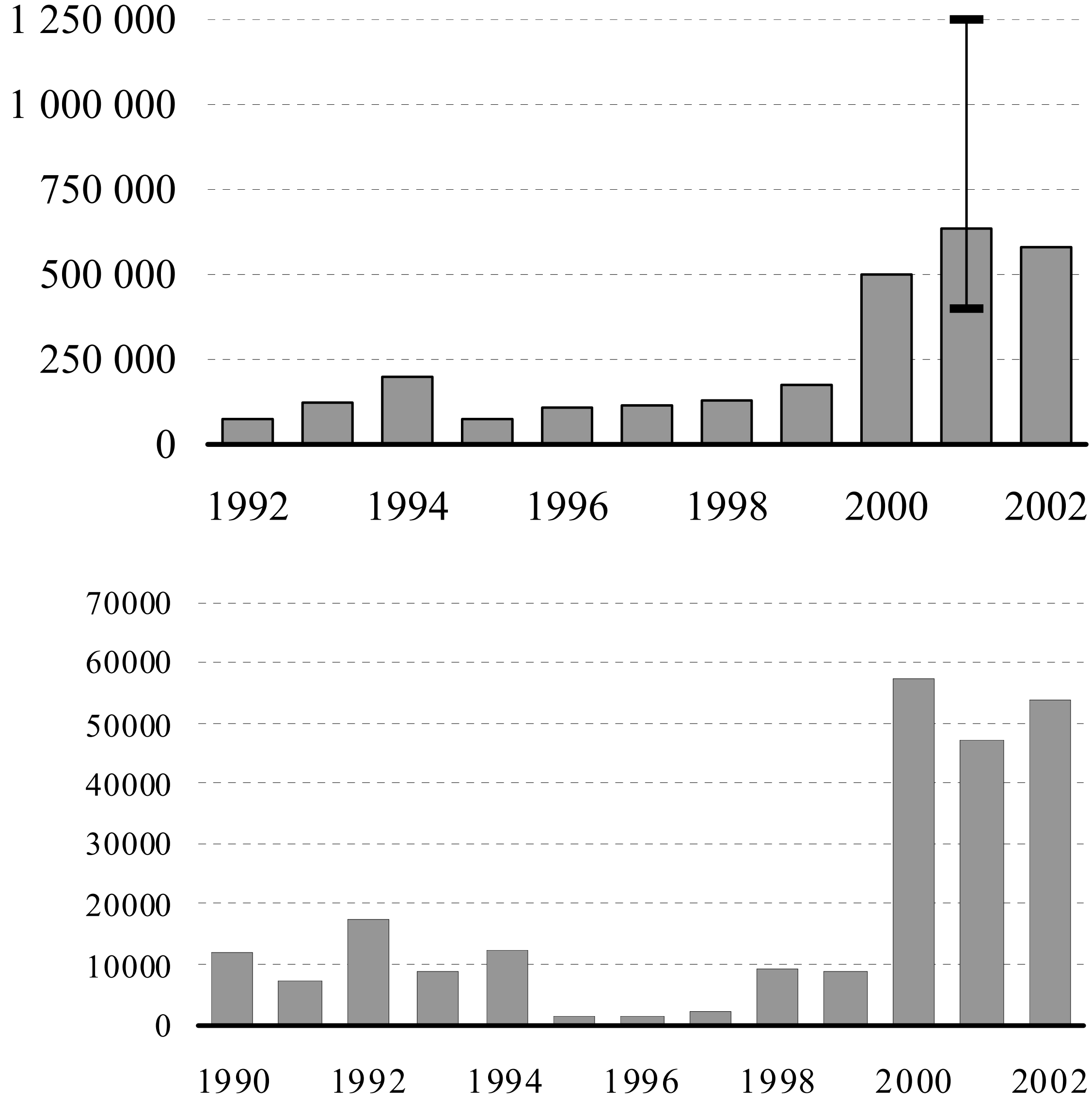


Figure 2.5.3.1. Estimated wild smolt run of the Rivers Tornionjoki (upper panel) and Simojoki (lower panel) in the northernmost Baltic Sea Region (Gulf of Bothnia). The error bar is presented as an example of the 95% confidence limits of the estimates. The probabilistic estimation methods used are presented in Mäntyniemi & Romakkaniemi (2002).



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

3.1 Fishing at Faroes in 2001/2002

No fishery for salmon was carried out in 2001/2002 or, to date, in 2002/2003. Consequently, no sample data is available from the Faroese area for this season. No buyout arrangement has been arranged since 1999. Although no research fishery was carried out some biological information is available from a DST tagging programme as detailed in section 2.4.4.

3.2 Homewater fisheries in the NEAC area

3.2.1 Significant events in NEAC homewater fisheries in 2002

Measures in Russia led to a considerable reduction in unreported catch and exploitation rate in some areas (see section 3.2.2). Gill nets that had been used for commercial in-river fisheries, in the Archangel Region of Russia, were prohibited in 2002. The only permitted gears remaining are those designed to trap salmon. For example, this measure led to a considerable reduction in unreported catch in the fishery conducted in the downstream section of the Severnaya Dvina River.

In Iceland, the Institute for Freshwater Fisheries, The Federation of River Owners and Association of Icelandic Angling Clubs formed a coalition to spare 2SW salmon by all means. This was done by voluntary catch and release of caught 2SW salmon and by various restrictions on fishing. The 2SW salmon in Icelandic salmon rivers have been declining in numbers and catch since 1985 and are currently at low numbers in many rivers. No such decline is evident for the 1SW salmon.

Sweden introduced new fishing regulations in 2002 by establishing fifteen new protected areas outside small sea trout rivers. In addition a number of existing protected areas outside individual salmon rivers were merged into larger units. For some of these larger protected areas, greater responsibility was given to county administrations to manage fisheries. Towards the end of year 2002 decisions were taken to have the salmon fishery in rivers closed in the period from 1 October to 31 March (previously 1 October- end of February). This regulation has been implemented from 1 January 2003.

In Ireland all fishermen (commercial and rod) are now obliged to tag their catch with locking coded strap tags (carcass tags) indicating the region, year and method of capture and to record details of the catch in a logbook. These logbooks must be returned to the Central and Regional Fisheries Boards who collate the information and report the catch statistics. In 2002, a TAC of 219,619 fish was imposed on the commercial fishery as a method of limiting catches and it is now illegal to sell rod caught fish.

A carcass tagging and logbook scheme for all salmon fishing was introduced into both fishery areas of UK (N. Ireland) for the first time during 2001, and had its first full year of operation in 2002. In the Fisheries Conservancy Board (FCB) area significant management changes came into effect in 2002, aimed at conservation of wild salmon stocks. For the 2001 season there was a voluntary agreement with licensed net operators that no net shall fish until the 1st June (season was previously 17th March to 15th September), with around 8 nets agreeing not to fish at all. Holders of drift net licenses agreed to operate for only eight weeks during the period 1 June to 15 September, broken down into two four-week periods. These voluntary agreements preceded a public:private sponsored voluntary buyout, which came into effect for the 2002 season, with funds being made available to purchase netting rights from a significant proportion of operators in the FCB area. Accompanying measures to regulate angling, introduced into the FCB area on a voluntary code-of-practice basis in 2001, operated again in 2002, pending introduction of appropriate bylaws.

In UK (Scotland) a ban on the sale of rod caught salmon came into effect on the 1st of October 2002.

A number of measures aimed at reducing exploitation were implemented or strengthened in UK (England & Wales) in 2002. A number of net fisheries are being (or have been) phased out because they exploit migratory salmonids returning to several rivers (i.e. mixed stock fisheries). A further phase out was introduced in 2002 for one fishery in South West England, as a result of a new net limitation order. This will reduce the number of nets permitted to zero; a byelaw was also introduced for this fishery to limit the fishing season to June and July only. Arrangements were also made to reduce netting effort in a number of other fisheries by compensating netsmen not to fish for particular periods.

3.2.2 Gear

Gill nets that had been used for commercial in-river fisheries, in the Archangel Region of Russia, were prohibited in 2002. The only permitted gears remaining are those designed to trap salmon. No changes in the type of gear used were reported by other countries

3.2.3 Effort

The number of gear units licensed or authorised in several of the NEAC area countries provides a partial measure of effort, but does not take into account other restrictions, for example, closed seasons (Table 3.2.3.1). In addition, there is no indication from these data of the actual number or licences utilised of the time each licence fished.

Trends in effort are shown in Figures 3.2.3.1 and 3.2.3.2 for the Northern and Southern NEAC countries respectively. In the Northern NEAC area, drift net effort in Norway accounted for the majority of the effort expended, in the early part of the time-series. However, this fishery closed in 1989, reducing the overall effort substantially. The liftnet fishery, which made a minor contribution to overall effort, showed a decreasing trend until it ceased to operate in 1993. The two remaining methods, bagnets and bendnets, show contrasting patterns of effort until the early 1990s when both show downward trends until the end of the time-series. In the Archangel region of Russia, the effort in the coastal fisheries in 2002 remained at the 5-year average while effort in in-river fisheries shows a decline and is at the lowest number for the period reported. In the Southern NEAC countries, net effort data show a downward trend of various degrees for UK (England & Wales), UK (N. Ireland), Ireland, France and UK (Scotland).

Rod effort, where available, show both upward and downward trends for the period reported. In the Northern NEAC area the catch and release rod fishery in Russia and the rod fishery in Finland showed an increase in 2002 from the previous year and were at the highest level for the period reported. In the Southen NEAC area rod fishing effort show decreasing trend in UK (England & Wales) over the period presented. In Ireland rod fishing effort has shown increase for the past 11 years.

3.2.4 Catches

NEAC area catches are presented in Table 3.2.4.1. The total catch in the NEAC area was 2,464 tonnes**,** down 14% on the 2001 catch, but representing 94% of the total North Atlantic nominal catch in 2002. Both Southern and Northern areas reported catches significantly below those in 2001. However catches for the Southern region were below the 5-year mean (by 1%) but catches were 7% above the 5-year mean in the Northern region.

Figure 3.2.4.1 shows the trends of nominal catches of salmon in the Southern and Northern NEAC areas, from 1971 until 2002. Catches in Southern countries were near to 4,500 t in 1972-1975 but in the latter part of the time series, average catches were between 1,000 and 1,500 t. The overall pattern is characterised by two steep declines, one in 1976 and the other over the years 1987-1991. Catches in Northern countries varied from 1,850 to 2,700 t from 1971 to 1986 and have undergone a slower decline since then to levels of 1,000 to 1,600 t during the 1995-2001 period. Thus, catches in the Southern countries, which were predominant in the NEAC area before 1990, are now slightly lower than those reported in the Northern countries.

3.2.5 Catch per unit effort (CPUE)

CPUE is a measure that can be influenced by various factors, and it is assumed that the CPUE of net fisheries is a more stable indicator of the general status of salmon stocks than rod CPUE; the latter may be more affected by varying local factors, e.g. weather conditions, management measures, angler experience and the degree to which catch and release is practised. Both may also be affected by many measures taken to reduce fishing effort, for example, changes in regulations affecting gear. 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.

An overview of the CPUE data for the NEAC area is presented in Figure 3.2.5.1. The CPUE values presented are standardized indices relative to the averages of the time series. The original, more detailed CPUE data are presented in Tables 3.2.5.1 - 3.2.5.5. The CPUE for rod fisheries have 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.

In the Southern NEAC area, CPUE shows a general increase in UK (N-Ireland) net fisheries, a decrease in UK(Scotland) net fisheries, whereas no trend was observed in UK(England & Wales) net fisheries and in French rod fisheries (Figure 3.2.5.1). In UK (England & Wales) CPUE for the net fishery decreased in most regions compared to 2001 and the previous 5-year averages (Table 3.2.5.3). The CPUE for the Scottish fixed engine fisheries were lower, whereas that of the net and coble fisheries was higher than in 2001 and the previous 5-year averages (Table 3.2.5.4). In UK (N-Ireland), the river Bush rod fishery CPUE showed a clear decrease compared to recent indices (Table 3.2.5.1).

In most of the Northern NEAC area, there has been an increasing trend in the CPUE figures for various fisheries, especially in recent years in Norway (net) and Finland (rod) (Figure 3.2.5.1). However, the figures for 2002 in Norway and Finland generally decreased from the previous year and were below the previous 5-year average (Tables 3.2.5.1 & 3.2.5.5). In comparison with the previous year, half of the CPUE values for the rod fisheries in Russian rivers were down and the other half was up. The same pattern was true in comparison with the previous five-year means (Table 3.2.5.2). No long-term trend can be detected either on the White Sea rivers or the Barents Sea rivers (Figure 3.2.5.1).

3.2.6 Age composition of catches

The percentage of 1SW salmon in catches is presented in Table 3.2.6.1 and Figures 3.2.6.1 and 3.2.6.2 for five Northern countries and four Southern countries of the NEAC area that have a time series of data. Several NEAC countries also report nominal catches partitioned according to sea-age category (Table 2.1.1.3.).

The percentage of 1SW fish in the catches of the Northern countries was 54 % in 2002, the lowest value since 1987 (Figure 3.2.6.1). It is below the 5-year mean (65%) and the 10-year mean (65%). Since 1987, this value has varied from 54 to 72 %. The five countries show similar percentages in 1987-1994, but have undergone substantial divergence since then. In most years Finland, Iceland, Russia are above the average of the Northern countries and have been in excess of 70% during the eight last years, whereas Norway and Sweden remain below the average of Northern countries.

For the Southern European countries (Figure 3.2.6.2), the overall percentage of 1SW fish varied from 49 to 65% since 1987 and was 64% in 2002, above the 5-year (62%) and the 10-year means (61%). (England & Wales) show high values (65 – 83% since 1990, 10-year mean = 75%), compared to UK (Scotland) (10-year mean = 54%). France shows quite variable values (27 to 74%) and Spain has the lowest percentages (10-year mean = 36%).

3.2.7 Farmed and ranched salmon in catches

The contribution of farmed and ranched salmon to national catches in the NEAC area in 2002 is again generally low (<2% in most countries) and is similar to the values that have been reported in previous reports (ICES 2000/ACFM:13, ICES 2001/ACFM:15, ICES 2002/ACFM:14). Consequently, the occurrence of such fish is ignored in assessments of the status of national stocks (Section 3.3.3). The exception to this is Norway, where farmed salmon continue to form a large proportion of the catch in coastal, fjordic and rod fisheries. An assessment of the likely effect of these fish on the output data from the PFA model was included in ICES 2001/ACFM:15.

3.2.8 National origin of catches

In 2002, a number of tags originating from fish released from other countries (UK (N. Ireland), UK (England & Wales), UK (Scotland) and Spain) were recovered in the Irish fisheries.

An update of the adult recovery information derived from tagged smolts released in Norway was made available to the Working Group. Between 1996 and 2001 a total of 532,742 smolts, mainly hatchery reared, were tagged and released. A total of 5,065 adult recoveries were reported from Norway and 24 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.

3.2.9 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, as a consequence of management measures and the reduced value of commercially caught salmon, as well as a reduction in the size of stocks. The overall nominal catch in the NEAC area in 2002 (2,464 t) represented a 14% decrease on the catch for 2001, but a 3% increase on the average 1997-2001 catch. Catches in both Southern and Northern areas decreased substantially compared to 2001 (-11% and -17% respectively), whereas compared to the 1997-2001 mean catches decreased in the Southern area (1%) while they increased in the Northern area (7%).

While there have been no major changes in the types of commercial fishing gear used, both northern and southern Europe have experienced general reductions in the number of licensed gear units. In contrast, there are no consistent trends for the rod fishing effort in NEAC countries.

CPUE data for various net and rod fisheries indicate a general increase in northern Europe while patterns in southern Europe are less consistent. 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.

The proportion of 1SW salmon in 2002 was the lowest (54%) since 1987 in the catches of the Northern countries of the NEAC areas and has decreased sharply since 2000. This proportion has been more stable in Southern Europe for the last years, and the 2002 figure (64%) is very near to the previous five -year average (62%) and the previous 10-year average (61%).

Despite the continued high levels of production in the salmon farming industry, the incidence of farmed salmon in NEAC homewater fisheries was generally low (<2%) and similar to recent years. The exception to this is Norway, where farmed salmon still comprise a large proportion of the catch in several of the coastal, fjordic and rod fisheries.

3.3 Status of stocks in the NEAC Area

3.3.1 Survival indices

An overview of the estimates of marine survival for wild and hatchery-reared smolts returning to homewaters (i.e. before homewater exploitation) for the 2001 and 2000 smolt year classes (returning 1SW and 2SW salmon, respectively) is presented in Figure 3.3.1.1. The survival values presented are standardized (Z-score) indices relative to the averages of the time series. The original survival indices for different rivers and experimental facilities are presented in Tables 3.3.1.1 and 3.3.1.2.

With the exception of the Northern NEAC hatchery indices, Northern and Southern NEAC areas show a general decline in marine survival over the past 10-20 years (Figure 3.3.1.1). The steepest decline appears to be for the wild smolts in the Southern NEAC area.

In general, a majority of the survival indices for the latest smolt year classes for both wild and hatchery-reared smolts were below those of the previous year and the 5- and 10-year averages (Tables 3.3.1.1 & 3.3.1.2). Return rates of hatchery released fish, however, may not always be a reliable indicator of marine survival of wild fish.

Results from these analyses are consistent with the information on estimated returns and spawners as derived from the PFA model (section 3.3.4), and suggest that returns are strongly influenced by factors in the marine environment.

3.3.2 The NEAC – PFA model

Description of 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. As reported last year (ICES 2002/ACFM:14), the Working Group has determined an 'm' value of 0.03 per month to be appropriate. A Monte Carlo simulation (1000 runs) using 'Crystal Ball' in Excel (Decisioneering, 1996) is used to estimate confidence limits on the PFA values. Potter et al. (1998) provides full details of the model.

3.3.3 Sensitivity analysis of the PFA model

A sensitivity analysis for the spreadsheet model which generates PFA estimates in the NEAC area was described in ICES 2002/ACFM:14.

The sensitivity of the overall assessment of PFA for the NEAC Area, and for the Northern and Southern European stock complexes, depends on the values of the various parameters provided for different countries, and these will also be weighted by the national catches. The analysis provided an evaluation of the effects (% change) on the assessment of PFA of maturing and non-maturing 1SW salmon from Northern and Southern Europe of making changes to the non-reporting rate ('R'), the exploitation rate ('U') and the time of return to homewaters ('t').

Changes to the parameter values listed in the text table below had a greater than 5% effect on the respective (ie. Northern or Southern European) PFA estimates indicating that particular attention should be paid to ensuring that these parameter values are accurate:

Country (Region)	Sea-age	Parameter
Norway (mid)	1SW	Non-reporting rate
Norway (North)	MSW	Non-reporting rate
Ireland	1SW	Non-reporting rate
Ireland	1SW	Exploitation rate
Scotland (East)	1SW	Exploitation rate
Scotland (East & West)	MSW	Exploitation rate
Scotland (East)	MSW	Non-reporting rate

No changes were made to any of these variables prior to running the NEAC PFA model for the 2003 assessment.

3.3.4 Grouping of national stocks

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

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

The groups were deemed appropriate by the Working Group as they fulfilled an agreed set of criteria for defining stock groups for the provision of management advice that were considered in detail at the 2002 meeting (ICES 2002/ACFM:14). Consideration of the level of exploitation of national stocks at both the distant water fisheries resulted in the proposal that that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC area stocks, but that advice for the West Greenland fishery should be based upon Southern European MSW salmon stocks only (comprising UK, Ireland, and France).

3.3.5 National input to the NEAC PFA model

To run the NEAC PFA model most countries are required to input the following time-series information (beginning in 1971) for 1SW and MSW salmon:

- Catch in numbers
- Unreported catch levels (min and max)
- Exploitation levels (min and max)

In some instances, the above information has been supplied in two or more regional blocks per country. In these instances, the model output is combined to provide one set of output variables per country. Descriptions of how the model input has been derived were presented in detail at the Working Group meeting in 2002 (ICES 2002/ACFM:14). Where there have been modifications to these derivation methods an explanation is given below. The input values for the required variables are provided in Table 3.3.3.1a-u.

Changes were made to the exploitation and unreported inputs for the Swedish data based on re-consideration of information available for wild salmon. In the case of UK (England & Wales) minor modifications were made to the values of unreported catch for the earlier part of the time series.

Changes were made to the Russian Kola Peninsula: Barents Sea Basin input data for 2003. In previous years, catches taken in the recently developed recreational rod fishery were not included, as the numbers were insignificant. Account was taken of these recreational catches in the "unreported catch" term in the model. As recreational catches are now substantial, they are now included in the 2003 catch input and the exploitation rate is adjusted accordingly.

3.3.6 Status of national stocks as derived from the PFA model

The Working Group has previously noted that the NEAC PFA model provides our best interpretation of available information on national salmon stocks. There remains considerable uncertainty around the derived estimates, and national representatives are continuing to improve the data inputs each year on the basis of new data, improved sampling and further analysis.

The National Conservation limits model has been designed as a means to provide a preliminary S_{lim} reference point for countries where river-specific reference points have not been developed. These figures should also be regarded as uncertain and should only be used with caution in developing management options. A drawback with an overall national status of stocks analysis is that it does not capture variations in status in different fishery areas or stock complexes; something that has been addressed, at least in part, by the area splits in some countries.

The model output for each country has been displayed as a summary sheet (Figures 3.3.4.1(a to j)) comprising the following:

- Estimated total returns and spawners (±SD) (derived from the National Conservation Limit model).

- Estimated total catch (including non-reported) of 1SW and MSW salmon.

- Estimated pre-fishery abundance (PFA) of maturing 1SW and non-maturing 1SW salmon (labelled as 1SW and MSW).

- Total exploitation rate of 1SW and MSW salmon estimated from the total returns and total catches derived from the model.

- National stock-recruitment relationship (PFA against lagged egg deposition), with S_{lim} fitted by the method presented in ICES 2001/ACCESS:14.

A brief description is given below summarising the outputs from the model.

Finland: Finnish salmon essentially comprise a single river stock, the River Teno (Tana). The data inputs include both Finnish and Norwegian catches for this river. The assessment suggests that the numbers of returns and spawners have fluctuated widely since 1971. The early part of the time-series (1971 to 1975) is characterised by a steep rise, followed by a sharp decline. Numbers of returns and spawners remained low until 1982, but have shown a steady increase since this time, reaching a peak in 2000. In the last two years both returns and spawners have shown a steep decline.

France: Returns and spawners are estimated to have declined over the past 20 years, although there have been large annual fluctuations. Numbers have been particularly low in recent years, with the last eight years being the lowest in the time-series. There has also been a decline in the proportion of MSW salmon in the catch over the time-series. The current status of the stocks must therefore be considered to be low with no indication of a recovery.

Iceland: The assessment suggests that there has been an overall decline in total returns of salmon to Iceland, from around 120,000 in the 1970s to about 60,000 in 2002. However the 2002 values for both returns and spawners are greater than observed in the two previous years. Estimated returns showed an upward trend in the early part of the time-series (1971-78), followed by a sharp decline (1979-84) and a brief recovery to early levels in the late 1980s. There has been a clear downward trend since 1988. There has also been a marked decline in MSW salmon relative to 1SW fish.

Ireland: Estimates of PFA and spawning stocks for Ireland show significant fluctuations over time and three distinct periods are indicated with highest abundance in the 1970's, lower abundance in the 1980's, and the lowest abundance occurring in the 1990's. The early part of the time-series (1971 to 1981) is characterised by a steep rise to the maximum value in the entire time-series, followed by a sharp and prolonged decline. A subsequent recovery period is noted from 1981 to 1989, although the values did not rise to the levels observed in the earlier part of the time-series. A period of steep decline occurred over the period 1989 to 1992 with stock levels fluctuating around a new, lower, level for the remainder of the time series. The status of the stocks must therefore be considered to be low with no significant recovery in the last decade.

Norway: Before 1983 the catch data were considered to be unreliable. Therefore, only catch information after this date were used for the development of the national PFA estimates. The data for the Norwegian part of the River Tana (Teno) are included in the Finnish PFA estimates. There was a decline until the late 1990s thereafter, a sustained increase in returns was observed over the period 1998-2001 but a decline was observed in 2002. The spawning stock has remained relatively constant throughout the period due to a reduced exploitation rate in the second half of the time period.

Russia: Total returns to Russia are estimated to have been generally greater in the early part of the time series. From 1987 onwards there has been a slight upward trend in the number of returns although the estimates in the last two years counter this general trend. Estimates of spawners follow a similar pattern to that described for returns. There has been a marked reduction in the exploitation rate in the last decade. It should be noted that, for Russia in particular, year on year trends in estimated PFA may not be closely reflected in the subsequent year on year trend in the number of spawners. To account for biological reality, the model assigns a fixed proportion of potential spawners returning in a given year to the spawning numbers for the following year.

Sweden: Stocks in Sweden have fluctuated widely throughout the time-series and following a substantial decline in the mid-1990s, there has been a rapid recovery followed by successive and moderate declines in the last two years. A feature of the latter half of the time-series is the increasing proportion of the stock that is comprised of MSW salmon. The exploitation rate has remained high over the last 30 years although there has been a decline from 1990 onwards.

UK (England & Wales): Stocks are estimated to have declined over the past 30 years, although there have been large annual fluctuations. The estimated PFA has declined more rapidly for MSW than 1SW salmon. There has been a slight up-turn in overall PFA since 1997, the lowest in the time-series. The decline in spawner numbers is less marked than that for the returns, reflecting a reduction in the homewater exploitation rate in the last decade.

UK (Northern Ireland): Stocks are estimated to have declined slowly during the 1970's and early 1980's, increasing again in the 1990's. However, estimates of PFA2 for the last four years being among the lowest over the period. The catch is dominated by 1SW fish, but there are uncertainties in the relative status of 1SW and MSW fish, as the data on catch composition by sea age are uncertain for most of the historical time-series.

UK (Scotland): The assessment indicates that stocks have fallen markedly since the early 1970s, although the decline in total spawner numbers has been less marked than those of homewater returns, reflecting the reduction in homewater exploitation rates. The estimated return rates for the last seven years are the lowest in the time series.

3.3.7 Summary of status of stocks

The marine survivals of wild and hatchery-reared smolts in both Northern and Southern NEAC areas show an overall decline over the past 20 years. The steepest decline is that in the wild smolts in Southern NEAC area (Figure 3.3.1.1). Survival of both wild and hatchery fish in the Northern NEAC area, however, have generally increased since 1997.

In general, the total returns of salmon and spawning stocks in the Northern NEAC area, as derived from the NEAC PFA model, have fluctuated for past 30 years but have undergone a relative increase since 1998, followed by a new decrease in the very last years for 1SW salmon. In contrast, salmon stocks in Iceland show a slow but constant decline since 1985 for both 1SW and MSW salmon.

Salmon stocks in the Southern NEAC area show a consistent declining trend over the past 30 years. This relates especially to the MSW component of the salmon stocks.

The consistent trends in marine survival of smolts and the estimated returns and spawners as derived from the PFA model underline the effect of factors in the marine environment on the number of returns.

3.4 Development of Age-Specific Conservation Limits

3.4.1 Progress with setting river-specific Conservation Limits

Information on progress with setting and use of CLs in individual countries and on a European project addressing this issue was reported to the Working group, as follows:

UK (England &Wales): In UK (England & Wales) the river-specific assessment procedures have been modified by addition of a Management Target (MT) for each river. The MT is a spawning stock level for managers to aim at, to ensure that the objective of exceeding the conservation limit (CL) is met in four years out of five (i.e. 80% of the time). It provides an additional mechanism to assist managers in safeguarding stocks. The value for the MT has been estimated using the standard deviation (SD) of egg deposition estimates for the last 10-years, where: MT = CL + 0.842*SD. The constant 0.842 is taken from probability tables for the standard normal distribution, such that the CL forms the 20 percentile of a distribution whose average (or 50 percentile) equates to the MT.

Management decisions in UK (England & Wales) are never based simply on a compliance result alone. Because stocks are naturally variable, the fact that a stock is exceeding its CL does not mean that there will be no need for any management action. Similarly, the fact that a stock may fall below its CL for a small proportion of the time may not mean there is a problem. Thus, a range of other factors are taken into account, particularly the structure of the stock and any evidence concerning the status of particular stock components, such as tributary populations or age groups, based for example on patterns of run timing and the production of juveniles in the river sub-catchments. A programme of river catchment monitoring provides these data.

The Environment Agency in UK (England & Wales) continues to review and revise its assessment procedures with the aim of incorporating more extensive statistical descriptions of the risks and uncertainties in reference points and assessments. An improved procedure for estimating angling exploitation is being developed which will take account of annual changes in fishing effort, as well as partitioning effort between salmon and sea trout (no distinction is currently made between these species when reporting effort). This new procedure is expected to be available shortly and will be applied retrospectively to the 2002 data set and earlier years. In addition, the Environment Agency is also considering the influence that recent changes in the marine survival of salmon might have in calculating CLs for all monitored rivers.

UK (N. Ireland): The most comprehensively developed conservation limit for N. Ireland at present is that for the R. Bush, derived from a whole river stock/recruitment relationship. Work is in progress to extend CL setting to all salmon producing rivers in the Fisheries Conservancy Board (FCB) area of N. Ireland, and to install fish counters to enable compliance to be assessed in key indicator rivers. Provisional CLs for all other rivers in the FCB area have been set by transporting the Bush CL on the basis of catchment area (ICES 1998/ACFM:13). These CLs are indicative only and not presently used for management. However, further work to refine these CLs by using available river-specific habitat data is in progress, with revised CLs being set for the Blackwater, Maine and Glendun rivers in 2002. Counters installed on these rivers to assess compliance with the CLs were operated for the first full year in 2002.

A spawning target based management system has been operating in the Foyle fishery area for many years, based on a scientific study of stock and recruitment relationships in the system (Elson & Tuomi, 1975). Associated management targets are operated on the basis that, if, at certain dates during the season, certain target numbers of fish have not been counted upstream at Sion Mills Weir (R. Mourne), and at two other rivers (R. Faughan & R. Roe) then specified closures of the angling and/or commercial fisheries take place. Conversely, if the seasonal management targets have been met by the normal end of the commercial netting season, an extension is granted. The Loughs Agency is in the process of setting conservation limits for the other rivers with counter sites within the catchment.

The SALMODEL project: The rate of development of river-specific conservation limits reflects *inter alia* the availability and representativeness of stock and recruitment (SR) data, together with the logistical difficulty of accurately surveying large numbers of rivers, often in remote locations. As a result, less than 25% of NEAC rivers have river-specific conservation limits at present, with many of those at interim/developmental stages.

These and related issues were considered by the EU funded SALMODEL Concerted Action *"A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic"* (Contract No**:** QLK5-CT1999-01546; www.salmodel.net). Reports on progress in SALMODEL have been presented to the Working Group in 2001and 2002 via a number of working papers. A brief summary of progress taken from the draft final report of the project is given below:

Setting and transporting biological reference points for Atlantic salmon

The analysis of SR data is the most widely used approach for deriving BRPs (Biological Reference Points) for Atlantic salmon. There are several hundreds of salmon stocks across the NEAC area, each having its own characteristics with regards to the SR relationship. Suitable SR series (both in terms of length and reliability of observations) are available for only a few monitored rivers. Extrapolation of knowledge gained from monitored rivers to rivers for which SR data are not available is therefore required.

Bayesian meta-analysis using hierarchical SR modelling provides a probabilistic framework for organising the transfer of information from the monitored rivers towards rivers with no SR data, while incorporating the nested structure of the uncertainty.

A Bayesian Hierarchical SR Analysis (BHSRA) was developed by SALMODEL. Merits and limits of this approach were assessed by applying it to a set of 15 existing SR series from NEAC monitored rivers. Riverine wetted area accessible to salmon and latitude were introduced as covariates explaining variations in the SR related parameters between rivers. The output of the analysis is the posterior probability distributions of the model parameters and related quantities of interest. Special attention was given to the prediction of conservation limits both at the river level and at an aggregated regional level.

The treatment of SR series from monitored rivers using BHSRA allows the derivation of a probability distribution of the NASCO standard CL (S_{lim}) for any river with no SR data. These distributions are very wide, mostly because, even within a narrow geographical range, CLs can vary widely between rivers. This indicates that over-reliance on local monitored rivers can lead to a major underestimation of the uncertainty of the management parameters for rivers without SR data and this practice is not advised.

Regional CLs are widely used at ICES for fisheries management advice to NASCO. In recent years, CLs for some countries have been set by means of non-parametric methods applied to 'pseudo' SR relationships (i.e. the national conservation limit model; Section 3.4.2,). One of the major shortcomings of this approach is that it does not allow for an assessment of the uncertainty in the CL estimates. SALMODEL developed an approach to provide a more objective estimate of CLs from the national SR relationships with confidence limits, which therefore take account of some of the uncertainty in the value. Nevertheless, the model is still recognised as providing only a crude measure of the conservation requirements of stocks, and SALMODEL has recommended that it should only be employed to provide preliminary estimates of CLs. The BHSRA offers an alternative approach that makes better use of biological information on stocks.

Such probability distributions are the natural complement of forecasted PFA probability distributions for the provision of management advice in a risk/decision analysis framework. This framework would account for the uncertainty in both the PFA and the CL. PFA and CL distributions can be easily combined to evaluate the probability of reaching a regional CL under various options of exploitation.

Transport of CLs between rivers

Salmon SR studies are resource-intensive and relatively scarce; hence for the foreseeable future we will need to find means of transporting CLs from data-rich rivers to data-poor rivers. Digital techniques combining database and mapping technologies (GIS) represent important and necessary tools in facilitating transportation.

SALMODEL reviewed different methodologies, revealing differing levels in detail and complexity. River habitat assessment approaches in the NEAC area vary with a definite bias (in number of rivers surveyed) towards measurements of catchment area, stream length, and stream order and wetted area. In most countries, only a minority of rivers had in-stream or remote-sensing measurements of physical habitat carried out. SALMODEL identified clear potential to improve and harmonise methodologies.

An intermediate habitat variable, such as wetted area, is identified as the only viable approach in the short to medium term for quantifying production areas for transport of BRPs. It can be obtained relatively easily without field based survey and in a standardized manner across countries, but it is also demonstrated that this alone does not reflect the actual proportions of various habitat types in this range of rivers. The choice to concentrate on wetted area, is therefore driven by necessity and it is important to assess the consequences of not making better use of other approaches reflecting the variation in quality of the habitat between rivers.

Use of Geographic Information System (GIS) derived measurements of wetted area is recommended to be used together with data from existing SR data sets in a Bayesian hierarchical framework for the transport of BRPs across NEAC rivers. It is also important to develop verification standards to ensure a highest possible level of consistency for these measurements, as well as indicator systems for habitat quality, based on GIS techniques. SALMODEL has provided a comprehensive explanation of methodology for GIS supported measurements of wetted fluvial areas.

CLs and underlying genetic structure

Genetic and ecological analyses of Atlantic salmon populations suggest that they are sufficiently isolated to allow the development of local adaptations through natural selection. This suggests that fitness and productivity may be compromised if important genetic units of Atlantic salmon are not recognised, and that management may benefit by considering the genetic structure of the species. However, estimates of gene flow between populations show that anadromous populations do not exist in isolation. A focus for SALMODEL was therefore to look at how genetic variation is lost from a group of Atlantic salmon populations that are harvested together in the ocean, but may be managed separately in fresh water. The scientific problem was formulated so as to combine the goals of optimal harvesting (maximum sustainable yield) and effective population size in a group of populations interconnected by migration. A second objective was to review knowledge about the fitness consequences of loss of genetic variation.

Effective population size is a key concept in population genetics. It is defined as the size of an ideal population that is losing genetic variation at the same rate as the actual population. It determines the rate of inbreeding in a population, and its rate of loss of heterozygosity and genetic variance in quantitative traits. Knowledge about local population sizes and migration patterns, or alternatively, studies of the genetic structure of the species, can be used to assess the relationship between local effective population sizes and the effective size of the total population.

By developing a model that maximises harvesting yield of a group of populations, subject to constraints set by maintaining the total effective size, SALMODEL has shown that:

- considerable gain can be made in total effective size in a group of populations through harvesting based on knowledge about population structure,
- in source-sink population systems, the total effective size can be increased without reducing total harvesting yield by first reducing the harvest in the smallest population(s), while maintaining the harvest in the largest population,

- when populations differ in their degree of isolation, it pays to harvest relatively less in isolated populations because these contribute more to the total effective size, and
- in cases with moderate or strong directionality in the migration pattern, the total effective size can become less than the sum of the subpopulation sizes.

SALMODEL discussed these results in the light of conservation genetic theory and empirical results on the fitness consequences of loss of genetic variation, and concluded that the genetic consequences of harvesting need to be assessed both at the level of local subpopulations and at the level of the total population.

The effects of dynamic change on the establishment of CLs

Using several statistical techniques, dynamic change (non-stationarity) was detected in all of the NEAC rivers where SR data were available. The two main periods identified were from 1970 to the mid 1980s and from the mid 1980s to the end of the 1990s. These changes result in large differences in the magnitude of BRPs derived from these relationships and make the choice of appropriate CLs more difficult. Selection of a CL that is too high relative to the prevailing stock capability would result in over-restrictive fishery measures. Similarly, selection of a low CL relative to the productive capacity of the system in question would result in a degradation of that productive capacity if insufficient spawners were allowed to seed the habitat effectively.

Transport of CLs to management situations under different scenarios of stock productivity in distinct periods was examined and it is suggested that transported targets from donor stocks must also represent the stock situation of the recipient river as closely as possible, rather than a pristine state. However, the establishment of a "benchmark" CL representing pristine conditions was also felt to be useful as these could be accepted or rejected depending on local conditions, and they represented a more likely limit to achieve in the event that factors limiting production were mitigated or overcome.

The implications of sympatric trout for the setting and use of Atlantic salmon CLs

Sea trout, the anadromous form of the brown trout (*Salmo trutta* L.), live sympatrically with salmon in many salmon rivers in the NEAC area. Because the two species have similar habitat requirements and a broadly similar life cycle, there is a *prima facie* case that interspecific interaction may be important for the setting of salmon CLs.

A review of relative abundance, based on rod catches from 192 rivers, showed that sea trout were generally more prevalent than salmon in smaller catchments. A few rivers supported very large sea trout stocks from which egg deposition was up to twice that of salmon. However, in the NEAC sample as a whole, 95% of salmon rod catch came from rivers in which salmon contributed the major part of migratory salmonid egg deposition. Electro-fishing data showed that trout was, on average, the dominant salmonid in small channels (<6 m wide). Such streams represented, however, only a small proportion of total catchment wetted area, so that in most of the wetted area where salmon occur they are the numerically dominant salmonid species.

Habitat overlap of juveniles gives rise to competitive interactions in which trout are normally dominant and, although local niche separation operates, there are several reported examples of trout limiting salmon abundance at macro-habitat (10 m) or smaller scale. However, at catchment scale segregating processes (e.g. spawning times and gravel size selection) operate, so the potential interaction presented by salmon and trout sympatry tend to be reduced by the details of their behaviour and ecology.

Analysis of data from Swedish and UK streams showed that trout summer 0+ abundance exerted only minor impact on salmon 0+ to 1+ loss rates, which were more strongly influenced by habitat and salmon 0+ density. However, an analysis of interactions during the early post-emergent phase when density-dependence is strongest was not possible due to lack of suitable data and this remains a key topic to investigate. Predation by mature trout (non-migratory) on salmon juveniles in freshwater was thought to be very important on some rivers and possibly was the most likely mechanism by which trout affect salmon, but this remains to be tested. This effect probably falls into the same category as other forms of predation and should be considered as part of the random annual variation on survival.

Overall, SALMODEL concluded that, trout egg deposition on catchment scale cannot be simply taken into account in setting salmon CLs. Combined SR relationships are currently not feasible and probably not appropriate for whole rivers. However, the possibility remains of important interspecific, early life stage density-dependent effects in smaller sub-catchments or in the comparatively few whole catchments where sea trout are particularly abundant.

Risk in setting CLs

The probability of achieving the spawning requirement objective in a specific year is defined by the stochastic properties of small numbers and factors such as the size of the stock, the proportion female in the stock, and annual variation in the biological characteristics. The uncertainty in achieving the spawning escapement objective is greater for small stocks than large ones, such that measures of annual performance are more variable for small stocks. Straying among rivers increases the uncertainty of achieving spawning requirements simultaneously in the rivers within the complex. Variations in productivity among rivers, when not accounted for, result in under-escapement in the lower productivity rivers.

Two case studies of aggregating rivers within a regional requirement were examined by SALMODEL. In the first case, 17 rivers within the Welsh region of UK (England & Wales) were combined and the probability profiles of achieving requirements in all rivers simultaneously were described. In order to achieve a probability greater than 50% of simultaneously achieving the required escapement in these 17 rivers, the regional spawner requirement must be increased by at least 10%. In the second case study, 15 monitored rivers across the NEAC area were aggregated into a NEAC complex. Even when releases from the fishery are double the regional spawning requirement, there is a less than 50% probability of meeting the spawning requirements simultaneously in all 15 rivers. This is a consequence of one of these being a small low productivity river, which produces proportionally fewer recruits than the other stocks and therefore has a lower probability of meeting spawning requirements compared to other more productive rivers when managed together in the same aggregation.

Each mixed stock fishery situation can and should be evaluated on a case-by-case basis. This can be done using the Monte Carlo techniques described. The impact of mixed stock fisheries can be most important on the small stocks and especially if these are of low relative productivity. Increasing the regional spawner requirement in an attempt to compensate for lower productivity may alleviate the problem somewhat but is not a guaranteed solution to the challenge of protecting low productivity stocks.

3.4.2 Description of 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 one 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).

As described in last years report (ICES 2002/ACFM:14), the model provides a means for relating estimates of the numbers of spawners and recruits derived from the PFA model. This is achieved 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. These proportions are then used to estimate the ‘lagged egg deposition’ contributing to the recruitment of maturing and non-maturing 1SW fish in the appropriate years. 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_{lim}). However, it is not straightforward to estimate this point on the national stock-recruitment relationships because the replacement line (ie the line on which ‘stock’ equals ‘recruits’) is not known for the pseudo-stock-recruitment relationships established by the national model because the stock is expressed as eggs, while the recruits are expressed as adult salmon. In 2001 the Working Group adopted a method for setting biological reference points from “noisy” (uncertain) stock-recruitment relationships, such as provided by the national pseudo-stock-recruitment datasets (ICES CM2001/ACFM:15). This model assumes that there is a critical stock level below which recruitment decreases linearly towards zero stock and recruitment, and above which recruitment is constant. The position of the critical stock level is determined by searching for the value that minimises the residual sum of squares. This point is a proxy for S_{lim} and is therefore defined as the conservation limit for salmon stocks. A modified version of this method, which updates the approach first used by ICES in 2001, by allowing uncertainty around these estimates to be described was outlined in last years report (ICES 2002/ACFM:14). This approach was again applied to the 2002 national stock-recruitment relationship assessment for countries where no river-specific conservation limits have been determined.

3.4.3 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 Figures 3.3.4.1. For Iceland, Russia, Norway, UK (Northern Ireland), and UK(Scotland) the input data for the PFA analysis (1971-2002) have been provided separately for more than one region; the lagged spawner analysis has therefore been conducted for each region separately and the estimated conservation limits summed for the country. The conservation limits derived from the national model and river-specific estimates are shown in Table 3.4.3.1. The Working Group has previously noted that outputs from the national model are only designed to provide a provisional guide to the status of stocks in the NEAC area. 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 3.4.3.1) and are given on Figures 3.5.1.4 and 3.5.1.6 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 stock complexes. The SERs are shown as horizontal lines in Figures 3.5.1.3 and 3.5.1.5. The Working Group also considers the current SER levels may be less appropriate for evaluating the historic status of stocks (e.g. pre-1985), that in many cases have been estimated with less precision.

3.5 Catch Options or Alternative Management Advice

3.5.1 Trends in the PFA for NEAC stocks

Tables 3.5.1.1 to 3.5.1.6 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 3.5.1.1 to 3.5.1.6.

The 95% confidence limits (dotted lines for PFA and vertical bars for the spawning escapement) shown in Figures 3.5.1.1 to 3.5.1.6 indicate the high level of uncertainty in this assessment procedure. 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 largely reflect uncertainties 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 3.5.1.1 shows that there has been a general decline in recruitment among 1SW and MSW salmon in the whole NEAC area over the past 30 years, and both age groups are currently the lowest levels observed. Numbers of 1SW and MSW spawners have also declined (Figure 3.5.1.2) 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. The general trends depicted are similar to those derived from the model run last year.

Figure 3.5.1.3 shows that recruitment of maturing 1SW salmon (potential grilse) in Northern Europe was generally high (around 1.1 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. Following an upturn over the years 1998-2001 there has bee a steep downturn in 2002 to approximately 727,000. In contrast, there is an increasing trend in the number of 1SW spawners (Figure 3.5.1.4) throughout the time-series, with escapement in 1987 to 2001 being above the conservation limit. This is consistent with a decline in exploitation. However, in 2002, there has been a marked drop in the number of 1SW spawners.

Numbers of non-maturing 1SW recruits (potential MSW returns) for Northern Europe (Figure 3.5.1.3) are also estimated to have fluctuated around 1.1 million between 1970 and 1985, but subsequently fell to about half this level in the late 1990s; there has been an upturn in the past five years. The numbers of MSW spawners, however, show no trend over the time-series although numbers appear to have increased in the last four years. 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 the Northern area (Section 3.3.1).

In the Southern European stock complex (Figure 3.5.1.5), the numbers of maturing 1SW recruits are estimated to have fallen substantially since the 1970s, with values in the last four years being among 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 in the Southern European area for which data were available (Section 3.3.1). 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.

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 3.5.1.5); these stocks have also reached their lowest levels at the end of the time-series. This is broadly consistent with the general pattern of decline in marine survival of 2SW returns in most monitored stocks in the area (Section 3.3.1). 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 3.5.1.6).

3.5.2 Forecasting the PFA for NEAC stocks

The Working Group has previously considered the development of a model to forecast the pre-fishery abundance of PFA *non-m* (PFA of non-maturing potential MSW) salmon from the Southern European stock group (comprising Ireland, France, and all parts of UK) (ICES 2002/ACFM:14). Stocks in this group are the main European contributors to the West Greenland fishery (See Section 3.3.2). The model took the form:

$$PFA\ non\text{-}m = Spawners^{\lambda} \times e^{B_0 + B_1\,Habitat + B_2 Year + Noise} \qquad (Model\ 1)$$

where the habitat term is the same as that used in the North American model (section 4).

Both the year and spawner term were found to be significant predictors but the habitat variable had no significant effect. Therefore, this year, the Working Group considered an alternative model that used only the year and spawner terms to predict PFA. This model took the following form:

$$PFA\ non\text{-}m = Spawners^{-0.127} \times e^{\,20.14 - 0.04984(Year - 1990)} \qquad (Model\ 2)$$

This year the model was fitted to data from 1977-2001 (Table 3.5.2.1) to predict PFA in the subsequent years 2002-2003.

The predictions using this model and the bootstrapped 95% confidence intervals are given in Table 3.5.2.2 and the trend in PFA *non-m* is shown in Figure 3.5.2.1. It should be noted that the confidence intervals are wide and this reflects the uncertainty around the point estimate. These predictions have been used as an input to the provision of quantitative catch advice for this stock complex for 2003.

Alternative model inputs

The Working Group also considered a further predictive model that used the PFA *m* (PFA of maturing 1SW salmon), in addition to the spawner term, as a predictor variable for the PFA *non-m* salmon in the Southern NEAC area the following year. The advantage of such a model is that the inclusion of the PFA *m* utilises a further biological variable and thus should capture, to some degree, the effects of biological influences on the stock. However, as predictions are required two years in advance to provide catch advice for the West Greenland fishery, the final value for the PFA of maturing 1SW salmon has to be estimated. Therefore the Working Group agreed not to include this variable in the 2003 assessment.

However, in the Northern NEAC area, predicting PFA *non-m* based on the PFA *m* might be more appropriate. In this case, the final input value of a PFA of maturing 1SW salmon predictor might be obtained in time (eg. from homewater fisheries) to provide catch advice to the Faroes fishery that, to the best of our knowledge, exploits salmon mainly from the northern NEAC area. The Working Group therefore considered the following model:

$$PFA\ non\text{-}m = Spawners \times e^{-7.603 + 0.638\log(PFA\ m) - 0.277 Habitat} \qquad (Model\ 3)$$

This analysis is exploratory and is restricted to the input variables available prior to the 2003 assessments. The habitat term (mean sea surface temperature (SST) in the month of February for the period 1982-2001 in the area 58-64ºN 10ºW – 10ºE) although available was not extracted for 2002. Thus, it was estimated as the mean of the previous three years. The data used to fit the model are shown in Table 3.5.2.3. The predictions using this model and the bootstrapped 95% confidence intervals are given in Table 3.5.2.4 and the trend in *PFA non-m* is shown in Figure 3.5.2.2. The Working Group recommended that such a model should be developed further.

3.5.3 Management Advice

The Working Group has been asked to provide catch options or alternative management advice, if possible based on a forecast of PFA, with an assessment of risks relative to the objective of exceeding stock conservation limits in the NEAC area. 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 emphasised that the national stock conservation limits discussed above are not appropriate for the management of homewater fisheries, particularly where these exploit separate river stocks. This is because of the relative imprecision of the national conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations. Nevertheless, 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 to the distant water fisheries.

Due to the preliminary nature of the conservation limit estimates, the Working Group is unable to provide quantitative catch options for most stock complexes at this stage. Furthermore, to do so requires predictive estimates of PFA which have not yet been developed for all stock complexes. However, for the second time, a quantitative prediction of PFA for Southern European MSW stocks is provided. The Working Group also notes that progress has been made in the development of an approach to derive predictive estimates of PFA for the Northern European PFA stocks (Section 3.5.2). The Working Group considers that the following qualitative catch advice is appropriate based upon the PFA data and estimated SERs shown in Figures 3.5.1.3 and 3.5.1.5.

Based on recent work on resolving the most appropriate stock groupings for management advice for the distant water fisheries (ICES 2002/ACFM 14) the Working Group agreed that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC stocks. Advice for the West Greenland fishery should be based upon southern European MSW salmon stocks only (comprising UK, Ireland and France).

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 PFA of 1SW salmon from the Northern European stock complex has been above the spawning escapement reserve throughout the time series (Figure 3.5.1.3a). However, the spawning escapement was at or below the conservation limit until 1997 (Figure 3.5.1.4a). There has been an upward trend throughout the time series until 2002 when there was a sharp decline taking the stock complex below the conservation limit again. The Working Group considers that the overall exploitation of the stock complex should decrease so that the conservation limit can be exceeded. It should be noted, however, that the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated. Since very few of these salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea, management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks.

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 (Figure 3.5.1.3b). The Working Group considers the Northern European MSW stock complex to be within safe biological limits, as spawners are above CL and trending in a positive direction (Figure 3.5.1.4b). However, it should be noted that the status of individual stocks may 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 caution should still be exercised in the management of these stocks particularly in mixed stock fisheries and exploitation should not be permitted to increase, until a clear pattern of status above SER is established.

Southern European 1SW stocks: Recruitment of maturing 1SW salmon in the Southern European stock complex has shown a strong decreasing trend throughout most of the time series (Figure 3.5.1.5a). Moreover the spawning escapement for the whole stock complex has fallen below the conservation limit in three of the past five years, although a small improvement was noted in 2002 (Figure 3.5.1.6a). Despite a small surplus above SER of around 300,000 fish during the last three years, exploitation in these years was clearly high enough to prevent conservation limits being consistently met. The Working Group therefore considers that mixed stock fisheries present particular threats to conservation and that reductions in exploitation rates are required for as many stocks as possible.

Southern European MSW stocks: The PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s (Figure 3.5.1.5b) and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years (537,000 and 524,000) (Figure 3.5.2.1). There is evidence from the prediction that PFA will decrease in the near future and the spawning escapement has not been significantly above conservation limit for the last seven years (Figure 3.5.1.6b). The stock group is therefore very close to safe biological limits, and the Working Group considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability.

With catch advice for three of the four stock groupings above still being provided on the basis of extrapolation from historical PFA data, the Working Group recommends that further progress be made with establishing PFA forecast methodologies. Catch advice would also be significantly enhanced if conservation limits were more certain for national stocks. The Working Group noted progress with both of these areas in the EU SALMODEL Concerted Action.

3.6 Evaluation of the effects on stocks and homewater fisheries of significant management measures introduced in the last 5 years

The Working Group noted the ongoing reductions in the number of gear units deployed in most countries in the NEAC area since 1997 (Table 3.6.1). This is thought to reflect both management measures aimed at reducing levels of exploitation and the declining commercial viability of some fisheries. A number of other measures have also been introduced, or continued, in NEAC countries over this period. These include: restrictions on fishing seasons and gear, buy-out arrangements, voluntary restrictions, and increasing use of catch and release. Given the widely divergent measures introduced, variability in the timing of their introduction and duration, and the nature of the fisheries themselves, the Working Group recognised that it was not possible to quantify the effects of management measures on stocks and fisheries across the NEAC area in a consistent manner.

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

NEAC northern area

In Russia, commercial catches have been declining steadily as a result of various management changes, including the prohibition of some important in-river fisheries, aimed at reducing the fishing effort and enhancing the development of recreational catch-and-release fisheries. The mean commercial catch in the last five years (1998-2002) is 15% below that of the previous five years (1993-1997). A large decline in the fishing effort by bend nets along part of the Norwegian coast was implemented in 1997 and the start of the fishing season for bag nets was delayed by 2 weeks from 1998. These measures have resulted in a substantial decline in fishing effort, and although it has not been possible to quantify this, exploitation is believed to have fallen markedly.

NEAC southern area

In Ireland, the introduction of measures in the commercial fishery in 1997 effectively reduced effort in the commercial fishery by about 20% (5 to 4 days). Further restrictions on night-time fishing further reduced the effort by up to 50% in some areas where all day fishing was previously carried out. Fishing effort on spring salmon stocks was also reduced with the later opening of the season for some gears. A more detailed appraisal of these methods on Irish stocks and fisheries was presented in ICES 2001/ACFM:15. This had concluded that the measures contributed to a reduction in both the overall catch and the exploitation rate on Irish stocks.

In UK (N. Ireland), significant management changes came into effect in the Fisheries Conservancy Board area in 2002, aimed at conservation of wild salmon stocks. For the 2001 season there was a voluntary agreement with licensed net operators that no net should operate until 1st June (season was previously 17th March to 15th September), with around 8 nets agreeing not to fish at all. Holders of drift net licenses agreed to operate for only eight weeks during the period 1st June to 15th September, split into two four-week periods. These voluntary agreements preceded a public:private sponsored voluntary buyout, which came into effect for the 2002 season, with funds being made available to purchase netting rights from a significant proportion of operators in the FCB area. This scheme has resulted in the buyout of some 18 commercial licence holders. The number of commercial licences issued in the FCB area fell to 14 for the 2002 season, in comparison to 23 in 2001 and 27 in 2000. Accompanying measures to regulate angling, introduced into the FCB area on a voluntary code-of-practice basis in 2001, operated again in 2002, pending introduction of appropriate byelaws. These included catch and release from the start of the season up to the end of May; a daily bag limit of two fish from 1st June to the end of the season, and a ban on the sale of rod caught salmon. While the effects of these measures on stock status will require some years to fully evaluate, it is noted that the voluntary net buyout scheme probably contributed to the reduction in net catch in the FCB area from 23.4 t in 2001 to 9.4 t in 2002.

National measures were introduced in UK (England & Wales) in 1999 to protect spring salmon. In 2002, these are estimated to have saved around 2,800 salmon from capture by net fisheries and around 1,300 by rod fisheries before June 1. These estimates are based on the catch and the average proportion of fish taken in this period in the 5 years prior to the measures being introduced; the latter estimate has been adjusted for catch and release.

Since 1993, there has also been a policy to phase out coastal mixed stock salmon fisheries in UK (England & Wales). The largest of these fisheries is on the north east coast, where the number of drift net licences issued has now been reduced by 51%. Nine other small coastal mixed stock fisheries have also been identified in recent years, seven of which are no longer operating, while the remaining two are in the process of been phased out. In some cases, these phase-outs have been accelerated where fishermen have agreed to accept compensation payments to give up their licences early. Although there have been large annual fluctuations in the declared catches, the overall effect of these measures has been to reduce the catches in these coastal fisheries from an average of about 39,000 fish for the period 1993-97 to a little under 32,000 for the period 1998-2002. These measures have had more of an impact at the local level. For example, prior to the buy-off of the nets and fixed engines on the River Usk in 2000, this fishery took, on average, about 1,000 fish each year (~40% of the total net catch in Wales). The partial phase out of the Taw/Torridge fishery in 2002 resulted in a drop in the catch from a five-year mean (1997-2001) of 665 fish to just 103 in 2002.

In Scotland, members of the Salmon Net Fishing Association, to which the majority of active netsmen are affiliated, continued a voluntary agreement, introduced in 2000, to delay fishing until the beginning of April in order to protect early running MSW salmon. This has resulted in about an 80% reduction in the catch of MSW salmon by nets and fixed engines in the months of February and March, compared with the five years previous.

In northern France, TACs have been operated in several regions for some years. In Brittany (which accounts for more than 60% of the total rod catch) a MSW-specific TAC was introduced in 2000. This continued to apply in 2002. One and two month delays to the start of the angling season were introduced in 2001 and continued in 2002 on three other rivers in an effort to reduce exploitation of spring salmon. However, catch data suggest that this resulted in catches well above average when the season commenced, suggesting that the measures merely delayed exploitation in these small rivers. In addition, the net fishery in the Adour estuary was subject to closed periods throughout the season, where previously this had been concentrated on June and July only. This resulted in a higher proportion of 1SW salmon in the catch (58%) than in 2001 (16%), but did not reduce the estimated level of exploitation on 2SW salmon (the objective of the measure), which remained at around 50%.

The above estimates and the overall reduction in gear units suggest that management measures introduced in the last 5 years have continued to reduce levels of exploitation on NEAC stocks.

3.7 Estimate of by-catches of Post-Smolts in mackerel and other pelagic fisheries

3.7.1 Research surveys and distribution of salmon

In the Norwegian research surveys a total of 4,164 post-smolts and 171 older salmon have been captured in 2,438 surface trawl hauls carried out since 1990 during cruises for surveying pelagic fish and during dedicated salmon surveys (Table 3.7.1.1). A specially designed "salmon trawl" with extra flotation on the head line and bridles was used together with a device for live fish capture (modified from Fish Lifter, Holst and McDonald, 2000) attached to the cod end of the trawl. The rope end of the trawl consisted of a segment of approximately 3,000 mm meshes, followed by mesh segments with diminishing mesh size. A 20 mm blinder net is used in the cod end. The horizontal opening of the trawl is 40 m and it covers 0 – 14 m vertically. The average towing speed with this trawl was 4.8 kt (SD ±0.4) and the wire length was 290 – 340 m depending on the condition of the waves. The trawl was towed in large arcs to avoid the wake of the ship.

Geographical distribution of all post-smolts and salmon captured in 2002 in the salmon surveys carried out by several countries is presented in Figure 3.7.1.1, and Norwegian captures in the period 1990-2001 is shown in Figure 3.7.1.2. Since the start of the dedicated salmon cruises in the Norwegian Sea in 1999, the CPUE values for post-smolts (number of fish caught per trawl hour) have been relatively high reaching a peak of 28 in 2001. However, this value was partly explained by the input from one very large catch. The values in 2002 of individual tows are lower (Table 3.7.1.1, cruise 4 ; Table 3.7.1.2) but more evenly distributed over the area than the values recorded in 2001 (0 – 93), indicating that the timing of the cruise must have been favourable in relation to the density of post-smolt cohorts passing through that particular area. However, the largest densities of post-smolts were recorded from June 21 to 24 around 68°N, earlier and further north than previously recorded (Figure 3.7.1.3). Smolt age distribution for these fish indicate a southern origin, as does the fact that 9 out of 10 microtags retrieved were Irish.

The surface trawls have previously been thought to catch predominantly post-smolts as it has been anticipated that the trawling speed is too low (3.2 – 3.8 kt) for capturing larger salmon and video recordings performed in the trawl in 2000-2002 seem to support this (M. Holm, pers obs.). Consequently, no efforts have been made to calculate CPUE for larger salmon. However, in a Nordic DST tag and release experiment where the new experimental salmon trawl was used in October - January, substantial numbers of pre-adult and adult salmon were captured raising concern about the potential risk of larger salmon also being intercepted by pelagic fisheries.

Several investigations indicate that while migrating through areas with intensive fish farming activity Atlantic salmon post-smolts may be heavily infested by sea lice, which may cause a considerable mortality. The number of potential hosts for sea lice along the coast of Norway has increased dramatically recently because of the increasing farming industry. A programme to study the sea lice infestations in fjords with different infestation potentials has been carried on since 1998. In 2002 the monitoring of seaward migrating wild salmon smolts has been continued by trawling and by lice counting on smolts in sentinel pens along fjordic and coastal migration routes. Highest intensities of infestation have been recorded in intensive farming areas in fjords at the southwestern coast of Norway. However, results show large variations in louse prevalence and mean intensity between years and between fjords (Figure 3.7.1.4) possibly as a result of a combination of timing of de-lousing activities at the farms and hydrographical conditions in the fjords at the time of migration.

One of the objectives of a Russian pelagic fish survey conducted by the research vessel "F. Nansen" in the Norwegian Sea from 29 May to 26 July 2002 was to map the distribution of post-smolts in the Norwegian Sea. This survey is a part of an international research programme to study commercial species in the Norwegian and Barents Seas and is conducted on a yearly basis in May-July. Its target species are herring, blue whiting and mackerel. According to standard methods used in the international assessment of pelagic fisheries, hauls were taken by pelagic research trawl with an opening of 45 x 40 m and 24 mm mesh blinder. The trawl was not rigged with additional floats. Towing speed was from 3.2 to 5.1 kt, with a standard duration of hauls of 30-60 min. The whole catch was screened and each fish was handled and identified to species. In surface hauls the headline moved at depths from 0 to 5 m, and 65 of 85 hauls taken in the Norwegian Sea in June-July were such surface hauls. Of the 20 non-surface hauls, three were towed at depths of 190-290 m while another 17 varied in depth from 5 to 40 m. Figure 3.7.1.5 shows a map of the area covered during surveys in the Norwegian Sea. In June hauls were taken mainly in the southern part of the sea, while in July the middle part up to the island of Jan Mayen was covered. In June 30 hauls were taken (in 22 the headline was at depth 0-5 m), of which 14 contained mackerel. In July mackerel was found in 26 of 52 hauls (43 at depth 0-5 m). Mackerel catch varied from 1 to 600 kg, the average being 136 kg, and was mainly taken in hauls with the headline towed at depth 0-5 m. In one haul taken at a depth of 40 m a catch of 500 kg of mackerel was taken. The total catch of mackerel was 5.45 t. No by-catch of post-smolts was recorded in June, however one adult salmon was caught in the international waters (Figure 3.7.1.6). In July another two adult salmon were found in two hauls. One was caught in the Norwegian Economic Zone at the latitude of Jan Mayen at 14°E, another was a previous spawner caught in the international waters of the Norwegian Sea (Figure 3.7.1.6). July, when the research was conducted to the north of 66°N, was the most productive in terms of post-smolt by-catch: in four hauls on 8, 9 and 15 July 32 post-smolts were found (Figure 3.7.1.6). In the two most northern hauls (2 and 17 post-smolts) no mackerel were caught, while in the other two (2 and 11 post-smolts) the catch of mackerel was 3 and 28 kg, respectively.

3.7.2 By-catches of post-smolts and salmon

A Norwegian research cruise was dedicated to salmon and mackerel investigations both in the international area west and north of the Voeringplateau and the Norwegian EEZ (cruise 4; table 3.7.1.1.) in the Norwegian Sea (66°N – 69.7°N and 1°W – 17.4° E). During the by-catch investigations, 44 tows were carried out between 21st June and 1st July, yielding catches of 590 post-smolts, 8 salmon and 19,125 kg mackerel. Starting from the north and moving southwards, the post-smolt catches were medium to large at the beginning of the cruise and became smaller when approaching the 66°N. The captures in single tows were smaller in the Norwegian EEZ than in the international zone, but every haul contained post-smolts, while 56 % of the hauls in the international zone contained post-smolts (Table 3.7.1.2, Figure 3.7.2.1). Large catches of mackerel were made in the same tows. The mackerel sometimes filled up the cod end and the Fish-Lifter completely, and the post-smolts were badly damaged when found. The average CPUE was 10 post-smolts per trawl hour in the international zone and 11.9 in the Norwegian EEZ. 10 micro tagged, but no Carlin- tagged post-smolts were found (Section 3.7.1).

The mean CPUE (catch per trawl hour) for mackerel was 589 kg in the international zone while it was 224 kg in the Norwegian EEZ (Table 3.7.1.2). Calculation of the ratio of total number of post-smolts per kg mackerel in the international zone gave an estimate 0.026 post-smolts per kg captured in the Norwegian research fishery in 2002. This area was not surveyed in 2001. In the Norwegian EEZ the ratio in 2002 was 0.057 compared with 0.025 post-smolts per kg mackerel in 2001 (cf. Table 3.7.2.1.). The degree of spatial and temporal overlap between the mackerel distribution and the northward migration routes for the post-smolts from the Southern NEAC area and south- Norway were discussed in ICES (2002/ACFM:14), and the 2002 investigations confirm the earlier observations, although both mackerel and post-smolts had an earlier and more northerly to north westerly distribution than previously recorded at these cruises.

In 2002 the Russian Federation carried out a comprehensive programme to study potential by-catch of Atlantic salmon and post-smolts in the Russian mackerel fishery in the Norwegian Sea. In June-August 16 scientific observers and fisheries inspectors worked onboard Russian fishing vessels. Their tasks included, *inter alia*, screening of the mackerel catch for potential by-catch of Atlantic salmon. Catches by 20 of the nearly 50 Russian fishing vessels, which fished mackerel in the Faroese fishing zone and international waters in 2002, were scanned immediately on board during the discharging of the trawl catch into bins and at a ship factory during grading. The vessel's crew assisted in this work.

Catch from screened hauls varied from a few hundreds of kilos to 87 t. Average catch of mackerel per haul for inspected vessels was 17.5 t and varied from 2 t to 42 t among vessels. For catches of more than 10 t one to three samples of 3000 kg each were taken for screening. Catches from a total of 1070 hauls, or 25% of all hauls taken by the Russian vessels during the fishing season, were screened (Figure 3.7.2.2). The details of the screening are given in Table 3.7.2.2. As a result of considerable effort invested by the Russian Federation into screening of commercial catches of mackerel, 15 adult salmon (one of them carried a Swedish Carlin tag) and 12 post-smolts were recorded. The highest occurrence of post-smolts (0.065 per haul) was recorded in June, while in July this index was 0.015, and in August no post-smolts were found in the commercial catch. All by-catches of post-smolts, except one, and by-catches of salmon were taken along the 200-mile limit of Norway in the area with coordinates 65°30' - 66°30'N and 01°00'-03°00E (Figure 3.7.2.3 & 3.7.2.4).

The Working Group received information from Iceland on a by-catch of almost 200 salmon (1 – 2 kg) in a herring catch of 800 metric tonnes from the Spitsbergen area in August 2002. The fish were taken by a multi-gear-vessel in a mid-water trawl. One of the salmon caught was tagged as a smolt in the River Drammen, Norway. Historical information from the 1960s on by-catches of up to 30 salmon per haul in the herring fishery from Iceland was also presented to the Working Group. To date no assessment on by-catch rates in the herring fishery is available. The Working Group recommended that further research should be carried out on the potential of salmon being taken in the herring fisheries.

No specific land based sampling or screening for salmon post-smolts has been initiated in recent years in the Faroes. However, routine samples of catches of herring, blue whiting and mackerel from the purse-seiners landed to a fish-meal factory in the Faroes have not revealed any salmon by-catch. No post-smolts have been reported taken as by-catch in the herring fisheries north of the Faroes in 2002, based on reports from captains and crew on board Faroese purse-seiners.

Assessment of by-catch survey results

The discrepancy between the large numbers of post-smolts caught along with mackerel in the Norwegian research fishery (13.25 and 13.47 post-smolts per haul in late June in the Norwegian EEZ and international waters respectively) and the low by-catch levels observed in the commercial mackerel fishery (0.065, 0.015 and 0 post-smolts per haul in June, July and August respectively) may have a number of possible explanations:

- Detection rates may decrease with increasing sample size. Therefore the rate of non-detection may be higher in the Russian survey as larger numbers of fish were sampled in the catches. However, Russian samplers considered it unlikely that any considerable portion of adult salmon or post-smolts were overlooked during sampling.

- The Working Group noted that the research fishery, due to its directed nature (post-smolts predominantly) and the trawl methods used, may lead to over-estimation of the salmon by-catch in commercial pelagic fisheries.

- The major component of the post-smolts migrating with the western branch of the Norwegian current may have passed international waters before a large-scale mackerel fishery starts there. In contrast, the research fishery specifically tries to sample the peak post-smolt migration in these areas.

- There are substantial differences between the Norwegian research trawl and the gear used in the commercial mackerel fishery. In particular, the research trawl is much smaller, is fished closer to the surface and is towed more slowly than the commercial gear. It has been speculated that post-smolts migrate very close to the surface and may thus avoid the commercial gear. However, the behaviour of post-smolts in relation to these different gears is not known. The extent to which post-smolts may be lost through the larger mesh in the cod end of commercial trawls (40mm as opposed to 20mm) is also not clear.

Research requirements

Given the large differences between the results from the Norwegian by-catch studies in 2001-02 and the Russian research trawling and screening of commercial catches, the Working Group agreed it was necessary to continue to collect data on the biology and distribution of post-smolts and older Atlantic salmon in the sea. In particular, scientific surveys of pelagic fish species in the Barents and Norwegian Seas were needed to collect data on by-catches of salmon from commercial vessels. The Working Group recommended that:

- Efforts should be made to inter-calibrate the CPUE for different trawling methods, in particular research gears against commercial trawls, to provide a better basis for assessing levels of by-catch.

- Studies on post-smolts and older salmon should be extended to elucidate behaviour patterns at sea and to investigate their behaviour in relation to different commercial gear types (e.g. pelagic trawls, purse seines).

- The Planning Group on Surveys on Pelagic Fish in the Norwegian Sea (PGSPFN) should consider intensive screenings of pelagic research hauls for the presence of post-smolts (small salmon in their 1st year at sea, generally < 45cm) and older salmon.

- Surveys should be extended to provide better temporal and spatial information on the distribution of post-smolts in relation to pelagic fisheries.

- Experimental trawling surveys should be conducted to evaluate the vertical distribution of post-smolts and older salmon in the sea, if possible in combination with tagging of post-smolt and salmon with depth and temperature recording tags (DSTs).

- The Working Group requests that ICES should make available the commercial catches of mackerel and herring in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (Division IVa), and the west of Ireland and Scotland (Divisions VI a & b; VII b,c,j & k) by ICES Division and standard week.

- The Working Group requests that ICES should make available the number of boats and gear types used in the commercial fishery of mackerel, herring and horse mackerel and blue whiting in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (Division IVa), and the west of Ireland and Scotland (Divisions VI a & b; VII b,c,j & k) by ICES Division and standard week.

3.7.3 Description of mackerel and other commercial pelagic fisheries

A detailed description of the mackerel fishery was provided by the Russian Federation and is presented in this section. No other details of fisheries were provided to the Working Group, and the descriptions below are taken from the reports of the Working Group on Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA 2003/ACFM:07) and Working Group on Northern Pelagics and Blue Whiting (WGNPBW 2002/ACFM:19).

Russian mackerel fishery: Over the period of 1977 – 2001 the Russian fishery for mackerel in the Norwegian Sea starts in the south-eastern part of the Faroese fishing zone in May-June, and follows the migrations of fish northward and north-eastward into the international waters of the Norwegian Sea. In July-August, when most of the catch is taken, the fishery is conducted in the north-eastern part of the Faroese fishing zone and international waters of the Norwegian Sea (Figure 3.7.3.1). Recently a total catch limit for mackerel includes a quota for the Faroese fishing zone allocated to Russia within the Russian-Faroese Fisheries Commission, a quota for the international waters allocated to Russia within NEAFC and allowed level of by-catch in the blue whiting fishery in the Norwegian economic zone.

In 2002 the Russian fishery for mackerel in the Faroese fishing zone started in the end of June in the area between 62°30 and 64°00N and from 4°30 to 9°00W. In July the fishery moved towards the 200-mile limit of Norway and took place in the area between 62°40 and 63°30N and from 4°30W to the 200-mile limit of Norway. In August a small group of vessels continued fishing in the same area until the middle of that month (Figure 3.7.3.2). In the international waters the fishery also began in the end of June and was prosecuted along the economic zone of Norway in the area between 65°30 and 66°30N. In June only 94 hauls were done in the international waters. In July the vessels were operating, mostly, near the 200-mile limit of Norway from the border between the zones to 67°N and 2-3°W in the west. In August fishery of mackerel mostly took place in the first half of the month along the 200-mile limit of Norway between 64°30 and 68°00N. In the south the vessels were operating along the northern boundary of the Faroese fishing zone (Figure 3.7.3.2).

The largest catches of mackerel were taken in the south-eastern section of the international waters, along the boundary of the Norwegian economic zone, south of 67°N. 5.5% of the total catch was fished in June (937 t or 2.4% in the international waters), and most of the catch (75.5%) was taken in July. Such a distribution of catch by month and area is typical of the history of the Russian mackerel fishery since 1977 (Figure 3.7.3.1).

Presently, in the fishery of mackerel in the Norwegian Sea the Russian fishing vessels use a midwater rope trawl, where ropes in mesh in the front part of the trawl can be as long as 3 to 25 meters. The length of the rope part in trawl used in the mackerel fishery can vary from 100 to 200 m. With the length of the rope part of the trawl of 100 m a small mesh retaining part is 14 m deeper (depth of net with the mesh size less than 800-400 mm) than the headline, and with the increase of the length of the rope part to 200 m, its depth increases to 28 m. The highest efficiency is achieved when the trawl has a horizontal opening of 50 to 120 m and a vertical opening of 40-70 m. Trawls are towed at a speed of 4.8 to 6.5 kt. A minimal mesh size in the blinder is 40 mm. Figure 3.7.3.3 shows a drawing of the midwater trawl used by Russian vessels in the mackerel fishery.

There are many pelagic fisheries going on in the Atlantic, and the Working Group has included only those few possibly relevant for by-catch of salmon in the descriptions.

Mackerel: The total estimated mackerel catch in 2001 was about 678,000 t (ICES CM 2003/ACFM:07). The catches per quarter are shown per statistical rectangle in Figure 3.7.3.4. 38% of the total catch was taken during the 1st quarter as the shoals migrate from Div. IVa through Sub-area VI to the main spawning areas in Sub-area VII. The proportion of the total catch taken in Quarter 2 increased slightly to 7%. 25% of the total catch was taken during Quarter 3 this is a similar pattern as in 2000. The main catches in the second quarter were taken from the summer feeding areas in Division IIa and IVa. During Quarter 4, 30% of the total catch was taken mainly from Division IVa. The main catches of southern mackerel are taken in VIIIc (83%) and these are mainly taken in the first quarter. Catches from IXa, which comprise 17% of southern mackerel catches, are mainly taken in the first and third quarters. Both purse-seiners and trawlers are used in the fishery.

Norwegian spring spawning herring: The catches of Norwegian spring-spawning herring by all countries in 2001 by ICES rectangles are shown in Figure 3.7.3.5 (per quarter). In 2001 the catch provided as catch by rectangle represented approximately 756,845 tonnes or 98.3% of the total catch. In general the development of the international fishery shown by these figures follows the known migration pattern for Norwegian spring-spawning herring (ICES CM 2002/ACFM:19). Both purse-seiners and trawlers are used in the fishery.

Blue-Whiting: Estimates of the total landings of blue whiting in 2001 by various fisheries of 1 780 000 were the highest ever and were 368,000 t more than the total landings of 1,412,000 t in 2000 (ICES CM 2002/ACFM:19). Total landings for 1999 were 1,256,000 tonnes. As in previous years, nearly 60% of blue whiting catches were taken in the spawning area. The catch there was 1,044,000 t in 2001 compared to 997,000 t in 2000, representing a slight increase of 5% from 2000 to 2001. Blue whiting is caught by different gears and mesh sizes and can be grouped in two types of fisheries: a directed fishery, where by-catches of other species are insignificant; a mixed fishery, where varying proportions of blue whiting are caught together with Norway pout or other species. As in previous years, the predominant part (1,676,000 t or 94%) of the total landings in 2001 was taken in the directed fishery and 104 000 t taken as by-catch in other fisheries, such as the Norway pout fishery. Most (74,000 t) of the by-catch of blue whiting is taken in the North Sea. The fishery in 2001 took place mainly in the second and third quarter (Figure 3.7.3.6). In the first quarter the fishery occurred on the spawning grounds from the Porcupine Bank to Rockall. The fishery continued in the area west of Rockall and in the shelf area off the Hebrides. In the second quarter the fishery was conducted mainly in Division VIa and in Division Vb and southeast of Iceland. During summer and autumn a significant fishery also took place in the southern part of the Norwegian Sea. The landings from the Norwegian Sea (Divisions I and II) and the area southeast of Iceland between Iceland and the Faroe Islands increased from 277,000 t in 2000 to 592,000 t in 2001.

Horse mackerel fishery: The total catch from all areas in 2001 was 283,300 tons, which is 11,000 tons more than in 2000 which was the lowest catch since 1988 t (ICES CM 2003/ACFM:07). Some countries have a directed trawl fishery and some a directed purse seine fishery for horse mackerel. Some nations conduct both trawl and purse seine fishery. The quarterly distributions of the fisheries are given in Figure 3.7.3.7.

Icelandic summer-spawning herring fishery: In 2001 the fishery started in September and terminated in January (ICES CM 2002/ACFM:19). The catch in September-January was 95,278 t. The catch was taken with traditional purse-seines and pelagic trawls. The main purse-seine fishery took place off the east coast of Iceland in September-November and only minor quantities were taken west of Iceland in October-January. The pelagic trawl fishery started in September, which is unusually early, but only 2,500 t were taken east of Iceland throughout the month. In October-January the pelagic trawl fishery took place both in the east and the west of Iceland.

Capelin fishery in the Iceland-East Greenland-Jan Mayen area: Over the years, fishing has not been permitted during April-June and the season has been opened in July/August or later, depending on the state of the stock (ICES CM 2002/ACFM:19). 2001 the fishery opened on 20 June and began in deep waters north of the shelf edge northeast and north of Iceland. As usual the fishery gradually shifted to the northwest and north in July. By the end of July, the total catch was 276,000 t. After July the capelin remained scattered and few catches were made for the rest of the year, except for 18,000 t taken in December. In January 2002, large fishable concentrations of adult capelin were located in deep waters off the shelf east of Iceland and resulted immediately in a successful fishery. The total catch during the 2002 winter season was 955,000 t, the highest on record.

3.8 Data deficiencies and research needs in the NEAC area

Data deficiencies and research needs for the NEAC area are presented in section 6.

Table 3.2.3.1 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)
1971	437	230	294	79	-	3,069	802	142	305	18	4,608	2,421	26	8,976
1972	308	224	315	76	-	3,437	810	130	307	18	4,215	2,367	24	13,448
1973	291	230	335	70	-	3,241	884	130	303	20	4,047	2,996	32	18,616
1974	280	240	329	69	-	3,182	777	129	307	18	3,382	3,342	29	14,078
1975	269	243	341	69	-	2,978	768	127	314	20	3,150	3,549	25	15,968
1976	275	247	355	70	-	2,854	756	126	287	18	2,569	3,890	22	17,794
1977	273	251	365	71	-	2,742	677	126	293	19	2,680	4,047	26	30,201
1978	249	244	376	70	-	2,572	691	126	284	18	1,980	3,976	12	23,301
1979	241	225	322	68	-	2,698	747	126	274	20	1,835	5,001	17	23,989
1980	233	238	339	69	-	2,892	670	125	258	20	2,118	4,922	20	25,652
1981	232	219	336	72	-	2,704	647	123	239	19	2,060	5,546	19	24,081
1982	232	221	319	72	-	2,415	647	123	221	18	1,843	5,217	27	22,520
1983	232	209	333	74	-	2,530	669.5	120	207	17	1,735	5,428	21	21,813
1984	226	223	354	74	-	2,443	653	121	192	19	1,697	5,386	35	21,210
1985	223	230	375	69	-	2,196	551	122	168	19	1,726	5,848	34	20,329
1986	220	221	368	64	-	1,996	618.5	121	148	18	1,630	5,979	14	17,945
1987	213	206	352	68	-	1,762	577	120	119	18	1,422	6,060	13	17,234
1988	210	212	284	70	-	1,577	402	115	113	18	1,322	5,702	11	15,532
1989	201	199	282	75	-	1,235	355.5	117	108	19	1,888	4,100	16	0
1990	200	204	292	69	-	1,280	339.5	114	106	17	2,375	3,890	7	0
1991	199	187	264	66	-	1,136	289	118	102	18	2,343	3,628	8	0
1992	203	158	267	65	-	850	292.5	121	91	19	2,268	3,342	5	0
1993	187	151	259	55	-	900	263.5	120	73	18	2,869	2,783	-	0
1994	177	158	257	53	37,278	752	243.5	119	68	18	2,630	2,825	-	0
1995	163	156	249	47	34,941	729	221.5	122	68	16	2,542	2,715	-	0
1996	151	132	232	42	35,281	644	200.5	117	66	12	2,280	2,860	-	0
1997	139	131	231	35	32,781	688	190	116	63	12	2,002	1,075	-	0
1998	130	129	196	35	32,525	545	143.5	117	70	12	1,865	1,027	-	0
1999	120	109	178	30	29,132	384	128.5	113	52	11	1,649	989	-	0
2000	110	103	158	32	30,139	385	119	109	57	10	1,557	982	-	0
2001	113	99	143	33	24,350	387	95	107	50	6	1,976	1,081	-	0
2002	113	85	140	34	29,065	318	77	106	47	4	1,666	917	-	0
Mean 1997-2001	122	114	181	33	29785	478	135 #	112	58	10 #	1810	1031		0
% change [4]	-7.7	-25.6	-22.7	3.0	-2.4	-33.4	-43.0 #	-5.7	-19.5	-60.8 #	-7.9	-11.0		
Mean 1992-2001	149	133	217	43	32053	626	190 #	116	66	13 #	2164	1968		0
% change [4]	-24.3	-35.9	-35.5	-20.4	-9.3	-49.2	-59.4 #	-8.7	-28.6	-70.1 #	-23.0	-53.4		

1 Total number of rod licences issued, data for 2002 is provisional.

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

[3] Number of gear units expressed as trap months.

[4] (2002/mean - 1) * 100

Table 3.2.3.1 continued Number of gear units licensed or authorised by country and gear type.

	Ireland				Finland				France			Russia		
					The Teno River			R. Näätämö				Kola Peninsula	Archangel region	
	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]	Catch-and-release Fishing days	Commercial, number of gears	
Year					Fishing days	Fishermen	Fishermen	Fishermen					Coastal	In-river
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	1711		
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71	4088		
1993	673	457	161	23,875	29,461	10,198	755	705	2,111	53	55	6026	59	199
1994	732	494	176	24,988	26,517	8,985	751	671	1,680	17	59	8619	60	230
1995	768	512	164	27,056	24,951	8,141	687	716	1,881	17	59	5822	55	239
1996	778	523	170	29,759	17,625	5,743	672	814	1,806	21	69	6326	85	330
1997	852	531	172	31,873	16,255	5,036	616	588	2,974	10	59	6355	68	282
1998	874	513	174	31,565	18,700	5,759	621	673	2,358	16	63	6034	66	270
1999	874	499	162	32,493	22,935	6,857	616	850	2,232	15	61	7023	66	194
2000	871	490	158	33,527	28,385	8,275	633	624	2,745 [3]	16	35	7336	60	173
2001	881	540	155	32,814	33,501	9,367	863	590	3,111 [7]	12	32	8468	53	121
2002	883	544	159	32,814	37,491	10,560	853	660	na. [7]	20	58	9624	63	72
Mean 1997-2001	870	515	164	32454	23955	7059	670	665	2684	14	50	7043	63	208
% change [6]	1.4	5.7	-3.2	1.1	56.5	49.6	27.4	-0.8		44.9	16.0	36.6	0.6	-65.4
Mean 1992-2001	799	509	168	28821	24508	7742	696	711	2306	23	56	6610	64	226
% change [6]	10.5	6.8	-5.1	13.9	53.0	36.4	22.5	-7.1		-14.5	3.0	45.6	-0.9	-68.2

[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] (2002/mean - 1) * 100

[7] Estimated from from licences sold to migratory salmonid fisheries.

Table 3.2.4.1 Nominal catch of SALMON in NEAC Area (in tonnes round fresh weight), 1960-2002 (2002 figures are provisional).

Year	Southern countries	Northern countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches NEAC Area	Unreported catches International waters (2)
1960	2641	2899	-	-	5540	-	-
1961	2276	2477	-	-	4753	-	-
1962	3894	2815	-	-	6709	-	-
1963	3842	2434	-	-	6276	-	-
1964	4242	2908	-	-	7150	-	-
1965	3693	2763	-	-	6456	-	-
1966	3549	2503	-	-	6052	-	-
1967	4492	3034	-	-	7526	-	-
1968	3623	2523	5	403	6554	-	-
1969	4383	1898	7	893	7181	-	-
1970	4048	1834	12	922	6816	-	-
1971	3736	1846	-	471	6053	-	-
1972	4257	2340	9	486	7092	-	-
1973	4604	2727	28	533	7892	-	-
1974	4352	2675	20	373	7420	-	-
1975	4500	2616	28	475	7619	-	-
1976	2931	2383	40	289	5643	-	-
1977	3025	2184	40	192	5441	-	-
1978	3102	1864	37	138	5141	-	-
1979	2572	2549	119	193	5433	-	-
1980	2640	2794	536	277	6247	-	-
1981	2557	2352	1025	313	6247	-	-
1982	2533	1938	606	437	5514	-	-
1983	3532	2341	678	466	7017	-	-
1984	2308	2461	628	101	5498	-	-
1985	3002	2531	566	-	6099	-	-
1986	3595	2588	530	-	6713	-	-
1987	2564	2266	576	-	5406	2554	-
1988	3315	1969	243	-	5527	3087	-
1989	2433	1626	364	-	4423	2103	-
1990	1645	1775	315	-	3735	1779	180-350
1991	1145	1677	95	-	2917	1555	25-100
1992	1523	1806	23	-	3352	1825	25-100
1993	1443	1853	23	-	3319	1471	25-100
1994	1896	1685	6	-	3587	1157	25-100
1995	1774	1503	5	-	3282	942	-
1996	1395	1358	-	-	2753	947	-
1997	1113	962	-	-	2075	732	-
1998	1121	1099	6	-	2226	1108	-
1999	934	1139	0	-	2073	887	-
2000	1210	1518	8	-	2736	1135	-
2001	1242	1634	0	-	2876	1089	-
2002	1109	1355	0		2464	946	-
Means							
1997-2001	1124	1271	4	-	2397	990	-
1992-2001	1365	1456	9	-	2828	1129	-

1. Since 1991, fishing carried out at the Faroes has only been for research purposes.
2. Estimates refer to season ending in given year.

Table 3.2.5.1 CPUE for salmon rod fisheries in Finland (Teno, Naatamo), France, and UK(N.Ireland)(Bush).

	Finland (R. Teno)		Finland (R. Naatamo)		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
2001	5.9	1.7	1.2	0.3	0.65	0.444
2002	3.1	0.9	0.7	0.2		0.184
Mean 1997-01	4.2	1.2	1.1	0.2	0.7	0.4

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

Table 3.2.5.2 CPUE for salmon rod fisheries in the Barents 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
2001	1.160	1.272	0.888	0.730	4.200	1.860	1.814	1.039
2002	2.390	0.993	0.794	2.822	5.807	1.436	2.108	0.360
Mean 1997-01	1.132	0.789	0.587	1.297	4.174	1.949	2.351	1.095

Table 3.2.5.3 CPUE data for net and fixed engine salmon fisheries by Region in UK (England & Wales). Data expressed as catch per licence-tide in all Regions except the North East, for which the data are recorded as catch per licence-day.

		Region (aggregated data, various methods)					
Year	North East drift nets	North East	Southern	South West	Midlands[1]	Wales	North West
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	8.23	6.43	No fishing			0.68	0.63
1994	9.02	7.53	-			1.02	0.71
1995	11.18	7.84	-			1.00	0.79
1996	4.93	3.74	-			0.73	0.59
1997	6.84	5.30	-	0.42		0.77	0.35
1998	6.49	5.12	-	0.56	0.25	0.69	0.32
1999	8.77	7.28	-	0.48	0.36	0.83	0.37
2000	12.21	10.50	-	0.69	0.43	0.40	0.64
2001	10.06	8.70	-	0.62	0.42	0.47	0.56
2002	8.23	7.00	-	0.62	0.34	0.53	0.63
Mean 1997-01	8.87	7.38		0.57	0.36	0.63	0.45

[1]Seine nets and lave nets only

Table 3.2.5.4 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	61.29	180.21
1983	55.84	203.59
1984	58.88	155.31
1985	49.60	148.88
1986	75.19	193.42
1987	61.83	145.61
1988	50.57	198.43
1989	71.04	262.35
1990	33.22	145.96
1991	35.87	106.35
1992	59.58	153.66
1993	52.84	125.23
1994	92.13	123.74
1995	75.60	142.27
1996	57.52	110.93
1997	32.96	57.79
1998	36.02	68.67
1999	21.94	58.78
2000	53.73	105.22
2001	60.26	76.14
2002	36.19	99.22
Mean 1997-01	40.98	73.32

[1] Excludes catch and effort for Solway Region

Table 3.2.5.5 Catch per unit effort for the marine fishery in Norway. The CPUE is expressed as numbers of salmon caught per net day in bagnets and bendnets divided by salmon weight.

	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
2001	1.52	1.03	0.22	1.03	1.39	0.36
2002	0.91	1.03	0.26	0.74	0.87	0.32

Table 3.2.6.1. Percentage of 1SW salmon in catches from countries in the North East Atlantic, 1987-2002

Year	Iceland	Finland	Norway	Russia	Sweden	**Northern countries**	UK (Scot)	UK (E&W)	France	Spain (1)	**Southern countries**
1987		66	61	71		**63**	61	68	77		**63**
1988		63	64	53		**62**	57	69	29		**60**
1989	69	66	73	73	41	**72**	63	65	33		**63**
1990	66	64	68	73	70	**69**	48	52	45		**49**
1991	72	59	65	70	71	**66**	53	71	39		**58**
1992	72	70	62	72	68	**65**	55	77	48		**59**
1993	76	58	61	61	62	**63**	57	81	74		**64**
1994	64	55	68	69	64	**67**	54	77	55	61	**61**
1995	72	59	58	70	78	**62**	53	72	60	22	**60**
1996	74	79	53	80	63	**61**	54	65	51	22	**57**
1997	73	69	64	82	54	**68**	54	73	51	21	**60**
1998	82	75	66	82	59	**70**	58	83	71	50	**65**
1999	71	83	65	78	71	**68**	45	70	27	13	**55**
2000	84	67	67	75	69	**69**	54	79	58	63	**66**
2001	81	48	58	74	55	**60**	55	75	51	36	**64**
2002	85	34	49	70	63	**54**	53	75	69	33	**64**
Means											
1997-2001	78	68	64	78	62	**67**	53	76	52	37	**62**
1992-2001	75	66	62	74	64	**65**	54	75	55	36	**61**

1. Extrapolation to the national catches of % found on the rivers of Asturias (90 % of the Spanish catch)

Table 3.3.1.1 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.Irl)[8]	Norway[2]		UK (Scotland)[2]			France	
migration	Ellidaar	Vesturdalsa[4]		R.Midfjardara[4]		R. Corrib	R. 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						17.9	0.6								
1981						7.6	3.8		17.3	4.0	13.7	6.9	0.3		
1982						20.9	3.3		5.3	1.2	12.6	5.4	0.2		
1983		2.0				10.0	1.9		13.5	1.3	-	-	-		
1984						26.2	2.0		12.1	1.8	10.0	4.1	0.1		
1985	9.4					18.9	1.8		10.2	2.1	26.1	6.4	0.2		
1986						-	-	31.3	3.8	4.2	-	-	-	15.1	
1987				2.4	1.4	16.6	0.7	35.1	17.3	5.6	13.9	3.4	0.1	2.6	
1988	12.7			0.6	0.9	14.6	0.7	36.2	13.3	1.1	-	-	-	2.4	
1989	8.1	1.1	2.0	0.2	0.7	6.7	0.7	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	5.0	0.6	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	7.3	1.3	27.8	8.7	1.2	11.2	4.5	-	9.2	
1992	9.6	2.4	0.8	1.4	0.5	7.3	-	29.0	6.7	0.9	-	-	-	8.9	6.9
1993	9.8	-	-	1.0	1.1	10.8	2.0	-	15.6		-	-	-	8.3 [7]	10.3
1994	9.0	-	-	1.4	0.6	9.8	1.4	27.1	-	-	17.2	2.3	0.1	7.2 [7]	7.5
1995	9.4	1.6	1.2	0.3	0.9	8.4	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	6.3	1.2	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	12.7	0.8	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	-	5.5	1.1	13.4	7.2	1.0	-	-	-	2.7	-
1999	7.7	1.3	0.9	-	-	5.8	0.7	16.5	4.2	2.2	-	-	-	2.9	-
2000	6.3	0.8	0.5	-		9.4		10.1	12.6	1.7	5.1	2.3		2.7	-
2001	5.1	2.8				5.5		12.4	3.8		9			2.8	
Mean															
(5-year)	5.8	1.0	0.8	1.6	0.7	7.6	0.9	17.2	5.8	1.3	8.7	5.0	0.1	3.2	4.8
(10-year)	7.6	1.7	0.8	1.3	0.8	8.2	1.0	21.8	6.9	1.2	11.0	4.1	0.1	5.2	7.4

[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 3.3.1.2 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]		UK (N. Ireland)[1]		Norway[2]				Sweden[2]	
	R. Ranga		R. Bush (1SW)		R. Imsa		R. Drammen		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			1.9	8.1	1.6	0.1				
1984			13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985			15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986			2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987			6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988			4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	1.63	0.08	8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	0.93	0.19	5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	0.09	0.04	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	0.43	0.05	6.0	7.8	3.8	0.7	0.4	0.6	1.5	0.4
1993	0.90	0.05	1.1	5.8	6.5	0.5	3.0	1.0	2.6	0.9
1994	1.21	0.16	1.6		6.2	0.6	1.2	0.9	4.0	1.2
1995	0.91	0.10	3.1	2.4	0.4	0.0	0.7	0.3	3.9	0.6
1996	0.13	0.03	2.0	2.3	2.1	0.2	0.3	0.2	3.5	0.5
1997	0.24	0.06	no release	4.1	1.0	0.0	0.5	0.2	0.6	0.5
1998	0.49	0.02	2.3	4.5	2.4	0.1	1.9	0.7	1.6	0.9
1999	0.59	0.04	2.7	5.8	6.6	0.6	2.0	1.8	2.1	
2000	1.01	0.06	2.8	4.4	9.3	0.1	1.3	0.7		
2001	0.24		1.1	2.2	2.4		2.5			
Mean										
(5-year)	0.49	0.05	2.5	4.2	4.3	0.2	1.2	0.6	2.0	0.6
(10-year)	0.60	0.07	3.0	5.1	4.2	0.5	1.1	0.6	2.6	1.0

[1]Microtagged.

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

Table 3.3.1.2 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			2.0	1.2		
1982	4.1		9.9			16.3	2.7	16.1	
1983	3.9		4.3			2.0	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	6.0	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	4.0	1.3
1992	4.3	1.3	7.1	10.0	5.2	-	0.9	0.6	-
1993	2.9	2.2	14.0	14.3	6.4	-	1.0	-	-
1994	5.1	1.9	13.1	5.6	8.1	-	-	5.3	-
1995	3.6	4.1	8.5	3.3	3.5	-	2.4	-	-
1996	2.9	1.8	5.5	9.9	3.3	-	-	-	-
1997	6.0	0.4	13.3	16.3	5.7	6.9	-	-	8.3
1998	3.1	1.3	4.9	7.1	2.6	4.6	3.3	2.9	2.5
1999	0.7	2.5	8.4	10.7	1.4	-	-	3.2	3.5
2000	1.2	3.7	11.7	14.4	4.1	3.5	6.7	-	4.0
2001	2.3	2.1	8.7	12.8	2.1	2.08	3.2	-	4.8
Mean									
(5-year)	2.8	1.9	8.8	11.7	3.4	4.3	5.0	3.1	4.6
(10-year)	3.4	1.9	9.9	10.2	4.5	3.9	3.0	3.2	3.9

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

[2] Different release sites

Table 3.3.3.1a Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - River Teno (FINLAND/NORWAY)

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	8,422	8,538	30	40	30	40	40	60	40	70
1972	13,160	13,341	30	40	30	40	40	60	40	70
1973	16,710	16,940	30	40	30	40	40	60	40	70
1974	16,194	17,265	30	40	30	40	40	60	40	70
1975	23,012	24,537	30	40	30	40	40	60	40	70
1976	20,112	21,444	30	40	30	40	40	60	40	70
1977	13,403	14,288	30	40	30	40	40	60	40	70
1978	9,504	8,633	30	40	30	40	40	60	40	70
1979	11,404	6,581	30	40	30	40	40	60	30	60
1980	9,817	7,746	20	30	20	30	40	60	30	60
1981	7,045	9,493	20	30	20	30	40	60	30	60
1982	5,844	12,164	20	30	20	30	40	60	30	60
1983	9,072	14,016	20	30	20	30	40	60	30	60
1984	13,604	13,124	20	30	20	30	40	60	30	60
1985	15,589	12,349	20	30	20	30	40	60	30	60
1986	16,190	8,566	20	30	20	30	40	60	30	60
1987	21,110	10,973	20	30	20	30	40	60	30	60
1988	12,657	7,464	20	30	20	30	40	60	30	60
1989	23,905	12,262	20	30	20	30	50	70	40	70
1990	21,618	12,005	20	30	20	30	50	70	40	70
1991	22,623	15,465	20	30	20	30	50	70	40	70
1992	28,925	21,786	20	30	20	30	50	70	40	70
1993	20,249	22,472	20	30	20	30	50	70	40	70
1994	19,520	23,214	20	30	20	30	50	70	40	70
1995	16,173	19,032	20	30	20	30	50	70	40	70
1996	25,880	6,996	20	30	20	30	40	60	30	60
1997	22,592	10,215	20	30	20	30	40	60	30	60
1998	26,501	8,709	20	30	20	30	40	60	30	60
1999	44,579	8,836	20	30	20	30	50	70	40	60
2000	47,393	19,651	20	30	20	30	50	70	40	60
2001	26,469	28,749	20	30	20	30	50	70	40	60
2002	13711	26062	20	30	20	30	50	70	40	60
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1b 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	1,544	1,489	0	0	0	0	5	20	20	40
2002	2,423	1,063	2	5	2	5	5	20	20	55
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1c Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - ICELAND-WEST & SOUTH

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	30618	16749	1	3	1	3	40	60	50	70
1972	24832	25733	1	3	1	3	40	60	50	70
1973	26624	23183	1	3	1	3	40	60	50	70
1974	18975	20017	1	3	1	3	40	60	50	70
1975	29428	21266	1	3	1	3	40	60	50	70
1976	23233	18379	1	3	1	3	40	60	50	70
1977	23802	17919	1	3	1	3	40	60	50	70
1978	31199	23182	1	3	1	3	40	60	50	70
1979	28790	14840	1	3	1	3	40	60	50	70
1980	13073	20855	1	3	1	3	40	60	50	70
1981	16890	13919	1	3	1	3	40	60	50	70
1982	17331	9826	1	3	1	3	40	60	50	70
1983	21923	16423	1	3	1	3	40	60	50	70
1984	13476	13923	1	3	1	3	40	60	50	70
1985	21822	10097	1	3	1	3	40	60	50	70
1986	35891	8423	1	3	1	3	40	60	50	70
1987	22302	7480	1	3	1	3	40	60	50	70
1988	40028	8523	1	3	1	3	40	60	50	70
1989	22377	7607	1	3	1	3	40	60	50	70
1990	20584	7548	1	3	1	3	40	60	50	70
1991	22711	7519	1	3	1	3	40	60	50	70
1992	26006	8479	1	3	1	3	40	60	50	70
1993	25479	4155	1	3	1	3	40	60	50	70
1994	20985	6736	1	3	1	3	40	60	50	70
1995	25371	6777	1	3	1	3	40	60	50	70
1996	21913	4364	1	3	1	3	40	60	50	70
1997	16007	4910	1	3	1	3	40	60	50	70
1998	21900	3037	1	3	1	3	40	60	50	70
1999	17448	5757	1	3	1	3	40	60	50	70
2000	15502	1519	1	3	1	3	40	60	50	70
2001	13586	2707	1	3	1	3	40	60	50	70
2002	17073	2550	1	3	1	3	40	60	50	70
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1d Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - ICELAND- North & East

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	4610	6625	1	3	1	3	40	60	50	70
1972	4223	10337	1	3	1	3	40	60	50	70
1973	5060	9672	1	3	1	3	40	60	50	70
1974	5047	9176	1	3	1	3	40	60	50	70
1975	6152	10136	1	3	1	3	40	60	50	70
1976	6184	8350	1	3	1	3	40	60	50	70
1977	8597	11631	1	3	1	3	40	60	50	70
1978	8739	14998	1	3	1	3	40	60	50	70
1979	8363	9897	1	3	1	3	40	60	50	70
1980	1268	13784	1	3	1	3	40	60	50	70
1981	6528	4827	1	3	1	3	40	60	50	70
1982	3007	5539	1	3	1	3	40	60	50	70
1983	4437	4224	1	3	1	3	40	60	50	70
1984	1611	5447	1	3	1	3	40	60	50	70
1985	11116	3511	1	3	1	3	40	60	50	70
1986	13827	9569	1	3	1	3	40	60	50	70
1987	8145	9908	1	3	1	3	40	60	50	70
1988	11775	6381	1	3	1	3	40	60	50	70
1989	6342	5414	1	3	1	3	40	60	50	70
1990	4752	5709	1	3	1	3	40	60	50	70
1991	6900	3965	1	3	1	3	40	60	50	70
1992	12996	5903	1	3	1	3	40	60	50	70
1993	10689	6672	1	3	1	3	40	60	50	70
1994	3414	5656	1	3	1	3	40	60	50	70
1995	8776	3511	1	3	1	3	40	60	50	70
1996	4681	4605	1	3	1	3	40	60	50	70
1997	6406	2594	1	3	1	3	40	60	50	70
1998	10905	3780	1	3	1	3	40	60	50	70
1999	5326	4030	1	3	1	3	40	60	50	70
2000	5595	2324	1	3	1	3	40	60	50	70
2001	4976	2587	1	3	1	3	40	60	50	70
2002	8809	2022	1	3	1	3	40	60	50	70
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1e 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	45.00	56.48	75.30	35.00	60.00
1972	523,742	58,194	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1973	560,323	62,258	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1974	617,806	68,645	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1975	643,355	71,484	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1976	453,194	50,355	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1977	398,323	44,258	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1978	357,097	39,677	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1979	318,484	35,387	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1980	248,333	39,608	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1981	173,667	32,159	30.00	45.00	30.00	45.00	42.32	56.43	35.00	60.00
1982	310,000	12,353	30.00	45.00	30.00	45.00	57.49	76.65	28.34	81.47
1983	502,000	29,411	30.00	45.00	30.00	45.00	56.24	74.99	10.34	45.41
1984	242,666	19,804	30.00	45.00	30.00	45.00	50.21	66.95	37.02	50.00
1985	498,333	19,608	30.00	45.00	30.00	45.00	61.67	82.22	31.18	39.45
1986	498,125	28,335	30.00	45.00	30.00	45.00	59.28	79.04	36.95	54.30
1987	358,842	27,609	20.00	40.00	20.00	40.00	55.85	74.47	27.50	36.86
1988	559,297	30,599	20.00	40.00	20.00	40.00	53.27	71.03	31.85	94.21
1989	305,667	24,891	20.00	40.00	20.00	40.00	58.88	78.51	38.35	78.00
1990	203,955	16,608	20.00	40.00	20.00	40.00	55.24	73.66	53.85	76.69
1991	140,796	11,465	20.00	40.00	20.00	40.00	51.56	68.75	30.47	61.54
1992	219,942	17,910	20.00	40.00	20.00	40.00	62.95	83.94	46.91	55.26
1993	187,742	15,288	15.00	35.00	15.00	35.00	49.85	66.47	23.59	56.43
1994	267,928	21,818	15.00	35.00	15.00	35.00	54.69	72.93	38.06	62.08
1995	271,497	22,108	15.00	35.00	15.00	35.00	66.90	89.20	40.65	46.62
1996	230,826	18,797	15.00	35.00	15.00	35.00	53.75	71.66	51.93	58.2828
1997	194,187	15,813	15.00	35.00	10.00	20.00	58.23	77.64	18.51	48.88
1998	219,767	17,896	15.00	35.00	10.00	20.00	51.29	68.39	60.47	63.25
1999	166,887	13,590	15.00	35.00	10.00	20.00	66.31	88.41	42.70	52.29
2000	211,035	17,185	15.00	35.00	10.00	20.00	63.56	84.75	26.51	37.51
2001	250,559	20,404	5	10	5	10	64	85	27	38
2002	234,386	19,087	5	10	5	10	40	65	20	30
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1f 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	212,691	129,618	40	60	40	60	70	90	70	90
1972	248,705	178,591	40	60	40	60	70	90	70	90
1973	243,685	204,556	40	60	40	60	70	90	70	90
1974	232,609	191,988	40	60	40	60	70	90	70	90
1975	233,720	164,641	40	60	40	60	70	90	70	90
1976	219,705	170,758	40	60	40	60	70	90	70	90
1977	226,835	170,296	40	60	40	60	70	90	70	90
1978	185,328	111,848	40	60	40	60	70	90	70	90
1979	333,578	197,717	40	60	40	60	70	90	70	90
1980	233,103	232,347	40	60	40	60	70	90	70	90
1981	230,572	204,381	40	60	40	60	70	90	70	90
1982	178,754	166,244	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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1g 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	104,040	49,413	40	60	40	60	70	90	70	90
1984	150,372	58,858	40	60	40	60	70	90	70	90
1985	118,841	58,956	40	60	40	60	70	90	70	90
1986	84,150	63,418	40	60	40	60	70	90	70	90
1987	72,370	34,232	40	60	40	60	70	90	70	90
1988	53,880	32,140	40	60	40	60	70	90	70	90
1989	42,010	13,934	40	60	40	60	60	80	60	80
1990	38,216	17,321	40	60	40	60	60	80	60	80
1991	42,888	21,789	40	60	40	60	60	80	60	80
1992	34,593	19,265	40	60	40	60	60	80	60	80
1993	51,440	39,014	30	50	30	50	60	80	60	80
1994	37,489	33,411	30	50	30	50	60	80	60	80
1995	36,283	26,037	30	50	30	50	60	80	60	80
1996	40,792	36,636	30	50	30	50	60	80	60	80
1997	39,930	30,115	25	45	25	45	60	80	60	80
1998	46,645	34,806	25	45	25	45	60	80	60	80
1999	46,394	46,744	25	45	25	45	60	80	60	80
2000	61,854	51,569	25	45	25	45	60	80	60	80
2001	46,331	54,023	25	45	25	45	60	80	60	80
2002	38,101	43,100	25	45	25	45	60	80	60	80
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1h 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	121,221	74,648	40	60	40	60	65	85	65	85
1984	94,373	67,639	40	60	40	60	65	85	65	85
1985	114,613	56,641	40	60	40	60	65	85	65	85
1986	106,921	77,225	40	60	40	60	65	85	65	85
1987	83,669	62,216	40	60	40	60	65	85	65	85
1988	80,111	45,609	40	60	40	60	65	85	65	85
1989	94,897	30,862	40	60	40	60	55	75	55	75
1990	78,888	40,174	40	60	40	60	55	75	55	75
1991	67,370	30,087	40	60	40	60	55	75	55	75
1992	51,463	33,092	40	60	40	60	55	75	55	75
1993	58,326	28,184	30	50	30	50	55	75	55	75
1994	113,427	33,520	30	50	30	50	55	75	55	75
1995	57,813	42,696	30	50	30	50	55	75	55	75
1996	28,925	31,613	30	50	30	50	55	75	55	75
1997	43,127	20,565	25	45	25	45	50	70	50	70
1998	63,497	26,817	25	45	25	45	50	70	50	70
1999	60,689	28,792	25	45	25	45	50	70	50	70
2000	109,278	42,452	25	45	25	45	50	70	50	70
2001	88,096	52,031	25	45	25	45	50	70	50	70
2002	42,669	52,774	25	45	25	45	50	70	50	70
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1i 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	40,511	37,105	40	60	40	60	65	85	65	85
1984	34,248	38,614	40	60	40	60	65	85	65	85
1985	47,877	36,968	40	60	40	60	65	85	65	85
1986	51,839	41,890	40	60	40	60	65	85	65	85
1987	48,690	39,641	40	60	40	60	65	85	65	85
1988	53,775	37,145	40	60	40	60	65	85	65	85
1989	43,128	25,279	40	60	40	60	55	75	55	75
1990	44,259	25,907	40	60	40	60	55	75	55	75
1991	30,771	19,054	40	60	40	60	55	75	55	75
1992	32,488	24,124	40	60	40	60	55	75	55	75
1993	34,503	22,835	30	50	30	50	55	75	55	75
1994	42,551	20,903	30	50	30	50	55	75	55	75
1995	32,685	24,725	30	50	30	50	55	75	55	75
1996	27,739	26,029	30	50	30	50	55	75	55	75
1997	31,381	14,922	25	45	25	45	50	70	50	70
1998	38,299	16,966	25	45	25	45	50	70	50	70
1999	31,256	9,881	25	45	25	45	50	70	50	70
2000	54,671	22,208	25	45	25	45	50	70	50	70
2001	59,425	29,896	25	45	25	45	50	70	50	70
2002	39068	21513	25	45	25	45	50	70	50	70
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)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

Table 3.3.3.1j Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA (Archangelsk & Karelia)

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	134	16,592	5	15	5	15	40	80	40	80
1972	116	14,434	5	15	5	15	40	80	40	80
1973	169	20924	5	15	5	15	40	80	40	80
1974	170	21137	5	15	5	15	40	80	40	80
1975	140	17398	5	15	5	15	40	80	40	80
1976	111	13781	5	15	5	15	40	80	40	80
1977	78	9722	5	15	5	15	40	80	40	80
1978	82	10134	5	15	5	15	40	80	40	80
1979	112	13903	5	15	5	15	40	80	40	80
1980	156	19397	5	15	5	15	40	80	40	80
1981	68	8394	5	15	5	15	40	80	40	80
1982	71	8797	5	15	5	15	40	80	40	80
1983	48	11938	5	15	5	15	40	80	40	80
1984	21	10680	5	15	5	15	40	80	40	80
1985	454	11183	5	15	5	15	40	80	40	80
1986	12	12291	5	15	5	15	40	80	40	80
1987	647	8734	5	15	5	15	40	80	40	80
1988	224	9978	5	15	5	15	40	80	40	80
1989	989	10245	5	15	5	15	40	80	40	80
1990	1418	8429	10	20	10	20	40	80	40	80
1991	421	8725	15	25	15	25	40	80	40	80
1992	1031	3949	20	30	20	30	40	80	40	80
1993	196	4251	25	35	25	35	40	80	40	80
1994	334	5631	30	40	30	40	40	80	40	80
1995	386	5214	40	50	40	50	40	80	40	80
1996	231	3753	50	60	50	60	40	80	40	80
1997	721	3351	50	60	50	60	40	80	40	80
1998	585	4208	50	60	50	60	40	80	40	80
1999	299	3101	50	60	50	60	40	80	40	80
2000	514	3382	50	60	50	60	40	80	40	80
2001	363	2348	50	60	50	60	40	80	40	80
2002	1676	2439	50	60	50	60	40	80	40	80
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)=	0.020	Return time (m)	1SW(min)	7	MSW(min)	19
M(max)=	0.040		1SW(max)	8	MSW(max)	21

Table 3.3.3.1k Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA (Kola Peninsula; Barents Sea Basin)

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	4892	5979	10	20	10	20	40	50	40	50
1972	7978	9750	10	20	10	20	40	50	40	50
1973	9376	11460	10	20	10	20	35	45	35	45
1974	12794	15638	10	20	10	20	35	45	35	45
1975	13872	13872	10	20	10	20	40	50	40	50
1976	11493	14048	10	20	10	20	50	60	50	60
1977	7257	8253	10	20	10	20	45	55	45	55
1978	7106	7113	10	20	10	20	50	60	50	60
1979	6707	3141	10	20	10	20	35	45	35	45
1980	6621	5216	10	20	10	20	35	45	35	45
1981	4547	5973	10	20	10	20	35	45	35	45
1982	5159	4798	10	20	10	20	30	40	30	40
1983	8504	9943	10	20	10	20	30	40	30	40
1984	9453	12601	10	20	10	20	30	40	30	40
1985	6774	7877	10	20	10	20	30	40	30	40
1986	10147	5352	10	20	10	20	35	45	35	45
1987	8560	5149	10	20	10	20	35	45	35	45
1988	6644	3655	10	20	10	20	30	40	30	40
1989	13424	6787	10	20	10	20	35	45	35	45
1990	16038	8234	10	20	10	20	35	45	35	45
1991	4550	7568	10	20	10	20	25	35	25	35
1992	11394	7109	10	20	10	20	25	35	25	35
1993	8642	5690	10	20	10	20	25	35	25	35
1994	6101	4632	10	20	10	20	25	35	25	35
1995	6318	3693	10	20	10	20	25	35	25	35
1996	6815	1701	15	25	15	25	20	30	20	30
1997	3564	867	20	30	20	30	10	20	10	20
1998	1854	280	30	40	30	40	10	15	10	15
1999	1510	424	35	45	35	45	5	10	5	10
2000	805	323	45	55	45	55	4	8	4	8
2001	591	241	55	65	55	65	2	5	2	5
2002	1436	2478	40	60	40	60	5	15	15	25
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)=	0.020	Return time (m)	1SW(min)	6	MSW(min)	17
M(max)=	0.040		1SW(max)	8	MSW(max)	20

Table 3.3.3.1l Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA (Kola Peninsula; White Sea Basin)

Year	Catch (numbers)		Unrep. as % of total		Unrep. as % of total		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	67845	29077	1	5	1	5	40	60	50	70
1972	45837	19644	1	5	1	5	40	60	50	70
1973	68684	29436	1	5	1	5	40	60	50	70
1974	63892	27382	1	5	1	5	40	60	50	70
1975	109038	46730	1	5	1	5	40	60	50	70
1976	76281	41075	1	5	1	5	40	60	50	70
1977	47943	32392	1	5	1	5	40	60	50	70
1978	49291	17307	1	5	1	5	40	60	50	70
1979	69511	21369	1	5	1	5	40	60	50	70
1980	46037	23241	1	5	1	5	40	60	50	70
1981	40172	12747	1	5	1	5	40	60	50	70
1982	32619	14840	1	5	1	5	40	60	50	70
1983	54217	20840	1	5	1	5	40	60	50	70
1984	56786	16893	1	5	1	5	40	60	50	70
1985	87274	16876	1	5	1	5	40	60	50	70
1986	72102	17681	1	5	1	5	40	60	50	70
1987	79639	12501	1	5	1	5	40	60	40	60
1988	44813	18777	1	5	1	5	40	50	40	50
1989	53293	11448	5	10	5	10	40	50	40	50
1990	44409	11152	10	15	10	15	40	50	40	50
1991	31978	6263	15	20	15	20	30	40	30	40
1992	23827	3680	20	25	20	25	20	30	20	30
1993	20987	5552	20	30	20	30	20	30	20	30
1994	25178	3680	25	35	25	35	20	30	10	20
1995	19381	2847	30	40	30	40	20	30	10	20
1996	27097	2710	30	40	30	40	20	30	10	20
1997	27695	2085	30	40	30	40	20	30	10	20
1998	32693	1963	30	40	30	40	20	30	10	20
1999	22330	2841	30	40	30	40	20	30	10	20
2000	26376	4396	30	40	30	40	20	30	10	20
2001	21697	4622	30	40	30	40	20	30	10	20
2002	21350	4721	30	40	30	40	20	30	10	20
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)=	0.020	Return time (m)	1SW(min)	7	MSW(min)	18
M(max)=	0.040		1SW(max)	10	MSW(max)	21

Table 3.3.3.1m Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA (Pechora River)

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	605	17,728	10	30	10	30	50	80	50	80
1972	825	24,175	10	30	10	30	50	80	50	80
1973	1,705	49,962	10	30	10	30	50	80	50	80
1974	1,320	38,680	10	30	10	30	50	80	50	80
1975	1,298	38,046	10	30	10	30	50	80	50	80
1976	991	34,394	10	30	10	30	50	80	50	80
1977	589	20,464	10	30	10	30	50	80	50	80
1978	759	26,341	10	30	10	30	50	80	50	80
1979	421	14,614	10	30	10	30	50	80	50	80
1980	1,123	39,001	10	30	10	30	50	80	50	80
1981	126	20,874	10	30	10	30	50	80	50	80
1982	54	13,546	10	30	10	30	50	80	50	80
1983	598	16,002	10	30	10	30	50	80	50	80
1984	1,833	15,967	10	30	10	30	50	80	50	80
1985	2,763	29,738	10	30	10	30	50	80	50	80
1986	66	32,734	10	30	10	30	50	80	50	80
1987	21	21,179	10	30	10	30	50	80	50	80
1988	3,184	12,816	10	30	10	30	50	80	50	80
			Input data for analisis of total adult returns to Home Waters				Input data for spawners abundance analysis			
Year	Estimated numbers of adult returns to fresh water		Soltwater Unrep. as % of adult returns to FW 1SW		Soltwater Unrep. as % of adult returns to FW MSW		Freshwater Unrep. as % of adult returns to FW 1SW		Freshwater Unrep. as % of adult returns to FW MSW	
	1SW	MSW	min	max	min	max	min	max	min	max
1989	24596	27404	5	15	5	15	50	80	50	80
1990	50	49950	5	15	5	15	50	80	50	80
1991	7975	47025	5	15	5	15	50	80	50	80
1992	550	54450	5	15	5	15	50	80	50	80
1993	68	67932	5	15	5	15	50	80	50	80
1994	3900	48100	5	15	5	15	50	80	50	80
1995	9280	70720	5	15	5	15	50	80	50	80
1996	8664	48336	5	15	5	15	50	80	50	80
1997	1440	38560	5	15	5	15	50	80	50	80
1998	780	59220	5	15	5	15	50	80	50	80
1999	2120	37880	5	15	5	15	50	80	50	80
2000	84	83916	5	15	5	15	50	80	50	80
2001	31636	12364	5	15	5	15	50	80	50	80
2002	405	44595	5	15	5	15	50	80	50	80
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	19
M(max)=	0.040		1SW(max)	8	MSW(max)	21

Table 3.3.3.1n 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	15	45	15	45	40	65	45	70
1972	5,005	295	15	45	15	45	40	65	45	70
1973	6,210	1,025	15	45	15	45	40	65	45	70
1974	8,935	660	15	45	15	45	40	65	45	70
1975	9,620	160	15	45	15	45	40	65	45	70
1976	5,420	480	15	45	15	45	40	65	45	70
1977	2,555	360	15	45	15	45	40	65	45	70
1978	2,917	275	15	45	15	45	40	65	45	70
1979	3,080	800	15	45	15	45	40	65	45	70
1980	3,920	1,400	15	45	15	45	40	65	45	70
1981	7,095	407	15	45	15	45	40	65	45	70
1982	6,230	1,460	15	45	15	45	40	65	45	70
1983	8,290	1,005	15	45	15	45	40	65	45	70
1984	11,680	1,410	15	45	15	45	40	65	45	70
1985	13,890	590	15	45	15	45	40	65	45	70
1986	14,635	570	15	45	15	45	40	65	45	70
1987	11,860	1,700	15	45	15	45	40	65	45	70
1988	9,930	1,650	15	45	15	45	40	65	45	70
1989	3,180	4,610	15	45	15	45	40	65	45	70
1990	7,430	3,135	5	25	5	25	30	60	35	65
1991	8,990	3,620	5	25	5	25	30	60	35	65
1992	9,850	4,655	5	25	5	25	30	60	35	65
1993	10,540	6,370	5	25	5	25	30	60	35	65
1994	8,035	4,660	5	25	5	25	30	60	35	65
1995	9,761	2,770	5	25	5	25	25	50	30	55
1996	6,008	3,542	5	25	5	25	25	50	30	55
1997	2,747	2,307	5	25	5	25	25	50	30	55
1998	2,421	1,702	5	25	5	25	25	50	30	55
1999	3,573	1,460	5	25	5	25	25	50	30	55
2000	7,103	3,196	5	25	5	25	25	50	30	55
2001	4,634	3,853	5	25	5	25	25	50	30	55
2002	4733	2826	5	25	5	25	25	50	30	55
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1o 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	28915	23611	29	48	29	48	36	56	31	51
1972	24613	34364	29	49	29	49	35	55	30	50
1973	28989	26097	29	48	29	48	35	55	29	49
1974	35431	18776	29	49	29	49	35	55	29	49
1975	36465	25819	29	48	29	48	35	55	29	49
1976	25422	14113	28	46	28	46	36	56	30	50
1977	27836	17260	29	49	29	49	37	57	31	51
1978	31397	14228	29	48	29	48	36	56	30	50
1979	29030	6803	29	48	29	48	35	55	30	50
1980	26997	22019	29	49	29	49	36	56	30	50
1981	28414	31115	29	48	29	48	36	56	30	50
1982	24139	12003	29	48	29	48	37	57	31	51
1983	35903	13861	28	46	28	46	37	57	31	51
1984	31923	11355	27	46	27	46	37	57	31	51
1985	30759	16020	29	49	29	49	37	57	31	51
1986	35695	21822	28	47	28	47	37	57	31	51
1987	36339	17101	29	48	29	48	37	57	31	51
1988	47242	21225	30	50	30	50	37	57	31	51
1989	32559	17532	28	46	28	46	37	57	31	51
1990	23635	21817	28	46	28	46	37	57	31	51
1991	22408	9152	28	47	28	47	37	57	31	51
1992	22233	6641	30	50	30	50	37	57	31	51
1993	29963	7028	29	48	29	48	34	54	28	48
1994	40610	12130	18	30	18	30	34	54	28	48
1995	29211	11360	17	28	17	28	31	51	26	46
1996	21294	11466	15	26	15	26	30	50	24	44
1997	18201	6732	14	24	14	24	27	47	22	42
1998	19271	3947	14	24	14	24	25	45	20	40
1999	14678	6291	13	22	13	22	20	40	12	32
2000	22466	5972	12	21	12	21	20	40	8	28
2001	18166	6055	12	20	12	20	18	38	6	26
2002	16807	5602	12	20	12	20	19	39	7	27
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	17
M(max)=	0.040		1SW(max)	9	MSW(max)	19

Table 3.3.3.1p Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Northern Ireland)- Foyle Fisheries area

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	21,827	1,149	0	10	0	10	45	55	25	35
2002	38730	2038	0	5	0	5	45	65	25	35
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)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

Table 3.3.3.1q Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Northern Ireland)-FCB area

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	9,703	510	10	17	10	17	56	68	34	42
1991	7,137	376	10	17	10	17	58	71	39	47
1992	9,546	502	10	23	10	23	50	62	30	36
1993	8,075	425	10	17	10	17	37	45	11	13
1994	11,446	602	10	28	10	28	63	77	36	44
1995	11,887	625	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	8278	436	0	10	0	10	45	55	25	35
2002	3314	174	0	5	0	5	45	65	25	35
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1r Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Scotland)-East

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	62.8	87.9	39.9	59.9
1972	220,106	183,872	49,097	15	35	15	35	64.0	89.6	41.2	61.7
1973	259,773	204,825	59,700	15	35	15	35	62.4	87.4	39.9	59.8
1974	245,424	158,951	50,118	15	35	15	35	68.3	95.6	45.1	67.6
1975	181,940	180,828	50,778	15	35	15	35	67.1	93.9	44.0	66.1
1976	150,069	92,179	14,759	15	35	15	35	63.8	89.3	40.5	60.8
1977	154,306	118,645	49,186	15	35	15	35	67.9	95.0	44.6	66.9
1978	158,844	139,688	47,500	15	35	15	35	63.0	88.2	40.8	61.2
1979	160,791	116,514	39,552	15	35	15	35	65.3	91.4	43.1	64.6
1980	101,665	155,646	41,202	10	25	10	25	64.0	89.6	41.6	62.4
1981	129,690	156,683	61,511	10	25	10	25	63.3	88.6	41.0	61.4
1982	175,355	113,180	44,147	10	25	10	25	59.2	82.9	36.2	54.3
1983	170,843	126,104	67,231	10	25	10	25	64.2	89.8	39.5	59.3
1984	175,675	90,829	50,994	10	25	10	25	58.4	81.8	35.1	52.7
1985	133,073	95,012	48,753	10	25	10	25	51.5	72.2	31.1	46.7
1986	180,276	128,813	53,277	10	25	10	25	49.6	69.4	30.0	45.1
1987	139,252	88,519	29,999	10	25	10	25	53.8	75.3	32.4	48.6
1988	118,580	91,068	41696	10	25	10	25	33.6	47.0	23.4	35.0
1989	142,992	85,348	33577	5	15	5	15	31.3	43.8	22.4	33.5
1990	63,297	73,954	41224	5	15	5	15	33.2	46.5	23.0	34.5
1991	53,835	53,676	20089	5	15	5	15	30.7	42.9	22.0	32.9
1992	79,883	67,968	15712	5	15	5	15	26.8	37.5	20.7	31.0
1993	73,396	60,496	32186	5	15	5	15	29.4	41.2	21.5	32.3
1994	80,555	72,746	35381	5	15	5	15	27.6	38.6	20.9	31.3
1995	72,986	69,115	39908	5	15	5	15	25.8	36.1	20.3	30.5
1996	56,617	50,361	13936	5	15	5	15	24.0	33.6	19.6	29.4
1997	37,465	34,841	16442	5	15	5	15	25.5	35.7	20.1	30.2
1998	44,915	32,264	13699	5	15	5	15	20.2	28.3	18.3	27.5
1999	20,840	26,979	20125	5	15	5	15	20.7	28.9	18.7	28.0
2000	36,735	31,188	32516	5	15	5	15	18.2	25.5	17.8	26.7
2001	36,632	30,464	27086	5	15	5	15	17.0	23.8	17.1	26.1
2002	25,528	22,437	23235	5	15	5	15	16.1	22.5	16.9	25.4
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)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 17
M(max)= 0.040 1SW(max) 8 MSW(max) 18

Table 3.3.3.1.s Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(Scotland)-West

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	31	44	20	30
1972	31359	34151	25	45	25	45	32	45	21	31
1973	33317	33095	25	45	25	45	31	44	20	30
1974	43992	29406	25	45	25	45	34	48	23	34
1975	40424	27150	25	45	25	45	34	47	22	33
1976	38423	22403	25	45	25	45	32	45	20	30
1977	39958	20342	25	45	25	45	34	48	22	33
1978	45626	23266	25	45	25	45	31	44	20	31
1979	26445	15995	25	45	25	45	33	46	22	32
1980	19776	16942	20	35	20	35	32	45	21	31
1981	21048	18038	20	35	20	35	32	44	20	31
1982	32706	15062	20	35	20	35	30	41	18	27
1983	38774	19857	20	35	20	35	32	45	20	30
1984	37404	16384	20	35	20	35	29	41	18	26
1985	24939	19636	20	35	20	35	26	36	16	23
1986	22579	19584	20	35	20	35	25	35	15	23
1987	25533	15475	20	35	20	35	27	38	16	24
1988	30518	21094	20	35	20	35	17	24	12	18
1989	31949	18538	15	25	15	25	16	22	11	17
1990	17797	13970	15	25	15	25	17	23	11	17
1991	19773	11517	15	25	15	25	15	21	11	16
1992	21793	14873	15	25	15	25	13	19	10	16
1993	21121	11230	15	25	15	25	15	21	11	16
1994	18904	12658	15	25	15	25	14	19	10	16
1995	16935	9337	15	25	15	25	13	18	10	15
1996	9796	7559	15	25	15	25	12	17	10	15
1997	9407	5586	15	25	15	25	13	18	10	15
1998	8532	6984	15	25	15	25	10	14	9	14
1999	4343	3672	15	25	15	25	10	14	9	14
2000	7144	5466	15	25	15	25	9	13	9	13
2001	5933	4444	15	25	15	25	9	12	9	13
2002	5033	4397	15	25	15	25	8	11	8	13
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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1t 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)=	0.020	Return time (m)=	1SW(min)	0	MSW(min)	1	
M(max)=	0.040		1SW(max)	1	MSW(max)	2	

Prop'n 1SW returning as grilse = min 0.170

max 0.270

Table 3.3.3.1u 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	14,333	0	0	14	24	100	100	100	100
2002	0	3,103	0	0	43	63	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)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	8
M(max)=	0.040		1SW(max)	8	MSW(max)	10

Table 3.4.3.1 **Conservation limit options for NEAC stock groups estimated from national lagged egg deposition model and from river specific values (where available).**

	National Model CLs		River Specific CLs		Conservation Limit used	
	1SW	MSW	1SW	MSW	1SW	MSW
Northern Europe						
Finland	24,579	17,840			24,579	17,840
Iceland	35,620	7,660			35,620	7,660
Norway[1]	136,882	80,934			136,882	80,934
Russia	99,960	44,413			99,960	44,413
Sweden			2,720	830	2,720	830
				Conservation Limit :	299,760	151,676
				Spawner Escapement Reserve:	379,178	258,346

[1]Norwegian Conservation Limits calculated on data from 1983

	National Model CLs		River Specific CLs		Conservation Limit used	
	1SW	MSW	1SW	MSW	1SW	MSW
Southern Europe						
France			17,400	5,100	17,400	5,100
Ireland	233,924	39,737			233,924	39,737
UK (E&W)			53,000	17,500	53,000	17,500
UK (NI)	16,740	2,321			16,740	2,321
UK (Scot)	189,646	198,277			189,646	198,277
				Conservation Limit :	510,709	262,935
				Spawner Escapement Reserve:	649,239	443,741

Table 3.5.1.1 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	26,165	72,892	0	156,180	17,799	**273,036**	18,752	53,838	1,167,024	104,283	186,687	620,738	**2,132,570**	143,519	**2,405,606**	144,739
1972	41,331	59,938	0	119,175	13,998	**234,442**	14,209	106,342	1,287,901	91,348	162,816	549,751	**2,198,158**	152,296	**2,432,600**	152,958
1973	52,139	65,693	0	175,358	17,496	**310,685**	19,766	65,245	1,377,352	108,016	142,002	650,695	**2,343,310**	166,651	**2,653,995**	167,820
1974	50,275	49,324	0	174,599	24,988	**299,186**	18,634	30,080	1,517,227	134,256	155,855	606,921	**2,444,339**	169,990	**2,743,525**	171,009
1975	72,571	73,349	0	267,484	27,268	**440,671**	29,530	60,247	1,588,861	135,314	127,606	498,772	**2,410,800**	181,595	**2,851,471**	183,980
1976	62,475	60,802	0	186,332	15,222	**324,831**	21,716	54,391	1,116,700	89,156	88,641	432,757	**1,781,645**	127,160	**2,106,476**	129,001
1977	42,058	66,854	0	119,260	7,210	**235,383**	14,580	43,330	983,089	100,053	87,198	445,029	**1,658,699**	114,614	**1,894,082**	115,537
1978	29,959	82,771	0	120,401	8,136	**241,267**	15,193	42,906	880,677	112,866	114,111	506,902	**1,657,462**	105,934	**1,898,729**	107,018
1979	35,928	77,153	0	166,126	8,579	**287,786**	19,635	50,429	781,458	106,035	80,285	411,579	**1,429,786**	95,087	**1,717,572**	97,093
1980	26,619	29,641	0	118,609	11,123	**185,992**	12,598	105,113	609,414	98,534	101,084	262,967	**1,177,113**	76,759	**1,363,104**	77,786
1981	19,115	48,501	0	97,379	20,052	**185,047**	11,540	83,089	566,750	101,815	79,425	330,644	**1,161,723**	71,588	**1,346,770**	72,512
1982	15,759	42,014	0	86,045	17,631	**161,449**	10,044	51,322	746,549	86,334	114,661	462,621	**1,461,488**	92,743	**1,622,936**	93,285
1983	24,508	54,540	703,194	144,018	23,434	**949,694**	63,109	54,381	1,243,061	125,197	161,881	460,704	**2,045,223**	145,547	**2,994,917**	158,640
1984	37,007	31,194	736,416	154,241	32,932	**991,791**	68,391	90,374	670,577	108,577	63,204	491,839	**1,424,571**	89,362	**2,416,362**	112,529
1985	42,088	68,221	743,236	211,954	38,793	**1,104,292**	68,268	33,681	1,125,890	108,679	82,058	411,062	**1,761,370**	128,638	**2,865,662**	145,631
1986	43,705	102,957	645,270	182,156	41,404	**1,015,494**	59,055	61,032	1,163,694	124,676	92,092	514,285	**1,955,780**	142,040	**2,971,273**	153,827
1987	56,891	62,868	547,253	192,379	33,172	**892,563**	50,491	108,018	794,454	128,451	50,145	395,094	**1,476,161**	118,143	**2,368,724**	128,480
1988	34,215	107,246	502,311	132,629	28,114	**804,515**	43,781	38,053	1,307,913	170,681	119,111	601,611	**2,237,369**	166,685	**3,041,885**	172,339
1989	53,619	59,324	556,933	197,570	8,936	**876,381**	53,862	20,231	641,830	111,883	114,938	664,201	**1,553,083**	93,566	**2,429,464**	107,961
1990	48,498	52,146	498,808	163,861	20,216	**783,530**	47,799	33,709	457,198	80,104	94,413	320,789	**986,213**	61,042	**1,769,743**	77,530
1991	50,933	61,535	432,927	139,427	24,150	**708,972**	40,429	25,033	339,820	78,238	52,634	313,587	**809,313**	49,151	**1,518,285**	63,642
1992	64,831	80,296	365,267	173,500	26,905	**710,800**	37,190	44,287	433,418	81,254	107,476	462,579	**1,129,014**	67,803	**1,839,814**	77,333
1993	45,496	74,958	365,736	148,896	28,540	**663,626**	33,342	64,497	432,979	112,502	124,755	408,461	**1,143,194**	68,974	**1,806,820**	76,610
1994	43,681	50,569	497,186	175,383	22,045	**788,864**	46,796	49,663	568,057	122,616	85,748	442,865	**1,268,949**	79,366	**2,057,814**	92,135
1995	36,263	70,814	324,318	157,951	32,086	**621,431**	31,243	15,549	470,013	92,312	79,729	431,182	**1,088,785**	62,313	**1,710,216**	69,707
1996	70,039	54,959	246,289	214,054	19,829	**605,169**	31,076	19,098	496,069	68,743	82,629	316,402	**982,941**	64,247	**1,588,110**	71,368
1997	60,885	46,238	282,353	210,105	8,997	**608,578**	32,348	9,834	382,943	62,271	98,124	226,597	**779,769**	48,237	**1,388,346**	58,079
1998	72,094	67,823	370,548	230,128	7,945	**748,538**	40,112	19,062	492,069	69,647	214,354	307,149	**1,102,282**	66,559	**1,850,820**	77,711
1999	100,560	47,215	343,148	177,997	11,479	**680,399**	34,973	6,422	291,067	61,794	55,421	153,144	**567,848**	37,686	**1,248,247**	51,414
2000	105,958	43,700	563,371	195,225	23,565	**931,819**	51,095	16,549	383,261	91,707	80,475	294,242	**866,233**	51,009	**1,798,052**	72,199
2001	59,431	38,472	491,127	217,286	15,137	**821,453**	45,830	14,006	368,677	82,040	63,541	295,188	**823,451**	42,263	**1,644,904**	62,342
2002	30,733	53,368	298,208	172,350	15,428	**570,087**	31,074	23,004	492,531	73,423	79,421	231,267	**899,646**	75,465	**1,469,733**	81,613
10yr Av.	62,514	54,812	378,228	189,937	18,505	**703,996**	37,789	23,768	437,767	83,705	96,420	310,650	**952,310**	59,612	**1,656,306**	71,318

Table 3.5.1.2 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	24,516	40,172	0	132,767	1,070	**198,525**	11,048	11,313	182,694	97,974	15,684	554,917	**862,581**	68,302	**1,061,106**	69,190
1972	38,573	61,885	0	135,442	751	**236,651**	12,645	22,525	201,478	146,481	13,709	712,673	**1,096,865**	84,802	**1,333,517**	85,740
1973	48,559	56,148	0	223,726	2,617	**331,050**	20,026	13,789	218,418	110,357	11,952	785,238	**1,139,753**	93,616	**1,470,804**	95,734
1974	49,764	50,107	0	211,340	1,702	**312,913**	18,138	6,458	237,672	81,179	13,186	566,723	**905,218**	73,601	**1,218,131**	75,803
1975	70,249	53,876	0	225,829	411	**350,365**	19,873	12,856	249,975	109,833	10,800	611,813	**995,277**	81,925	**1,345,642**	84,301
1976	61,572	45,996	0	195,679	1,227	**304,473**	17,271	9,444	173,753	57,007	7,498	390,271	**637,972**	51,377	**942,445**	54,202
1977	41,045	50,744	0	134,646	927	**227,362**	12,030	7,188	154,087	71,120	7,399	417,519	**657,313**	52,216	**884,675**	53,584
1978	24,761	65,442	0	116,917	712	**207,832**	11,448	7,390	137,231	58,865	9,631	529,731	**742,848**	63,335	**950,681**	64,361
1979	23,318	42,435	0	101,936	2,040	**169,729**	9,773	8,410	122,953	29,019	6,714	401,314	**568,410**	49,846	**738,139**	50,795
1980	23,973	59,619	0	169,563	3,590	**256,744**	15,549	17,444	135,429	92,201	8,521	474,811	**728,405**	56,574	**985,149**	58,672
1981	29,284	32,179	0	97,132	1,046	**159,642**	9,981	12,394	111,392	127,509	6,701	493,646	**751,642**	57,798	**911,284**	58,653
1982	37,600	26,400	0	85,818	3,741	**153,560**	10,206	7,786	39,931	49,193	9,666	413,826	**520,402**	44,846	**673,961**	45,992
1983	43,079	35,505	429,194	124,281	2,596	**634,655**	38,168	8,316	196,197	55,221	13,607	444,490	**717,832**	95,243	**1,352,487**	102,607
1984	40,955	33,290	438,313	124,081	3,603	**640,241**	37,497	13,587	73,895	44,629	5,328	374,866	**512,304**	37,281	**1,152,545**	52,876
1985	38,163	23,378	403,050	136,181	1,512	**602,285**	36,012	10,157	89,442	65,392	6,948	457,817	**629,756**	46,569	**1,232,040**	58,869
1986	26,548	30,869	482,844	134,041	1,465	**675,766**	42,393	10,455	100,914	88,594	7,786	583,709	**791,457**	62,939	**1,467,223**	75,885
1987	33,712	29,849	363,833	100,021	4,348	**531,763**	32,238	5,546	124,298	68,649	3,967	384,311	**586,771**	42,256	**1,118,534**	53,150
1988	23,064	25,512	306,598	99,987	4,213	**459,374**	26,197	15,346	77,472	88,966	11,190	600,284	**793,258**	62,614	**1,252,632**	67,873
1989	30,601	22,353	216,876	97,852	11,686	**379,368**	20,815	6,905	63,370	69,635	8,948	521,074	**669,931**	50,569	**1,049,298**	54,685
1990	29,908	22,761	257,018	125,102	7,643	**442,431**	23,571	6,991	37,031	85,939	8,118	425,849	**563,928**	41,834	**1,006,359**	48,017
1991	38,584	19,726	218,108	122,424	8,788	**407,631**	20,979	6,325	37,259	37,338	4,164	331,739	**416,825**	31,566	**824,455**	37,901
1992	54,472	24,754	235,801	116,596	11,427	**443,049**	23,113	8,180	50,572	28,012	9,532	450,289	**546,585**	40,818	**989,634**	46,908
1993	55,874	18,524	227,318	137,819	15,412	**454,946**	20,857	3,959	54,849	31,080	22,492	369,163	**481,542**	36,899	**936,488**	42,386
1994	57,897	21,241	222,904	123,113	11,373	**436,527**	22,073	7,992	59,140	42,561	7,908	450,620	**568,221**	42,629	**1,004,749**	48,005
1995	47,509	17,714	238,839	139,107	8,002	**451,170**	21,843	3,791	67,891	42,410	6,680	410,448	**531,220**	39,309	**982,391**	44,971
1996	21,530	15,337	239,746	105,131	10,271	**392,016**	20,563	6,698	45,629	43,425	7,470	314,521	**417,743**	32,046	**809,759**	38,076
1997	31,644	12,874	159,739	85,610	6,584	**296,452**	14,837	3,459	59,308	27,222	9,281	218,701	**317,971**	27,167	**614,424**	30,955
1998	26,867	11,702	191,295	105,708	4,830	**340,403**	16,559	2,954	34,072	16,749	12,788	240,512	**307,077**	22,049	**647,480**	27,575
1999	23,894	16,758	206,430	93,567	4,180	**344,830**	18,427	6,394	33,859	37,930	5,761	176,565	**260,508**	20,239	**605,338**	27,371
2000	53,165	6,607	283,825	163,361	9,207	**516,165**	25,173	4,411	63,842	45,779	7,656	231,104	**352,791**	28,030	**868,957**	37,674
2001	78,464	9,099	335,237	90,287	11,035	**524,122**	29,024	5,168	69,398	50,725	5,641	220,461	**351,392**	31,054	**875,514**	42,506
2002	70,930	7,842	290,106	85,797	8,017	**462,692**	27,335	3,194	83,460	45,816	7,622	178,837	**318,930**	26,276	**781,622**	37,916
10yr Av.	46,777	13,770	239,544	112,950	8,891	421,932	21,669	4,802	57,145	38,370	9,330	281,093	390,740	30,570	812,672	37,743

Table 3.5.1.3 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	33,421	92,539	0	201,772	22,829	**350,560**	26,744	68,622	1,489,709	133,095	237,537	783,904	**2,712,866**	200,102	**3,063,426**	201,882
1972	52,712	76,120	0	153,342	17,998	**300,173**	20,114	135,482	1,643,994	116,624	207,256	693,597	**2,796,953**	212,483	**3,097,126**	213,433
1973	66,485	83,449	0	225,661	22,471	**398,066**	28,048	83,151	1,757,992	137,900	180,844	820,826	**2,980,713**	231,492	**3,378,778**	233,185
1974	64,063	62,651	0	223,962	31,967	**382,644**	25,936	38,386	1,935,942	171,221	198,330	765,820	**3,109,698**	233,752	**3,492,341**	235,187
1975	92,462	93,197	0	344,545	34,926	**565,130**	42,579	76,830	2,028,251	172,568	162,467	630,089	**3,070,205**	256,275	**3,635,335**	259,788
1976	79,566	77,227	0	240,000	19,496	**416,288**	30,817	69,364	1,425,454	113,708	112,833	546,984	**2,268,342**	179,426	**2,684,630**	182,053
1977	53,552	84,940	0	153,506	9,259	**301,258**	20,417	55,199	1,254,757	127,528	110,979	562,099	**2,110,562**	159,946	**2,411,820**	161,243
1978	38,158	105,150	0	155,085	10,421	**308,814**	21,531	54,663	1,123,677	143,751	145,164	640,234	**2,107,489**	144,439	**2,416,303**	146,035
1979	45,792	97,994	0	214,166	11,031	**368,982**	27,937	64,259	997,768	135,184	102,213	519,518	**1,818,942**	134,477	**2,187,925**	137,348
1980	34,103	37,655	0	152,852	14,429	**239,039**	18,045	134,018	778,147	125,951	128,901	332,715	**1,499,731**	105,881	**1,738,770**	107,408
1981	24,693	61,605	0	126,086	25,951	**238,335**	16,272	106,147	724,043	130,468	101,588	418,420	**1,480,666**	99,284	**1,719,001**	100,608
1982	20,405	53,350	0	111,110	22,831	**207,696**	14,145	65,606	953,282	110,628	146,321	585,033	**1,860,869**	127,779	**2,068,565**	128,559
1983	31,572	69,275	897,368	185,558	30,284	**1,214,057**	85,680	69,574	1,587,057	160,256	206,444	582,879	**2,606,209**	201,391	**3,820,266**	218,859
1984	47,253	39,624	938,434	198,133	42,201	**1,265,645**	92,572	115,208	856,079	138,564	80,655	621,500	**1,812,007**	122,914	**3,077,651**	153,875
1985	53,700	86,670	946,924	273,273	49,630	**1,410,196**	93,706	43,006	1,437,063	138,641	104,554	519,208	**2,242,472**	179,508	**3,652,668**	202,494
1986	55,789	130,799	822,492	234,505	52,991	**1,296,576**	81,020	77,904	1,485,569	159,137	117,395	649,048	**2,489,053**	197,387	**3,785,630**	213,368
1987	72,504	79,860	697,318	247,941	42,452	**1,140,074**	68,690	137,690	1,014,580	163,892	64,003	499,095	**1,879,259**	162,946	**3,019,334**	176,832
1988	43,707	136,244	640,304	170,525	36,016	**1,026,795**	60,117	48,585	1,669,607	217,754	151,700	760,404	**2,848,049**	230,092	**3,874,844**	237,816
1989	68,317	75,376	709,317	252,557	11,505	**1,117,073**	72,729	25,889	819,024	142,723	146,310	838,739	**1,972,685**	126,976	**3,089,758**	146,330
1990	61,790	66,252	635,272	209,479	25,880	**998,672**	64,917	42,983	583,833	102,160	120,170	405,449	**1,254,595**	85,933	**2,253,267**	107,697
1991	64,834	78,192	551,188	179,256	30,851	**904,321**	55,069	31,873	433,776	99,738	66,997	396,582	**1,028,967**	67,697	**1,933,288**	87,267
1992	82,489	102,012	464,992	221,935	34,341	**905,767**	50,931	56,360	553,043	103,520	136,709	584,445	**1,434,078**	92,585	**2,339,845**	105,669
1993	57,911	95,213	465,550	190,787	36,420	**845,882**	45,806	82,107	552,432	143,295	158,669	515,870	**1,452,373**	92,829	**2,298,255**	103,515
1994	55,569	64,245	632,791	225,606	28,129	**1,006,340**	64,551	63,218	725,034	156,164	109,060	559,102	**1,612,578**	109,361	**2,618,918**	126,991
1995	46,143	89,969	412,873	202,746	40,920	**792,652**	43,427	19,820	599,834	117,635	101,410	544,423	**1,383,123**	86,843	**2,175,774**	97,095
1996	89,129	69,821	313,524	274,875	25,291	**772,640**	43,501	24,313	633,214	87,605	105,094	399,228	**1,249,452**	89,624	**2,022,093**	99,623
1997	77,455	58,752	359,237	269,917	11,462	**776,823**	44,553	12,510	488,744	79,290	124,747	286,047	**991,338**	67,026	**1,768,161**	80,483
1998	91,718	86,194	471,543	296,569	10,128	**956,152**	55,582	24,248	628,034	88,685	272,526	387,528	**1,401,021**	92,178	**2,357,173**	107,639
1999	127,863	59,978	436,801	228,260	14,627	**867,529**	48,327	8,167	371,486	78,657	70,470	193,210	**721,990**	52,383	**1,589,519**	71,270
2000	134,791	55,512	716,856	251,077	30,039	**1,188,276**	69,980	21,066	489,009	116,797	102,312	371,262	**1,100,446**	70,363	**2,288,722**	99,238
2001	75,603	48,861	624,946	277,188	19,298	**1,045,895**	62,922	17,810	470,535	104,462	80,790	372,362	**1,045,958**	61,189	**2,091,853**	87,768
2002	39,081	67,795	379,393	221,032	19,676	**726,977**	42,367	29,286	628,553	93,498	100,950	291,804	**1,144,092**	101,848	**1,871,069**	110,309
10yr Av.	79,526	69,634	481,351	243,806	23,599	**897,917**	52,102	30,255	558,688	106,609	122,603	392,084	**1,210,237**	82,364	**2,108,154**	98,393

Table 3.5.1.4 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	65,186	104,745	0	268,600	6,043	**444,575**	17,328	54,722	438,012	349,357	22,925	1,639,991	**2,505,007**	166,005	**2,949,582**	166,907
1972	81,629	95,083	0	432,298	9,012	**618,020**	18,790	35,272	441,419	260,963	19,995	1,653,550	**2,411,199**	191,938	**3,029,220**	192,856
1973	83,532	84,761	0	401,647	6,479	**576,419**	18,419	21,895	466,003	203,680	22,046	1,247,309	**1,960,934**	143,115	**2,537,352**	144,295
1974	117,827	91,176	0	432,574	4,773	**646,350**	24,716	32,155	485,032	251,281	18,064	1,318,100	**2,104,632**	160,740	**2,750,982**	162,629
1975	103,323	77,830	0	370,951	5,502	**557,606**	21,132	28,685	366,979	171,277	12,537	986,290	**1,565,768**	104,707	**2,123,375**	106,818
1976	68,927	85,411	0	255,386	3,817	**413,542**	16,074	19,724	304,338	166,641	12,374	904,754	**1,407,831**	103,559	**1,821,373**	104,800
1977	41,745	109,915	0	220,943	3,225	**375,830**	13,988	21,156	280,829	151,190	16,115	1,118,616	**1,587,905**	125,612	**1,963,735**	126,389
1978	39,186	71,560	0	199,417	5,819	**315,982**	11,490	19,689	241,465	82,701	11,222	831,209	**1,186,286**	101,312	**1,502,268**	101,961
1979	40,389	101,054	0	345,015	11,491	**497,949**	13,658	37,504	283,732	209,370	14,243	1,043,919	**1,588,769**	116,536	**2,086,718**	117,334
1980	49,306	56,023	0	236,846	10,227	**352,402**	13,311	28,444	247,788	270,267	11,206	1,086,426	**1,644,132**	115,334	**1,996,534**	116,100
1981	63,092	46,211	0	212,526	14,177	**336,006**	15,884	19,540	120,029	127,950	16,159	918,922	**1,202,600**	95,215	**1,538,607**	96,531
1982	72,263	61,012	0	269,289	10,595	**413,159**	18,199	19,187	372,441	129,909	22,740	928,019	**1,472,295**	173,075	**1,885,454**	174,030
1983	68,615	56,729	802,431	254,435	10,231	**1,192,442**	76,023	25,199	146,857	94,146	8,912	726,800	**1,001,915**	74,462	**2,194,357**	106,415
1984	63,896	40,162	743,493	278,649	6,721	**1,132,921**	68,712	18,937	170,428	127,506	11,612	856,872	**1,185,355**	92,072	**2,318,276**	114,885
1985	44,632	52,873	885,993	277,763	7,370	**1,268,630**	83,372	23,475	212,637	190,259	13,016	1,170,846	**1,610,232**	126,810	**2,878,863**	151,762
1986	56,560	51,140	684,804	214,788	12,057	**1,019,349**	64,384	14,682	248,571	152,562	6,634	816,905	**1,239,354**	85,553	**2,258,702**	107,073
1987	38,772	43,409	556,797	199,826	9,942	**848,745**	52,306	30,742	163,057	183,370	18,708	1,157,607	**1,553,484**	119,848	**2,402,229**	130,764
1988	51,394	38,355	419,872	200,966	23,335	**733,921**	40,469	17,912	148,380	158,355	14,956	1,061,430	**1,401,032**	99,730	**2,134,954**	107,628
1989	50,100	38,869	482,059	250,397	16,011	**837,436**	47,115	13,787	80,751	162,807	13,567	797,901	**1,068,812**	84,148	**1,906,248**	96,440
1990	64,605	33,321	387,050	231,498	16,121	**732,596**	41,263	11,655	71,465	71,530	6,961	599,200	**760,811**	62,093	**1,493,407**	74,553
1991	91,186	41,592	405,753	215,620	20,046	**774,197**	45,077	16,326	100,610	63,380	15,934	831,918	**1,028,167**	81,914	**1,802,365**	93,498
1992	93,524	31,130	390,286	254,370	26,576	**795,886**	42,286	8,470	103,498	64,363	37,595	675,443	**889,369**	74,175	**1,685,255**	85,382
1993	96,826	35,616	382,306	228,107	19,677	**762,532**	42,254	13,440	100,961	74,223	13,217	772,039	**973,881**	90,568	**1,736,412**	99,940
1994	79,488	29,762	410,021	258,625	14,098	**791,994**	42,814	6,385	115,896	74,168	11,169	704,571	**912,189**	83,302	**1,704,183**	93,660
1995	36,055	25,786	411,211	196,324	17,889	**687,265**	40,202	11,655	80,468	77,972	12,495	550,095	**732,685**	66,041	**1,419,950**	77,315
1996	52,968	21,529	268,118	156,225	11,129	**509,969**	29,071	6,172	101,880	49,057	15,510	381,115	**553,733**	53,434	**1,063,702**	60,830
1997	44,908	19,563	320,303	193,547	8,161	**586,482**	32,260	5,090	58,082	29,690	21,380	412,174	**526,416**	44,109	**1,112,898**	54,647
1998	39,975	28,001	345,641	170,314	7,030	**590,960**	37,169	10,767	57,153	65,805	9,628	301,635	**444,988**	37,791	**1,035,947**	53,006
1999	88,968	11,046	475,242	298,260	15,505	**889,021**	48,963	7,442	107,645	79,476	12,803	394,357	**601,723**	46,131	**1,490,744**	67,271
2000	131,172	15,208	560,779	163,243	18,562	**888,964**	57,940	8,839	117,653	88,612	9,433	379,267	**603,804**	47,580	**1,492,767**	74,973
2001	118,669	13,106	485,199	309,882	13,493	**940,349**	52,622	5,568	141,565	80,367	12,740	306,698	**546,939**	40,870	**1,487,288**	66,629
10yr Av.	78,255	23,075	404,911	222,890	15,212	**744,342**	42,558	8,383	98,480	68,373	15,597	487,739	**678,573**	58,400	**1,422,915**	73,365

Table 3.5.1.5 Estimated number of 1SW SPAWNERS by NEAC country and year

Year	Northern Europe							Southern Europe						
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total	
						Est.	SD						Est.	SD
1971	13,204	36,941	109,661	43,524	8,631	**175,019**	18,466	52,098	403,629	56,842	37,483	260,012	**810,063**	130,905
1972	20,997	30,297	127,624	72,769	6,759	**228,149**	13,974	102,862	445,486	50,726	32,741	205,974	**837,789**	138,003
1973	26,423	33,358	126,613	79,064	8,545	**240,645**	19,489	63,115	474,092	60,565	28,504	250,705	**876,981**	151,671
1974	25,307	24,816	120,852	94,384	12,060	**252,602**	18,110	29,090	527,004	75,201	31,305	209,133	**871,733**	152,579
1975	37,054	37,045	120,751	113,088	13,276	**284,169**	29,033	58,267	552,329	75,612	25,534	191,033	**902,775**	166,113
1976	31,501	30,781	113,886	110,280	7,399	**263,066**	21,488	52,571	385,833	48,679	17,818	172,211	**677,113**	115,154
1977	21,407	33,790	117,567	75,260	3,508	**217,743**	14,485	41,930	341,614	54,017	17,421	175,716	**630,699**	104,346
1978	15,296	42,018	96,659	59,477	3,921	**175,353**	15,102	41,471	304,939	61,513	22,908	222,560	**653,392**	96,235
1979	18,363	39,220	179,330	75,468	4,127	**277,288**	19,549	48,784	269,018	58,392	16,217	155,055	**547,466**	86,489
1980	13,520	15,002	126,944	73,949	5,443	**219,856**	12,433	101,683	210,983	53,672	20,315	111,720	**498,373**	71,416
1981	9,704	24,603	126,535	53,916	9,781	**199,936**	11,027	80,369	288,778	55,535	16,015	143,996	**584,693**	68,234
1982	7,959	21,259	99,845	49,917	8,551	**166,272**	9,531	49,642	249,431	46,888	22,948	204,123	**573,033**	85,150
1983	12,396	27,633	164,139	65,518	11,427	**253,480**	49,331	52,581	435,061	67,795	32,707	199,524	**787,668**	133,559
1984	18,824	15,792	167,925	81,190	16,007	**283,945**	52,071	87,414	280,526	57,983	12,724	226,514	**665,160**	84,129
1985	21,255	34,609	173,692	93,517	18,755	**307,218**	53,668	32,581	323,956	58,113	16,445	214,751	**645,846**	114,674
1986	22,123	52,211	153,626	103,628	20,230	**299,608**	46,988	57,632	363,257	66,820	18,375	264,157	**770,240**	130,240
1987	28,765	31,789	130,905	96,262	16,018	**271,949**	40,823	102,018	278,814	68,960	15,649	190,628	**656,068**	109,610
1988	17,332	54,374	121,293	87,451	13,686	**239,762**	34,479	35,953	499,084	91,455	42,576	415,180	**1,084,249**	151,875
1989	21,675	30,017	191,430	96,788	4,325	**314,218**	46,405	19,131	204,560	59,772	13,144	465,504	**762,112**	85,521
1990	19,646	26,291	171,998	97,490	11,398	**300,531**	41,597	31,809	164,104	42,528	36,049	228,096	**502,585**	55,741
1991	20,735	31,318	147,725	83,595	13,517	**265,572**	34,820	23,633	137,218	42,191	18,757	228,960	**450,759**	46,074
1992	26,207	40,503	124,156	116,904	15,248	**282,514**	32,842	41,787	117,370	43,934	47,705	346,373	**597,168**	62,200
1993	18,497	38,050	122,888	114,664	16,102	**272,151**	29,649	60,897	182,329	63,695	73,674	300,237	**680,831**	66,004
1994	17,583	25,667	172,332	116,615	12,542	**319,072**	41,814	46,863	209,330	69,243	25,816	329,664	**680,916**	74,151
1995	14,672	35,963	110,918	121,889	20,577	**268,056**	28,104	13,880	106,056	54,668	26,537	328,846	**529,987**	55,432
1996	35,443	27,812	82,637	138,880	12,715	**269,675**	29,354	17,035	186,801	41,888	35,954	241,248	**522,927**	59,302
1997	30,780	23,369	105,198	159,070	5,745	**300,793**	30,910	8,774	122,890	39,841	39,752	173,188	**384,444**	43,684
1998	36,757	34,356	140,436	162,962	5,092	**345,247**	38,109	16,997	198,361	45,885	161,398	246,524	**669,165**	62,434
1999	40,934	23,978	128,855	163,078	7,244	**340,112**	32,782	5,732	67,130	43,980	20,545	124,495	**261,882**	33,304
2000	42,591	22,174	213,817	142,222	15,166	**413,796**	47,096	14,757	100,106	64,821	33,890	244,361	**457,934**	45,943
2001	24,054	19,530	189,568	167,997	9,657	**391,276**	42,614	12,462	97,745	60,282	31,870	247,022	**449,381**	42,015
2002	12,452	26,953	112,579	134,191	9,841	**269,062**	29,493	20,494	239,108	53,312	36,286	196,588	**545,786**	73,669
10yr.av.	27,376	27,785	137,923	142,157	11,468	**318,924**	34,993	21,789	150,986	53,761	48,572	243,217	**518,325**	55,594

Table 3.5.1.6 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
1971	11,360	16,321	66,568	14,495	462	**92,883**	11,008	7,253	97,748	59,449	7,871	332,330	**504,651**	66,387	**613,856**	67,293
1972	17,992	25,089	91,895	59,014	324	**169,225**	12,591	14,405	107,959	89,777	6,867	412,130	**631,137**	82,103	**825,451**	83,063
1973	22,441	22,622	104,772	66,760	1,135	**195,107**	19,968	8,819	118,365	67,889	5,979	458,352	**659,405**	90,625	**877,134**	92,798
1974	23,134	20,324	100,094	99,510	745	**223,482**	18,068	4,148	127,524	50,029	6,616	307,340	**495,657**	71,044	**739,462**	73,306
1975	32,425	21,835	84,471	87,625	180	**204,702**	19,773	8,236	135,177	67,394	5,428	328,615	**544,849**	79,225	**771,385**	81,655
1976	28,534	18,715	87,598	87,079	530	**203,741**	17,184	6,064	92,516	34,564	3,764	232,247	**369,155**	50,019	**591,610**	52,889
1977	19,073	20,589	87,029	72,197	404	**178,703**	11,973	4,588	82,783	42,655	3,730	226,802	**360,559**	50,342	**559,851**	51,746
1978	11,453	26,475	57,746	50,870	312	**120,381**	11,420	4,725	73,422	35,621	4,837	306,240	**424,845**	61,360	**571,702**	62,413
1979	13,179	17,188	109,737	45,182	880	**168,978**	9,744	5,355	66,015	17,842	3,356	220,184	**312,753**	48,150	**498,919**	49,126
1980	13,638	24,270	125,299	48,170	1,570	**188,677**	15,522	11,074	72,184	55,830	4,280	261,558	**404,926**	55,391	**617,872**	57,525
1981	16,613	13,048	110,297	66,480	457	**193,848**	9,959	8,314	59,637	76,672	3,369	278,310	**426,302**	56,592	**633,197**	57,462
1982	21,383	10,723	91,420	41,106	1,622	**155,531**	10,175	5,266	20,025	29,552	4,843	255,471	**315,157**	44,218	**481,410**	45,374
1983	24,340	14,434	102,565	49,524	1,135	**177,565**	30,188	5,616	148,929	33,063	6,825	263,687	**458,120**	94,802	**650,120**	99,492
1984	23,417	13,524	103,960	62,184	1,558	**191,119**	29,739	9,147	42,044	26,625	2,669	241,927	**322,412**	36,700	**527,055**	47,237
1985	21,697	9,491	94,545	51,529	655	**168,426**	28,854	6,827	58,012	39,004	3,485	315,372	**422,700**	46,021	**600,617**	54,318
1986	15,095	12,512	114,198	53,055	635	**182,983**	33,527	7,055	55,230	53,087	3,901	399,644	**518,916**	62,212	**714,410**	70,671
1987	19,041	12,111	88,544	53,605	1,874	**163,065**	25,885	3,746	84,703	40,759	2,146	255,128	**386,482**	41,653	**561,657**	49,041
1988	13,085	10,305	74,081	45,282	1,815	**134,263**	20,890	10,346	33,383	53,293	7,181	460,340	**564,542**	62,108	**709,110**	65,527
1989	14,231	9,065	74,731	51,140	5,017	**145,120**	18,183	4,605	27,560	41,514	3,587	403,025	**480,290**	50,322	**634,475**	53,507
1990	13,867	9,234	88,385	48,591	3,937	**154,781**	20,272	4,691	13,081	51,198	5,048	326,239	**400,257**	41,592	**564,272**	46,269
1991	17,927	8,007	74,131	60,597	4,498	**157,154**	18,478	4,225	20,840	22,552	2,379	257,656	**307,652**	31,448	**472,813**	36,475
1992	25,427	10,076	80,895	58,506	5,917	**170,744**	20,468	5,480	24,807	16,827	6,397	356,018	**409,529**	40,671	**590,350**	45,531
1993	25,869	7,475	75,828	55,811	7,929	**165,438**	18,857	2,659	34,405	19,612	19,801	287,840	**364,317**	36,781	**537,231**	41,333
1994	26,928	8,594	74,931	65,458	5,879	**173,196**	20,296	5,692	29,921	26,603	4,757	354,051	**421,024**	42,481	**602,814**	47,080
1995	22,087	7,218	81,410	64,905	4,734	**173,136**	19,847	2,696	38,293	27,750	3,881	321,923	**394,542**	39,158	**574,896**	43,901
1996	12,191	6,186	80,867	63,342	6,081	**162,482**	18,408	4,756	20,524	28,969	5,015	249,031	**308,294**	31,930	**476,962**	36,856
1997	17,999	5,218	58,001	52,929	3,857	**132,785**	13,761	2,458	40,691	18,918	6,212	172,985	**241,263**	27,129	**379,266**	30,420
1998	15,233	4,747	69,612	42,092	2,816	**129,753**	15,197	2,108	12,990	11,886	10,003	195,899	**232,886**	22,004	**367,386**	26,742
1999	12,094	6,771	73,398	54,321	2,446	**142,259**	16,710	4,563	17,827	30,301	3,927	141,936	**198,553**	20,206	**347,583**	26,221
2000	26,934	2,686	103,475	59,019	5,417	**194,845**	23,172	3,134	43,586	38,625	5,208	189,562	**280,115**	27,996	**477,646**	36,342
2001	40,096	3,696	123,922	90,200	6,495	**260,713**	26,671	3,679	47,335	43,471	3,970	181,009	**279,463**	31,032	**543,873**	40,918
2002	36,080	3,176	107,633	75,405	4,687	**223,805**	25,394	2,092	62,819	39,108	5,354	148,351	**257,724**	26,261	**484,704**	36,530
10yr.av.	23,551	5,577	84,908	62,348	5,034	**175,841**	19,831	3,384	34,839	28,524	6,813	224,259	**297,818**	30,498	**479,236**	36,634

Table 3.5.2.1. Southern NEAC data used to fit Model 2.

Year	Eggs	PFA non-maturing
1977	5169363	1587905
1978	5088304	1186286
1979	4693474	1588769
1980	3855084	1644132
1981	3400569	1202600
1982	3401872	1472295
1983	3329957	1001915
1984	3221789	1185355
1985	3276919	1610232
1986	3131179	1239354
1987	3960293	1553484
1988	3386262	1401032
1989	3619099	1068812
1990	4121259	760811.2
1991	4125306	1028167
1992	4543234	889369.2
1993	4393550	973880.7
1994	3602204	912189.1
1995	3023640	732684.9
1996	3243208	553732.8
1997	3587644	526416.4
1998	3474276	444987.5
1999	3382478	601723.2
2000	2991141	603803.6
2001	2538619	546938.8
2002	2480898	-
2003	2020357	-

Table 3.5.2.2 Predictions and 95% bootstrap confidence limits (thousands) of *PFA non-m* using Model 2.

Year	Egg Numbers	Prediction	Lower limit	Upper limit
2002	2481	537	345	847
2003	2020	524	315	840

Table 3.5.2.3. Northern NEAC data used to fit Model 3.

Year	SST	Eggs	PFA mature	PFA immature
1977	-	-	1,032,178	878,720
1978	-	-	905,074	1,231,937
1979	-	2,293,293	1,482,010	1,615,901
1980	-	2,370,945	1,012,907	1,398,799
1981	-	2,343,301	1,009,079	1,212,160
1982	6.71	2,147,198	814,640	1,236,230
1983	6.73	1,803,297	1,206,970	1,189,529
1984	6.74	1,814,200	1,244,888	1,133,716
1985	6.95	1,888,311	1,399,276	1,270,229
1986	6.48	1,913,018	1,280,650	1,015,643
1987	6.89	1,724,616	1,122,800	845,943
1988	7.06	1,620,814	1,009,838	730,935
1989	7.49	1,746,818	1,112,747	838,175
1990	7.63	1,822,182	989,836	728,414
1991	7.02	1,858,662	893,680	741,995
1992	7.35	1,781,856	915,222	763,396
1993	6.95	1,559,622	837,792	719,927
1994	6.47	1,450,367	996,955	752,677
1995	6.84	1,464,338	779,271	673,754
1996	7.21	1,538,926	763,657	495,569
1997	7.27	1,623,042	768,041	577,084
1998	7.85	1,602,155	948,603	582,724
1999	6.99	1,705,543	859,789	865,921
2000	7.25	1,665,728	1,166,274	874,134
2001	7.15	1,549,842	1,030,205	-
2002	7.13*	1,502,368	1,018,756*	-

* Estimated values (average of previous 3 years)

Table 3.5.2.4 Predictions and 95% bootstrap confidence limits (thousands) of *PFA non-m* used to fit Model 3.

Year	*PFA m* ($\times 10^3$)	SST	Prediction	Lower limit	Upper limit
2001	1030	7.15	736	580	936
2002	1019	7.13	712	559	907

Table 3.6.1. Percentage change in gear units over the period 1997-2002 for countries where such data are available (excludes rod fisheries).

Country	Type of gear units	% Change in gear units from 1997 to 2002
Russia	Coastal nets In-river nets	-7 -74
Norway	Bag net Bend net	-17 -15
UK (England & Wales)	Gill net Sweep net Hand-held net Fixed engine	-19 -35 -39 -3
UK (Scotland)	Fixed engine Net and coble	-54 -59
UK (N. Ireland)	Drift net Draft net Bag nets and boxes	-9 -25 -67
Ireland	Drift net Draft net Other nets	+4 +2 -8
France	Commercial nets in freshwater Commercial nets in estuary	+20 -37

TABLE OF CONTENTS

Section **Page**

Table 3.7.1.1. Cruises with surface trawling (flotation on trawl wings), captures of post-smolts and older salmon and smolt catch per unit of effort (CPUE, trawl hours) in 2002 and summary of catches, 1990 – 2001.

Year and Cruise	Gear	Dates	Total number of surface hauls	% hauls with post-smolt captures	Number of post-smolts captured	Number of salmon captured	Mean CPUE Post-smolts	Area surveyed
2002-1	*Åkra trawl*[A]	*16.05- 28.05*	*29 (47)*	*0*	*0*	*4*	*	*Northern Norwegian Sea 68.3-74.3°N; 9.2 – 18.5°E*
2002- 2[SS]	*Smolt trawl*[B]*; Fish lift*	*19.05-29.05*[SS]	*20*	*45*	*310*	*2*	*9.22*	*The Sognefjorden (Salmon lice investigations) 61.05 – 61.15°N; 4.9- 6°E*
2002- 3[SS]	*Salmon trawl* [C]*; Fish lift*	*22.5 - 05.06*[SS]	*54*	*39*	*248*	*21*	*2.44*	*Mid Norwegian coast- west of the mid-Norwegian shelf edge (63.4-65.4°N; 9.0-11.1°E*
2002- 4[SS]	3.8.1 Salmon trawl [C]; Fish lift	*20.06- 05.07*[SS]	*64*	*47*	*590*	*17*	*10.51*	*Norwegian Sea east (Norway's EEZ and International zone, mackerel by-catch investigations) , 66 – 69.7°N; 1°W- 17.4°E*
2002- 5	*Harstad trawl, 10* [D]	*09.06- 04.07*	*47 (49)*	*4*	*2*	*5*	*0.09*	*Barents Sea, 70.2-71.9°N;19.1- 32.0°E*
2002- 6	*Åkra trawl*	*28.07 – 13.08*	*24 (54)*	*17*	*9*	*2*	*0.81*	*Norwegian Sea (north east), Barents Sea (west), 63.1 – 77.5°N; 2°W – 17.00°E*
2002-7	*0-group surface trawl, 10* [E]	*24.08 – 07.09*	*55 (59)*	*2*	*1*	*0*	*0.04*	Norwegian Sea North, 70.9- 79.9°N; 3.5 – 21.4°E
		TOTAL 2002	***291***		***1160***	***51***		
		1990 - 2001	***2147***		***3004***	***120***		
	TOTAL	1990 - 2002	2438		4164	171		

* CPUE for post-smolts not calculated, only salmon captured. Area surveyed and timing of cruise was far out of range for likelihood of post-smolt occurrence
(..) total nr of trawl hauls deeper hauls included
[A] Dimensions of the Åkra trawl opening 25 x 25 m
[B] Dimensions of the trawl opening 12 x 25 m
[C] Dimensions of trawl opening 14 x 20
[D] Dimensions of the trawl opening 18 x 18 m
[E] Dimensions of the trawl opening 10 x 10 m
[SS] Cruises dedicated to salmon investigations

Table 3.7.1.2. Catch numbers, weight and catch per unit of effort (CPUE, trawl hours) of post-smolts and mackerel in the international area of the Norwegian Sea, 21st June – 01st July 2002.

Fished area	Date, **YYMMDD**	Tow time Hrs	Station no.	*Mackerel* *Catch, kg*	CPUE, kg h^{-1}	*Post-smolts* Catch, no.	CPUE, No. h^{-1}	No. per CPUE of mackerel
Internat. zone	020622	2.0	235	61.1	31.31	49	25.13	1.56
- " -	020622	2.0	236	293.4	146.70	133	66.50	0.91
- " -	020622	2.1	237	272.0	131.61	40	19.35	0.30
- " -	020623	1.0	238	14.0	14.18	2	2.00	0.14
- " -	020623	1.0	239	1,152.0	1,152.00	11	11.00	0.01
- " -	020623	1.0	241	272.0	276.61	0	0.00	0.00
- " -	020623	1.0	242	92.0	92.00	6	6.00	0.07
- " -	020623	1.0	243	858.0	858.00	86	86.00	0.10
- " -	020624	0.9	244	95.7	106.33	29	32.22	0.27
- " -	020624	1.0	245	1,100.0	1,100.00	18	18.00	0.02
- " -	020624	1.0	247	14.9	14.86	0	0.00	0.00
- " -	020625	1.0	249	96.5	96.50	0	0.00	0.00
- " -	020625	1.3	252	195.0	153.95	0	0.00	0.00
- " -	020625	1.1	253	1,386.0	1,320.00	11	10.48	0.01
- " -	020626	1.0	254	1,000.0	1,000.00	0	0.00	0.00
- " -	020626	1.0	255	92.6	94.17	0	0.00	0.00
- " -	020626	1.1	256	95.0	87.69	1	0.92	0.01
- " -	020626	1.2	257	45.2	36.62	10	8.11	0.27
- " -	020626	1.2	258	66.5	57.83	6	5.22	0.10
- " -	020627	0.9	260	320.0	342.86	0	0.00	0.00
- " -	020627	1.0	261	1,330.0	1,330.00	3	3.00	0.00
- " -	020628	1.0	268	2,300.0	2,300.00	0	0.00	0.00
- " -	020629	0.5	271	198.0	396.00	0	0.00	0.00
- " -	020629	0.6	272	81.0	142.94	0	0.00	0.00
- " -	020629	1.0	274	198.0	198.00	1	1.00	0.01
- " -	020629	1.0	275	530.0	530.00	1	1.00	0.00
- " -	020629	1.0	276	640.0	640.00	0	0.00	0.00
- " -	020630	0.5	277	2,200.0	4,400.00	0	0.00	0.00
- " -	020630	0.5	278	480.0	929.03	0	0.00	0.00
- " -	020630	1.0	279	560.0	560.00	0	0.00	0.00
- " -	020701	1.0	280	190.0	190.00	14	14.00	0.07
- " -	020701	1.0	282	120.0	120.00	10	10.00	0.08
Internat. zone, Sum		33.7	32	16,348.9	Mean, 589.04	431	Mean, 10.00	Mean, 0.12

Ratio of total no of post-smolts captured per total catch of mackerel = 0.026
Mean number of post-smolts per haul = 13.47

Table 3.7.1.2. contd. Catch numbers, weight and catch per unit of effort (CPUE, trawl hours) of post-smolts and mackerel in the Norwegian EEZ of the Norwegian Sea, 21st June – 01st July 2002.

Fished area	Date YYMMDD	Tow time hours	Station no.	*Mackerel* Catch, kg	CPUE, kg h^{-1}	*Post-smolts* Catch, no.	CPUE, no. h^{-1}	No. per CPUE of mackerel
Norw. EEZ	020621	2.0	234	24.4	12.21	36	18.00	2.95
- " -	020624	1.0	246	264.0	264.00	47	47.00	0.18
- " -	020624	1.0	248	759.0	759.00	5	5.00	0.01
- " -	020625	1.0	250	280.5	275.90	2	1.97	0.01
- " -	020625	1.0	251	95.5	93.93	9	8.85	0.10
- " -	020627	1.0	262	27.6	27.56	20	20.00	0.73
- " -	020627	1.0	263	363.0	363.00	4	4.00	0.01
- " -	020628	1.0	265	231.0	231.00	8	8.00	0.03
- " -	020628	1.0	266	39.3	39.34	12	12.00	0.31
- " -	020628	1.0	267	185.0	185.00	13	13.00	0.07
- " -	020628	1.5	269	429.0	286.00	1	0.67	0.00
	020629	0.5	273	78.5	151.94	2	3.87	0.01
Norw. EEZ, Sum		13.0	12	2,776.8	Mean, 224.07	159	Mean, 11.86	Mean, 0.37
Total fished area		46.7	44	19,125.7	Mean, 89.50	590	Mean, 10.51	Mean, 0.14

Ratio of total no of post-smolts captured per total catch of mackerel = 0.057
Mean number of post-smolts per haul= 13.25

Table 3.7.2.1. Ratio between post-smolts and mackerel in Norwegian research trawl captures in the Norwegian Sea

Year	**Norwegian zone** Total ratio	Unwght. mean	**International zone** Total ratio	Unwght. mean
2001	0.016	0.025	-	-
2002	0.057	0.370	0.026	0.120

Table 3.7.2.2. Details of the screening of catches from the Russian mackerel fishery in the Norwegian Sea in June-August 2002.

Month	Number of hauls		Catch, t					
	Total	Screened	Total*		In screened hauls			
			All species	Mackerel	All species	Mackerel	Post-smolts, indiv.	Salmon, indiv.
June	232	46 (5 vessels)	2,344	2,135	289	245	3	3
July	2897	595 (20 vessels)	35,744	29,802	5,683	4,156	9	9
August	1222	429 (14 vessels)	14,334	7,509	4,940	3,359	0	3
Total	4351	1070 (20 vessels)	52,422	39,446	10,912	7,760	12	15

* Provisional figures

Figure 3.2.3.1 Overview of effort as reported for various fisheries and countries 1971-2002 in the Northern NEAC area.

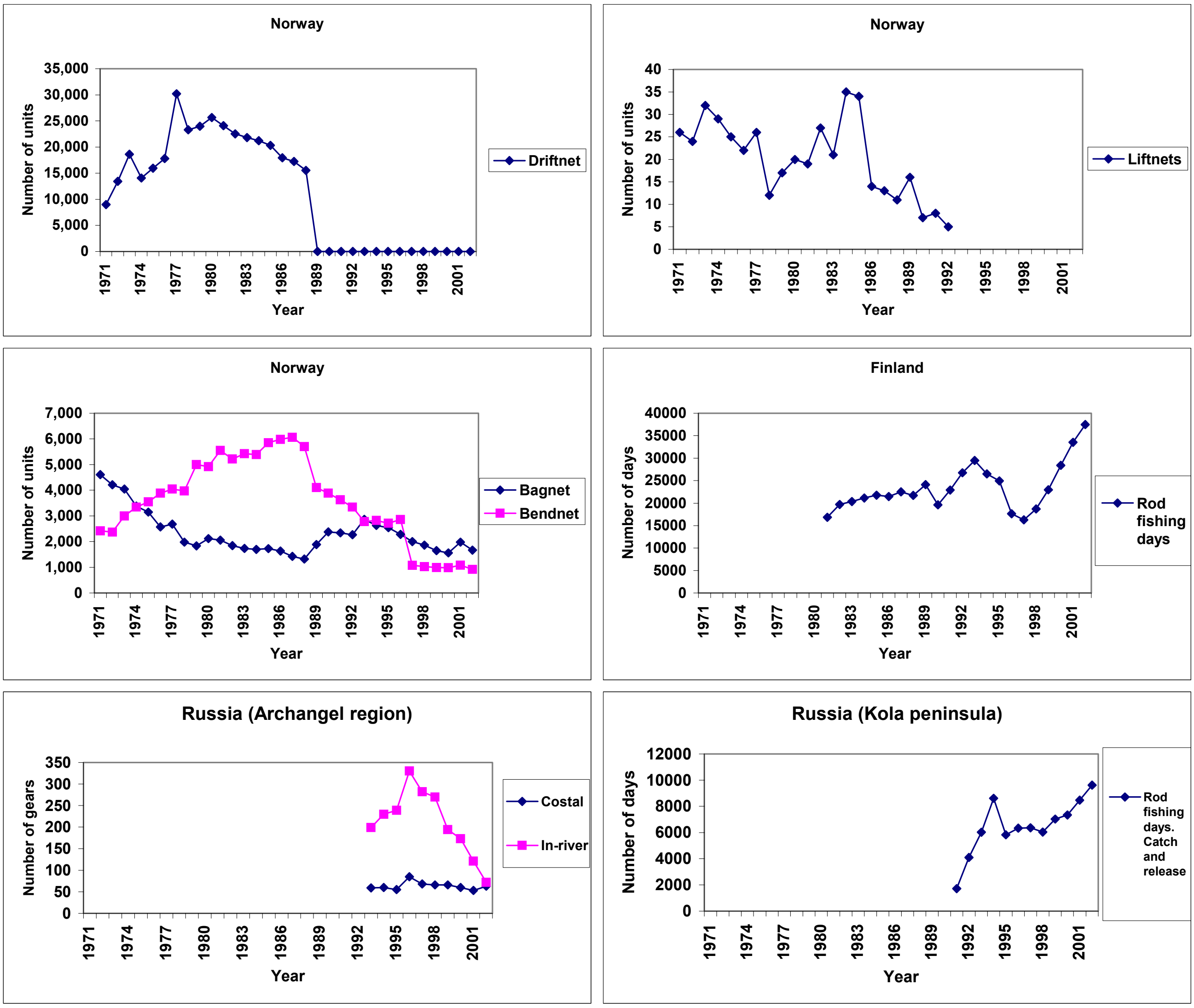


Figure 3.2.4.1 Nominal catches of salmon and 5-year running mean in the Southern and Northern NEAC areas, 1971-2002

Figure 3.2.3.2 Overview of effort as reported for various fisheries and countries 1971-2002 in the Southern NEAC area.

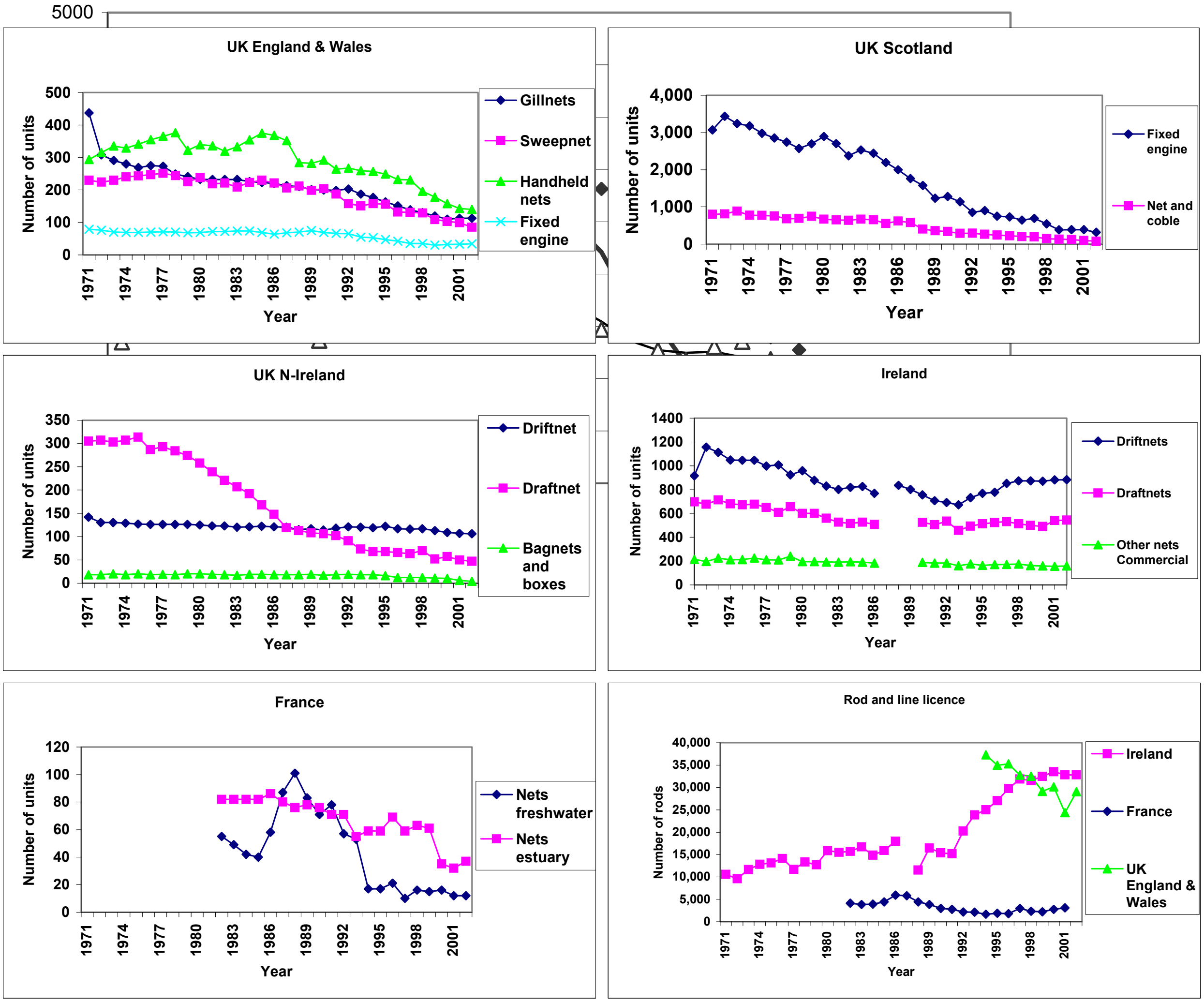
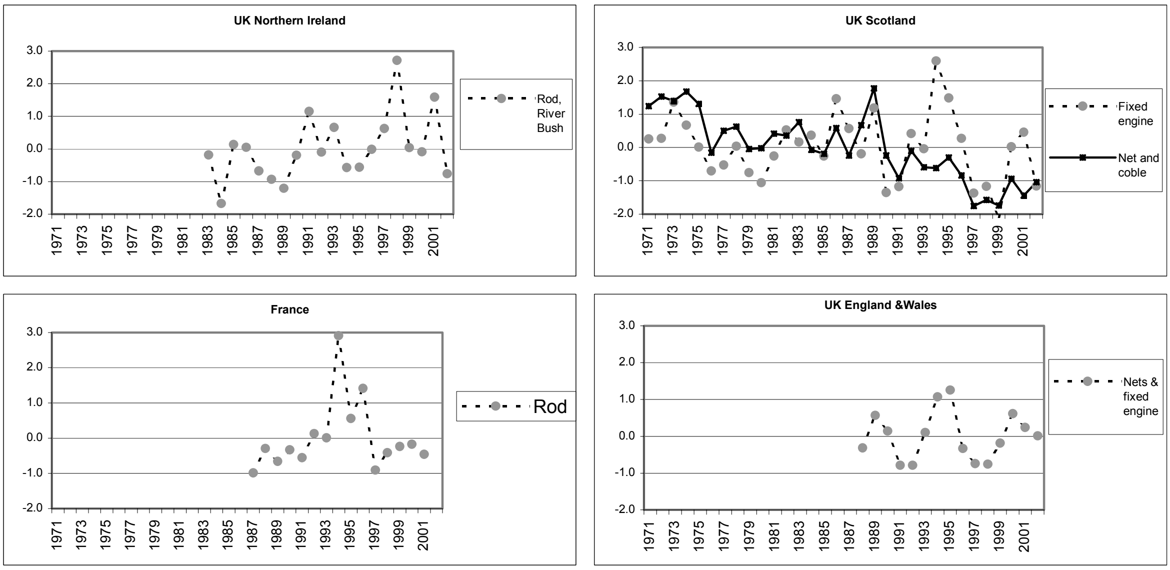


Fig. 3.2.5.1. CPUE indices in various fisheries of the NEAC countries. Vertical axes represent standardized (Z-score) index values, or averages of several series, relative to the average of the time series (0.0).

Southern NEAC area



Northern NEAC area

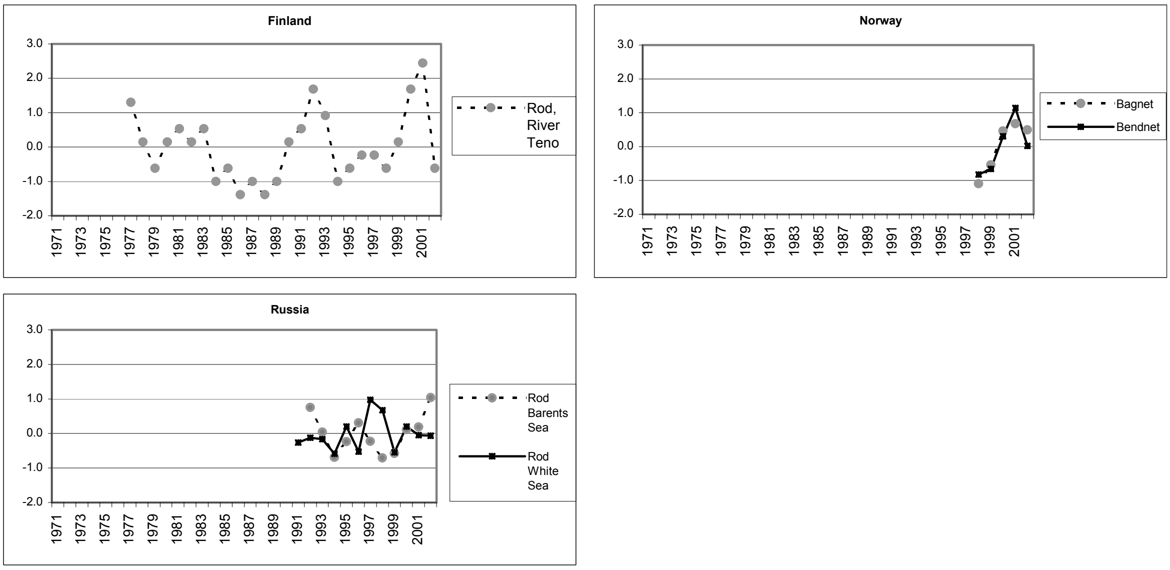


Figure 3.2.6.1. Percentage of 1 SW salmon in the reported catch of the Northern countries of the NEAC area (1987-2002).

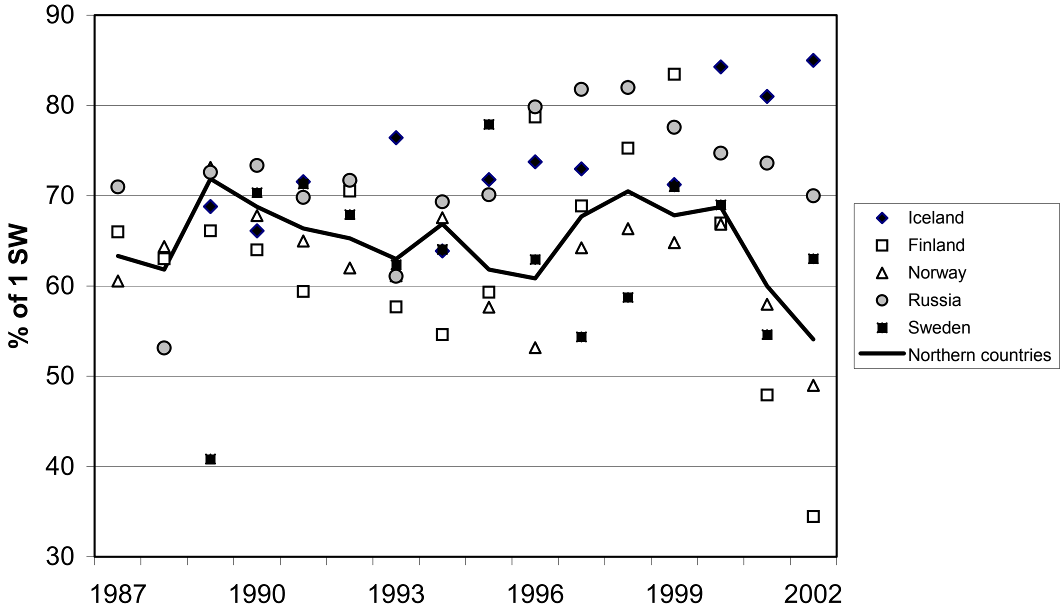


Figure 3.2.6.2. Percentage of 1 SW salmon in the reported catch of the Southern countries of the NEAC area (1987-2002).

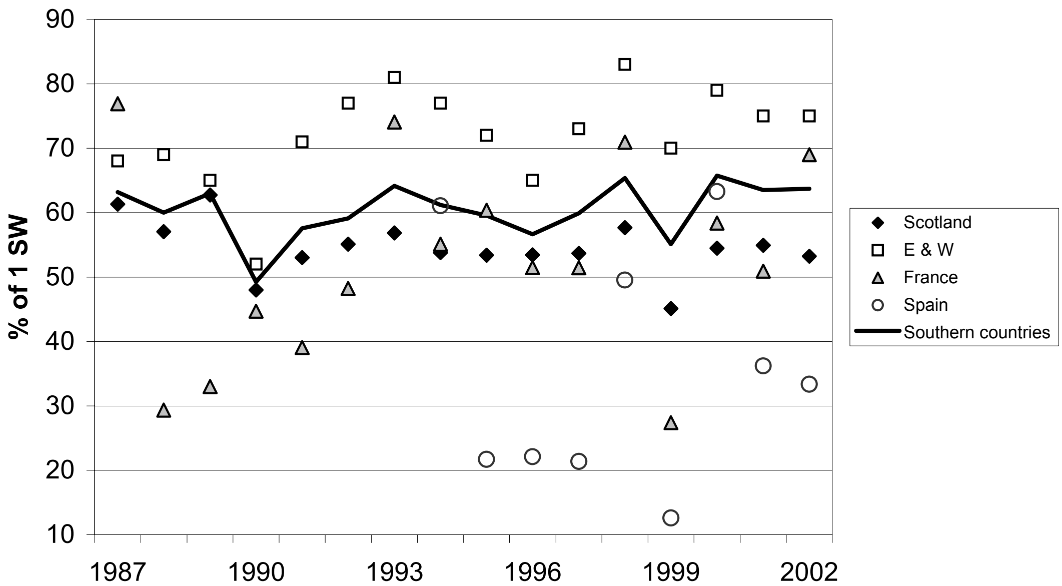


Fig. 3.3.1.1. An overview of the estimated survival indices of wild and hatchery smolts to adult returns to homewaters (prior to coastal fisheries) in Northern and Southern NEAC area.
Index values represent averages of standardized (Z-score) survival estimates for monitored rivers and experimental facilities, and are relative to the average of the time series (0).
The number of rivers included are indicated in each panel legend.Years refer to smolt cohorts.

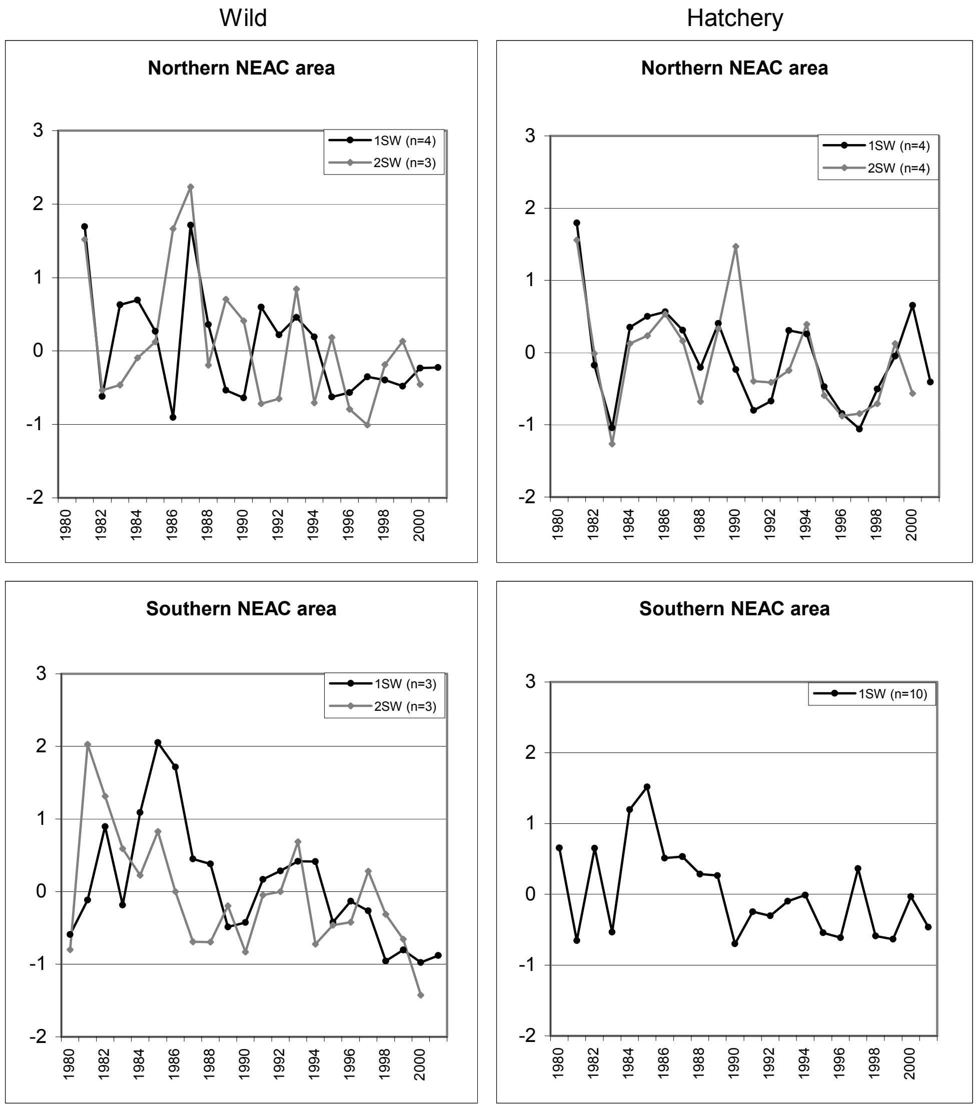


Figure 3.3.4.1a
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
Finland (R. Teno, including Norwegian R. Teno catch)

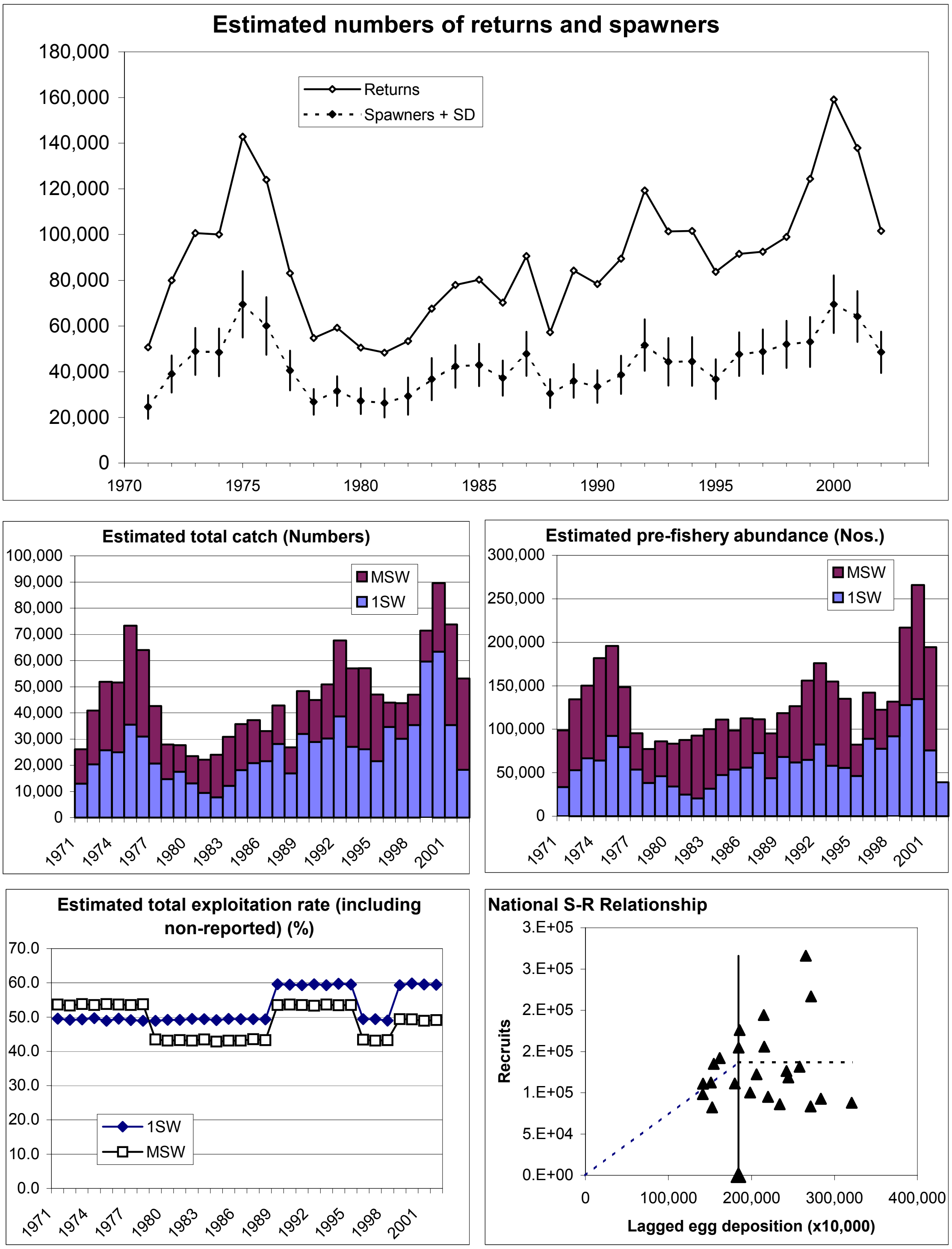
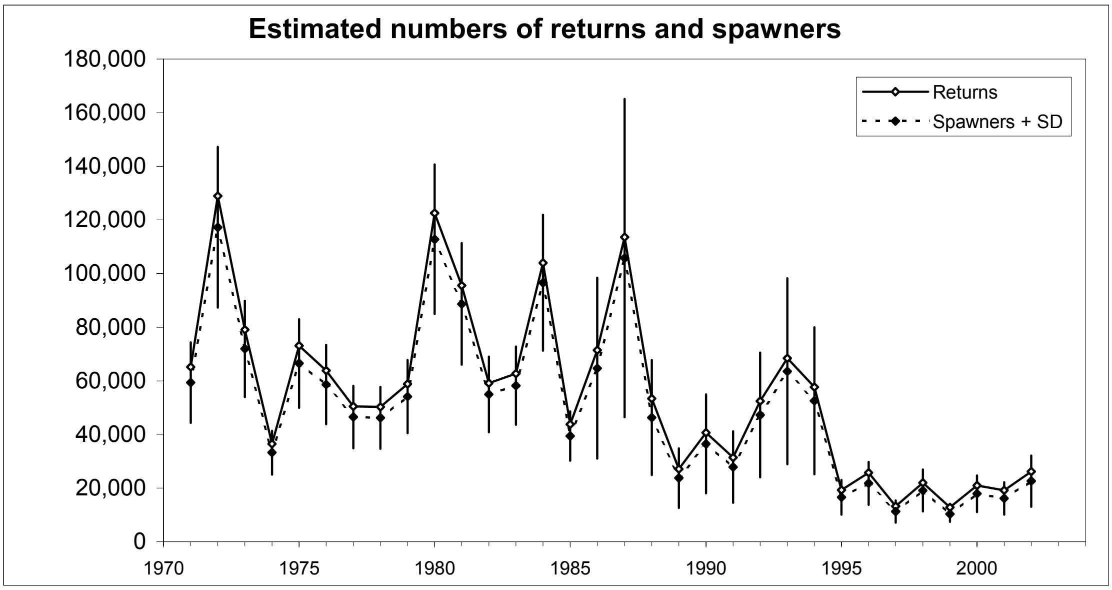
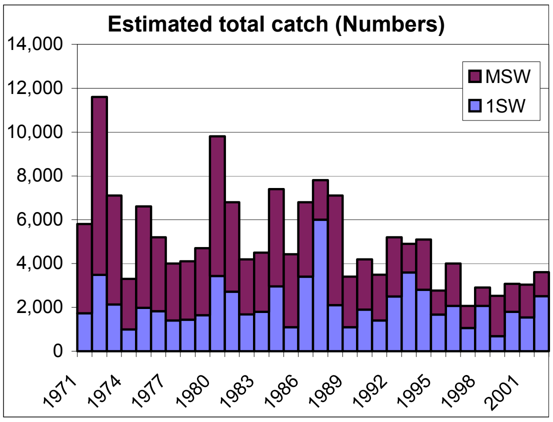
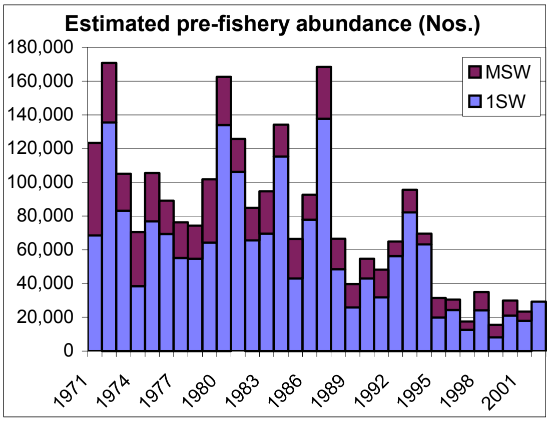
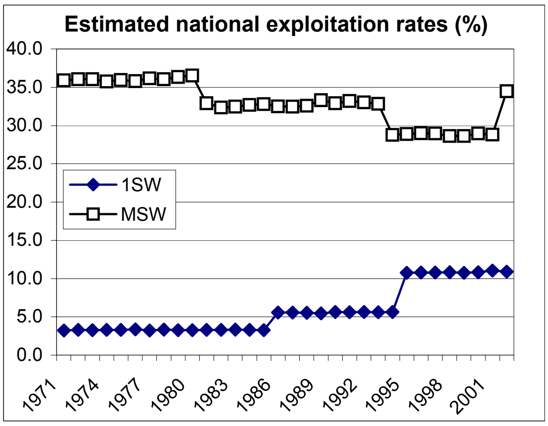


Figure 3.3.4.1b
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
France









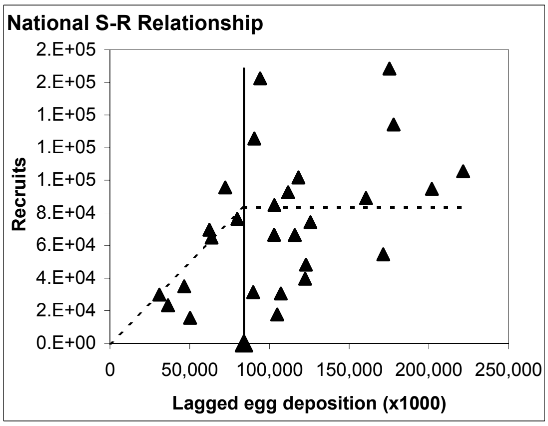


Figure 3.3.4.1c
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
Iceland

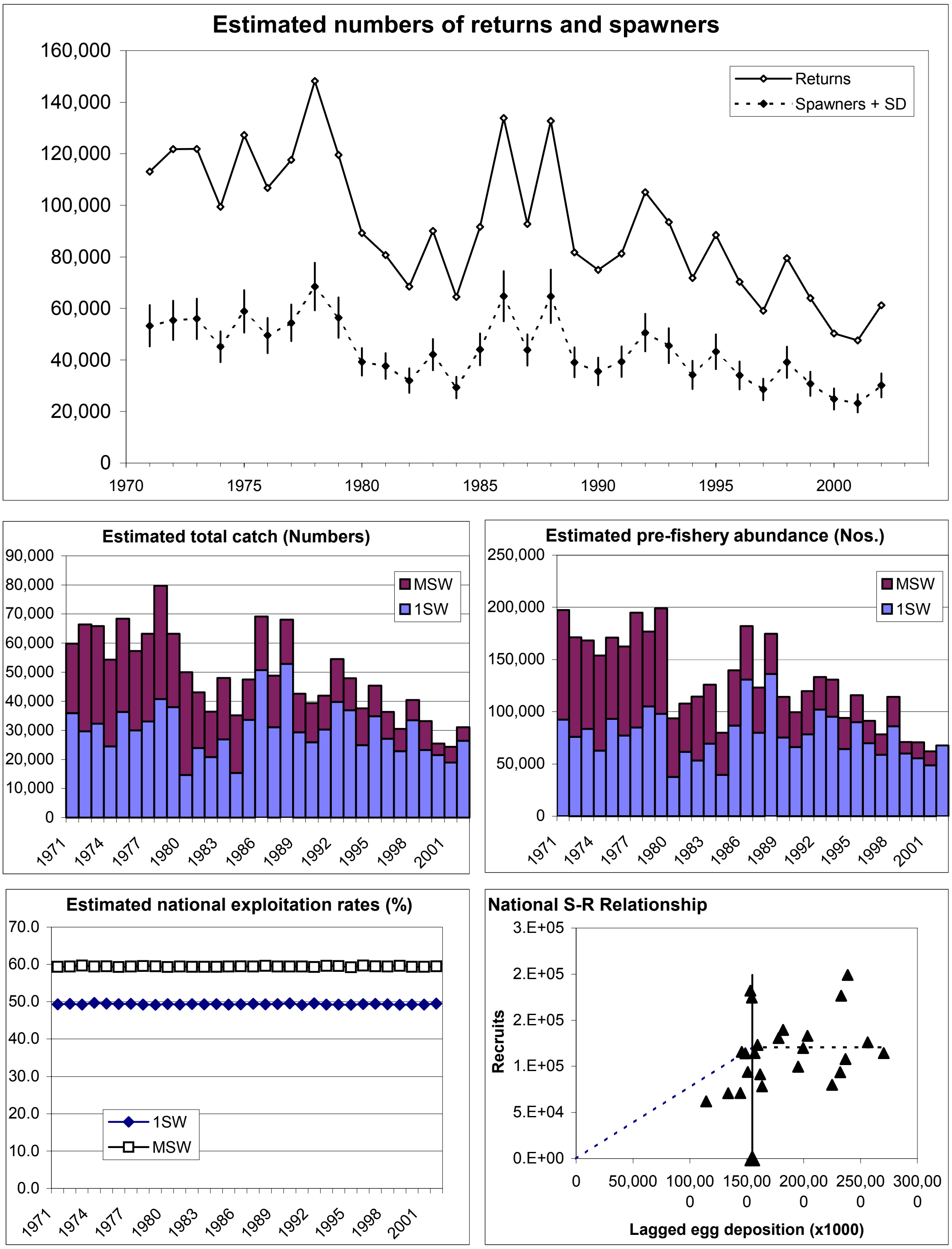


Figure 3.3.4.1d
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
Ireland

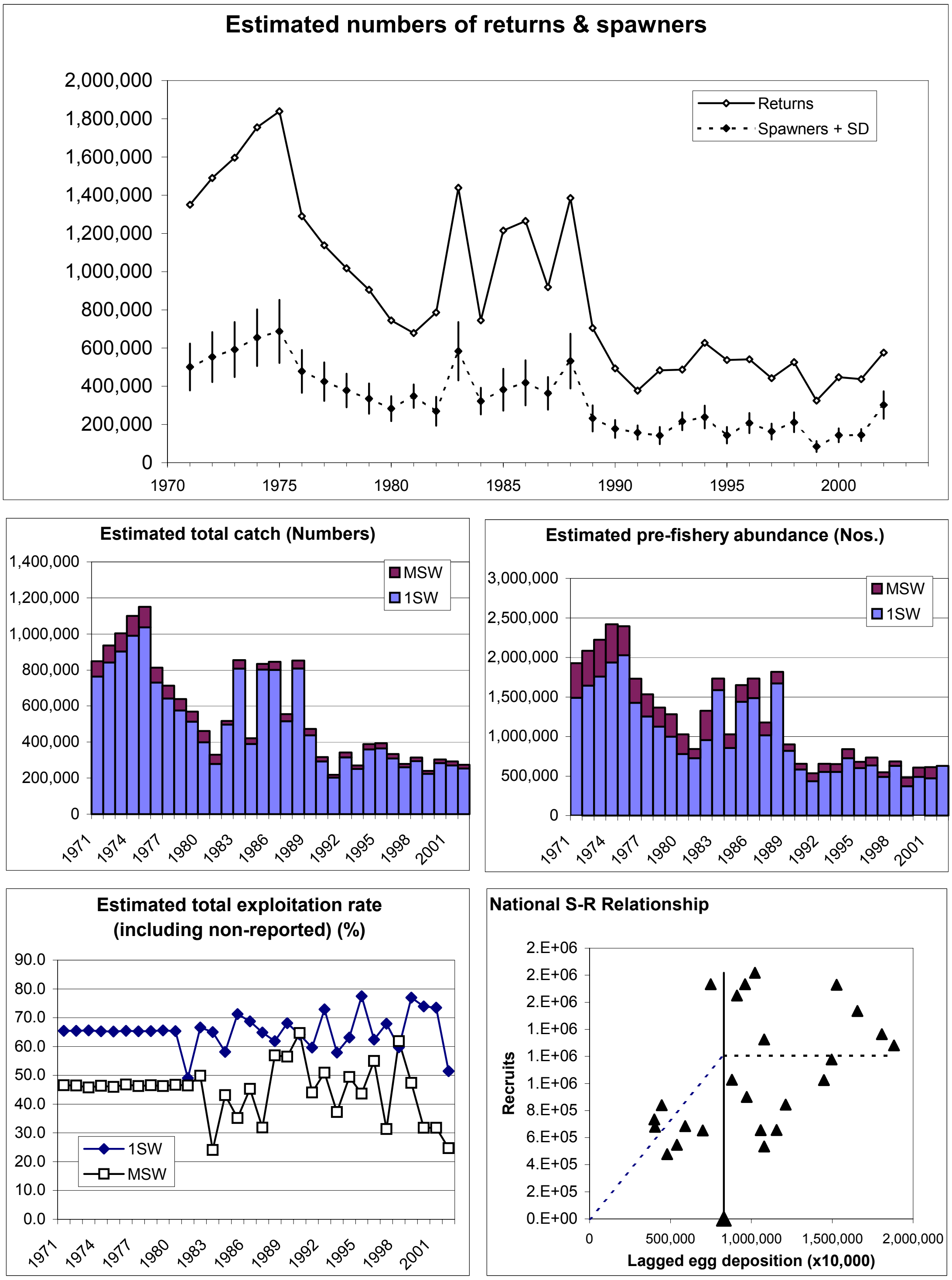
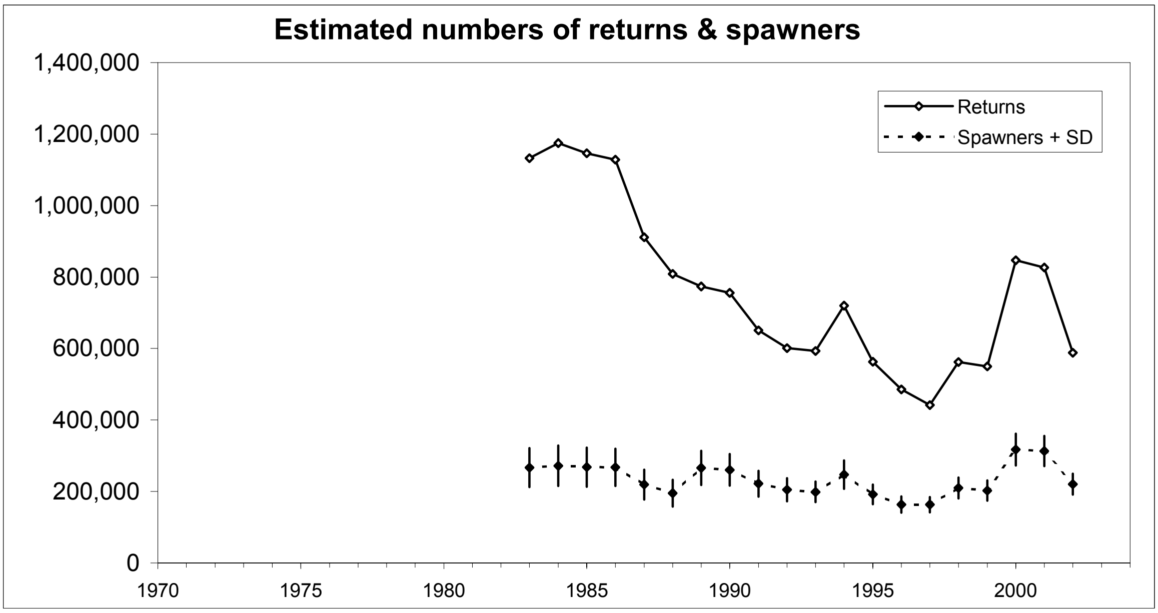
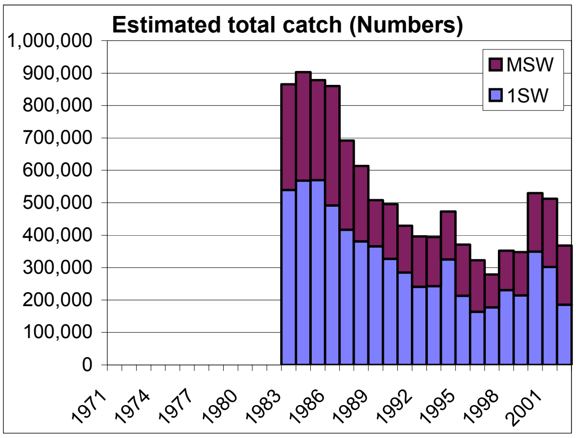
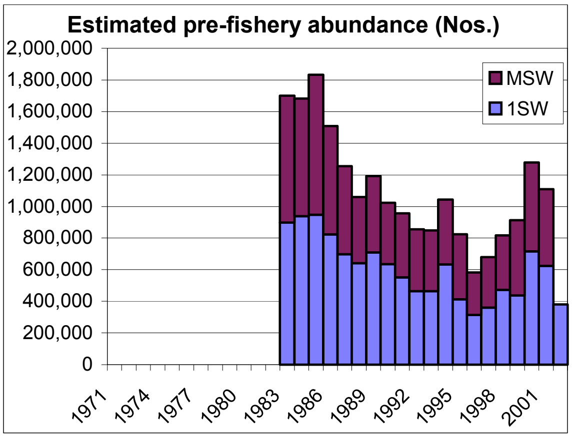
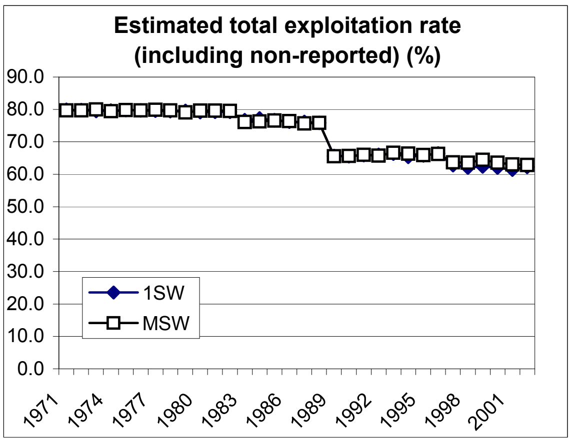


Figure 3.3.4.1e
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
NORWAY (minus Norwegian catches from the R. Teno)









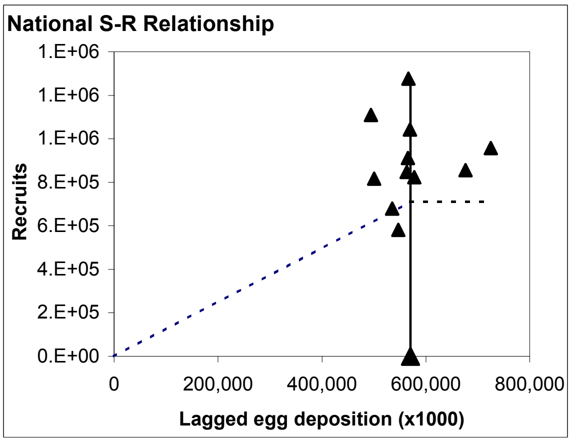
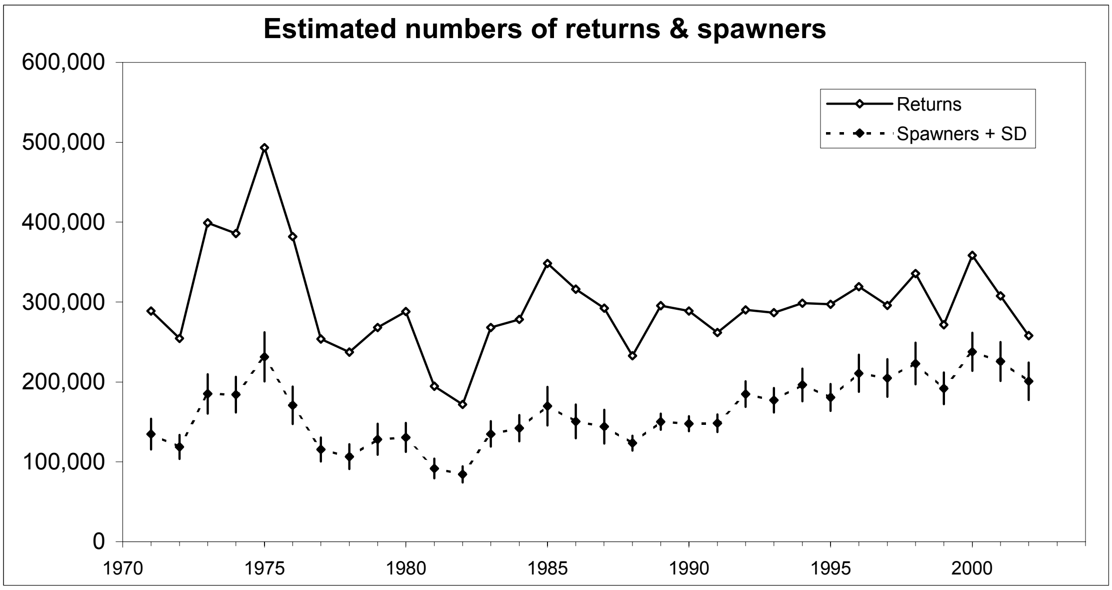
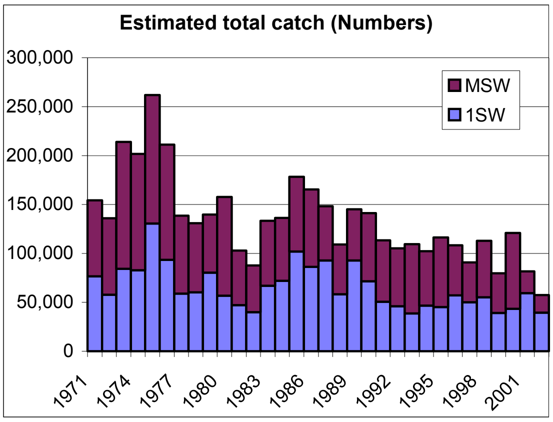
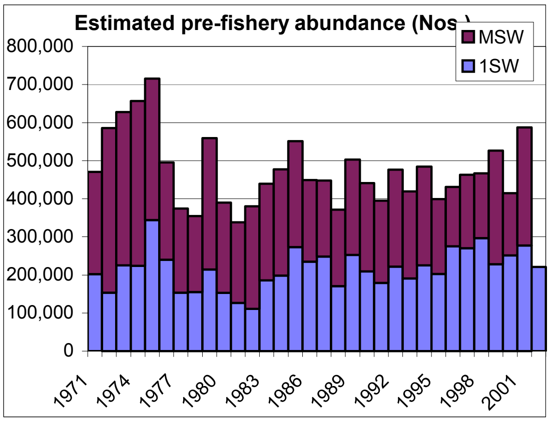
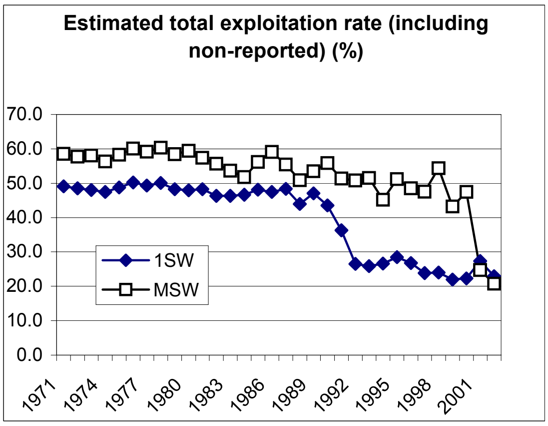


Figure 3.3.4.1f
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
Russia









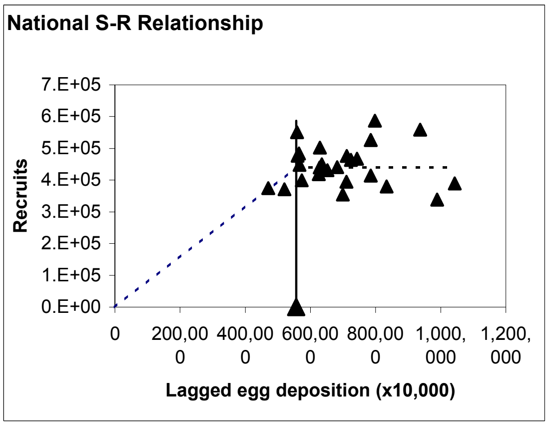
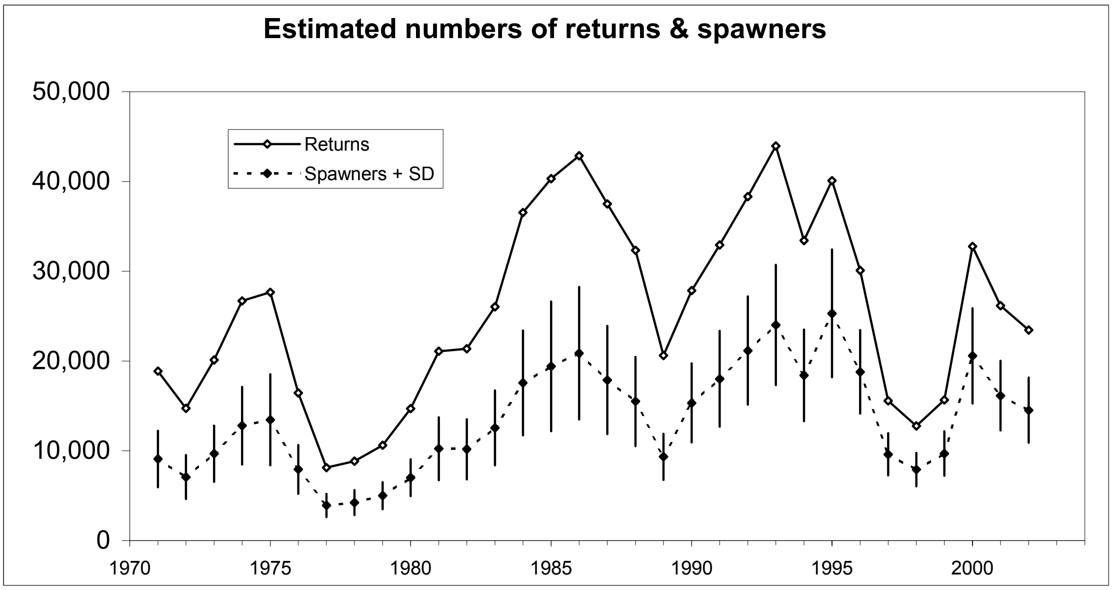
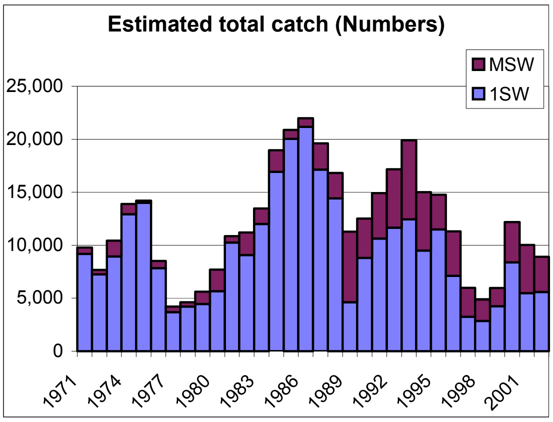
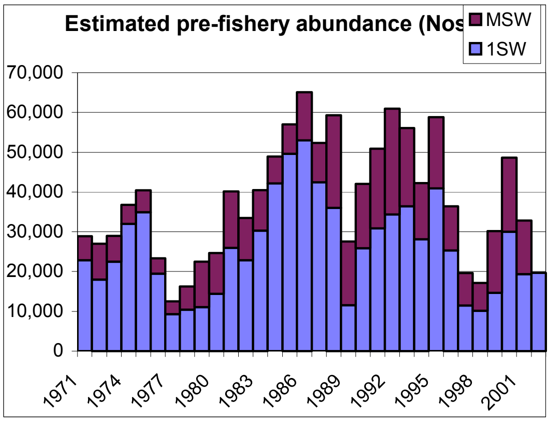
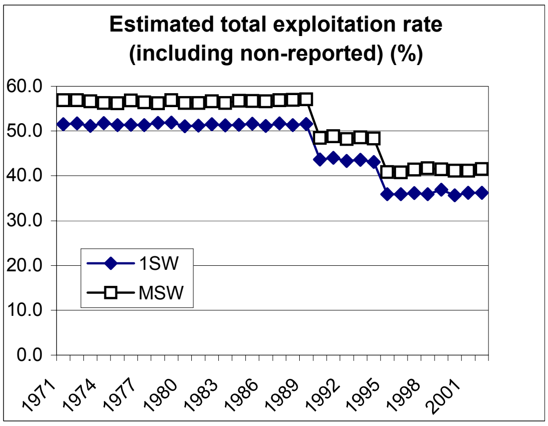


Figure 3.3.4.1g
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
Sweden









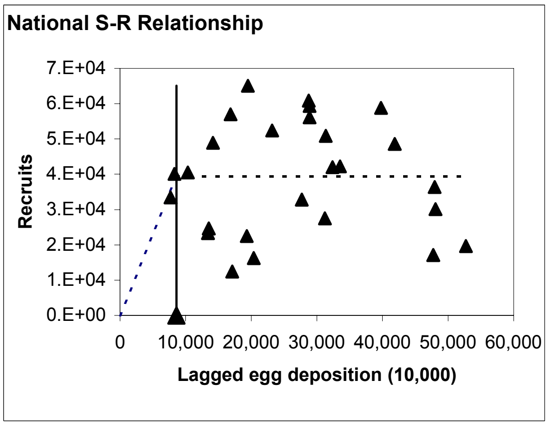


Figure 3.3.4.1h
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
UK (England and Wales)

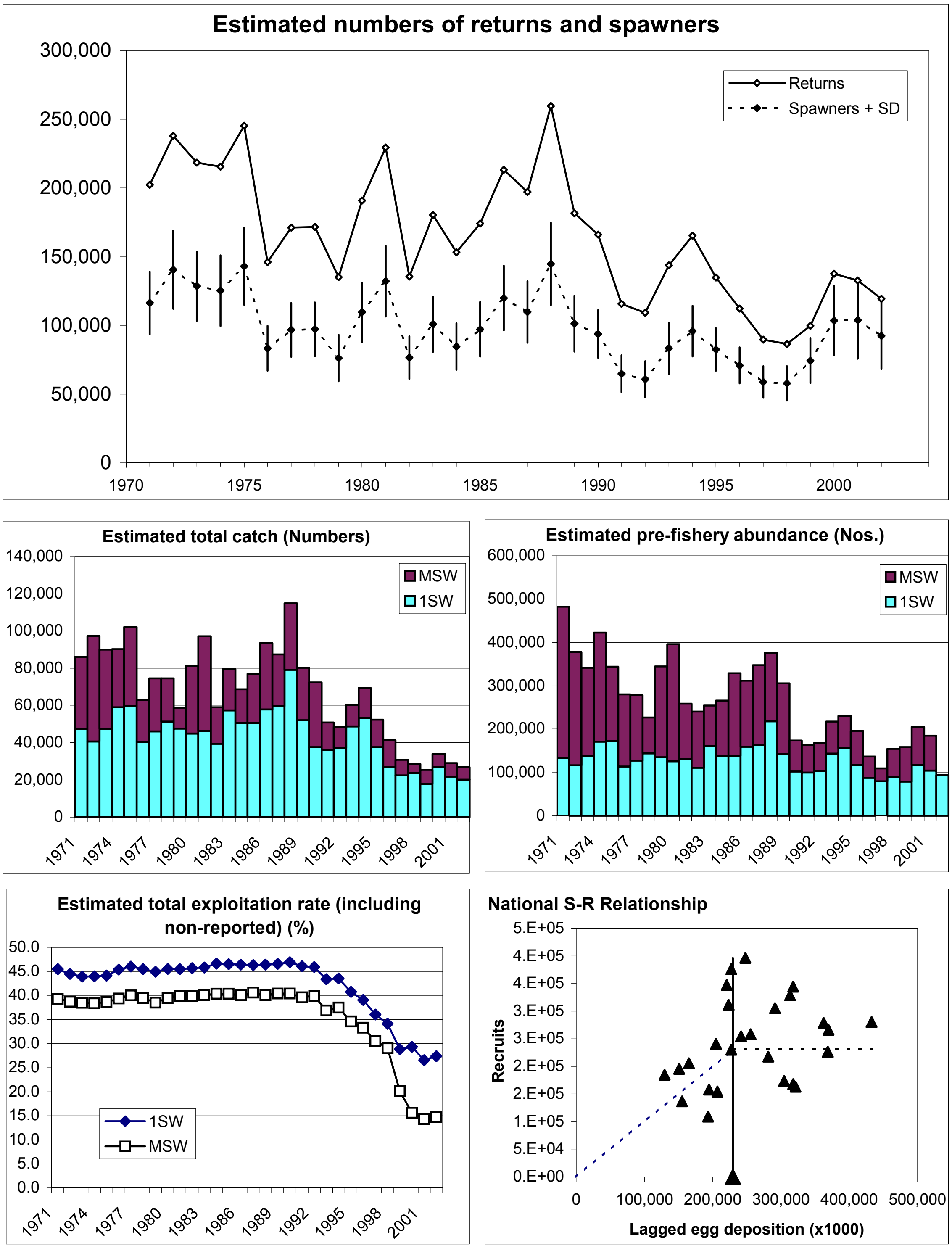


Figure 3.3.4.1i
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
UK (Northern Ireland)

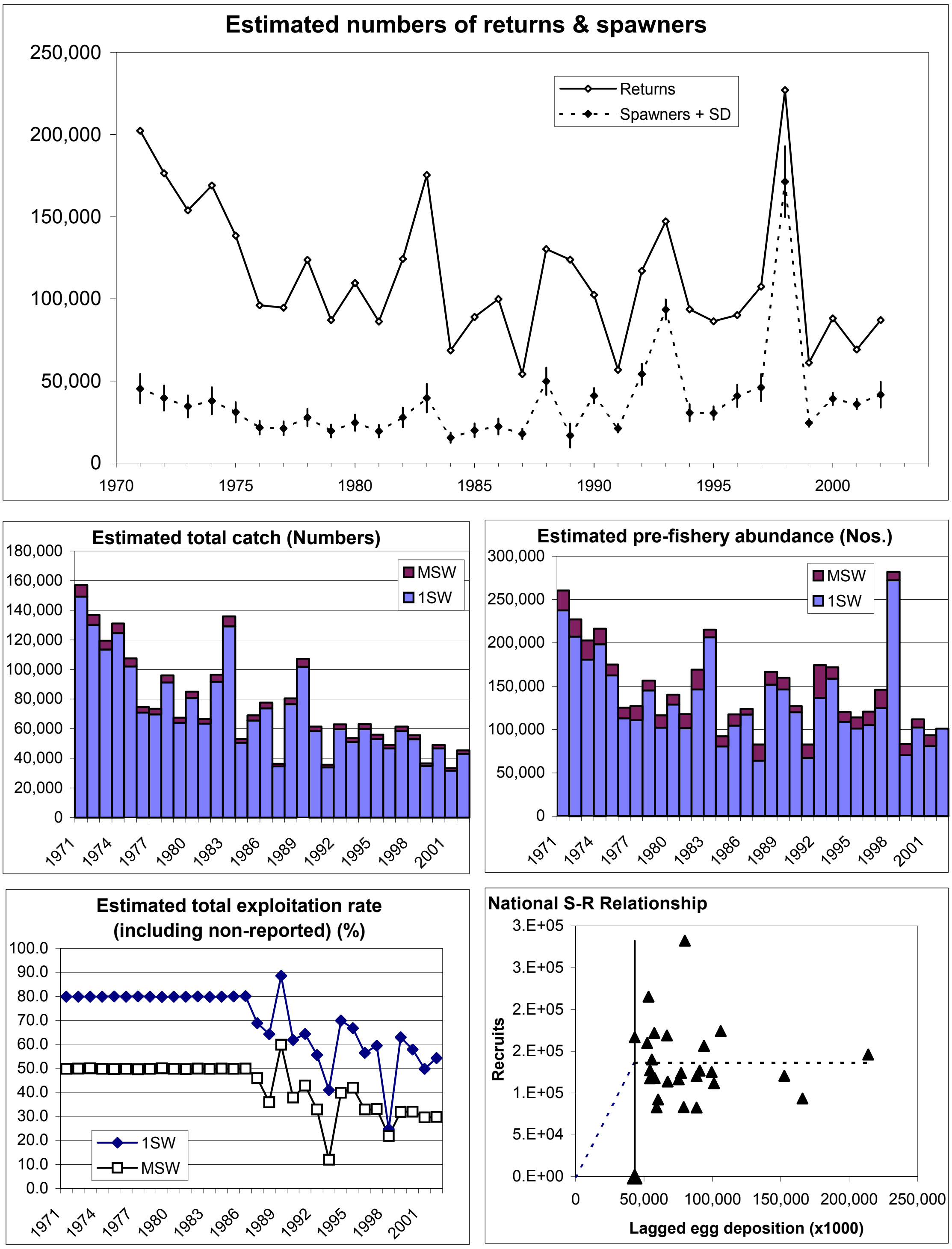
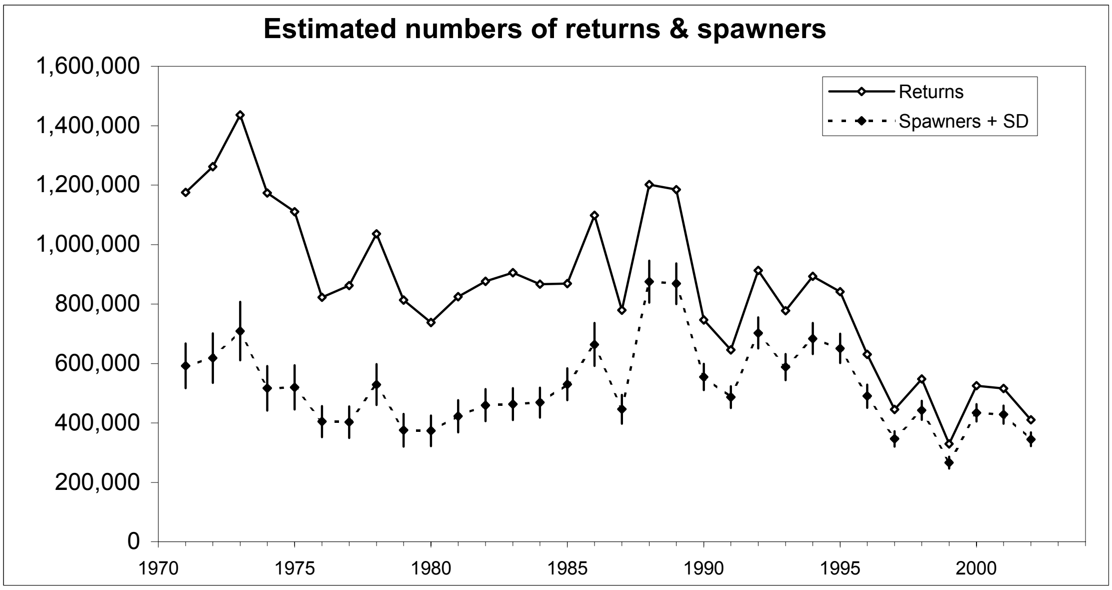
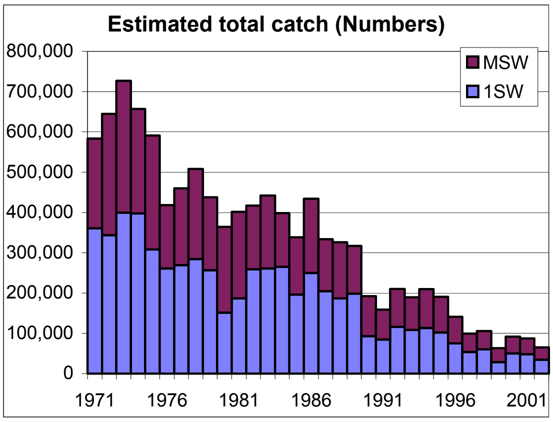
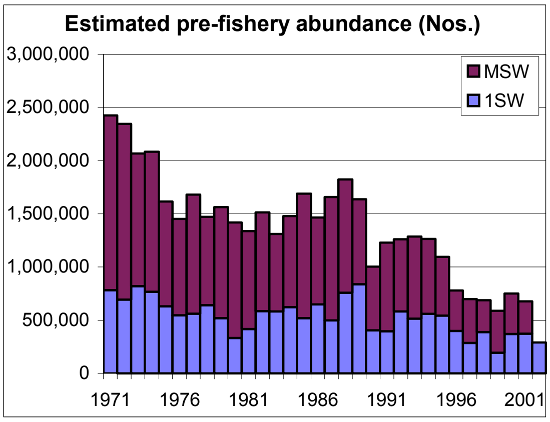
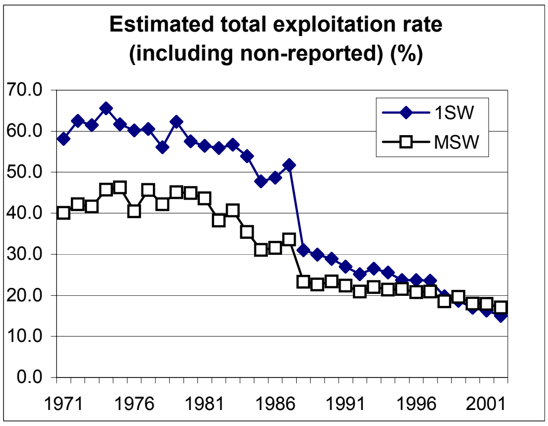


Figure 3.3.4.1j
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
UK (Scotland)









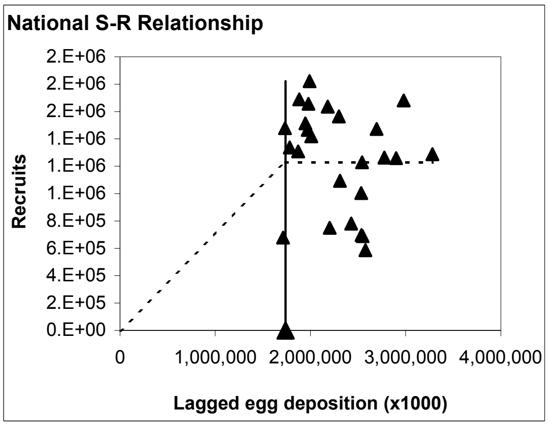
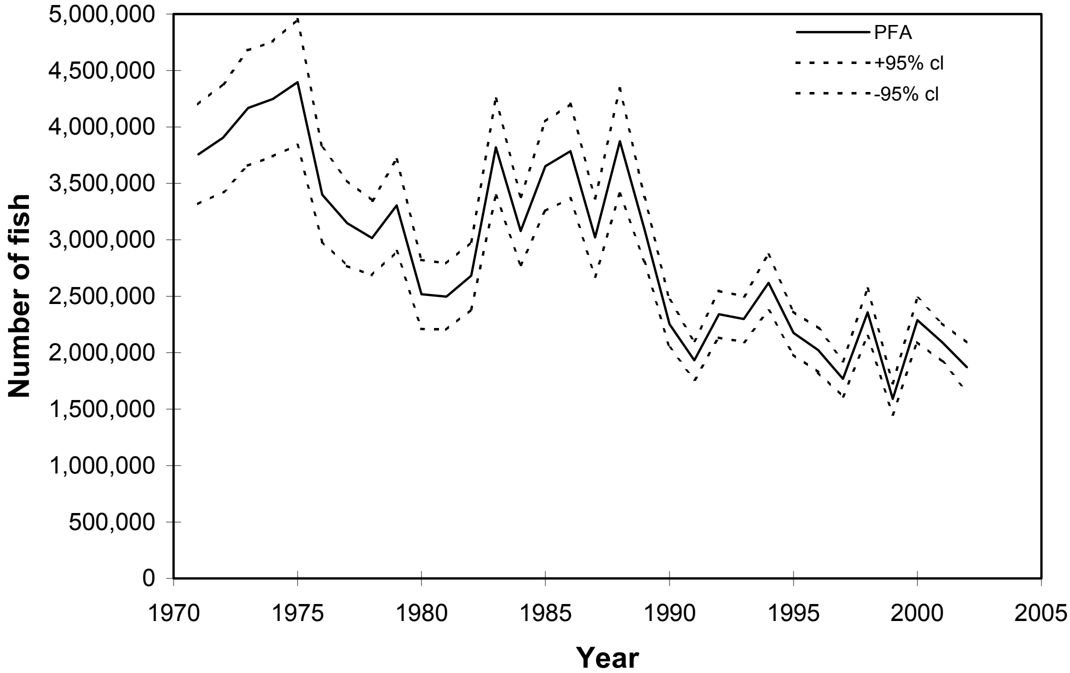


Figure 3.5.1.1 Estimated recruitment (PFA) in the NEAC area 1970-2002

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)

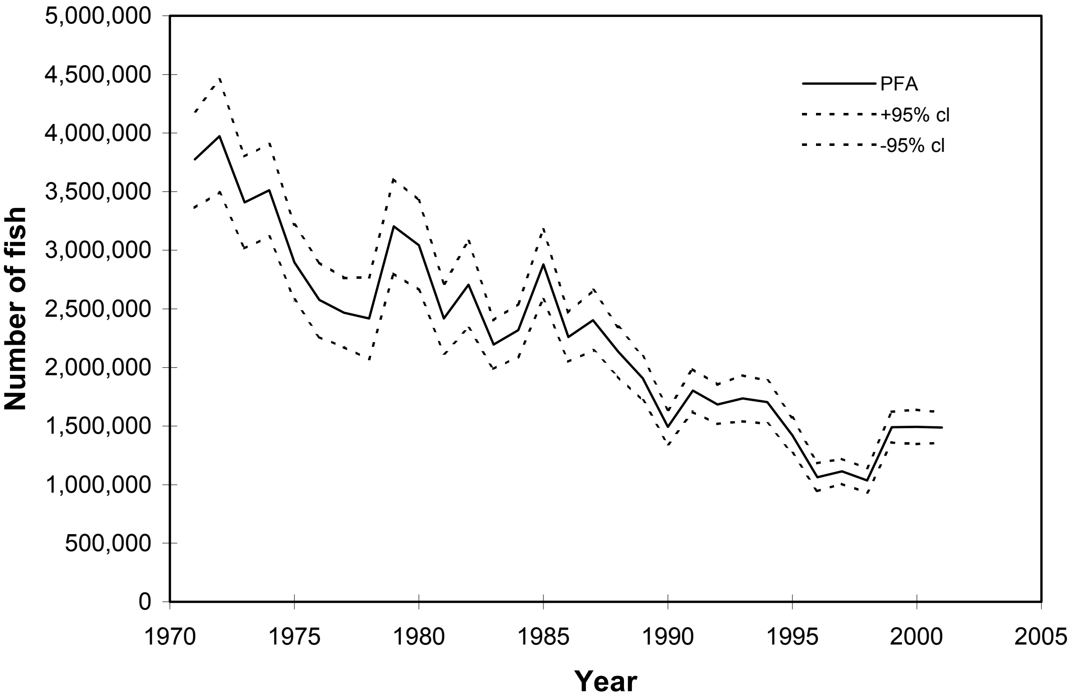
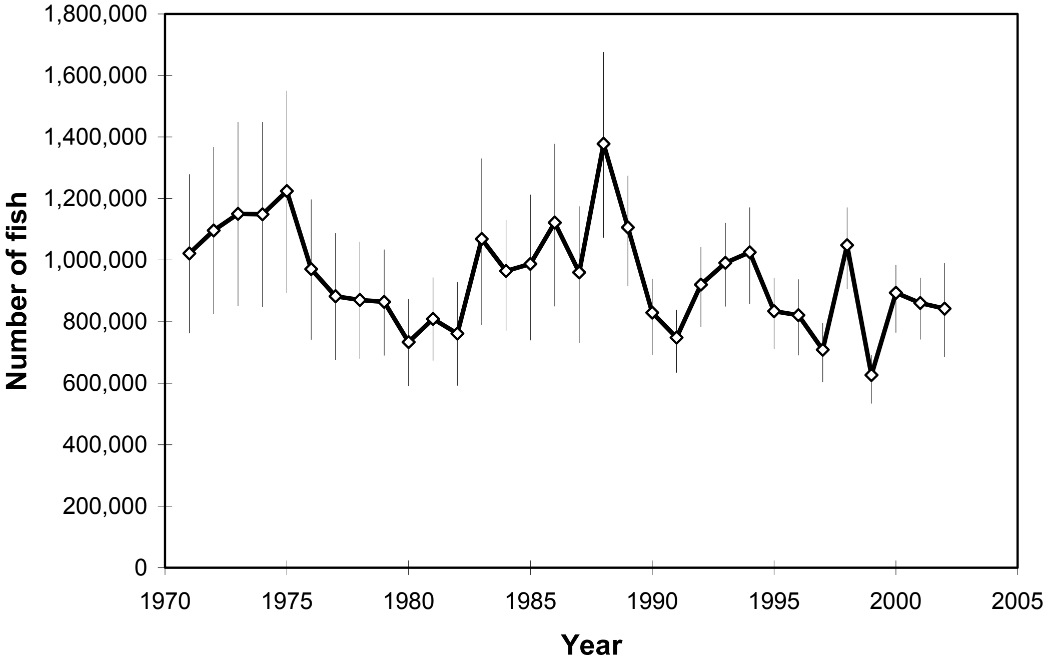


Figure 3.5.1.2 Estimated spawning escapement in the NEAC area 1970-2002

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



b) MSW spawners (and 95% confidence limits)

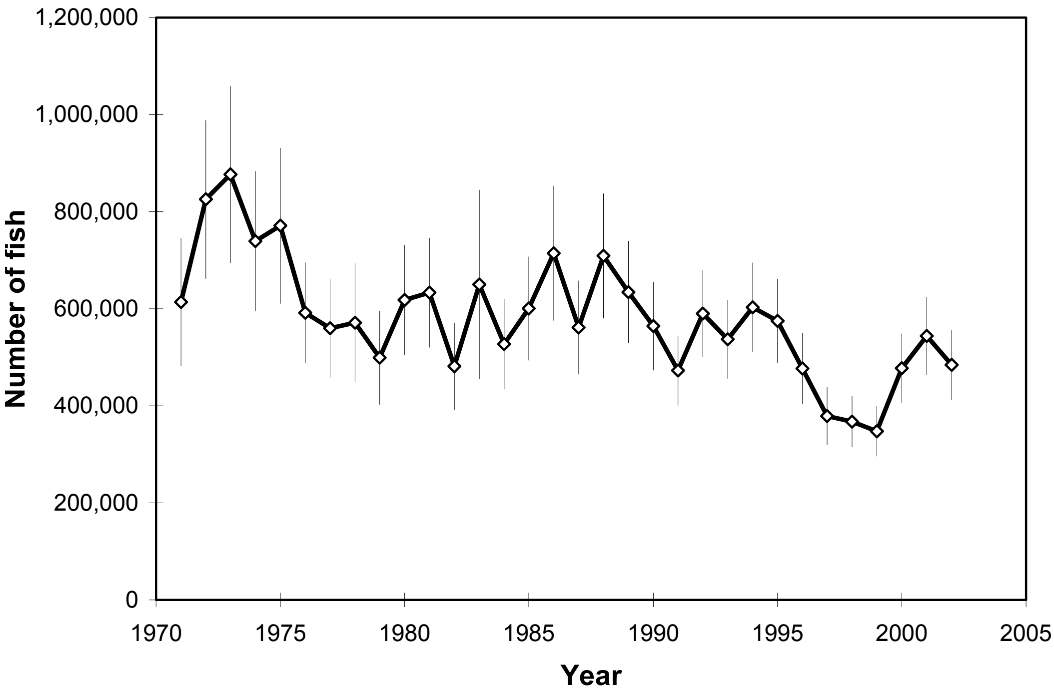
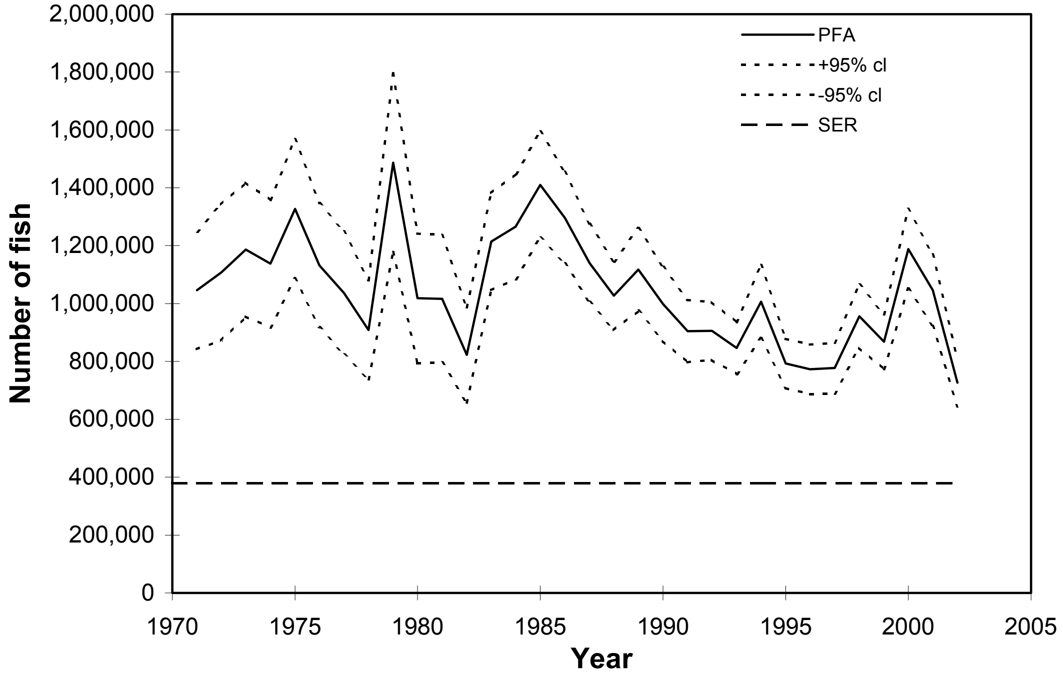


Figure 3.5.1.3 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Northern Europe, 1971-2002

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)

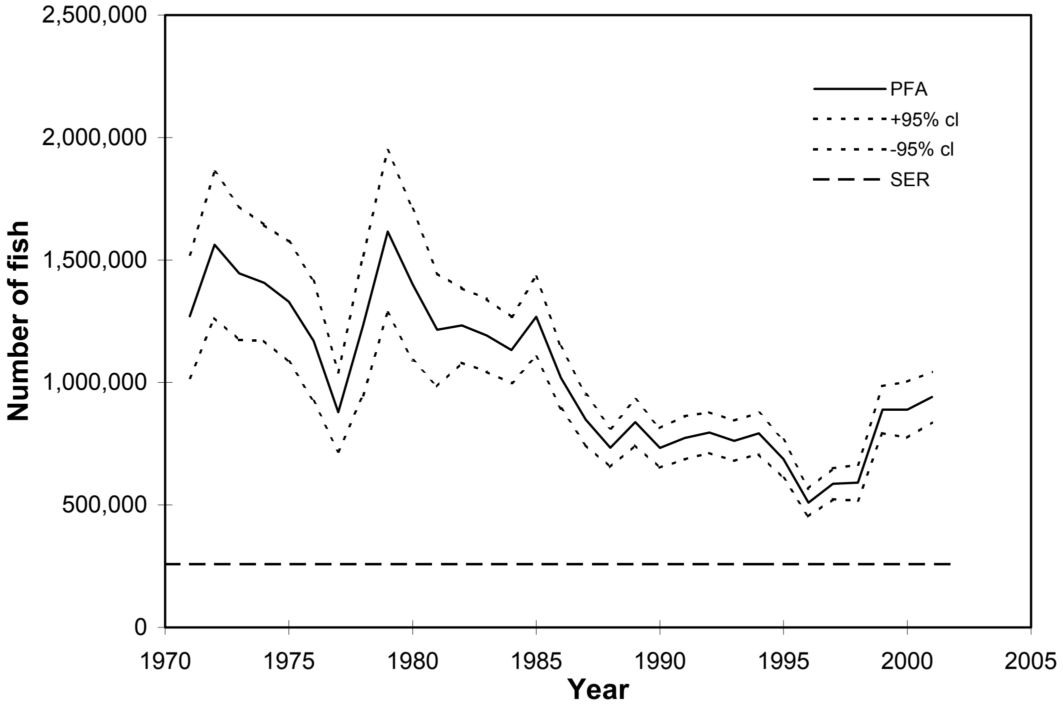
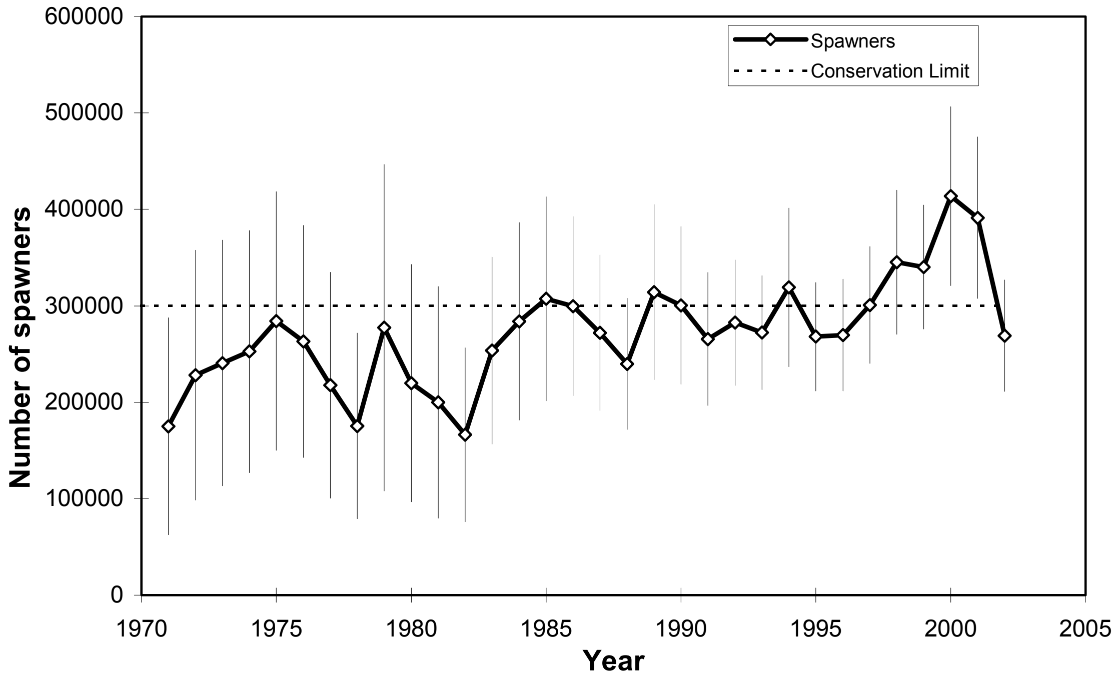


Figure 3.5.1.4 Estimated spawning escapement of maturing and non-maturing salmon in Northern Europe, 1971-2002

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



b) MSW spawners (and 95% confidence limits)

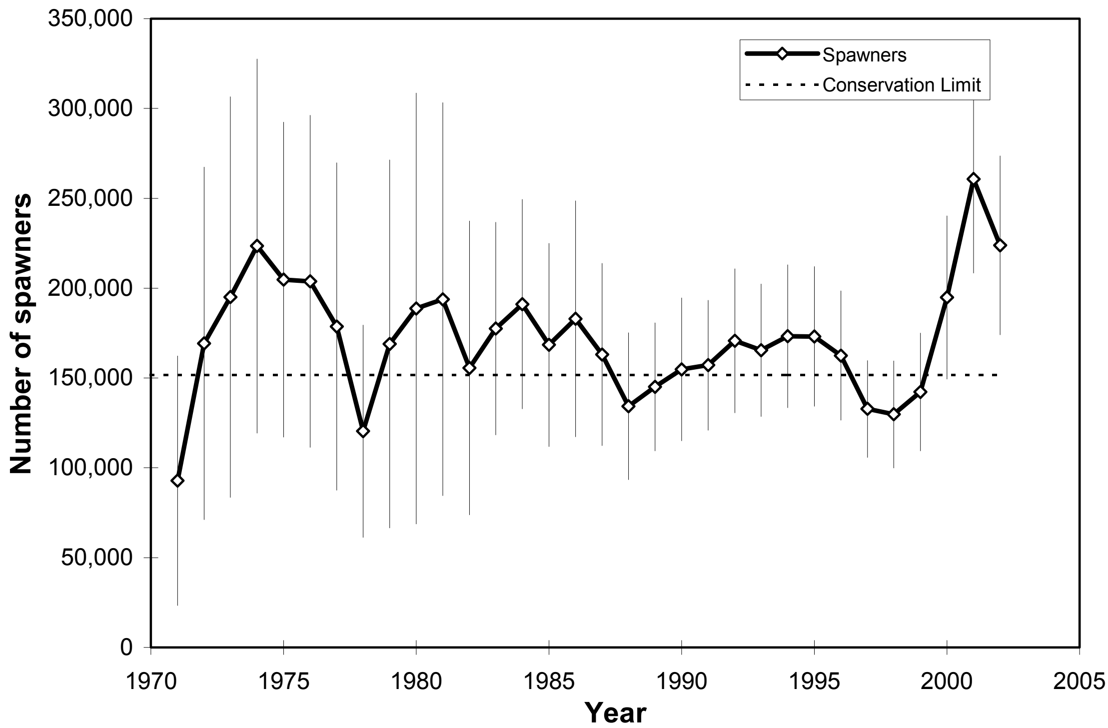
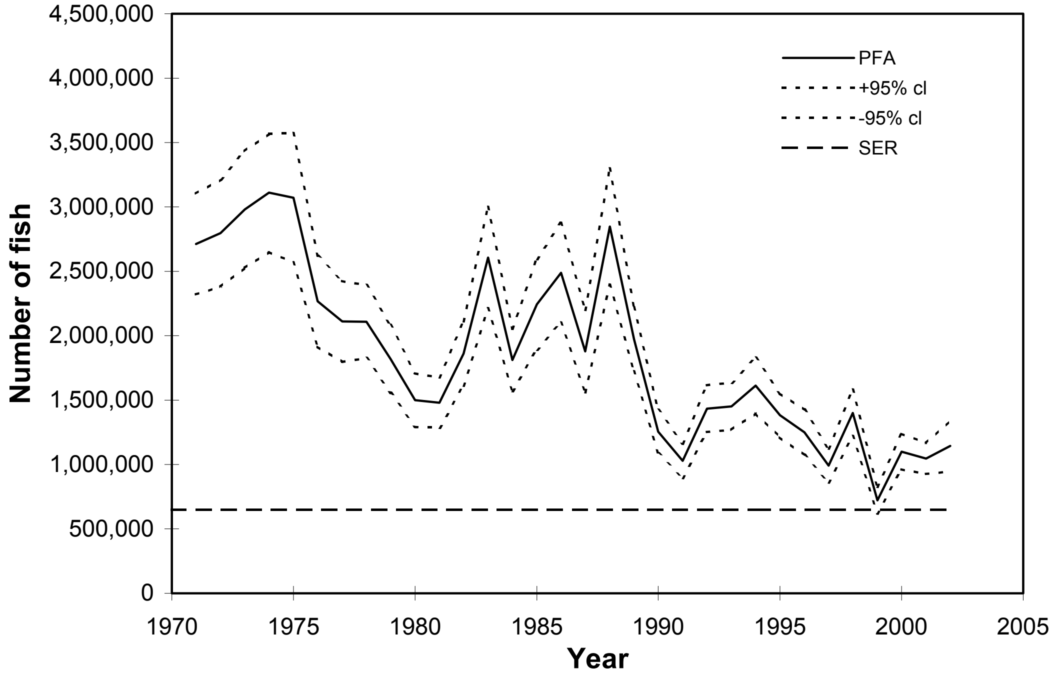


Figure 3.5.1.5 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Southern Europe, 1971-2002

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)

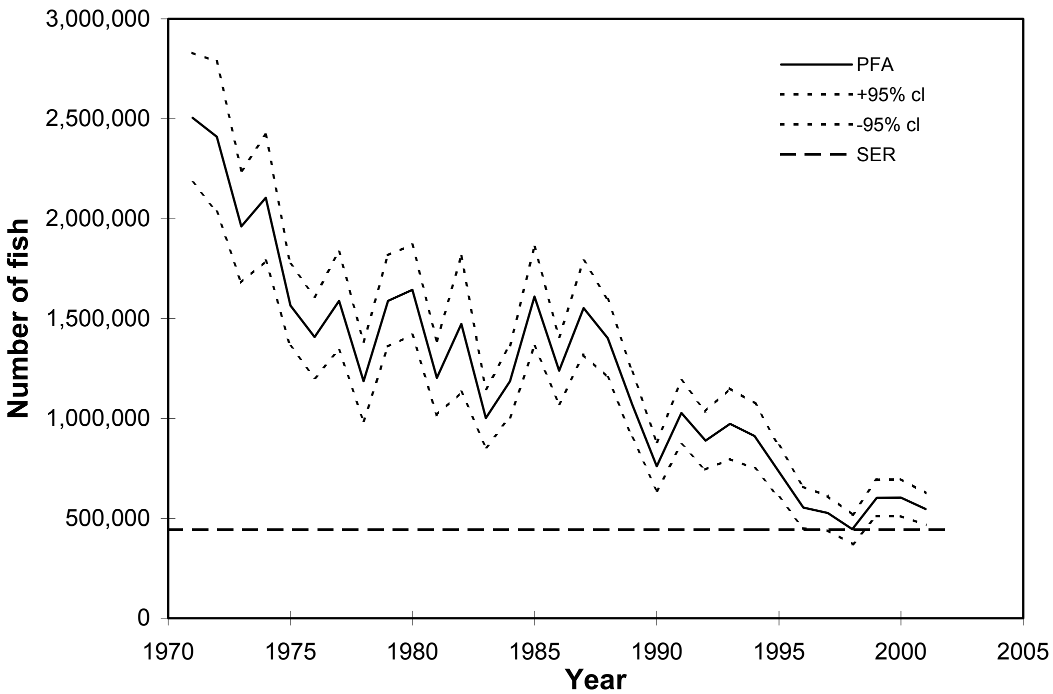
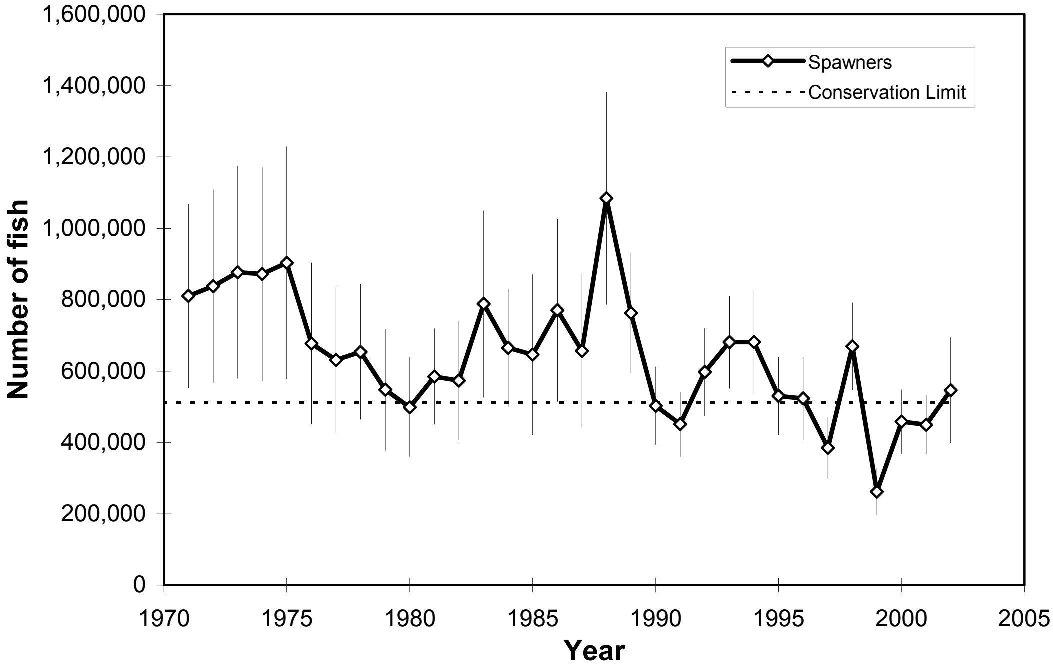


Figure 3.5.1.6 Estimated spawning escapement of maturing and non-maturing salmon in Southern Europe, 1971-2002

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



b) MSW spawners (and 95% confidence limits)

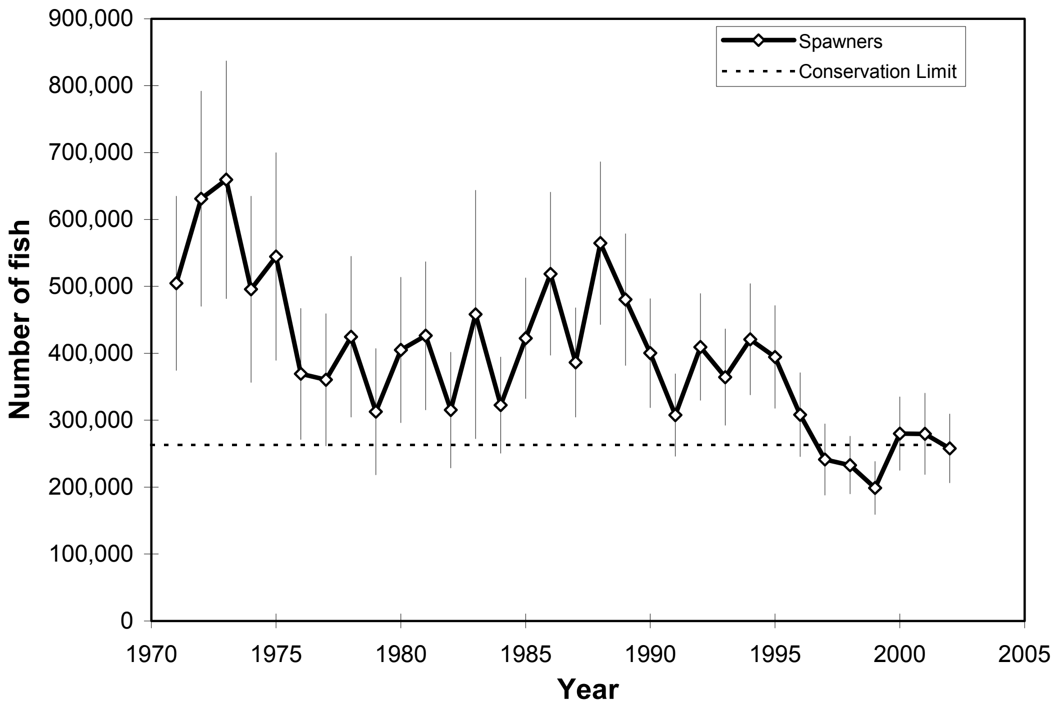


Figure 3.5.2.1 *PFA non-m* trends and predictions (+/- 95% confidence intervals) using Model 2 to predict for SouthernEuropean stock.

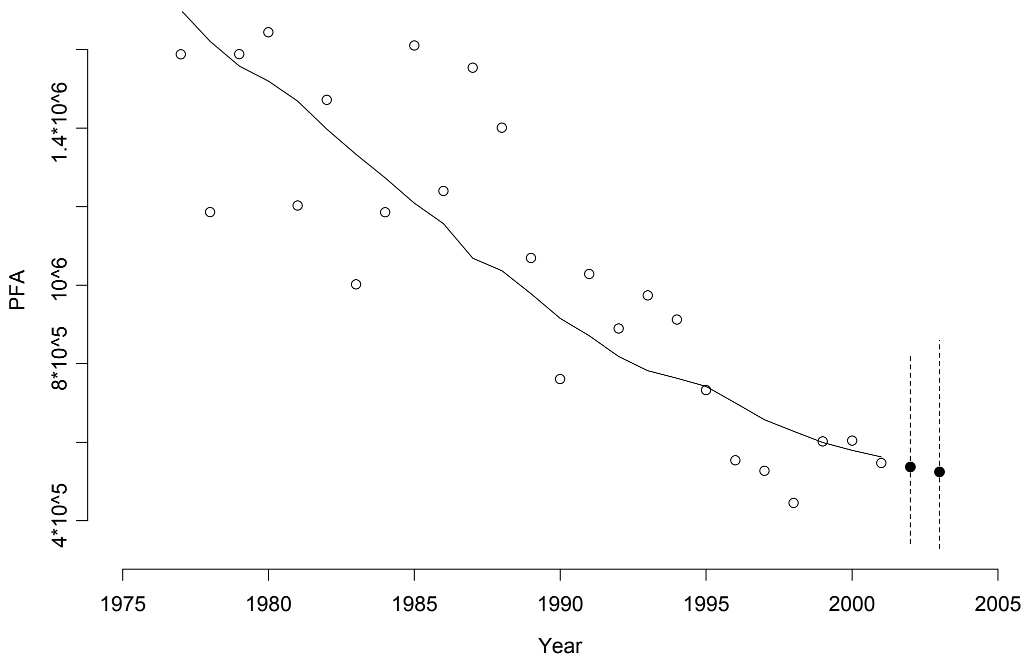


Figure 3.5.2.2 *PFA non-m* trends and predictions (+/- 95% confidence intervals) using Model 3 to predict for Northern European stock.

Figure 3.7.1.1. Distribution of Norwegian, Russian, Faroese and Icelandic captures of salmon in 2002. Legends in figure. Captures in Iceland's and the Faroes' EEZ were taken in a Nordic salmon data storage tagging (DST) programme.

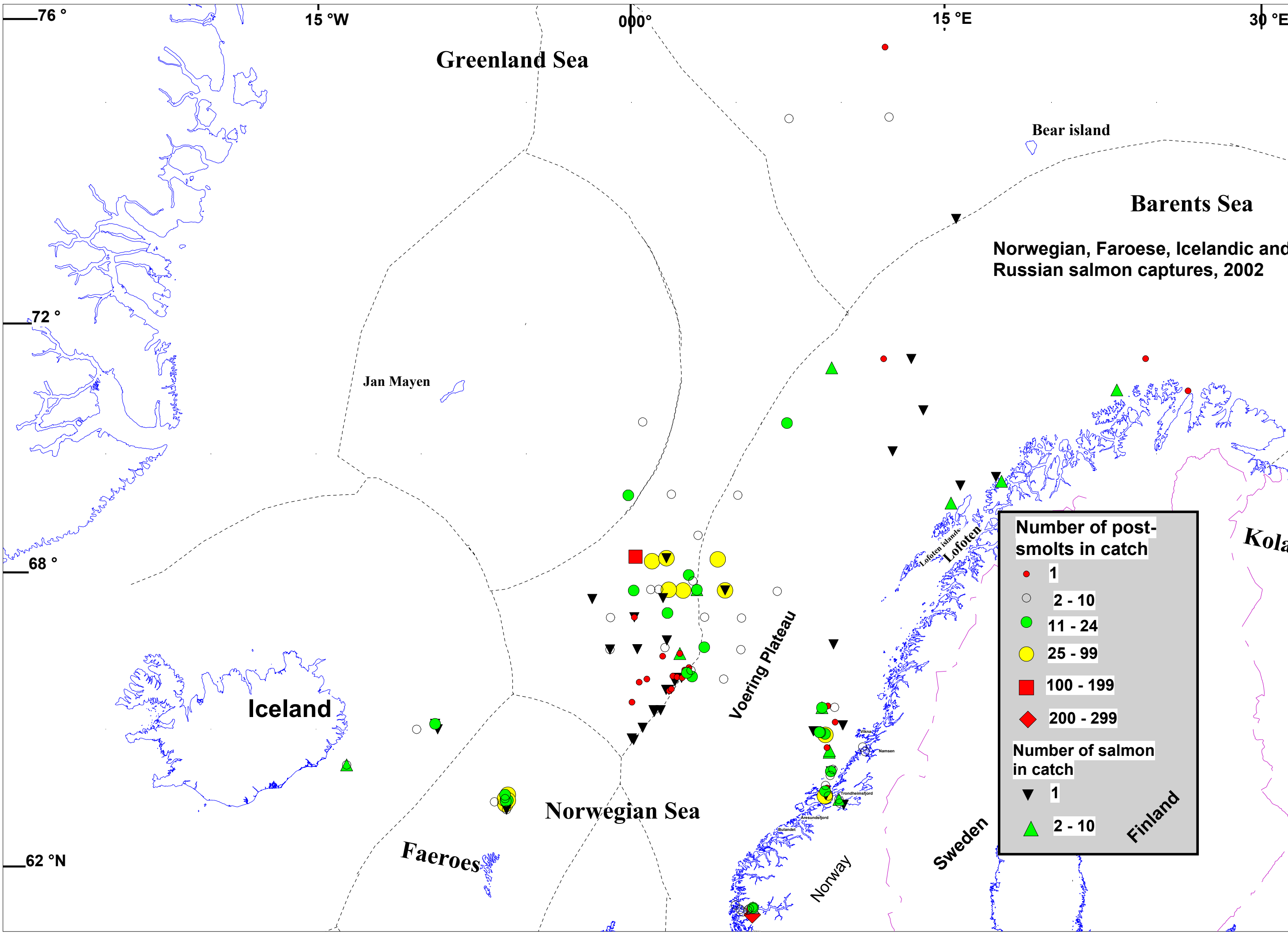


Figure 3.7.1.2. **Distribution of Scottish and Norwegian post-smolt captures 1990 – 2001 (Holm *et al.* 2003; Shelton 1997). Numbers of post-smolts in catches presented as symbols, legends in figure.**

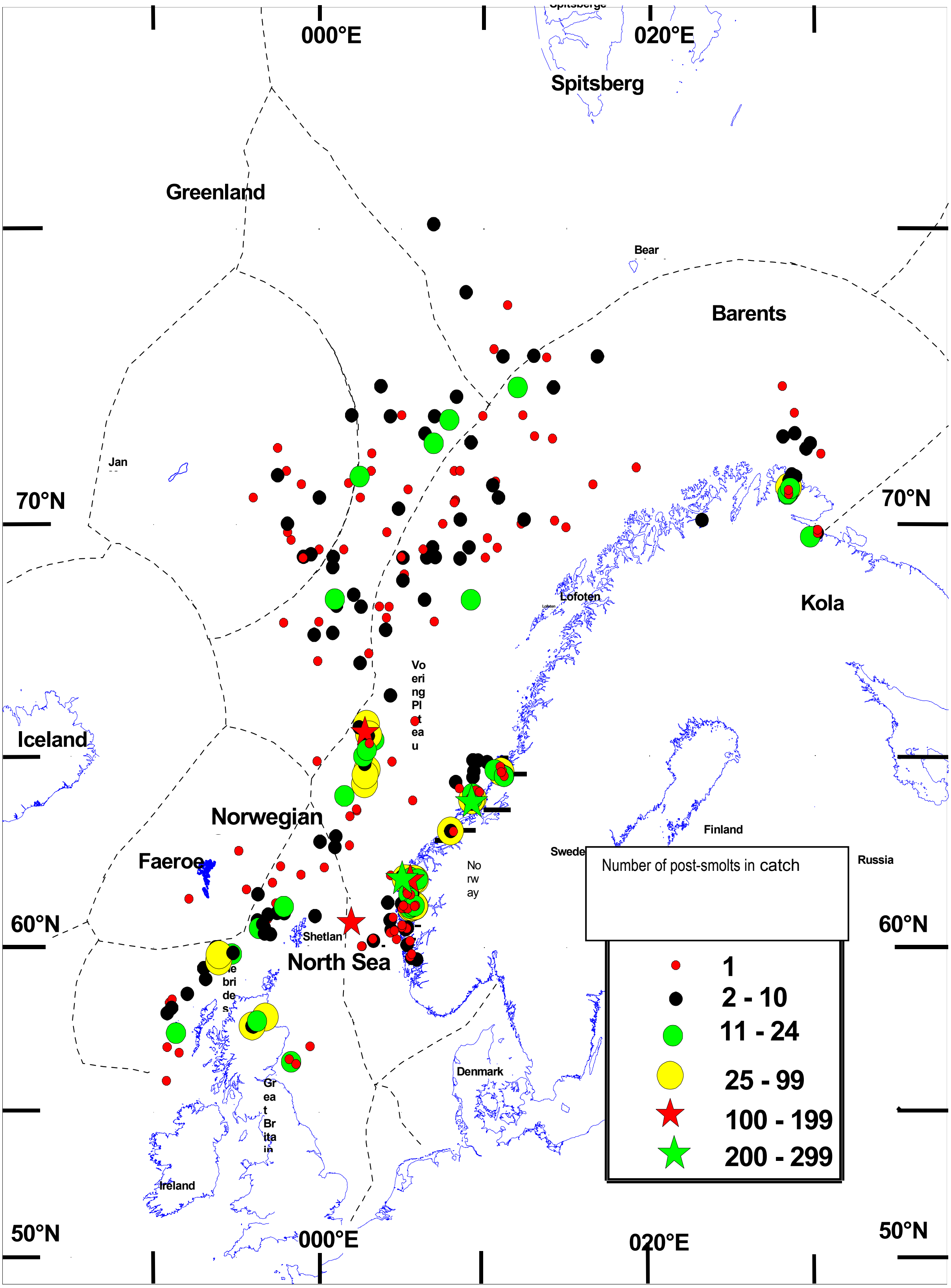


Figure 3.7.1.3 Catch per unit of effort (CPUE, number per nautical miles) of post-smolts by latitude. Timing of peak CPUE in 2000 (upper panel), 2001 (mid panel) and 2002 (lower panel). All cruises have been going from north to south.

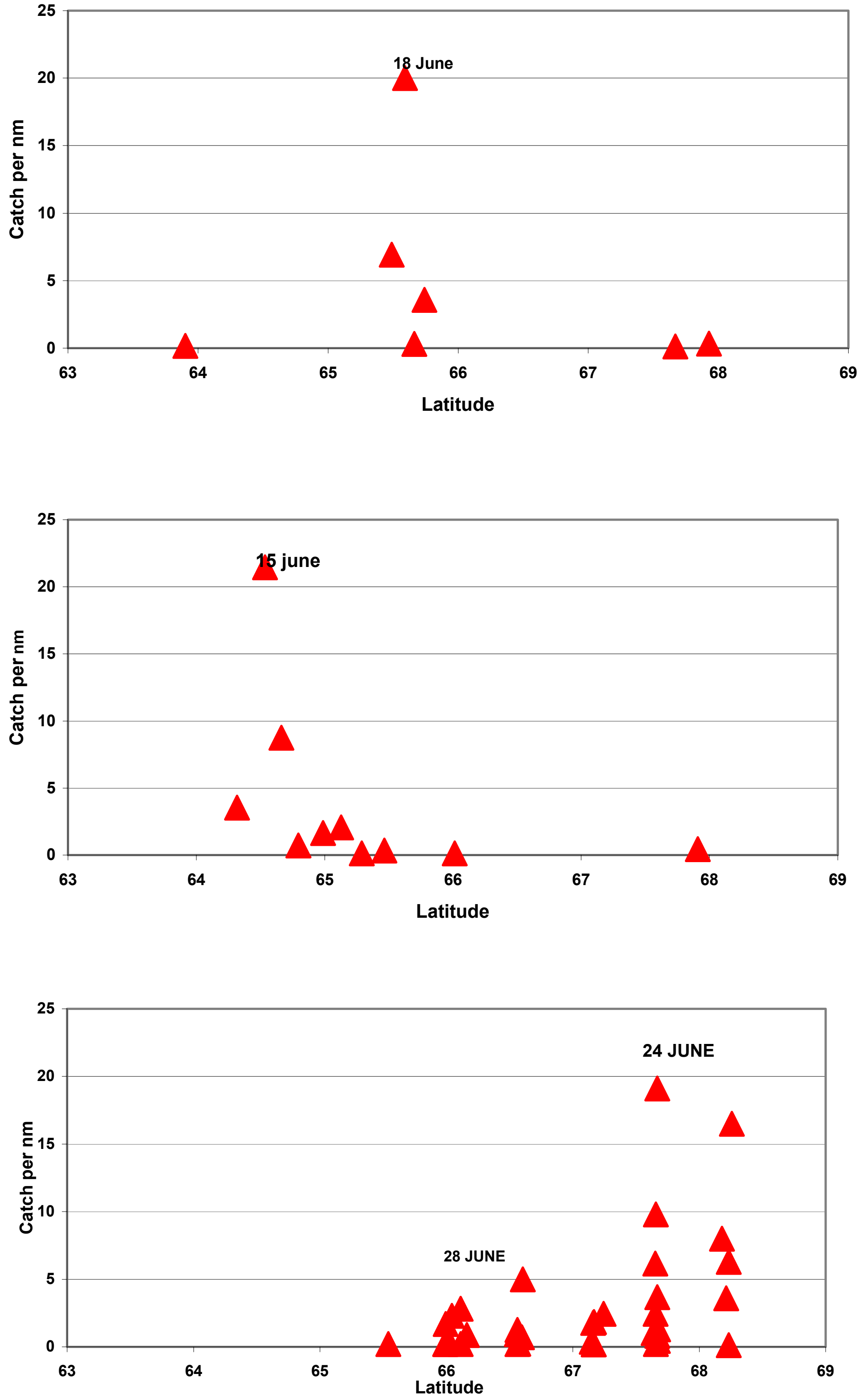


Figure 3.7.1.4. **Mean abundance of salmon lice on running salmon post smolts caught by the surface trawl "Ocean Fish Lift" in two Norwegian fjords (Sognefjord and Nordfjord) in 1998- 2002**

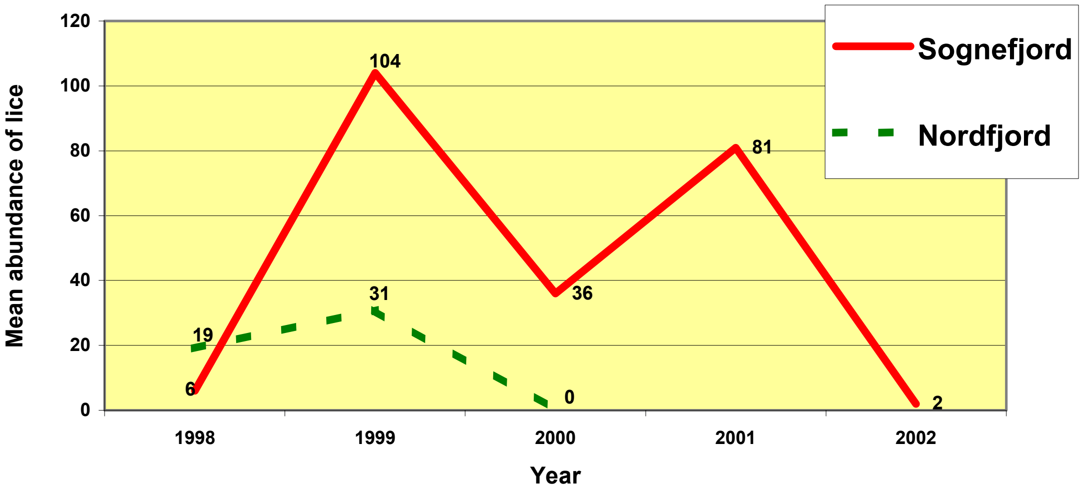


Figure 3.7.1.5. Positions of pelagic trawl hauls in herring survey conducted by R/V "F.Nansen" in June and July 2002. Filled triangles indicate mackerel in catch.

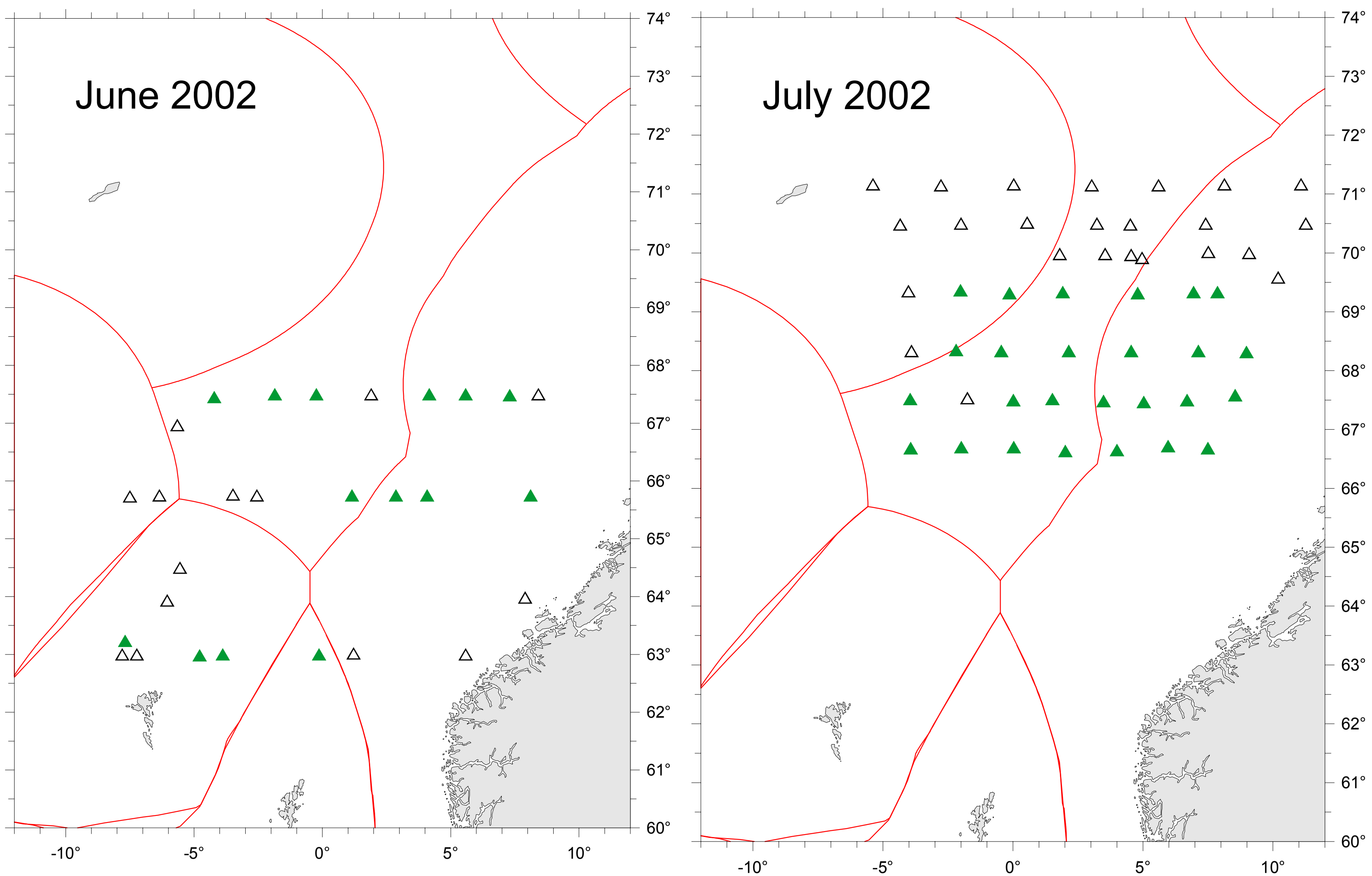


Figure 3.7.1.6. Adult Atlantic salmon and post-smolts caught during R/V "F. Nansen" herring survey in 2002.

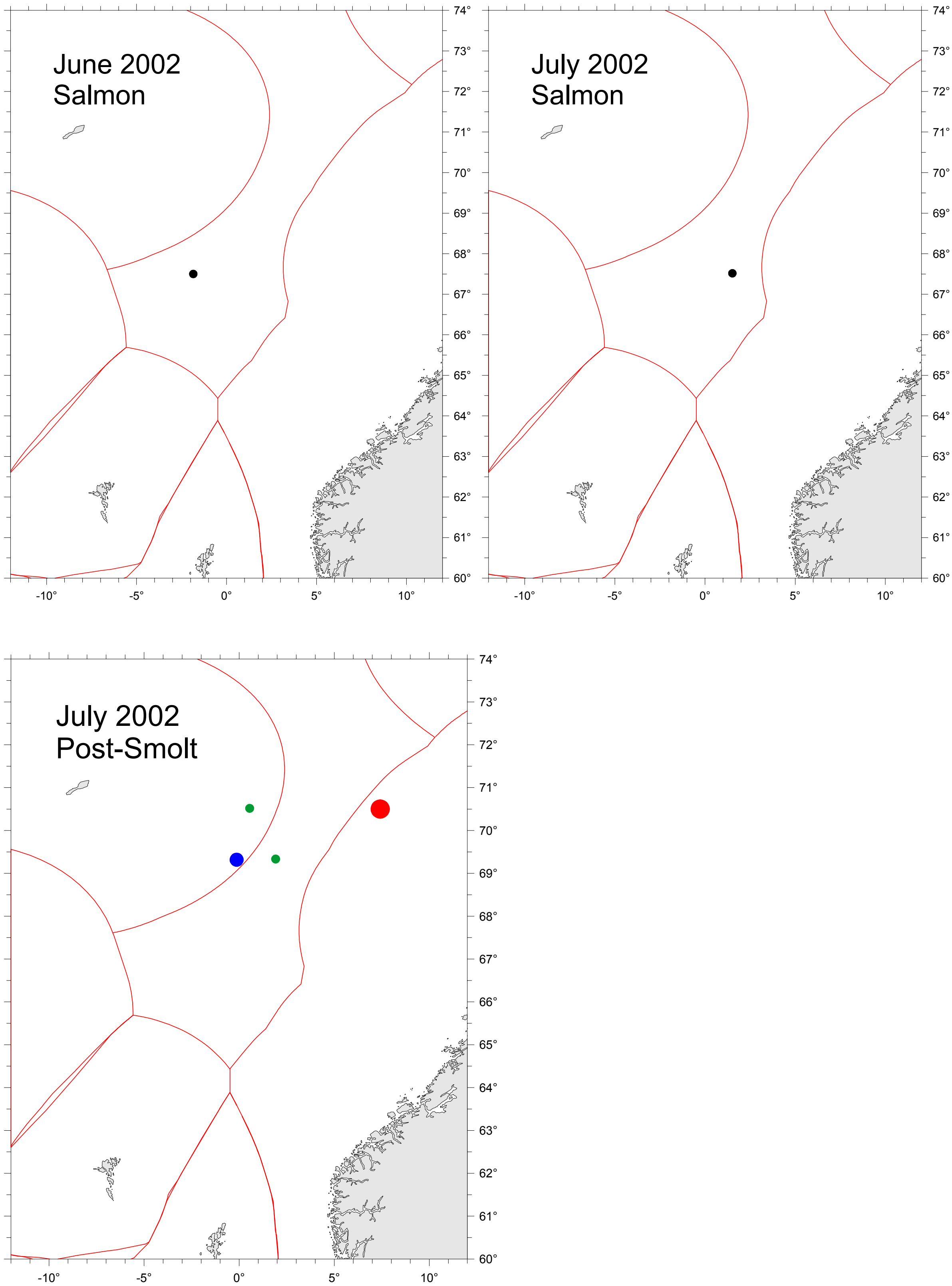


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Figure 3.7.2.1. Density distribution of post-smolts June 21 – July 1 2002. The darker the shade and the denser the isolines, the higher the density of post-smolts. Highest density was found in the NW of the surveyed area. Numbers indicate number of post-smolts in haul. Crosses indicate the starting positions of the trawl hauls.

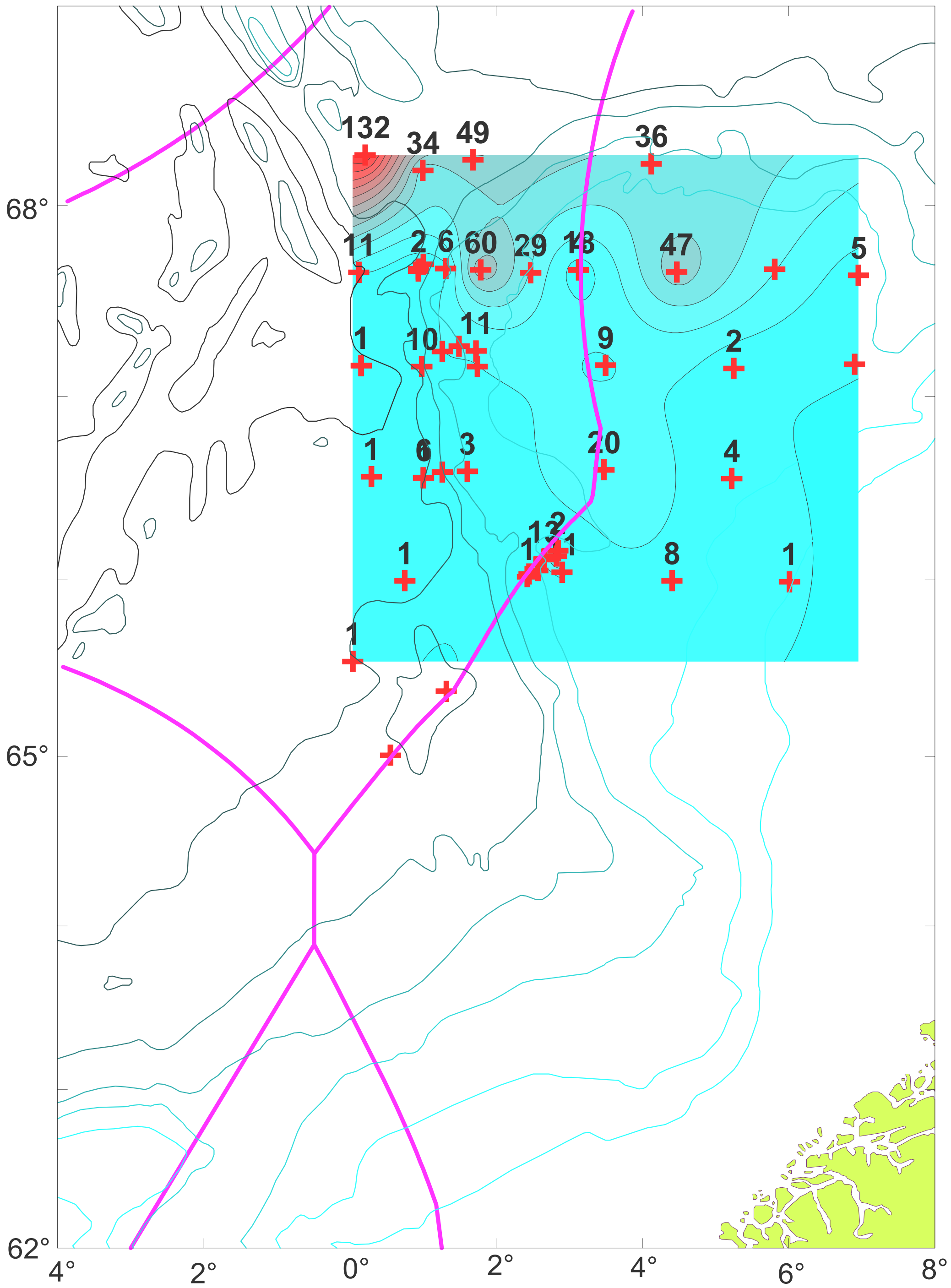


Figure 3.7.2.2. Positions of commercial trawl hauls screened for post-smolts. (Circles in NEZ show positions of screened blue whiting catches containing mackerel as by-catch).

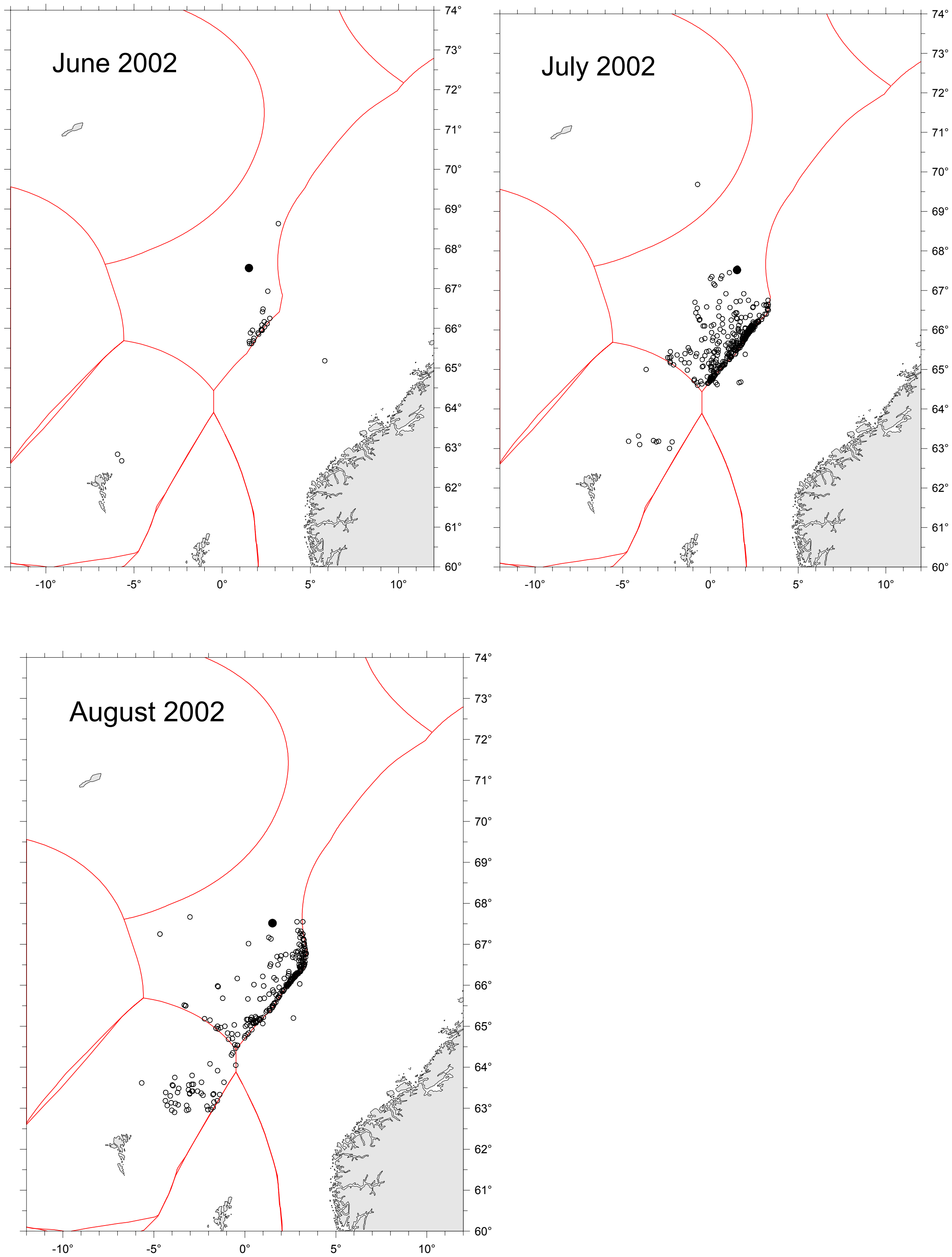


Figure 3.7.2.3. Salmon by-catch in Russian mackerel fishery in 2002.

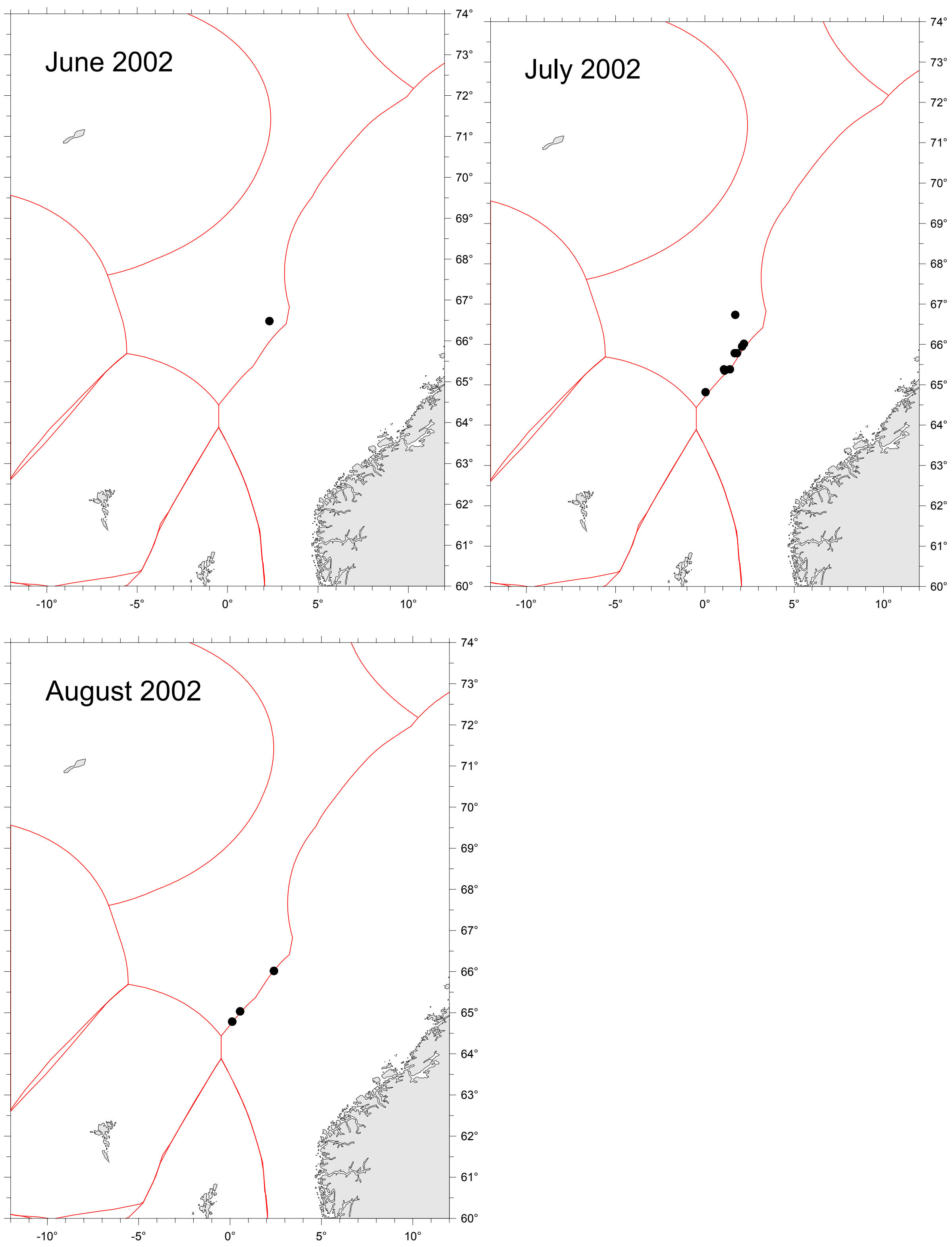


Figure 3.7.2.4. Post-smolt by-catch in Russian mackerel fishery in 2002.

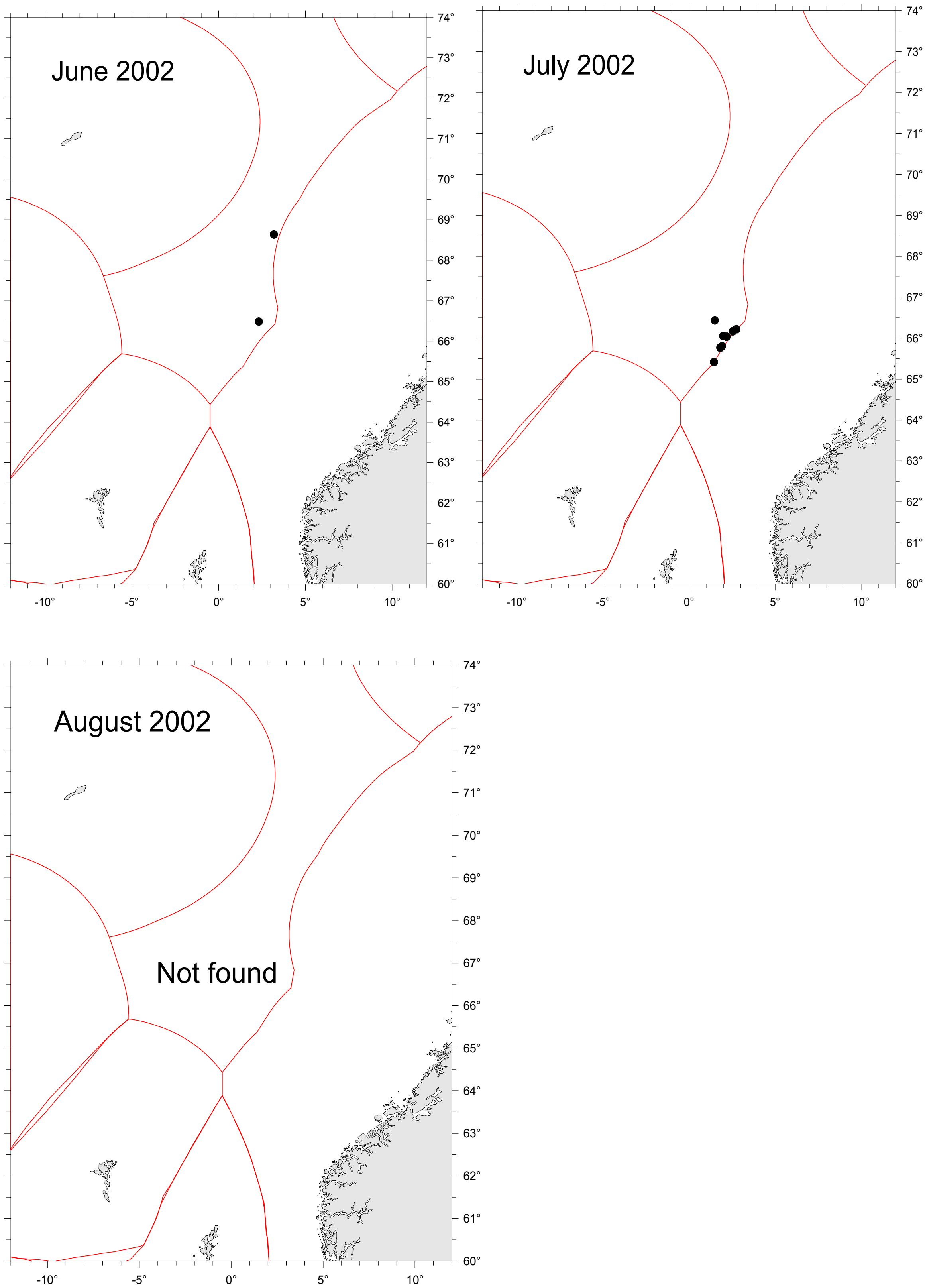


Figure 3.7.3.1. Russian mackerel catches in 1977-2001. (1977-1997 NEAFC database, 1998-2001 WGMHSA 1999-2002).

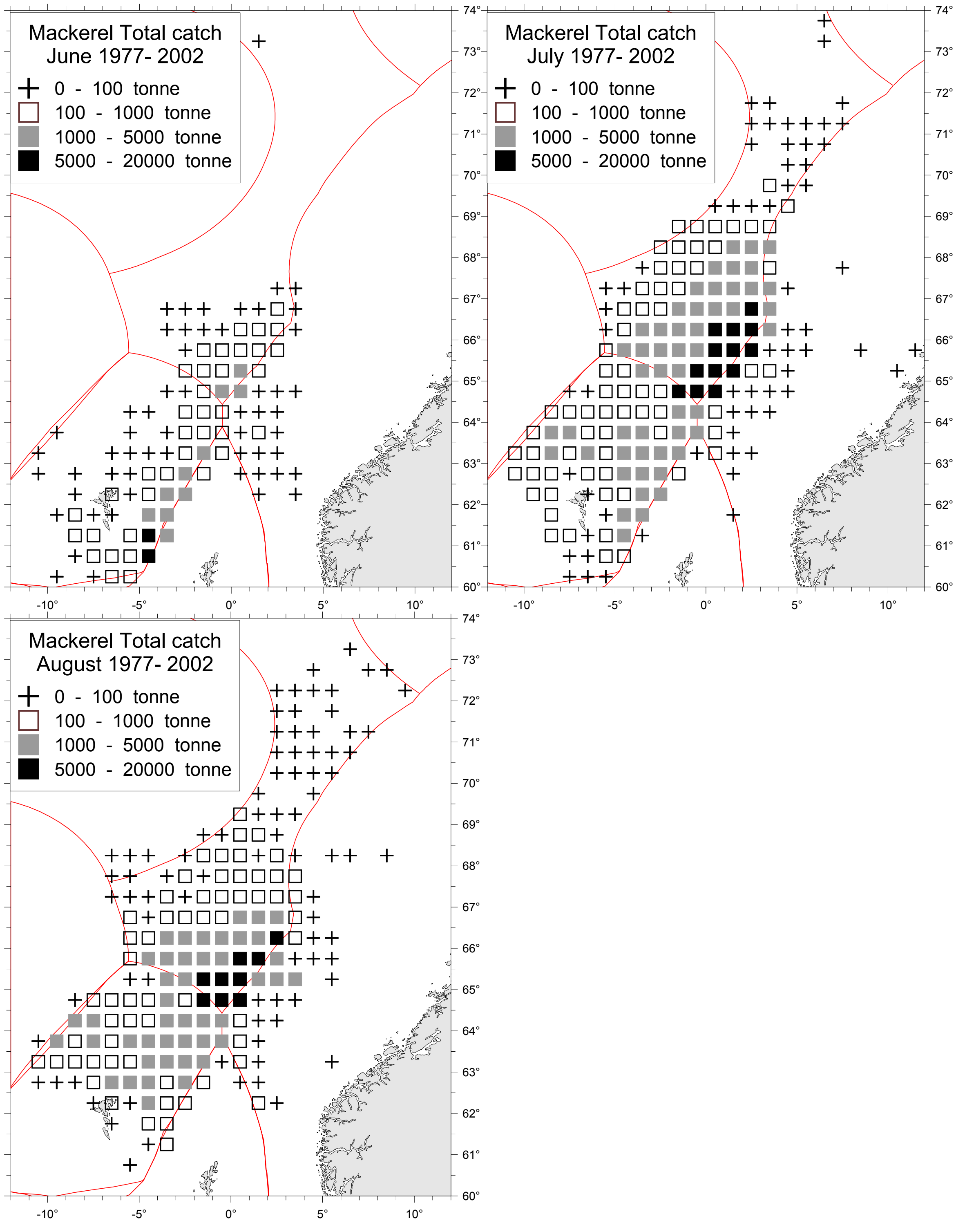


Figure 3.7.3.2. Areas of the Russian mackerel fishery in June-August 2002.

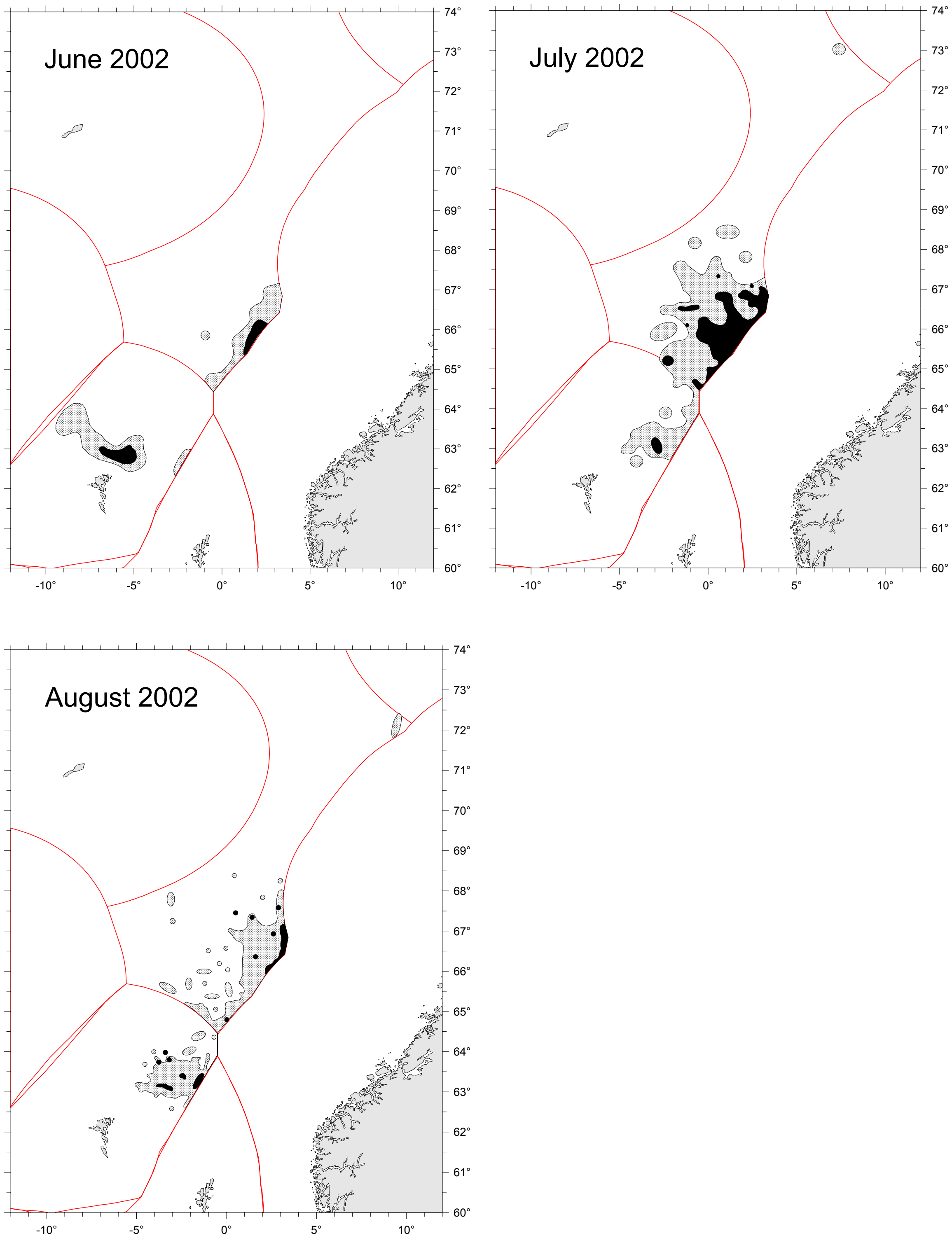


Figure 3.7.3.3. Russian midwater trawl for fishing mackerel.

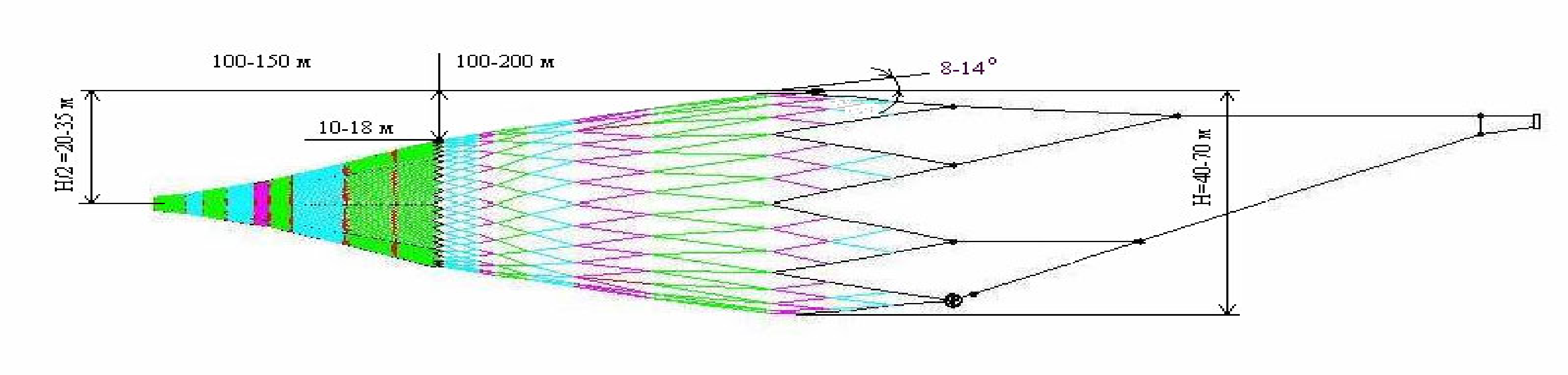
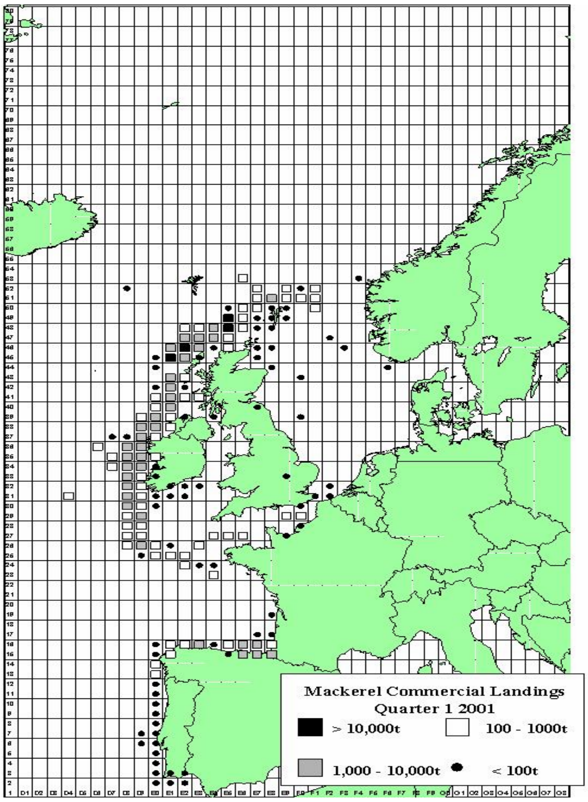
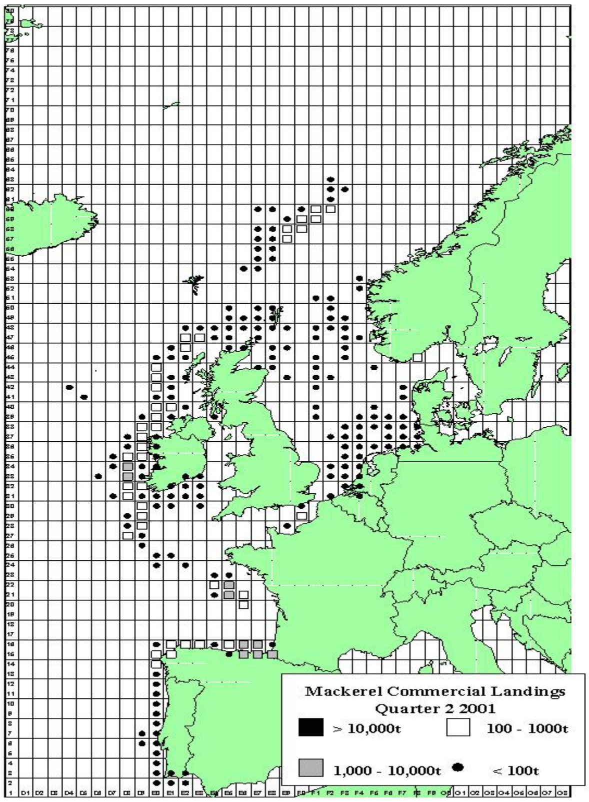
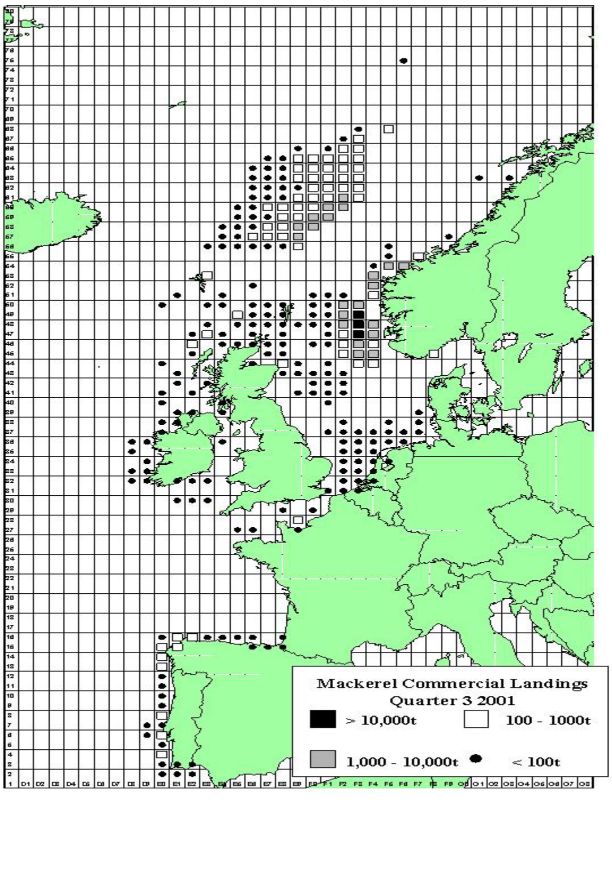


Figure 3.7.3.4. Total mackerel commercial catches by quarters in 2001 (ICES CM 2003/ACFM:07).







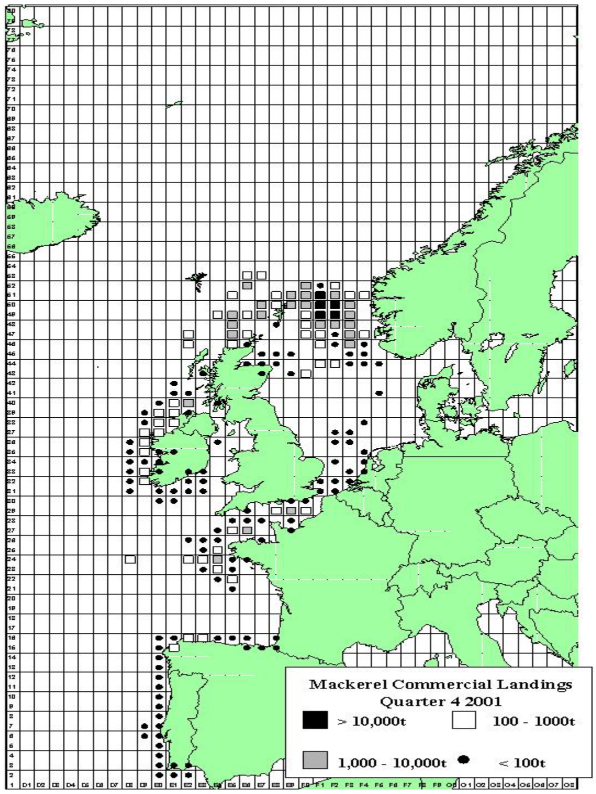


Figure 3.7.3.5. Total catches of Norwegian spring-spawning herring in 2001 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t (ICES CM 2002/ACFM:19).

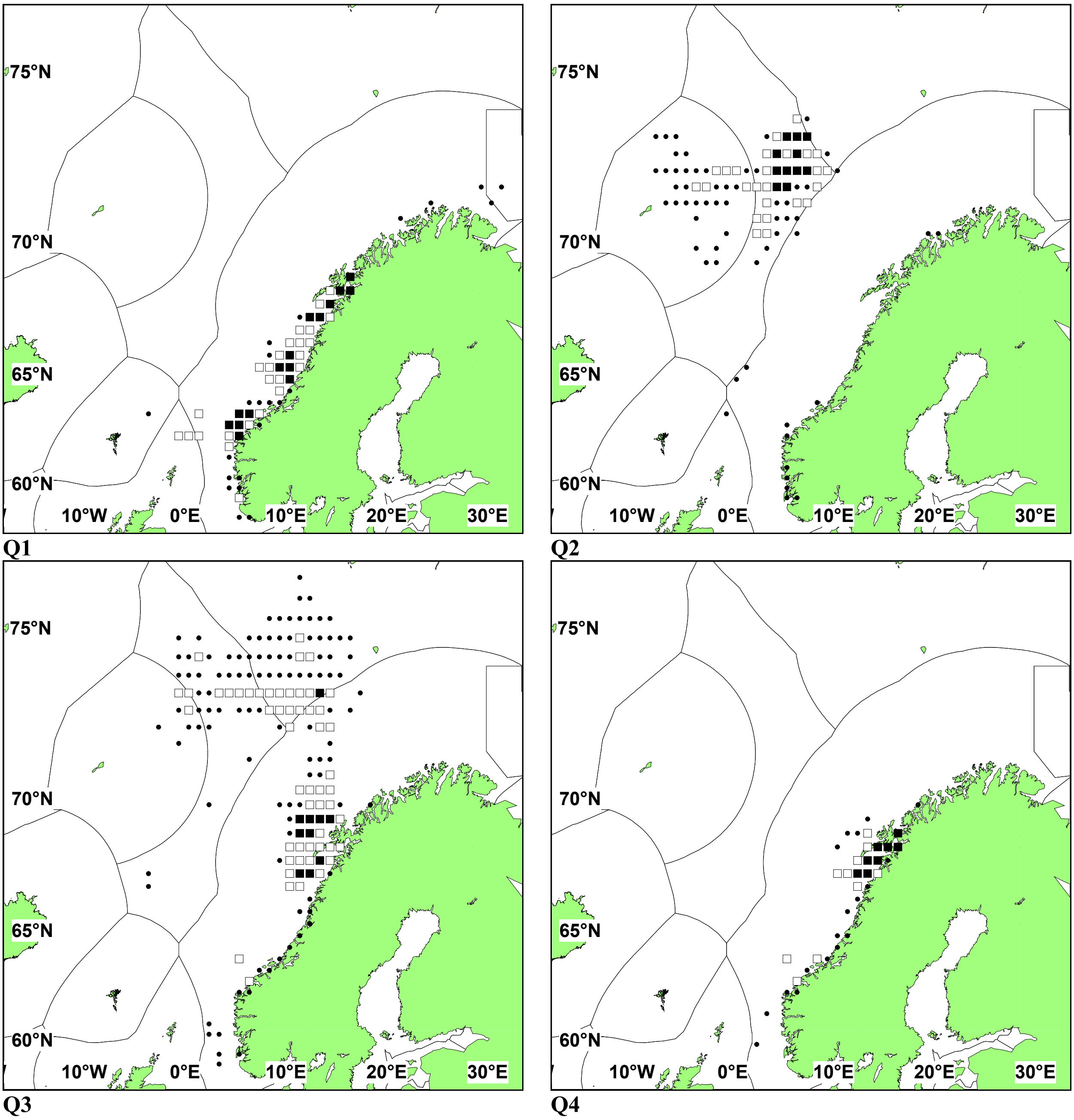


Figure 3.7.3.6 Total catches of blue whiting in 2001 by quarter and ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, gray squares 1 000-10 000 t, and black squares > 10 000 t. (ICES CM 2002/ACFM:19).

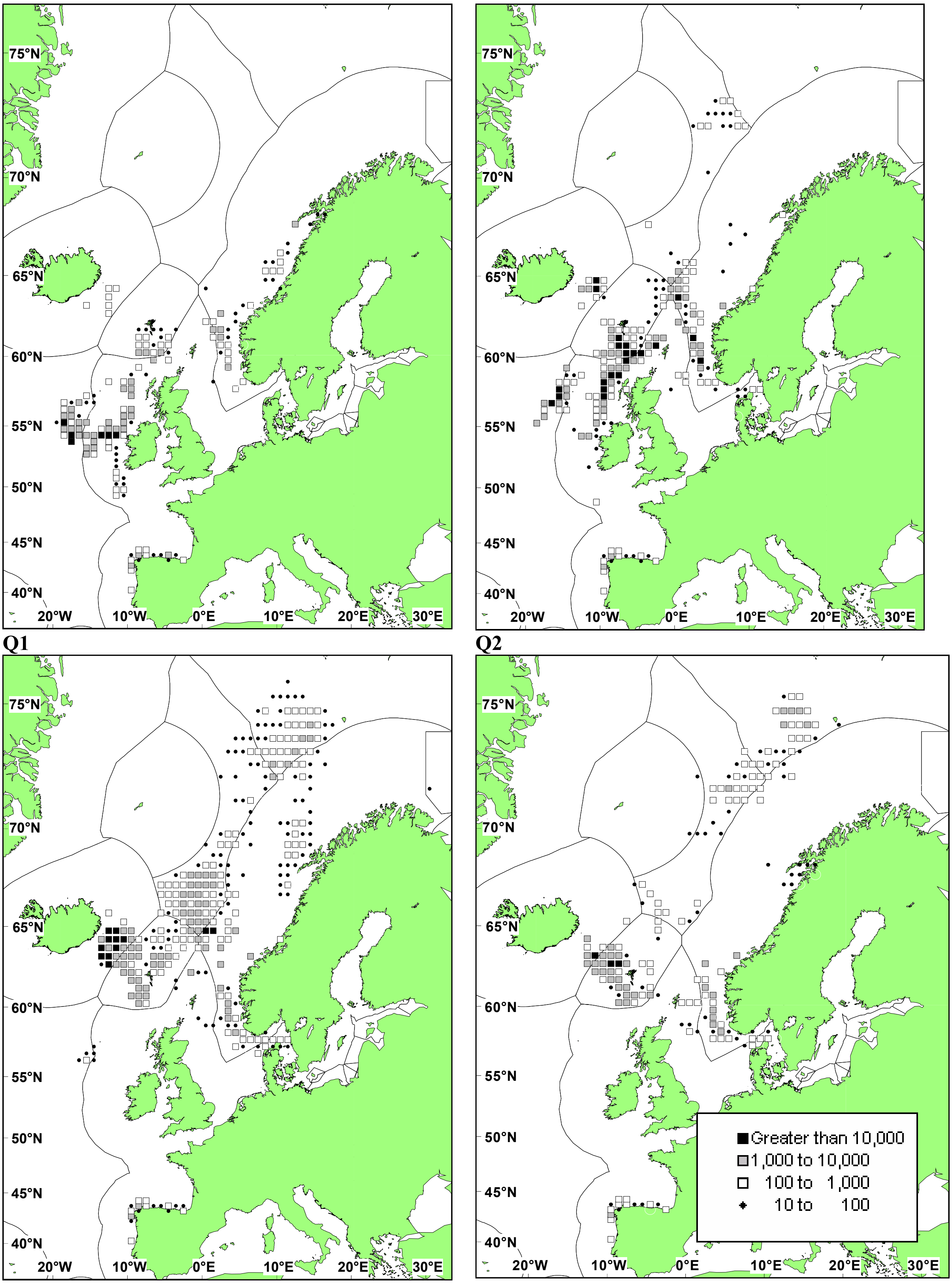
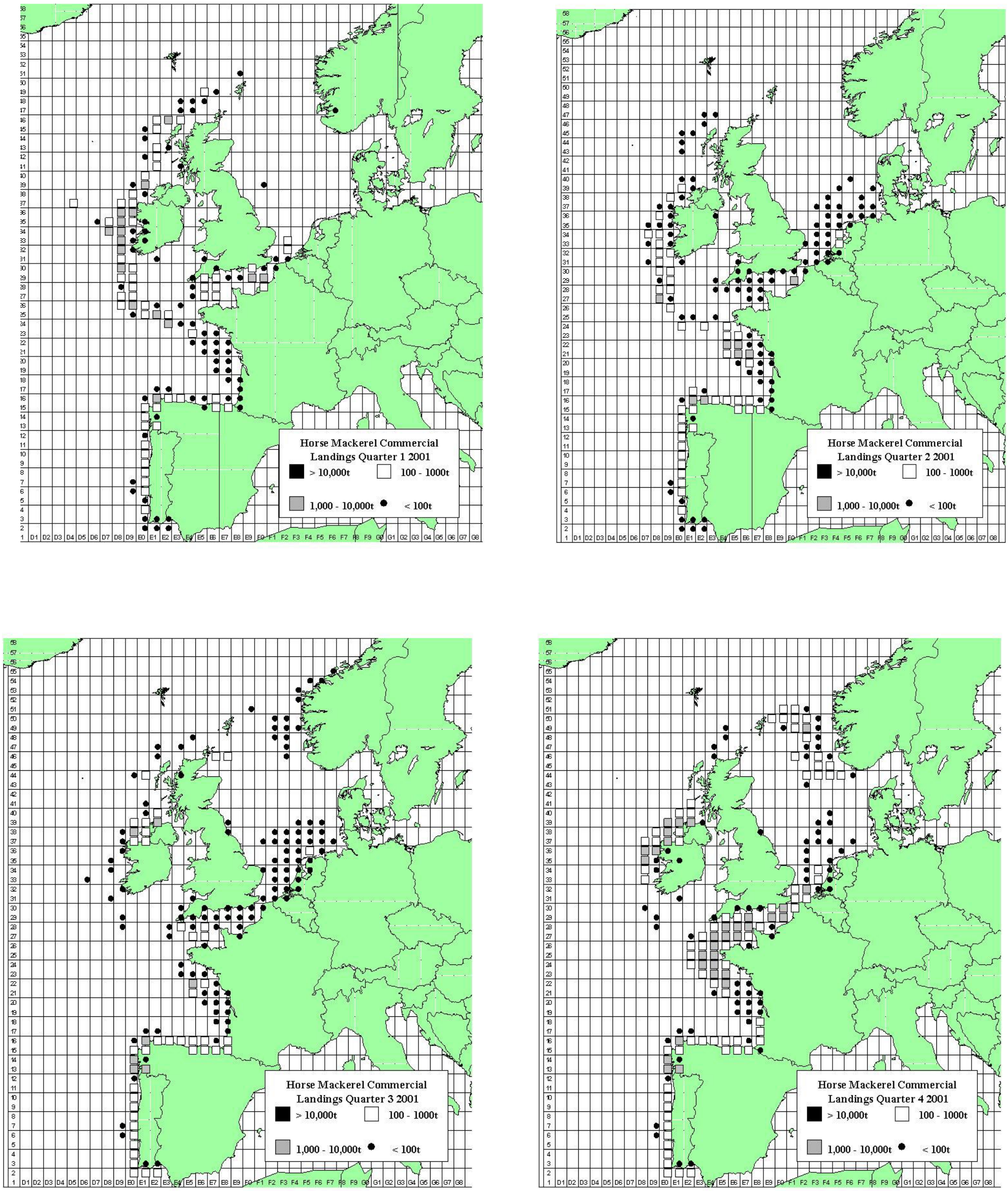


Figure 3.7.3.7. Horse Mackerel commercial catches by quarters in 2001. (ICES CM 2003/ACFM:07).



4 NORTH AMERICAN COMMISSION

4.1 Description of Fisheries

4.1.1 Gear and effort

Canada

The 23 areas for which the Department of Fisheries and Oceans (DFO) manages the salmon fisheries are called Salmon Fishing Areas (SFAs); for Québec, the management is delegated to the 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, generally 1SW, in the recreational fisheries refer to salmon less than 63 cm fork length, whereas in commercial fisheries, it refers to salmon less than 2.7 kg whole weight. Large salmon, generally MSW, in recreational fisheries are greater than or equal to 63 cm fork length and in commercial fisheries refer to salmon greater than or equal to 2.7 kg whole weight.

Three user groups exploited salmon in Canada in 2002: Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. Commercial quotas normally fished by Aboriginal peoples in Ungava Bay (zone Q11) remained closed. Hence there were no commercial fisheries in Canada in 2002.

The following management measures were in effect in 2002:

<u>Aboriginal peoples' food fisheries</u>:

In Québec, Aboriginal peoples' food fisheries took place subject to agreements or through permits issued to the bands. There are 10 bands with subsistence fisheries in addition to the fishing activities of the Inuit in Ungava (Q11), who fished in estuaries or within rivers. The permits generally stipulate gear, season, and catch limits. Catches for subsistence fisheries have to be reported collectively by each Aboriginal 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 Aboriginal peoples groups (mostly First Nations) in 2002. The signed agreements often included allocations of small and large salmon and the area of fishing was usually in-river or estuaries, except in Labrador. Harvests which occurred both within and outside agreements were obtained directly from the Aboriginal peoples. In Labrador (SFAs 1 and 2), food fishery arrangements with the Labrador Inuit Association and the Innu resulted in fisheries in estuaries and coastal areas. There were no food fisheries on the island of Newfoundland in 2002. Under agreements reached in 2002, several Aboriginal communities in Nova Scotia agreed to retain only "adipose clipped" 1SW salmon from five Atlantic coast rivers (Musquodoboit, Sackville, Mushamush, LaHave, and Tusket) in SFA's 20 and 21, using methods that allowed live release of wild fish. Harvest by Aboriginal peoples with recreational licenses are reported under the recreational 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 salmon of any size while fishing for trout and charr; four salmon tags accompanied each license. All licensees were to complete logbooks.

<u>Recreational fisheries</u>:

Unless otherwise determined by management authorities, licenses are required for all persons fishing recreationally for Atlantic salmon, gear is generally restricted to fly fishing and there are restrictive daily/seasonal bag limits. Recreational fisheries management in 2002 varied by area (Figure 4.1.1.2). Except in Québec and Labrador (SFA 1 and some rivers of SFA 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 seven and one respectively. Catch-and-release fishing only for all sizes of Atlantic salmon was in effect in SFA 19 of Nova Scotia. In SFAs 20-23 of Nova Scotia and New Brunswick, most rivers were closed to all salmon angling, except for four acid-impacted rivers on the Atlantic coast of Nova Scotia, where retention of small salmon was allowed. As well, eight Atlantic coast rivers of Nova Scotia were opened for a hook and release fishery from June 1 to July 15 in 2002.

A five-year (2002-2006) management plan was introduced in Newfoundland and Labrador in 2002, based upon the river classification system utilized for SFAs 3-14B in 1999-2001. For insular Newfoundland (SFAs 3 to 14A) and the Strait of Belle Isle of Labrador (SFA 14B), retention limits ranged from a seasonal limit of six fish on Class I rivers, to no retention and catch-and-release only on Class IV rivers . Some rivers were closed to all angling and were not assigned a class number. In SFA 1 and some rivers of SFA 2 of Labrador, there was a seasonal limit of four fish, only one of which could be a large salmon, except in those rivers (now Class II) of SFA 2 crossed by the new Trans Labrador Highway, where a seasonal retention limit of two small salmon and no large salmon was imposed.

In Québec, three different fishing permits are sold. The first allows a landing total of seven salmon for the season. The second is a one day permit and allows a landing total of two salmon. The third type of permit is for catch and release only. In the northern zones, the management regimes for Q8,Q9 and Q11 (44 rivers) were applied uniformly to rivers within each zone. Retention of both small and large salmon was generally allowed throughout these northern zones. However fishing was not permitted on the Matamec River and only small salmon could be retained in the sport fishery on the Mingan River. The daily limit was two fish in Q8 and Q9, and one fish in zone Q11. Release of large salmon occurred mainly on a voluntary basis in these zones. The 74 rivers of the southern zones were managed river by river. Fishing was not allowed on 29 rivers, retention of small salmon only was in force on 22 rivers, and retention of small and large salmon was allowed on 23 rivers at the start of the season. However, on these 23 rivers, 16 were further restricted to retention of small salmon only after mid-season reviews.

USA

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

France (Islands of Saint-Pierre and Miquelon)

For the Saint-Pierre and Miquelon fisheries in 2002, there were 12 professional and 42 recreational gillnet licenses issued. Since 1997, the number of professional fishermen has doubled from six to 12 and the number of recreational licenses has increased by six to 42.

Year	Number of Professional Licenses	Number of Recreational Licenses
1995	12	42
1996	12	42
1997	6	36
1998	9	42
1999	7	40
2000	8	35
2001	10	42
2002	12	42

There is no legal limit on the number of professional and recreational licences. However, local authorities have restricted these numbers to 12 (professional) and 42 (recreational) so far, based on the maxima observed since the beginning of the statistics recording on salmon fishing at SPM in 1990.

Due to a sharp decline in other fish resources exploited by the professional fishermen (lumpfish, snow crab and cod), more of them have expressed interest in having salmon licenses and have asked for an increase in the number of licences that could be compensated by a reduction in the number of recreational licences.

4.1.2 Catch and catch per unit effort (CPUE)

Canada

The provisional harvest of salmon in 2002 by all users was 148 t, the same as the 2001 harvest (Table 2.1.1.1; Figure 4.1.2.1). The 2002 harvest was 53,832 small salmon and 8,401 large salmon, 5% more small salmon and 27% fewer large salmon, compared to 2001 (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 the Québec commercial fishery in 2000 (Figure 4.1.2.1). These reductions were introduced as a result of declining abundance of salmon.

The 2002 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 83% 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 2002 (69% by number).

Aboriginal peoples' food fisheries:

Harvests in 2002 (by weight) were up 9 % from 2001 and 3 % above the previous 5-year average harvest.

Aboriginal 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	45.7	68	41
2001	42.1	72	47
2002	45.9	68	43

Residents fishing for food in Labrador:

The estimated catch for the entire fishery in 2002 was 5.9 t, about 2,700 fish (83% small salmon by number).

Recreational fisheries:

Harvest in recreational fisheries in 2002 totalled 47,140 small and large salmon, 5 % below the previous 5-year average and 4 % below the 2001 harvest level and the lowest total harvest reported (Figure 4.1.2.2). The small salmon harvest of 44,518 fish was about the same as the previous 5-year mean. The large salmon harvest of 2,622 fish was a 51 % decline from the previous five-year mean. Small and large salmon harvests were up 3 % and down 53 % from 2001, 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).

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 2002 were closed to retention of all sizes of salmon (Figure 4.1.1.2).

Hook-and-release salmon fisheries:

In 2002, about 54,400 salmon (about 18,700 large and 35,700 small) were caught and released (Table 4.1.2.2), representing about 54% of the total number caught, including retained fish. This was a 7 % decrease from the number released in 2001. Most of the fish released were in Newfoundland (53 %), followed by New Brunswick (33%), Québec (10%), Nova Scotia (4%), and Prince Edward Island (0.4%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, Nova Scotia released the highest percentage (87%), followed by Prince Edward Island (67%), New Brunswick (57%), Newfoundland (55%), and Québec (37%). As has been mentioned in Section

2.1.2, there is some mortality on these released fish, which is accounted for when individual rivers are assessed for their attainment of conservation limits.

Commercial fisheries:

All commercial fisheries for Atlantic salmon were closed in Canada in 2002 and the catch therefore was zero. Catches have decreased from a peak in 1980 of almost 2,500 t to zero currently as a result of effort reductions, low abundance of stocks, and closures of fisheries.

Unreported catches:

Canada's unreported catch estimate for 2002 was about 83 t. Estimates were included for four of five provinces as no estimates were available for New Brunswick. Estimates provided for Newfoundland and Labrador were the same as those estimated in 2001 and estimates were available for only three of five SFAs in Nova Scotia. Estimates were provided mainly by enforcement staff. 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 2002 were:

Stock Area	Unreported Catch (t)
Labrador	4
Newfoundland	45
Gulf	< 1
Scotia-Fundy	< 1
Québec	34
Total	83

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 2002. Unreported catches in the USA were estimated to be zero t.

France (Islands of Saint-Pierre and Miquelon)

The harvest in 2002 was reported to be 3.6 t from professional and recreational fishermen, 67% higher than in 2001 and the largest catch recorded since before 1960 (Table 2.1.1.1). Professional and recreational fishermen reported catching 2,437 kg and 1,153 kg of salmon, respectively. There was no estimate available of unreported catch for 2002.

Year	Catch by Professional Licenses (kg)	Catch by Recreational Licenses (kg)	Total (kg)
1990	1,146	734	1,880
1991	632	530	1,162
1992	1,295	1,024	2,319
1993	1,902	1,041	2,943
1994	2,633	790	3,423
1995	392	445	837
1996	951	617	1,568
1997	762	729	1,491
1998	1,039	1,268	2,307
1999	1,182	1,140	2,322
2000	1,134	1,133	2,267
2001	1,544	611	2,155
2002	2,437	1,153	3,590

4.1.3 Origin and composition of catches

In the past, salmon from both Canada and the USA have been taken in the commercial fisheries of eastern Canada. These fisheries have been closed. The Aboriginal Peoples' and resident food fisheries that exist in Labrador may intercept some salmon from other areas of North America although there are no reports of tagged fish being captured there in 2002. The fisheries of Saint-Pierre and Miquelon catch salmon of both Canadian and US origin (section 4.6). Little if any sampling occurs in these remaining fisheries.

Fish designated as being of wild origin are defined as the progeny of fish where mate selection occurred naturally (eggs not stripped and fertilized 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 at any life stage, were identified on the basis of the presence of marks or 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. Commercial fish-farm escapees were differentiated from hatchery fish on the basis of scale characteristics and fin erosion (especially of the tail).

The returns in 2002 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 noted in the returns to five rivers of the Bay of Fundy and the coast of USA (Saint John, Magaguadavic, St. Croix, Dennys, Union).

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to over 34,000 t in 2002 (Table 2.2.1.1). Escapes of Atlantic salmon have occurred annually. Reports of these escapes have not been made available to the Working Group.

In the Magaguadavic River (SFA 23; Table 4.1.3.1), which is located in close proximity to the center of both the Canadian and USA east coast salmon farming areas, the proportion of the adult run composed of fish farm escapees has been high (greater than 50%) since 1994. Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of adult salmon counts. However, while fish farm escapees have dominated the run in terms of percentages, in absolute terms, their numbers have been trending downwards, with the exception of 2000 (Table 4.1.3.1). Fish farm escapees were also monitored in the St. Croix River (Canada/USA border), and Maine's Dennys, Narraguagus and Union rivers. The St. Croix and Dennys rivers are also in close proximity to the principal USA and Canadian salmon farming areas, whereas the Narraguagus and Union are more to the south, but have a few farm sites located in their vicinity. Percentages of returns that were fish farm escapees in the returns to the St. Croix and Dennys rivers in 2002 were 66% and 20% respectively. In the Union and Narraguagus rivers, fish farm escapees in 2002 made up 55% and 0% of the runs, respectively.

4.1.4 Exploitation rates in Canadian and USA fisheries

Canada

There is no exploitation by commercial fisheries and the only remaining fisheries are for recreation and food.

In the Newfoundland recreational fishery, exploitation rates were available for 12 rivers in 2002. For those rivers with retention of small salmon, exploitation rates ranged from 7% to 41% with a mean value of 14%. All values were about the same as those from 2001.

In the Québec recreational fishery, exploitation rates were available for 38 rivers. Exploitation rates of small salmon ranged from 3% to 69% with a mean value of 38%. Retention of large salmon was permitted on 20 of those rivers; exploitation rate for large salmon ranged from 1% to 25% with a mean value of 12%. Overall exploitation rates by the Québec recreational fishery, using mid-point estimates of total returns and recreational landings, were 23% for small salmon and 8% for large salmon.

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 - 2002, 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 - 2002. Harvests of 53,832 small and 8,401 large salmon in 2002 were less than those of 1997, substantially in the case of large salmon. Exploitation rates in 1997 were estimated to be between 14% and 26% for small and between 15% and 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 2002.

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

1985-2002 patterns of adult returns:

The returns represent the size of the population before any in-river and estuarine removals (Figure 4.2.1.1). These returns can include returns from hatchery stocking but do not account for commercial fisheries removals in Newfoundland, Labrador, Québec, and Greenland. A gradual moratorium closed the Newfoundland, Labrador and Québec commercial salmon fisheries in Canada between 1992 and 2000.

Annual returns of salmon by size group are available for 22 rivers in eastern Canada since 1985. Peak return years differed for regions within eastern Canada (Figure 4.2.1.1). For rivers in Scotia-Fundy, Gulf, and Québec regions, the returns have been generally decreasing since the closures of the Newfoundland and Québec commercial fisheries, showing that factors other than fisheries are influencing marine mortality. Alternatively, the returns to seven rivers in Newfoundland have generally increased since the commercial fisheries closures there in 1992. These Newfoundland stocks mainly mature at 1SW age and seem to have been more heavily affected by the local commercial fisheries. The large salmon are mostly repeat-spawning 1SW fish. The total returns of these seven Newfoundland rivers doubled during 1993 to 2001 from the low levels observed during 1989 to 1991 period (Figure 4.2.1.1).

The returns for 2002 of large salmon in Scotia-Fundy, Gulf, and Québec regions were down by 68, 48, and 31% respectively from 2001, down 66, 43, and 24% respectively from the recent five year average and are at their lowest levels observed during the last 15 years. Large salmon decreased (24%) also in Newfoundland to the lowest value since 1998 and were 39% lower than the recent five year average (Figure 4.2.1.1). Returns of small salmon in 2002 relative to 2001 for the rivers of Newfoundland were approximately the same as 2001 and 27% lower than the recent five year average. In Scotia-Fundy,Gulf, and Québec regions, the returns in 2002 of small salmon increased by 68, 39 and 63 %, respectively from 2001. In Scotia-Fundy the 2002 small salmon return was about equal to the recent five year average, whereas in Gulf and Québec, the small salmon returns were 34 and 41%, respectively, higher than the five year average.

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 by a factor of three. Wild smolt production was estimated in 10 rivers of eastern Canada in 2002. Of these, nine rivers have several years of data (Figure 4.2.1.2). In numerous other rivers, juvenile abundance surveys have been conducted.

In 2002, smolt production improved from the previous year in only two of five monitored rivers in Newfoundland, decreased in both rivers of Québec, and improved in two of three rivers in the Maritimes Provinces (Figure 4.2.1.2). In only three of these monitored rivers was smolt production in 2002 above the previous five-year mean (or the maximum number of years available in that period). These three rivers were all located in Newfoundland.

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 4.2.1.3). In the rivers of the southern Gulf, 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 4.2.1.3). Densities of parr in 2002 remained at high values in the both the Southwest and Northwest Miramichi. In the Restigouche River, both fry and parr densities increased and remained higher than average values since 1986. 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 lethal to salmon. Prognoses for salmon populations in 47 of 65 of these rivers indicate that 40 populations are likely to be extirpated if the trend in low annual marine survival of salmon persists. In the low-acidified St. Mary's River, fry (age 0+) density was at its lowest and older parr (age-1+ and 2+) densities remain low (Figure 4.2.1.3). Trends in densities of age-1+ and older parr in the outer Bay of Fundy (SFA 23) have varied since 1980. Parr densities in the Nashwaak River and Saint John River above Mactaquac Dam have generally declined in accordance with reduced spawning escapements. Although densities increased in 2001, they declined again in 2002 to either average and low values (Nashwaak) or to record lows (Saint John above Mactatquac). During the same period, densities in the Hammond River that have periodically increased since 1984, have now decreased in 2002 to among the lowest values recorded during the past 10 years.

The salmon stock in 33 rivers of the inner Bay of Fundy (SFA22 and a portion of SFA 23) was listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada in 2000 (Section 4.2.6). Juvenile densities remained critically low in 2002.

USA

2002 Adult Returns

Total estimated return to USA rivers was 985. These are the sum of documented returns to traps and returns estimated using redd counts on selected Maine rivers. However, the documented return of Atlantic salmon as determined strictly from returns to traps and weirs in New England was 962. Returns of 1SW salmon were 436, a 64% increase from the 266 in 2001. Returns of MSW salmon were 526, a 32% decrease from the 797 in 2001. 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 (Figure 4.2.1.4). 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.

For five of the eight rivers that comprise the Endangered Gulf of Maine Distinct Population Segment (DPS), redd counts were used to estimate returns because traps or weirs were not present. The total estimated returns in 2002 for the entire DPS was 33 (95% CI = 23-46) originated either from natural spawning or hatchery fry, with two rivers having an estimate of zero. These numbers are down from the 2001 estimates of 98 (95% CI = 81-122) with two rivers having an estimate of zero.

The majority of the returns were recorded in the rivers of Maine, with the Penobscot River accounting for nearly 79% of the total New England returns. The Connecticut River returns accounted for 4.6% of the total and 44% of the adult returns outside Maine. Overall, 46% of the adult returns were 1SW salmon and 54% were MSW salmon. Most returns (88%) originated from hatchery smolts and the balance (12%) originated from either natural spawning or hatchery 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 by applying a variety of methods to 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 the 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.

Canada:

Labrador:

The basis for estimates of 2SW and 1SW salmon returns and spawners for Labrador (SFAs 1, 2 & 14B) prior to 1998 are catch data from angling and commercial fisheries. In 1998-2002, there was no commercial fishery in Labrador and although counting projects took place in 2002 on four 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.

Newfoundland:

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 were derived from exploitation rates estimated from rivers with counting facilities which were 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 were 2SW. Beginning in 1999, the method used in previous years was modified to take into consideration the changes implemented in the 1999-2002 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. Returns and spawners were estimated as documented previously (ICES 2002/ ACFM:14). Catches in 2001 and the calculated exploitation rates were updated and catches in 2002 and exploitation rates were calculated.

The mid-point of the estimated returns (156,400) of 1SW salmon to Newfoundland rivers in 2002 is 6% lower than in 2001 and 26% lower than the average 1SW returns (210,700) 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 (6,100) of the estimated 2SW returns to Newfoundland rivers in 2002 was 9% lower than in 2001 and 25% lower than the recent 5-year average of 8,100 (Figure 4.2.2.2, Appendix 5).

Québec:

The mid-point (34,200) of the estimated returns of 1SW salmon to Québec in 2002 is 65% higher than that observed in 2001 and is 22% higher than the previous five-year mean (Figure 4.2.2.1, Appendix 5).The mid-point (22,400) of the estimated returns of 2SW salmon in Québec in 2002 is 26% lower than that observed for 2001 (Figure 4.2.2.2). Within the 1971-2002 time-series, the 2002 value is the lowest estimated and a substantial decline from the high of 98,000 2SW salmon in 1980.

Gulf of St. Lawrence, SFAs 15−18:

The mid-point (58,900) of the estimated returns in 2002 of 1SW salmon returning to the Gulf of St. Lawrence was a 31% increase from 2001 and it is the highest value since 1996. The low values noted in 1997 through 2002 are low relative to the high value of about 189,000 in 1992 (Figure 4.2.2.1, Appendix 5).
The mid-point (12,000) of the estimate of 2SW returns in 2002 is 47% lower than the estimate for 2001 and the second lowest of the time-series (Figure 4.2.2.2, Appendix 5), the lowest being 1979 at 11,500. Returns of 2SW salmon have declined since 1995 with only slight improvement shown in 2001, relative to the years prior to 1995.

Scotia-Fundy, SFAs 19-23:

The mid-point (12,500) of the estimate of the 1SW returns in 2002 to the Scotia-Fundy Region was a 36% increase from the 2001 estimate, however, it was the third lowest value in the time-series, 1971-2002. Returns have generally been low since 1990 (Figure 4.2.2.1, Appendix 5). The mid-point (1,800) of the 2SW returns in 2002 is 65% lower than the returns in 2001 and the lowest value in the time-series, 1971–2002 (Figure 4.2.2.2, Appendix 5). A declining trend in returns has been observed from 1985 to 2002.

USA:

Total salmon returns for USA rivers in 2002 were based on trap and weir catches (documented returns). Because many of the Maine rivers do not have fish counting facilities, total abundance continues to be underestimated. The 1SW returns to USA rivers in 2002 were 436 fish. This was an increase from the 2001 estimate and larger than both the previous 5-year and 10-year averages. The 2SW returns in 2001 to USA rivers were 504 fish. There were 22 3SW and repeat spawners compared to only 9 in 2001.

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

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 2002/ACFM:14 (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.

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 Aboriginal 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, Aboriginal peoples' food harvests of small (AH_s) and large salmon (AH_l) were included in the reported catches for 1999-2002. 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 Aboriginal peoples' harvests that was 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 $$NC1(i) = [(H\_s(i)_{\{1\text{-}7,14b\}} + H\_l(i)_{\{1\text{-}7,14b\}} * q) * f\_imm] + [(AH\_s(i) + AH\_l(i) * q) * af\_imm], \text{ and}$$

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

As in 1998-2001, the commercial fishery in Labrador remained closed in 2002. 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 beginning in 1998, the time-series also ended. However, in order to estimate pre-fishery abundance it was still necessary to include Labrador returns for 1998-2002. 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 1998-2002 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 0.03 per month (Section 2.3) 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 (1992–2001), and Labrador fishery (1998-2001), 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 2001. This is because pre-fishery abundance estimates for 2002 require 2SW returns to rivers in North America in the year 2003, 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 2001 abundance estimates ranged between 54,615 and 111,372 salmon. The mid-point of this range (82,993) is 29% lower than the 2001 value (117,084) and is the lowest in the 30-year time-series (Figure 4.2.3.1). The most recent five 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 the general decline in recent years is still continuing and current year values are still much lower than the 917,282 in 1975. The Working Group expressed concern over the dramatic decline in the 2001 value and that pre-fishery abundance still remains considerably lower than the conservation limits.

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 1998-2002 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 0.03 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 $\quad MC1(i) = [(1\text{-}f\_imm)(H\_s(i)_{\{1\text{-}7,14b\}} + q*H\_l(i)_{\{1\text{-}7,14b\}})] + H\_s(i)_{\{8–14a\}} + [(1\text{-}af\_imm)(AH\_s(i) + q*AH\_l(i))]$

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 1992–2002 and for Labrador for 1998-2002 to remain consistent with catches used in other years in these areas (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 four 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 2002 (376,296) is 9% higher than in 2001 (345,308) which had increased considerably from the low 1997 value of 331,762, which was the lowest, estimated in the time-series 1971-2002. The reduced values observed in 1978 and 1983–84 and 1994 were followed by large increases in pre-fishery abundance.

Total 1SW recruits (maturing and non-maturing)

Figure 4.2.3.1 shows the pre-fishery abundance of 1SW maturing for the 1971-2002 and 1SW non-maturing salmon from North America for 1971-2001. Figure 4.2.3.2 shows these data combined to give the total 1SW recruits. While maturing 1SW salmon in 1998-2002 have increased over the lowest value achieved in 1997, the non-maturing portion of these cohorts remained unchanged since 1997. As the prefishery abundance of the non-maturing portion (potential 2SW salmon) has been consistently well below the Spawning Escapement Reserve (derived from S_{lim}) since 1993, 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

Egg depositions in 2002 exceeded or equaled the river specific conservation limits in 23 of the 85 assessed rivers (27%) and were less than 50% of conservation limits in 40 other rivers (47%) (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 that were less than 50% of conservation limits. Proportionally fewer rivers in Gulf (0%) and Québec (38%) had egg depositions less than 50% of conservation limits. Only 40% of the Gulf rivers and 33% of the

Québec rivers had egg depositions that equaled or exceeded conservation limits (Figure 4.2.4.1). In Newfoundland, 30% of the rivers assessed met or exceeded the conservation limits and 35% had egg depositions that were less than 50% of limits. Most of the deficits occurred in the east and southwest rivers of Newfoundland (SFA 13). All USA rivers had egg depositions less than 5% of conservation limits (Figure 4.2.4.1).

On assessed rivers, escapements over time relative to conservation limits (S_{lim}) in 2002 in Bay of Fundy/Atlantic coast of Nova Scotia and the Gulf areas and Newfoundland were mostly stable whereas Québec regions decreased in 2002 (Figure 4.2.4.2). The proportion of the conservation limits achieved on three Bay of Fundy/Atlantic coast of Nova Scotia rivers has severely declined, especially since 1989. However, 2002 was the highest of the time series in this area since 1992. For the Québec rivers, spawning escapements declined continually from a peak median value in 1988 with two slight recoveries in 1995 and 1999. In almost all years in Québec, the median proportion of conservation requirements achieved has exceeded the requirements. However, in 2002, the median proportion was the lowest value of the time series at 64% of the conservation limit. This reflects the poor returns of the 2SW salmon observed for all of the Québec areas in 2002. Although high returns of 1SW salmon were noted in Québec, they are almost all males and do not contribute to egg depositions. The rivers of the Gulf of St. Lawrence have also previously been quite consistent in equalling or exceeding the conservation limits. The median escapements were slightly below conservation limits in 2002. Newfoundland rivers in 2002 have shown a small increase to be just over the conservation limit. The exceeding of limits encountered in Newfoundland from 1992 to 2000 corresponded to the commercial salmon and groundfish moratoria initiated in 1992.

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, 1971-2001 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 conservation limits (S_{lim}) 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 - 2002 due to lack of assessment information.

<u>Newfoundland:</u>

The mid-point of the estimated numbers of 2SW spawners (5,800) in 2002 was 9% below that estimated in 2001 (6,400) and was 144% of the total 2SW conservation limit (S_{lim}) for all rivers. The 2SW spawner limit has been met or exceeded in ten years since 1984 (Figure 4.2.2.2). The 1SW spawners (132,800) in 2002 were 5% less than the 140,400 1SW spawners in 2001. The 1SW spawners since 1992 were higher than the spawners in 1989–91 and similar to levels in the late 1970s and 1980s (Figure 4.2.2.1), although in 1995-1996 they were unusually high. There had been a general increase in both 2SW and 1SW spawners during the period 1992–96 and 1998-2001, 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 (15,100) in 2002 was 26% lower than that observed for 2001 and was about 52% of the total 2SW conservation limit (S_{lim}) for all rivers (Figure 4.2.2.2). The spawning escapement in 2002 was the second lowest in the time-series (1971-2002), with 1971 having been the lowest. Estimates of the numbers of spawners approximated the spawner limit from 1971 to 1990; however, they have been below the limits since 1990. The mid-point of the estimated 1SW spawners in 2002 (21,600) was about 55% higher than in 2001 (Figure 4.2.2.1) and similar to the mean value of the previous ten years.

<u>Gulf of St. Lawrence:</u>

The mid-point of the estimated numbers of 2SW spawners (11,500) in 2002 was about 45% lower than estimated in 2001 (20,900) and was about 38% of the total 2SW conservation limits (S_{lim}) for all rivers in this region (Figure 4.2.2.2). This is the seventh time in ten years that these rivers have not exceeded their 2SW spawner limits. The mid-point of the estimated spawning escapement of 1SW salmon (42,100) increased by 42% from 2001 and was the fourth highest in the last ten years. The abundance remains low relative to the peak (154,000) 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 (1,500) in 2002 is a 68% decrease from 2001, the lowest in the time series, 1971-2002 and is about 6% of the total 2SW conservation limits (S_{lim}) for rivers in this region (Figure 4.2.2.2). Neither the spawner estimates nor the conservation limits 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. The mid-point of the estimated 1SW spawners (12,300) in 2002 is a 37% increase from 2001 and is the eighth lowest in the time-series, 1971-2002. There has been a general downward trend in 1SW spawners since 1990 (Figure 4.2.2.1).

USA:

Spawning 2SW salmon were only 1.7% of their conservation limit (S_{lim}) for all USA rivers combined. Spawners of all age classes (1SW, 2SW, 3SW, and repeat) in 2002 (962 salmon) represented 3.3% of the 2SW conservation spawner limits (S_{lim}) for all USA rivers combined. On an individual river basis, the Penobscot River met 5.6% of its conservation limit while all the other USA rivers (Connecticut, Pawcatuck, Merrimack, Narraguagus, Pleasant, Dennys and all other Maine rivers combined) met less than 1% each.

4.2.4.2 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 3% per month. These values, termed potential 2SW recruits, along with total North American 2SW returns, spawners, and conservation limits (S_{lim}) are shown in Figure 4.2.4.3 and indicate that the overall North American conservation limit 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, conservation limits 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). Furthermore, for 1977, a value was obtained by estimating contributions from Québec and Newfoundland where five year old smolts exist, representing about 9% of the spawners from these two areas.

Except for Labrador, the 2SW spawners to North America have been estimated to 2005. In Labrador, the spawning stock is only known to 1997 and therefore lagged spawners contributing to the pre-fishery abundance can only be completely assembled to the 2002 pre-fishery abundance (Figure 4.2.4.4, Table 4.2.4.4). In Labrador, age-3 smolts contribute about 7% to 2SW returns six years later, or five years later to the pre-fishery abundance.
Spawning escapement of 2SW salmon to several stock complexes has been below S_{lim} (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 these six geographic areas 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 initial increased proportion of the spawning stock from the Gulf of St. Lawrence and, more recently, from Labrador rivers to future recruitment is most noticeable. Only the Newfoundland stock complex has received spawning escapements that have exceeded the area's requirements, all other complexes were below requirement, and most declined further in 2002.

4.2.5 Survival Indices

With the closure of most sea fisheries, counts of smolts and returning adult salmon can provide indices (% smolt survival) of natural survival at sea. These estimates are potentially influenced by annual variation in the size, age and sex composition of smolts leaving freshwater and possibly, annual variation in sea-age at maturity. Data available in 2002 on rivers with smolt counts and corresponding adult counts were from 11 wild and four hatchery populations distributed among Newfoundland (SFAs 4, 9, 11, 13, and 14a), Québec (Q2 and Q7), Nova Scotia (SFA 21), New Brunswick (SFA 16, 23) and Maine (USA).

Plots of percent returns of 1SW and 2SW adults over time (Figures 4.2.5.1 to 4.2.5.4) provide 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:

- Survival of North American stocks to home waters has not increased as expected after closure of the commercial fisheries in 1984 and 1992,
- 1SW survival greatly exceeded that of 2SW fish (except for Maine, where survival of 2SW fish generally exceeds that of 1SW fish),
- Survival of wild stocks exceeded that of hatchery stocks by roughly a factor of 10, and
- Survival of fish from many rivers in North America is low compared to historic levels, especially in the south.

In 2002, estimated return rates for 1SW fish improved somewhat for 10 stocks, declined in two, and was unchanged in two compared to 2001. By contrast, 2SW fish estimated return rates in 2002 improved in one stock, decreased in four, and was unchanged in two compared to 2001.

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.

Sea-age		Number of stocks					
		Relative to 2001			10-Year Trend		
& stock	Province/region	⇧	⇔	⇩	⇧	⇔	⇩
1SW Wild	West & North Nfld	1		1		2	
	South Nfld	2	1			3	
	Québec	1		1		2	
	NS/NB	3					
Hatchery	Québec			1		1	
	NS	1					1
	NB	1				1	
	Maine	1				1	
	Total	10	1	3	0	10	1
2SW Wild	West & North Nfld		1				
	Québec	1		1		1	1
Hatchery	Québec			1		1	
	NS			1			1
	NB			1		1	
	Maine			1			1
	Total	1	1	5	0	3	3

The return rates of 2SW adults from hatchery-reared smolts released in the Penobscot River drainage in 2000 was 0.06%. This was the second lowest rate observed in the time series (Figure 4.2.5.4). Marine survival for this cohort of Penobscot River hatchery-reared smolts continued the downward trend that began in the mid-1980s. However, the return rates of 1SW adults from hatchery-reared smolts released to the Penobscot River drainage in 2001 was 0.07%, which is the second highest survival documented for this adult return age class since 1991.

4.2.6 Atlantic Salmon Recovery and Restoration Actions

Recovery and Restoration Programs

Salmon populations in the southern portion of the range in North America and in isolated locations throughout the range have diminished to levels that require actions to prevent their extirpation. Programs have been initiated or have evolved from previous supplementary stocking programs and now seek to maintain numeric robustness and genetic integrity of affected populations. Programs operate on discrete populations identified through geographic separation, similar phenotypic and life history traits and through genetic typing (Table 4.2.6.1).

Two population segments in North America have been listed as Endangered by their respective national legislation, one listing consists of eight rivers in Maine, USA and the other consists of thirty-three rivers of the inner Bay of Fundy, Canada. Two of the eight listed rivers in the USA have not had returns for two consecutive years. At least two areas in Canada, the Atlantic coast of Nova Scotia and the outer Bay of Fundy have salmon populations that have been extirpated or are perilously close to extirpations. Because of the length of time required to obtain listings and because of uncertainty in the availability of discrete and specific data that are required to attain listings, limited actions have been taken to restore some of these populations before further extirpations occur. Assessed salmon populations of the Gulf of St. Lawrence and those further north persist at sustainable levels and therefore recovery actions in addition to standard fisheries management actions have not been deemed necessary.

In Canada, a legislated Recovery Program is being established for inner Bay of Fundy salmon and operational changes have taken place in supportive rearing programs operating on some of the remaining non-listed residual populations. In the USA formal Recovery Action Plans for the eight listed rivers have been initiated and similar changes have taken place in supportive rearing programs to restore some of the few remaining populations e.g. Penobscot.

Recovery programs for residual populations generally differ from programs that support fisheries in their source of broodstock and distribution of fish. Because sufficient numbers of adult fish with adequate genetic diversity cannot be captured, annual collections of parr are raised to maintain a captive brood population. Brood fish are genetically characterized prior to sexual maturity to guide hatchery-spawning operations and either insures siblings or closely related individuals are not mated or mated according to a designed pedigree. These measures are taken to reduce inbreeding and loss of genetic diversity and fitness. The captive broodstock serve multiple purposes:

(a) provide a reservoir of diverse genetic material to protect from catastrophic losses in the wild;
(b) increase the effective spawning population size (N_e) of each river population;
(c) minimize loss of genetic diversity (genetic bottlenecks) associated with very small populations;
(d) support river-specific stocking strategy to enhance juvenile population abundance; and
(e) provide fish for research.

Stocking into the natal rivers include fry, parr, limited numbers of smolts and redundant mature fish.

In larger rivers of the USA, adult fish are used as egg producers for one or more years, after which they too are returned to the rivers as kelts. River specific juvenile production for the Penobscot River is based on eggs taken annually from returning adults. On the Connecticut River, broodstock include sea run adults, rejuvenated kelts, and captive reared adults. Fry were the most numerous life stage of Atlantic salmon stocked into USA rivers, although other life stages are stocked (Table 4.2.6.1).

In the Saint John River, Canada, the focus of fish culture is changing from restoration to recovery. More juveniles are being grown to adult stages for release in the upper tributaries of the river. These actions have been necessary because of reduced adult returns (Table 4.2.6.1).

In addition to protecting populations, there are efforts underway to protect and restore freshwater habitat. These include: regulating water withdrawals for irrigation, reducing point and non-point source pollution, protecting riparian land, improving passage and habitat connectivity, reducing escapes from fish culture and aquaculture rearing facilities, instream habitat restoration. In addition, attempts are being made to use the link between Atlantic salmon survival and air quality to affect air and water quality policy.

Donor Stock Programs

In some rivers of the USA where stocks were extirpated and broodstock is being developed, donor stocks are based on adjacent rivers. In some of these cases, stocking has produced adult returns that are captured and used to complement the donor stock contributions. In others, at least a portion of riverine production will depend on stocking from the donor broodstock. The primary life stage stocked into these rivers is fry numerically, but smolts are a significant component of the programs (Table 4.2.6.1).

In Canada, the opportunity for donor stocking has diminished substantially due to low adult returns and the increased occurrence of the more space-demanding recovery programs.

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 1993–2001 was the lowest in the time-series (Figure 4.2.3.2) with 2001 at 428,300 being the lowest point. During 1993 to 2000, the total population of 1SW and 2SW Atlantic salmon was about 600,000 fish, about half of the average abundance during 1972 to 1990. A further 50% decrease has occurred between 2000 and 2001, the most recent year for which it is possible to estimate the total population. 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 in 2002 of 2SW fish are at or near the lower end of the 32-year time-series (1971-2002). In Newfoundland, the 2 SW salmon are a minor age group component of the stocks in this area and even here, decreases of about 30% have occurred from peak levels of a few years ago. Returns of 1SW salmon generally increased from the extremely low values of 2001 in all areas except Newfoundland.

The rank of the estimated returns in 2002 in the 1971–2002 time-series for six regions in North America is shown below:

Region	Rank of 2002 returns in 1971-2002 (1=highest)		Rank of 2002 returns in 1993-2002 (1=highest)		Mid-point estimate of 2SW spawners as proportion of conservation limit (S_{lim})
	1SW	2SW	1SW	2SW	(%)
Labrador	Unknown	Unknown	Unknown	Unknown	Unknown
Newfoundland	25	11	8	8	144
Québec	13	32	4	10	52
Gulf	21	31	5	10	38
Scotia-Fundy	28	32	7	10	6
USA	12	31	2	9	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 in North America were generally decreased from 2001 often to record low values, while small salmon returns increased. Any increases however in small salmon returns were from often record low values in 2001. For the rivers of Newfoundland, large salmon returns decreased from 2001, but remained high relative to the years before the closure of the commercial fisheries. 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.

Egg depositions in 2002 exceeded or equaled the river-specific conservation limits (S_{lim} for eggs) in 23 of the 85 assessed rivers (27%) and were less than 50% of conservation in 40 other rivers (47%). 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 limits. Proportionally fewer rivers in Gulf (0%) and Québec (38%) had egg depositions less than 50% of conservation. Only 40% of the Gulf rivers and 33% of the Québec rivers had egg depositions that equaled or exceeded conservation. In Newfoundland, 30% of the rivers assessed met or exceeded the conservation egg limits, and 35% had egg depositions that were less than 50% of limits. The deficits mostly occurred in the east and southwest rivers of Newfoundland (SFA 13) and in Labrador. All USA rivers had egg depositions less than 5% of conservation limits.

In 2002, the overall conservation limit (S_{lim}) for 2SW salmon was not met in any area except Newfoundland. The overall 2SW conservation limit for Canada could have been met or exceeded in only nine (1974-78, 1980-82 and 1986) of the past 31 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, conservation limits could not have been met even if all terminal harvests had been eliminated. It is only within the last decade that Québec and the Gulf areas have failed to achieve their overall 2SW salmon conservation limits.

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 2002. 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.

Based on the genera1ly increased 1SW returns in 2002, some modest improvement is expected for large salmon in 2003, however, this improvement will be from usually record low returns of large salmon in 2002. An additional concern is the low abundance levels of 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.

4.3 Evaluation of management measures

The management of Atlantic salmon in eastern North America has focused on the management of spawning escapement to meet or exceed conservation limits. Significant measures introduced in the last five years in order to meet this objective have included the closure of all commercial fisheries in eastern Canada as of 2000, the complete closure of numerous rivers to any fishing including Native and recreational fisheries, and the imposition of catch and release only access in others. The Working Group (ICES 1997/Assess:10, ICES CM 2002/ACFM:14) considered specifically the impact of the 1992 Newfoundland commercial fishery moratorium on the objective of reducing exploitation and meeting conservation limits. Within Newfoundland, the commercial fishery closure resulted in increased escapements of both small and large salmon, increased catches of large salmon increased escapements of both size groups. However in some areas, the increased escapements did not always result in increased smolt production nor were the increased escapements realized in all areas. The latter response indicates that factors other than fishing were impacting on survival of Atlantic salmon at sea.

Management measures may have impacts on Atlantic salmon stocks beyond changes in abundance of returning and spawning Atlantic salmon. The Working Group reviewed some examples of biological characteristics of stocks which may change as a consequence of changes in fishing exploitation (Section 2.4.3). These included changes in spawning escapement, juvenile abundance, age structure and composition, survival rates, size-at-age and run-timing. Of the changes resulting from reductions in fisheries, changes in spawning escapement and subsequently juvenile production are the most anticipated. Looking back three decades at the performance of some Maritime provinces stocks to changes in fisheries management, spawning escapements responded initially to the 1984 management plan (closure of commercial fisheries and mandatory catch and release of large salmon throughout the Maritimes) but the higher escapements were not sustained into the 1990s (Fig. 2.4.3.1). Juvenile abundance has generally increased in the Miramichi River but a statistically significant response in this abundance was not observed until six years after the increases in escapement (Fig. 2.4.3.1).

Reduced exploitation on large salmon in the in-river and estuarine fisheries of the Miramichi has resulted in an expanded age structure in which repeat spawners have comprised as much as 50% of the large salmon returns. Particularly notable is that since 1995, salmon with six previous spawnings have been observed in the returns to the Miramichi and salmon on the third to fifth spawnings are more abundant (Fig. 2.4.3.3; Table 2.4.3.1). That it took over 11 years after the management plan of 1984 to see these older salmon is consistent with the time required for the first maiden fish of 1984 to reach that sea age (9 sea years of age). Alternate repeat spawners undertake feeding migrations to West Greenland as evidenced from Carlin tag returns from that fishery of salmon tagged in the Miramichi on their spawning migrations the previous year.

There are fewer repeat spawner components in the Saint John River than in the Miramichi and there has not been any change in relative proportions over time as was seen in the Miramichi (Table 2.4.3.2). The post-spawner survival in the Saint John River is likely constrained by downstream fish passage through 2 to 3 hydro-generating facilities which cannot be managed like the fishing exploitation rates on the Miramichi stock. For the Saint John River, therefore, reduced fisheries exploitations have not resulted in improved post-spawner survivals.

The repeat spawning return rates of 1SW maiden salmon have not increased significantly over the past 30 years (Fig. 2.4.3.4). The returns rates are relative to maiden fish prior to in-river exploitation, and since there is exploitation of this age group by both the Native and recreational fisheries, survival of maiden fish to a second return was expected to be lower. In addition to being more abundant in recent years, repeat spawners from the Miramichi grow substantially between spawning events. These larger fish of proportionally greater abundance in the river are of interest to the recreational fishermen, produce more eggs per fish than maiden spawners, and provide a buffer to the annual spawning escapement when smolt to maiden spawner survivals are low.

Over the 1971 to 2002 period, the average length of 1SW and 2SW maiden salmon has increased. The 2SW salmon from the Miramichi River during 1999 to 2002 are the largest of the time series (Fig. 2.4.3.6) and the mean size increased in 1986, two years after the home water commercial fishery moratorium. The mean size of 1SW salmon of the last four years were also the largest of the time series (Fig. 2.4.3.6) and the change in size was also first observed in 1986. Moore et al. (1995) suggested that the stepped change in mean length-at-age of 1SW salmon which occurred post 1984 was evidence of a size-selective fishery on these fish. The change in size was also observed for the 2SW fish, however, it is not obvious how the fishing gear could have been selecting the larger 2SW salmon. Similar increases in mean size of 1SW salmon were observed in the Nashwaak River and the Saint John River, both Bay of Fundy stocks. The mean size in the last three years of both 1SW and 2SW salmon have been average to less than average for the 1986 to 2002 period (Fig. 2.4.3.6). Similar to the Miramichi, the change in mean size also first occurred in 1986. It is possible that exploitation with nets was still taking place on these stocks in 1984 and 1985.

Many historical commercial fisheries were prosecuted early in the season and frequently not in proportion to the timing of the fish entering the river. Evidence of the effect of fisheries exploitation in coastal waters on time of entry of salmon to rivers was evident in the time series of catches at the estuary trapnet in the Miramichi. The 50th percentile count of large salmon at the trapnet in the 1950s and 1960s was post Sept. 1 but became progressively earlier in 1970 to 1972 following the closure of the directed commercial fisheries in the Maritimes and in the last part of the time series, the median date oscillated around mid-August (Fig. 2.4.3.7).

With management of salmon fisheries in eastern Canada now restricted mainly to home rivers, a number of stock characteristics were expected to have changed. Most notably, the mean size-at-age of salmon has increased in many rivers in which net fisheries of salmon historically occurred. Reduced exploitation in both the marine and freshwater environments has benefited the Miramichi River by providing repeat spawners as a buffer to the maiden salmon population when the latter is low.

4.4 Update of age-specific stock conservation limits

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

The Working Group has been providing advice on 2SW salmon stock conservation limits for over a decade, and changes from year to year have been documented in annual Working Group reports. Stock-recruitment curves that formed the basis of conservation requirements can be found in Prevost and Chaput (2001), Chaput (1997), and ICES 1994/M:6.

The conservation limits for USA rivers were reviewed in 1995 (ICES 1995/Assess:14). A review of the spawner limits for Canada was conducted in 1996 (ICES 1996/Assess:11), and were further refined by O'Connell *et al* 1997. This publication provided for the first time a comprehensive list of references documenting the methodologies and origins of the parameter values used to derive egg and spawner conservation limits throughout Atlantic Canada. Conservation limits so derived were adopted by the working group in 1998 (ICES CM 1998/ACFM:15). Limits were generally set on the basis of egg deposition densities which provided for MSY on a limited number of stocks where data was available, and such densities were used on the remainder of rivers where only habitat area and spawner demographics were available as documented in O'Connell *et al* 1997. The added production from lacustrine areas in Newfoundland and Labrador was also accommodated.

In 2000, a further refinement of the conservation limits was considered by the Working Group, specifically for stocks in Québec (ICES CM 2000/ACFM:13). Stock-recruitment analysis for six Québec rivers was used to define the conservation limit, defined as the S_{MSY} level at 75% probability level calculated by Bayesian analysis. A relationship between conservation limits and habitat production units was applied to all rivers after calculating production units for each river by means of aerial photography and habitat suitability indices specific to those Québec rivers. Overall, the conservation limit for 2SW salmon in Québec decreased by over 50% from that previously used by the Working Group and has resulted in the values currently used.

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, 1972-2002, are provided in Tables 4.5.1 and 4.5.2. and expressed as 2SW salmon equivalents. The Newfoundland-Labrador commercial fisheries historically was a mixed stock fishery and 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 3 % per month for 13 months, and 2SW harvests in these same fisheries have been adjusted by one month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. Starting in 1998, the Labrador commercial fishery was closed. An Aboriginal Peoples' fishery occurred in 1998 - 2002 that 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 which started in 2000 is included. 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). The terminal fisheries areas included coastal and river catches of all areas, except Newfoundland and Labrador where only river catches were included. Mortalities within North America peaked at about 365,000 in 1976 and are now about 10,000 2SW salmon equivalents. In the most recent four years estimated (that is those since the closure of the Labrador commercial fishery), those taken as non-maturing fish in Labrador comprise 3%, or less, of the total in North America.

Of the North American fisheries on the cohort destined to be 2SW salmon, 86% of the catch comes from terminal fisheries in the most recent year. This value has ranged from as low as 20% in 1973, 1976 and 1987 to values of 77-91% in 1996-2002 fisheries (Table 4.5.1). The percentage increased significantly with the reduction and closures of the Newfoundland and Labrador commercial mixed stock fisheries, particularly since 1992.

Table 4.5.2 shows the mortalities expressed as 2SW equivalents in Canada, USA, and Greenland for 1972–2001, by applying a mortality of 3 % per month for 11 months to the estimates of harvests of 1SW non-maturing North American salmon in the Greenland fishery. 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 have been harvested in North American waters has ranged from 48-100%, with the most recent year estimated at 58%. 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 2003 for 2SW maturing fish is based on a new forecast of the 2002 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2002 as 1SW non-maturing fish. The second is a new estimate for 2004 based on the pre-fishery abundance forecast for 2003 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 2003 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 2002 is provided below.

Catch Options for 2002 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	91,807	0
30	99,352	0
35	107,418	0
40	115,459	0
45	123,662	0
50	133,087	0

This value of 133,087 at the 50% probability level is much lower than the value forecast last year at this time of 329,552 (See Section 5.5.2 for more detailed derivation of the models used). A pre-fishery abundance of 133,087 in 2002 can be expressed as 2SW equivalents by considering natural mortality of 3% per month for 11 months (a factor of 0.718924), resulting in 95,679 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 2002 for both the Labrador (299) and Greenland (1,499) fisheries (Tables 4.5.1 and 4.5.2) for a total of 1,798 2SW salmon equivalents already harvested, when the mortality factor is considered.

The table above uses the probability density projections for the revised pre-fishery abundance estimate of 133,087 (at 50% probability), converts them to 2SW salmon equivalents and subtracts the 2SW conservation limit (S_{lim}) of 152,548 and the harvests in Greenland and Labrador of 1SW non-maturing salmon that have been converted to 2SW salmon equivalents (from Tables 4.6.1 and 4.6.2). The calculation is as follows:

[(PFA_i – harvest in Greenland in 2002 of 1SW non-maturing fish) x exp - (0.03 *11 months)]
minus
[harvest in Labrador in 2002 of 1SW non-maturing fish x exp –(0.03*13 months)]
minus
the conservation limit
where PFA_i = values from 25–50%
conservation limit = 152,548

From the text table above, there are no harvest possibilities at forecasted levels considered risk-neutral or risk-averse, that is, at probability levels of 50% and below. 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.

Regional assessments in some areas of eastern North America provide a more detailed consideration of expectations for 2003, taking into consideration the contribution of all sea ages of salmon to the spawning population. By area, these are:

Labrador:

As there has been a lack of long-term monitoring facilities in Labrador, there is little information available to comment on expectations for 2003 and beyond.

Newfoundland:

There are no forecasts available for returns of small and large salmon in 2003. The majority of returns are small salmon and their return depends mainly on marine survival which has been quite variable. Exploitation in Newfoundland occurs primarily on maturing 1SW salmon.

Gulf:

In all rivers of the Gulf Region, large salmon returns and spawners in 2002 declined from 2001 and spawning escapement was below or at the conservation requirement. Small salmon abundance was above the previous five year average abundance and improved substantially from 2001. Exploitation on salmon in the Gulf region is restricted to retention of small salmon in the recreational fisheries and an allocation of large salmon to the native fisheries. Harvest rates on large salmon resulting from catch and release mortality and native fisheries has been rarely above 10% and usually less than 5%. The majority of the egg depositions come from large salmon which are predominantly females with some additional eggs from the small salmon which can be comprised of upwards of 25% female but are more often less than 10% female. The largest salmon producing river, the Miramichi, did not meet the conservation requirements in 2002, the fourth time in five years and the outlook for 2003 is for an improved return of large salmon greater than in 2002 and about 75% chance of meeting the conservation requirement in the Miramichi River overall. Because the majority of salmon returning to the Morell (91% in 2002) and to other PEI rivers (SFA 17) are of hatchery origin, current fisheries have little impact on future runs. In all areas of the Gulf, with the exception of the southeast New Brunswick rivers which are closed to salmon fishing, juvenile abundance in rivers are at historical high levels.

Scotia-Fundy:

Expectations that salmon returns in 2003 will meet or exceed conservation limits among 11 assessed rivers of the Atlantic coast of Nova Scotia range from zero to about 20%. Harvest in home waters is dependent on bi-weekly in-season assessments beginning June 15, at two monitoring facilities, Morgans Falls fishway on the LaHave River and at Mactaquac dam fishway on the Saint John River. Under the existing fisheries management strategy, harvest fisheries including aboriginal, hook and release recreational fishery or retention of small salmon in the recreational fishery would only be considered if the probability of achieving the conservation limit was greater than 75%. Supportive rearing programs are expected to move away from fisheries support objectives and toward population maintenance by rearing parr to mature adult spawners, pedigree breeding and earlier ages for stocking.

Québec:

There were 65% more 1SW returns in 2002 than in 2001, and the 2002 value was similar than the 1992-2001 mean. Returns of large salmon in 2002 are expected to increase by a range of 15% to 25% over 2001 and be similar to the previous 10 year mean. This level of increase should be sufficient for attainment of conservation limits on a majority of rivers, but not on all. Consequently, retention of large salmon is not expected to be permitted on 39 rivers.

USA: Salmon returns (both large and small) in 2003 are not expected to be sufficient to meet conservation limits in any river, including those receiving hatchery stocking.

4.5.2 Catch advice for 2004 fisheries on 2SW maturing salmon

Most catches (92%) 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 2003 (111,042 at the 50% probability level) would apply principally to North American fisheries in 2004 and hence the level of fisheries in 2003 needs to be accounted for before providing these catch options. Assuming probability values at 50 % and below, accounting for mortality and the conservation limit and considering an allocation of 60% of the surplus to North America, would yield catch options in 2SW salmon equivalents of zero fish. This zero catch option refers to the composite North American fisheries. As the biological objective is to have all rivers reaching or exceeding their conservation limits, river-by-river management will be necessary. On individual rivers, where conservation limits are being achieved, there are no biological reasons to restrict the harvest.

4.6 Biological sampling program for the Islands of Saint-Pierre and Miquelon

A small Atlantic salmon fishery occurs off the coast of Saint-Pierre and Miquelon. A total of six tag returns of North American origin have been reported from this fishery since 1976.

Tag code	Country of origin	River of release	Year of release	Recovery date	Total length (cm)	Total weight (g)
BBS75332	CAN	Miramichi River, NB	1974	05/23/1976[1]	77	4,200
BBS84564	CAN	Miramichi River, NB	1973	5/28/1976	80	4,200
BBK78583	CAN	Morell River, PEI	1976	05/21/1977	76	3,975
BBX00427	CAN	Liscomb River, NS	1980	06/17/1981	51	1,200
AW14198	CAN	St John River, NB	1984	06/25/1985	85	3,966
A3458	USA	Penobscot River, ME	1980[2]	06/27/1981	80	3,600[3]

[1]capture response indicates that catch occurred in a research net
[2]fish was tagged as returning adult captured at the Veazie Trap
[3]estimated gutted weight

Fishery generated tag return data are not necessarily representative of the occurrence of tags within the catch. Not all countries/regions have large scale tagging operations, tagging operations are often not representative of countries/regions and internal tags, such as coded wire tags, would not have been detected as there was not a system set up to identify and recover these tags. As well, publicity concerning the existence of past tagging programs and instructions on the procedure to return tags from this fishery was not targeted on this area. Catch composition in terms of country/region of origin can therefore not be determined from these data. However, these types of data do confirm that North American fish from both Canada and USA have both been historically susceptible to capture in the Saint-Pierre and Miquelon fishery.

Given the increase in the number of licensed Saint-Pierre and Miquelon gillnet fishermen (section 4.1.1), the increase in reported catch (Table 2.1.1.1) and the historic tag return data, a biological sampling program is needed to investigate the composition and origin of the Saint-Pierre and Miquelon Atlantic salmon catches. These data are essential to characterize the effects that this fishery may have on the Atlantic salmon populations of North America and, in particular, on their “endangered” populations.

The following types of data are essential to gaining a better understanding of the composition of the Saint-Pierre and Miquelon Atlantic salmon fishery and for determining the effect that this fishery has on the Atlantic salmon resources of North America.

A biological sampling program for the Saint-Pierre and Miquelon gillnet fishery should be an international cooperative effort between USA, Canada, France and the local government of Saint-Pierre and Miquelon. At a minimum, an individual sampler will need to be coupled with a local contact and stationed in Saint-Pierre for a period of 2-3 weeks during the period when the fishery is expected to be prosecuted (June through August). The local contact would be essential for connecting the sampler with individuals who would likely be gillnetting during this period. The sampler would collect information related to fishing effort (description of gear, number of nets fished, soak time etc.) as well as catch (type and amount of species caught). In addition, detailed biological data needs to be collected for each individual Atlantic salmon sampled: including individual length and individual weight data plus a scale and genetic sample (o provide data on origin). The presence or absence of any external tags, clips or marks should also be noted for each individual as well as any abnormal physical features. Additional support from the countries involved could result in an increase of the number of sampling teams. This increase could be used to widen the sampling coverage in both time and space. Increased sampling may be valuable, depending on the spatial and temporal occurrence of the fishery, which is currently unknown.

4.7 Data deficiencies and research needs in the North American Commission Area

Data deficiencies and research needs for the NAC area are presented in Section 6.

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 2002.

	% of provincial harvest			% of eastern Canada	Number of fish
	Native peoples' food fisheries	Recreational fisheries	Resident food fisheries		
		Small salmon			
Newfoundland / Labrador	11.4	80.9	7.6	54.1	29,139
Québec	12.2	87.8	0.0	14.9	8,026
New Brunswick	16.5	83.5	0.0	29.9	16,103
P.E.I.	19.5	80.5	0.0	0.3	149
Nova Scotia	21.9	78.1	0.0	0.8	415
		Large salmon			
Newfoundland / Labrador	59.8	12.6	27.6	19.1	1,606
Québec	61.8	38.2	0.0	75.5	6,342
New Brunswick	100.0	0.0	0.0	3.9	324
P.E.I.	-	-	-	0.0	0
Nova Scotia	100.0	0.0	0.0	0.2	129
Eastern Canada		**% by user group**			
Small salmon	13.2	82.7	4.1		53,832
Large salmon	63.5	31.2	5.3		8,401

Table 4.1.2.2. Hook-and-release Atlantic salmon caught by recreational fishermen in Canada, 1984 – 2002.

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	27,778	6,030	33,808	407	1,303	1,710	3,154	6,689	3,455	8,690	21,988	101	46	147	445	4,008	4,453	**38,574**	**23,532**	**62,106**
2001	21,969	5,137	27,106	527	1,199	1,726	3,094	6,166	3,829	11,252	24,341	202	103	305	809	4,674	5,483	**32,767**	**26,194**	**58,961**
2002	23,993	4,574	28,567	936	1,196	2,132	2,362	7,351	2,927	5,349	17,989	207	31	238	812	4,687	5,499	**35,661**	**18,764**	**54,425**

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

	Dennys			Narraguagus			St Croix			Union			Magaguadavic		
Year	*1SW*	*MSW*	*AQ*	*1SW*	*MSW*	*AQ*	*1SW*	*MSW*	*AQ*	*1SW*	*MSW*	*AQ*	*1SW*	*MSW*	*AQ*
1992													155	138	148
1993													113	124	154
1994				4	47	1	47	37	97	0	0		43	88	1200
1995				0	56	0	15	31	14	0	0		50	29	712
1996				10	54	8	23	109	20	6	63		21	48	240
1997				1	36	0	26	2	42	0	8		33	26	119
1998				1	21	0	32	9	25	2	11		27	4	222
1999				6	26	3	8	5	23	3	6	63	12	12	90
2000	1	1	28	13	10	0	10	10	30	1	1	3	14	0	30
2001	4	13	62	5	27	1	13	7	58	0	0	2	11	6	130
2002	2	0	4	4	4	0	14	6	5	0	5	6	7	0	35

Blank cells-no data available.
All counts come from fish ladders, except the Dennys' River weir

Table 4.2.2.1 Estimated numbers of 1SW returns in North America by geographic regions, 1971 – 2002.

	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	33,115	57,968	11,515	19,525	32	205,241	441,490	323,365
1972	24,675	86,362	109,282	219,412	12,470	18,704	42,195	73,700	9,522	16,915	18	198,161	415,112	306,637
1973	5,399	18,897	144,267	289,447	16,585	24,877	43,653	77,061	14,766	24,823	23	224,693	435,128	329,910
1974	27,034	94,619	85,216	170,748	16,791	25,186	65,663	114,068	26,723	44,336	55	221,481	449,011	335,246
1975	53,660	187,809	112,272	225,165	18,071	27,106	58,607	101,878	25,940	36,316	84	268,633	578,358	423,496
1976	37,540	131,391	115,034	230,595	19,959	29,938	90,292	155,669	36,931	55,937	186	299,942	603,716	451,829
1977	33,409	116,931	110,114	220,501	18,190	27,285	31,311	56,070	30,860	48,387	75	223,959	469,250	346,605
1978	16,155	56,542	97,375	195,048	16,971	25,456	26,003	45,407	12,457	16,587	155	169,117	339,195	254,156
1979	21,943	76,800	107,402	215,160	21,683	32,524	50,771	93,190	30,875	49,052	250	232,923	466,976	349,950
1980	49,670	173,845	121,038	242,499	29,791	44,686	45,688	81,695	49,925	73,560	818	296,929	617,103	457,016
1981	55,046	192,662	157,425	315,347	41,667	62,501	70,085	128,432	37,371	62,083	1,130	362,724	762,155	562,440
1982	38,136	133,474	141,247	283,002	23,699	35,549	79,756	143,370	23,839	38,208	334	307,011	633,938	470,474
1983	23,732	83,061	109,934	220,216	17,987	26,981	25,325	43,905	15,553	23,775	295	192,826	398,233	295,530
1984	12,283	42,991	130,836	262,061	21,566	30,894	37,670	63,906	27,954	47,493	598	230,907	447,943	339,425
1985	22,732	79,563	121,731	243,727	22,771	33,262	61,215	110,517	29,410	51,983	392	258,250	519,444	388,847
1986	34,270	119,945	125,329	251,033	33,758	46,937	114,665	204,378	30,935	54,678	758	339,715	677,730	508,722
1987	42,938	150,283	128,578	257,473	37,816	54,034	86,492	155,985	31,746	55,564	1,128	328,698	674,466	501,582
1988	39,892	139,623	133,237	266,895	43,943	62,193	123,472	223,211	32,992	56,935	992	374,529	749,850	562,189
1989	27,113	94,896	60,260	120,661	34,568	48,407	72,906	129,462	34,957	59,662	1,258	231,063	454,347	342,705
1990	15,853	55,485	99,543	199,416	39,962	54,792	83,611	159,181	33,939	60,828	687	273,595	530,390	401,992
1991	12,849	44,970	64,552	129,308	31,488	42,755	59,671	113,512	19,759	31,555	310	188,629	362,409	275,519
1992	17,993	62,094	118,778	237,811	35,257	48,742	146,460	231,161	22,832	37,340	1,194	342,514	618,342	480,428
1993	25,186	80,938	134,150	268,550	30,645	42,156	89,840	146,770	16,714	27,539	466	297,001	566,419	431,710
1994	18,159	56,888	95,981	192,138	29,667	40,170	55,604	117,491	8,216	11,583	436	208,062	418,705	313,384
1995	25,022	76,453	202,739	435,153	23,851	32,368	25,985	96,813	14,239	21,822	213	292,049	662,821	477,435
1996	51,867	153,553	257,215	559,079	32,008	42,558	50,232	99,456	22,795	36,047	651	414,767	891,344	653,056
1997	66,812	155,963	99,029	146,050	24,300	33,018	27,495	54,429	7,173	10,467	365	225,175	400,292	312,733
1998	-	-	146,371	247,035	24,495	34,301	38,007	69,067	16,770	26,481	403	-	-	-
1999	-	-	156,740	224,959	25,880	36,679	28,847	53,157	10,556	16,901	419	-	-	-
2000	-	-	151,313	260,251	24,129	35,070	40,197	63,543	10,997	18,343	270	-	-	-
2001	-	-	136,949	194,299	16,931	24,437	32,575	58,320	6,752	11,746	266	-	-	-
2002	-	-	126,992	185,819	28,754	39,568	43,649	74,171	9,207	15,870	450	-	-	-

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 – 2002.

	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	29,450	46,846	11,187	16,410	653	81,905	153,310	117,607
1972	3,706	25,168	2,511	9,003	45,094	67,642	35,604	59,953	14,028	19,731	1,383	102,328	182,881	142,604
1973	5,183	35,196	2,995	11,527	49,765	74,647	34,871	59,568	10,359	14,793	1,427	104,600	197,158	150,879
1974	5,003	34,148	1,940	6,596	66,762	100,143	49,044	83,418	21,902	29,071	1,394	146,045	254,771	200,408
1975	4,772	32,392	2,305	7,725	56,695	85,042	31,153	51,874	23,944	31,496	2,331	121,200	210,860	166,030
1976	5,519	37,401	2,334	7,698	56,365	84,547	29,238	51,439	21,768	29,837	1,317	116,541	212,240	164,390
1977	4,867	33,051	1,845	6,247	66,442	99,663	58,774	100,788	28,606	39,215	1,998	162,533	280,963	221,748
1978	3,864	26,147	1,991	6,396	59,826	89,739	30,411	51,505	16,946	22,561	4,208	117,247	200,555	158,901
1979	2,231	15,058	1,088	3,644	32,994	49,491	8,643	14,337	8,962	12,968	1,942	55,860	97,440	76,650
1980	5,190	35,259	2,432	7,778	78,447	117,670	43,359	73,863	31,897	44,823	5,796	167,121	285,189	226,155
1981	4,734	32,051	3,451	12,035	61,633	92,449	17,695	29,615	19,030	28,169	5,601	112,144	199,921	156,033
1982	3,491	23,662	2,914	9,012	54,655	81,982	31,591	51,156	17,516	24,182	6,056	116,222	196,049	156,136
1983	2,538	17,181	2,586	8,225	44,886	67,329	28,987	46,897	14,310	20,753	2,155	95,462	162,540	129,001
1984	1,806	12,252	2,233	7,060	44,661	59,160	20,437	34,150	17,938	27,899	3,222	90,298	143,743	117,020
1985	1,448	9,779	958	3,059	45,916	61,460	22,965	43,606	22,841	38,784	5,529	99,657	162,218	130,937
1986	2,470	16,720	1,606	5,245	55,159	72,560	35,866	71,110	18,102	33,101	6,176	119,379	204,912	162,145
1987	3,289	22,341	1,336	4,433	52,699	68,365	22,289	48,137	11,529	20,679	3,081	94,223	167,036	130,629
1988	2,068	14,037	1,563	5,068	56,870	75,387	25,976	50,039	10,370	19,830	3,286	100,134	167,646	133,890
1989	2,018	13,653	697	2,299	51,656	67,066	17,094	35,461	11,939	21,818	3,197	86,602	143,493	115,047
1990	1,148	7,790	1,347	4,401	50,261	66,352	24,173	53,374	10,248	18,871	5,051	92,228	155,839	124,034
1991	548	3,740	1,054	3,429	46,841	60,724	20,748	44,638	10,613	17,884	2,647	82,452	133,063	107,757
1992	2,515	15,548	3,111	10,554	46,917	61,285	29,406	62,972	9,777	16,456	2,459	94,185	169,275	131,730
1993	3,858	18,234	1,499	5,094	37,023	46,484	25,114	51,446	6,764	11,087	2,231	76,490	134,576	105,533
1994	5,653	24,396	1,902	6,174	37,703	47,180	22,368	58,670	4,379	6,908	1,346	73,351	144,673	109,012
1995	12,368	44,205	3,635	12,592	43,755	54,186	23,490	61,639	4,985	8,317	1,748	89,981	182,686	136,333
1996	9,113	32,759	4,457	14,159	39,413	49,846	20,135	43,167	7,227	12,054	2,407	82,751	154,391	118,571
1997	9,384	23,833	3,887	8,355	32,443	41,017	15,245	34,502	3,645	5,922	1,611	66,214	115,240	90,727
1998	-	-	5,322	12,453	24,358	31,832	7,251	18,426	2,728	6,003	1,526	-	-	-
1999	-	-	4,254	14,262	25,415	33,710	9,808	24,059	3,482	7,107	1,168	-	-	-
2000	-	-	3,176	16,144	24,317	33,992	10,915	23,375	2,038	5,079	533	-	-	-
2001	-	-	2,629	10,679	25,562	35,398	15,761	29,891	3,099	6,902	788	-	-	-
2002	-	-	2,054	10,078	18,700	26,108	6,950	17,042	1,399	2,141	511	-	-	-

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).

	SFA {1}			SFA {1-7, 14b}		SFA {8-14a}		SFA {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	1352	1084	0	0	0	0	0
2000	5323	1673	1352	0	0	0	0	0
2001	4789	1404	1673	0	0	0	0	0
2002	5560	0	1404	0	0	0	0	0

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

i	Year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.03 per month)
t1	Time between the mid-point of the Canadian fishery and return to river = 1 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 Lab
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	102328	182881	642279	819184	730732
1972	200784	15768	37316	203072	248628	104600	197158	636167	847954	742060
1973	241493	21150	51412	223422	262767	146045	254771	767376	1001982	884679
1974	220584	21187	50243	223332	266337	121200	210860	711821	923643	817732
1975	278839	32385	73371	243315	285486	116541	212240	801769	1032796	917282
1976	155896	24285	57005	225424	271703	162533	280963	710550	970471	840510
1977	189709	24323	57902	146535	177644	117247	200555	574920	766372	670646
1978	118853	11796	29813	86644	103079	55860	97440	325305	423344	374325
1979	200061	19478	42242	202634	245013	167121	285189	725526	969725	847626
1980	187999	31132	70739	186367	228568	112144	199921	626689	845357	736023
1981	227727	31000	70441	125578	151442	116222	196049	589902	775292	682597
1982	194715	23583	52338	104116	125802	95462	162540	491624	642955	567290
1983	33240	17688	39712	76554	94103	90298	143743	279866	399920	339893
1984	38916	13255	30019	74062	88256	99657	162218	290764	413708	352236
1985	139233	18582	40002	97329	118841	119379	204912	455247	624679	539963
1986	171745	23343	50988	121610	150859	94223	167036	490306	658712	574509
1987	173687	29639	65127	74996	92205	100134	167646	443842	596469	520156
1988	116767	20709	44860	75300	92364	86602	143493	359581	485900	422740
1989	60693	18139	39691	53173	65040	92228	155839	278895	404946	341920
1990	73109	11072	24518	37739	45590	82452	133063	249811	344253	297032
1991	110680	9302	20175	22639	29107	94185	169275	281550	405602	343576
1992	41855	2748	6790	11967	15386	76490	134576	167152	256606	211879
1993	0	1878	4441	10764	13839	73351	144673	118437	224357	171397
1994	0	1018	2651	7823	10058	89981	182686	136738	270339	203538
1995	21341	910	2267	5090	6545	82751	154391	144226	247195	195710
1996	21944	858	2006	4860	6249	66214	115240	121464	192680	157072
1997	16814	1045	2367	1588	2269	41185	70239	80262	147151	113706
1998	3026	161	367	759	1084	44127	80306	68710	147114	107912
1999	5374	142	306	946	1352	40979	79124	66708	147773	107241
2000	5571	273	573	1171	1673	47839	83658	77373	156796	117084
2001	9722	248	529	983	1404	29614	55880	54615	111372	82993
2002	2085	285	598	0	0	0	0	2370	2683	2527

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	205241	441490	425478	722655	574067
1972	237286	279064	198161	415112	441483	706818	574150
1973	346109	408260	224693	435128	577645	856639	717142
1974	322772	379370	221481	449011	550998	842055	696527
1975	351015	422105	268633	578358	627830	1018077	822953
1976	313060	375300	299942	603716	622137	997402	809769
1977	252058	318032	223959	469250	482838	801573	642205
1978	132546	172340	169117	339195	306813	521865	414339
1979	218442	252711	232923	466976	458459	733909	596184
1980	343344	412617	296929	617103	649316	1048513	848915
1981	308670	377651	362724	762155	682441	1163018	922729
1982	265678	312538	307011	633938	582039	965782	773910
1983	197184	234389	192826	398233	395882	644750	520316
1984	158852	187900	230907	447943	396791	649485	523138
1985	227928	259284	258250	519444	494043	794548	644295
1986	278654	321357	339715	677730	628714	1019727	824221
1987	319510	375472	328698	674466	658218	1070479	864349
1988	240291	276488	374529	749850	626226	1049175	837700
1989	205998	239495	231063	454347	444099	707679	575889
1990	134630	156382	273595	530390	416557	702925	559741
1991	117141	133509	188629	362409	311515	506956	409235
1992	21986	30556	342514	618342	374932	667730	521331
1993	15027	19983	297001	566419	321073	603651	462362
1994	8142	11928	208062	418705	222541	443384	332963
1995	7278	10200	292049	662821	308221	693207	500714
1996	6861	9028	414767	891344	434260	927517	680888
1997	8358	10652	225175	400292	240390	423135	331762
1998	3054	3302	226047	377287	245424	621457	433441
1999	2705	2758	222441	332115	241198	546903	394050
2000	5185	5156	226906	377476	248562	623622	436092
2001	4708	4762	193474	289069	212237	478378	345308
2002	5415	5383	209051	315878	229666	522925	376296

Table 4.2.4.1. Estimated numbers of 2SW spawners in North America by geographic regions, 1971-2002.

	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	4,270	8,251	4,496	9,032	490	26,907	72,444	49,675
1972	3,435	24,812	2,008	8,240	23,160	34,741	17,768	33,012	7,459	12,699	1,038	54,868	114,541	84,705
1973	4,565	34,376	2,283	10,449	23,564	35,346	20,469	38,143	3,949	7,844	1,100	55,929	127,256	91,593
1974	4,490	33,475	1,510	5,942	28,657	42,985	31,661	57,942	9,526	15,979	1,147	76,991	157,470	117,231
1975	4,564	32,119	1,888	7,086	23,818	35,726	18,450	33,223	11,861	18,830	1,942	62,522	128,926	95,724
1976	4,984	36,701	2,011	7,198	22,653	33,980	14,787	29,709	11,045	18,337	1,126	56,608	127,051	91,829
1977	4,042	31,969	1,114	5,088	32,602	48,902	32,485	60,210	13,578	23,119	643	84,462	169,932	127,197
1978	3,361	25,490	1,557	5,712	29,889	44,834	11,446	22,859	6,517	11,428	3,314	56,085	113,637	84,861
1979	1,823	14,528	980	3,463	12,807	19,210	3,541	6,839	4,683	8,234	1,509	25,343	53,783	39,563
1980	4,633	34,525	1,888	6,925	35,594	53,390	19,884	37,673	14,270	25,628	4,263	80,533	162,404	121,468
1981	4,403	31,615	3,074	11,442	26,132	39,199	4,599	10,054	5,870	13,353	4,334	48,412	109,997	79,205
1982	3,081	23,127	2,579	8,481	26,492	39,738	10,965	20,363	5,656	11,335	4,643	53,416	107,687	80,551
1983	2,267	16,824	2,244	7,677	17,308	25,963	7,375	14,316	1,505	6,529	1,769	32,468	73,078	52,773
1984	1,478	11,822	2,063	6,800	22,345	32,659	15,295	27,213	14,245	23,650	2,547	57,973	104,690	81,332
1985	1,258	9,530	946	3,042	20,668	31,742	21,037	40,053	18,185	33,580	4,884	66,978	122,830	94,904
1986	2,177	16,334	1,575	5,198	24,088	35,939	32,662	65,164	15,435	30,120	5,570	81,507	158,325	119,916
1987	2,895	21,821	1,320	4,409	21,723	31,727	19,513	43,333	10,235	19,233	2,781	58,468	123,304	90,886
1988	1,625	13,452	1,540	5,033	25,390	38,343	23,247	44,937	9,074	18,381	3,038	63,914	123,184	93,549
1989	1,727	13,270	690	2,289	25,016	35,905	14,557	30,985	11,689	21,539	2,800	56,478	106,786	81,632
1990	923	7,493	1,327	4,372	24,422	36,219	22,128	49,737	9,688	18,245	4,356	62,843	120,422	91,633
1991	491	3,665	1,041	3,410	19,959	29,052	19,375	42,143	9,356	16,479	2,416	52,639	97,165	74,902
1992	2,012	14,889	3,057	10,474	19,337	28,833	27,763	55,806	8,725	15,280	2,292	63,186	127,573	95,380
1993	3,624	17,922	1,449	5,017	15,774	21,428	24,595	46,024	5,710	9,921	2,065	53,217	102,376	77,796
1994	5,339	23,981	1,840	6,077	15,631	21,147	20,590	55,697	3,682	6,093	1,344	48,426	114,338	81,382
1995	12,006	43,726	3,563	12,481	22,575	28,703	21,870	59,214	4,672	7,971	1,748	66,434	153,843	110,139
1996	8,838	32,395	4,372	14,028	19,010	25,421	18,196	39,951	6,507	11,242	2,407	59,331	125,444	92,387
1997	9,221	23,646	3,780	8,190	15,531	20,780	13,657	31,944	3,095	5,311	1,611	46,895	91,483	69,189
1998	-	-	5,222	12,295	14,240	19,439	5,530	15,581	2,424	5,663	1,526	-	-	-
1999	-	-	4,169	14,126	17,250	23,811	8,885	22,223	3,041	6,648	1,168	-	-	-
2000	-	-	2,873	15,704	16,128	23,331	9,242	20,951	1,855	4,877	1,587	-	-	-
2001	-	-	2,403	10,352	16,696	24,056	14,273	27,439	2,860	6,631	1,491	-	-	-
2002	-	-	1,838	9,766	12,454	17,760	6,620	16,319	1,144	1,851	511	-	-	-

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, 1971-2002.

	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	19,871	35,529	4,800	12,810	29	149,049	373,287	261,168
1972	21,728	83,415	84,880	195,010	8,213	12,320	24,314	43,310	2,992	10,385	17	142,144	344,457	243,301
1973	0	11,405	108,785	253,965	10,987	16,480	28,087	51,224	8,658	18,715	13	156,530	351,802	254,166
1974	24,533	92,118	58,731	144,263	10,067	15,100	48,337	84,673	16,209	33,822	40	157,916	370,016	263,966
1975	49,688	183,837	78,882	191,775	11,606	17,409	42,665	74,913	18,232	28,608	67	201,139	496,608	348,873
1976	31,814	125,665	80,571	196,132	12,979	19,469	56,010	99,791	24,589	43,595	151	206,115	484,803	345,459
1977	28,815	112,337	75,762	186,149	12,004	18,006	14,038	27,572	16,704	34,231	54	147,377	378,350	262,864
1978	13,464	53,851	68,756	166,429	11,447	17,170	13,765	25,469	5,678	9,808	127	113,237	272,854	193,046
1979	17,825	72,682	76,233	183,991	15,863	23,795	29,700	57,265	18,577	36,754	247	158,444	374,732	266,588
1980	45,870	170,045	85,189	206,650	20,817	31,226	26,433	50,265	28,878	52,513	722	207,909	511,420	359,664
1981	49,855	187,471	110,755	268,677	30,952	46,428	39,325	77,324	18,236	42,948	1,009	250,132	623,858	436,995
1982	34,032	129,370	99,376	241,131	16,877	25,316	51,946	96,935	12,179	26,548	290	214,700	519,591	367,145
1983	19,360	78,689	77,514	187,796	12,030	18,045	13,604	24,669	7,747	15,969	255	130,509	325,423	227,966
1984	9,348	40,056	91,505	222,730	16,316	24,957	17,980	33,633	17,964	37,503	540	153,653	359,420	256,537
1985	19,631	76,462	85,179	207,175	15,608	25,140	39,506	73,871	18,158	40,731	363	178,446	423,742	301,094
1986	30,806	116,481	87,833	213,537	22,230	33,855	82,118	149,553	21,204	44,947	660	244,850	559,033	401,941
1987	37,572	144,917	104,096	232,991	25,789	40,481	59,320	110,287	21,589	45,407	1,087	249,452	575,169	412,311
1988	34,369	134,100	93,396	227,054	28,582	44,815	85,594	159,806	23,288	47,231	923	266,153	613,930	440,041
1989	22,429	90,212	41,798	102,199	24,710	37,319	44,713	81,697	23,873	48,578	1,080	158,603	361,086	259,845
1990	12,544	52,176	69,576	169,449	26,594	39,826	56,143	113,203	22,753	49,642	617	188,226	424,914	306,570
1991	10,526	42,647	44,023	108,779	20,582	30,433	44,348	87,707	13,814	25,610	235	133,528	295,410	214,469
1992	15,229	59,331	95,096	214,129	21,754	33,583	118,678	189,160	15,125	29,633	1,124	267,007	526,960	396,984
1993	22,499	78,251	107,816	242,217	17,493	27,444	70,912	117,942	11,539	22,252	444	230,703	488,549	359,626
1994	15,228	53,958	66,185	162,342	16,758	25,642	32,635	90,297	6,918	10,218	427	138,151	342,884	240,517
1995	22,144	73,575	172,727	405,141	14,409	21,548	15,387	61,203	12,114	19,697	213	236,993	581,377	409,185
1996	48,362	150,048	218,639	520,504	18,923	27,805	24,352	70,119	19,253	32,472	651	330,181	801,599	565,890
1997	64,049	153,200	80,096	127,116	14,724	22,210	12,695	36,680	6,143	9,428	365	178,072	349,000	263,536
1998	-	-	124,551	225,216	16,743	25,730	23,572	46,533	16,342	26,028	403	-	-	-
1999	-	-	135,561	203,780	18,969	28,808	18,206	36,229	10,177	16,516	419	-	-	-
2000	-	-	127,839	236,777	16,444	25,865	25,960	43,486	10,656	17,977	270	-	-	-
2001	-	-	111,756	169,106	10,829	16,974	20,216	39,274	6,449	11,414	266	-	-	-
2002	-	-	103,344	162,171	17,215	25,918	30,539	53,672	8,937	15,568	450	-	-	-

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.

Stock area	Smolt age (years)					
	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	49675		730732		16447		4936		14777		6261		6764		490	
1972	84705		742060		14124		5124		28951		25390		10079		1038	
1973	91593		884679		19470		6366		29455		29306		5896		1100	
1974	117231		817732		18982		3726		35821		44802		12752		1147	
1975	95724		917282		18341		4487		29772		25836		15345		1942	
1976	91829		840510		20842		4605		28316		22248		14691		1126	
1977	127197		670646		18006		3101	4921	40752	20734	46347	26394	18348	7549	643	1111
1978	84861	95412	374325	3.92	14425	14759	3635	5802	37362	28016	17152	35360	8973	10034	3314	1442
1979	39563	107013	847626	7.92	8175	17486	2221	4664	16008	32232	5190	36809	6459	14270	1509	1553
1980	121468	96086	736023	7.66	19579	18903	4406	4316	44492	31940	28779	24963	19949	14937	4263	1029
1981	79205	104065	682597	6.56	18009	18795	7258	4472	32666	30266	7327	31944	9612	16888	4334	1699
1982	80551	107269	567290	5.29	13104	19695	5530	3661	33115	34821	15664	34034	8496	12699	4643	2358
1983	52773	82167	339893	4.14	9546	18710	4961	3440	21636	36526	10845	13244	4017	7514	1769	2733
1984	81332	79786	352236	4.41	6650	15422	4432	2801	27502	28065	21254	14925	18947	14569	2547	4006
1985	94904	85392	539963	6.32	5394	11576	1994	3786	26205	32359	30545	19559	25882	13668	4884	4443
1986	119916	80959	574509	7.10	9255	15361	3386	6075	30013	35728	48913	11269	22777	8998	5570	3528
1987	90886	78592	520156	6.62	12358	17772	2865	6023	26725	33119	31423	13506	14734	5813	2781	2359
1988	93549	78987	422740	5.35	7538	14762	3287	5209	31866	27538	34092	15128	13728	13002	3038	3347
1989	81632	93758	341920	3.65	7498	10875	1490	4544	30461	25762	22771	24650	16614	23026	2800	4901
1990	91633	103342	297032	2.87	4208	7799	2850	2951	30320	26580	35933	37586	13966	23978	4356	4449
1991	74902	99865	343576	3.44	2078	6285	2225	2953	24506	28072	30759	41424	12917	17965	2416	3166
1992	95380	89409	211879	2.37	8451	8072	6765	3018	24085	28227	41784	32997	12002	14173	2292	2922
1993	77796	91733	171397	1.87	10773	10649	3233	3080	18601	29616	35309	29513	7816	15464	2065	3410
1994	81382	88883	203538	2.29	14660	9247	3958	2178	18389	30646	38143	28339	4888	15007	1344	3464
1995	110139	89406	195710	2.19	27866	7453	8022	2400	25639	30138	40542	33495	6322	13350	1748	2570
1996	92387	85064	157072	1.85	20617	5299	9200	2585	22216	27289	29073	35300	8875	12373	2407	2219
1997	69189	83266	113706	1.37	16434	3511	5985	5004	18155	24550	22801	38891	4203	9493	1611	1817
1998	41723	76245	107912	1.42		6285	8758	4368	16839	21312	10555	36629	4044	6080	1526	1571
1999		80120	107241	1.34		9930	9148	3994	20531	19459	15554	39019	4845	5764	1168	1954
2000		88524	117084	1.32		14098	9289	6574	19730	22055	15097	35913	3366	7845	1587	2039
2001		88137	82993	0.94		22118	6378	8490	20376	22898	20856	26914	4746	6056	1491	1661
2002		73672				22527	5802	7215	15107	20286	11470	18113	1497	4133	511	1400
2003		44803						7892		18121		12902		4525		1363
2004								8908		18894		15228		3952		1508
2005								9103		19796		17403		4202		1132

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. 4.2.6.1 Number of Atlantic salmon released by life stage from fish culture facilities in Canada and the USA in 2002 by program intention and source of brood. Releases by some non-government organizations are not reported.

Action and area	Rivers	Fry	Parr	Smolt	Adult	Total
Recovery						
USA	6	1,080,000	48,400	49,000	227	1,177,400
Canada	10	241,413	237,635	43,351	242	522,642
Restoration						
Using river of origin						
USA	2	8,151,000	399,200	547,500	1,078	9,097,700
Canada	33	1,673,177	1,604,184	665,971	0	3,943,332
Using donor rivers						
USA	8	2,711,000	17,300	119,400	2,271	2,847,700
Canada	6	0	27,620	34,160	0	0
Total	65	13,856,590	2,334,339	1,459,382	3,818	17,588,774

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, 1972-2002.
Only mid-points of the estimated values have been used.

Year	CANADA										USA	Total	
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i								
	NF-LAB Comm 1SW (Yr i-1) (b)	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) (b)	NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	Year i		Terminal Fisheries as a % of Total
1972	20,857	9	153,775	174,632	314	633	27,417	22,389	6,801	232,186	346	232,532	25
1973	17,971	6	219,175	237,146	719	895	32,751	17,914	6,680	296,105	327	296,433	20
1974	24,564	7	235,910	260,475	593	542	47,631	21,430	12,734	343,405	247	343,652	24
1975	24,181	7	237,598	261,779	241	528	41,097	15,677	12,375	331,696	389	332,085	21
1976	35,801	10	256,586	292,388	618	412	42,139	18,090	11,111	364,758	191	364,949	20
1977	27,519	8	241,217	268,736	954	946	42,301	33,433	15,562	361,932	1,355	363,287	26
1978	27,836	11	157,299	185,135	580	559	37,421	23,806	10,781	258,281	894	259,175	29
1979	14,086	10	92,058	106,144	469	144	25,234	6,300	4,506	142,798	433	143,231	26
1980	20,894	6	217,209	238,103	646	699	53,567	29,832	18,411	341,257	1,533	342,789	31
1981	34,486	11	201,336	235,822	384	485	44,375	16,329	13,988	311,383	1,267	312,650	25
1982	34,341	14	134,417	168,757	473	433	35,204	25,709	12,353	242,929	1,413	244,342	31
1983	25,701	12	111,562	137,263	313	445	34,472	27,097	13,515	213,105	386	213,491	36
1984	19,432	14	82,807	102,238	379	215	24,408	6,040	3,971	137,252	675	137,927	26
1985	14,650	11	78,760	93,410	219	15	27,483	2,741	4,930	128,798	645	129,443	28
1986	19,832	12	104,890	124,723	340	39	33,846	4,575	2,824	166,346	606	166,952	25
1987	25,163	13	132,208	157,371	457	20	33,807	3,790	1,370	196,814	300	197,115	20
1988	32,081	21	81,130	113,211	514	29	34,262	3,916	1,373	153,304	248	153,552	26
1989	22,197	16	81,355	103,551	337	9	28,901	3,507	265	136,569	397	136,966	24
1990	19,577	18	57,359	76,937	261	24	27,986	2,841	593	108,642	696	109,338	30
1991	12,048	14	40,433	52,481	66	16	29,277	1,934	1,331	85,106	231	85,337	39
1992	9,979	14	25,108	35,087	581	67	30,016	4,405	1,114	71,271	167	71,438	51
1993	3,229	7	13,273	16,502	273	63	23,153	2,971	1,110	44,072	166	44,238	63
1994	2,139	5	11,938	14,077	365	80	24,052	2,376	756	41,706	1	41,707	66
1995	1,242	3	8,677	9,918	420	92	23,331	2,022	330	36,113	0	36,113	73
1996	1,075	3	5,646	6,721	320	108	22,413	2,577	766	32,905	0	32,905	80
1997	969	3	5,390	6,360	175	136	18,574	2,072	581	27,898	0	27,898	77
1998	1,155	7	1,872	3,027	276	129	11,256	2,283	322	17,293	0	17,293	82
1999	179	1	894	1,073	311	111	9,032	1,380	450	12,355	0	12,355	91
2000	152	1	1,115	1,267	404	372	9,425	2,048	193	13,709	0	13,709	91
2001	286	2	1,380	1,666	336	277	10,104	1,970	255	14,608	0	14,608	89
2002	263	3	1,158	1,421	221	264	7,297	526	273	10,002	0	10,002	86
2003	299	-	-	-	-	-	-	-	-	-	-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.677057 (M of 0.03 per month for 13 months to July for Canadian terminal fisheries)
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.970446 (M of 0.03 per month for 1 month to July of Canadian terminal fisheries)
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998-2002 and resident food fishery harvest in 2000-2002

Year	Canadian total	USA total	Grand Total	North America	Greenland total	Atlantic Total	as % of total NW Atlantic
1972	232,186	346	232,532	0.15	206,814	439,346	53
1973	296,105	327	296,433	0.11	144,348	440,781	67
1974	343,405	247	343,652	0.07	173,615	517,267	66
1975	331,696	389	332,085	0.12	158,583	490,668	68
1976	364,758	191	364,949	0.05	200,464	565,413	65
1977	361,932	1,355	363,287	0.37	112,077	475,364	76
1978	258,281	894	259,175	0.34	136,386	395,561	66
1979	142,798	433	143,231	0.30	85,446	228,677	63
1980	341,257	1,533	342,789	0.45	143,829	486,618	70
1981	311,383	1,267	312,650	0.41	135,157	447,807	70
1982	242,929	1,413	244,342	0.58	163,718	408,060	60
1983	213,105	386	213,491	0.18	139,985	353,476	60
1984	137,252	675	137,927	0.49	23,897	161,824	85
1985	128,798	645	129,443	0.50	27,978	157,421	82
1986	166,346	606	166,952	0.36	100,098	267,050	63
1987	196,814	300	197,115	0.15	123,472	320,586	61
1988	153,304	248	153,552	0.16	124,868	278,420	55
1989	136,569	397	136,966	0.29	83,947	220,913	62
1990	108,642	696	109,338	0.64	43,634	152,972	71
1991	85,106	231	85,337	0.27	52,560	137,897	62
1992	71,271	167	71,438	0.23	79,571	151,008	47
1993	44,072	166	44,238	0.38	30,091	74,329	60
1994	41,706	1	41,707	0.00	0	41,707	100
1995	36,113	0	36,113	0.00	0	36,113	100
1996	32,905	0	32,905	0.00	15,343	48,247	68
1997	27,898	0	27,898	0.00	15,776	43,674	64
1998	17,293	0	17,293	0.00	12,088	29,381	59
1999	12,355	0	12,355	0.00	2,175	14,530	85
2000	13,709	0	13,709	0.00	3,863	17,572	78
2001	14,608	0	14,608	0.00	4,005	18,613	78
2002	10,002	0	10,002	0.00	6,989	16,992	59
2003	299	-	299	-	1,499	-	-

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

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

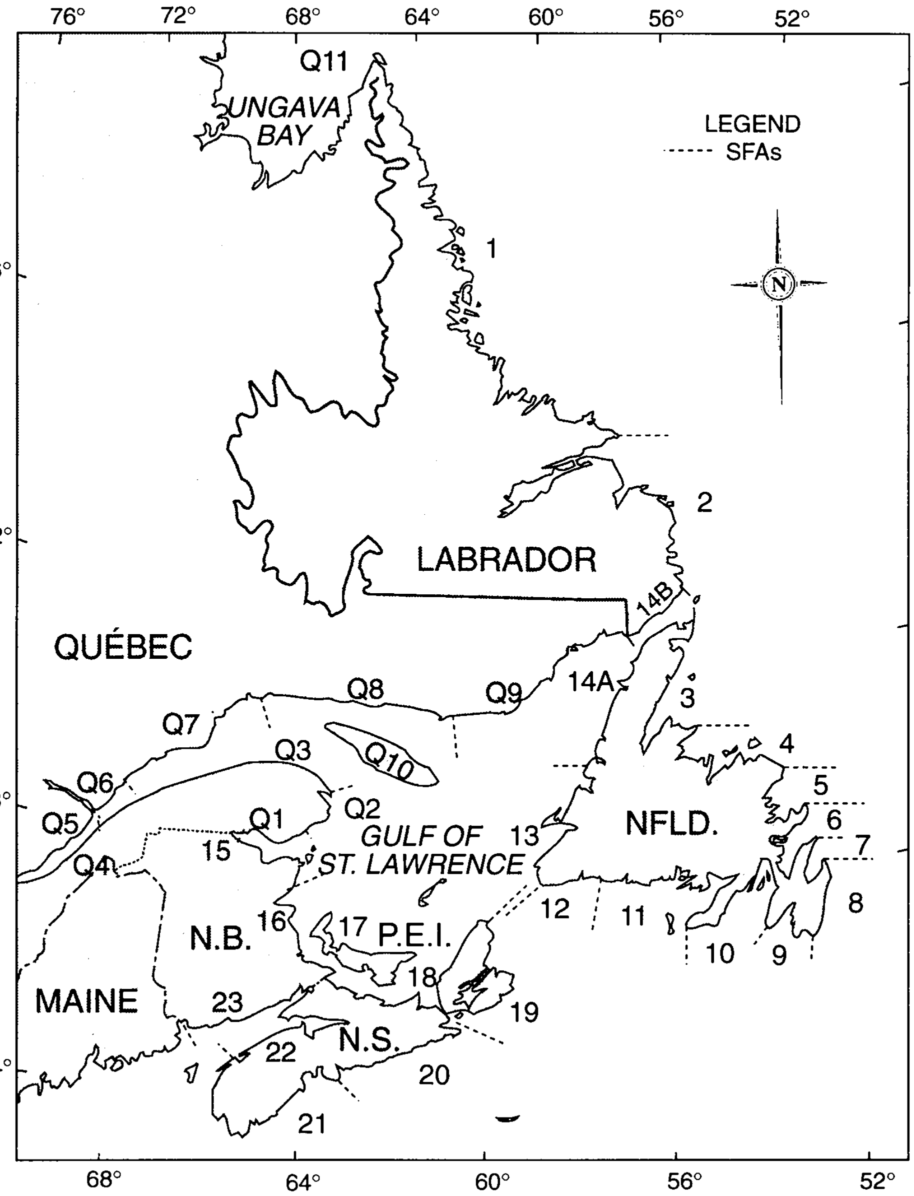


Figure 4.1.1.2. Summary of recreational fisheries management in eastern Canada and Maine (U.S.A.) during 2002.

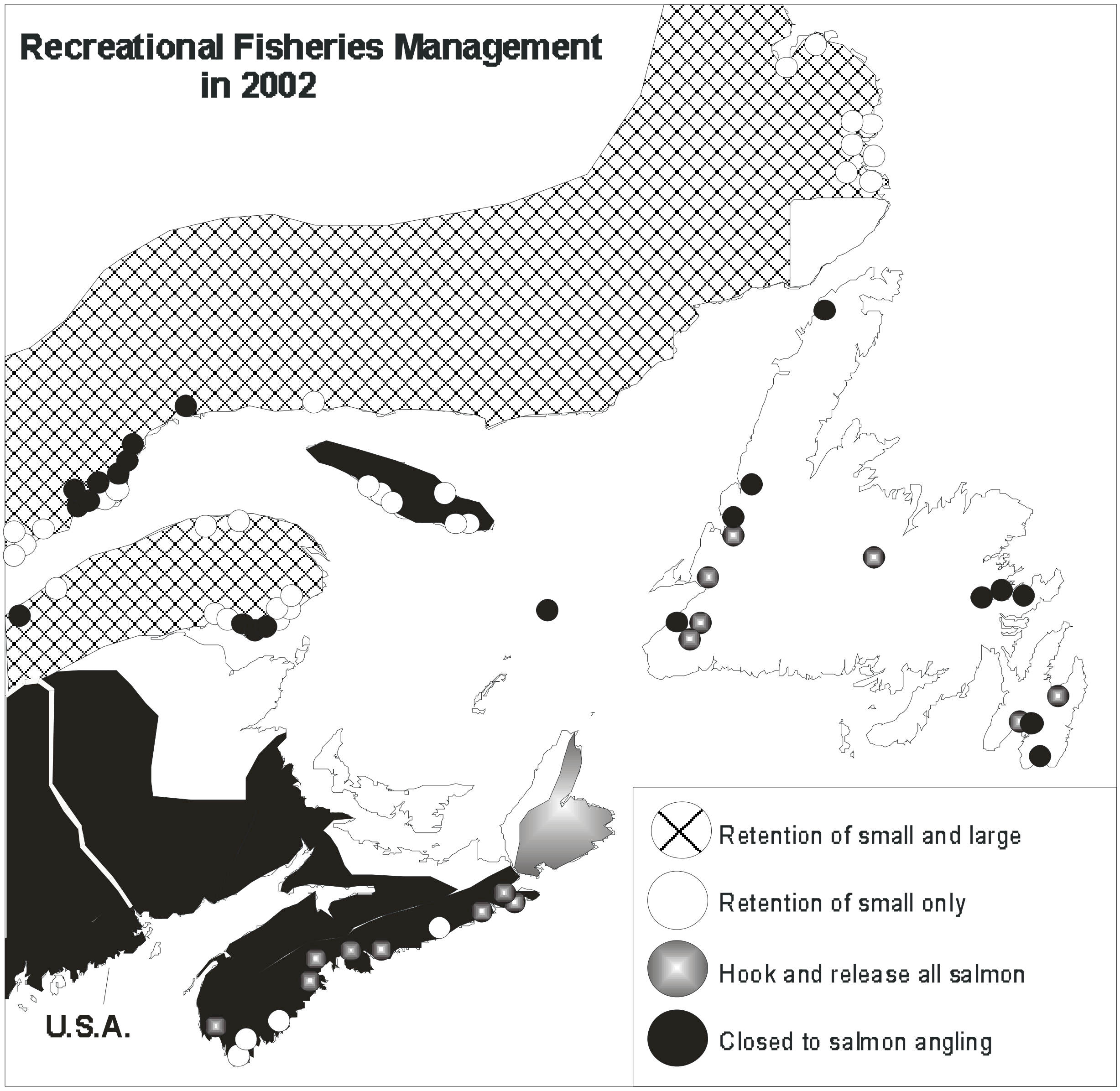


Figure 4.1.2.1. Harvest (t) of small salmon, large salmon, and combined in Canada, 1960-2002 by all users.

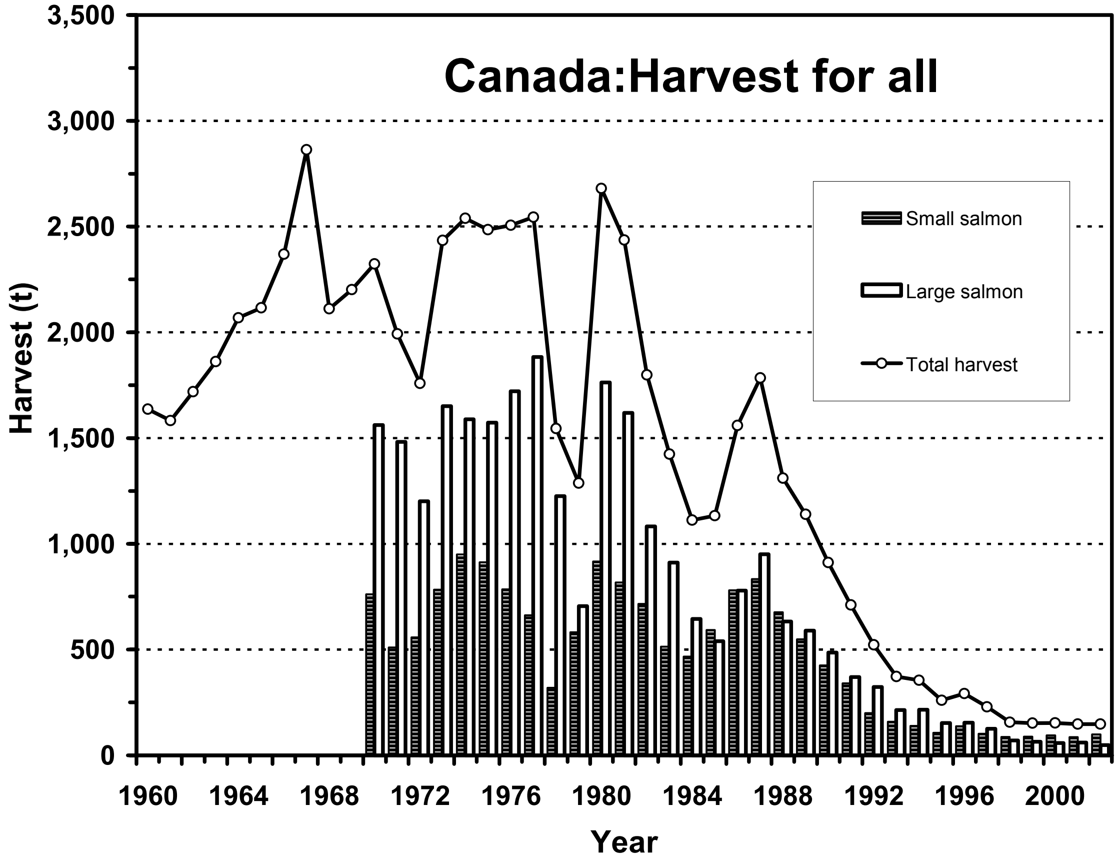


Figure 4.1.2.2. Harvest (number) of small and large salmon and both sizes combined in the recreational fisheries of Canada, 1974 to 2002.

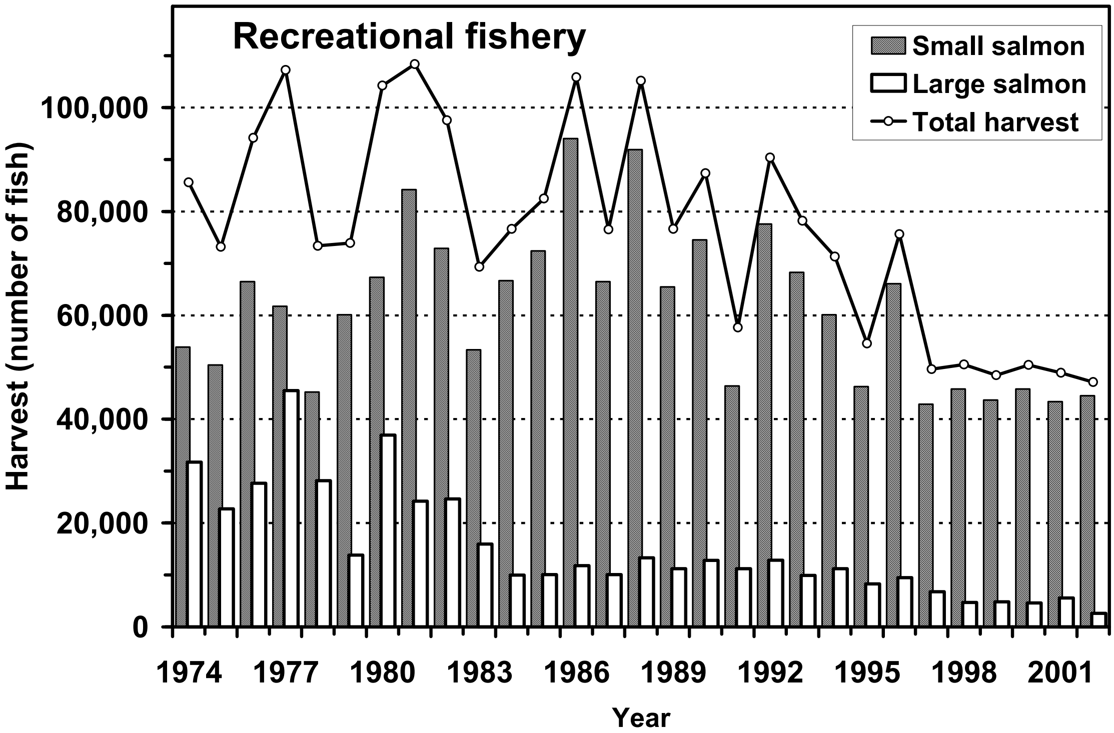


Figure 4.1.3.1. Origin (wild, hatchery, farmed) of Atlantic salmon returning to monitored rivers of eastern North America in 2002. Only rivers in which more than one origin type was expected, based on previous returns, are indicated.

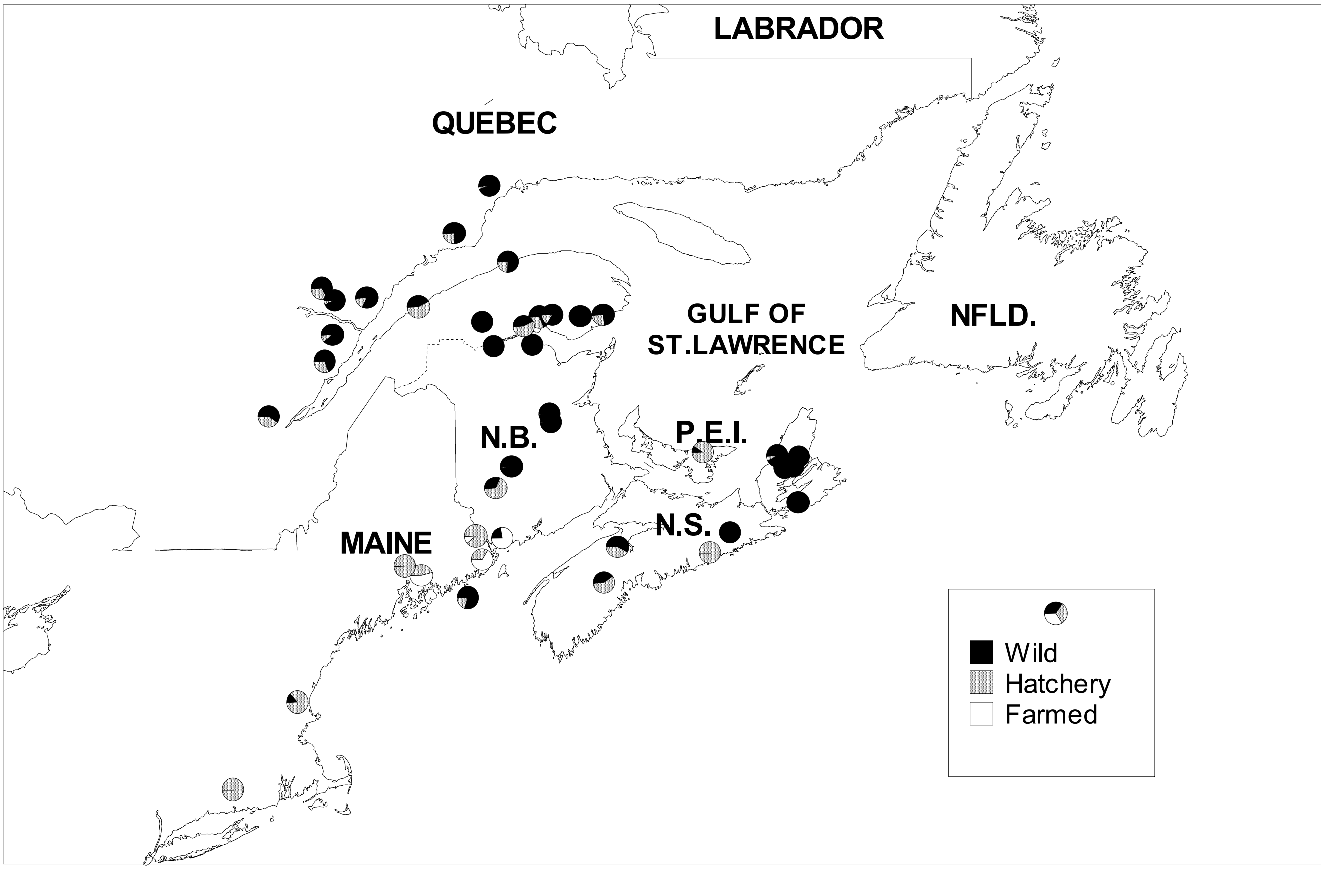


Figure 4.2.1.1. In-river returns of small salmon and large salmon for 22 monitored rivers in four geographic areas of eastern Canada from 1985 to 2002. The in-river returns do not account for removals in marine fisheries. Rivers by area are: Newfoundland (Conne, Exploits, Middle Brook, Northeast Trepassey, 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, Margaree), and Scotia-Fundy (LaHave, Saint John at Mactaquac).

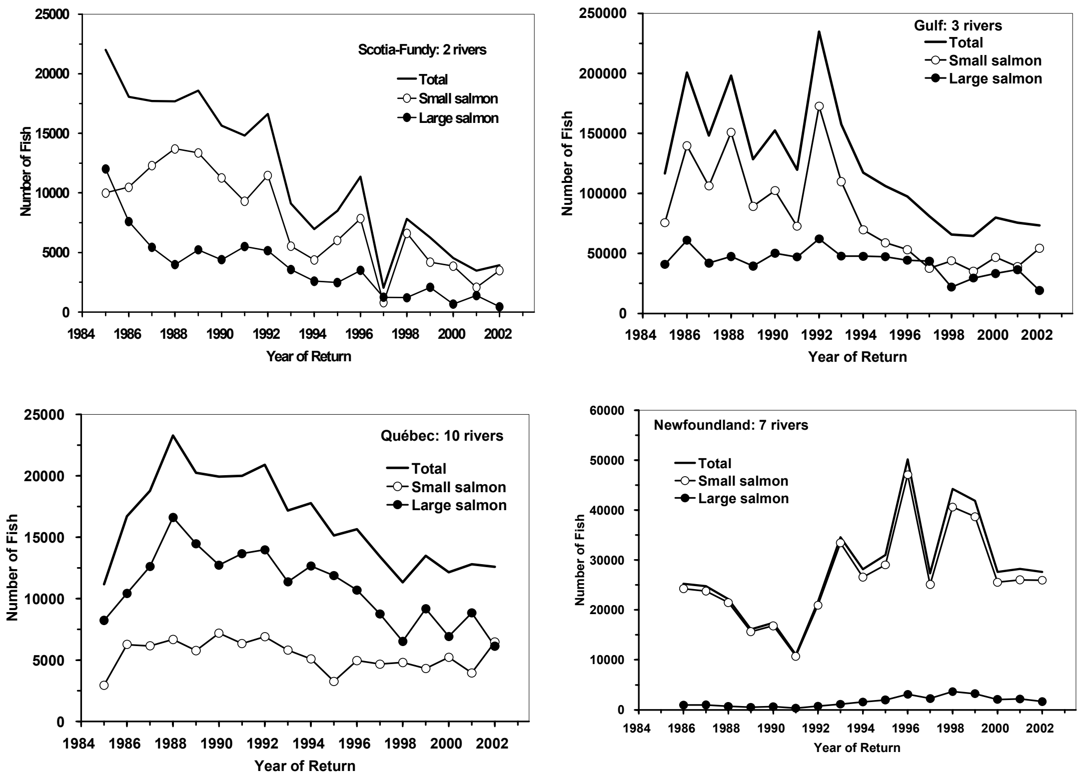


Figure 4.2.1.2. Wild smolt production from twelve rivers of eastern Canada, 1971 to 2002. Smolt production is expressed relative to the conservation egg requirements for each river (smolt output / conservation egg requirements).

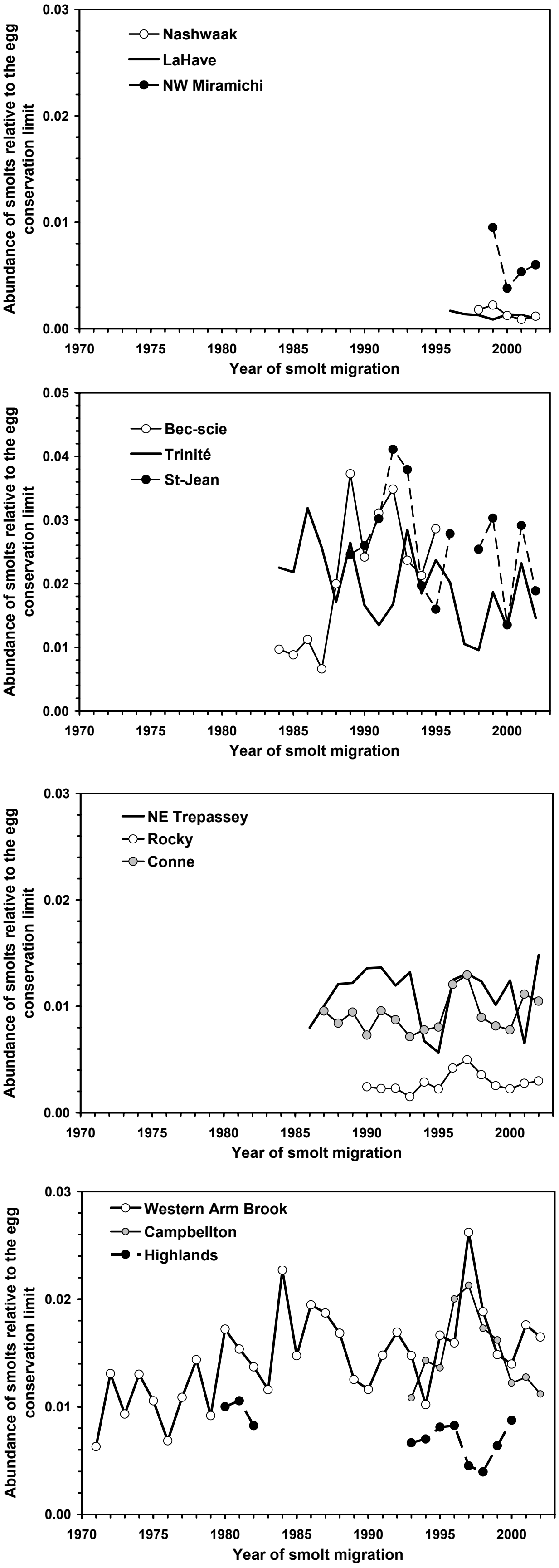
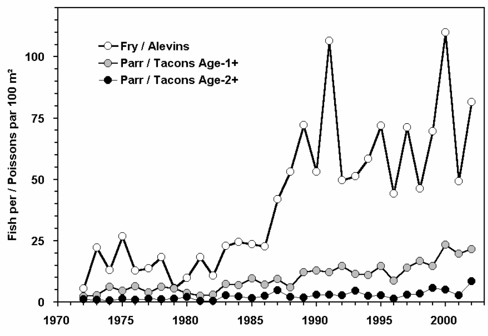
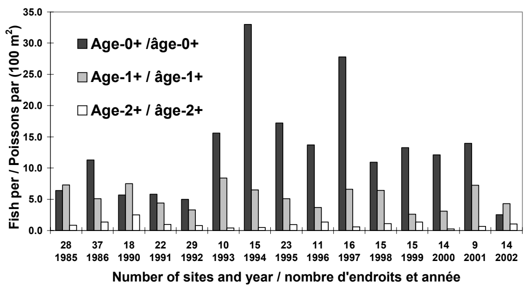


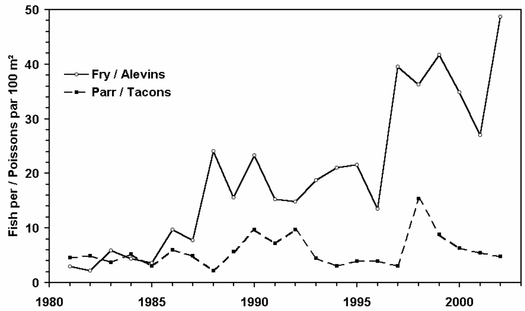
Figure 4.2.1.3 Atlantic salmon juvenile densities in eight rivers of the Maritime provinces (Restigouche SFA 15; Nepisiguit SFA 15; Miramichi SFA 16; St. Mary's SFA 20; Nashwaak, Hammond and upstream of Mactaquac, Saint John River SFA 23).

Restigouche (NB)

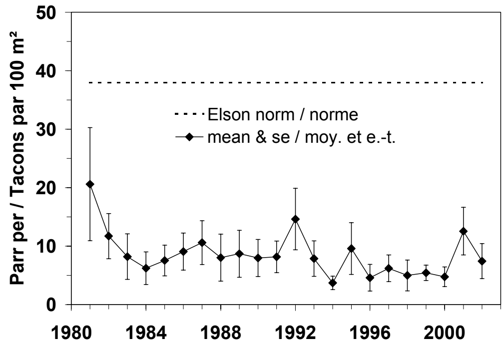




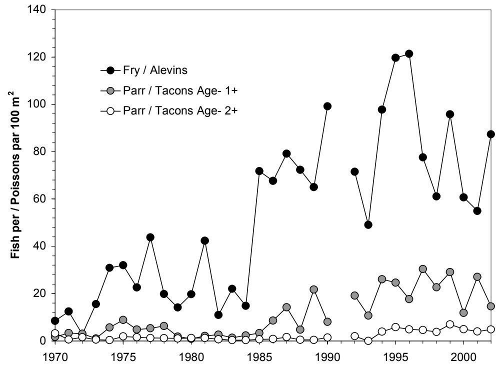
Nepisiguit



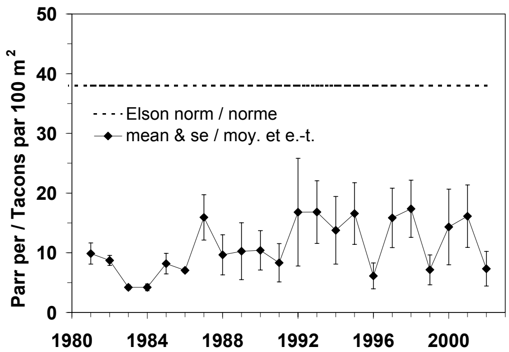
Nashwaak



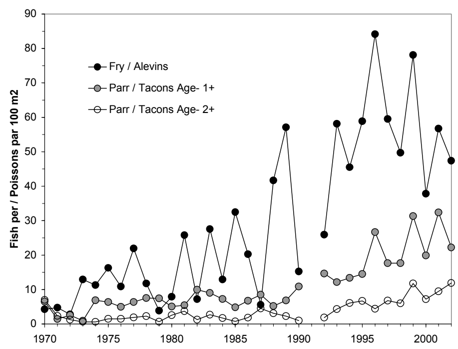
Southwest Miramichi



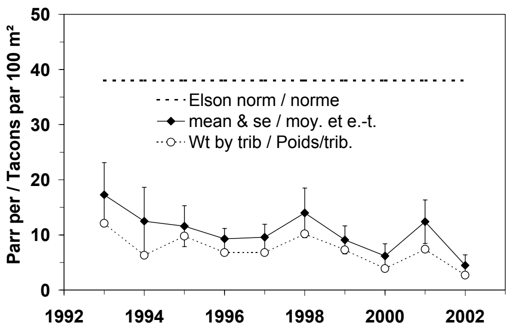
Hammond



Northwest Miramichi



Upstream of Mactaquac



St. Mary's

Figure 4.2.1.4. Documented returns of Atlantic salmon to USA rivers, 1967 to 2002.

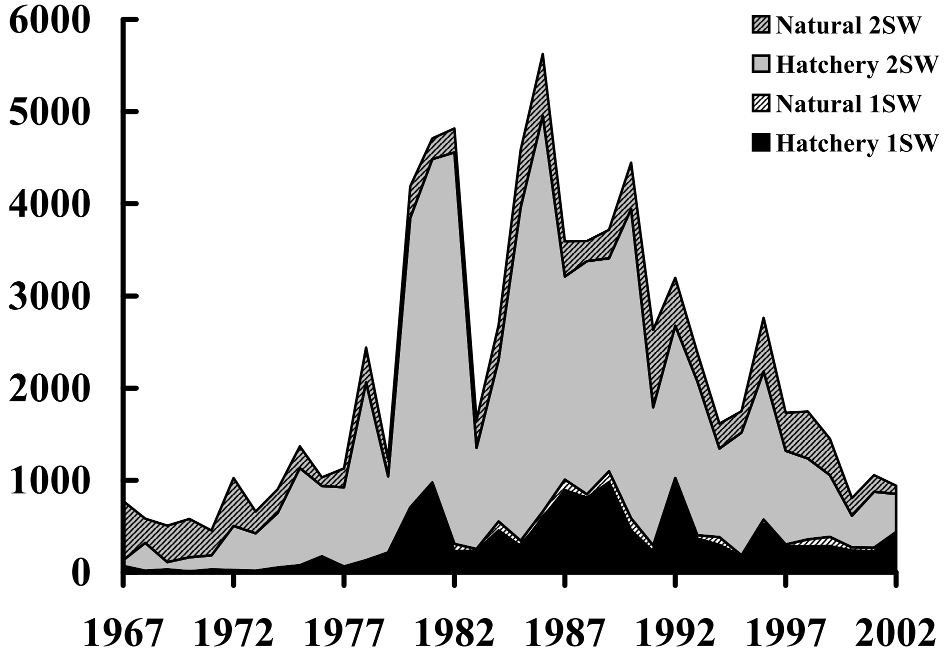


Figure 4.2.2.1 Comparison of estimated mid-points of 1SW returns to and 1SW spawners in rivers of six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

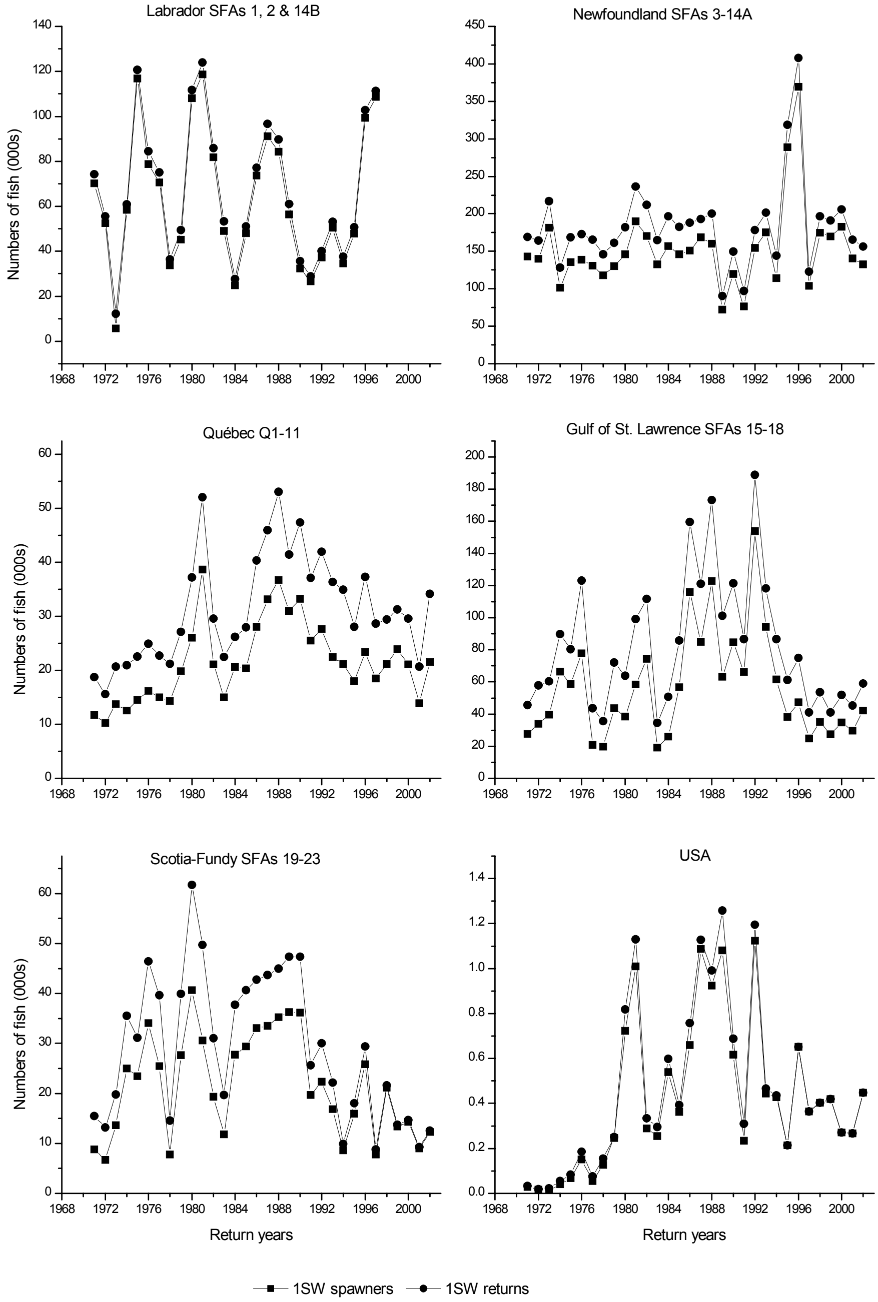


Figure 4.2.2.2 Comparison of estimated mid-points of 2SW returns, 2SW spawners, and 2SW conservation requirements for six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

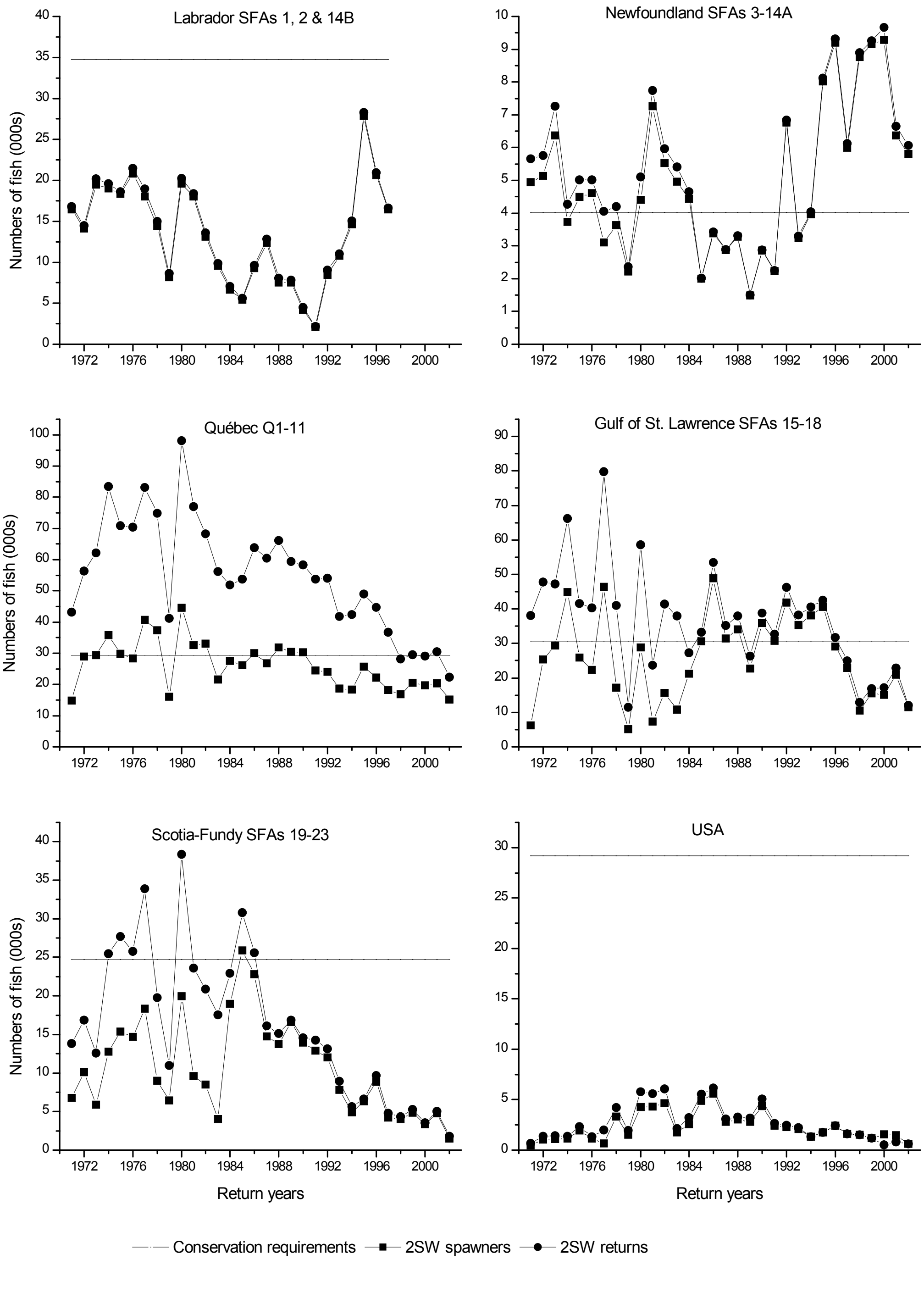


Fig. 4.2.3.1. Prefishery abundance estimate of maturing and non-maturing salmon in North America. Open symbols are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America.

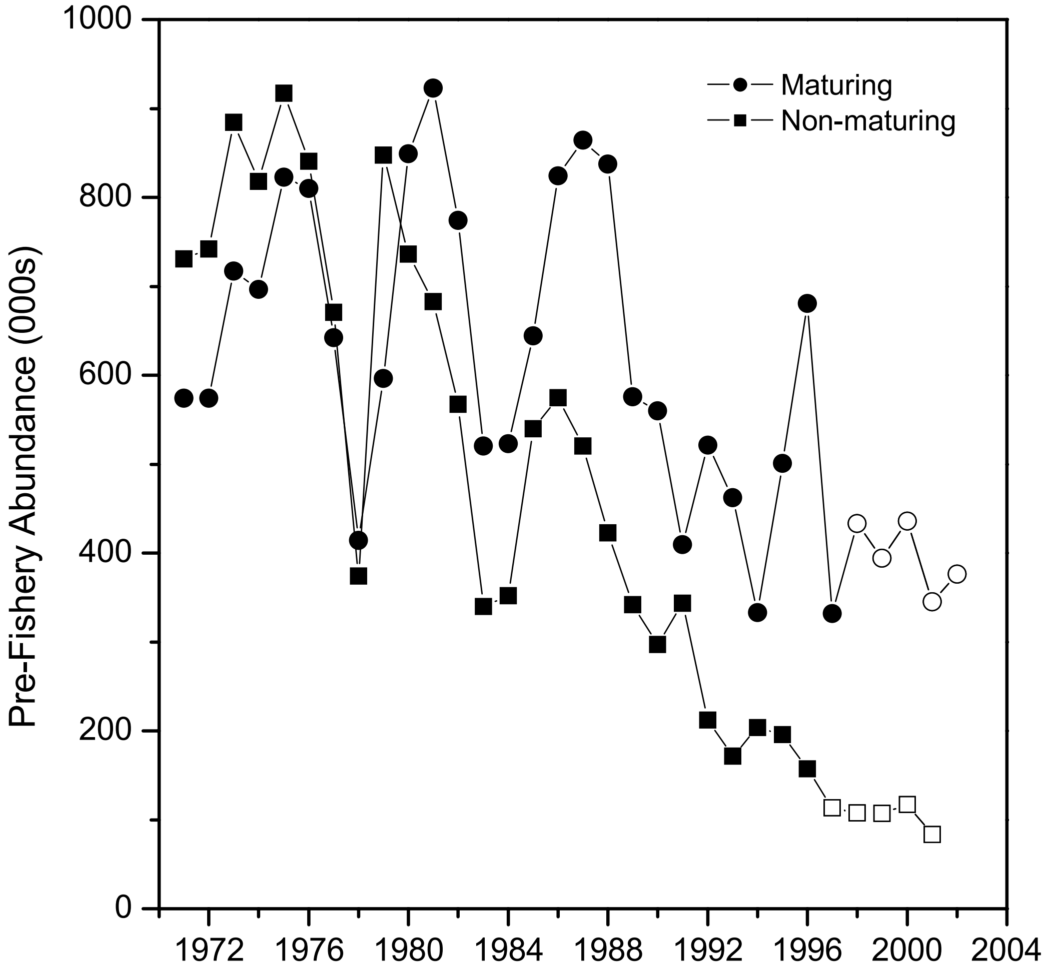


Fig. 4.2.3.2. Total 1SW recruits (non-maturing and maturing) originating in North America.

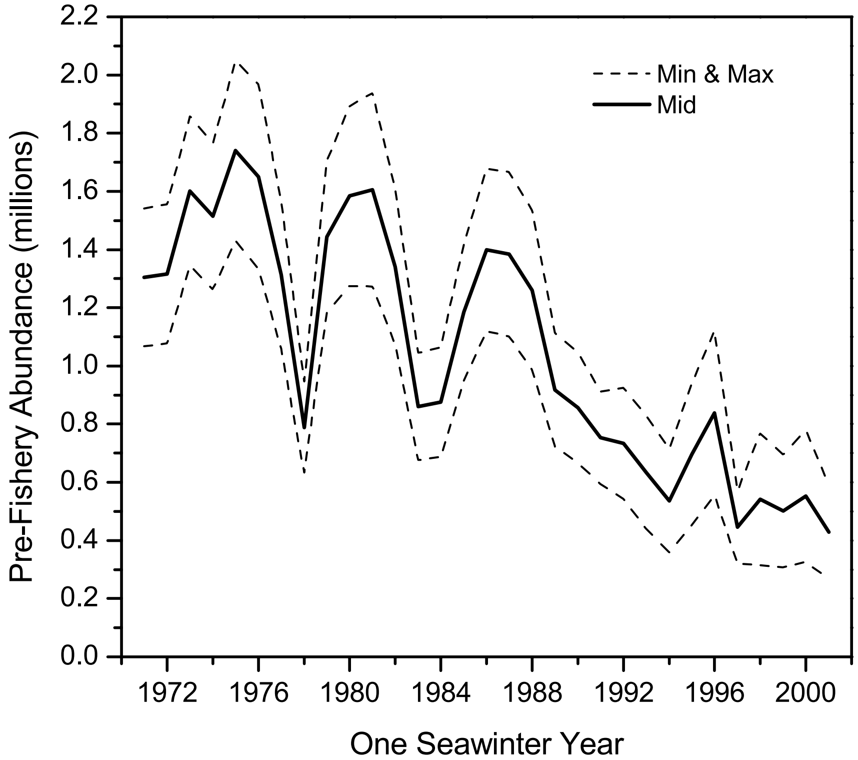


Figure 4.2.4.1. Egg depositions relative to conservation limits in 85 rivers of North America in 2002. The black slice represents the proportion of the limit achieved. A solid black circle indicates the egg deposition limit was attained or exceeded.

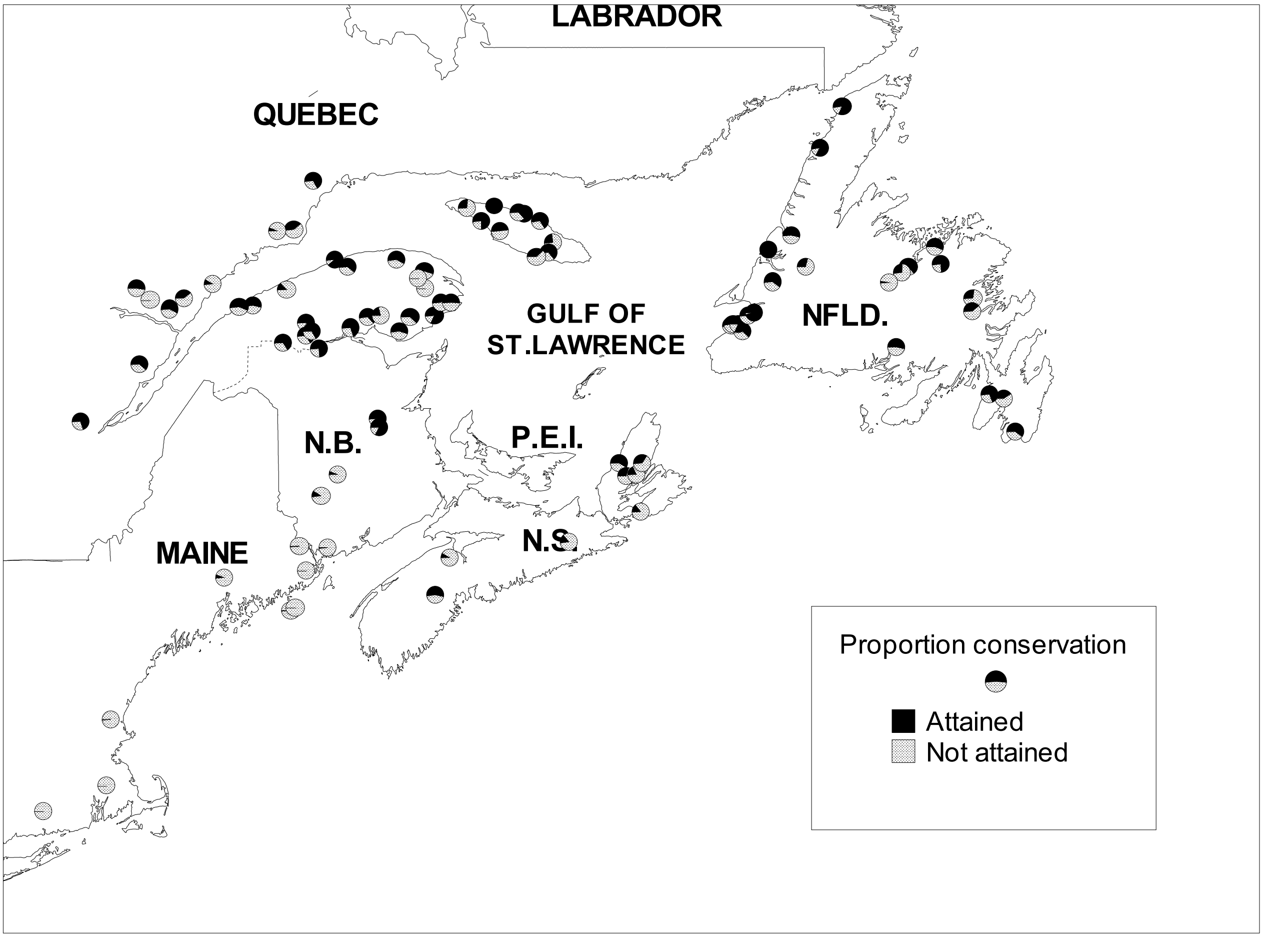


Figure 4.2.4.2. Proportion of the conservation limits met in monitored rivers in four geographic areas of eastern Canada, 1984 to 2002. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion. The range of the number of rivers included in the annual summary was 7-8 for Newfoundland, 3-8 for the Gulf, 2-3 for Scotia-Fundy and 9 for Québec.

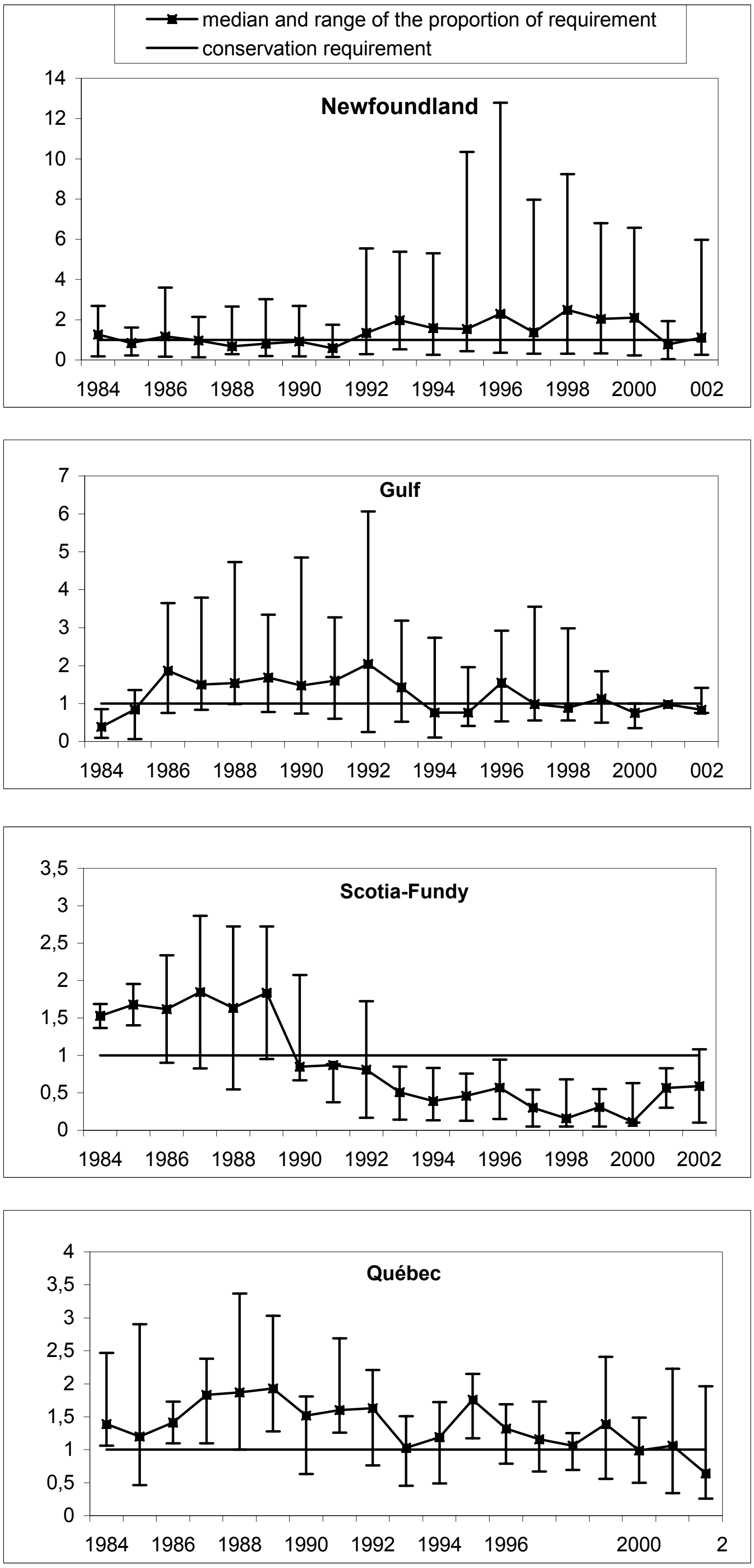


Figure 4.2.4.3 Top panel: comparison of estimated potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971-2002 and 2SW returns and spawners for 1971-97, as 1998-2002 data for Labrador are unavailable. The horizontal line indicates the 2SW conservation limits. Bottom panel: comparison of potential maturing 1SW recruits, 1971-2002 and returns and 1SW spawners for 1971-97 return years as Labrador data for 1998-2002 are unavailable.

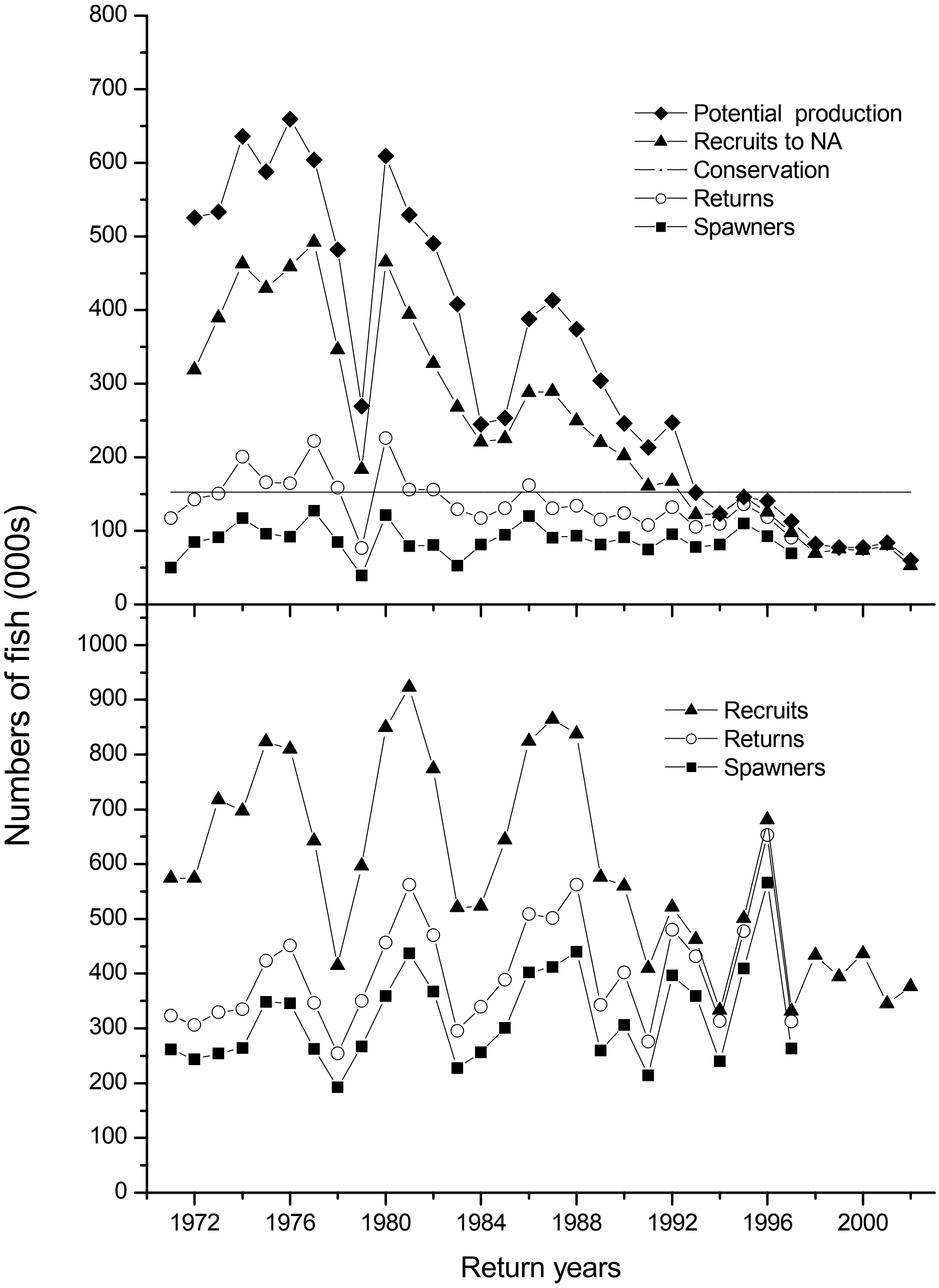


Fig. 4.2.4.4. Midpoints of lagged spawners (solid circles) and estimated annual spawners (open circles) as contribution to potential recruitment in the year of prefishery abundance (PFA) for six geographic areas of North America. The horizontal line represents the spawning requirement (in terms of 2SW fish) in each geographic area. Labrador spawner numbers not available after 2002 or for 1977.

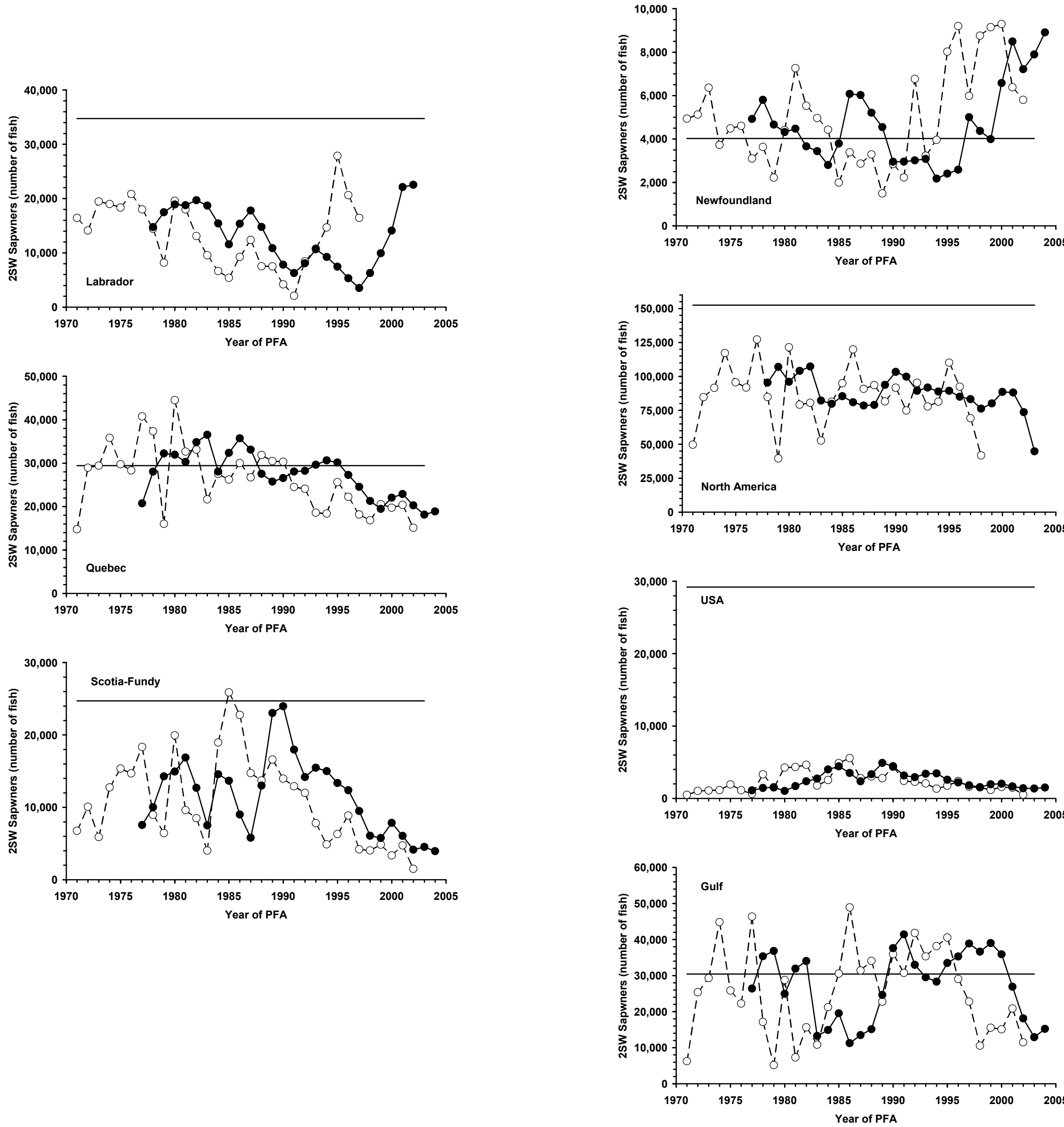


Fig. 4.2.4.5. Proportion of spawners (mid-points) lagged to year of PFA (solid circles) and as returns to rivers (open circles) in six geographic areas of North America relative to the total lagged spawner or annual spawning escapement to North America. The horizontal line represents the theoretical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

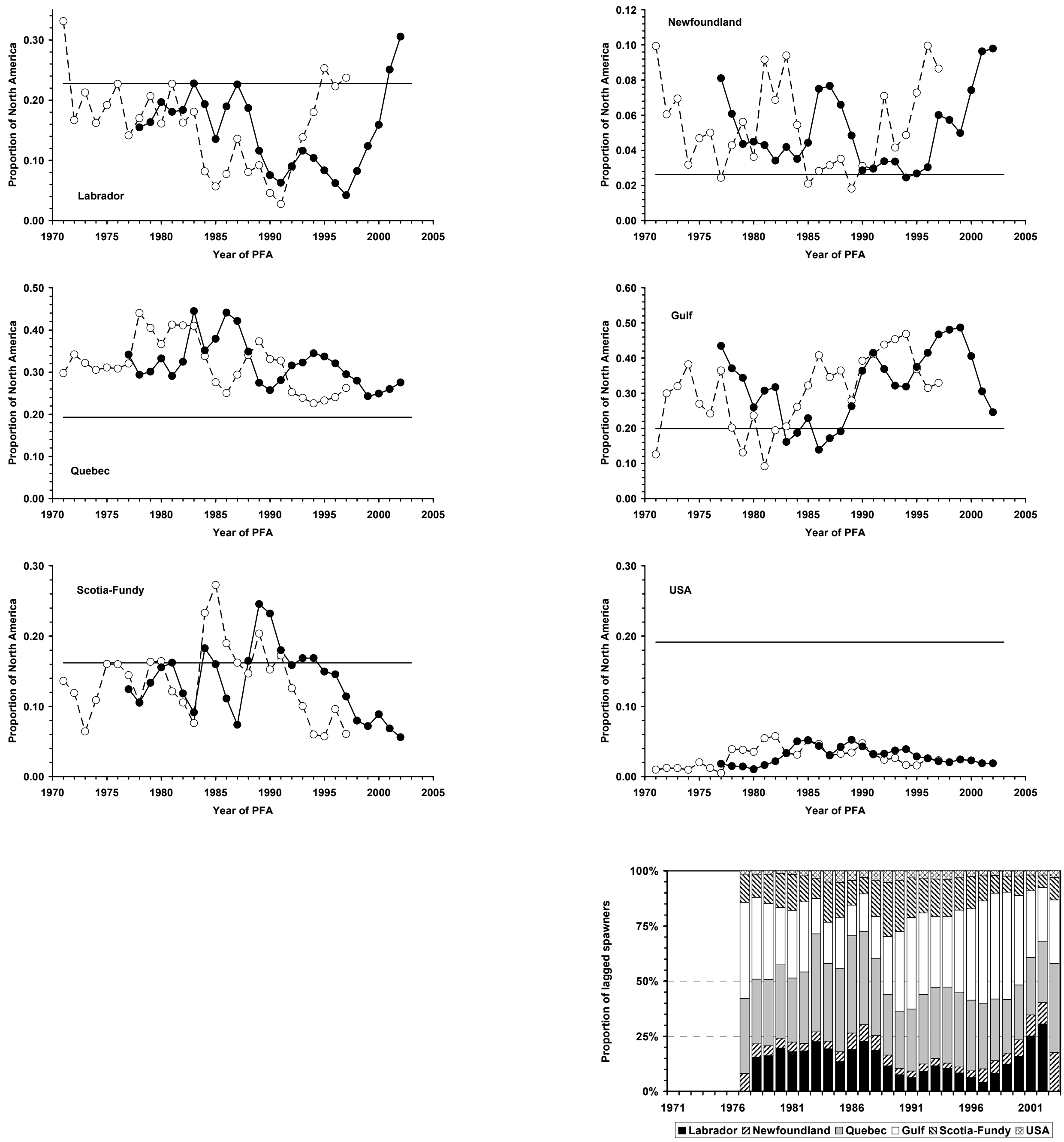
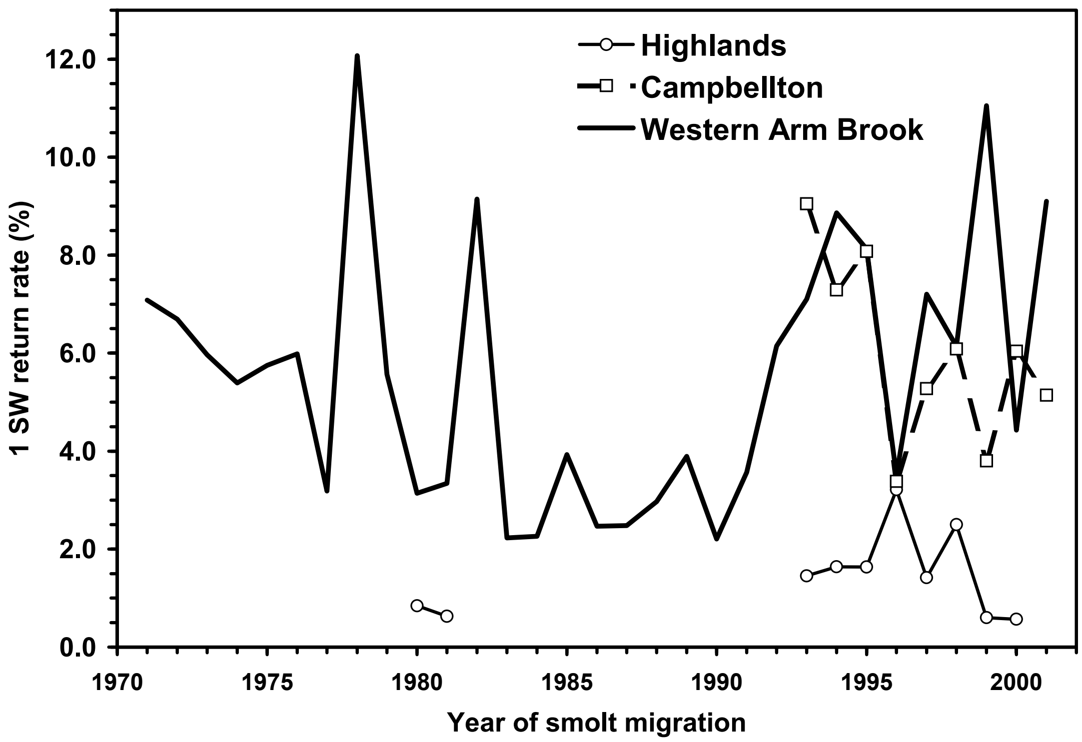


Figure 4.2.5.1. Return rates (%) of wild smolts to return as 1SW salmon from the rivers in west and north Newfoundland (Highlands, SFA 13, Western Arm Brook, SFA 14A and Campbellton, SFA 4) and south Newfoundland (NE Trepassey, SFA 9; Rocky, SFA 9; and Conne, SFA 11).



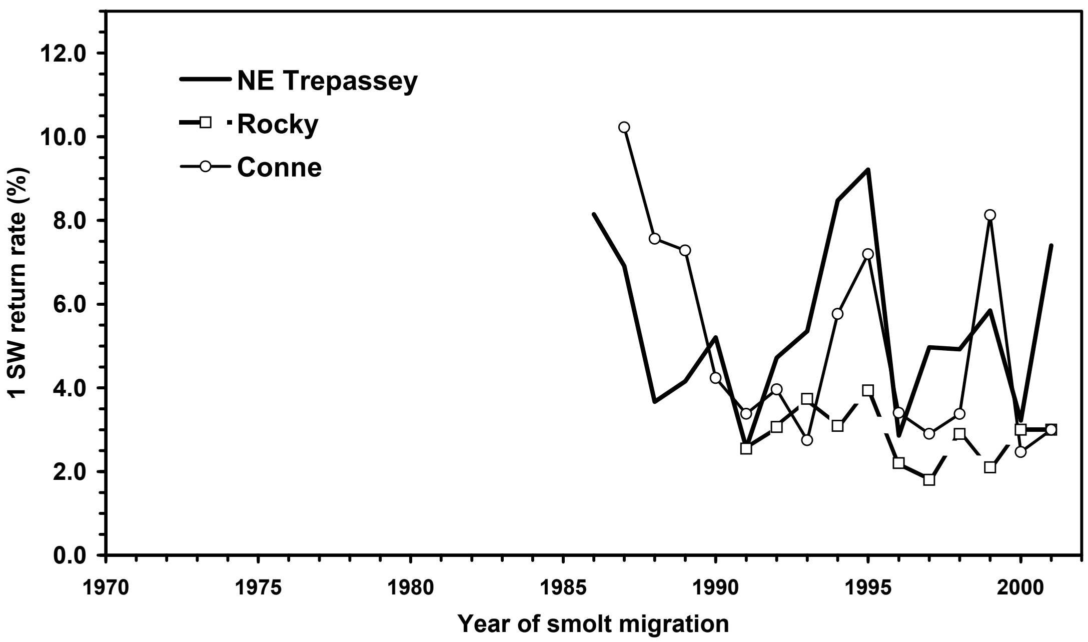


Figure 4.2.5.2. Return rates (%) of wild smolts to return as 1SW (upper two panels) and 2SW (bottom panel) salmon from the rivers in the Maritime provinces (top: Northwest Miramichi SFA 16, LaHave SFA 21, Nashwaak SFA 23) and Quebec (Bec-Scie Q10, de la Trinité, Q7 and Saint-Jean, Q2).

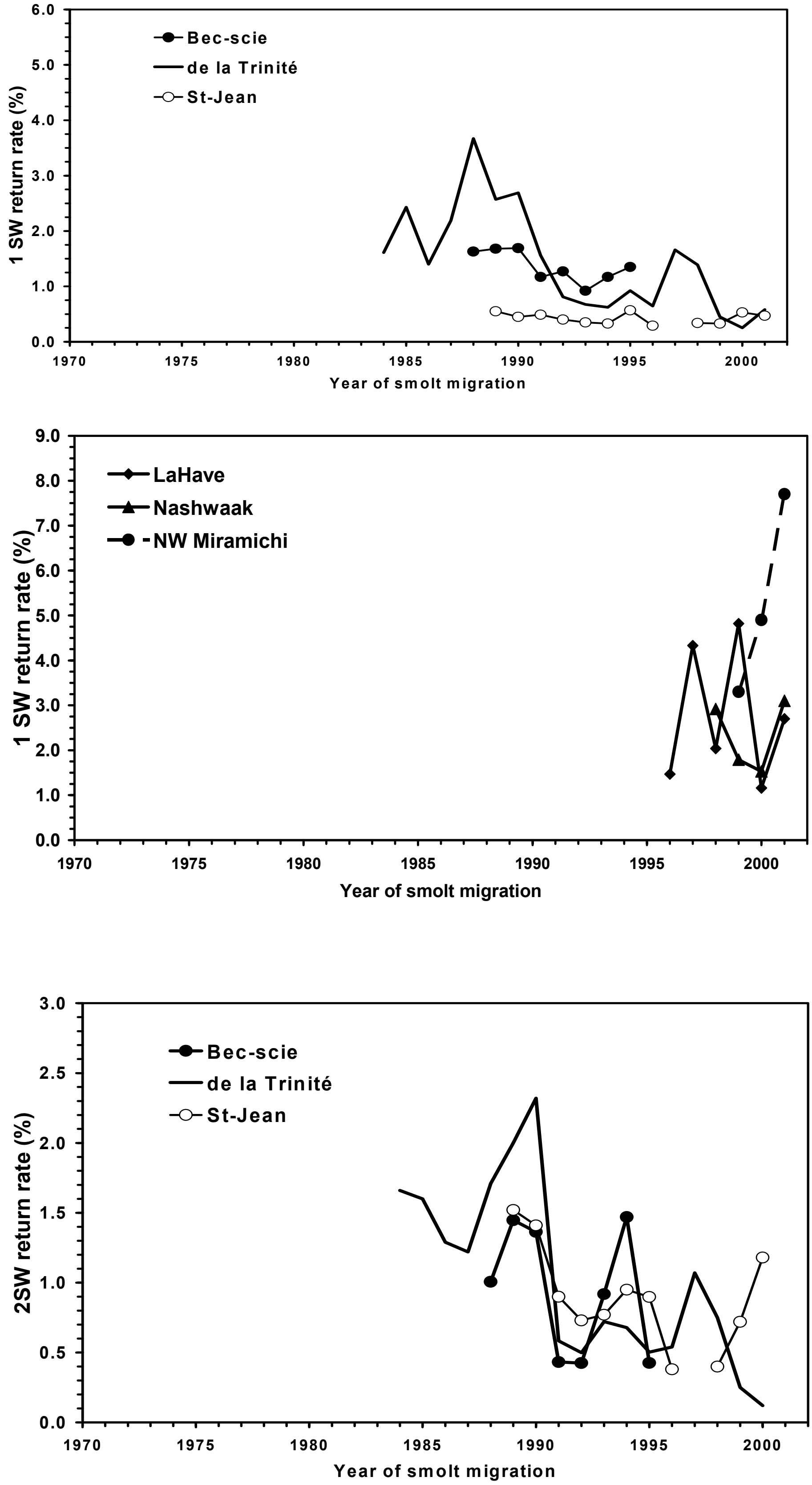


Figure 4.2.5.3. Return rates (%) to the river of hatchery released smolts from the Saint John River (SFA 23), LaHave River (SFA 21), Liscomb and East Rivers (SFA 20), and Aux Rochers River (Q7) as 1SW (upper panel) and 2SW (lower panel) salmon.

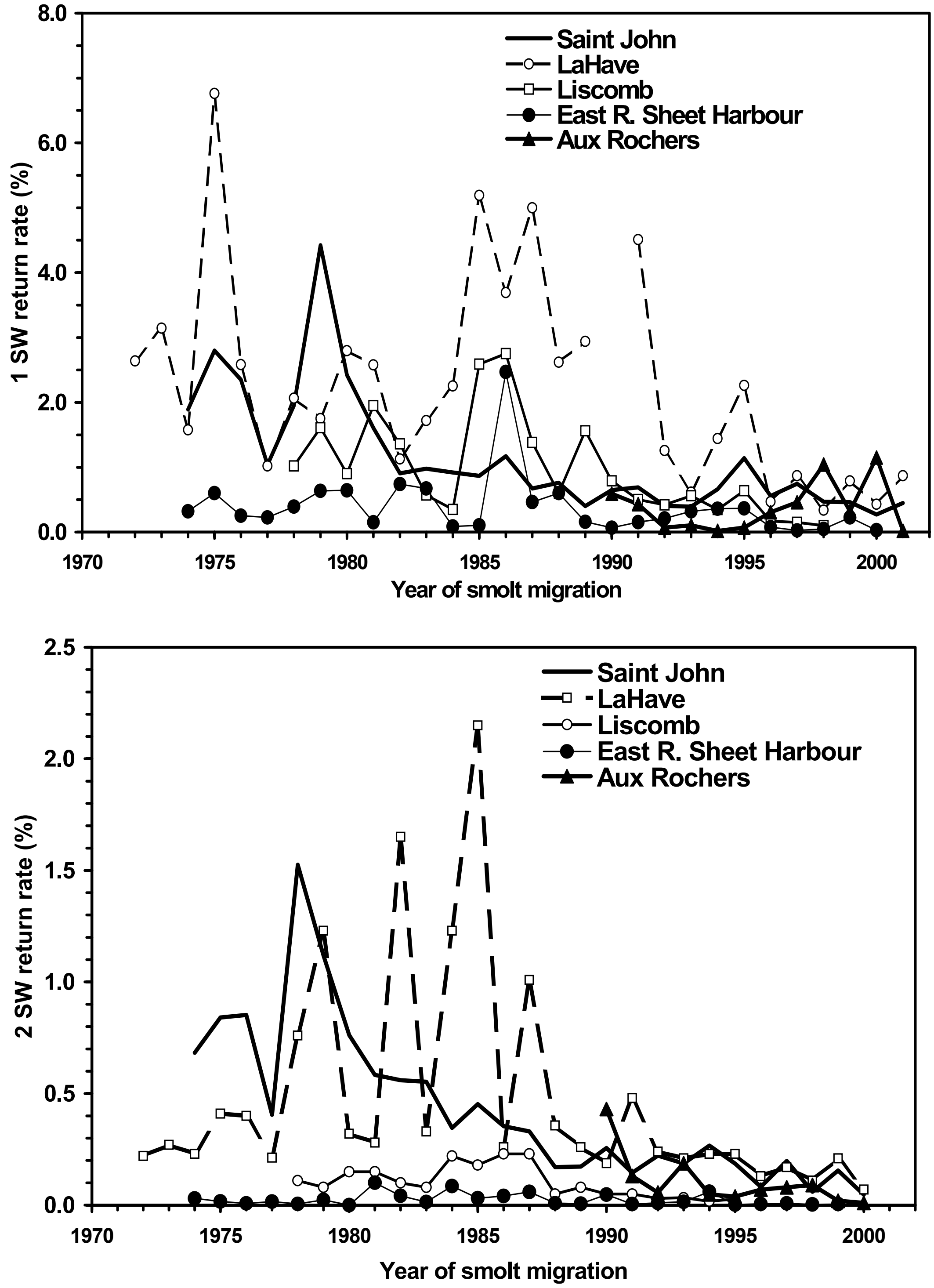
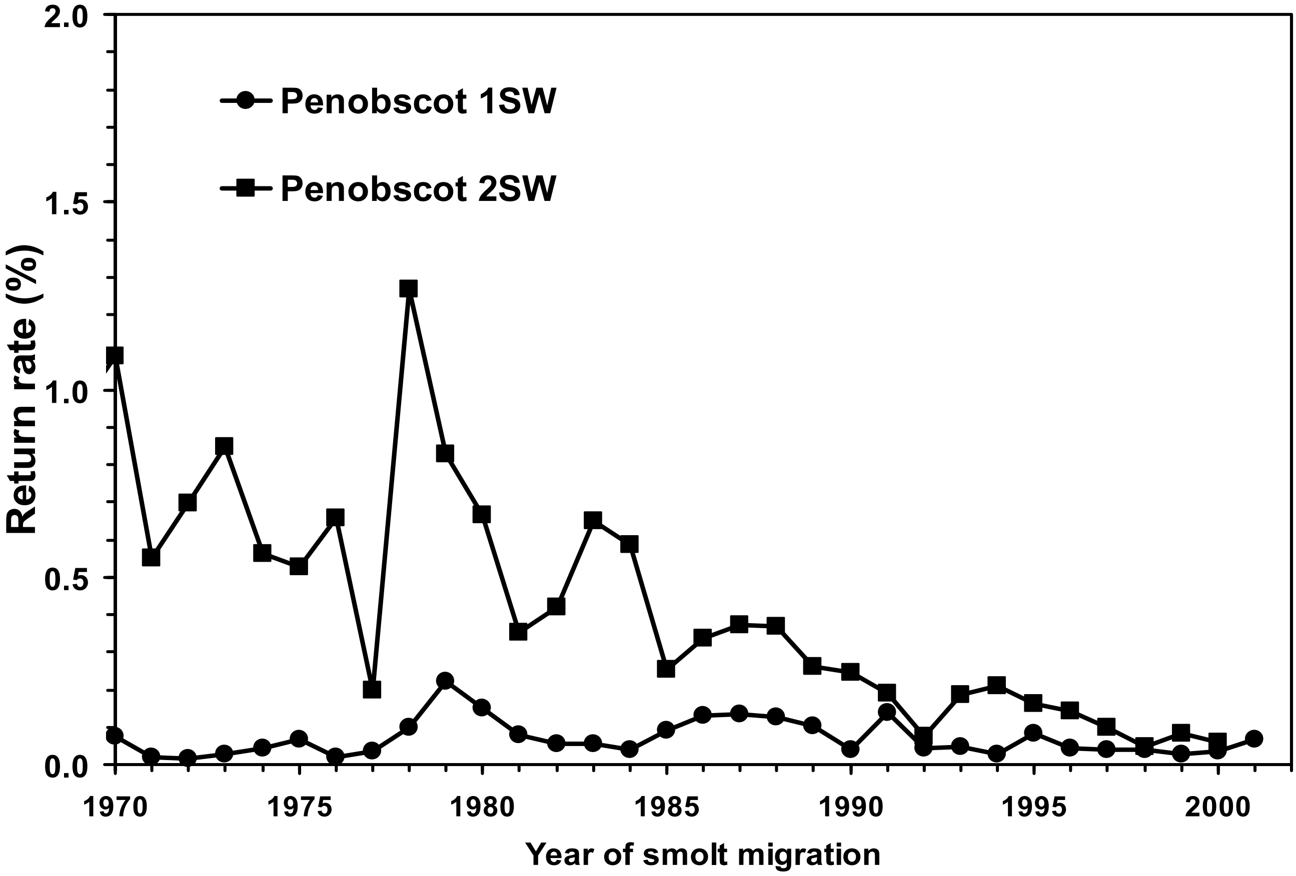


Figure 4.2.5.4. River return rates (%) of hatchery released smolts from the Penobscot River (Maine, USA) as 1SW and 2SW salmon.



5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION

5.1 Catch and effort in 2002

At its annual meeting in June 2002 NASCO agreed to a revised *ad hoc* management programme for the 2002 fishery at West Greenland that as in the previous year incorporated the use of real-time data to allocate quota for the commercial fishery. The commercial fishery is defined as landings sold to processing plants and excludes reported private landings (not sold to plants) and unreported catch. The commission noted that the forecast pre-fishery abundance is considered to be highly uncertain, but also that there appears to be a relationship between the estimated pre-fishery abundance and catch per unit of effort in West Greenland, measured as average daily landings per licensed fisherman. Two harvest periods were implemented with quotas dependent on the observed average CPUE during the fishery in the first harvest period.

The initial quota for the first quota period of up to two weeks was set at 20 t, and additional quota was allocated for the subsequent harvest period of a maximum of five weeks based on catch per unit effort observed in the fishery. The maximum quota for the fishery as a whole would have depended on the observed average commercial CPUE during the first period of fishing, being 20, 38 and 55 t, respectively for three levels of CPUE.

Shortly before the opening date of the fishing season (August 12) the Organization of Fishermen and Hunters in Greenland and the North Atlantic Salmon Fund agreed to suspend the commercial fishery for salmon in 2003. The subsistence fishery was not affected by this agreement. As is the past, there was no quota limit set for the subsistence fishery. The authorities did not apply a closing date for the fishing season, i.e. the season was open till the end of the year.

By regulation, all catches including landings to local markets, privately purchased salmon, and salmon caught by food fishermen, are to be reported on a daily basis to the Fishery Licence Office. By the end of the year a total of 9 t of landed salmon was reported (Table 5.1.1.1). The geographical distribution of catches by Greenland vessels is given in Table 5.1.1.2 for the years 1977-2002. The unusually high proportion of catch observed in southern Greenland in 2000 and 2001 is not indicated for the 2002 season, being close to the average for the period 1995-1999.

Licences for the salmon fishery were issued to fishers fishing for factories, local markets, hotels, hospitals etc., while fishing for personal use was permitted without licence for residents of Greenland. The number of reporting fishers in the salmon fishery has decreased sharply since 1987, when a catch of more than 900 t was allowed and more than 500 licenses were active in the fishery. During the 2002 season 41 fishers reported catches, the lowest number on record.

Landing reports were received from August 15 until December 11. Due to a lesser incentive for a thorough and early reporting of catches many of the reports combined more than one landing of salmon. Some of the reports were probably also sent to the License Office with a considerable delay in relation to the time of fishing. Because of these changes in reporting, the Working Group was unable to estimate average CPUE values for that part of the fishery in 2002, which is comparable with the commercial fishery in preceding years. As a result, it was not possible to update the data series used to develop the *ad hoc* management programme used in the previous two years.

Due to the character of this fishery, which includes provisions for personal consumption, some unreported catch likely occurs. Unreported catch is primarily associated with personal consumption or subsistence fishing, which appears to have remained relatively stable through time. There is presently no quantitative approach for estimating the magnitude of unreported catch; however, based on local knowledge it is at the same level used for recent years (around 10 t).

5.1.1 Biological characteristics of the catches

Biological characteristics (length, weight, and age) were recorded from 1,297 fish in catches from NAFO Div. 1C, 1D and 1F (Figure 5.1.2.1) in 2002 and presented in Tables 5.1.2.1 to 5.1.2.3 together with corresponding data from sampling in Greenland since 1968.

The general downward trend in mean length and weight (unadjusted for sampling date) of both European and North American 1SW salmon observed from 1969–1995 reversed in 1996, when mean lengths and weights increased (Table 5.1.2.1, Section 5.2.3.1). In 2000, a decrease was observed, mainly in the North American component where the mean lengths and weights were among the lowest observed in the time series. In 2001 and 2002, mean lengths and mean weights increased again to a level close to the overall average for the recent decade.

Distribution of the catch by river age in 1968-2002 as determined from scale samples is shown in Table 5.1.2.2. The percentage 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, the 2000 value being the highest on record, but the percentage decreased thereafter to 10 % in 2002. A low percentage of this group suggests a low contribution from Southern European stocks. In 1998 and 1999 low percentages of 7.6 and 7.2 %, respectively, of river age-3 were observed, the lowest on record. In 2002, the percentage was 18 %, close to the overall mean of 16.9 %. The mean river age of the contribution from Southern European stocks reflects these changes in percentages, with the overall mean age of 2.0 years. The percentage of river age-2 salmon of North American origin declined somewhat from 1998, which was close to the overall mean value of 33.5 %, to 26.7 in 2002. In 2001 the lowest value on record was observed (15.2 %). The mean river age of the catch has varied throughout the last 10 years, but in 2002 is above age 3.0, the overall mean.

The sea-age composition of the samples collected from the West Greenland fishery showed no significant changes in the percentages in the North American component of fish from 1998 to 2002 (Table 5.1.2.3). The percentage of 1SW salmon in the European component has been very high since 1997 (99.3 %), and was 100 % from 1999 to 2000.

5.1.2 Origin of catches at West Greenland

5.1.2.1 Continent of Origin

An international sampling program requested by NASCO was instituted in 2001 to sample landings at West Greenland, and repeated in the 2002 fishing season. The sampling program included sampling teams from Greenland, United Kingdom, Ireland, United States and Canada. Teams were in place at the start of the fishery and continued to the end of September although landings continued until December. In total, 1,374 specimens, representing 44 % by number of the landings, were sampled for presence of tags, fork length, weight, scales, and tissue samples for DNA analysis. The limitation of the fishery to subsistence fishing caused severe practical problems for the sampling teams; however, the sampling program was successful in adequately sampling the Greenland catch temporally and spatially.

Tissue and biological samples were collected from the mixed population at West Greenland caught for local consumption in 2002. Samples were obtained from four landing sites, Qaqortoq and Narsaq (NAFO Div. 1F), Nuuk (NAFO Div. 1D) and Maniitsoq (NAFO Div. 1C). The sampled salmon were measured, scales were removed for ageing, tissue for analysis, and gutted weight recorded. No disease sampling was conducted in 2002 because of logistical difficulties, however, the Working Group recommends that it be done in 2003.

A total of 1,329 tissue samples were removed and preserved for DNA analysis. Funding was available to analyse about 500 tissue samples, so collected samples were subsampled to select samples for analysis that were representative of standard weeks and statistical areas where landings were prevalent. A total of 501 samples were genotyped at 11 microsatellite DNA loci for assignment to continent of origin. The maximum likelihood genetic distances between North American and European populations are used to generate continent of origin assignments that have been estimated to be virtually 100 % correct. Continent of origin assignments is based on 4,373 Atlantic salmon genotypes (individuals): 459 from Europe and 3,914 from North America with 600 of these from Canadian stocks. These genotypes of known origin were used to assign the 501 salmon to continent of origin using the Bayesian maximum likelihood algorithm. In total, 338 (67.5 %) of the salmon sampled from the 2002 fishery were of North American (NA) origin and 163 (32.5 %) fish were determined to be of European origin (Table 5.1.3.1).

The Working Group noted that the differences (see table below) among the continental percentages in the three NAFO divisions (Chi Square $p < 0.001$) requires sampling catch from all to achieve the most accurate estimate of the contribution of fish from each continent to the mixed fishery.

NAFO division	North America		Europe	
	Number	%	Number	%
Div. 1C	102	69.9	44	30.1
Div. 1D	181	88.7	23	11.3
Div. 1F	55	36.4	96	63.3

Applying the continental percentages for reported catch by NAFO Division results in estimates of 6.4 t (2200 salmon) of North American origin and 2.6 t (900 salmon) of European origin fish landed in West Greenland in 2002. For divisions without samples the overall average weight and continent of origin splits were assumed. Quota reductions have resulted in an overall reduction in the numbers of both North American and European salmon landed at West Greenland until 1999. The number of North American salmon remained about the same in 1999 and 2000 (5-6,000 salmon), but increased in 2001. In 2002, the number of landed salmon decreased to the lowest number on record (Table 5.1.3.2, Fig. 5.1.3.1). A high percentage of European salmon in Div. 1F was observed in 2000-2002.

5.1.2.2 Origin of Atlantic salmon caught at West Greenland at a finer resolution than continent of origin

Within a mixed stock fishery, the identification of the origin and composition of the exploited resource is essential for the responsible management of the shared resource. This is especially true for stocks that are protected under various nation-specific Endangered species legislations. In addition, the NASCO Decision Structure requires that the stock composition of mixed stock fisheries be considered while developing management plans. As an example, the West Greenland Atlantic salmon fishery falls within this category.

Atlantic salmon is highly genetically structured compared to most fish species (Ward et al.1994). Enzyme variants (allozymes) show that approximately one third of the total genetic diversity of Atlantic salmon results from genetic differences between populations. Analyses of microsatellite DNA data from archived scales indicates that the local genetic structure of Atlantic salmon is temporally stable, even over several decades (Nielsen et al. 1999). A major genetic dichotomy exists between populations from either side of the North Atlantic Ocean and between European populations in Baltic and Atlantic drainages (Ståhl 1987). One microsatellite locus has shown almost perfect separation of North American and European Atlantic salmon (Taggart et al. 1995; Koljonen et al. 2002). Such hypervariable nuclear DNA marker types can in theory be used to distinguish any distinct population group from one another, provided that there is a demonstrated positive correlation between genetic and geographic distance and that a sufficient number of unlinked loci are studied. However, it remains to be seen how well these markers estimate finer scale composition within a mixed stock fishery where a large number of populations are contributing.

Data collected for continent of origin assignments for the West Greenland mixed stock fishery have been based on 4,373 Atlantic salmon genotypes (individuals): 459 from Europe and 3,914 from North America with 600 of these from Canadian stocks. These data have also been used to do preliminary assignments of countries, and thus stock complex within Europe, and between Canada and USA. What follows describes an approach for estimating the catch of fish from the USA Distinct Population Segment (DPS), eight rivers in Maine collectively listed as Endangered.

Probabilistic-based Genetic Assignment model (PGA)

The PGA is a probabilistic model that uses Monte Carlo sampling (using @RISK, an Excel add-on) to determine the continent of origin, country of origin or finer scales of resolution for a mixed stock fishery where genetic assignment data and the variability surrounding these data are available.

Generalized approach:

All genetically characterized individuals from the 2002 West Greenland fishery were assigned to continent of origin and country of origin (for NA assigned individuals only). Unanalysed individuals from the catch were assigned to continent of origin (COO) according to a binomial distribution from known (genetically analysed) COO assignments. Furthermore, all North American (NA) origin individuals were assigned to country of origin according to a binomial distribution from the country of origin assignments provided. The regional assignments within the USA were calculated according to the proportion of the 2SW adult returns to all Atlantic salmon rivers within the USA. For the DPS estimate, a Pert distribution, based on the mean estimate, 90% confidence intervals and a truncation of the minimum value (at 0) generated from the linear regression model was used to generate the estimate. Finally the regional assignments were adjusted for natural mortality to estimate the increase in returns that would have resulted with no commercial harvest.

It is estimated that the reference dataset correctly assigns continent of origin 100% of the time whereas the country of origin assignments (USA vs. Canada) are estimated to be 92.2% for assigning USA samples back to the USA and 88.0% for assigning Canadian samples back to Canada (Spidle et al. 2003). These accuracies reflect the high degree of genetic separation between continents and the much lower separation on the country scale (Figure 5.1.3.2). The composition of the reference dataset greatly affects its assignment accuracy, both in terms of the spatial coverage of samples within the dataset as compared with the unknown samples and the quantity of samples within these reference sets. If a reference dataset is used to classify unknown samples, but the reference dataset does not include known samples from the range of possible populations or there are a disproportionate number of samples from one known group or another, the misclassification rate can rise significantly above that recorded through cross validation procedures on the reference dataset. However, if the classification accuracies of the reference dataset are known, the misclassification rates can be accounted for and the tallies produced for the PGA can be adjusted.

While trying to identify USA origin fish in the 2002 West Greenland catch, biological inconsistencies were identified that confounded the model outputs. The cause of these inconsistencies appears to be related to the assignment accuracy of the reference dataset as determined by cross validation procedures. Whenever using genetic data to assign individuals to continent, country or region, external supporting data should be used to corroborate the assignments. Supporting evidence can come from past tagging studies or biological characteristics.

Classifying Southern and Northern European stock complexes in the West Greenland catch has direct applicability to the forecast of PFA. However, finer scale classification within continent will also be useful in evaluating the effects of other fisheries on salmon stocks.

Even finer resolution using genetic techniques is possible, but requires different techniques and more extensive datasets of known origin fish. In some cases, this level of genetic characterization is maintained for broodstock and consulted to reduce sibling mating at hatcheries managing endangered stocks. It is possible to determine the probable parents of an unknown juvenile if the suite of potential parents has been genetically characterized. This level of detail could be available for wild stocks on the verge of extirpation.

Within NEAC and NAC countries, the primary fisheries management unit is watershed. Managers are using differentiation of origin among tributaries for fish captured in mixed stocks fisheries within individual rivers to develop these plans. In UK (N. Ireland), analysis of genetic variation at microsatellite loci in baseline samples from river populations and from a mixed stock fishery in the Foyle area is being used to identify river populations contributing to the fishery. Preliminary analysis using genetic stock identification and assignment techniques is indicating that several areas of the overall Foyle catchment are driving the fishery, whereas other Foyle rivers are apparently under-represented. Results of this analysis may enable managers to regulate the fishery to achieve conservation in all stocks and take specific action to restore production in vulnerable stocks.

These examples show the need for the identification of country or region of origin for the management of mixed stock fisheries. Presently, the reference datasets used for these assignments lack adequate spatial and temporal sample coverage to consistently assign to finer scale with acceptable assignment accuracy. This is especially true for the European and Canadian stock complexes. Efforts need to be taken to bolster these reference datasets by collecting and analysing samples from additional populations over as wide a geographic scale as possible.

5.2 Status of the stocks in the West Greenland area

The salmon caught in the West Greenland fishery are mostly (>90%) non-maturing 1SW salmon, many of which would return to homewaters in Europe or North America as MSW fish if they survived the fishery. There are also 2SW salmon and repeat spawners, including salmon that had originally spawned for the first time after 1-sea-winter and 2-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. Most MSW stocks in North America are thought to contribute to the fishery at West Greenland.

In European and North American areas, the overall status of stocks contributing to the West Greenland fishery is at the lowest level recorded, and as a result, the status of stocks within the West Greenland area is thought to be extremely low compared to historical levels. There has been no significant increase in survival index for the stock. Status of relevant stocks in the NEAC and NAC areas are summarized below, and detailed information can be found in Sections 3.4 and 4.2.

5.2.1 Southern European Stock

The main contributor to the abundance of the European component of the West Greenland stock complex is non-maturing 1SW salmon from southern Europe. The percentage of European fish in catches at West Greenland was around 30% in the early 1990’s and the 2000’s, but was below 20% from 1996 to 1999. A Run-Reconstruction Model was used to estimate the pre-fishery abundance of non-maturing 1SW salmon from 1971 to the present. These have declined since the 1970s, with the 2001 abundance of 546,939 being the 3rd lowest estimate on record (Figure 3.5.1.5). The contributions of countries within NEAC to this PFA, based on tagging data are: France, 2.7%; Ireland, 14.7%; UK (England &Wales), 14.9%; UK (Northern Ireland), <0.01%; UK (Scotland), 64.5%; and northern NEAC countries, 3.2%. Southern European MSW salmon stocks in the Southern NEAC area show a consistent decline over the past 10-15 years, and the estimated overall spawning escapement has been below conservation limits (S_{lim}) in four out of the past six years. Information from individual countries is summarized below:

France:
- MSW returns second lowest in the time series
- MSW spawners lowest in the time series

Ireland:
- MSW returns above the median value for the time series
- MSW spawners above the median value for the time series

- MSW numbers subject to considerable uncertainty as the sea age composition of the catch is not known accurately

UK (England & Wales):
- MSW returns 20% below the median value for the time series
- MSW spawners close to the median value for the time series

UK (Northern Ireland):
- Historical trends unclear as the sea age composition of the catch is unknown for most of the time series.

UK (Scotland):
MSW fish estimated to contribute between 40% & 70% of the spawning stock
MSW returns second lowest in the time series
MSW spawners second lowest in the time series

5.2.2 North American Stock

The North American Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971-2001. The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has declined since the 1970s, with the 2001 abundance of 428,300 being the lowest estimate (Figure 4.2.3.2). The percentage of North American salmon in the West Greenland catch was less than 70 % for all but one year until 1992, and then increased from 60% to 90% from 1995 to 1999, and has averaged approximately 67% from 2000 to 2002 (Table 5.1.3.1). In 2002, the overall conservation limit (S_{lim}) for 2SW salmon was not met in any area except Newfoundland. Specifically:

Newfoundland:
- 2SW and 3SW salmon are a relatively small component of this stock complex
- 2SW returns third lowest in the last 10 years
- 2SW spawners in 2002 at approximately 1.5 times the 2SW stock conservation limits (S_{lim})

Labrador:
- 2SW salmon historically an important part of this stock complex
- 2SW returns peaked in 1995, and decreased again in 1996 and 1997
- no estimate is given after 1997 from this area when the commercial fishery, the basis for the return and spawner model for Labrador, ended

Québec:
- 2SW and 3SW salmon an important part of this stock complex
- 2SW returns lowest in a 32-year time-series
- 2SW spawners in 2002 at 52% of 2SW conservation limit (S_{lim})

Gulf of St. Lawrence:
- 2SW salmon an important part of this stock complex
- 2SW returns second lowest in a 32-year time-series
- 2SW spawners in 2002 at 38% of 2SW conservation limit (S_{lim})

Scotia-Fundy:
- 2SW salmon historically an important part of this stock complex
- 2SW returns lowest in a 32-year time-series
- 2SW spawners in 2002 at 6% of 2SW conservation limit (S_{lim})
- inner Bay of Fundy stocks listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada

United States:
- 2SW salmon historically an important part of this stock complex
- 2SW returns second lowest in a 32-year time-series
- 2SW returns in 2002 at 3% of 2SW conservation limit (S_{lim})
- stocks in 8 rivers listed as Endangered under the Endangered Species Act

5.2.3 Evaluating Atlantic salmon biological data for phase shifts

For the past two years the Working Group has noted that there is a potential problem of non-stationary relationships in spawners to PFA. In 2002, the report included regressions of CPUE (kg/reported landings) and North American and Southern European PFA, with residuals demonstrating a shift in the relationship following the 1992-1993 closure (ICES 2002/ACFM:14, Figure 5.1.2.1). This year the Working Group examined biological data from all three Commission areas for non-stationarity, specifically attempting to identify the transition year(s) where a phase shift was evident. It was hoped that this evaluation would inform the modeling process and facilitate change to integrate trends contained in the time-series of PFA and lagged spawner in NEAC and NAC.

North-East Atlantic Commission

Anon. (2003) provides a critical examination of selected NEAC stock and recruitment relationships Six rivers were considered: the R. Frome UK (England and Wales), the Girnock Burn and the R. North Esk UK (Scotland), the R. Bush and R. Burrishoole (Ireland) and the R. Ellidaar (Iceland). Stock (S) and recruits (R) were expressed in eggs. Recruitment was estimated from estimated returns of adult salmon back to the coast, prior to any homewater fishery. Preliminary examination of these SR series suggested a consistent drop in recruitment levels around the mid 1980s. Analysis of the 12 SR series (i.e. two periods for six rivers) was conducted using a Ricker model. Comparisons before and after the mid 1980s were made for two parameters: the slope at origin (a) and the maximum recruitment per m^2 of wetted area accessible to salmon (smax). Comparisons were based on the median of the posterior distribution of the parameters.

For all the six rivers analysed, there is an obvious drop in the recruitment process occurring in the mid 1980s (Figure 5.2.3.1). In four of the six instances, the productivity (Ricker α parameter - recruits produced per stock unit at low egg depositions) has also dropped significantly. Causes for this phenomenon are unclear although it certainly relates, at least partly, to changes in marine survival observed over the last three decades and to habitat changes (degradation of spawning areas or loss of specific spawning areas).

A non-parametric ratio test (NPRATIO) was used to investigate phase changes in time series of marine survival for salmon stocks in the southern part of the NEAC area (Rago 1993). The software generates the ratio of means from a baseline period compared to a treatment period (i.e the R_{crit} value). Random ratios are then generated from the time series and the number of times the R_{crit} is equal to, higher than or less than these random ratios is calculated. In the present analysis, a moving baseline period starting with the first year was initially compared to all other years in the series i.e. the treatment period. Each successive year was then removed from the treatment period and added to the baseline period with the analysis being repeated with each additional year. In this way, consistent differences in the ratio of the mean survival values of the baseline period and the treatment period could be tracked through each series. In order to provide significance levels at the 5% level, 1,000 random ratios were simulated for each comparison of baseline mean with treatment mean (Rago 2001).

Data for 1SW survival rates were available for five Irish stocks (Shannon hatchery, Screebe hatchery, Burrishoole hatchery, Corrib hatchery and wild), two UK (N. Ireland) stocks (Bush hatchery and wild) and one UK (Scotland) stock (N. Esk wild). These data extended through most of the period from 1980 through 2001 smolt migration years. Marine survival data were available for 2SW fish from four Irish stocks (Shannon hatchery, Burrishoole hatchery, Corrib Hatchery and Corrib wild), and one UK (Scotland) river (N. Eske wild). The time series extended from 1980 through 1998 smolt migration years.

Starting at the first baseline period for 1SW survival (i.e. 1980) compared to the treatment period of 1981-2001, the probability of observing an R_{crit} greater than the randomised ratios was 0.68 (680 of 1,000). Therefore, this R_{crit} value could have occurred by chance alone (Figure 5.2.3.2), indicating no significant difference in the survival in 1980 compared to the mean for the rest of the series. Similarly, for each successive addition of years to the baseline from the treatment period up to 1980/1984, the probability of the R_{crit} being less than the random ratio is less than 0.95, showing that the mean survival for the period 1980-84 was not significantly different to the post-1984 period. After the 1980/1984 period however, the successive removal of each years data from the treatment period and addition of this year to the baseline period indicates a significant difference in the means for each successive comparison up to the 1980-99 baseline and 2000-01 treatment period.

The first baseline period for 2SW survival is 1980, which is compared to the 1981-1998 treatment period. The probability of observing an R_{crit} greater than the randomised ratios was 0.36 (360 of 1,000) and therefore could have occurred by chance alone (Figure 5.2.3.3). For each successive comparison up to 1980/1989 the mean survivals are significantly higher in the earlier period compared to the later period ($p < 0.95$ in each case). After the 1980/1989 baseline period, the successive removal of each years data from the treatment period and addition of this year to the baseline period results in consistent period where the survival rates for the successive baseline/treatment comparisons are not significantly different.

These results provide some support of a phase change in marine survival consistent with other observed stock dynamic changes occurring in other stocks from the North East Atlantic and North America, particularly around the 1989/1990 period for 2SW stocks and possibly earlier for 1SW stocks. The percentage of Southern NEAC stock caught in the Greenland fishery has ranged from 10% to 66% and is estimated to be 33% presently. Therefore, the results of the 2SW analysis may be particularly pertinent to the identification of phase shifts affecting the dynamics of the Greenland fishery.

North American Commission

The relation between the returns of 1SW and MSW from a given smolt cohort was examined for three data sets from Québec for 1980 – 2001. The data were: estimates of total salmon returns in Québec and of returns from two index rivers. Returns were corrected based on estimates of captures made in home water, but not those in the distant fisheries. The regressions of 1SW to 2SW returns for a cohort were developed and residuals plotted against year (Figure 5.2.3.4). In each analysis the residuals for the regressions demonstrate two periods, namely from 1980 and 1990 and the period starting in 1991. A similar regression approach did not produce evidence for a shift in survial rate of hatchery 2SW returns to the Penobscot River. However, inverse weight estimates for North America show an increase in theoretical M in the second year over the last decade (Figure 2.3.1.2)

On the LaHave River, Nova Scotia, the natural log of recruits per spawner (survival index) determined at Morgans Falls had normal variance to 1986 but has been below replacement (zero line) ever since (Figure 5.2.3.5). The shift in population stability was not associated with an acute loss in freshwater productivity monitored by both juvenile densities and smolt emigration. However, the drop in the survival index (Ln(R/S)) in 1986 is associated with the decline in smolt age two-sea age two (age 2.2) and is equivalent to the 1990 PFA year.

Greenland Commission Area

The whole weight of 1SW North American salmon in the West Greenland fishery (uncorrected for sampling date) was examined in two independent tests. Mean 1SW salmon whole weights from 1969-2002 were regressed against year to determine when the relationship became significant by casting forward in groups of four years. There was a significant decline in weight from 1969 to 1992, followed by a significant increase in weights over time (1995-2002) (Figure 5.2.3.6), identifying the change in relationship in the early 1990's. These data were also analyzed using the randomization method described for Southern NEAC survival, identifying the break in the same time period (Figure 5.2.3.7). An analysis of river age distribution (%) for North America was begun, however, the analysis was confounded by changes in hatchery produced river age 1-fish over time and was abandoned.

Therefore the Working Group decided that the phase shift, detected in about 1990, needed to be considered when providing catch advice for the West Greenland fishery in 2003.

5.3 Evaluation of the effects on European and North American stocks of the West Greenland management measures

There have been the following 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 next 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.
- In 1998, NASCO agreed on a subsistence fishery of 20 t, which in the past has been estimated for internal consumption at Greenland. In 1999, a multi-year management was agreed restricting the annual catch to that amount used for internal consumption.
- An *ad hoc* management arrangement for 2001 was agreed by NASCO, implementing an adaptive quota calculation, based upon three harvest periods. The resulting total quota for all harvest periods was 114 t.
- A revised *ad hoc* management arrangement for 2002 was agreed to by NASCO. In addition, an agreement was negotiated between the North Atlantic Salmon Fund and its partners, and the Greenland Association of Hunters and Fishers (KNAPK), to suspend the commercial part of the salmon fishery. The agreement is for a total of five years, and is automatically renewed annually unless one of the parties gives notice in advance of the fishing season of their intention to withdraw.

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 5.3.1). The variables in the table (percent of origin, mean weights, and percent of 1SW fish) are used in the analyses (Section 5.1).

The numbers of fish spared by the 1993-1994 closures are shown in Table 5.3.1. 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 contains 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 1993-2002 of potentially returning fish per ton caught at Greenland is calculated to 166 and 92 salmon for North America and Europe, respectively.

To estimate the number of salmon spared by the suspension of the fishery in 2002 the following assumptions are made:

- Excluding year 2000 the availability of salmon and the potential effort in 2002 is assumed to be close to average for the recent five years (1997-2001).
- The non-commercial landings in 2002 would have been close to average for the recent five years (as above) had there been a commercial fishery.

The average commercial catch for the period was 27,900 kg, and the non-commercial part was 4,800 kg. The difference between the reported non-commercial catch in 2002 and the five-year average is 4,200 kg, leaving 23,700 kg as a potential commercial landing in 2002. The corresponding number of salmon is 5,400 and 2,500 salmon of North American and European origin, respectively.

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 home-water 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.

Following on the above recommendation, the Working Group reviewed an analysis of the impacts of variations of the West Greenland fishery on expected returns to rivers. The analysis was based on an examination of the 1SW to 2SW relationship demonstrated for several stocks in eastern Canada and focused on the explanatory power of the West Greenland catches on the residuals of the relationship.

In the absence of fishing mortality, it was assumed that stocks would display an average 1SW to 2SW relationship albeit over a short time interval and with variation around the average relationship arising from several stock driven or environmentally driven factors. If fisheries mortality is proportional on both age groups, the relationship should be undistinguishable from the natural process. If a fishery exploits the 2SW age group but not the 1SW age group, then the 1SW to 2SW ratio should be unnaturally high. If fisheries exploit 1SW age group preferentially, then the 1SW to 2SW ratio would be unnaturally low. The absence of exploitation on one age group can be used to assess the relative impacts of the fishery on the other age group, especially if there have been changes in fisheries management affecting the age group of interest.

The fishery at West Greenland exploits predominantly 1SW salmon destined to mature and return as 2SW salmon the following year. Since 1992, essentially only 2SW salmon are presently exploited at West Greenland as a result of the progressive closures of the commercial fisheries in eastern Canada. It was assumed therefore that the 1SW salmon returning to rivers in eastern Canada and particularly so to the Maritimes have been filtered by natural survival only. Variations in 2SW returns to eastern Canada from the expectation of the 1SW to 2SW relationship may be exaggerated by variations in fisheries harvests at West Greenland.

This effect was examined using data from the following Maritime rivers:

- 1SW and 2SW returns of wild and hatchery origin salmon from the Saint John River at Mactaquac
- 1SW and 2SW wild and hatchery salmon from the LaHave River
- 1SW and 2SW wild salmon from the Miramichi River

The reference 1SW-2SW relationship for the Maritime rivers was considered to be 1992 to 2002. To assess whether there were any detectable effects on 2SW returns to rivers as harvests at Greenland varied, a covariance analysis was conducted. The model was:

$2SW_{i+1} = f\{1SW_{I,} GN1\}$

where 2SWi+1 = returns of 2SW salmon in the river in year I+1

1SWi = returns of 1SW salmon to the river in year I,

GN1 = harvest of North American 1SW salmon at West Greenland in year I

The returns data were log transformed before analysis therefore the model being adjusted was:

Ln(2SW returns in year I+1) = Ln(1SW returns in year I) + GN1

<u>1SW-2SW associations</u>

There are several strong associations between 1SW to 2SW salmon, particularly for the wild salmon. In both the LaHave and Southwest Miramichi relationships, the 2SW returns in 1993 are exceptionally low relative to the 1SW returns in 1992 (Fig. 2.4.3.8). There is a negative association between the level of harvest at West Greenland and the difference from expected (based on the 1SW / 2SW relationship) in the 2SW returns (Fig. 2.4.3.9). For all rivers and stocks (wild, hatchery) examined, the correlation coefficient of GN1 was consistently negative, meaning that as the harvests of 1SW nonmaturing salmon at West Greenland increased, the returns of 2SW salmon to these rivers, based on the expectation from the smolt cohort and returns of 1SW salmon the previous, were lower than expected. For the

Nashwaak River and the hatchery salmon from the Saint John River, consideration of the Greenland harvest did not contribute to describing the variations in 2SW returns corrected for variation in 1SW return the previous year (Fig. 2.4.3.9).

The analysis indicated that the variations in high seas exploitation at Greenland could be detected in the returns of 2SW salmon in home waters in the Maritimes, but only after correcting for the 1SW abundance of the same cohort. The benefits of reduced exploitation can only be appropriately evaluated if the variations in natural mortality are accounted for, as is the case for the 1SW-2SW associations. This also requires that the returns of one age group, in this case the 1SW age group, be exempt from exploitation, which has been the case for the 1SW maturing age group in North America since the closure of the commercial fisheries in 1992-1998. The reduced exploitations at West Greenland has benefited the rivers of the Maritimes although it is clear that fishing at West Greenland does not seem to be the major constraint on 2SW salmon in some areas of eastern Canada.

5.4 Age-Specific Stock Conservation Limits for All Stocks in the West Greenland Commission Area

Sampling of the fishery at West Greenland (Table 5.1.4.3) 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 3SW salmon, if surviving to spawn. Usually less than 3% of the harvest is composed of salmon that have previously spawned and a few percent are 2SW salmon that would mature as 3SW or older salmon. 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 in Section 4.4. The 2SW spawner limits of salmon stocks from North America total 152,548 fish, with 123,349 and 29,199 required in Canadian and USA rivers, respectively.

Conservation limits for the NEAC area have been split into 1SW and MSW components on the basis of the average age composition of catches in the past ten years. The stocks have also been partitioned into northern and southern stock complexes, and tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern stock complex. The current conservation limit estimate for southern European MSW stocks is approximately 263,000 fish (Table 3.4.3.1). There is still considerable uncertainty in the conservation limits for European stocks and estimates may change from year to year as the input of new data affects the 'quasi-stock-recruitment relationship'. The Working Group has previously noted that outputs from the national PFA model are only designed to provide a guide to the status of stocks in the NEAC area. Previously, the conservation limits for MSW salmon in the NEAC area have not been incorporated into the modeling of catch options for West Greenland.

5.5 Catch Options with Assessment of Risks Relative to the Objective of Achieving Conservation Limits

5.5.1 Overview of provision of catch advice

The Working Group was asked to advise on catch levels that would maintain 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 of concern. In principle, adjustments to catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mortality on the contributing populations. However, benefits to particular stocks would be difficult to demonstrate, in the same way that damages to individual stocks are 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 is to regulate catches while achieving overall spawning escapement reflecting the spawner limits 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 pre-fishery 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 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 that 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 had 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 had been consistent since 1993, the models themselves have varied slightly over the years. Changes have been made to these models in attempts to improve their predictive capabilities and add more biological reality. 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 1996-2001 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada. In 2000-2001, the model was based on the natural log of PFA relative to the natural log of spawners and habitat variables. In this way, the survival rate of salmon (PFA / Spawners) has a mean survival level that is modified by the habitat environmental variable.

The Working Group had previously noted that because the method of estimating spawning escapement for Labrador was based on commercial catches and exploitation rates which ended in 1997 following closure of the commercial fishery, lagged spawner values would have missing components in year 2003. Thus, an alternative index of salmon abundance is required and described below.

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 (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 to 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

The Working Group has been using the relationship between marine habitat, an index of 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; 2000/ACFM:13, and 2001/ACFM:15). 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 has been updated to include 2002 and January and February 2003 year data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 5.5.1.1 and Figure 5.5.1.1). Available habitat for February is unchanged from 2002. The 2003 February value is more than 10% higher than the long-term mean of 1,661.

Update of Lagged Spawners

The lagged spawner variable used in the model is an index of the 2SW parental stock of the PFA. It provides a means of examining the value in managing for spawning escapement and predicting recruitment in the extant seas fisheries. 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 this variable. The exclusion of a major component of the spawning stock contributing to the PFA was less than satisfactory. As well, spawning escapement estimates for Labrador are not available for the years 1998-2001. The previously formulated lagged spawner variable is therefore not available beyond 2002.

The Working Group investigated two approaches to resolve the issue: 1) estimating lagged spawners for Labrador using data from other areas to develop a relative spawner index, and 2) continue the lagged spawner index and exclude the Labrador time series.

A relative (time) index of spawners is sufficient to assess population dynamics or recruits per spawner. Covariance models can be used to derive relative indices and are used extensively in fisheries assessment for standardizing catch rates by vessel type or gear type or for season or area effects (Hilborn and Walters 1992; Gavaris 1980). An analysis using simulated series indicated that the covariance models could not account for missing components of index series when there are trends present. The ratio of Labrador spawners to the sum of the remaining region spawners fluctuated around 0.2 from 1978 to 1988, decreased and fluctuated around 0.1 from 1989 to 1999 and rose rapidly to over 0.4 in 2002. Such variation is difficult to capture in any model and the subsequent behaviour of the ratio beyond the measured year is unpredictable. If a ratio were used to fill in the missing years for Labrador, the Labrador spawner values would simply be adjusted as a fixed proportion of the trend in the sum of the spawners in the remaining regions, an assumption which cannot be tested with existing information or verified until alternative indices of spawner abundance for Labrador become available.

Patterns of standardized spawner indices (annual number/mean for period) without Labrador did not differ greatly from the sequence of spawner abundance with Labrador included. The trends in lagged spawners have fluctuations that demonstrate consistent patterns among adjacent areas. The trend is down since 1989 for USA and Scotia-Fundy spawners (Figure 4.2.4.4). There is a downward trend for Quebec spawners since the mid 1980s whereas Gulf spawners recovered quickly after the 1984 management plan, remained high through 1990 to 2000 and are declining into 2003. Newfoundland, like Labrador, has an increasing trend in spawner abundance since the mid-1990s, consistent with the management plan that increased escapement (Figure 4.2.4.4).

The variation in Labrador spawners has been much greater than the variation of the sum of the regions (Figure 5.5.1.2). The sum of the other region spawners declined from 1978 to 1988 and rose rapidly in 1989, directly as a response to the management plan of 1984 which imposed the closure of the commercial fishery and the mandatory release of large salmon in the Maritimes – the stepped increase in 1989 was driven by the Gulf stock. Subsequent to 1989, lagged spawners have been declining almost continually and most rapidly into 1992 (Figure 5.5.1.2). The exclusion of the Labrador time series in the North American spawner index is not ideal but is easier to defend in the context of the information available. Excluding the spawner series from Labrador is equivalent to assuming that the trend in Labrador is correlated with the trend of the remaining five regions.

In light of the analyses conducted, the Working Group developed a new lagged spawner index for North America, which consists of the sum of the lagged spawners from the five regions (US, Scotia-Fundy, Gulf, Quebec, Newfoundland) excluding Labrador (Table 5.5.1.1). Spawner estimates are available for these regions and are anticipated to continue into the future. The Working Group recognized however that this is not an ideal situation as this spawner index may not be an unbiased measure of the overall lagged spawner abundance from North America, particularly as the impression into the late 1990s was that spawning escapement in Labrador was estimated to have been rising rapidly. However the exclusion of Labrador did allow the lagged spawner series to be extended back in time one more year, the 1977 year of PFA (Section 4.2.4.2).

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

North American Forecast Model

The 2002 forecast of pre-fishery abundance was based on a modeling approach where habitat acts on PFA through survival rather than on absolute abundance. The model took the following form:

$$PFA = Spawners^{\gamma} * \exp^{-(\alpha + B*Habitat + \xi)}$$

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 that is modified by the habitat variable. A linear form of the model fits the natural log of PFA relative to the natural log of spawners and habitat variables:

$$Ln(PFA) = Ln(Spawners) + Habitat + intercept + \xi$$

The basis for the model was the same two predictor variables as used from 1999 to 2001: 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 et al. 1989; Reddin and Shearer 1987; Friedland et al. 1993; Friedland et al. 1998).

With the development of an alternative lagged spawner index for 2003, the model was fitted with the new lagged index series and the February habitat index, as in previous years. Revised PFA values (based on updated information from previous years) were also used (Section 4.2.3). The data are summarized in Table 5.5.1.1 and Figure 5.5.1.1. The model was not significant ($p = 0.27$) with an r^2 value of 0.11.

The absence of a significant association between the PFA, lagged spawner index and habitat was expected given the analyses from previous years which indicated that the inclusion of Gulf Region lagged spawners resulted in a non-significant model. However, an analysis of the sequence of PFA and lagged spawner values revealed structure within the data set that had not appeared previously and that could not be accounted for by the model used in previous years. Specifically, when perceived over time, two states of Atlantic salmon production become evident with a transition state from 1988 to 1990 (Figure 5.5.2.1). Other indicators of a change in marine dynamics were presented in Section 5.2.3., and many were consistent with this time period. Average relative production, expressed as PFA / lagged spawner index, was 7.6 during 1977 to 1988 and averaged only 1.9 during the 1992 to 2001 period (Figure 5.5.2.1). This dynamic indicates that mortality of salmon between the spawner and PFA recruit stage has changed in the last 15 years. To capture this dynamic, a model that incorporated a break into two time periods, termed phases, was fitted to the data. The position of the change between the high production phase and the lower, more recent production phase was considered to be 1989 as this PFA year is the midpoint in the slide from a low spawner index and high PFA abundance to a high spawner index and unchanged PFA abundance (Figure 5.5.2.1).

The model fitted was similar to the previous year models with the addition of an indicator variable to capture the change between the phases.

$$PFA_{NA} = LS^{\gamma}_{NA}\ e^{(\alpha + \beta * Ph + \delta Hab + \xi)}$$

where PFA_{NA} = PFA for North America

LSNA = Lagged spawner index excluding Labrador (1977 to 2001)

Ph = Phase (indicator variable representing 2 time periods (1979-1988, 1990-2001)

Hab = Thermal habitat index for February

$\alpha, \beta, \gamma, \delta$ = coefficients of the variables and intercept

ξ = residual error, lognormal

The PFA_{NA} and LS_{NA} variables were natural log transformed before analysis. The linearized form of the model was:

$$Ln(PFA_{NA}) = \alpha + \beta * Ph + \delta\ Hab + \gamma * Ln(LS_{NA}) + \xi'$$

The year 1989 was considered transitional. It was alternatively placed in either the upper phase or lower phase in two runs of the model. The model was fittted initially using the annual mid-point values of PFA_{NA} and LS_{NA} (Table 5.5.1.1).

The thermal habitat variable was not a significant ($P > 0.50$) explanatory variable of PFA variability after accounting for the lagged spawners and the phase shift. Lagged spawner index and the phase shift were highly significant and accounted for more than 82% of the variance in $Ln(PFA_{NA})$ (Table 5.5.2.1). The year 1989, in either the first phase or the second phase, did not affect the overall explanatory power of the lagged spawner and phase shift variables. The model selected for generating the PFA_{NA} for 2003 and the catch advice included $Ln(LS_{NA})$ and a phase shift variable set around 1989 (Figure 5.5.2.2). The two phases share a common PFA_{NA}/LS_{NA} slope but with an intercept change which describes the large change in productivity between the two phases. The year 1989 is allocated to either phase using an uninformative prior.

Using the current model to estimate the 2002 pre-fishery abundance using the updated value for 2001 yields a PFA_{NA} prediction that is less than half of the previous year value (Figure 5.5.2.3). The impact of the change in the model and the hypothesis of the change in dynamic are evident in the PFA prediction.

For 2003, the PFA_{NA} forecast is among the lowest of the time series with a median value of 111,000 fish and about a 10% chance the abundance will be sufficient to meet the spawner reserve of 212,000 2SW salmon to North America (Figure 5.5.2.4).

Stochastic Analyses for North American PFA

Although the exact error bounds for the estimates of pre-fishery abundance (NN1(i)) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods, in the software package SAS (SAS Institute, 1996), were used to generate the probability density function of NN1(i) (PFA_{NA}) (Appendix 4). This was done in a seven-step procedure as follows:

Step 1: Annual values (1977–2001) 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 (1977-2001) of the new lagged spawner index (LS_{NA}) were generated assuming a uniform distribution of the minimum to maximum values of LS_{NA}.

Step 3: The year 1989 is assigned randomly to the first phase (1977-1988) or the second phase (1990-2001) using an uninformative prior, draw from a uniform distribution with the criterion set at 0.5.

Step 4: The model incorporating LS_{NA} and a phase shift indicator variable, which estimates an intercept term for each phase is fitted using GLM procedure (SAS).

Step 5: A single pre-fishery forecast value for 2002 or 2003 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 year 2002 or 2003 was assigned to one of the phases based on the likelihood of observing a change from PFA levels sufficient to move the stock to an alternate state (see following section). The normal distribution was used because the error structure of the regression (after log transformation) is assumed to be normal.

Step 6: Steps 1-5 are repeated 10,000 times to generate a vector of forecast values from variable model fits and predicted values. This resampling incorporates the uncertainty of the input parameters (steps 1 to 3) and the unexplained variance in pre-fishery abundance from the regression (steps 4 and 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.

These estimates were then used to develop the risk analysis and catch advice presented in Section 5.5.3. Managers may use this information to determine the relative risks borne by the stock (i.e., not meeting spawning limits S_{lim}) versus the fishery (e.g., reduced catches).

Determining the probability of 2003 being in one of the phases

When sequential observations are autocorrelated, previous states may provide a reasonable forecast of the immediate future. In the case of the phases described by the lagged spawner and PFA_{NA} model, it seems reasonable to expect that 2003 will be in the lower phase, as observed over the last ten years. However, to provide a PFA_{NA} for 2003, a quantification of the probability of being in either phase is required. The approach taken to estimate this probability was to examine the historical changes in PFA_{NA} from year t to year t+2. The two-year lag is used because current year PFA (i.e 2002) is not available due to its dependence upon 2SW returns in the next year. These historical observations are used to estimate the possible values of PFA_{NA} in the predicted year from the observed PFA_{NA} two years earlier under the assumption that the rate of change in PFA_{NA} is stationary over time (Figure 5.5.2.5). Application of these observed rates of change to last year's PFA_{NA} results in a distribution of potential PFA_{NA} values for the forecast year. These values are not used for catch advice, but rather to determine the probability of being in each phase of the two-phase regression. Using the mean square error from the fit model, the probability of any PFA value given a lagged spawner value can be calculated for each regression. Summing and standardizing these probabilities over all the potential PFA values for each regression and standardizing produces the probability of being in either phase (Table 5.5.2.2).

For the 2003 forecast of PFA_{NA}, the probability of being in the first phase (similar to 1977-1988 time period) is 4.8% and the probability of being in the lower productivity phase is 95.2% (Table 5.5.2.2). The predicted PFA_{NA} is then a modeled average distribution with random draws of a binomial distribution determining which intercept shift is applied to the lagged spawner variable in the year of interest. This selection is done at each iteration of step 5 above. This distribution can be thought of as a weighted combination of the two possible predicted PFA distributions from the two regressions, with weights determined by the probability of being in each phase.

5.5.3 Development and risk assessment of catch options for 2003

5.5.3.1 Development of catch advice

The provision of catch advice in a risk framework involves incorporating the uncertainty in all the factors used to develop the catch options. The ranges in the uncertainties of all the factors will result in assessments of differing levels of precision.

The analysis of risk involves four steps: 1) identifying the sources of uncertainty; 2) describing the precision or imprecision of the assessment; 3) defining a management strategy; and 4) evaluating the probability of an event (either desirable or undesirable) resulting from the fishery action. Atlantic salmon are managed with the objective of achieving spawning conservation limits. The undesirable event to be assessed is that the spawning escapement after fisheries will be below the conservation limit.

A composite spawning limit (S_{lim}) for the North American 2SW stock complex was developed by summing the spawning limits of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawner limits are provided in (ICES 1996/Assess:11) and in Section 4.4 of this report.

The fishery allocation for West Greenland is for fisheries on 1SW non-maturing salmon in 2003, whereas the allocation for North America can be harvested in fisheries on 1SW salmon in 2003 and/or in fisheries on 2SW salmon in 2004. To achieve spawner limits, a reserve of fish must be set aside prior to fishery allocation in order to meet spawner limits and allow for natural mortality in the intervening months between the fishery and return to river. The spawner limit for North America is 152,548 2SW fish. Thus, 212,189 pre-fishery abundance fish must be reserved ($152{,}548/\exp^{(-.03*11)}$) to equate to inriver S_{lim} because of natural mortality between Greenland and Canada.

Fisheries are managed for harvests of fish, not for escapes of fish. As such the development of catch advice in a risk analysis framework considers the consequences to the objective of meeting conservation limits in the rivers of North America of catching different quantities of fish. The risk consists of not having sufficient numbers of fish returning after the harvesting has taken place and the evaluation of the risk of not meeting the conservation limits depends upon the degree of uncertainty associated with the predicted number of salmon returning to the rivers to spawn.

The risk analysis of catch options for Atlantic salmon from North America incorporates the following input parameter uncertainties:

1) the uncertainty in attaining the conservation requirements simultaneously in different regions,
2) the uncertainty of the pre-fishery abundance forecast, and
3) the uncertainty in the biological parameters used to translate catches (weight) into numbers of North American origin salmon.

The risk analysis proceeds as illustrated in the flowchart of Figure 5.5.3.1. The three primary inputs are the PFA_{NA} forecast for the year of the fishery, the harvest level being considered (t of salmon), and the spawner requirements in the rivers of North America. The uncertainty in the PFA_{NA} is accounted for in the resampling approach described in Section 5.5.2. The number of fish of North American and European origin in a given catch (t) is conditioned by the continent of origin of the fish (propNA, propE), by the average weight of the fish in the fishery ($Wt1SW_{NA}$, $Wt1SW_E$) and a correction factor by weight for the other age groups in the fishery (ACF). These parameters define how many fish originating from the NAC and NEAC areas will be in the fishery. Since these parameters are not known, they must be borrowed from previous year values. For the 2003 fishery, it was assumed that the parameters for $Wt1SW_{NA}$, $Wt1SW_E$, propNA, and propE, and the ACF could vary uniformly within the values observed in the past five years (Tables 5.1.2.1, 5.1.3.2). After the fishery, fish returning to home waters are discounted for natural mortality from the time they leave West Greenland to the time they return to rivers, a total of 11 months at a rate of M = 0.03 (equates to 28.1% mortality). The fish that survive to homewaters are then distributed among the regions and the total fish escaping to each region is compared to the region's 2SW spawning requirements.

Harvest

For a level of fishery under consideration, the weight of the catch is converted to fish of each continent's origin and subtracted from one of the simulated forecast values of PFA_{NA}. The fish that escape the Greenland fishery are immediately discounted by the fixed sharing fraction (Fna) historically used in the negotiations of the West Greenland fishery. The sharing fraction chosen is the 4:6 West Greenland:North America split. Any sharing fraction can be considered and incorporated at this stage of the risk assessment.

Spawning Requirements

The spawning requirement risk profile for North America was described previously in ICES 1997/Assess:10. Briefly, North America is divided into six stock areas that correspond to the areas used to estimate returns and spawning escapements (Table 4.4.1). Under the assumption of equal production from all stock areas (i.e., recruitment in direct proportion to the spawner requirement) just over 172,000 fish should escape to North America as spawners to achieve the spawner requirement in all six stock areas at a 50% probability level. This value is higher than the point estimate for the North American stock complex (152,548 2SW salmon, Table 4.4.1) because it includes the annual variation in proportion female and the objective to have sufficient escapement in six stock areas simultaneously.

The Working Group had previously expressed concerns that the spawning requirement used for North America is for the continent as a whole and does not reflect the expected returns to the six regions, i.e. even if 172,000 2SW salmon reach the coast of North America, there will likely be severe under-escapement in some regions. Specifically, the 2SW returns to Scotia-Fundy, and USA have been below their corresponding conservation limits since 1985 (Figure 4.2.2.2). For the 1998 to 2002 PFA years, the most recent years when estimates of lagged spawners are available for all regions of North America, the Quebec and Gulf regions have accounted for a disproportionate number of lagged spawners relative to their 2SW requirements (Figure 5.5.3.2).

Based on past performance, there is no reason to expect the abundance of salmon in the North Atlantic to be proportional to the regional 2SW spawner requirements. Assuming that the abundance of Atlantic salmon in 2003 will be proportional to the abundance of lagged spawners in the last five years when lagged spawner estimates across regions were available, it is possible to calculate the number of salmon required to return to North America to achieve region-specific conservation requirements. For example, to achieve the Newfoundland 2SW requirement of 4,022 2SW salmon, a total of 72,062 fish would be required to leave West Greenland at the PFA_{NA} stage (Table 5.5.3.1). In the regions with lower stock performance, total PFA_{NA} abundance of about 454,000 fish would be required for the Scotia-Fundy region, and PFA_{NA} abundance of almost 1.9 million fish would be required for achieving the USA conservation requirements (Table 5.5.3.1).

There is a zero chance that the returns to USA rivers will meet or exceed the conservation limit, about 29,000 2SW salmon, in 2004 (Section 4.2.8). There is little chance of returns in 2004 being sufficient to meet the Scotia-Fundy requirement even in the absence of high seas fisheries. There would be a small chance that the PFA_{NA} abundance in 2003 would be sufficient to meet the conservation requirements based on the realized returns in recent years and the anticipated PFA of salmon in 2003 (Figure 5.5.2.4; Table 5.5.3.2).

Alternate Management Objectives
To guide the management, an alternative risk analysis was conducted. The Working Group recommends that fisheries managers attempt to meet the conservation limits simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf. For the two southern regions, Scotia-Fundy and USA, an alternate objective to that of achieving the conservation requirement would be to achieve increases in returns relative to previous years with the intention that this will lead to the rebuilding of stocks, i.e. assess fisheries relative to the objective of achieving a minimally pre-agreed increase in returns relative to the realized returns of a previous time. Rates of improvement from previous years could be as low as 10% for those stocks that are approaching a stock status objective. A greater improvement as might be associated with more aggressive rebuilding rates might be to seek a 25% improvement over returns of a previous time period. These rates of increase refer to current stock size and not to percent of conservation limits. In Section 2.5, it was shown that stocks with low productivity such as these take a long time to rebuild to conservation limits. Both levels of spawner level improvements were quantified in the following risk analysis.

The final step in the risk analysis of the catch options involves combining the conservation requirement with the probability distribution of the returns to North America for different catch options. The returns to North America are partitioned into regional returns based on the regional proportions of lagged spawners for the 1998 to 2002 period. Estimated returns to each region are compared to the conservation objectives of Labrador, Newfoundland, Quebec, and Gulf. Estimated returns for Scotia-Fundy and US are compared to the objective of achieving at least a 10% increase or a 25% increase relative to average returns of the previous five years. The management objectives are shown in Table 5.5.3.1.

5.5.3.2 Catch Advice for the NAC

The pre-fishery abundance of salmon in 2003 is expected to be among the lowest on record (Figure 5.5.2.4; 5.5.3.3). Even in the absence of fisheries on the non-maturing 1SW salmon at West Greenland in 2003 and subsequently on the returning 2SW salmon to North America in 2004, there is only a 28% chance that the abundance of salmon will be sufficient to achieve the conservation requirements for 2SW salmon in the four northern regions. There is a better chance of realizing increases in returns to the southern North American stocks however at a fishery of 50 t in West Greenland in 2003, the chance of an improvement of 25% or more in both regions falls to less than 50% (Table 5.5.3.2). The Working Group indicated last year that a higher probability level than 50% should be used to evaluate catch options relative to the attainment of conservation limits. Using the 75% probability level, none of the management objectives would allow a fishery to take place.

The Working Group concludes that the North American stock complex of non-maturing salmon has declined to record levels and is in tenuous condition. Increased spawning escapements to rivers of some areas of eastern North America resulted in improved abundance of the juvenile life stages. Despite the closure of Newfoundland commercial fisheries in 1992 and subsequently in Labrador in 1998 and Québec in 2000, 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 2003 in eastern Canada will be slightly improved from 2002 (Section 4.2.8). Smolt production in 2001 and 2002 in monitored rivers of eastern Canada were less than or similar to 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.

The model presently describes two phases of salmon production in the Northwest Atlantic. The ability to detect a phase shift in recruitment per spawner in the northwest Atlantic during the last two decades was enhanced with the passage of time. The lower recruitment rates, which may not replace the spawners that generated them, are evident throughout eastern Canada and U.S., especially so in the southern regions. The reduced relative rate of recruitment does not suggest that the problem is entirely in the marine environment. The problem may be an integration of factors across all aquatic habitats of Atlantic salmon. Large areas of production have been lost or are severely impacted by anthropogenic factors. Given the presently described condition of salmon stocks, there is no evidence in the stock status from any of the regions in North America that there will be a turnaround in productivity in the ocean in 2003.

5.5.3.3 Catch advice for combined NAC and NEAC PFA

The Working Group considered a process for the provision of catch advice for West Greenland based on the combined PFA and CLs of the NAC and NEAC areas. A procedure for doing this is outlined in Figure 5.5.3.1 in which the PFA for NAC and NEAC are applied in parallel to the Greenland fishery and then combined at the end of the process into a single summary plot or catch advice table.

The parameters of the NAC risk analysis are described in Section 5.5.3.1.

For the NEAC evaluation, the following parameter inputs were used.

- The NEAC PFA prediction model for MSW salmon from southern Europe and the prediction of PFA_{NEAC} for 2003 are presented in Section 3.5.2. For 2003, the forecast for the southern Europe MSW salmon on January 1 of the first sea-winter year is 524,000 fish (95% C.I. 315,000 to 840,000).
- The PFA_{NEAC} for 2003 is adjusted for 8 months of natural mortality (0.03 per month) which equates to 79% survival to bring the fish to August of the fishery year at Greenland
- The sharing arrangement for the West Greenland fishery used in this example corresponds to the sharing arrangement used for the provision of catch advice for the NAC area. The sharing arrangement negotiated with one of the commission areas automatically determines the arrangement for the other area as the West Greenland fishery cannot selectively harvest fish on the basis of their continent of origin. Historically, the West Greenland share of the total NEAC MSW harvest was on average 40% from 1970 to 1993.
- The biological characteristics of the fish at West Greenland are simultaneously derived for fish from both continents
- The conservation limit for the NEAC MSW salmon is 262,935 fish (Table 3.4.3.1)

In the absence of any fishery at West Greenland, there is a less than 75% probability that the MSW conservation limit for southern Europe will be met (Table 5.5.3.3). The average biological characteristics of the previous five years in the fishery at West Greenland provide continental distributions of 78% NAC 1SW salmon in the fishery.

Using the 75% probability level, none of the management objectives in NAC or NEAC would allow a fishery to take place.

The Working Group also noted that the PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s (Figure 3.5.1.5), and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years (537,000 and 524,000 fish) (Figure 3.5.2.3). There is evidence from the prediction that PFA will decrease in the near future and the spawning escapement has not been significantly above the conservation limit for the last six years (Figure 3.5.1.6). The stock group is therefore thought to remain very close to safe biological limits, and the Working Group therefore considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability. The Working Group also notes that mixed stock fisheries present particular threats to conservation.

5.6 Updates to and Critical Assessment of the 'Model' Used to Provide Catch Advice

The following updates were made in the model to forecast PFA for the North American Commission Area. The portions of Section 5.5 that provide justification for the updates are noted in parentheses.

- Labrador was not included in the lagged spawners index due to lack of data (Section 5.5.1)
- Returns to Gulf and USA regions, excluded in previous years, were included in the lagged spawners index (Section 5.5.1)

- A two phase regression between PFA and lagged spawners was used (Section 5.5.2) to account for phases in productivity (Section 5.2.3)
- The habitat index did not provide a statistical improvement to the model and so was not included (Section 5.5.2)

Critical evaluations of updates to the model were documented during the process of developing catch advice. The portions of Section 5.5 that provide those critical evaluations are noted in parentheses.

- A comparison of the 2003 PFA estimates from the updated model to the configuration of the model used last year is not possible because the lagged spawner index for Labrador cannot be estimated. However, application of the updated model to estimate the 2002 PFA produced a lower estimate (median 135,000) than the estimate provided last year (median 325,000). (Figure 5.5.2.3, 5.5.3.3)
- The lagged spawner variable used in the model declines in 2003 to its lowest value and is used to predict PFA using relative spawner abundances that are outside the range of previously observed values. The uncertainty of associations increases as the predictor variable gets farther from the mean, which is the case for the 2003 projection.
- A jack-knife analysis of the two-phase regression model demonstrated that the model has better predictive capacity for the more recent years than for the earlier years. The 1989 value seems to fit better with the second phase than with the first phase (Figure 5.6.1 and Figure 5.6.2). However, residuals were positive for the years 1989 to 2001, demonstrating that the model underestimates subsequent PFA values.
- To compute the probability of achieving a given level of stock increase for the USA and Scotia-Fundy regions of North America, the Working Group used the recent a 5-year average of returns. The Working Group noted that if a moving average is used, and these stocks continue to decline, so will the baseline value. The Working Group draws attention of managers of the need to establish the range of years to define the baseline and the percentage increase from that baseline. This will provide the Working Group with the criteria to assess performance of the fisheries management.

5.7 Continuing Model Development

5.7.1 Juvenile Abundance Indices

The Working Group previously considered, juvenile abundance indices as an alternative to the lagged spawner variable. As surrogates of potential smolt production, a juvenile index model is conceptually more attractive because juveniles represent a life-stage closer to the PFA than the lagged spawner variable currently used. Consequently, some of the noise corresponding to the stochasticity in the recruitment process should be reduced, favoring a more direct link between the predictors and the PFA. Unfortunately, the Working Group has noted that alternate variables do not negate any of the assumptions within a model, and are also influenced by non-stationarity. Therefore the Working Group, suspended investigation of juvenile abundance indices to focus on issues of non-stationarity that may apply to any relationship between a predictive variable and PFA.

5.8 Data Deficiencies and Research Needs in the WGC area

Recommendations for the West Greenland Commission area are in Section 6.2.

Table 5.1.1.1. Nominal catches of salmon, West Greenland 1977-2002 (metric tons round fresh weight).

Year	Total	Quota
1977	1,420	1,191
1978	984	1,191
1979	1,395	1,191
1980	1,194	1,191
1981	1,264	1,265[2]
1982	1,077	1,253[2]
1983	310	1,191
1984	297	870
1985	864	852
1986	960	909
1987	966	935
1988	893	-[3]
1989	337	-[3]
1990	274	-[3]
1991	472	840
1992	237	258[4]
1993	0[1]	89[5]
1994	0[1]	137[5]
1995	83	77
1996	92	174[4]
1997	58	57
1998	11	20[6]
1999	19	20[6]
2000	21	20[6]
2001	43	114[7]
2002	9	- [5,8]

[1] The fishery was suspended.
[2] Quota corresponding to specific opening dates of the fishery.
[3] 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.
[4] Set by Greenland authorities.
[5] Quotas were bought out.
[6] Fishery restricted to catches used for internal consumption in Greenland.
[7] Calculated final quota in *ad hoc* management system.
[8] No factory landing allowed.

Table 5.1.1.2. Distribution of nominal catches (metric tons), Greenland vessels (1977-2002).

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

[1]) The fishery was suspended
+) Small catches <0.5 t
-) No commercial landings

Table 5.1.2.1. Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-1992 and 1995-2002. 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	-
2001	2.89	3.03	6.76	5.96	4.41	4.06	2.95	3.09	3.00	63.1	63.7	81.7	79.1	75.3	72.1
2002	2.84	2.92	7.12	-	5.00	-	2.89	2.92	2.90	62.6	62.1	83.0	-	75.8	-

Table 5.1.2.2. River age distribution (%) and mean age for all North American origin salmon caught at West Greenland, 1968-1992 and 1995-2002.

Year	River age 1	2	3	4	5	6	7	8	Mean age
North American origin									
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0	3.4
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0	3.1
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0	2.6
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0	3.1
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0	2.9
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0	2.8
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0	3.1
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0	3.3
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0	3.0
1977	-	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0	3.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0	2.7
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0	2.9
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0	3.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2	2.9
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0	2.7
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0	2.6
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0	2.7
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0	2.9
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0	2.8
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0	3.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0	2.8
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0.0	2.6
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0.0	2.8
1992	6.7	36.7	34.1	19.1	3.2	0.3	0.0	0.0	2.8
1995	2.4	19.0	45.4	22.6	8.8	1.8	0.1	0.0	3.2
1996	1.7	18.7	46.0	23.8	8.8	0.8	0.1	0.0	3.2
1997	1.3	16.4	48.4	17.6	15.1	1.3	0.0	0.0	3.3
1998	4.0	35.1	37.0	16.5	6.1	1.1	0.1	0.0	2.9
1999	2.7	23.5	50.6	20.3	2.9	0.0	0.0	0.0	3.0
2000	3.2	26.6	38.6	23.4	7.6	0.6	0.0	0.0	3.1
2001	1.9	15.2	39.4	32.0	10.8	0.7	0.0	0.0	3.4
2002	0.6	26.7	44.8	16.9	10.1	0.9	0.0	0.0	3.1
Mean	3.0	33.5	38.2	17.2	6.8	1.3	0.1	0.0	3.0

cont.

Table 5.1.2.2. cont. River age distribution (%) and mean age for all European origin salmon caught at West Greenland, 1968-1992 and 1995-2002.

	River age								Mean
Year	1	2	3	4	5	6	7	8	age
European origin									
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0	2.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0	2.2
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0	2.1
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0	2.2
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0	2.1
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0	1.9
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0	1.9
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0	2.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0	1.9
1977	-	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0	1.8
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0	1.9
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0	1.9
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0	2.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0	2.2
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0	1.8
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0	2.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0	2.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0	2.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0	2.0
1988	18.4	61.6	17.3	2.3	0.5	0.0	0.0	0.0	2.1
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0	2.1
1990	15.9	56.3	23.0	4.4	0.2	0.2	0.0	0.0	2.2
1991	20.9	47.4	26.3	4.2	1.2	0.0	0.0	0.0	2.2
1992	11.8	38.2	42.8	6.5	0.6	0.0	0.0	0.0	2.5
1995	14.8	67.3	17.2	0.6	0.0	0.0	0.0	0.0	2.0
1996	15.8	71.1	12.2	0.9	0.0	0.0	0.0	0.0	2.0
1997	4.1	58.1	37.8	0.0	0.0	0.0	0.0	0.0	2.3
1998	28.6	60.0	7.6	2.9	0.0	1.0	0.0	0.0	1.9
1999	27.7	65.1	7.2	0.0	0.0	0.0	0.0	0.0	1.8
2000	36.5	46.7	13.1	2.9	0.7	0.0	0.0	0.0	1.8
2001	16.0	51.2	27.3	4.9	0.7	0.0	0.0	0.0	2.2
2002	10.1	65.2	18.4	6.3	0.0	0.0	0.0	0.0	2.2
Mean	18.8	61.7	16.9	2.4	0.3	0.0	0.0	0.0	2.0

Table 5.1.2.3. Sea-age composition (%) of samples from commercial catches at West Greenland, 1985-2002.

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
2001	98.2	1.3	0.5	97.8	2.0	0.3
2002[1]	97.3	0.9	1.8	100.0	0.0	0.0

[1] Catches for local consumption only.

Table 5.1.3.1. 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, 1995-97 and 2001), and from local consumption samples (1998-2000 and 2002).

		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	3,488	3,488	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	1,653	1,653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4,570	1,930	59	(61,58)	41	(42,39)
	1982	1,949	414	62	(64,60)	38	(40,36)
	1983	4,896	1,815	40	(41,38)	60	(62,59)
	1984	7,282	2,720	50	(53,47)	50	(53,47)
	1985	13,272	2,917	50	(53,46)	50	(54,47)
	1986	20,394	3,509	57	(66,48)	43	(52,34)
	1987	13,425	2,960	59	(63,54)	41	(46,37)
	1988	11,047	2,562	43	(49,38)	57	(62,51)
	1989	9,366	2,227	56	(60,52)	44	(48,40)
	1990	4,897	1,208	75	(79,70)	25	(30,21)
	1991	5,005	1,347	65	(69,61)	35	(39,31)
	1992	6,348	1,648	54	(57,50)	46	(50,43)
	1995	2,045	2,045	68	(72,65)	32	(35,28)
	1996	3,341	1,297	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	[4]	30	[4]
Commercial	2001	2,896	1,718	69	(72,67)	31	(33,29)
Local cons.	2002	1,326	501	68	[4]	33	[4]

[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.

[4] Determined by genetic analysis to be 100% correct

Table 5.1.3.2. The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2002. 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	192,200	143,800
1983	40	60	39,500	60,500
1984	54	46	48,800	41,200
1985	47	53	143,500	161,500
1986	59	41	188,300	131,900
1987	59	41	171,900	126,400
1988	43	57	125,500	168,800
1989	55	45	65,000	52,700
1990	74	26	62,400	21,700
1991	63	37	111,700	65,400
1992	45	55	46,900	38,500
1993	-	-	-	-
1994	-	-	-	-
1995	67	33	21,400	10,700
1996	73	27	22,400	9,700
1997	85	15	18,000	3,300
1998	79	21	3,100	900
1999	91	9	5,700	600
2000	65	35	5,100	2,700
2001	69	31	9,400	4,700
2002	68	32	2,200	900

Table 5.3.1. Number of salmon returning to home waters provided no fishery 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	2001	2002
Nominal catch at Greenland (tons) [1]:	89	137	83	92	58	11	19	21	43	9
Proportion of NA fish in catch (PropNA):	0.540	0.540	0.680	0.732	0.796	0.785	0.910	0.650	0.670	0.680
Proportion of EU fish in catch (PropEU):	0.460	0.460	0.320	0.268	0.204	0.215	0.090	0.350	0.330	0.320
Mean weight, NA fish, all sea ages (kg):	2.655	2.655	2.450	2.830	2.630	2.760	3.090	2.470	2.950	2.890
Mean weight, EU fish, all sea ages (kg):	2.745	2.745	2.750	2.900	2.840	2.840	3.030	2.810	3.090	2.920
Mean weight of all sea ages (NA+EU fish):	2.696	2.696	2.546	2.849	2.673	2.777	3.085	2.589	2.996	2.900
Proportion of 1SW NA-fish in catch:	0.919	0.919	0.968	0.941	0.982	0.968	0.968	0.974	0.982	0.973
Catch of 1SW NA fish:	16635	25607	22300	22392	17238	3029	5416	5383	9590	2066
Catch of 1SW EU fish:	13706	21098	9349	8000	4091	806	546	2548	4510	962
Natural mortality during migration to NA:	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Natural mortality during migration to EU:	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Additional fish if no fishery at Greenland:										
2SW fish returning to NA (numbers):	**11960**	**18410**	**16032**	**16098**	**12393**	**2177**	**3894**	**3870**	**6895**	**1485**
Percent of conservation limit [2]:	**6.2**	**9.5**	**8.6**	**8.9**	**6.9**	**1.2**	**2.1**	**2.5**	**4.5**	**1.0**
2SW fish returning to EU (numbers):	**10782**	**16597**	**7354**	**6293**	**3218**	**634**	**430**	**2004**	**3547**	**757**
Percent of conservation limit [3]:	**4.1**	**6.3**	**2.8**	**2.4**	**1.2**	**0.2**	**0.2**	**0.8**	**1.3**	**0.3**

[1] Figures for 1993 and 1994 correspond to calculated quotas.

[2] As estimated annually by ICES

[3] Conservation limit for Southern Europe, Table 3.4.3.1

Average number of salmon potentially returning to home waters per ton caught in Greenland:	
2SW fish returning to NA (numbers per ton, average of 1993-2002):	**166**
2SW fish returning to EU (numbers per ton, average of 1993-2002):	**92**

Table 5.5.1.1. Pre-fishery abundance estimates, thermal habitat index for February based on sea surface temperature (H2), lagged spawner index for North America excluding Labrador, and the phase shift indicator set in its initial state.

Year	Pre-fishery abundance Low	Pre-fishery abundance High	Pre-fishery abundance Mid-point	Thermal Habitat February (H2)	Lagged spawners minus Labrador Low	Lagged spawners minus Labrador High	Lagged spawners minus Labrador Mid-point	Initial Phase
1977	574,920	766,372	670,646	1915	45,090	80,829	62,960	1
1978	325,305	423,344	374,325	1951	58,384	103,147	80,766	1
1979	725,526	969,725	847,626	2058	66,110	112,944	89,527	1
1980	626,689	845,357	736,023	1823	57,102	97,266	77,184	1
1981	589,902	775,292	682,597	1912	62,334	108,205	85,270	1
1982	491,624	642,955	567,290	1703	64,593	110,555	87,574	1
1983	279,866	399,920	339,893	1416	47,729	79,186	63,458	1
1984	290,764	413,708	352,236	1257	48,387	80,341	64,364	1
1985	455,247	624,679	539,963	1410	54,463	93,169	73,816	1
1986	490,306	658,712	574,509	1688	48,067	83,130	65,599	1
1987	443,842	596,469	520,156	1627	44,071	77,569	60,820	1
1988	359,581	485,900	422,740	1698	47,579	80,871	64,225	1
1989	278,895	404,946	341,920	1642	61,637	104,129	82,883	1
1990	249,811	344,253	297,032	1503	69,100	121,987	95,544	2
1991	281,550	405,602	343,576	1357	66,400	120,760	93,580	2
1992	167,152	256,606	211,879	1381	58,010	104,664	81,337	2
1993	118,437	224,357	171,397	1252	58,993	103,174	81,084	2
1994	136,738	270,339	203,538	1329	57,595	101,676	79,636	2
1995	144,226	247,195	195,710	1311	58,448	105,458	81,953	2
1996	121,464	192,680	157,072	1470	57,314	102,216	79,765	2
1997	80,262	147,151	113,706	1594	57,149	102,362	79,756	2
1998	68,710	147,114	107,912	1849	48,723	91,197	69,960	2
1999	66,708	147,773	107,241	1741	45,750	94,631	70,191	2
2000	77,373	156,796	117,084	1634	50,240	98,612	74,426	2
2001	54,615	111,372	82,993	1685	46,422	85,616	66,019	2
2002	.	.	.	1865	36,092	66,200	51,146	1
2003	.	.	.	1864	31,356	58,249	44,803	1

Table 5.5.2.1. ANOVA table of deterministic model associating Ln(PFA_{NA}) to Ln(LS_{NA}) and intercept shift describing two phases of production. In the upper panel, the year 1989 is included in the first phase (1977-1989) whereas in the lower panel, the year 1989 is included in the second phase (1989-2001).

Dependent Variable: lnpfa

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	9.59252936	4.79626468	50.46	<.0001
Error	22	2.09117579	0.09505344		
Corrected Total	24	11.68370515			

R-Square	Coeff Var	Root MSE	lnpfa Mean
0.821018	2.448709	0.308307	12.59061

Source	DF	Type III SS	Mean Square	F Value	Pr > F
phase	1	9.56685114	9.56685114	100.65	<.0001
lnspawner	1	1.19192058	1.19192058	12.54	0.0018

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		-7.998510081	B	5.64462663	-1.42	0.1705
phase	1	1.299546689	B	0.12953625	10.03	<.0001
phase	2	0.000000000	B	.	.	.
lnspawner		1.772232482		0.50047336	3.54	0.0018

Dependent Variable: lnpfa

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	9.64452778	4.82226389	52.03	<.0001
Error	22	2.03917738	0.09268988		
Corrected Total	24	11.68370515			

R-Square	Coeff Var	Root MSE	lnpfa Mean
0.825468	2.418073	0.304450	12.59061

Source	DF	Type III SS	Mean Square	F Value	Pr > F
phase	1	9.61884955	9.61884955	103.77	<.0001
lnspawner	1	1.59231205	1.59231205	17.18	0.0004

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		-11.54042743	B	5.69114945	-2.03	0.0549
phase	1	1.33004233	B	0.13056298	10.19	<.0001
phase	2	0.00000000	B	.	.	.
lnspawner		2.09077665		0.50444023	4.14	0.0004

Table 5.5.2.2. Assignment of probability of a given year of interest, for example 2003, being in one of the productivity states given the recent rate of change in PFA from previous years and the expected PFANA at the lagged spawner level if the productivity is in either state. The ratios for 2003 are combined with the probability distributions in Figure 5.5.2.5 to develop a weighted probability of 2003 being in each state. The probability of the 2003 productivity being in phase 1 = 0.048, and in phase 2 = 0.952.

YEAR	Lagged Spawner	PFA	Ratio for 2003 PFA (year) / PFA (year-2)	Possible levels of PFA in 2003 using ratio	Probability of phase state: 2003 in phase 2, 89 in phase 1	2003 in phase 2, 89 in phase 2	2003 in phase 1, 89 in phase 1	2003 in phase 1, 89 in phase 2
					Probability of phase	0.952		0.048
						0.609		*0.031*
1971	.	730732						
1972	.	742060						
1973	.	884679	1.21	100478	0.0050	0.0067	0.0007	0.0012
1974	.	817732	1.10	[illegible]	0.0086	0.0086	0.0004	0.0008
1975	.	917282	1.04	[illegible]	0.0097	0.0097	0.0003	0.0006
1976	.	840510	1.03	[illegible]	0.0100	0.0100	0.0003	0.0005
1977	62960	670646	0.73	60678	0.0144	0.0144	0.0000	0.0001
1978	80766	374325	0.45	36961	0.0075	0.0075	0.0000	0.0000
1979	89527	847626	1.26	104894	0.0060	0.0060	0.0008	0.0014
1980	77184	736023	1.97	163186	[illegible]	0.0009	0.0033	0.0043
1981	85270	682597	0.81	66835	[illegible]	0.0139	0.0001	0.0001
1982	87574	567290	0.77	63967	[illegible]	0.0143	0.0000	0.0001
1983	63458	339893	0.50	41326	[illegible]	0.0101	0.0000	0.0000
1984	64364	352236	0.62	51531	0.0137	0.0137	0.0000	0.0000
1985	73816	539963	1.59	131845	0.0025	0.0025	0.0020	0.0029
1986	65599	574509	1.63	135364	0.0022	0.0022	0.0022	0.0031
1987	60820	520156	0.96	79949	0.0114	0.0114	0.0002	0.0004
1988	64225	422740	0.74	61069	0.0144	0.0144	0.0000	0.0001
1989	82883	341920	0.66	54555	0.0142	0.0142	0.0000	0.0000
1990	95544	297032	0.70	58314	0.0144	0.0144	0.0000	0.0000
1991	93580	343576	1.00	83395	0.0105	0.0105	0.0003	0.0005
1992	81337	211879	0.71	59201	0.0144	0.0144	0.0000	0.0001
1993	81084	171397	0.50	41402	0.0101	0.0101	0.0000	0.0000
1994	79636	203538	0.96	79726	0.0114	0.0114	0.0002	0.0004
1995	81953	195710	1.14	94766	0.0079	0.0079	0.0005	0.0009
1996	79765	157072	0.77	64046	0.0142	0.0142	0.0000	0.0001
1997	79756	113706	0.58	48218	0.0129	0.0129	0.0000	0.0000
1998	69960	107912	0.69	57018	0.0144	0.0144	0.0000	0.0000
1999	70191	107241	0.94	78274	0.0116	0.0116	0.0002	0.0003
2000	74426	117084	1.08	90047	0.0088	0.0088	0.0004	0.0007
2001	66019	82993	0.77	64228	0.0142	0.0142	0.0000	0.0001
2002	51146	.						
2003	44803	.						
2004	[illegible]	.						
2005	[illegible]	.						

0.609 / (0.609+0.031)

Sum of both columns

82993 / 107241

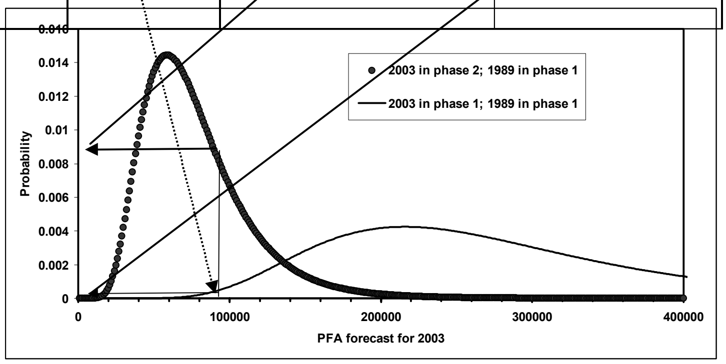


Table 5.5.3.1. A - Regional spawner requirement (2SW salmon), lagged spawners contributed by each region to PFA in last five years with available data, and the PFA number of fish required to meet region specific conservation limits if the returns to the regions are in proportion to the average lagged spawner distributions of 1998 to 2002. B - 2SW returns to the regions of North America, 1998 to 2002. C – Management objectives for the NAC area used to develop the risk analysis of catch options for the 2003 fishery.

A

Achieved lagged spawners by PFA year

	Region Labrador	Newfoundland	Quebec	Gulf	Scotia-Fundy	US	North America
1998	6285	4368	21312	36629	6080	1571	76245
1999	9930	3994	19459	39019	5764	1954	80120
2000	14098	6574	22055	35913	7845	2039	88524
2001	22118	8490	22898	26914	6056	1661	88137
2002	22527	7215	20286	18113	4133	1400	73672
Total	74957	30641	106010	156588	29878	8625	406698
% of total NA	18.4%	7.5%	26.1%	38.5%	7.3%	2.1%	
Sum of LNQG	90.5%						

2SW Conservation Limit

	Labrador	Newfoundland	Quebec	Gulf	Scotia-Fundy	US	North America
Number of fish	34,746	4,022	29,446	30,430	24,705	29,199	152,548
Prop. of NA	0.228	0.026	0.193	0.199	0.162	0.191	

Spawner Reserve corrected for 11 months of M at 0.03 per month 212,189

PFA required to meet regional 2SW requirements based on average from 1998 to 2002

Labrador	Newfoundland	Quebec	Gulf	Scotia-Fundy	US
254,479	72,062	152,490	106,685	453,940	1,858,520

B

2SW Returns to regions in past five years

	Region Labrador	Newfoundland	Quebec	Gulf	Scotia-Fundy	US
1998	.	8887	28095	12838	4366	1526
1999	.	9258	29562	16933	5295	1168
2000	.	9660	29155	17145	3559	533
2001	.	6654	30480	22826	5001	788
2002	.	6066	22404	11996	1770	617
Average		8105	27939	16348	3998	926

C

Management objectives for NAC area

	Region				**Region**		
	Labrador	**Newfoundland**	**Quebec**	**Gulf**	Scotia-Fundy	US	
	2SW Conservation Limit				**Average returns**		
Number of fish	34,746	4,022	29,446	30,430	3,998	926	
	2SW Conservation Limit				**Increase relative to previous five years**		
					4,398	**1,019**	**+10%**
Total	**98,644**				**4,997**	**1,158**	**+25%**

Table 5.5.3.2. Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf) and achieving increases in returns from the previous five-year average (examples: minimally 10% or minimally 25% increase in returns of 2SW salmon in 2003) in the two southern areas (Scotia-Fundy and USA) relative to quota options for West Greenland. A sharing arrangement of 40:60 (Fna) of the salmon from North America was assumed.

Probability of meeting management objectives			
West Greenland Harvest Tons	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Simultaneous Improvement (SF, USA) of Returns in 2004 >=10% of prev. avg.	>=25%of prev. avg.
0	**0.28**	0.71	0.62
5	0.26	0.68	0.60
10	0.25	0.66	0.58
15	0.24	0.64	0.55
20	0.23	0.61	0.53
25	0.22	0.59	0.50
30	0.21	0.56	0.48
35	0.20	0.54	0.46
40	0.19	0.52	0.44
45	0.19	0.49	0.42
50	0.18	0.47	0.40
100	0.12	0.29	0.25
500	0.02	0.03	0.02

Table 5.5.3.3. Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf), achieving increases in returns from the previous five-year average (examples: minimally 10% or minimally 25% increase in returns of 2SW salmon in 2003) in the two southern areas (Scotia-Fundy and USA), and achieving the MSW conservation limit for southern Europe relative to quota options for West Greenland. A sharing arrangement of 40:60 (Fna) of the salmon at West Greenland, regardless of continent of origin was assumed.

Probability of meeting management objectives				
West Greenland Harvest Tons	NAC Conservation (Lab, NF, Queb, Gulf)	Simultaneous Improvement (SF, USA) of Returns in 2004 >=10% of prev. avg.	>=25%of prev. avg.	Southern Europe Conservation MSW
0	**0.28**	0.71	0.62	0.73
5	0.26	0.68	0.60	0.72
10	0.25	0.66	0.58	0.72
15	0.24	0.64	0.55	0.71
20	0.23	0.61	0.53	0.71
25	0.22	0.59	0.50	0.71
30	0.21	0.56	0.48	0.70
35	0.20	0.54	0.46	0.70
40	0.19	0.52	0.44	0.70
45	0.19	0.49	0.42	0.69
50	0.18	0.47	0.40	0.69
100	0.12	0.29	0.25	0.65
500	0.02	0.03	0.02	0.37

Figure 5.1.2.1. West Greenland NAFO divisions.

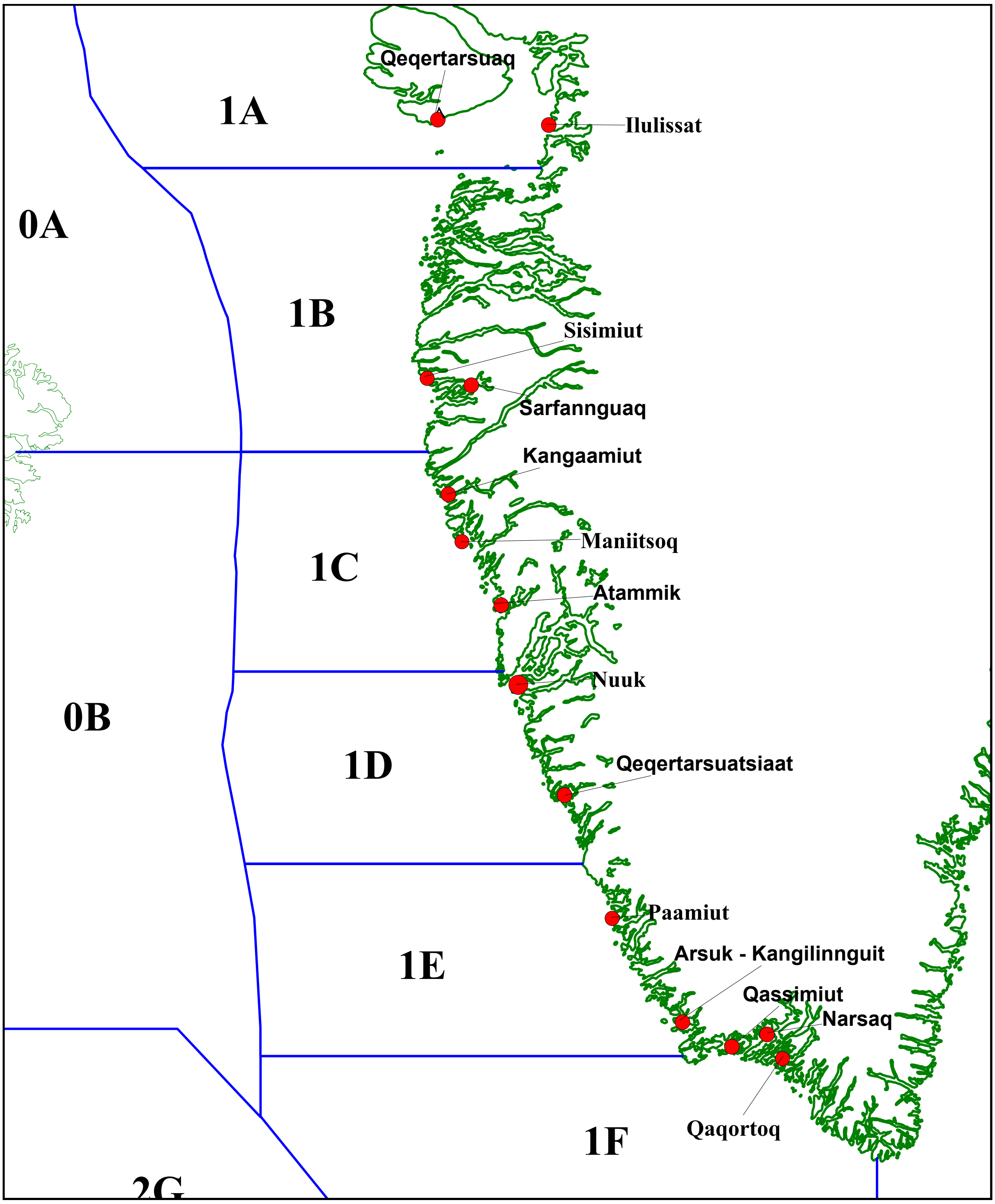


Fig. 5.1.3.1. Number of North American and European salmon caught at West Greenland 1982-1992 and 1995-2002.

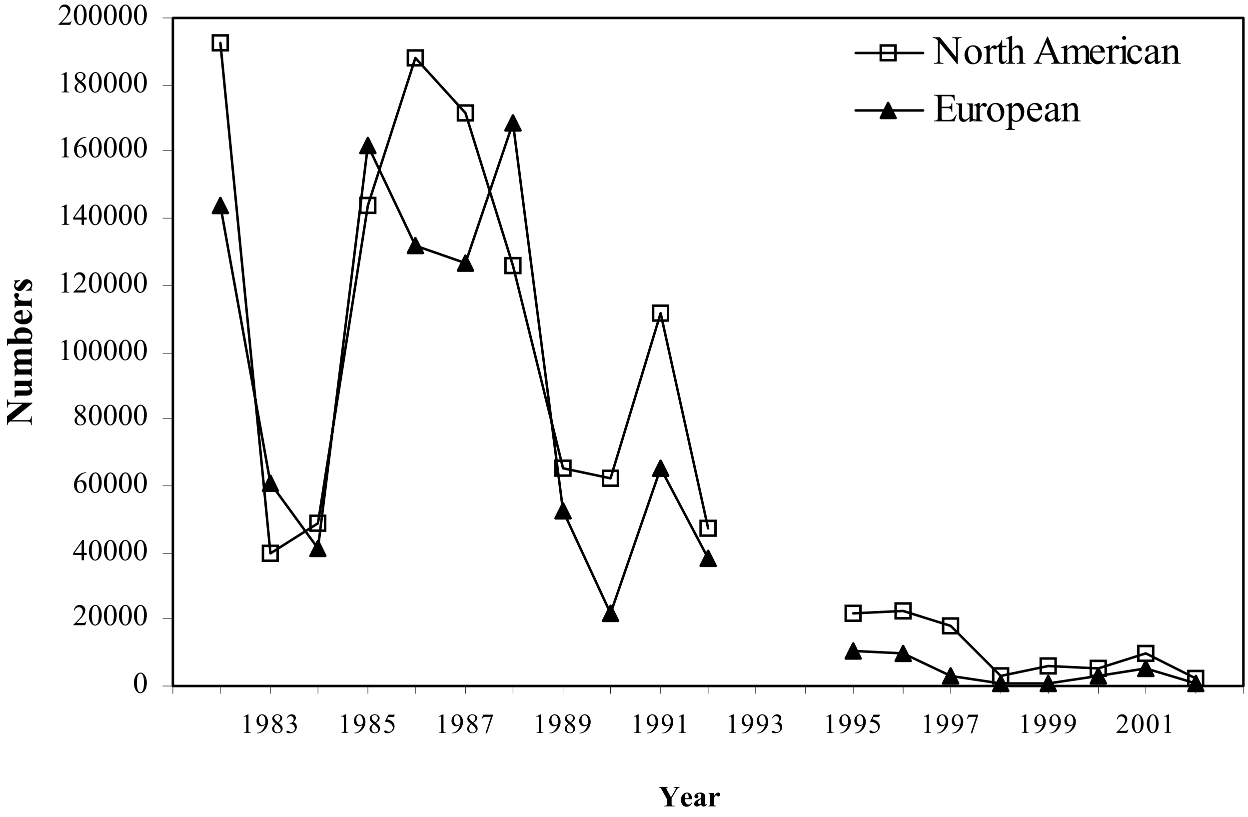


Fig. 5.1.3.2. (a) Maximum likelihood distances from North American and European assigned samples collected from the 2002 West Greenland Atlantic salmon fishery. Points above the Y=X line are assigned North America origin. (b) Maximum likelihood distances from Canada and Maine assigned samples collected from the 2002 West Greenland Atlantic salmon fishery. Points above the Y=X line are assigned Maine origin.

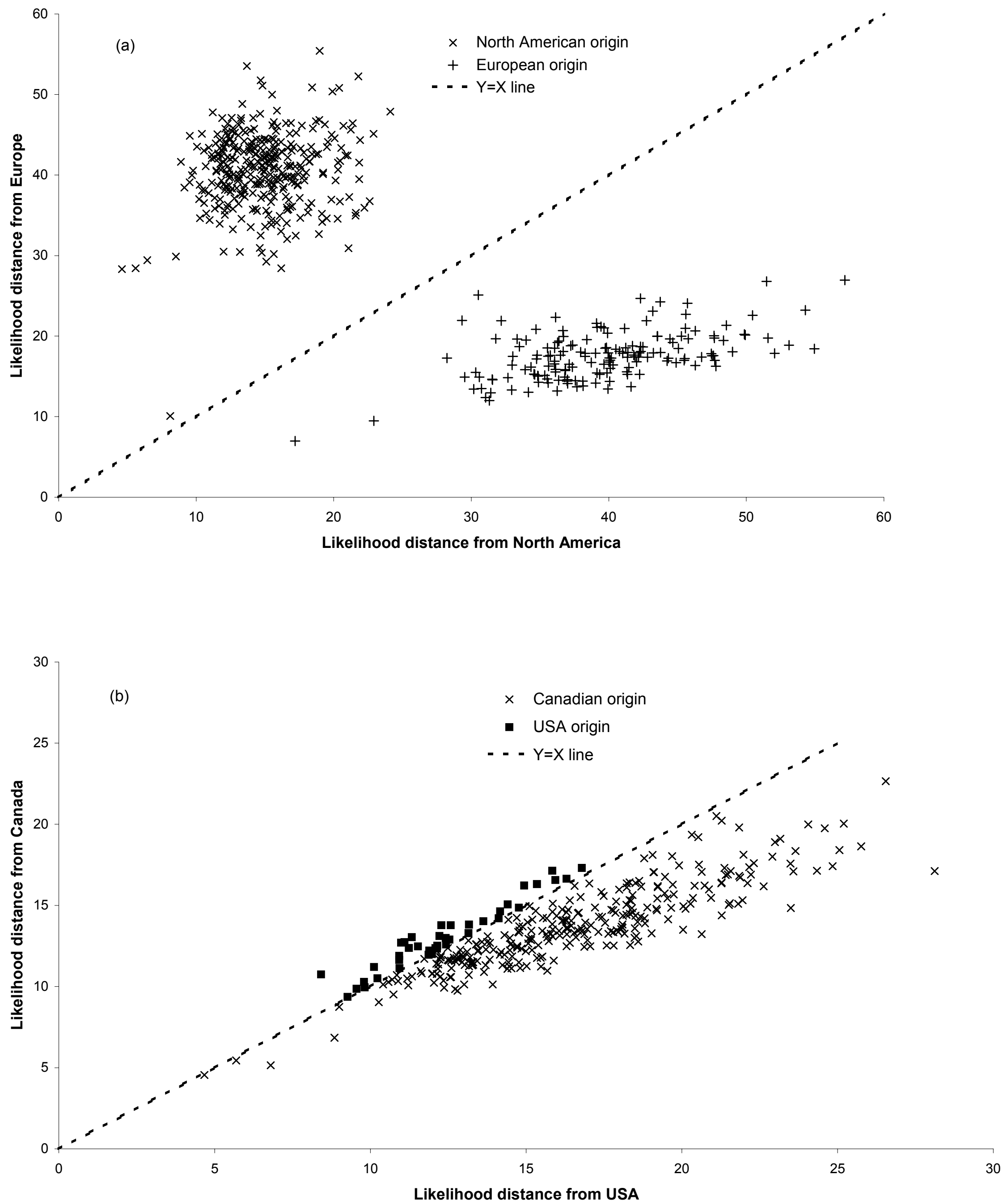


Figure 5.2.3.1. Examination of non-stationarity in the SR relationship for six long NEAC datasets. Two periods are considered for each river before (1) and after (2) the mid 1980s. Two parameters derived of the Ricker model are considered: the slope at origin (a) and the maximum recruitment per m² of wetted area accessible to salmon (s_{max}). The median of the posterior distribution is taken as parameters estimates.

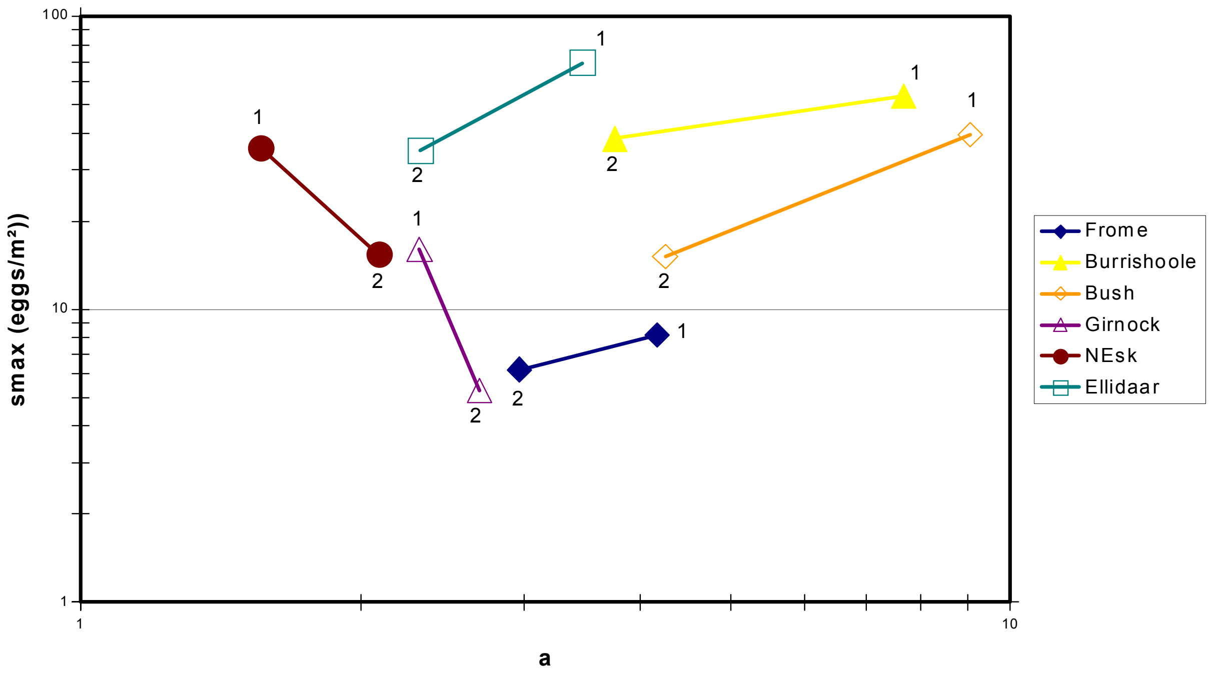


Figure 5.2.3.2. Random ratio test for phase shift in marine survival of Southern NEAC 1SW salmon
R_{crit} = ratio of mean survival Baseline period to Treatment period (<1 if Baseline mean is higher)

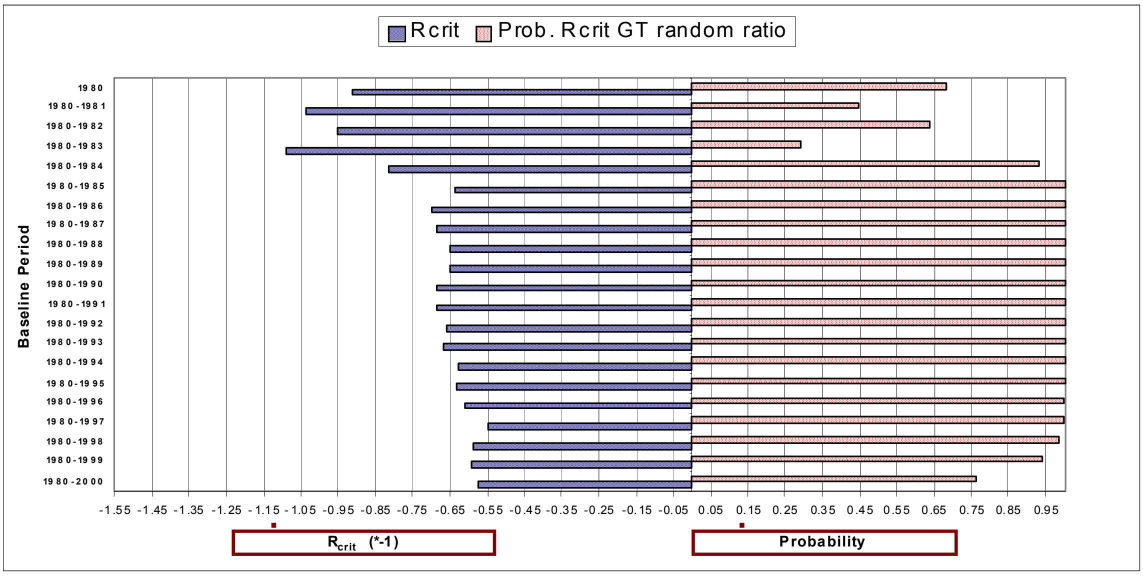


Figure 5.2.3.3. Random ratio test for phase shift in marine survival of Southern NEAC 2SW salmon
R_{crit} = ratio of mean survival Baseline period to Treatment period (<1 if Baseline mean is higher)

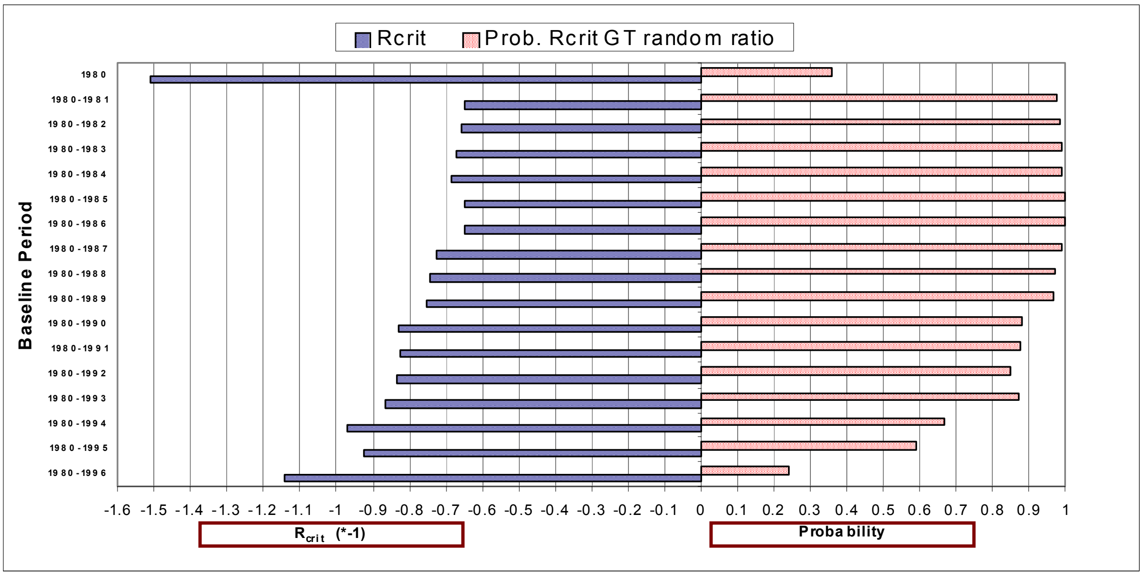


Fig 5.2.3.4. Relation between 1SW returns and corresponding MSW for total Québec returns (A) and 1SW and corresponding 2SW returns on St-Jean (B) and the Trinité Rivers (C).

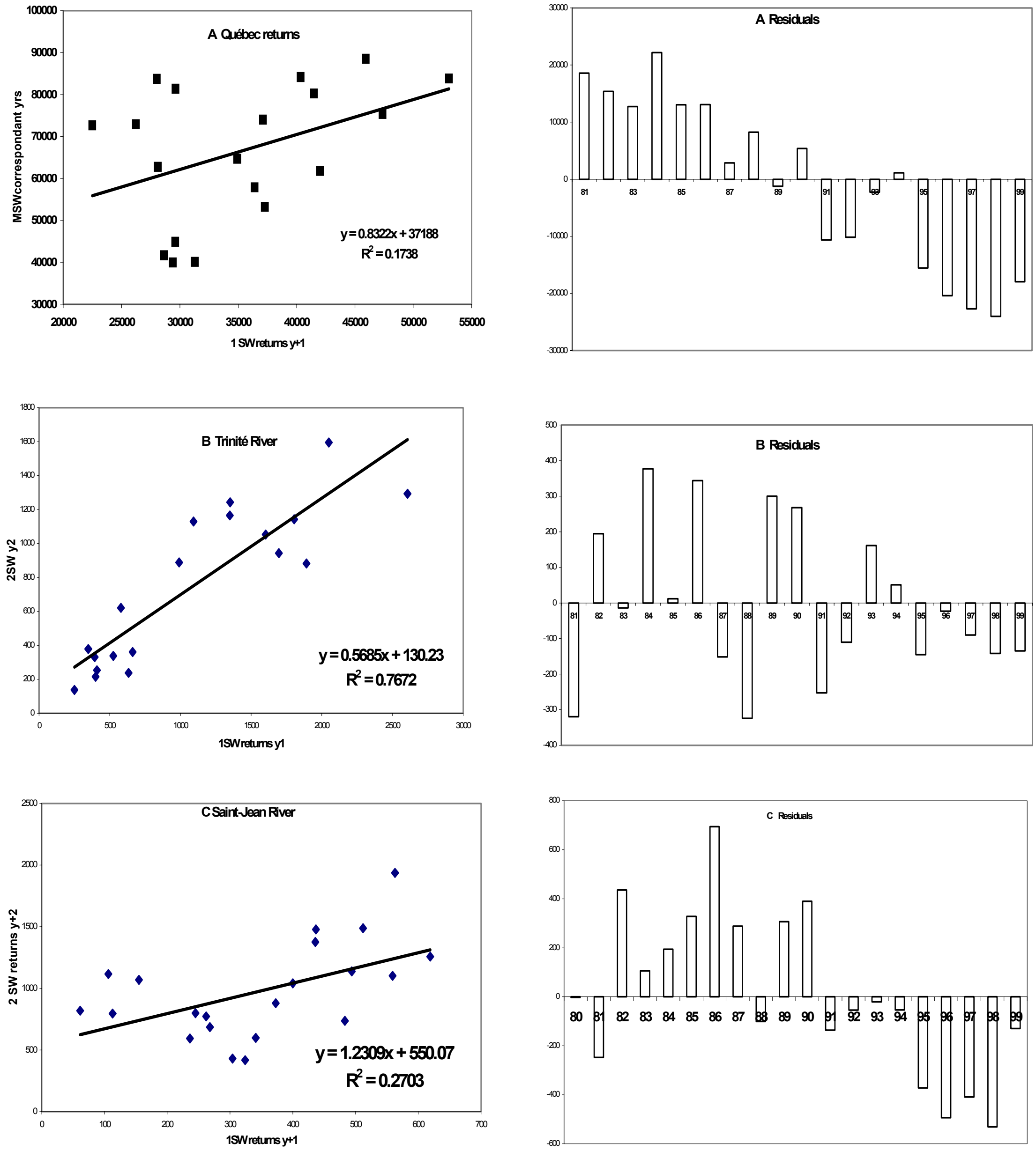


Figure 5.2.3.5. Phase shift in recruits per spawner for wild salmon in the LaHave River, NB Canada.

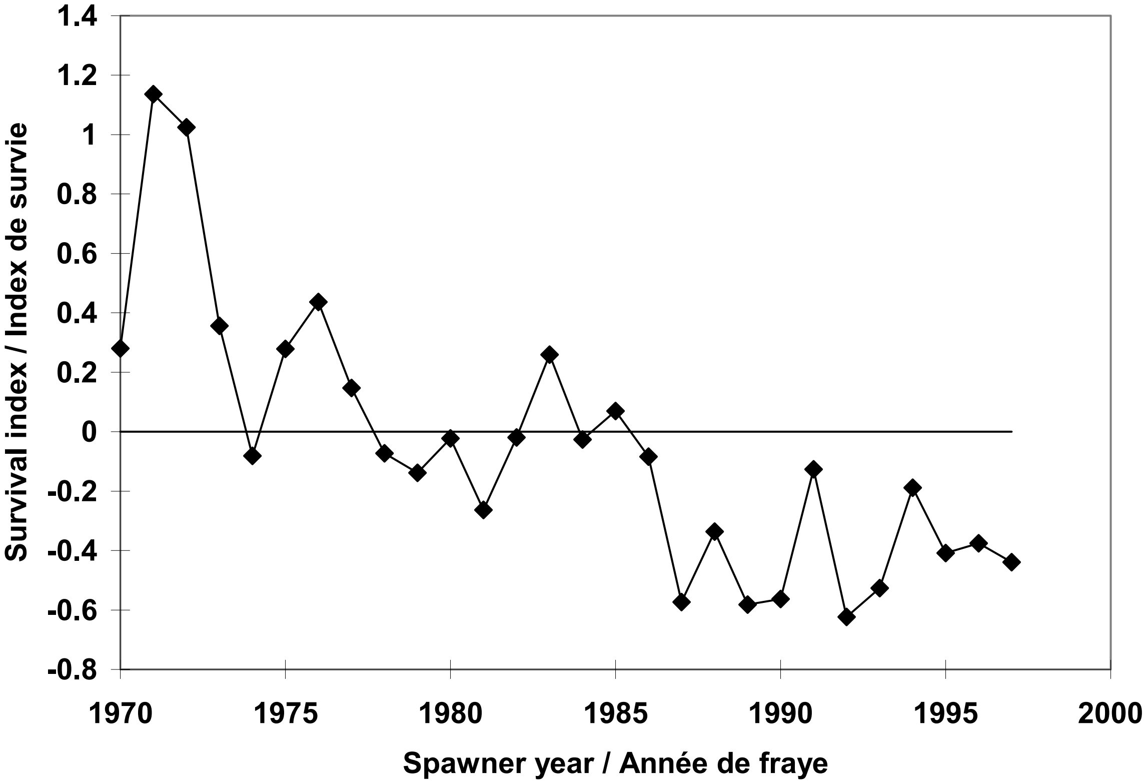


Figure 5.2.3.6.
Mean weight (kg, unadjusted for date of catch) of North American origin 1SW salmon in the West Greenland fishery 1969-1992, 1995-2002.

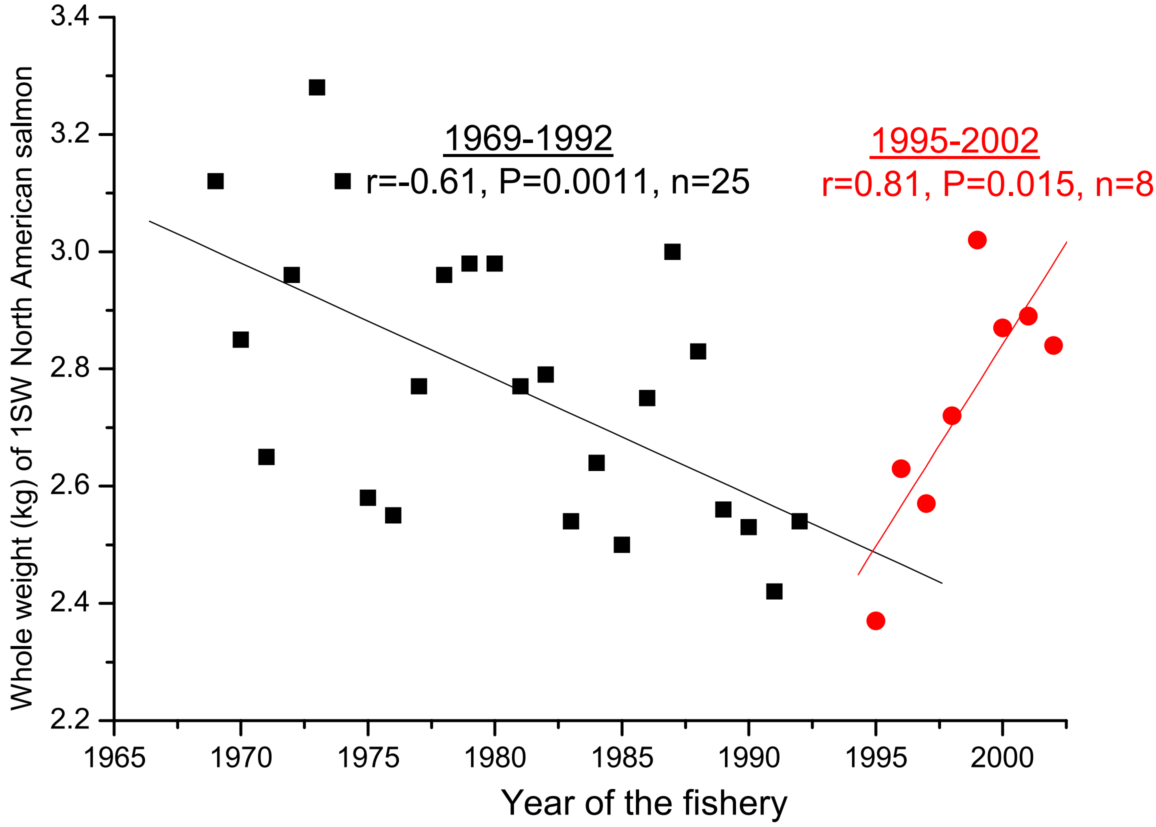


Figure 5.2.3.7. Random ratio test for phase shift in North American average weights at Greenland (R_{crit} is < 1 if the baseline mean weight is higher)

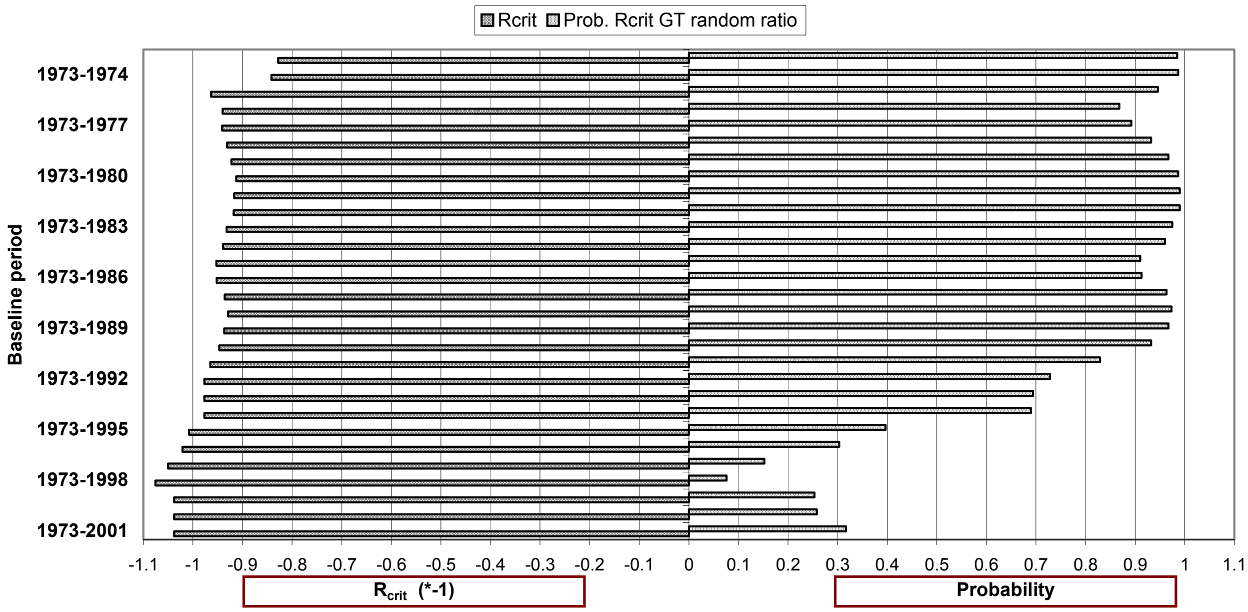


Figure 5.5.1.1. Lagged spawner index (upper panel), PFA (middle) and February habitat index (lower) used in the forecasting of PFA abundance for the NAC area.

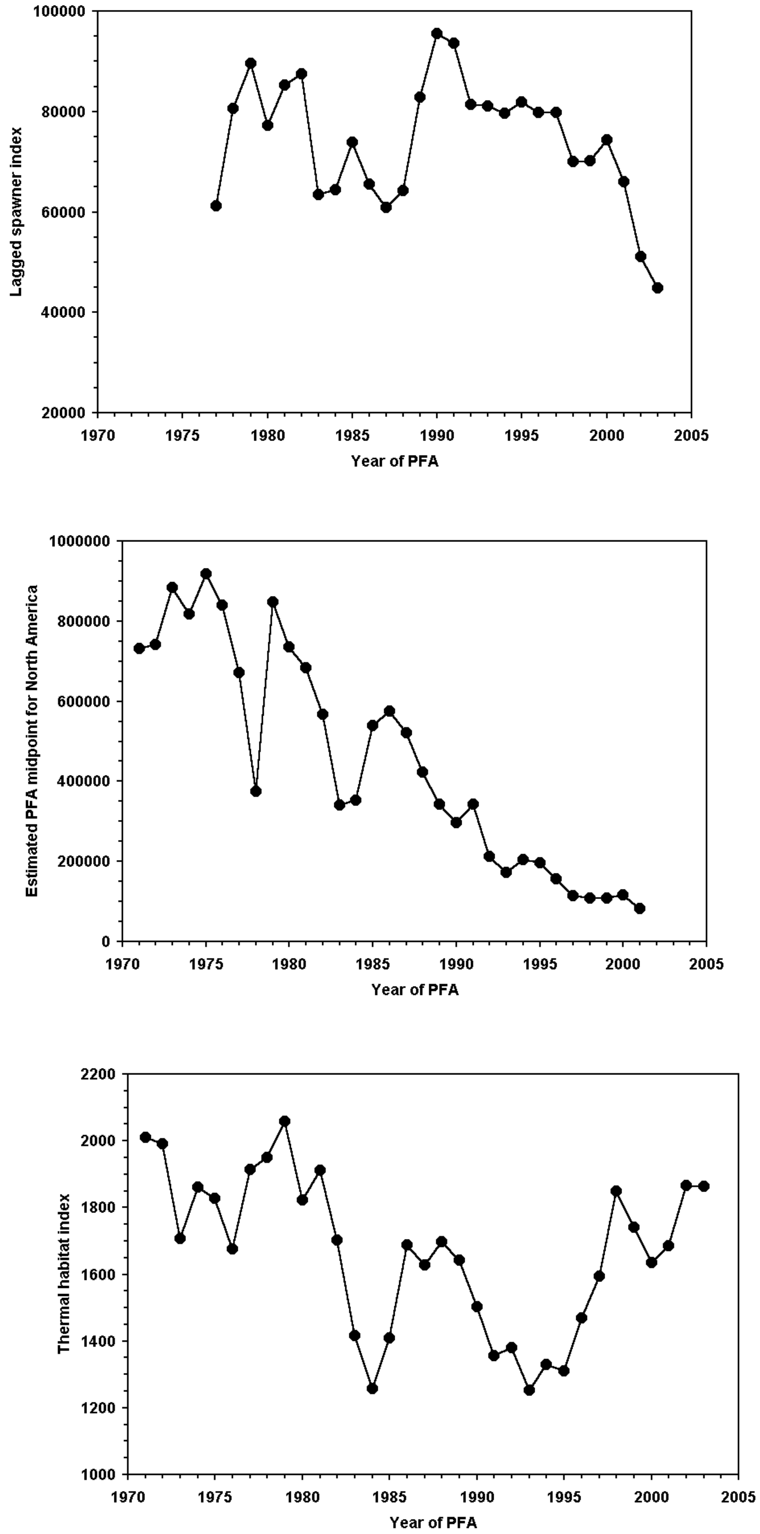


Figure 5.5.1.2. Standardized lagged spawners for Labrador, sum of other regions, and total for North America.

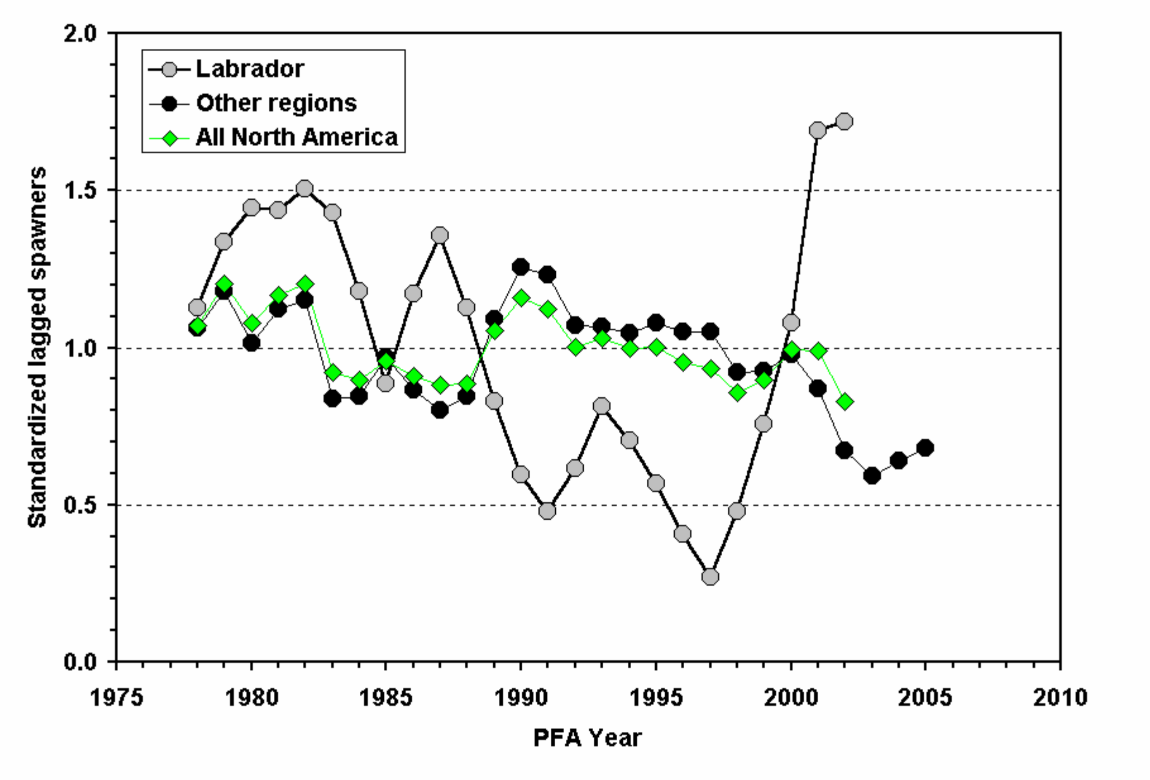


Figure 5.5.2.1. PFA (mid-point) and lagged spawner (mid-point) association for the NAC area showing the sequence from 1977 to 2001 (upper panel) and the relative change of the PFA (recruit) to lagged spawner index over the time series (lower panel).

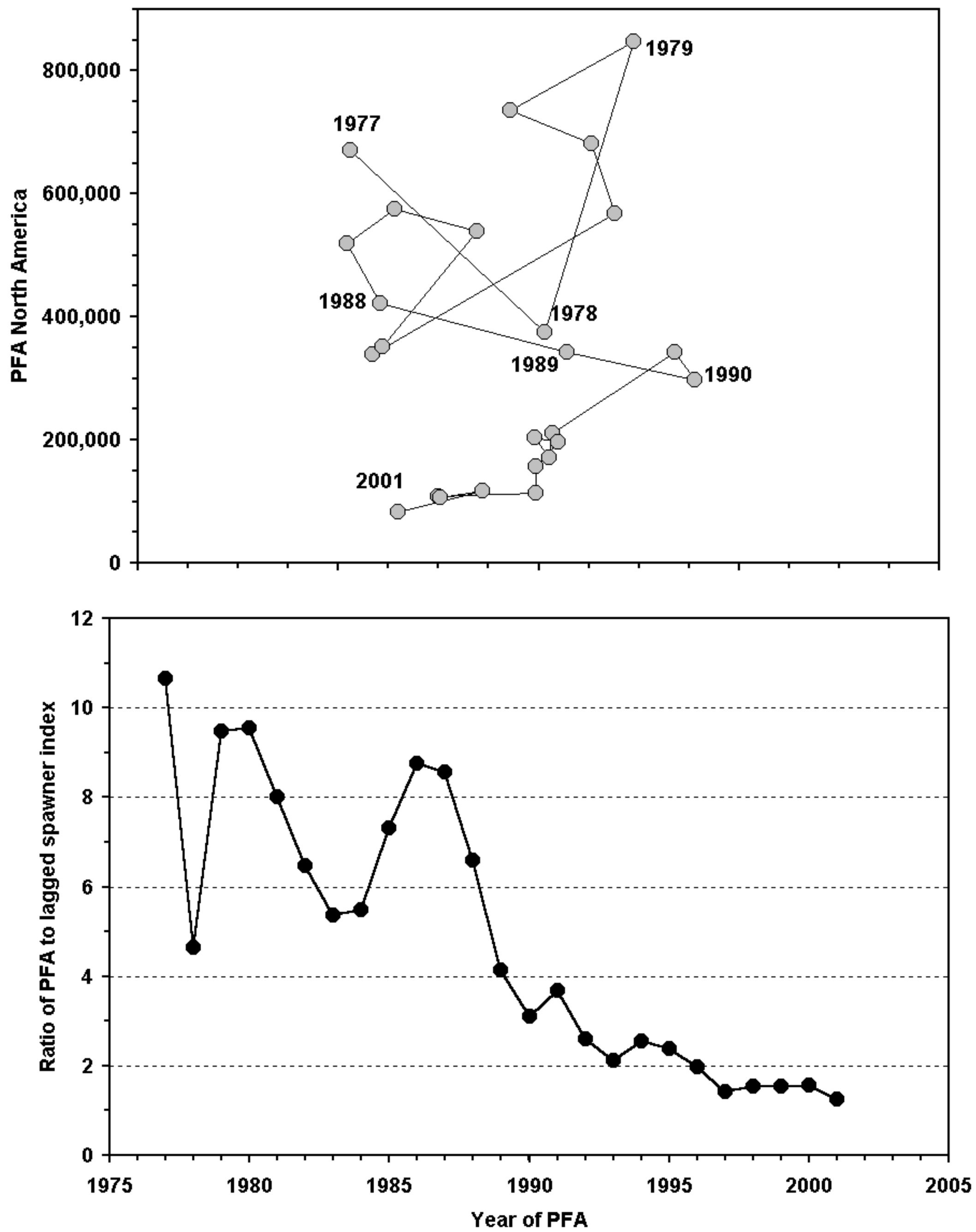


Figure 5.5.2.2. PFA (mid-point) and lagged spawner (mid-point) association for the NAC area modeled using an intercept variable to capture the dynamic change in productivity among the two time periods. The 1989 year was assigned using an uninformative prior to the time periods. The trend lines in the graph illustrate the PFA_{NA}/LS_{NA} trajectories for the two time periods.

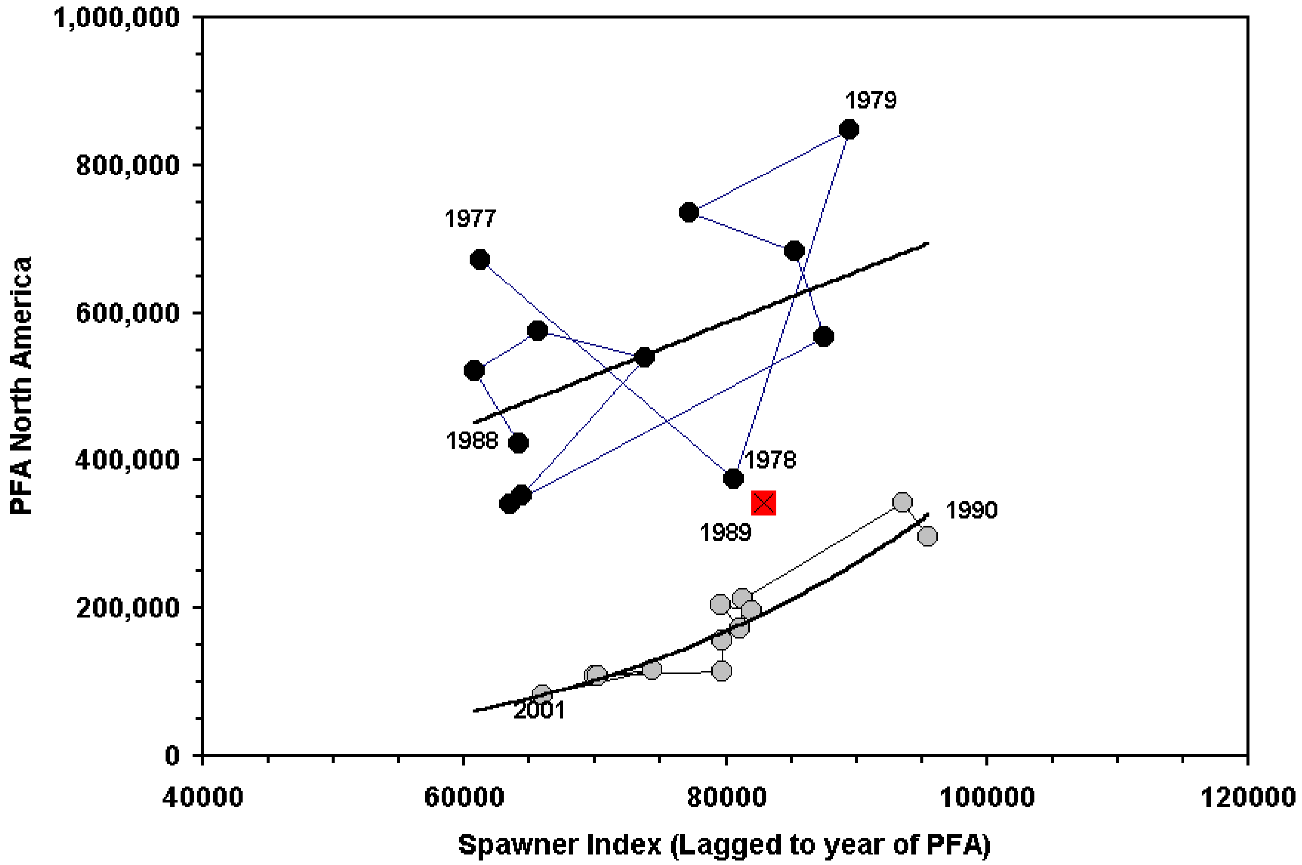


Figure 5.5.2.3. Revised PFA_{NA} estimate for the 2002 PFA year using the updated model (upper panel) and value forecast using the previous year's formulation (lower panel).

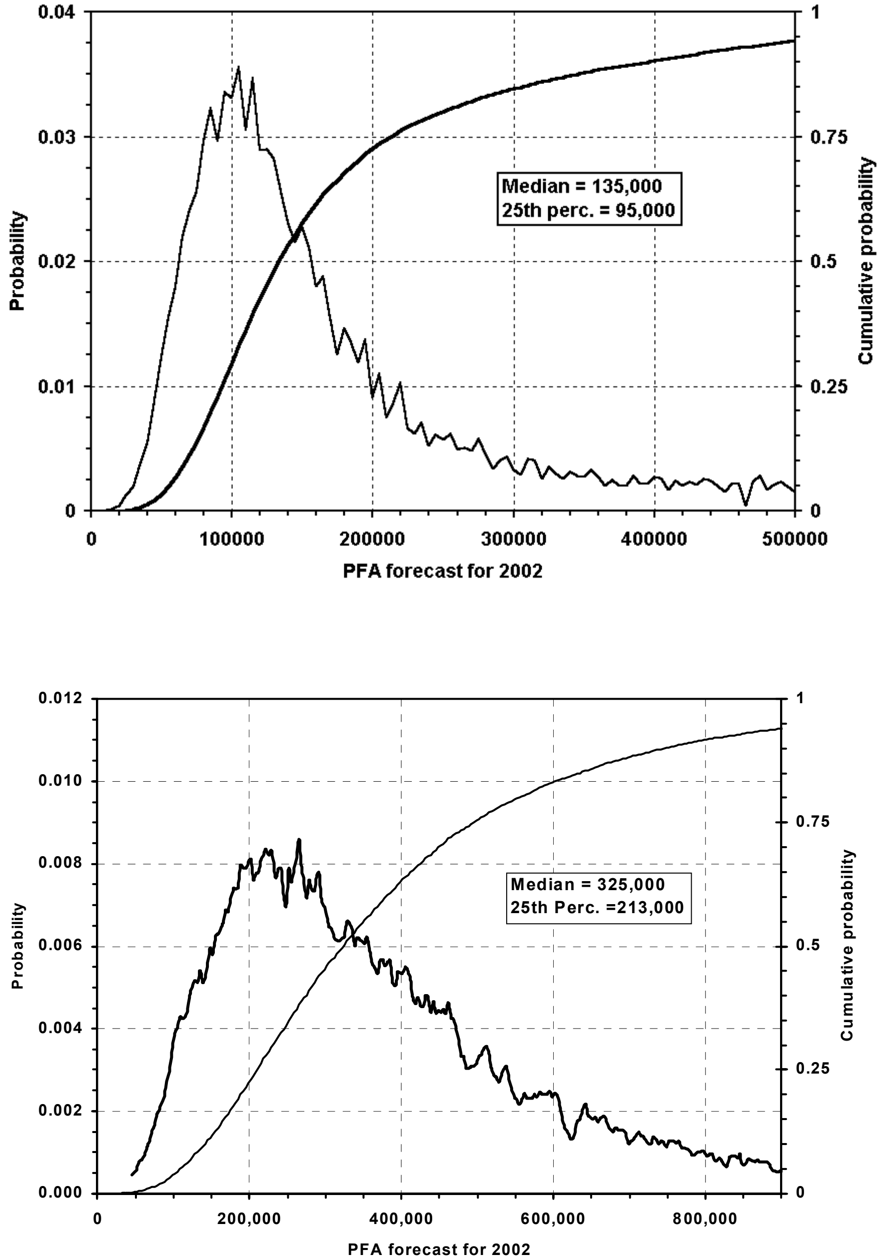
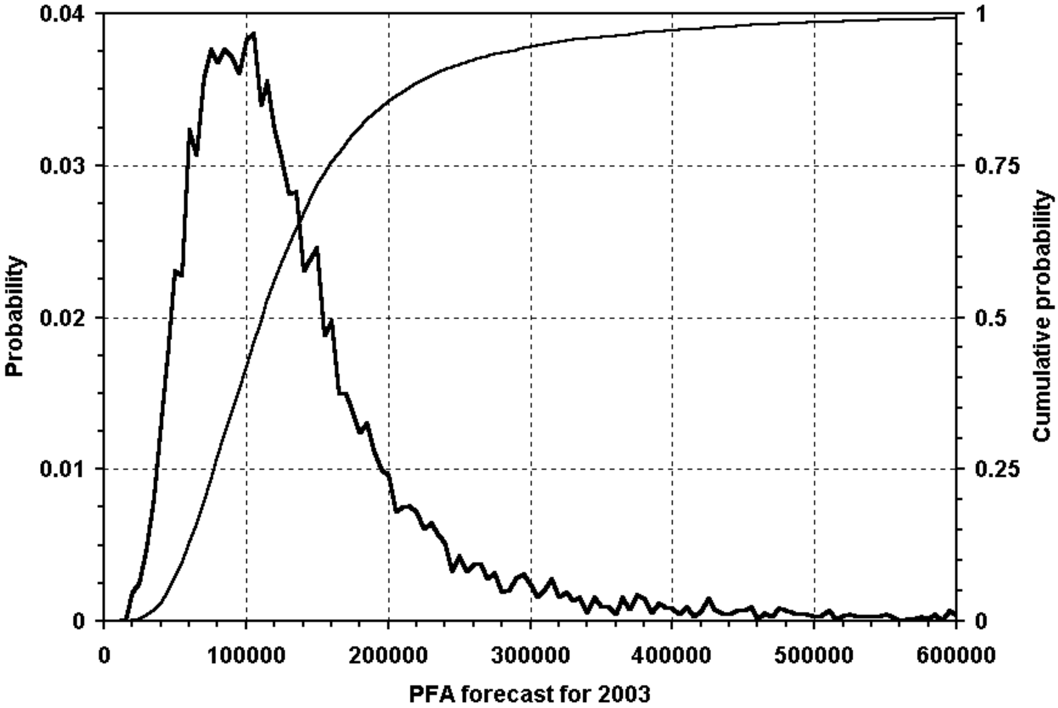


Figure 5.5.2.4. PFA_{NA} forecast estimate distribution for the year 2003 non-maturing 1SW salmon based on the phase shift and lagged spawner index model of 2003. The percentile of the forecast by 5% percentiles is shown in the lower panel.



Percentiles	PFA
5	45200
10	55800
15	63900
20	70800
25	77300
30	84200
35	90800
40	97800
45	104100
50	111400
55	118700
60	127000
65	136000
70	146400
75	158600
80	175400
85	196700
90	231900
95	311000

Figure 5.5.2.5. Relative change in PFA value in year relative to PFA in year-2 (upper panel) and predicted PFA distributions for 2003 (middle) and for 2002 (lower) based on allocating 1989 to either phase 1 or phase 2 and the 2003 or 2002 production levels being in phase 1 or phase 2. The probability profiles are the distributions of a single predicted value using the mid-points of PFA_{NA} and LS_{NA}.

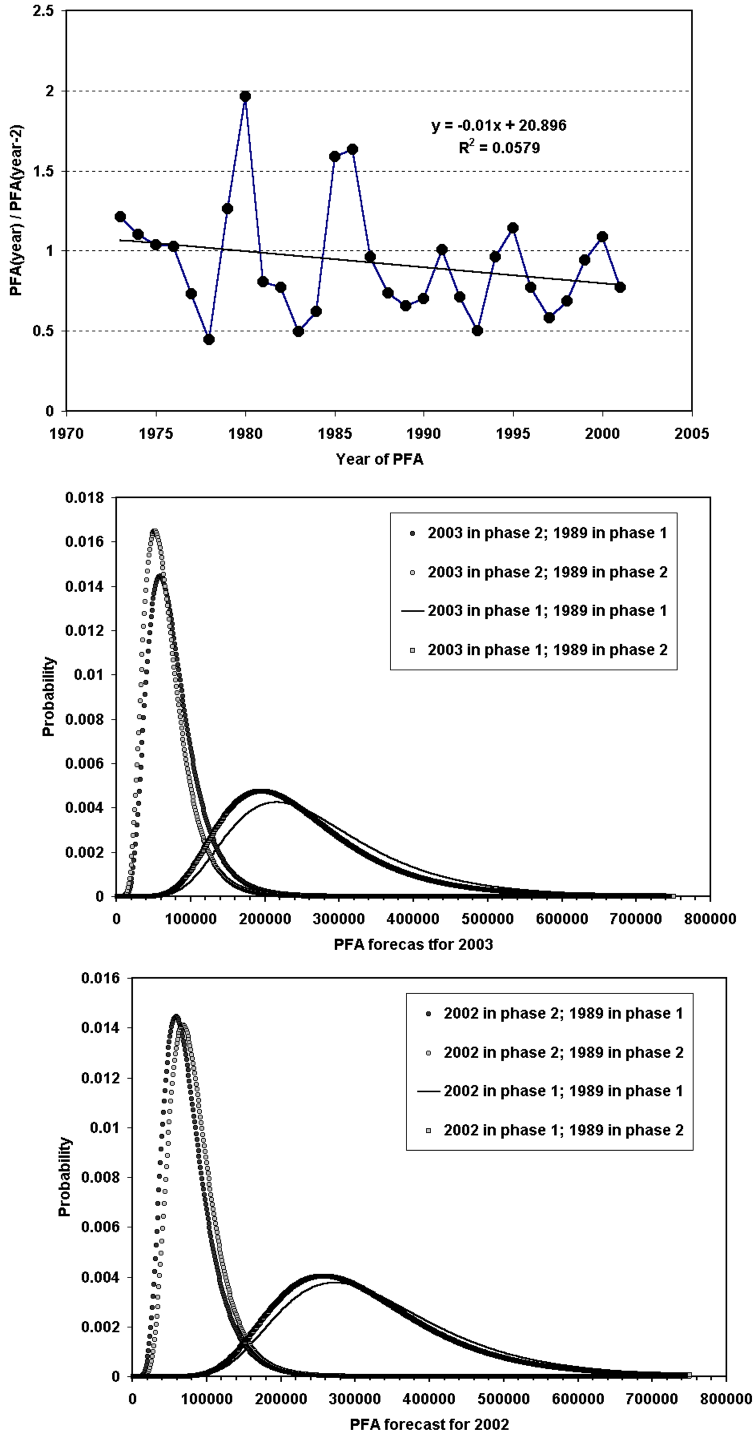


Figure 5.5.3.1. Flowchart of risk analysis of catch options at West Greenland using the PFA_{NA} and the PFA_{NEAC} predictions for the year of the fishery. Inputs with solid borders are considered known without error. Inputs with dashed borders are estimated, contain observation error which is incorporated in the analysis. Solid arrows are functions which introduce or transfer without error whereas dashed arrows transfer errors through the components.

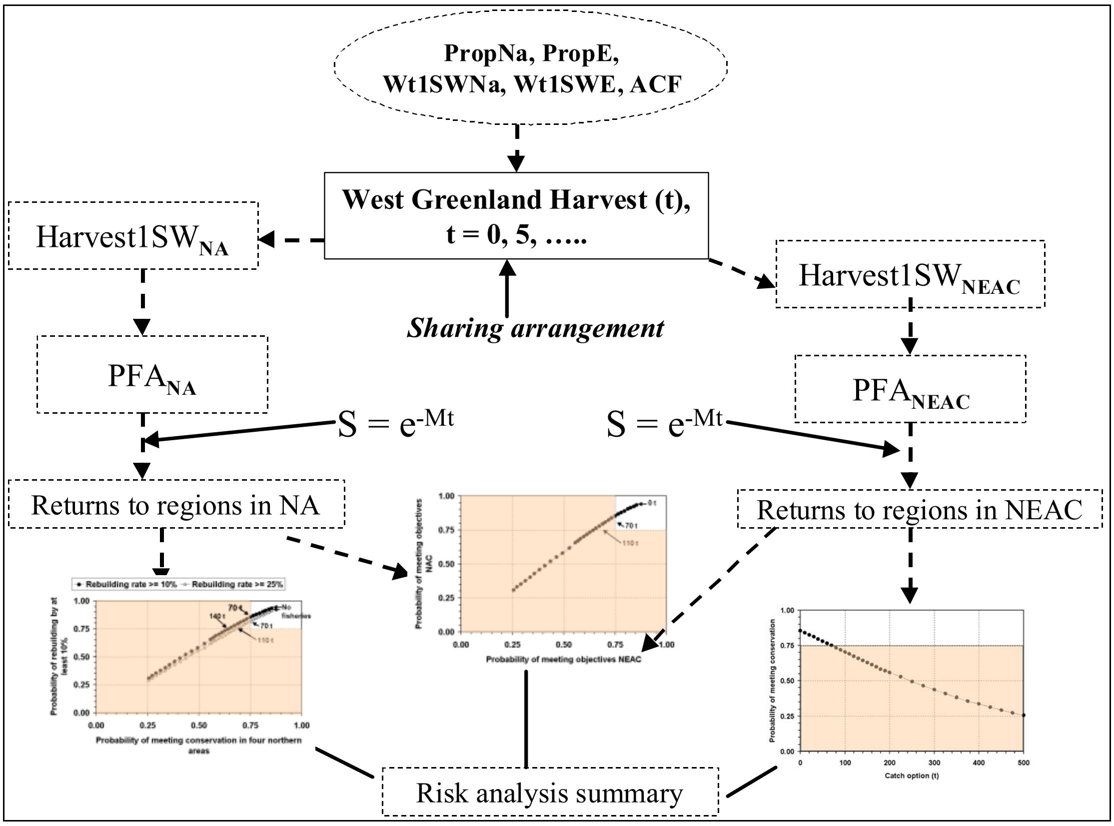


Figure 5.5.3.2. Average lagged spawners in the six regions of North America for the PFA years 1998 to 2002 and the 2SW spawner requirement in each region expressed as a proportion of the total for North America.

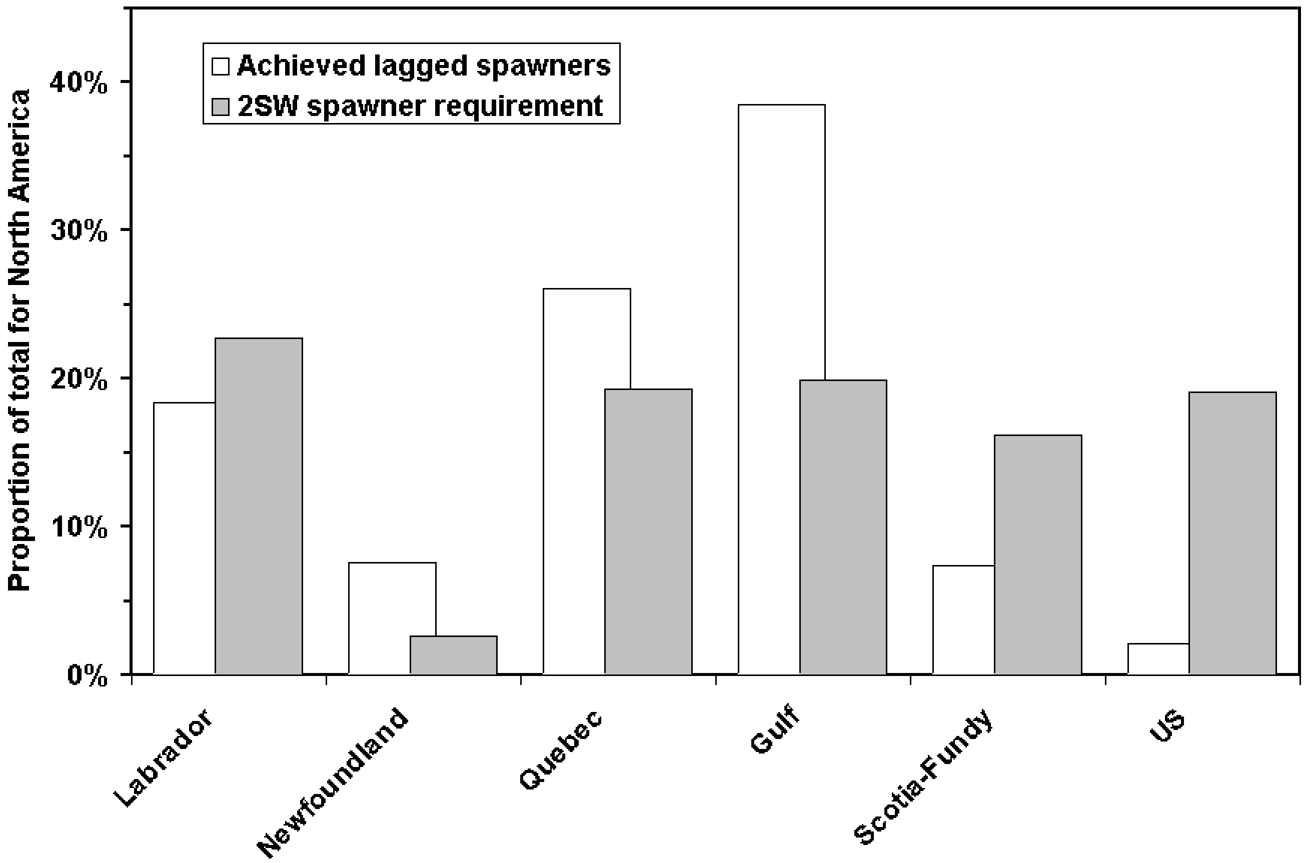


Figure 5.5.3.3. PFA_{NA} estimated for 1971 to 2001 and predicted PFA_{NA} for 2002 and 2003. There are two PFA_{NA} predictions for 2002. The open square is the value from the 2002 assessment using the lagged spawner variable, which included Labrador and excluded Gulf and US and the thermal habitat index. The dashed lines encompass the minimum to maximum range of the PFA estimated value. The shaded circles are the new model estimates for 2002 and 2003 using the revised lagged spawner index and a phase shift variable. The error bars on the predicted values describe the 5th to 95th percentile range.

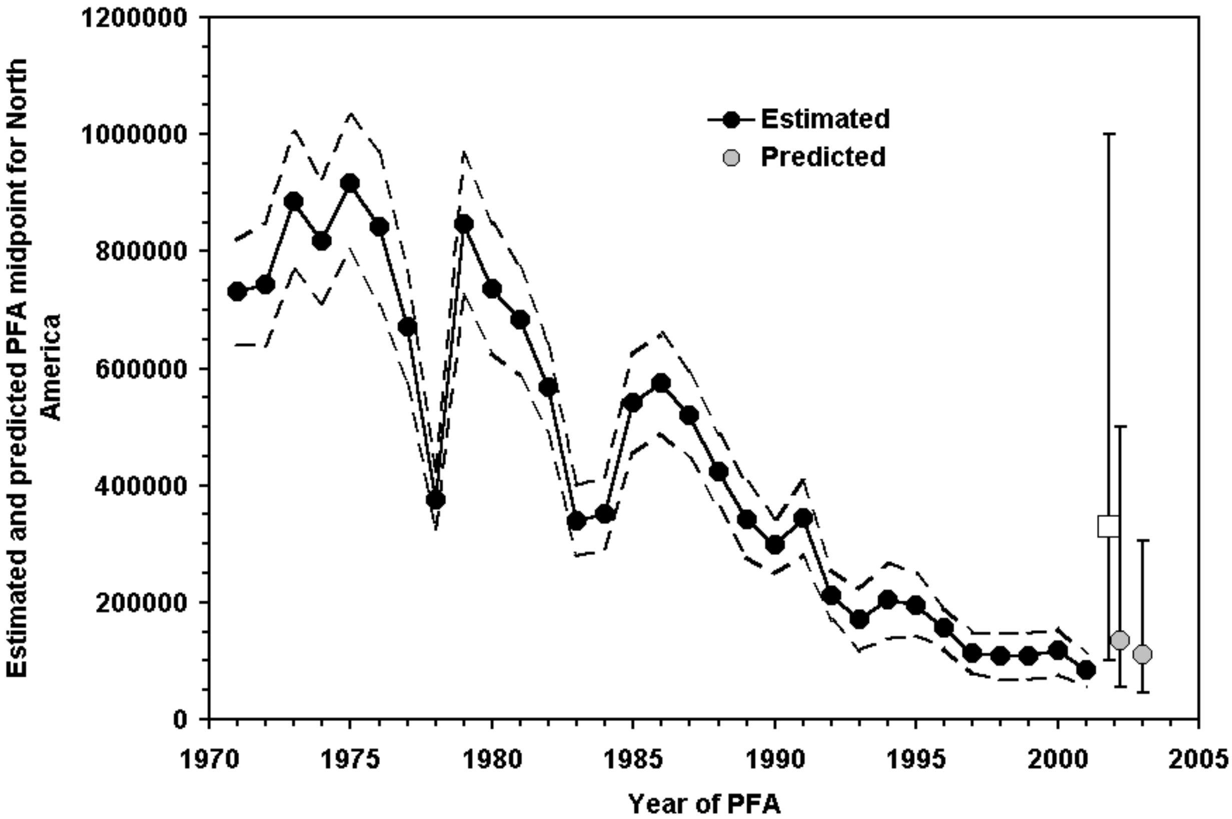


Figure 5.6.1. Observed estimates, jacknifed historical predictions, and simulated forecasts (Upper Panel A) of pre-fishery abundance from the multiplicative model with 1989 in Phase 1. The residual pattern from the jacknifed predictions is shown in the lower panel (Lower Panel B).

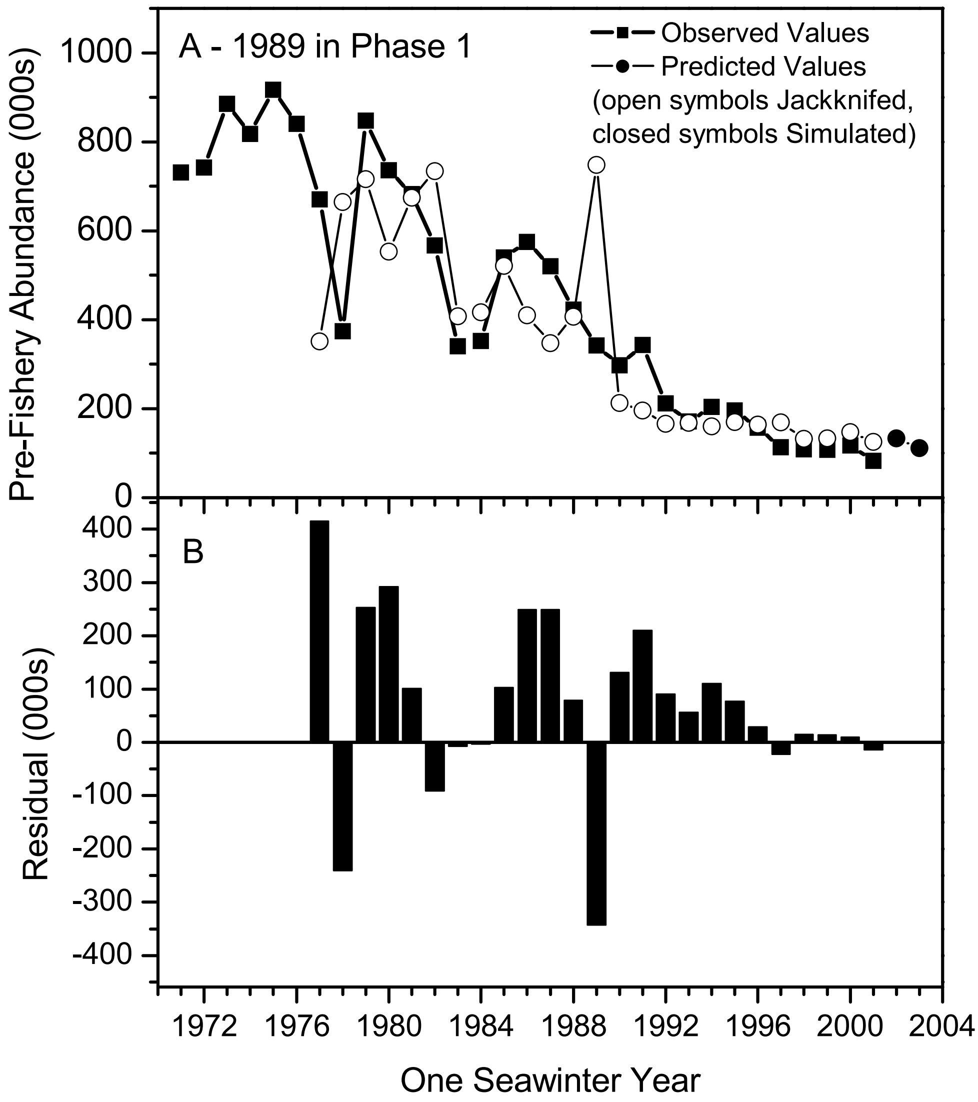


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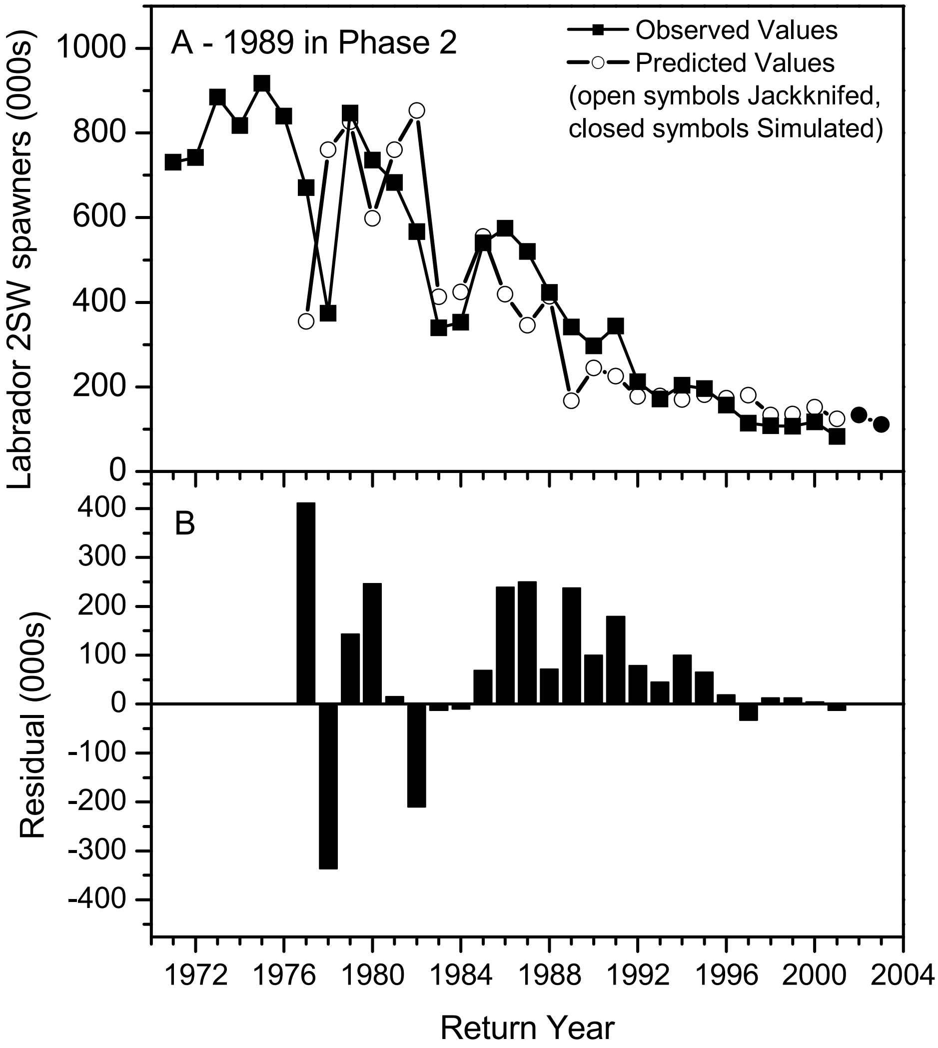
Figure 5.6.2. Observed estimates, jackknifed historical predictions, and simulated forecasts (Upper Panel A) of pre-fishery abundance from the multiplicative model with 1989 in Phase 2. The residual pattern from the jackknifed predictions is shown in the lower panel (Lower Panel B).



6 GENERAL RECOMMENDATIONS

The Working Group recommends that it should meet in 2004 to address questions posed by ACFM, including those posed by NASCO. An invitation to host the meeting was proposed to and agreed by the Working Group. Therefore, the Working Group intends to convene from the *29 th March – 8th April 2004* inclusive, in Halifax (Canada). 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.

6.1 Data deficiencies and research needs.

Recommendations from Section 2- Atlantic salmon in the North Atlantic Area:

1. Given the importance of M in the provision of catch advice and in the understanding of the dynamics of Atlantic salmon in the ocean, and in order to refine the assessment of M with the maturity schedule method, hatchery stocking programs should attempt to confirm the sex ratio of the released smolts (Section 2.3.1).

2. The Working Group recommends that life history characteristics of salmon stocks including age structure, length at age, relative and absolute abundance of repeat spawners, run-timing and other such features be examined for Atlantic salmon stocks to ensure that conservation of salmon go beyond abundance (Section 2.4.3).

3. A coordinated tagging study should be designed and carried on to give information on migration, distribution, survival and growth of escaped farmed salmon from the NEAC countries (Sections 2.6.1 & 2.6.3).

4. The Working Group recommends that information on the application of tags to salmon placed in sea cages by commercial companies should be made available through State agencies and included in the tag compilation database (Section 2.7.1).

Recommendations from Section 3 - Fisheries and Stocks from the North East Atlantic Commission Area:

1. Further progress should be made in establishing a PFA predictive model using the PFA of maturing 1SW salmon, in addition to the spawner term, as a predictor variable for the PFA of non-maturing 1SW in the Southern NEAC area (Section 3.5).

2. Surveys should be extended to provide better temporal and spatial information on the distribution of post-smolts in relation to pelagic fisheries (Section 3.7).

3. Experimental trawling surveys should be conducted to evaluate the vertical distribution of post-smolts and older salmon in the sea, if possible in combination with tagging of post-smolt and salmon with depth and temperature recording tags (DSTs) (Section 3.7).

4. Studies on post-smolts and older salmon should be extended to elucidate behaviour patterns at sea and to investigate their behaviour in relation to different commercial gear types (e.g. pelagic trawls, purse seines) (Section 3.7).

5. Efforts should be made to inter-calibrate the CPUE for different trawling methods, in particular research gears against commercial trawls, to provide a better basis for assessing levels of by-catch (Section 3.7).

6. The Planning Group on Surveys on Pelagic Fish in the Norwegian Sea (PGSPFN) should consider intensive screenings of pelagic research hauls for the presence of post-smolts (small salmon in their 1st year at sea, generally < 45cm) and older salmon (Section 3.7).

7. The Working Group requests that ICES should make available data on the commercial catches of mackerel and herring in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (Division IVa), and the west of Ireland and Scotland (Divisions VI a & b; VII b,c,j & k) by ICES Division and standard week. Further information on the number of vessels fishing, gear types and fishing techniques is also requested. (Section 3.7).

Recommendations from Section 4- Fisheries and Stocks from 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.

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 region of Québec (Sections 4.2.2 & 4.2.4).

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age and river-age composition) of returns to rivers, of smolt output, of spawning stocks of Canadian and US rivers, and the harvest in food fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model (Sections 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 (Section 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 (Sections 4.2.3 & 4.2.5).

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

6. A consistent approach to estimating returns is needed for instances in which offspring from broodstock are stocked back into the management area from which their parents originated (Section 4.1.3).

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

1. Continued efforts should be made to improve the estimates of the annual catches of salmon taken for private sales and local consumption in Greenland (Section 5.1.1).

2. The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. The Working Group recommends that the sampling program be continued and closely coordinated with fishery harvest plan to be executed annually in West Greenland (Sections 5.1.2 , 5.1.3.1, 5.1.3.2 & 5.5.3).

3. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farm salmon. To investigate this observation, farmed salmon need to be genetically characterized and included as baseline populations in continent of origin analyses of samples collected at West Greenland (Section 5.1.3.1).

4. Continue testing for ISAv and other diseases in Atlantic salmon caught in West Greenland (Section 5.1.3.1).

5. CPUE was not available in 2002 in West Greenland. Thus, there is a need to collect more refined data characterizing fishing effort to characterize availability of Atlantic salmon (Section 5.1.1).

6. Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future source of confirmatory information of abundance (Section 5.5.1).

7. 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. Other indices of change, i.e. changes in age composition, size at age and sea survival, should also be included in this analyse (Section 5.2.3).

8. The Working Group endorses the continued development of genetic methods that will increase the precision and accuracy of the classification of stock complexes within and among continents, countries, and individual rivers, and recommends (Section 5.1.3.2):

    - to further evaluate the extent to which the genetics of stocks have been characterized within each country, and share that information at the Working Group meeting in 2004.
    -

- that all efforts be made to extend the spatial and temporal coverage of existing baseline genetic dataset for North Atlantic salmon stocks, especially those vulnerable to mixed stock fisheries, while making efforts to duplicate tissue sample representation across different laboratories.

- that an inventory of genetic material, particularly from historic scale samples and samples taken prior to significant management measures or ecological events, be assembled and that inter-laboratory calibration and standardization should be carried out to ensure optimal use of existing samples and samples to be taken in future.

APPENDIX 1

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP
ON NORTH ATLANTIC SALMON, 2003

1. King T. L., Reddin D. G. and Sheehan T. Continent of Origin of Atlantic Salmon Collected at West Greenland, 2002.
2. Short P. B., Johnson R. W., Reddin D. G., Brown, R., King T. and Kanneworff, P. Identification and characteristics of North American and European Atlantic Salmon (Salmo salar L.) caught at West Greenland in 2001.
3. Reddin D. G. Return & spawner estimates Atlantic salmon for insular Newfoundland.
4. Crozier W. W., Kennedy G. J. A., Boylan P. and Kennedy R. Summary of salmon fisheries and status of stocks in Northern Ireland for 2002.
5. McKeon J., Sweka J., Trial J., Marancik G., Rowan J., Sprankle K., Rideout S., Legault C. and Sheehan,T. National Report for the United States, 2002.
6. Whoriskey F. and Carr J. W. Magaguadavic River salmon restoration program.
7. Sheehan T., Legault C. and Brown R. Identifying the Gulf of Maine distinct population segment component of the West Greenland Atlantic salmon catch
8. Legault C. M. Atlantic salmon population viability analysis.
9. Vauclin V. Salmon fisheries and status of salmon stocks in France : National report for 2002.
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APPENDIX 3

LIST OF PARTICIPANTS

Name	Address	Telephone	Fax	E-mail
Walter Crozier (Chair)	DARD River Bush Salmon Station 21 Church Street Bushmills BT57 8Q5 United Kingdom	+ 44 2820 731435	+ 44 2820 732130	walter.crozier@dardni.gov.uk
Peter Amiro	Dept. of Fisheries and Oceans Diadromous Fish Division BIO P.O.Box 1006, Dartmouth, NS B2Y 4A2 Canada	+1 902 426 8104	+1 902 426 6814	amirop@mar.dfo-mpo.gc.ca
François Caron	Direction de la Recherche Faune et Parcs Québec, 675, est, Boul. René-Lévesque Québec, Québec G1R 5V7 Canada	+1 418 521-3955 ext 4377	+1 418 646 6863	francois.caron@fapaq.gouv.qc.ca
Gerald Chaput	Dept. of Fisheries and Oceans P.O. Box 5030 Moncton NB E1C 9B6 Canada	+1 506 851 2022	+1 506 851 2147	ChaputG@dfo-mpo.gc.ca
Jaakko Erkinaro	Finnish Game and Fisheries Research Institute Oulu Game and Fisheries Research Tutkijantie 2 FIN-90570 Oulu	+358 205 751 871	+358 205 751 879	jaakko.erkinaro@rktl.fi
Pierre-Michel Fontaine	Ministère de l'Environnement Direction des evaluations enviromentales 6 étage, boite 83 675, Boul. René Lévesque est Québec, Québec, G1R 5V7 Canada	+1 (418) 521 3933 #4792	+1 (418) 646 0266	Pierre-michel.fontaine@menv.gouv.qc.ca
Gudni Gudbergsson	Institute of Freshwater Fisheries Vagnhöfda 7 110 Reykjavik Iceland	+354 567 6400	+354 567 6420	gudni.gudbergsson@veidimal.is
Lars Petter Hansen	Norwegian Institute for Nature Research P.O. Box 736, Sentrum N-0105 Oslo Norway	+47 23 35 5000 Direct: +47 23 35 5113	+47 23 35 5101	l.p.hansen@nina.no
Marianne Holm	Institute of Marine Research P.O. Box 1870 - Nordnes N-5817 Bergen Norway	+47 55 23 68 92	+47 55 23 63 79	marianne.holm@imr.no
Jan Arge Jacobsen	Fiskirannsóknarstovan P.O. Box 3051, Noatún FO-110 Tórshavn Faroe Islands Denmark	+298 315 092	+298 318 264	janarge@frs.fo
Per Kanneworff	Greenland Institute of Natural Resources P.O. Box 570 DK-3900 Nuuk Denmark	+299 32 1095	+299 32 5957	pka@natur.gl

Name	Address	Telephone	Fax	E-mail
Lars Karlsson	National Board of Fisheries Institute of Freshwater Research Brobacken SE-81494 Alvkarleby Sweden	+46 268203 mobile +46 70 210 4544	+46 26 82515	lars.karlsson@fiskeriverket.se
Christopher Legault	NOAA-Fisheries 166 Water Str. Woods Hole, MA 02543 USA	+1 508 4952025	+1 508 4952393	chris.legault@noaa.gov
Julian MacLean	FRS, FL Field Station 16 River St. Montrose, Angus DD10 8DL Scotland, United Kingdom	+44 1674 677070	+44 1674 672604	j.c.maclean@ marlab.ac.uk
Dave Meerburg	Dept. of Fisheries and Oceans 200 Kent Street Ottawa, Ont. K1A 0E6 Canada	+1 613 990 0286	+1 613 954 0807	meerburd@ dfo-mpo.gc.ca
Niall Ó Maoiléidigh	Marine Institute Abbotstown Castleknock Dublin 15 Ireland	+353-1-8228200	+353-1-8205078	Niall.omaoileidigh@marine.ie
Sergei Prusov	Polar Research Institute of Marine Fisheries & Oceanography 6 Knipovitch Street 183767 Murmansk Russia	+7 815 247 3658	+47 78 91 05 18	prusov@pinro.ru
Dave Reddin	Dept. of Fisheries and Oceans Po.Box 5667 St. John's Newfoundland A1C 5X1 Canada	+1 709 772 4484	+1 709 772 3578	ReddinD@DFO- MPO.GC.CA
Ian Russell	CEFAS Lowestoft Laboratory Pakefield Rd Lowestoft, Suffolk NR33 0HT United Kingdom	+44 1502 562244 (Inst.) +44 1502 524330 (Dir.)	+44 1502 513865	i.c.russell@ cefas.co.uk
Tim Sheehan	NOAA-Fisheries 166 Water Str. Woods Hole, MA 02543 USA	+1 508495-2215	+1 5084952393	tim.sheehan@noaa.gov
Gordon Smith	FRS FL Field Station 16 River Street Montrose DD10 8DL Scotland, UK	+ 44 1674 677070	+ 44 1674 672604	g.w.smith@marlab.ac.uk
Joan Trial	Maine Atlantic Commission 650 State Street Bangor, Maine, 04401 USA	+1 207 941 4452	+1 207 941 4443	joan.trial@maine.gov
Vincent Vauclin	Conseil Supérieur de la Pêche Délégation régionale n°3 23, rue des garennes Marly - France	+ 33 3 87629336	+ 33 3 87656480	Vincent.vauclin@csp.environnement.gouv.fr
Fred Whoriskey	Atlantic Salmon Federation P.O.Box 5200 St Andrews NB ESB 3A9 Canada	+1 506 529 1039	+1 506 529 4985	asfres@nbnet.nb.ca

APPENDIX 4

Examples of SAS programs to (1) calculate jacknife residuals for PFA estimates and (2) calculate Atlantic salmon pre-fishery abundance with an estimate of precision based on empirically derived distributions of observed patterns of pre-fishery abundance and analysis of risk of achieving spawner requirements in North America and Europe.

Program 1. Jacknife residuals

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FILENAME IN DDE 'EXCEL | Vardata ! R8C1:R32C17';

OPTIONS NOCENTER LINESIZE = 80;

*----------------  JACKNIFE03.SAS  ---------------;
*-THIS PGRM USED TO JACKNIFE PREDICTED & RESIDUAL VALUES  ---;
*--J_RES & J_PRED ARE JACKNIFED RESIDUAL & PREDICTED VALUES -;
*-N_RES & N_PRED ARE THE NORMAL RESIDUAL & PREDICTED VALUES -;
*-runs from PFA input data.XLS on a sheet labelled vardata --;

*============================================================ ;
4 STATEMENTS MUST BE CHANGED TO RUN THIS PROGRAM ;

*  1.  UPDATE DATABASE WHICH WAS OUTPUT FROM SAS USING EXPORT OPTION UNDER FILE;
*  2.  PROC REG SHOULD BE CHANGED AT MODEL STATEMENT TO CURRENT YEAR MODEL;
*  3.  RUN THE RESIDUALS AND JACKNIFED RESIDUALS FOR 1989 IN PHASE 1 AND THEN IN PHASE 2;
*  4.  CHANGE TITLE DEPENDING ON THE RUN;
* =========================================================== ;

title 'This is with Phase=1 in 1989 ';

DATA PFAdata;
   INFILE in MISSOVER;
   INPUT YEAR NG1 NC1_L NC1_H NC2_L NC2_H NR2_L NR2_H NN1_L NN1_H NN1_M RFL2_L RFL2_H H2
LSexLab_L LSexLab_H ;
LSexLab_M = (LSexLab_L + LSexLab_H)/2;  * lagged spawner index for NA excluding Labrador;
lnpfa = LOG(NN1_M);
lnspawner = LOG(LSexLab_M);
if year<1989 then phase = 1;
if year=1989 then phase = 2;
*rerun again with phase = 1 & then change to phase = 2;
if 1990 le year le 2001 then phase = 2;
if year>2001 then delete;  *change next year ;

proc print;

run;

*<> <> <> <> <> <> <> <> <> <> <> <>;
PROC SORT; BY YEAR;

proc reg data = PFAdata;
  id year;
  model lnpfa = phase lnspawner / P R COLLIN INFLUENCE CLI;
  OUTPUT OUT=PRESS PRESS=P P=PP R=R RSTUDENT=RS STDI=STE H=H;

*THIS NEXT STEP CALCULATES JACKNIFED & NORMALIZED RESIDUALS -;
*--  CALCULATION OF NORMAL RES & PRED WAS NOT NECESSARY ---;
*--  AS THEY ARE PRESENT AS R & PP BUT IT MADE A GOOD TEST --;

*<> <> <> <> <> <> <> <> <> <> <> <> <> ;
DATA CALC;  SET PRESS;
  J_RES=RS*STE;
  N_RES=P*(1-H);
```

```
  J_PRED=lnpfa-J_RES;
  N_PRED=lnpfa-N_RES;

*<> <> <> <> <> <> <> <> <> <> <> <> ;
PROC PRINT DATA=CALC;
  VAR N_PRED J_PRED N_RES J_RES ;

RUN;
```

Program 2. Risk analysis of PFA forecast & catch advice

```
***FILE CALLED regime-pfa.sas;

OPTIONS NOCENTRE;

/* input data file is an ascii file taken from the Excel file LOG-RISKVAR.XLS from the
worksheet tab  "All years"  */

Filename in "c:/data/Chaput/Ices2003/pfainputs.prn";

/* this program incorporates a regime shift in R/S for NAC PFA
the transition year 1989 is allocated to one of the states using an uninformative prior,
The probability of the year of interest being in one state or the other
is calculated bythe relative change in PFA from the level two years hence (PFA / PFA in year-2)*/

DATA CATCH;
   INFILE in MISSOVER;
   INPUT YEAR NG1 NC1_L NC1_H NC2_L NC2_H NR2_L NR2_H NN1_L NN1_H NN1_M RFL2_L RFL2_H H2
LSexLab_L LSexLab_H ;
LSexLab_M = (LSexLab_L + LSexLab_H)/2;  * lagged spawner index for NA excluding Labrador;
lnpfa = LOG(NN1_M);
lnspawner = LOG(LSexLab_M);
if year le 1989 then phase = 1;  *rerun again with phase = 2;
if 1990 le year le 2001 then phase = 2;
if 2002 le year le 2003 then phase = 1;  * rerun again for different phases with 2003 = 1 or 2;

run;

/* conduct deterministic modelling of PFA lagspawners by switching 1989 in either one state
or the other while also putting the year of interest in one state or the other. This results in 4 analyses
with 1989 as {phase - 1, 2} and year of interest for example 2003 as {Phase = 1, 2}.
The predictions for the year of interest and the standard error of a single predicted value
are copied to Excel to generate the probability profiles for the year of interest PFA.
See weighting-phases.xls for the calculation  */

proc glm data = catch;
  id year;
  class phase;
  model lnpfa = phase lnspawner / solution;
  output out = determ89  p = predpfa  stdi = prederror;

run;

proc print data = determ89;
  var year phase LSexLab_M NN1_M predpfa prederror;

run;

/* this part does the resampling within the returns, catches to Canada, to generate PFA, resammples within lag spawner
min and max, allocates 1989 to one of the phases randomly, and allocates the year of interest to one of the phases based
on the phase-weighting parameters calculated in the spreadsheet weighting-phase.xls  */
```

```
data regime; set catch;

do sim = 1 to 10000;

 seed = 0;
 if year le 1989 then phase = 1;
    * everything before 1989 is phase 1, high phase;
 if 1990 le year le 2001 then phase = 2;
    * everything between 1990 and 2001 is phase 2, low phase;
 if year = 1989 then phase = 1 + (ranuni(seed)>0.5);
    * allocate 1989 to one of the phases;
 if year = 2002 then phase = 1 + (ranuni(seed)< 0.822);
    * allocate previous year to one of the phases
      based on value from phase-weighting.xls;
 if year = 2003 then phase = 1 + (ranuni(seed)< 0.952);
    * allocate previous year to one of the phases
       based on value from phase-weighting.xls;

 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));
 if rfl2_l = 1.00 then RAN_RFL2 = 1;
  else RAN_RFL2 = RFL2_L + ((RFL2_H - RFL2_L) * RANUNI(SEED));             *ratio correction for Labrador;
 lnpfa = LOG(RAN_RFL2*((((RAN_R2/0.970446) + RAN_C2)/0.740818) + RAN_C1) + NG1);
*log of PFA based on equation 4.2.3.3 in WG report;
 lnspawn=log(LSexLab_L+((LSexLab_H-LSexLab_L)*RANUNI(SEED)));
* log of lag spawner index which is sum of 5 regions and excludes Labrador;

 output;

end;

run;

/*proc print data = regime;

run;*/

proc sort data = regime;
  by sim;

proc glm data = regime noprint;
  by sim;
  id year;
  class phase;
  model lnpfa = phase lnspawn / solution;
  output out = predpfa  p = pfanew  stdi = stdnew;

run;

/*proc print data = predpfa;
  var year phase pfanew;

run;*/

/* take a random draw of a single prediction for the year of interest from the expected value
and the std dev. for a single observation. Do this once, the uncertainty arises from the
resampling of the regressions*/

data pfa2003 (keep = pfapred2003 harvestNA harvestNEAC);
     set predpfa;
         if year = 2003;
```

```
   seed = 0;
   if year = 2003 then do;
  pfapred2003 = exp(pfanew + (stdnew*rannor(0)));

/* input parameters for biological characteristics variations for 2003
 PropNA:  0.65 to 0.91
 PropE:  1 - propNA
 Wt1SWNA:  2.47 to 3.02 kg
 Wt1SWE:  2.81 to 3.03 kg
 ACF:    1.041 to 1.130
 HarvestNA:harvest of NA 1SW salmon based on biocharacteristics.
 Harvest per ton = (1000 / ACF / (propNA*Wt1SWNA + propE*Wt1SWE))/propNA
 HarvestNEAC: harvest of NEAC 1SW salmon based on bio characteristics.
Harvest (per ton) = (1000 / ACF / (propNA*Wt1SWNA + propE*Wt1SWE))/propE
*/

propNA = 0.65 + ((0.91 - 0.65)*ranuni(seed));
propE =  1 - propNA;
Wt1SWNA = 2.47 + ((3.02 - 2.47)*ranuni(seed));
Wt1SWE = 2.81 + ((3.03 - 2.81)*ranuni(seed));
ACF = 1.041 + ((1.130 - 1.041)*ranuni(seed));
HarvestNA=(1000/ACF/ (propNA*Wt1SWNA+propE * Wt1SWE))* propNA;
HarvestNEAC =(1000/ACF/(propNA*Wt1SWNA+propE*Wt1SWE))* propE;

 output;

   end;

run;

/*proc print data = pfa2003;

run;*/

proc univariate data = pfa2003;
 var pfapred2003;
 output out=percentiles pctlpre = P_  pctlpts = 5 to 95 by 5;

run;

proc print data = percentiles;

run;

data _nul_; set pfa2003;
 file "c:/data/chaput/ices2003/pfa-harvest-2003.dat";
 put pfapred2003 12. harvestNA 10.  harvestNEAC 10.;

run;
```

APPENDIX 5

Appendix 5(i). Estimated numbers of 1SW salmon recruits, returns and spawners for Labrador.

Year	Commercial catches of small salmon SFA 1	SFA 2	SFA 14B	Grilse Recruits SFA 1,2&14B+Nfld Min	Max	Grilse to rivers SFA 1,2&14B Min	Max	Labrador grilse spawners Angling catch subtracted SFA 1,2&14B 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, 1969-2001.
Ret. = retained fish; Rel. = released fish.

	Small catch	Small returns to river		Small recruits		Small spawners		Large returns to river		Large recruits		Large catch	Large spawners		2SW returns to river	
Year	Retained	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Min	Max	Min	Max
1969	34,944	109,580	219,669	219,160	732,230	74,636	184,725	10,634	25,631	35,446	256,307	2,310	8,324	23,321	2,193	8,995
1970	30,437	140,194	281,466	280,388	938,221	109,757	251,030	12,731	29,313	42,435	293,127	2,138	10,593	27,175	3,135	11,517
1971	26,666	112,644	226,129	225,288	753,763	85,978	199,463	9,999	23,221	33,330	232,208	1,602	8,397	21,619	2,388	8,923
1972	24,402	109,282	219,412	218,564	731,374	84,880	195,010	10,368	23,434	34,560	234,343	1,380	8,988	22,054	2,511	9,003
1973	35,482	144,267	289,447	288,534	964,822	108,785	253,965	13,489	31,645	44,964	316,451	1,923	11,566	29,722	2,995	11,527
1974	26,485	85,216	170,748	170,431	569,159	58,731	144,263	10,541	21,113	35,137	211,133	1,213	9,328	19,900	1,940	6,596
1975	33,390	112,272	225,165	224,544	750,550	78,882	191,775	11,605	23,260	38,682	232,596	1,241	10,364	22,019	2,305	7,725
1976	34,463	115,034	230,595	230,068	768,650	80,571	196,132	10,863	21,768	36,211	217,677	1,051	9,812	20,717	2,334	7,698
1977	34,352	110,114	220,501	220,229	735,004	75,762	186,149	9,795	19,624	32,650	196,237	2,755	7,040	16,869	1,845	6,247
1978	28,619	97,375	195,048	194,751	650,159	68,756	166,429	7,892	15,841	26,307	158,411	1,563	6,329	14,278	1,991	6,396
1979	31,169	107,402	215,160	214,803	717,199	76,233	183,991	5,469	10,962	18,230	109,619	561	4,908	10,401	1,088	3,644
1980	35,849	121,038	242,499	242,076	808,330	85,189	206,650	9,400	18,866	31,335	188,656	1,922	7,478	16,944	2,432	7,778
1981	46,670	157,425	315,347	314,850	1,051,158	110,755	268,677	21,022	42,096	70,074	420,961	1,369	19,653	40,727	3,451	12,035
1982	41,871	141,247	283,002	282,494	943,342	99,376	241,131	9,060	18,174	30,198	181,736	1,248	7,812	16,926	2,914	9,012
1983	32,420	109,934	220,216	219,868	734,053	77,514	187,796	9,717	19,490	32,391	194,903	1,382	8,335	18,108	2,586	8,225
1984	39,331	130,836	262,061	261,673	873,537	91,505	222,730	8,115	16,268	27,052	162,684	511	7,604	15,757	2,233	7,060
1985	36,552	121,731	243,727	243,461	812,424	85,179	207,175	3,672	7,370	12,240	73,702	0	3,641	7,339	958	3,059
1986	37,496	125,329	251,033	250,657	836,778	87,833	213,537	7,052	14,140	23,505	141,400	0	6,972	14,060	1,606	5,245
1987	24,482	128,578	257,473	257,157	858,244	104,096	232,991	6,394	12,817	21,313	128,170	0	6,353	12,776	1,336	4,433
1988	39,841	133,237	266,895	266,474	889,652	93,396	227,054	6,572	13,183	21,908	131,832	0	6,512	13,123	1,563	5,068
1989	18,462	60,260	120,661	120,520	402,203	41,798	102,199	3,234	6,482	10,780	64,815	0	3,216	6,463	697	2,299
1990	29,967	99,543	199,416	199,086	664,721	69,576	169,449	5,939	11,909	19,798	119,093	0	5,889	11,859	1,347	4,401
1991	20,529	64,552	129,308	129,105	431,027	44,023	108,779	4,534	9,090	15,112	90,896	0	4,500	9,056	1,054	3,429
1992	23,118	118,778	237,811	118,778	237,811	95,096	214,129	16,705	33,463	16,705	33,463	0	16,564	33,322	3,111	10,554
1993	24,693	134,150	268,550	134,150	268,550	107,816	242,217	8,121	16,267	8,121	16,267	0	7,957	16,103	1,499	5,094
1994	28,959	95,981	192,138	95,981	192,138	66,185	162,342	8,089	16,216	8,089	16,216	0	7,884	16,010	1,902	6,174
1995	29,055	202,739	435,153	202,739	435,153	172,727	405,141	16,175	34,633	16,175	34,633	0	15,956	34,414	3,635	12,592
1996	36,715	257,215	559,079	257,215	559,079	218,639	520,504	21,957	46,706	21,957	46,706	0	21,693	46,442	4,457	14,159
1997	17,388	99,029	146,050	99,029	146,050	80,096	127,116	15,318	22,183	15,318	22,183	0	14,985	21,850	3,887	8,355
1998	19,672	146,371	247,035	146,371	247,035	124,551	225,216	23,032	36,266	23,032	36,266	0	22,672	35,906	5,322	12,453
1999	19,960	156,740	224,959	156,740	224,959	135,561	203,780	21,198	41,674	21,198	41,674	0	20,853	41,329	4,254	14,262
2000	20,486	151,313	260,251	151,313	260,251	127,209	235,410	16,735	55,085	16,735	55,085	0	16,202	54,552	3,176	16,144
2001	23,398	136,949	194,299	136,949	194,299	111,756	169,106	14,600	37,187	14,600	37,187	0	14,200	36,787	2,629	10,679
2002	21,761	126,992	185,819	126,992	185,819	103,344	162,171	10,491	33,879	10,491	33,879	0	10,143	33,532	2,054	10,078

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				Large salmon				Proportion 2SW in large salmon	2SW salmon			
	Returns		Spawners		Returns		Spawners			**Returns**		**Spawners**	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		**Min.**	**Max.**	**Min.**	**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	3235	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	27353	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	3572	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	7350	2511	5706	0.65	2225	4778	1632	3709
2000	7659	12983	4581	9160	4782	7193	2805	4838	0.65	3108	4676	1823	3145
2001	7232	15183	3644	9750	4835	9691	3165	7018	0.65	3142	6299	2057	4562
2002	10766	17943	8776	15569	3186	5310	3090	5214	0.65	2071	3452	2009	3389

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.
For 2001, returns and spawners are based on previous five-year average, incomplete angling data were available.

Appendix 5(v)a. Returns of large salmon and 2SW salmon to SFA 16.

	2SW returns to SFA 16		Large Salmon Returns to the Miramichi River						Returns of large salmon to SFA 16	
			Point	0.8	1.33	Prop.	2SW Returns			
Year	Min.	Max.	Estimate	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	20835	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	20117	33444	37000	29600	49210	0.618	18306	30434	32527	54077
1993	21329	35460	35200	28160	46816	0.689	19410	32269	30945	51446
1994	15151	38979	27450	18278	47023	0.754	13788	35471	20086	51674
1995	18315	46697	32627	19747	50348	0.844	16667	42494	21700	55327
1996	13071	24396	24812	17443	32557	0.682	11894	22201	19168	35777
1997	9054	16567	18422	14183	25953	0.581	8239	15076	15586	28520
1998	3410	5684	9500	7500	12500	0.414	3103	5172	8242	13736
1999	6364	14386	16200	11900	26900	0.487	5791	13091	13077	29560
2000	6927	15261	18200	13300	29300	0.474	6304	13888	14615	32198
2001	11565	19440	20600	16300	27400	0.646	10524	17691	17912	30110
2002	3982	10057	10585	7216	18223	0.502	3624	9152	7930	20026

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 2002, min and max are 5th and 95th percentiles from the assessment.
Prop. 2SW are from scale ageing and have been corrected for 2001 from previous year's table.
Prop. 2SW for 2002 are based on 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. Large salmon and 2SW salmon spawners to SFA 16. Same procedure as for returns (Appendix 5(v)a)

Same procedure for escapements as used to calculate returns.

	2SW spawners to SFA 16		Large Salmon Spawners to the Miramichi River						Large salmon spawners to SFA 16	
			Point	0.8	1.33	Prop.	2SW Spawners			
Year	Min.	Max.	Estimate	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	19899	28933	35927	29281	42573	0.618	18108	26329	32176	46784
1993	21422	31147	34702	28282	41122	0.689	19494	28344	31079	45189
1994	14762	38590	27147	17808	46553	0.754	13433	35117	19569	51157
1995	17796	46178	32093	19188	49789	0.844	16195	42022	21086	54713
1996	12545	23870	23478	16741	31855	0.682	11416	21722	18397	35005
1997	8526	16039	17596	13357	25127	0.581	7759	14596	14678	27612
1998	3308	5513	9215	7275	12125	0.414	3010	5017	7995	13324
1999	6173	13954	15714	11543	26093	0.487	5618	12698	12685	28674
2000	6720	14803	17654	12901	28421	0.474	6115	13471	14177	31232
2001	11218	18857	19982	15811	26578	0.646	10208	17160	17375	29207
2002	3863	9755	10267	6999	17677	0.502	3515	8877	7692	19425

Assumes removal rates of 3% for large and 34% for small salmon for the years 1998 to 2002. These are average rates for 1993 to 1997 as per assessment.

Appendix 5(v)c. Returns of small salmon and 1SW salmon to SFA 16.

			Returns to the Miramichi River			1SW Returns to Miramichi	
	1SW returns to SFA 16			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	35600	30000	42100	29100	42100
2001	24730	38242	28200	23200	34800	22504	34800
2002	32326	51208	37578	30327	46599	29417	46599

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millb
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 2002, 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. Small salmon and 1SW salmon spawners to SFA 16. Same procedure as for Appendix 5(v)c.

Same procedure for escapements as used to calculate returns.

	1SW Escape to SFA 16		Escapement to Miramichi			1SW Escape to Miramichi	
				0.8	1.33	0.97	1
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
2001	16322	25240	18612	15312	22968	14853	22968
2002	21335	33797	24801	20016	30755	19415	30755

Assumes exploitation rates of 3% for large and 34% for small salmon for the years 1998 to 2002. These are average rates for 1993 to 1997 as per assessment.

Appendix 5(vi). Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1970-2002.

	Small recruits		Small spawners		Large recruits		Large spawners		2SW recruits		2SW spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
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
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	5	9	3	7	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	14	28	8	22	2	5	1	4	2	5	1	4
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	2	5	1	4	5	9	3	7	5	9	3	7
1980	12	23	7	18	2	5	1	4	2	5	1	4
1981	259	498	151	390	40	77	36	73	40	77	36	73
1982	175	336	102	263	16	31	8	23	16	31	8	23
1983	17	32	10	25	17	32	15	30	17	32	15	30
1984	17	32	10	25	13	26	13	26	13	26	13	26
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	210	385	118	292	169	310	166	307	169	310	166	307
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	304	584	177	457	56	108	55	107	56	108	55	107
2001	429	824	250	645	57	110	55	107	57	110	55	107
2002	307	591	179	463	46	88	45	87	46	88	45	87
70-89 X	213	410	124	321	21	40	20	40	21	40	20	40
90-02 X	887	1721	519	1353	99	193	98	191	99	193	98	191

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, 1999, and 2002, percent small is calculated from numbers of small and large salmon taken at the Leard's Pond trap.

For 1998 and 2000-2001, 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(vii). Total returns and spawners of small salmon and large salmon, and 2SW salmon returns and spawners to SFA 18.

	Small salmon				Large Salmon				2SW Salmon			
	Returns		Spawners		Returns		Spawners		Returns		Spawners	
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	264	1,073	167	842	6,161	7,858	709	2,660	4,744	6,836	546	2,314
1971	65	265	41	208	2,456	3,198	276	1,036	1,891	2,782	213	901
1972	131	530	82	416	6,095	6,924	293	1,101	4,693	6,024	226	958
1973	516	2,095	325	1,645	5,376	6,299	309	1,160	4,140	5,481	238	1,009
1974	187	757	118	595	7,119	7,963	343	1,286	5,481	6,928	264	1,119
1975	112	454	71	357	4,483	4,989	231	864	3,452	4,340	178	752
1976	299	1,212	188	951	3,578	4,223	288	1,080	2,755	3,674	222	939
1977	215	871	135	684	5,175	6,280	424	1,587	3,985	5,463	326	1,381
1978	78	316	49	248	5,954	7,201	550	2,062	4,585	6,265	424	1,794
1979	1,857	7,536	1,170	5,915	1,676	2,315	286	1,071	1,290	2,014	220	932
1980	520	2,108	327	1,655	4,846	5,951	536	2,009	3,732	5,177	413	1,748
1981	2,797	11,348	1,762	8,908	3,234	4,332	487	1,823	2,490	3,769	375	1,586
1982	2,150	8,722	1,354	6,847	5,370	6,783	598	2,242	4,135	5,901	461	1,951
1983	212	858	133	674	4,848	6,024	517	1,938	3,733	5,241	398	1,686
1984	460	1,867	182	1,210	3,105	4,107	319	1,236	2,391	3,573	246	1,075
1985	730	3,167	144	1,786	1,196	5,150	1,105	4,955	921	4,481	851	4,311
1986	965	3,854	64	1,731	2,953	13,195	2,786	12,835	2,274	11,479	2,145	11,166
1987	1,316	5,061	191	2,410	3,209	15,193	3,084	14,923	2,471	13,218	2,375	12,983
1988	1,927	7,900	915	5,514	1,387	5,794	1,233	5,461	1,068	5,040	949	4,751
1989	680	2,651	35	1,129	1,842	8,579	1,707	8,289	1,418	7,464	1,315	7,211
1990	1,082	13,778	335	12,017	3,754	18,429	3,610	18,117	2,891	16,033	2,779	15,762
1991	914	10,559	48	8,519	1,998	13,439	1,825	13,065	1,539	11,692	1,405	11,366
1992	1,448	6,565	807	5,053	5,257	21,778	5,092	21,423	4,048	18,947	3,921	18,638
1993	1,714	10,451	1,043	8,869	2,597	14,305	2,452	13,994	2,000	12,445	1,888	12,175
1994	660	2,988	298	2,136	2,534	10,454	2,382	10,126	1,951	9,095	1,834	8,810
1995	619	2,939	379	2,372	1,887	8,862	1,826	8,730	1,453	7,710	1,406	7,595
1996	1,470	8,033	1,076	7,105	2,388	9,408	2,158	8,913	1,839	8,185	1,662	7,755
1997	364	4,117	78	3,444	3,524	12,626	3,242	12,017	2,714	10,984	2,496	10,455
1998	402	4,410	145	3,805	2,462	8,823	2,280	8,430	1,896	7,676	1,755	7,334
1999	372	4,369	115	3,764	1,553	5,575	1,376	5,194	1,196	4,850	1,060	4,519
2000	257	3,713	97	3,335	1,069	3,828	837	3,329	823	3,331	644	2,896
2001	184	4,071	1	3,639	1,294	4,646	1,225	4,497	996	4,042	943	3,913
2002	249	4,429	249	3,843	1,105	3,961	915	3,550	851	3,446	704	3,088

Numbers revised from 2002 because of updated angling catches, standardization of calculations

Appendix 5(viii). Total 1SW returns and spawners, SFAs 19, 20, 21 and 23, 1970-2002.

	RETURNS						TOTAL		SPAWNERS						TOTAL	
	River returns		Comm-	SFA 23			RETURNS			Spawners		SFA 23			SPAWNERS	
	SFA 19-21		ercial	Wild	Wild	Hatch	SFAs 19,20,21,23		angled	19-21		H+W	rtns	Harvest	19,20,21,23	
Year	MIN	MAX	19-21	MIN	MAX		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
2001	4,239	8,884	0	2,513	2,862		6,752	11,746	0	4,239	8,884	2,210	2,530		6,449	11,414
2002	5,706	11,879		3,501	3,991		9,207	15,870	0	5,706	11,879	3,232	3,689		8,937	15,568

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, 1993-2001, 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, 1970-2002.

								SFA 23					
	SFA 19		***SFA 20***		***SFA 21***		Total	Wild	Wild	Htch	Htch	***TOTAL RETURNS***	
	MIN	MAX	MIN	MAX	MIN	MAX	Comm-	MIN	MAX	MIN	MAX	***SFAs 19,20,21,23***	
	2SW=0.7-0.9		2SW=0.6-0.9		2SW=0.5-0.9		ercial	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		19-21	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
2001	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,374	4,720	0	1,725	2,182			3,099	6,902
2002	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				876	1,483	0	523	658			1,399	2,141

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 1998-2001 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, 1993-2001, 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-'02, 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, 1970-2002.

	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
2001	>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,374	4,720			1,374	4,720	1,725	2,182	239	271	2,860	6,631
2002	>>>>>>>>>>>>>>>>>>>>>>>>>>>				876	1,483			876	1,483	523	658	255	291	1,144	1,851

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.

pendix 5(x). Estimated numbers of salmon returns and spawners for Québec 1969-2002.

	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	24,495	29,398	34,301	33,368	38,487	43,605	16,743	21,237	25,730	19,506	23,068	26,629
1999	25,880	31,279	36,679	34,815	40,496	46,178	18,969	23,889	28,808	23,631	28,124	32,618
2000	24,129	29,599	35,070	33,312	39,938	46,565	16,444	21,154	25,865	22,094	27,027	31,960
2001	16,931	20,684	24,437	35,016	41,753	48,490	10,829	13,902	16,974	22,871	27,913	32,954
2002	28,754	34,161	39,568	25,617	30,691	35,764	17,215	21,566	25,918	17,061	20,695	24,329