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REPORT OF THE WORKING GROUP ON NORTH ATLANTIC SALMON

Moncton, Canada

10–19 April 1996

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Main Tasks

At its 1995 Statutory Meeting, ICES resolved (C. Res.1995/2:13:12) that the Working Group on North Atlantic Salmon (Chairman: Mr. E.C.E. Potter, UK) should meet in Moncton, Canada from 10–19 April 1996 to consider questions which include those posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). The terms of reference are set up to provide the Advisory Committee on Fishery Management with the information required to respond to the request for advice from NASCO. The full terms of reference are listed below with details of where each question is answered in the report.

Questions:	Section of report (by NASCO Commission Area)		
	NEAC	**NAC**	**WGC**
a) with respect to Atlantic salmon in each Commission area:			
i. describe the events of the 1995 fisheries,	4.1 4.2	5.1	6.1
ii. describe the status of the stocks and, where appropriate, evaluate the causes for any changes in salmon abundance with special reference to changes in natural mortality,	4.3 4.4 4.5	5.2 5.3	6.2
iii. identify data deficiencies and research requirements relevant to the management of salmon stocks;	4.6	5.4	6.3
b) report on significant research developments which might assist NASCO with the management of salmon stocks, with special reference to:			
i. possible explanations for changes in sea-age at maturity of Atlantic salmon,		7.1	
ii. the criteria for defining salmon stocks;		7.2	
c) update the evaluation of the effects of the following measures on the stocks and fisheries occurring in the respective Commission areas:			
i. quota management and closures implemented after 1991 in the Canadian commercial salmon fisheries,	8.1		
ii. the suspension of commercial fishing activity at the Faroes since 1991,		8.2	
iii. the suspension of commercial fishing activity during 1993 and 1994 at West Greenland;			8.3
d) with respect to the fishery in the West Greenland Commission area:			
i. review the age specific target spawning levels in Canadian rivers,		9.1	9.1
ii. provide catch options with an assessment of risks relative to the objective of achieving target spawning escapement;			9.2
e) with respect to fisheries and stocks in the North-East Atlantic Commission area:			
i. provide estimates of age specific spawning targets,	10.1		
ii. provide catch options with an assessment of risks relative to the objective of achieving target spawning escapement;	10.2		
f) with respect to Atlantic salmon in the NASCO area, provide a compilation of microtag, finclip and external tag releases by ICES Member Countries in 1995;		11	
g) provide a definition of wild salmon;		12	
h) evaluate the methods used in the estimation of unreported landings;		13	
i) provide information on, and explanations for, changes in growth rate and mean weight at age and changes in the proportion of different size groups in the fisheries.		14	

The Working Group considered 24 Working Documents submitted by participants (Appendix 1); other references cited in the report are given in Appendix 2.

In addition to addressing the questions posed on significant research developments (Section 7.1 and 7.2), the Working Group has reported on a new method for discriminating farm origin salmon (Section 7.3) and work on the use of Sr:Ca ratios in otoliths to determine maturation status. Preliminary results of surface trawl surveys which have caught significant numbers of post-smolts in the Norwegian Sea are presented in Section 4.4.

In view of the particular emphasis placed upon the effects of changes in natural mortality on salmon abundance, this has been addressed in two separate sub-sections (4.5 and 5.3) relating to the North East and North American Commission areas respectively.

1.2 Participants

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Porter, T.R.	Canada
Prévost, E.	France
Roche, P.	France
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Stolte, L.W.	USA
Whoriskey, F.	Canada
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A full address list for the participants is provided in Appendix 3.

2 CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches of Salmon

Total nominal catches of salmon reported by country in all fisheries for 1960–1995 are given in Table 2.1.1, and nominal catches in homewater fisheries, divided into size or age categories where such data are available, are given in Table 2.1.2. Catch statistics in the North Atlantic also include fish farm escapees and, in the north-east Atlantic, ranched fish (see Section 3). Figure 2.1.1 shows the nominal catch data grouped by the following areas: 'Scandinavia and Russia' (including Denmark, Finland, Iceland, Norway, Russia and Sweden); 'Southern Europe' (including France, Ireland, UK(England and Wales), UK(Northern Ireland) and UK(Scotland)); and 'North America' (including Canada, USA and St Pierre et Miquelon); and 'Greenland and Faroes'.

The updated total nominal catch for 1994 of 3,954 t is 231 t greater than the total for 1993 of 3,723 t. However, catches in most countries remain below the averages of the previous 5 and 10 year averages. Figures for 1995 (3,416 t) are provisional and incomplete, but the final total is unlikely to exceed the 1994 value.

The lack of information on fishing effort presents major difficulties in interpreting catch data for any one year and also in comparing catches in different years. However, it is clear that management plans in several countries have decreased fishing effort and this accounts for some of the decline in catches in recent years.

2.2 Catches in Numbers by Sea-Age and Weight

Reported nominal catches for several countries by season and weight are summarised in Table 2.2.1. As in Tables 2.1.1 and 2.1.2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1995 are provisional and incomplete. Different countries use different methods to partition their catches by sea-age class. These methods are described in the footnotes to Table 2.2.1. The composition of catches in different areas is discussed in more detail in Sections 4, 5 and 6.

2.3 Unreported Catches

2.3.1 Unreported catches within commission areas

Unreported catches by year and Commission Area are presented in Table 2.3.1. A discussion of the methods used to evaluate the unreported catches is provided in Section 13. The total unreported catch in 1995 was estimated to be 1,050 t, a decrease of about 18% compared with 1994 and 38% on the 1990-94 mean of 1691 t.

The unreported catch estimated for the North-East Atlantic Commission Area in 1995 was 942 t, a 40% reduction on the mean for 1990-94 of 1,557 t, and that for the North American Commission Area was 98 t, 24% below the 1990–1994 mean of 129 t. There was little change in the small estimated unreported catch for the West Greenland Commission Area of around 10 t.

2.3.2 Unreported catches in international waters

No data were available on fishing for salmon in international waters in the Norwegian Sea or on vessels landing catches from this area in the 1994/1995 season. Only one surveillance flight was reported to have been undertaken by the Icelandic coastguard, and no salmon fishing was observed in the area. The Working Group recommends that every effort should be made to instigate a surveillance programme to provide reliable estimates of the fishing effort for salmon in this area. It was noted that a number of countries conduct research vessel cruises in this area and that they could be asked to monitor any salmon fishing activity.

Preliminary results of surveys in the Norwegian Sea suggest that post-smolts are widely distributed in this area and may be caught in pelagic trawls fished at the surface (Section 4.4). Such fishing gear is used by the commercial fleet fishing for mackerel on the eastern edge of the Faroes EEZ and in the south-eastern corner of the international waters to the north of Faroes. The Working Group was not able to estimate the level of unreported by-catch of salmon in these fisheries, but noted that the fishery operated in only a small part of the area occupied by salmon post-smolts. The Working Group recommended that efforts be made to obtain further information on by-catches in these fisheries.

3 FARMING AND SEA RANCHING OF ATLANTIC SALMON

3.1 Production of Farmed Salmon

The production of farmed salmon in the North Atlantic area in 1995 was 413,200 t (Table 3.1.1 and Figure 3.1.1). This was the highest production in the history of the farming industry and represented a further 26% increase compared to 1994 (326,630 t) and a 61% increase on the 1990–1994 average (256,123 t). The countries with the largest production were Norway and Scotland, which accounted for 71% and 17% of the total respectively. The greatest proportional increases in production have occurred in USA, Norway and Scotland. The production of farmed salmon in 1995 was about 120 times the nominal catch of salmon in the North Atlantic.

3.2 Production of Ranched Salmon

Ranching has been defined as the production of salmon through smolt releases with the intent of harvesting the total population that returns to freshwater (harvesting may include collecting fish for broodstock) (Anon.

1994/M:16). The total production of ranched salmon in countries bordering the North Atlantic in 1995 was 309t which is the lowest value since 1990 (Table 3.2.1 and Figure 3.2.1). The majority (94%) of the ranching is conducted in Iceland, where it represents 66% of the nominal catch. Production at experimental facilities in Ireland, UK (N. Ireland) and Norway has remained low. (Data for Ireland for 1985–1995 have been updated to include two additional facilities.) Production in Ireland includes catches in net, trap and rod fisheries. Icelandic catches, on the other hand, are entirely from estuarine and freshwater traps at the ranching stations.

4 FISHERIES AND STOCKS IN THE NORTH EAST ATLANTIC COMMISSION AREA

4.1 Fishing in the Faroes Area

4.1.1 The research programme at Faroes

The Faroese salmon quota has been bought out since 1991, however, the Faroes Government continued sampling inside the 200 mile EEZ. As a result a joint Nordic research programme was designed which was intended to give more knowledge about salmon in the Norwegian Sea.

The main aims of the project are:

- to record the catches and catch per unit effort, lengths and weights of the fish caught and the proportion of discards (i.e. fish less than 60 cm).
- to collect suitable scale samples to assess smolt age, sea age, and the incidence of farmed fish.
- to assess the migration of wild and farmed salmon by tagging and releasing groups of fish caught at sea.
- to provide qualitative and quantitative estimates of the feeding habits of salmon in the Norwegian Sea.

The Working Group endorses the terms of reference of the project outlined above and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North East Atlantic.

4.1.2 Catches and discards

No commercial fishery took place in 1994/1995. The research fishery followed the normal pattern of previous seasons, beginning close to the islands and moving in a north-easterly direction towards the fishery limit during the season. The total catch in the 1994/1995 season was 7 t and the preliminary catch for the calendar year 1995 was 5 t, excluding fish that were tagged and released (Table 4.1.2.1), all catches being by the research fishery. The catch in numbers by month is given in Table 4.1.2.2. No research fishery took place outside the Faroes EEZ.

A total of 4,178 fish (including fish tagged and released) was measured of which 634 were less than 60 cm total length (Table 4.1.2.3). In the commercial fishery, fish of this size should be discarded. Thus the proportion of the catch that would have discarded ranged from 5.0 to 39.7%, and the overall estimate was 15.1%. This value is in the upper end of the range observed since the 1982/1983 season.

4.1.3 Catch per unit of effort (CPUE)

The gear in use in the Faroese research fishery did not change in 1994. The fishing effort was low due to the buy-out of the Faroes quota. Only one research vessel operated during the fishing season under supervision of the Faroes Fishery Laboratory. A total of 49 sets was fished by this vessel during 5 trips in the 1994/1995 season.

The catch in number per 1000 hooks (CPUE) by statistical rectangle for the whole season is shown in Figure 4.1.3.1. The CPUE was low during most of the season (between 29–34 salmon per 1,000 hooks) but increased to 50 salmon per 1000 hooks in March (Table 4.1.3.1).

The overall CPUE of 36 salmon per 1000 hooks for the 1994/1995 season is the second lowest value since the 1981/1982 season (Table 4.1.3.1). In the 1992/1993 season the CPUE of 84 was the highest observed since 1981/1982 season. One of the explanations for the high CPUE in the 1992/1993 season was the increase in the numbers of fish farm escapees in that period (see section 4.1.6). Analysis of scale samples has confirmed that between 17% and 37% of catches in the last four seasons were of farmed origin. Figure 4.1.3.2 shows the CPUE for farm origin salmon separately from the remainder of the stock and indicates that the decrease in the total CPUE since 1993/94 has been due in part to the decrease in the number of farmed fish in the area. No significant trend was observed in the CPUE during the past ten seasons when farmed fish were ignored. It is important that scale analysis to identify farm origin salmon continues because the presence of large numbers of reared salmon could mask a decline in the wild stocks in the area.

4.1.4 Biological composition of the catch

Some of the basic parameters sampled during the research programme in the long-line fishery at Faroes in the 1994/1995 season are listed in Table 4.1.4.1. Salmon were weighed and measured, and scale and stomach samples were taken. The presence of finclips, external tags and CWTs was also recorded. About one third of the fish caught were tagged with external tags and released. Various biological measurements from the research programme at Faroes are discussed below:

Length distribution: The fork length distribution of wild and reared salmon combined (excluding tagged and released fish) is shown in Figure 4.1.4.1. Two main length cohorts, representing 1SW and 2SW fish, are well separated in the catch.

Sea age distribution: Prior to the 1991/1992 season, the total catch was grouped into sea-age classes using length splits (e.g. Anon. 1992/M:4) or scale readings of wild and reared fish combined. However, since the 1991/1992 season the sea-age composition has been estimated for the proportion of the catch not thought to be of reared origin (including fish < 60 cm). The sea-age distribution in the 1994/1995 season was estimated in a similar way from the scale samples (Table 4.1.4.2). The sea age varied between 1 and 3 years, and the mean sea ages in the November–December period being significantly lower than in February–March (χ^2= 28.7; df=2; p<0,001). Table 4.1.4.3 shows the sea-age composition of the research catches (excluding reared escapees) from the 1991/1992 fishing season onwards.

Weight distribution: The weight composition is only available for wild and reared fish combined (Table 4.1.4.4). The increasing trend in the proportion of large fish (> 5 kg), observed from the 1989/1990 season to the 1992/1993 season (Figure 4.1.4.2), has reverted to the proportions observed prior to 1989.

Smolt age distribution: In order to compare smolt age composition of the wild fish caught in the 1994/95 season with the two preceding fishing seasons, the samples were grouped for November–December 1994 (n= 115) and February–March 1995 (n=163). In 5% of these samples smolt ageing was not possible because of lack of complete scales or disagreement in classification of annual zones. Among the interpretable samples, smolt age varied between 1 and 4 years in the November–December period and between 1 and 5 years in the February–March period (Table 4.1.4.5). Mean smolt age was significantly lower in the November–December period than in the February–March period (χ^2= 12.3; df=4 p<0.01). The smolt age distribution (%) since the 1984/1985 season is given in Table 4.1.4.6.

Stomach samples: Preliminary results were available for the analysis of 3,409 stomachs collected during the three seasons 1992/1993-1994/1995. In the 1994/1995 season 1571 stomachs were collected. The stomach contents are analysed qualitatively and quantitatively, and some preliminary results are shown in Table 4.1.4.7 and 4.1.4.8. The proportion of empty stomachs increased from 25% in 1992/1993 to 34% and 37% respectively in the next two seasons (Table 4.1.4.7), and the frequency with which fish species were found in the stomach samples fell from 76% to 44% and 45% during these three seasons (Table 4.1.4.8). Both fish and crustaceans are important prey groups for salmon in the sea north of the Faroes. The most important crustaceans were the hyperiid amphipods of the genus *Parathemisto* and Euphausiids. The fishes were mainly lantern fishes, *Maurolicus muelleri* and barracudinas.

4.1.5 Origin of the catch

The entire catch taken by the Faroes research fishery was scanned for CWTs and external tags in the 1994/1995 season. A total of 32 microtags was recovered, 14 of which were from 1SW salmon (all less than 60 cm) and 18 from 2SW salmon (Table 4.1.5.1). All of the 1SW fish originated from Irish rivers (Burrishoole 5, Shannon 4, Bundorragha 3, Screebe 2). There were 13 2SW tags recovered from Norwegian release locations (Vega Island 7, Selstøvågen 4 and Imsa 2). Two tags each were recovered from Iceland and Scotland and a single tag recovery from UK (N. Ireland).

There were 22 external tags recovered in the fishery. The majority of these tags (20) were from Norwegian salmon releases (3 tags each from Vega Island, River Opløy, Vefsna, Imsa, and Selstøvågen; 2 tags from the River Drammen and Surna; and a single recovery from the Kvitsøy). These tags originated from two 1SW salmon and eighteen 2SW salmon. Single tags from 2SW salmon were recovered from Sweden (River Götaälv) and UK(Scotland)(River Tay).

There has been a marked reduction in the rate of recapture per 1,000 fish released due to the continued suspension of commercial fishing at Faroes since 1991 (Tables 4.1.5.1 and 4.1.5.2). As in earlier years, the highest recapture rates have been recorded for salmon originating from Sweden and Norway, which are mainly taken as 2SW fish. Lower rates have been recorded for salmon from UK and Ireland; most of the Irish recaptures are 1SW fish less than 60 cm in length (discards).

Tagging programme at Faroes

In the 1994/1995 fishing season 1783 salmon caught on long-line were tagged with Lea tags and released in the sea north of the Faroes (43% of the total catch), adding to the 3050 and 617 fish tagged in the 1992/1993 and 1993/1994 seasons respectively. This brings the total number of tagged fish released to 5450. Tags have been reported by commercial fishermen and anglers from home water fisheries throughout Europe and in North America.

Further tag recoveries are expected, and the current analysis takes no account the age composition or proportion of farmed/reared fish in the tagged groups. However, after three fishing seasons (i.e. 1993-1995) a total of 98 tagged fish have been reported recaptured in 10 different countries (Table 4.1.5.3), including 4 fish taken in SFA16 in Canada. Most recaptures (59 %) were from Norway, which supports earlier information that the majority of salmon in the Faroese area originate from Norway. Preliminary analysis suggests that the recapture rate of farmed fish is lower than for wild fish, and 17-33 % of the tagged fish were assumed to be of farmed origin.

The reason for the low reported recapture rate could include high tagging mortality (as many of the fish were released with the hook in the gut), higher than expected mortality rates of salmon in the second sea winter, and reduced exploitation rates (or low tag reporting rates) in homewater fisheries.

4.1.6 Incidence of reared salmon in the Faroes fishery

It was estimated that in the 1994/1995 season 19 %. of the fish taken were of reared origin. Additional results from previous fishing seasons were available to the Working Group, and the complete time series starting in 1980/1981 is shown in Table 4.1.6.1 and Figure 4.1.6.1. The proportion of reared fish in the samples was low until the 1987/1988 fishing season, reached a peak in the 1989/1990 and 1990/1991 seasons at around 40% and has since dropped to a level of less than 20% in the last two seasons. The production of farmed fish increased dramatically in the same period as the fish farmed escapees increased (1988–1991) (see Table 3.1.1 and Figure 3.1.1). However, the incidence of fish farm escapees has declined after 1991, while the production of farmed fish has continued to increase.

The method of identification (Lund *et al.* 1989; Lund and Hansen 1991) may underestimate the proportion of reared fish, in particular failing to identify some of those fish that escaped at the freshwater stage or at an early marine stage as being of reared origin. On the other hand, the method will also detect some salmon released for ranching or stock enhancement programmes, although this is not thought to affect the results significantly as a large proportion of these fish carry tags and/or fin clips (Anon., 1994/Assess:16) and can be excluded from the analysis. Furthermore, the number of hatchery reared smolts released in the North-East Atlantic is relatively small compared with the number of wild salmon present. The exception is Iceland where ranching has been established as an industry, but very few fish tagged in Icelandic ranching operations have been reported from the Faroes fishery, suggesting that they migrate to other feeding areas. As a result it appears that escaped farmed salmon account for the major proportion of the reared fish in the catch, and deliberately released salmon smolts form only a small component of the reared salmon sampled.

A new method for identifying farm origin salmon is discussed in Section 7.3.

4.1.7 Exploitation rates in the Faroes fishery

The exploitation rates in the Faroes fishery on several stocks from Ireland, Norway, Sweden, UK (N. Ireland) and UK (Scotland) are summarised in Table 4.1.7.1.

Many of the estimates are imprecise as some figures are based on less than 10 tag recoveries. This is particularly so in recent years because there have been fewer tag recoveries due to the suspension of the commercial fishery.

While Scandinavian stocks appear to be exploited more consistently and at a higher rate than other European stocks, relatively high exploitation rates have also been recorded for North Esk (UK Scotland) MSW stocks in the past. As would be expected, the current rates of exploitation on all stocks are very low.

4.2 Homewater Fisheries in the North-East Atlantic Commission Area

4.2.1 Gear and effort

The following national reports were provided on changes in gear and effort in homewater fisheries. The numbers of licences issued by gear are given in Table 4.2.1.1.

Finland: No change in gear was reported and there have been no changes in fishery regulations in the Rivers Tenojoki and Näätämöjoki in 1995. Effort in the recreational fishery continued to decline slightly from previous years. In 1995 there were 25,000 angler days in the R. Tenojoki compared to 26,500 in 1994. Over the same period, the number of anglers decreased from 9000 to 8100. Water levels were abnormally low in the R. Tenojoki at the end of the fishing season in August, which could affect the salmon catches.

France: There was no change in fishing regulations in 1995. The sport and commercial fisheries in the Loire basin are still closed, following a decision in 1994 to protect the very small remaining stock. In two rivers in Brittany (Aulne and Trieux) the angling effort probably increased in response to significant returns of adults from smolt releases. The number of licenses has increased slightly compared to 1994 after a steady decline in the last 9 years.

Iceland: No changes in gear and effort have been introduced since the last report. The two weeks extension in fishing season allowed from 1994 has been used in only a few rivers. This extension lead to an increased catch in the clear tributaries of glacial rivers as salmon ascended these rivers later in the season.

Ireland: While a number of local bye-laws were introduced to extend or curtail the fishing season, no significant changes occurred in the legislation of the fishing season. A total of 773 drift net licences were taken out from a maximum number of 847 licences allowable. The number of drift net licences taken out in 1995 was slightly higher than in 1994. The maximum number of draft net licences allowable is 604 of which 446 were taken out. This was a reduction on the number of draft net licences from the previous year. The number of licences for other net types did not change. The higher level of marine surveillance by the Navy and Regional Fisheries Boards in recent years has lead to a reduction in the use of illegal gear and illegal fishing. There was little change in the number of rod licences issued in 1995 (25,000).The upward trend in rod licence sales in recent years has been due in part to the introduction of new types of licence.

Norway: There have been no significant changes in gears and effort in marine fisheries. No new regulations were introduced in 1995.

Russia: No changes in gear and effort have been introduced since the last report.

Sweden: No new regulations with regard to gear and effort have been introduced since the last report.

UK (England and Wales): There have been no significant changes in the methods used in the net fisheries. Byelaws were introduced to reduce exploitation of spring running fish in the Rivers Dee, Wye and Usk in Wales in 1995. Effort in the net fisheries has continued to decline gradually, partly as a result of the continued phasing out of drift netting in the north-east coast fishery. Angling effort tends to reflect prevailing flow conditions and perceived availability of fish. Prolonged dry weather and low flows during the summer months in 1995 resulted in reduced angling effort and poor catches in this period.

UK (N. Ireland): The number of commercial fishing licences issued in 1995 (206) was similar to 1994 (205), with 2 fewer bagnets and 3 more drift nets licensed. No changes occurred in fishing seasons or gear regulations.

UK (Scotland): Several new fishing regulations were introduced in 1995. The use of prawns and shrimps was banned on the River Nith (Solway region). In the Clyde region, the annual close time in the Eachaig District was extended to protect early running fish. Effort data for 1995 are not yet available. In 1994, there was a 13% reduction in the number of fixed engine gear units used compared with 1993 and an 8% decrease in the number of net and coble crews operating.

4.2.2 Catches and catch per unit effort (CPUE)

Catch data are presented in Tables 2.1.1 and 2.1.2. In addition CPUE data are available for the following countries:

Finland: CPUE on the Teno river in 1995 was slightly higher than in 1994 but lower than the 1990 to 1994 average (Table 4.2.2.1).

France: The catch in 1995 (9t) represented 55% of the 1994 catch and 45% of the previous 10 year average. The catches were particularly low in the south-west region, where the estuarine commercial fishery took only 20% of the 1994 catch. CPUE data were collected from a sample of anglers in 1995 and were found to be similar to 1994 and more than double that in any year between 1987 and 1993 (Table 4.2.2.1). The average rod effort within the sample was 182 hours for the season. On average 79 hours were required to catch one salmon.

Iceland: The 1995 reported catch was 439 t. The sport catch (109t) increased by 18% compared to 1994 but was 5% lower than the average for the last 22 years. The gill-net catch (41 t) showed a 13% increase compared to 1994 due mainly to an increase in the coastal gill-net catch.

Ireland: The declared catch of 712 t in 1995 was 11% lower than that recorded in 1994 (817 t). Catches were higher than the previous 5 year average but lower than the previous 10 year average. Drift net catches accounted for 74% of the declared catch, while draft nets took 16%. Despite the improvement in estimating rod catches since 1994, the percentage taken by rods (7%) remains an underestimate of the total salmon rod catch. Warm weather and low flows prevented effective drift net fishing and probably discouraged salmon from entering freshwater until later in the season.

Norway: The methods used to collect catch statistics changed in 1993 resulting in an improvement in the quality of the statistics. However this makes comparisons with previous years more difficult. The 1995 catch of 839 t was 16% down on the final 1994 catch (996 t) and down on both the previous 5 and 10 year averages. No effort data are available.

Russia: The total catch in 1995 was 129 t, slightly down (7%) on the 1994 catch but 34% and 64% down on the previous 5 and 10 year averages.

Sweden: The reported catch of 37 t in 1995 was 16% less than in 1994 and was down on both the previous 5 and 10 year averages. One possible reason for this decline could be the decreased level of coastal fishing effort due to environmental problems such as algae and high sea water temperatures.

UK (England and Wales): The provisional catch of salmon in 1995 was 311 t. The total net and fixed engine catch (252 t) was marginally greater than in 1994 and 27% above the previous 5 year average. However, the estimated rod catch (59 t) was 38% lower than in 1994 and 11% below the previous 5 year average reflecting the adverse (dry) weather conditions prevalent for a large part of the season. CPUE data are available for net fisheries in a number of regions and in three out of four regions the CPUE was above the previous 5 year average (Table 4.2.2.2).

UK (N. Ireland): The provisional catch for the 1995 fishery was 83 t. This was lower than in 1994 (91 t), similar to the previous 5 year average and lower than the previous 10 year average. Rod catches in the R Foyle system were poor, probably as a result of the low river flows. The phenomenon of substantial very late runs of 1SW fish, observed in 1993 and 1994, was not repeated in 1995. Reliable rod CPUE estimates are available only for the R Bush (Table 4.2.2.1), and were lower in 1995 compared to the average for the last 5 years, though they remain higher in the 1990s compared to the 1980s.

UK (Scotland): The final reported catch for 1994 was 649 t. This total was 4% greater than the previous 5 year average but 20% down on the previous 10 year average. The catch data for 1995 (457.1t) are incomplete, but it is unlikely that the final figure will exceed the 1994 figure.

CPUE in the fixed engine increased in 1994 by 77% and was the highest recorded in the series. (Compared to 1993, the 1994 catch increased by 48% while effort decreased by 17%). The 1994 net and coble CPUE was marginally down (1.3%) on the 1993 figure (Table 4.2.2.3). No effort data are collected from rod fisheries.

4.2.3 Composition of catches

Data on the age composition of catches are presented in Table 2.2.1.

Finland: In the River Tenojoki in the rod catch (about 50% of the total catch) the proportion of 1SW fish was 58%, 2SW 7 % and MSW 34%. The ageing is based on scale readings. There were no significant changes in timing of runs.

France: The proportion of 1SW salmon in the catches was 60%, 52% in the rod fishery and 91% in the net fishery. The proportion of 1SW fish in the last 3 years has been higher than the 5 year average. At least part of the reason is the later closure of the angling season since 1993 and the closure of the Loire fishery which is predominantly a MSW fishery. About a third of the catches are salmon released as parr and smolts in two rivers in Brittany.

Iceland: In the Icelandic sport fishery in 1995 about 75% were 1SW and 25% 2SW. This is about the average for previous 5 years.

Ireland: The majority of the commercial catch (>90%) is assumed to be comprised of 1SW salmon. However, an assessment of the sea age of the catch has not been carried out since 1988.

Norway: In 1995 the proportion of 1SW salmon was 58% of the total catch which is lower than in 1994 (67%). In 1994 the proportion of 1SW fish was higher than in previous years leading to relatively high number of 2SW salmon in 1995. This is probably due to low post-smolt mortality in 1993.

Russia: The contribution of 1SW fish in 1995 catch was similar to that of 1994 at approximately 70%.

Sweden: The proportion of 1SW fish in the 1995 catch (61%) was similar to the two previous years (62% and 63% respectively.). 1SW salmon were smaller than the average calculated for the period 1981 to 1994. There was no change in the mean size of the MSW fish compared to the previous two years.

UK (England and Wales): It was not possible to provide a reliable estimate of the age composition of the salmon catch in 1995. There were no changes in the overall size composition or timing of runs of salmon. Anecdotal reports indicate that 1SW fish still comprise the majority of the catch in most regions, but the proportion of MSW fish is thought to have increased in a number of areas over recent years.

UK (N. Ireland): Although dealers in Northern Ireland provide statutory returns, in which they split the catches into grilse and salmon, this is based on weight, the accuracy of which has not been assessed. Accordingly, the national catch is published as a single figure covering all sea ages. In future, it is intended to carry out sampling of commercial salmon fisheries to provide a basis for assessment of catch composition by sea age.

UK (Scotland): In 1994, 54% of the reported catch was recorded as grilse. However, scale analyses of samples from major fisheries in each of the main statistical regions have indicated that the actual proportion of grilse is always much higher than the reported figure as a result of 1SW fish being misreported as MSW fish. The errors in classification are not consistent between regions or between years.

4.2.4 Origin of the catches

The contribution of wild, farm origin and ranched salmon to national catches in the North-East Atlantic in 1991-1995 is shown in Table 4.2.4.1.

Finland: Escaped farmed salmon have been observed in the River Tenojoki and have ascended to upper parts of the river. Farmed fish have been caught in the River Inarjoki, which is one of the tributaries, about 230 km from the sea. There is evidence from the presence of possible spawning marks on the scales that spawning may have occurred.

Iceland: The contribution of ranched fish in the salmon harvest in Iceland has been between 65 and 75% for the past 4 years. There are some strays of ranched fish to salmon rivers, and contribution of 38% ranched fish was recorded in the catch in River Ellidaar in 1995. There has been a decreasing number of fish farm escapees in the sport fishery due to decreasing production of farmed fish. Fish farm escapees were only detected in a few rivers.

Ireland: Based on the examination of 49% of the declared catch, the proportion of fish identified as farm escapees (based on external examination only) ranged from 0.02% in Donegal to 0.19% in the South Western region (Table 4.2.4.2). This is considerably less than in the previous 4 years where data are available.

Ranching is carried out in three Irish salmon rivers under experimental conditions. While smolts are released in several other rivers in Ireland, this is carried out mainly to augment rod catches or for stock restoration programmes). The returns from these releases comprise approximately 16t or 2.2% of the commercial catch. This is an increase over previous years due to the inclusion of data from two other rivers.

Norway: The proportion of farmed fish in samples from coastal fisheries in 1995 averaged 42%, which is an increase compared with 1994. In fjord fisheries the corresponding proportion was 17% which is about the same as in 1994, and in anglers catches 4% of the landed catch were estimated to be farmed, which is approximately at the same level as in 1994 (Tables 4.2.4.3 and 4.2.4.4). According to figures from the Directorate for Fisheries, 645,000 farmed salmon escaped from cages in 1994, and provisional data from 1995 suggest that 220,000 farmed fish escaped, which is significantly less than in previous years. Salmon ranching in Norway is carried out on a small experimental scale, and the catch of these fish in 1995 is about 2 t.

UK (England and Wales): There are no salmon cage rearing facilities or ranching programmes in UK(England & Wales). There were no reports of farmed fish contributing to catches.

UK (Scotland): Since 1994, fishermen have been required to identify farmed fish in their catches; prior to this estimates were obtained from sampling programmes (Table 4.2.4.1). Of the 649 t caught and retained in 1994, 644 t was reported as wild salmon and 4.6 t (<1%) was reported as farmed fish. In 1995, the provisional total of fish caught and retained (456 t) was reported as comprising 455 t wild fish and 1.4 t of farmed fish.

UK (N. Ireland): In 1995, ranched salmon accounted for a very small component of the catch (<1t) and comprised fish released from the R. Bush for research purposes.

In 1995, over 4% of commercially caught salmon in the summer grilse fishery were identified as being of farm origin by experienced fishermen, an increase on the 1.2% reported in 1994 and the highest level recorded since regular monitoring started in 1992 (Table 4.2.4.2). Only 0.4% of the adult salmon entering the R. Bush in 1995 (ranched fish excluded) were judged by scientific staff to be of farm origin, the second lowest in the time series (Table 4.2.4.5). External morphology was the basis of identification in all cases, and this method is believed to underestimate the occurrence of escaped farmed salmon.

4.2.5 Exploitation rates in homewater fisheries

Exploitation rates for various monitored rivers in homewater fisheries in the North- East Atlantic are shown in Table 4.2.5.1. The method of estimating these values is described in brief for each country; details of external tag reporting rates assumed for the analyses are given in the footnotes to Table 4.2.5.1.

Iceland: The exploitation rate on salmon in river Ellidaar was 43% in 1995 which is close to the average for the time series. The exploitation rate seems fairly stable in this river, and is probably representative of other

Icelandic rivers. Only a limited number of rods is allowed in each river and this number has remained about the same for many years. The estimates of the river stock size are based on counter and catch figures.

Ireland: Estimates are based on microtag recoveries raised to total catch and including an estimate of non-catch mortality (including non-reported catch). Exploitation by commercial nets on reared Burrishoole stock returning to Irish coastal waters was estimated to be 84% for 1 sea winter salmon in the 1995 fishing season compared to 73% in the 1994 season. The exploitation rate has returned to values experienced in the early and middle 1980's. As would be expected the highest rate of exploitation was by the marine fishery operating closest to the river.

Commercial exploitation of the River Corrib wild stock is estimated from tag returns from the rod fishery and in-river trap fishery, assuming a 33% operational efficiency for the traps (Browne, 1989). High exploitation rates (> 60%) have been recorded for this stock. The highest recorded exploitation rate on 2SW fish (~40%) was recorded in 1991. These figures are based on relatively low tag recaptures of 2SW fish, and the data should therefore be treated with caution. The decrease in exploitation in the early 1990's for both the Burrishoole and Corrib stocks can be attributed, in part, to the imposition of bye-laws restricting the use of commercial engines in parts of the West of Ireland since 1991.

Norway: Marine exploitation of both 1SW and 2SW salmon on the River Drammen stock was 36% and 40% respectively. The rod exploitation rate downstream of the salmon ladder was 53%. The marine exploitation of wild fish from the River Imsa was 86%, but there were no data available for 1SW fish. For hatchery fish from Imsa the marine exploitation was 55% for 1SW fish and 88% for 2SW fish. The marine exploitation has increased for the Imsa stock in recent years, but this is not the case for the Drammen stock. The estimates are based on external tag recoveries and counter figures.

Russia: In 1995 the exploitation rates show a slight rise in comparison with 1994. The estimates are based on counter and catch figures from net fisheries only.

Sweden: The homewater exploitation rate on the River Lagan 1SW and 2SW salmon in 1995 was 58% and 66% respectively, a marked reduction on previous years. Exploitation rates on the River Lagan stock have previously been estimated using the run-reconstruction model and estimating that the broodstock fishery took 50% of the spawning escapement. Tagging studies in 1994 and 1995 indicated that the broodstock fishery took 49% and 27% in these two years and these results were used to run the model. In other fisheries a tag reporting rate of 0.65 is assumed.

UK (England and Wales) Exploitation rates for rod fisheries in the Test (28%), Itchen (27%) and Dee (9%) in 1995 were all lower than in 1994, but within the reported range for recent years. The estimates are based on counter data and mark/recapture experiments.

UK (Northern Ireland): Data on exploitation rates are available from microtagging experiments on hatchery-reared and wild R. Bush smolts. In 1995, exploitation of wild 1SW fish (67%) was higher than in the previous five years (56%), and a little higher than the average for the available time series (64%), while exploitation of hatchery-reared 1SW fish (1+ smolt origin) at 69% was lower than the time series average (78%) though similar to the 1994 estimate (71%). Exploitation of 2SW salmon in 1995 (mainly hatchery origin), was estimated at 42%, very similar to the 1994 figure (40%) and to the average for the available time series (38.5). The estimates are based on microtag recoveries raised to total catch and including estimate of non- catch fishing mortality.

UK (Scotland): The only fishery in Scotland for which there is a time series of exploitation rates is the North Esk net and coble fishery. The exploitation rates for 1SW and MSW fish in 1995 were 14% and 13% respectively. Rates of exploitation have declined, particularly since 1991 when there was a major reduction in effort. The estimates are based on counter and catch figures.

4.2.6 Summary of homewater fisheries in the North East Atlantic Commission Area

There has been a continuation in the trend to reduce commercial fishing effort in the North-East Atlantic area in recent years, mainly reflecting conservation measures in the respective countries and the reduced value of commercially caught salmon. Minor changes in commercial and recreational salmon fishing effort were reported in 1995.

Provisional figures suggest that nominal catches of salmon in North-East Atlantic countries in 1995 were at a similar level to or below those in 1994. The final figures for 1994 were slightly higher than in the previous year but still below the previous 5 and 10 year averages. CPUE varies considerably between fisheries. In UK(Northern Ireland) and UK(England & Wales) levels in 1995 were similar to 1994, but in UK(Scotland) the CPUE increased, particularly in the fixed engine fisheries.

The proportion of 1SW fish in national catches varied from 58% to over 90%. The lowest proportions of 1SW fish in catches were reported in Norway, Finland and France (rod fishery) and the highest in Ireland, France (net fishery), Iceland and Russia. No significant changes in the 1SW/MSW salmon ratio was reported compared to the previous year. In Norway, the number of 2SW salmon was high following the high proportion of 1SW fish in 1994.

Ranched fish continue to comprise the majority of the Icelandic catch and some straying is observed into rivers. In Norway, the proportion of farm origin fish in samples from coastal fisheries has increased slightly compared to 1994, but the proportion of farm origin fish in the Faroes catches has fallen from a peak of over 40% to around 20% in recent years. Fish farm escapees are also observed at variable levels in coastal and in-river fisheries in UK(Scotland) and in small numbers in catches in Ireland and UK (N. Ireland).

Exploitation rates in most homewater fisheries were similar to previous years. In-river exploitation rates in several rivers in parts of UK were reduced, probably due to low river flow conditions.

4.3 Status of Stocks in the North-East Atlantic Commission Area

4.3.1 Attainment of spawning targets

Provisional spawning targets have been defined for several rivers in the North-East Atlantic Commission area. including new data from one river in France. In general, they are derived from stock-recruitment data collected on monitored rivers. Where possible, targets have been set at the Minimum Biologically Acceptable Level (MBAL) for the stocks according to guidelines presented in Section 8.1.1 of the 1995 Working Group report (Anon. 1995/Assess:14). Table 4.3.1.1 shows the targets set for North-East Atlantic rivers and gives time series to assess historical attainment.

France: Data are available for two years for the R Scorff and in both years egg deposition exceeded the target. It should be noted that the egg deposition target has been re-evaluated downwards since last year (Anon 1995/Assess:14). New data, from the River Nivelle, spanning 1984-1995, were presented to the Working Group. In the first two years of the time series, egg deposition was not attained. However, the improved egg deposition from 1986 onwards can be attributed to an enhancement programme begun in the early 1980s.

Ireland: In the R Burrishoole, the egg deposition target has been met in only two of the past 16 years; however egg deposition has exceeded 75% of the target in 12 years. It is also noted that the target only relates to areas of salmonid habitat contributing to production in recent years and does not reflect historical production levels for this river.

UK(N. Ireland): For the R Bush, target egg deposition has been exceeded in 8 out of the last 11 years. However, the target has not been met in the two most recent years. It is noted that for several of the years when egg deposition was above target, smolt production was reduced relative to that expected at target level (Kennedy & Crozier, 1993). This is explained by the nature of the stock/recruitment relationship and serves to illustrate that exceeding the target by a large margin may reduce recruitment.

Russia: The R Tulome has been below target throughout of the 14 years examined and less than 50% for 10 of those years.

UK(England & Wales): For the River Dee, egg deposition was close to the target in only one of the last four years and was about 50% of the target in the other three years.

UK(Scotland): For the North Esk the target was set on the basis of ACFM's definition of MBAL (Anon 1995/Assess:14). It has been met or exceeded in all of the time series (1981–1995) presented to the Working Group.

A route regression analysis was applied to the 5 series that provided long-term information (1985-1995) on the level of egg deposition/target (R Bush, North Esk, R Nivelle, R Burrishoole and R Tuloma) (Table 4.3.1.2). An increasing trend was observed over the last 10 years. It should be stressed that no information is available for the great majority of the North-East Atlantic stock complex. It should also be noted that the targets are currently set at the MBAL level and are provided here simply for the purpose of providing a comparative measure of the status of stocks.

4.3.2 Measures of juvenile abundance

Freshwater production

Counts or estimates of wild smolt production, or juvenile survey data are available for 23 rivers (Table 4.3.2.1), and complete smolt estimates are available for 8 of these in 1995. Smolt runs showed improvements on the previous 5 year average on the Hogvadsån (Sweden) but were well below in 4 rivers (Imsa and Orkla (Norway), the Bush (UK, N Ireland), North Esk (UK, Scotland). However, in the case of the River Imsa this is because very few spawners have been released upstream into the river in order to prevent the spread of furunculosis. On the three other rivers, the 1995 smolt run estimate was within 10% of the previous 5 year average. Low juvenile population densities were recorded on the rivers Avon, Frome and Piddle (all UK, England & Wales) and Inarijoki (Finland) in 1995.

There is no evidence that freshwater productivity in the North-East Atlantic in general has decreased over the last decade, or even within the last 5 years. Route regression analyses were carried out on smolt run estimates for 7 rivers for the past 10 years and on 13 rivers for the past 5 years (Table 4.3.1.2). These showed no common significant trend in smolt production.

4.3.3 Spawning escapement

Adult counts or estimates of wild salmon runs in 1995 are available for 26 rivers in the North-East Atlantic area (Table 4.3.3.1).

Counts in most Russian rivers were below the average for the previous 5 year (and the long-term averages) as were counts in the R Hogvadsån (Sweden), and the three rivers in France and two in UK(Scotland) for which there was information. Recorded counts in the R Burrishoole (Ireland), N Esk (UK, Scotland) and R Usk (UK England & Wales) were above the 5 year average.

Due to differences in the size of stocks considered and in their migration patterns, route regression analyses were conducted separately on the adult counts in Russian rivers and the counts for the rivers in the other countries. An increasing trend was apparent for Russian rivers over the 30 year time series of data ($p<0.01$, Table 4.3.1.2). However, no trend was noted when the analysis was carried out over the last 20 years, while over the last 10 years there was a significant downward trend ($p=0.036$). Data for the past 5 years were also available for the rivers Vazuga and Keret; with these rivers included there was no common trend in the data sets ($p>0.1$).

An increasing trend in adult runs to rivers in Scandinavia and southern Europe was shown for last 10 years ($p=0.019$), probably reflecting decreases in the level of exploitation in many areas, but not for the last 5 years ($p>0.1$).

4.3.4 Survival indices

Estimates of marine survival for wild smolts from 6 stocks returning to homewaters (i.e. before homewater exploitation) and for 8 stocks returning to freshwater in 1995 are presented in Tables 4.3.4.1 and 4.3.4.2 respectively. In Table 4.3.4.2, indices of return rates are also provided from autumn 0+ parr; this provides an approximation of marine survival as more than 80% of the juveniles emigrate after only 1 year in freshwater.

Marine survival rates for hatchery smolts are given in Tables 4.3.4.3 (survival to homewaters for 7 stocks) and Tables 4.3.4.4 (survival to freshwater for 7 stocks). The Working Group noted that estimates of return to homewaters are likely to present a clearer picture of marine survival than returns to freshwater because of variation in exploitation in coastal fisheries.

Route regression analyses of trends in survival of wild 1SW fish back to homewaters showed a slight downwards trend for the last 10 years ($p=0.058$), but no trend for the last 5 years ($p>0.1$). For 2SW fish, there was a downward trend over the last 10 and 5 years ($p=0.037$ and $p=0.059$, respectively) (Table 4.3.1.2).

Results for European hatchery smolt releases indicated decreased survival of both 1SW and 2SW fish to both homewaters over the last 10 years ($p<0.05$), while over the last 5 years the only apparent trend was a decrease in the survival of the 2SW fish to homewaters ($p=0.49$) (Table 4.3.1.2).

4.3.5 Summary of status of stocks in the North-East Atlantic Commission area

Reference spawning levels (MBAL) were provided for 7 rivers in the NEAC area. In three of these, egg deposition exceeded MBAL in 1995 and in a fourth it was within 10% of MBAL. Of the five rivers for which data were available for at least 10 years, three had exceed the reference egg deposition level in at least 72% of years while the other two failed to meet their reference levels in at least 77% of the years. The assumption must be made that, if the MBAL levels are correct, then those rivers that failed to meet these levels are under-performing and could increase production substantially.

Examination of the general trends from the analyses carried out in the previous sections suggests that there has been no significant change in smolt production in the North-East Atlantic as a whole. Adult runs in western European rivers appear to be increasing or at least remaining stable, probably due to lower exploitation in recent years.

Survival indices to homewaters for wild 1SW and 2SW stocks showed a downward trend over the past decade. The 2SW stock also showed a decrease over the last 5 years. 1SW and 2SW hatchery stocks showed the same downwards trend in survival to homewaters as the wild stocks.

4.4 Surface Trawl Surveys in the Norwegian Sea

In July/August 1991 the Institute of Marine Research (IMR, Norway) conducted a pair-trawling experiment (two boat trawl) with a surface trawl to catch young herring in the northern Norwegian Sea. Among several other pelagic species, 34 post-smolts and two 1SW salmon were taken as by-catch. This was the first time that post-smolts had been caught in significant numbers in the open sea in the North East Atlantic (Holm, *et al.*, 1996: Holst *et al.*, 1993). A new (one boat) pelagic research trawl was developed at the IMR for scientific surveys of the pelagic fish stocks. This trawl can be rigged for surface trawling (depth 0 to ~25 m), and is currently in use on all IMR pelagic research cruises (Figure 4.4.1).

During a scientific survey for herring in the Norwegian Sea in July/ August 1993 a study was made on whether the new trawl would catch salmon. Thirteen post-smolts and one 1SW salmon were caught. Consequently, investigation of the by-catch of Atlantic salmon post-smolts was included in a large scale ecology study in the Norwegian Sea, the so called "Mare Cognitum Programme" (MCP).

In 1995, the first year of salmon surveys in the MCP framework, attempts were made to catch salmon by otter-board trolling and long-lining with 200 hooks, in addition to the surface trawls; these were deployed from the R/V "Johan Hjort". Although other pelagic species were captured, no salmon were caught by long-line or trolling. A total of 110 post-smolts and six 1SW salmon were caught in the surface trawl hauls. Of the post-smolts, 46 were caught in an area west of Scotland and the Hebrides in June, and 62 were caught in July and 2 in August in an area delineated by 62° and 72°N and 16°E and 7°W (Figure 4.4.2). Two of the 1SW fish were caught in June and 4 in July.

The mean length of post-smolts was greater at more northerly locations, possibly because these areas were surveyed later. The proportion of 1 year smolts was significantly higher in the northern than in southern areas suggesting that a relatively large proportion originated from more southerly countries.

A large international fleet fishing for mackerel with pelagic trawls was observed in international waters just outside the Norwegian EEZ at around 66 ° N while the above survey was conducted. These fisheries occur in an area where the post-smolts are abundant but their effect on salmon is unknown. However, salmon could be taken as by-catch and could escape from the trawls in a damaged condition and subsequently die. The Working Group recommends that steps should be taken to estimate the catches and non-catch fishing mortality of salmon in these fisheries in the NEAC area.

4.5 Changes in Natural Mortality on Salmon Stocks in the North-East Atlantic Commission Area

The Working Group was asked to provide advice on changes in natural mortality on salmon stocks in the NEAC area. Natural mortality was taken to mean all moralities other than those caused by fisheries. No reliable estimates were available on the levels of natural mortality due to particular causes at any stages of the life cycle. There is particular uncertainty about the factors affecting smolts and post-smolts in the first few weeks or months in the sea, when natural mortality is thought to be both high and variable. High marine mortality has been identified for many salmon stocks in the NEAC area in recent years, but the underlying reasons for the increase are not known.

It is important to note that populations have adapted to sustain certain levels of mortality without long term adverse effects. However, many of these natural factors can be influenced by the actions of man and result in normal mortality rates being increased. The Working Group therefore considered those factors which were most likely to cause significant changes in natural mortality over the short or long-term, although it was not possible to say which of these was most likely to have been responsible for recent changes.

Environmental factors - The direct effects of adverse weather conditions on fish populations can often be seen in the short term. Such effects occur due to sudden changes in normal conditions which are outside the range usually experienced by the fish (e.g. abnormally protracted dry period, flash flooding, sudden freezing etc.) Short term effects in weather conditions can also operate indirectly on the fish if they cause profound changes in associated conditions (e.g. food or habitat availability). Long term effects can be observed if these conditions continue or escalate over a sufficient period of time and affect several generations. This includes extended periods of unfavourable marine or freshwater temperatures for migration, growth or development. Environmental anomalies have been identified in a number of NEAC countries which could also account for low marine survival in certain periods.

Habitat limitation: Limitation on the availability of suitable freshwater habitat may cause changes in natural mortality in both the short and longer-term. Habitat degradation, through such factors as acidification, bank erosion and compaction of spawning gravels can lead to significant increases in mortality particularly for the developing juvenile stages and have long-term effects on the productivity of a population. Impoundments in estuaries and freshwater can also have significant effects on migrating fish and can cause significant loss of spawning habitat. The effects of environmental conditions on the availability of suitable marine habitat has been mentioned above.

Diseases and pathogens - Many diseases of salmon are documented and incidences of short-term mortality have been described, however the long-term effects on populations is not clearly established. Again, it is probable that these factors operate on all populations without usually causing population collapses. One examples of a disease which caused significant population changes is UDN which depleted 2SW stocks in many rivers in the NEAC area in the 1970's. In addition, *Gyrodactylus* was responsible for the loss of salmon populations in Norwegian and is also an example of how accidentally introduced pathogens can cause profound effects on wild salmon. However, diseases which have a less dramatic effect may be very difficult to detect in wild populations. The effects of large concentrations of salmon in farm cages on disease incidence in wild fish is not known.

Predation - Predation is a normal part of the salmon life cycle. Operating in the short term, heavy predation can lead to significant mortality on any life stage of salmon. In the longer term, if predator population sizes are increasing then changes in salmon populations could occur if there is a corresponding increase in predation.

The predators for which there is some information available and which appear to cause most concern in the NEAC area are seals and cormorants. Other predators have also been identified as potential threats to salmon (e.g. fin whales and sharks in the Faroes, gulls in Norway and Sweden). In Norway predation rates of 25% have been estimated by cod on Norwegian salmon smolts. In UK(Scotland), concerns have been expressed over the possible impact of herons and sawbill ducks. Studies have shown that sawbill ducks take parr and smolts, but there is little information available on the overall impacts.

Three species of seal are believed to prey on salmon in the NEAC area, but the rate of predation is unknown. Seals are known to interact with fishing gears and to enter freshwater in search of food.

Harp seals: Harp seals have a wide range of distribution in the Norwegian sea and recent tagging studies have shown a substantial migration to and from the ice edge in the area between Greenland to Jan Maya and the area north west of the Faroes and south of the Faroes. Harp seals are known to migrate through the area north-west of the Faroes when the salmon fishery is taking place.

Harbour seals: Harbour, or common, seals (*Phoca vitulina*), of which there are five subspecies described , occur throughout the northern hemisphere. According to Anderson (1990), the world population of common seals is thought to be around 500,000 animals. In the eastern Atlantic, there are approximately 100,000 common seals. The size of the total British population common seal population was estimated to be at least 24,950 in 1990 (Hiby *et al*, 1992).

Grey seals (*Halichoerus grypus*) have a more restricted distribution and are thought to be limited to the Atlantic Ocean. Tagging and tracking studies have shown that they can migrate over long distances (Thompson *et al.*, 1991). Seals tagged in the UK have been recovered in Irish waters and Norway and are regularly seen around oil rigs in the North Sea. The total world population of grey seals is approximately 200,000 - 250,000 animals (Anderson, 1990). Surveys have indicated that grey sea populations in the UK have continued to increase since the 1970's at an average rate of 4-5%. The British population at the start of the 1990 pupping season was estimated to be 85,100 (NERC, 1992). Of these, 78,000 or 92% of the total is associated with breeding sites in Scotland. The equivalent estimates for 1989 are 79,400 giving an increase in the population of 7.3%.

Cormorants: Recent data have indicated an increase in populations of cormorants in many parts of Europe. For example, information from Ireland shows that breeding populations have increased from 1,865 breeding pairs in 1969/70 to 4,455 pairs in 1985/86. The total number of birds, including non-breeding juveniles is estimated at approximately 8,000 in Ireland and 2,400 in UK (N. Ireland). The increase is likely to be due to a reduction in human interference as cormorants have been protected, and increased availability of winter foods (mainly roach and other coarse fish) in inland waters. Cormorants are known to frequent inland waters where there are few, if any, coarse fish species and the only species present are salmonids and eels. Work carried out on the Bush (Kennedy and Greer, 1988) have suggested that predation levels on wild smolts can be high (51-66%) over the short time of the smolt run. Brown trout were also found to be important in the diet. A recent investigation carried out on the River Shannon has indicated that the rate of predation by cormorants on migrating salmon smolts is probably low.

4.6 Data Deficiencies and Research Needs for the North East Atlantic Commission Area

1. The Working Group supports the continuation of the research fishing programme in the Faroes area and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North East Atlantic.

2. Norwegian scientists have obtained important preliminary information on the distribution of post-smolts in the North East Atlantic area. Continued and enhanced efforts should be made by all parties to provide more information on post-smolt biology.

3. Spawning targets still have to be developed for the majority of salmon rivers in the NEAC area. To facilitate this more information is required on juvenile production in rivers based on fry/parr surveys and smolt counting. More effort is also needed in quantifying habitat types in order to use spawning targets derived from rivers which have established stock and recruitment relationshiops to rivers where this information is not available.

4. Further work should be conducted on methods for discriminating farm origin and reared salmon in catches, with particular reference to the use of intra-abdominal lesions. (See Section 7.3).

5. Information on fishing effort should be collected in more fisheries in order to develop time series of CPUE data.

6. Estimates of unreported catches should be improved for all fisheries.

7. The estimates of pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area should be improved and possible relationships with environmental variables should be investigated.

5 FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA

5.1 Description of Fisheries

5.1.1 Gear and effort

Canada

The 23 areas for which the Department of Fisheries and Oceans manages the salmon fisheries directly are called Salmon Fishing Areas (SFA) (Figure 5.1.1.1). For the province of Québec, management is delegated to the Ministère de l'Environnement et de la Faune (MEF) and the fishing areas are designated as Q1 through Q11. Harvests (fish which are killed) and catches (including fish caught and released in recreational fisheries) are categorized in two size groups: small and large. Small salmon in the recreational fisheries refer to salmon less than 63 cm fork length, whereas in commercial fisheries, it refers to salmon less than approximately 2.7 kg whole weight. Large salmon in recreational fisheries are greater than or equal to 63 cm fork length and in commercial fisheries refer to salmon greater than or equal to about 2.7 kg whole weight.

Three user groups exploited Atlantic salmon in Canada in 1995: First Peoples fisheries (Indigenous peoples), commercial fisheries, and recreational fisheries. The following management measures were in effect in 1995.

First Peoples fisheries: In Quebec (Q1 to Q11), First Peoples' food fisheries took place subject to agreements or through permits issued to the bands. The permits generally describe gear and fishing effort limits. In SFAs 1 to 23, food fishery harvest agreements were signed with several First Peoples in 1995. The signed agreements included allocations of small and large salmon. Harvests which occurred both within and outside agreements were obtained directly from the First Peoples. In SFA 23 (outer Bay of Fundy, NB), First Peoples declined a harvest of small salmon because of concerns to conservation. The Conne River (SFA 11) food fishery did not occur in 1994 and 1995 because the expected returns were below the conservation target for the river. Harvest by First Peoples with recreational or commercial licenses are reported under the recreational and commercial harvest categories.

Commercial fisheries: The five-year moratorium which was placed on the commercial fishery in insular Newfoundland in 1992 remained in effect in 1995. In Labrador, commercial fishing quotas and numbers of fishers were decreased. Quotas were assigned by SFA. The opening date of the commercial fishery was delayed in 1995 to July 3 (from June 5 in 1994) to increase the escapement of large salmon to rivers, and closed on October 15, or when the quota was caught. Commercial fisheries in Quebec were active in only two zones, Q9 (June 24 to August 31) and Ungava Bay (Q11) (no close season).

	1989	1990	1991	1992	1993	1994	1995
Labrador							
No. of licenses	610	570	570	495	288	216	213
Quota (t)	N/A	340	295	273	178	92	73.5
Quebec (Q7 to Q9)							
No. of licenses	185	165	152	147	94	90	90
Quota (number)	33,125	29,605	28,359	23,400	15,325	15,225	15,225

Recreational fisheries: Except in Quebec and Labrador, 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 (SFA 15, 16, 23) and Nova Scotia (SFA 18 to 22) with a daily limit of two retained; however SFAs 22 and 23 were closed for fishing. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. For insular Newfoundland (SFAs 3 to 14A), the seasonal bag limit in 1995 was six fish, three small salmon prior to July 31 and three small salmon after that date. After the bag limit was reached in each time period, only hook-and-release fishing was permitted; the daily bag limit was two fish. In Labrador (SFA 1, 2 & 14B), there was no seasonal division of the bag limit but the limit for large salmon was reduced from four in 1993, two in 1994 to one in 1995, with a daily limit of two fish. In Quebec, season and bag limits varied by zone with seasonal limits of seven to ten fish of any size. Just over 73,000 Atlantic salmon recreational licenses were issued in 1995 throughout Atlantic Canada which represented a potential harvest of approximately 494,000 fish, of which 75% would be small salmon.

USA

In the USA, the retention of sea-run Atlantic salmon was prohibited in 1995 (since June 9, 1995, in State of Maine) and the sport fishery was restricted to catch and release. License sales compared to the previous years declined by 20% (from 1,849 to 1,481).

France (Islands of Saint-Pierre and Miquelon)

No new information was available for Saint-Pierre and Miquelon fisheries. In 1994, there were 10 (9 in 1993) professional fishermen using an estimated 9,180 m of surface gillnet and 26 (28 in 1993) licensed recreational gillnet fishermen using an estimated 13,860 m of surface gillnet.

5.1.2 Catch and catch per unit effort (CPUE)

Canada

The provisional harvest of salmon in 1995 by all users was 270 t, a reduction of 24% by weight from 1994. This harvest represented about 72389 small salmon and 33224 large salmon, reductions of 28% and 23% respectively from 1994 harvests (Table 2.1.1).

The dramatic decline in harvested tonnage since 1988 is mostly the result of the large reductions in commercial fisheries effort and, since 1992, the closure of the insular Newfoundland commercial fishery (Figure 5.1.2.1).

The 1995 harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and the size group exploited. Newfoundland reported the largest proportion of the total harvest of small salmon and Quebec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in all the provinces and overall in Canada (79.5%). Commercial fisheries took the largest share of large salmon (61.0%). First Peoples harvested 5.1% (by number) of the total small salmon and 14.1% of the total large salmon harvests in eastern Canada.

	% of provincial harvest			% of eastern Canada	Number of fish
	First Peoples	Recreational	Commercial		
Small salmon					
Newfoundland / Labrador	0.0[1]	81.5	18.5	53.6	38,825
Québec	3.4	49.0	47.5	11.4	8,238
New Brunswick	14.6	85.4	0.0	30.9	22,338
P.E.I.	3.9	96.1	0.0	0.7	507
Nova Scotia	5.8	94.2	0.0	3.4	2,481
Large salmon					
Newfoundland / Labrador	0.0[1]	5.1	94.9	32.4	10,759
Québec	18.1	35.6	46.2	65.4	21,712
New Brunswick	100.0	0.0	0.0	1.7	564
P.E.I.	0.0	0.0	0.0	0.0	0.0
Nova Scotia	100.0	0.0	0.0	0.6	189

[1] First Peoples in Conne River Newfoundland (SFA 11) did not fish in 1995 because of low returns.

First Peoples Fisheries: In Quebec, First Peoples food fisheries took place subject to agreements or through communal licences. There are nine native bands with food fisheries in addition to the fishing activities of the Inuit in Ungava. The permits generally describe gear and fishing effort limits but not catch limits. In the Maritimes and Newfoundland, food fishery harvest agreements were signed with several First Peoples in 1995. The signed agreements included allocations of small and large salmon. In many cases, harvests were less than the allocations. Harvests which occurred both within and outside agreements were obtained directly from the

First Peoples. In SFA 23 (outer Bay of Fundy, NB), First Peoples declined a harvest of small salmon because of concerns to conservation. The Conne River (SFA 11) food fishery did not occur in 1994 and 1995 because the expected returns were below the conservation target for the river. Harvest by First Peoples with recreational or commercial licenses are reported under the recreational and commercial harvest categories.

First Peoples harvests in 1995 (by weight) were 78% of the previous year's harvest and 10% below the previous 5-year average harvest. The proportion of the harvest composed of large salmon remained unchanged relative to previous years.

	Year						
Harvests	1989	1990	1991	1992	1993	1994	1995
Weight (t)	30.4	31.9	29.1	34.2	42.6	41.7	32.3
% Large by weight	85%	78%	87%	83%	83%	83%	82%

Recreational Fisheries: Harvest in recreational fisheries in 1995 totalled 65,862 small and large salmon, the second lowest recorded since 1974 (Figure 5.1.2.2). Small salmon harvests were 12% less than the previous five-year mean while large salmon harvests were the lowest ever at 8286 fish. Small salmon harvests have contributed more than 86% of the total harvests of both size groups since the imposition of hook and release recreational fisheries in the Maritime and Insular Newfoundland fisheries in 1984.

Reported harvests in all regions represent a small fraction of the potential harvests if all recreational license holders had caught the maximum allowed.

Province	Number of licenses[1]	Number of tags[2]	Size category of fish	Potential Harvests	Reported Harvests[1]	% of Potential
New Brunswick	30,500	8	Small	216,000	19,076	9%
Nova Scotia	4700	8	Small	38,000	2,337	3%
Prince Edward Island	633	7	Small	4431	487	11%
Newfoundland & Labrador	22,200	6	Small & Large	133,200	32,183	24%
Quebec	<15,000	7	Small & Large	102,000	11,779	12%

[1] License sales and reported harvests for 1995 are preliminary

[2] Number of tags issued with a full-season recreational license. Fewer tags are issued for different classes of non-resident licenses.

Recreational catches (including retained and released fish) by fishing area in 1995 were variable and generally less than the catches reported in most of the previous ten years (Figure 5.1.2.3).

Catches of small salmon were generally above the previous ten-year average in Labrador, the northeast coast of Newfoundland (SFA 1 to 11, 14) but down throughout Quebec, New Brunswick, Nova Scotia and Prince Edward Island (PEI). Catches in PEI (SFA 17) were above average but more than 90% of the returns originate from smolt stocking programs. Catches of large salmon in New Brunswick, Nova Scotia, PEI and Québec were down from the average, but catches were among the highest in the last 10 years in western Newfoundland and Labrador (SFA 1, 2, 13, 14).

Because of the changes which have occurred in the management of the recreational fisheries since 1984, the use of angling catches as indices of abundance has been seriously compromised. Therefore, the interpretation of trends in abundance relies mostly on rivers where returns have been estimated or completely enumerated. As well, in 1995, rivers in several SFA were closed to angling for all or part of the season as a result of low stock abundance or low water and high temperatures (see regional summaries).

Commercial Fisheries: The commercial harvest in Labrador and Quebec in 1995 declined to less than 100 t from a peak of more than 2,400 t in 1980 (Figure 5.1.2.4). Commercial harvest in Labrador was the lowest ever (55 t) but large salmon made up the second highest proportion of the harvests since the introduction of quotas in 1990. For Quebec, the harvest and the proportion large salmon in the commercial fishery continued to decline in 1995.

	1989	1990	1991	1992	1993	1994	1995
Labrador							
Licensed effort	610	570	570	495	288	213	213
Quota (t)	N/A	340	295	273	178	92	73.5
Harvest (t)	330	202	120	204	112	93	55
% Large (by number)	46%	45%	33%	57%	50%	64%	59%
Quebec (Q7 to Q9)							
Licensed effort	185	165	152	147	94	90	90
Quota (number)	33,125	29,605	28,359	23,400	15,325	15,175	15,175
Harvest (number)	20,790	19,517	19,653	19,700	14,869	14,240	13,653
% Large (by number)	87%	82%	83%	80%	75%	72%	71%

USA

Due to regulations in effect, there was no harvest of sea-run Atlantic salmon in the USA in 1995. The number of salmon caught and released was estimated at 370 fish, a 41% increase over the previous year. Most of the increase occurred in the Penobscot River where 300 fish were caught compared to 182 in 1994.

France (Sainte-Pierre and Miquelon Island)

The harvest of salmon by commercial nets is estimated to have been 414 kg. There is no estimate of the harvest by recreational fishermen using gillnets.

5.1.3 Origin and composition of catches

In the past, salmon from both Canada and USA have been taken in the commercial fisheries of Labrador. No tags of USA origin were reported from this fishery in 1995.

Stochastic Analysis of historical tag returns

A persistent problem in evaluating harvest and exploitation estimates derived from Carlin tag data has been the doubt about the precision levels associated with these estimates. Monte Carlo simulation offers the means to evaluate the robustness of model parameters and the assumptions associated with model formulation. The Working Group considered an assessment of US Carlin tag return data with two major changes to the way the assessment has previously been conducted (Anon. 1987/Assess:12; Anon. 1989/Assess:12). First, the model was simplified by basing the assessment on tags and returns for the Penobscot River only. Other rivers in Maine, previously included in the model, simply added many poorly estimated model parameters which undoubtedly eroded model precision. Second, the model was transported into a risk modelling package (AtRisk) which allows for random resampling of parameters based on empirically estimated distributions. This type of assessment yields empirically derived confidence intervals and characterises parameter sensitivity.

The equations used to estimate harvests and extant exploitation of Penobscot origin salmon are the same as used previously for Maine origin salmon (Anon. 1987/Assess:12; Anon. 1989/Assess:12). Formulas to estimate numbers of tagged and untagged fish in homewater runs, and thus the RATIO parameter, have been modified to include data from the Penobscot River only and thus exclude data and parameters used to estimate abundance for other Maine rivers. The immediate effect of this is to reduce estimates of run size and harvest. Though the harvest raising formulae have not been modified, variables for tag recovery now only include counts for Penobscot tags, (i.e. the formula is the same but the exact meaning of the variables has changed to accommodate the removal of data for other Maine rivers).

The input data now represent a subset of previous run and tag counts since they are for the Penobscot only. Homewater tag, angler, and trap counts for 2SW and 3SW salmon, and tag returns by fishery region and sea age can be found in Table 5.1.3.1. Time series of the scalars used to represent changes in reporting rate attributable to the NASCO lottery and comparisons with Canadian catch rates can be found in Table 5.1.3.2. These adjustments reflect the reporting rate time series agreed by the Working Group (Anon. 1995/Assess:14). The balance of the model parameters are input as uniform distributions (Table 5.1.3.3). A sensitivity analysis was carried out by regressing output values to input parameters and by rank correlation of the two variables for each year. To summarise the data, the mean rank for each model parameter was computed.

The harvest model revealed surprisingly high levels of precision. Total harvest of the non-maturing component was as high as 5,000 fish, and despite these high harvest levels, empirically derived 95% confidence intervals were only of the order of ±500 fish (Figure 5.1.3.1). As harvests have declined in recent years so have the widths of the confidence intervals suggesting that even small harvests, based on low tag returns, are estimated with high precision. The estimated harvests in Greenland have exceeded those observed in Canada (Figure 5.1.3.2) and the 1993 harvest in Greenland appears to be well estimated.

In the present model formulation, passage efficiency and reporting rate in Greenland rank as the most important parameters in the exploitation rate model (Table 5.1.3.4). These two scaling parameters have a direct effect on the RATIO value and exploitation rate numerator, respectively. Also of importance were tag loss rate, non-catch fishing mortality in Greenland, and reporting rate in Newfoundland. Rates associated with Greenland harvest overshadow rates used to characterise Canadian harvests because the Canadian harvests are computed in two stages; different parameters are use in Newfoundland and Labrador. Homewater reporting rates are imbedded in RATIO calculation and are overshadowed by the magnitude of the trap catch data, thus, their effect is minimal. Model sensitivity should also be examined with proportional scaling of all parameters which was not done in this particular model formulation.

Origin of returns in 1995

Fish designated as being of wild and naturalised origin comprise those fish that are 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. (see Section 12) Hatchery origin fish, designated as fish introduced into the rivers regardless of life stage, were identified on the basis of the presence of an adipose-clip, from fin deformations, and/ or from scale characteristics. Not all hatchery fish could be identified as such in the returns because of stocking in the early life stages. Aquaculture escapees were identified from hatchery fish on the basis of fin erosion (especially of the tail) and from scale characteristics.

The returns to the majority of the rivers in Newfoundland and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon (Figure 5.1.3.3). Hatchery origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy and the Atlantic coast of Nova Scotia. Aquaculture escapees were sampled from the returns to several rivers of the Bay of Fundy (St. Croix, Magaguadavic, Saint John, Stewiacke, Gaspereau) and in the Conne River, Newfoundland as well as in at least one river from the Bras d'Or Lakes of Cape Breton (Baddeck River). Other salmonid aquaculture escapees, rainbow trout from the Bay d'Espoir aquaculture industry, were observed at Conne River. Cage-reared Big Salmon River salmon (SFA 23) were released into the Big Salmon River and in the Petitcodiac in the fall of 1995 to augment the natural spawning; as in 1994, these releases were greater than the estimated returns of wild salmon to the Big Salmon River.

The proportion of aquaculture origin salmon in catches on the Magaguadavic River from 1992-95 is shown in Table 5.1.3.5 with run information from earlier years for comparison. The proportion in 1995 continues the high values observed in 1994 with approximately 90% of the salmon catch originating from aquaculture escapees.

5.1.4 Exploitation rates in Canadian and USA fisheries

Canada

Within eastern Canada salmon were exploited by three user groups: First Peoples, recreational anglers, and commercial interests. The harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and category (small salmon or large salmon) being exploited. Exploitation rates can be estimated by dividing the catches by the sum of the estimated returns of small and large salmon to the rivers of Atlantic Canada and the Newfoundland-Labrador catches of small and large salmon. Calculated in this manner, the exploitation rate on all small salmon in eastern Canada was between 0.17 and 0.38 and for large salmon, between 0.25 and 0.44.

First Peoples fisheries: The harvest of salmon in eastern Canada by First Peoples in 1995 totalled 3,710 small salmon and 4,687 large salmon. The exploitation rate for small salmon in eastern Canada by the First Peoples was between 0.01 and 0.02 and for large salmon the rate of exploitation was 0.04 and 0.06.

Recreational fisheries: The recreational harvest of salmon in eastern Canada during 1995 totalled 57,576 small salmon and 8,286 large salmon. The exploitation rate for small salmon in eastern Canada was between 0.09 and 0.20 and for large salmon between 0.06 and 0.11.

Commercial fisheries: The commercial harvest of salmon in eastern Canada during 1995 totalled approximately 11,103 small salmon and 20,251 large salmon (total 31,354). The exploitation rate for small was between 0.03 and 0.06 and for large salmon was between 0.15 and 0.27.

USA

There was no exploitation of USA salmon in USA waters was recorded. There was no salmon of USA origin detected in Canadian catches in 1995.

Historical exploitation of USA origin salmon: Extant exploitation for the Penobscot stock was computed from the Monte Carlo analysis described in section 5.1.3. Extant rates are computed with the same model used in Anon. 1995/Assess:14. Extant exploitation of non-maturing 1SW salmon from the Penobscot stock has generally varied between 0.3 and 0.7 over the time series (Figure 5.1.4.1). Confidence intervals are wider on the exploitation estimates than on the harvest estimates reflecting the increased number of parameters needed in the calculation. Comparing the mean trend in extant exploitation of the Penobscot stock to the 1995 assessment of exploitation of stocks from Maine rivers (including the Penobscot) (Anon. 1995/Assess:14) reveals a distinct time series trend (Figure 5.1.4.2). Agreement between the two estimates increased over time roughly reflecting the reduced role of rivers other than the Penobscot in tags and run sums. The Working Group noted that the parameters used to estimate exploitation rates on the Penobscot stock are more reliable than those for the other Maine rivers.

5.2 Status of Stocks in the North American 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. Assessments are prepared for a limited number of specific rivers, mostly on the basis of the size of the Atlantic salmon resource within the river, the demands by user groups, and as a result of requests for biological advice from fisheries management. The status is evaluated in terms of the returns and escapement relative to the conservation target.

5.2.1 Spawning targets

The spawning targets for USA rivers were reviewed in 1995 (Anon 1995/Assess 14). A review of the targets for Canada was conducted this year and the results are presented in Section 9.1.1. The revised targets for Canada and USA, summarized in Table 9.1.1.1, total 180,495 2SW salmon. The Working Group again recommends that these targets be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

5.2.2 Measures of abundance in monitored rivers

Canada

A total of 73 rivers were assessed in eastern Canada in 1995. Estimates of total returns of small and large salmon were obtained using various techniques; 46 were derived from counts at fishways and counting fences, 7 were obtained using mark and recapture experiments, 2 using fence counts and spawner redd counts, 13 using visual counts by snorkeling or from shore, 1 from an acoustic system, and 4 from angling catches. For 56 of these rivers data were also available for 1994. The comparisons between returns in 1995 and 1994 are summarized in the table below. Both small and large salmon tended to be higher in the rivers in Newfoundland and Labrador in

1995, whereas large salmon were lower or unchanged in the Bay of Fundy and Atlantic coast of Nova Scotia. There was no clear trend for small or large salmon returns in the rivers in the Gulf of St. Lawrence and Québec in 1995.

		Number of rivers in each category		
		Returns in 1995 relative to returns in 1994		
Size group	Total	<90%	90% to 110%	> 110%
Bay of Fundy, Atlantic coast of NS (SFA 19 to 23)				
Small + Large	14	6	2	6
Small	9	3	1	5
Large	9	4	4	1
Southern Gulf of St. Lawrence and Québec (SFA 15 to 18, Q1 to Q10)				
Small + Large	23	11	3	9
Small	21	9	7	5
Large	21	7	5	9
Insular Newfoundland and Labrador (SFA 1 to 14)				
Small + Large	19	3	4	12
Small	19	3	4	12
Large	19	5	5	9

Fewer rivers, 28 in eastern Canada, have had returns enumerated each year since 1985. With the exception of the Newfoundland and Labrador rivers, the returns in 1995 in eastern Canada were generally among the lowest observed in the time series (Table 5.2.2.1). For the rivers of Newfoundland and Labrador, large salmon and small salmon returns were among the highest in the last 11 years. Large salmon returns in the Gulf of St. Lawrence and Québec were at median levels whereas small salmon returns were among the lowest. In all areas of eastern Canada, except Newfoundland / Labrador, the returns in 1995 were generally among the lowest since 1990. In Newfoundland and Labrador, returns of large salmon were the highest observed in the last six years in more than half the rivers assessed.

Annual returns of salmon to rivers (sizes combined) are available for 28 rivers in Atlantic Canada since 1984 (Figure 5.2.2.1). These returns do not account for commercial fisheries removals in Canada and Greenland and in some rivers include returns from hatchery stocking. Returns after commercial fisheries have varied between 141,000 and 288,000 fish with a peak return year in 1992, but the 1995 value was one of the lowest in the time series.

The returns of salmon differentiated into small and large size categories have been estimated for 22 rivers within four geographic areas of Canada. Peak return years differed for regions within eastern Canada: 1993 for Newfoundland rivers, 1988 for Québec rivers, 1992 for southern Gulf of St. Lawrence rivers and 1984 for the Bay of Fundy / Atlantic coast region. (Figure 5.2.2.2). The substantial reductions in the commercial exploitation since 1992 has produced a noticeable improvement in the returns of small and large salmon to Newfoundland rivers. Returns of small salmon remained unchanged since 1984 but declined in the last two years in the Québec and southern Gulf of St. Lawrence stocks (Gulf). Returns of small and large salmon to the Bay of Fundy / Atlantic coast rivers have declined persistently since 1984.

Where spawning targets have been met or exceeded in recent years, the juvenile abundance in the rivers has increased. Densities of juveniles have been monitored annually since 1971 in the Miramichi and Restigouche rivers (SFA 15 & 16). In these rivers, juvenile 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 escarpment (Figure 5.2.2.3). High densities of juveniles have also been reported from Nova Scotia rivers along the Gulf of St. Lawrence (SFA 18) and in several Cape Breton Island streams (SFA 19). This is in contrast to juvenile densities from an inner Bay of Fundy river (Stewiacke River) which have declined since 1984, as a result of reduced spawning escapement. (Figure 5.2.2.3). Except for the rivers along the eastern and southern shores of Nova Scotia which have been impacted by acid precipitation and rivers of the inner Bay of Fundy, the freshwater production of the monitored rivers in Atlantic Canada has increased or remained constant at high levels since 1985. Rivers along the south and northeastern shore of Nova Scotia (SFA 20 and 21) remain vulnerable to acid precipitation. Populations of Atlantic salmon are considered extinct in 14 rivers and remnant populations survive in 19 other rivers as a result of water quality impaired by acidification.

USA

Documented adult salmon returns to rivers in New England (excluding the Aroostook River in Maine) amounted to 1,751 salmon - a 7% increase from 1994. While returns of 1SW salmon to New England declined by 52% (from 380 to 184), MSW returns increased by 27% (from 1,234 to 1,567). These are minimal estimates, since many of the rivers in Maine do not contain counting facilities, and not all counting facilities are 100% effective at capturing adult salmon.

The majority of the USA returns were recorded in the rivers of Maine, with the Penobscot River accounting for about 76% of the total (1,342 salmon). Salmon returns to the Penobscot River were 29% higher than the previous year, but were 35% lower than the previous 5-year average and 50% lower than the previous 10-year average.

Documented adult salmon returns to Maine rivers in 1995 increased by 20% (from 1,260 to 1,523), as a result of a 47% increase in MSW salmon returns over those observed in 1994. However, there was a 47% decrease in the returns of 1SW salmon to Maine rivers compared to the previous year.

About 11% of the total New England salmon returns (188 salmon) were recorded in the Connecticut River watershed in 1995. This was a 42% decrease (138 fish) from the previous year and was representative of decreases of 36% and 29% from the 5-year and 10-year averages for the Connecticut.

Documented salmon returns to the Merrimack River numbered 34 fish. While this represented a 62% increase (13 fish) from the previous year, the 1995 salmon run was 80% below the 5-year average and 77% below the 10-year average for the Merrimack.

5.2.3 Estimates of total abundance by geographic area

For assessment purposes, SFAs were grouped into the following regions: Labrador (SFA 1, 2, & 14B), Newfoundland (SFA 3-14A), Quebec (Q1-Q11), Gulf of St. Lawrence (SFA 15-18), and Scotia-Fundy (SFAs 19-23). Returns of 1SW and 2SW salmon to each region (Tables 5.2.3.1 and 5.2.3.2; Figures. 5.2.3.1 and 5.2.3.2; and Appendices 4-13b) were estimated by updating the methods and variables used by Rago *et al* (1993) and reported in Anon (1993/Assess 10); the estimates of 1SW returns have been made for the first time for the above regions. The returns for both sea age groups were derived using a variety of methods using data available for individual river systems and SFAs. These methods including 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 (Appendices 4-13b). MSW returns were proportioned to 2SW returns on the basis of sea-age composition of one or more indicator stocks. In the context used here "returns" means the number of salmon that returned to the geographic region. The returns to Newfoundland and Labrador regions includes catches of Newfoundland and Labrador origin salmon caught in homewater commercial fisheries. Returns to Quebec, Gulf of St. Lawrence, Scotia Fundy and USA regions do not include salmon originating in these regions that are caught in Newfoundland and Labrador commercial fisheries.

Labrador: The mid-point of the 1SW salmon returns to Labrador in 1995 was about 44,000, which is the fourth lowest in the time series, 1969 to 1995 (Figure 5.2.3.1, Appendix 5). The abundance of 1SW salmon, 1971-88, have been quite variable with low numbers returning in 1973, 1978, and 1984. The mid-point of the estimated number of returns declined from about 150,000 1SW salmon in 1987 to about 45,000 in 1991 and remained between 41,000 and 63,500 from 1992 to 1995 at a time when the commercial catches was significantly reduced. The estimated mid-point of the 2SW returns to Labrador in 1995 is about 29,000, which is the highest estimate since 1990 (Figure 5.2.3.2, Appendix 4). There was a decline in returns of 2SW salmon from 1980 to 1991, and remained between 20,000 and 29,000 fish from 1992 and 1995. The low returns of 1SW and 2SW in 1991 may be underestimates of the population size since severe ice conditions in that year affected the commercial catch which is used to estimate population size.

Newfoundland: The mid-point of the estimated returns (168,000) of 1SW salmon to Newfoundland rivers in 1995 is similar to the average 1SW returns (171,000) for the period 1992-94 (Figure 5.2.3.1, Appendix 6). The 1992–1995 1SW returns are higher than the returns in 1989–1991, but similar to the returns to the rivers between 1971 and 1988. The mid-point (4,900) of the estimated 2SW returns to Newfoundland rivers in 1995 is slightly higher than in 1994 and 1993 (Figure 5.2.3.2, Appendix 6). The 2SW returns in 1993–1995 are the lowest observed in the time series (1969–1995).

Quebec: The mid-point (18,000) of the estimated returns of 1SW salmon to Quebec in 1995 is a decrease from the returns observed between 1986 and 1994 (Table 5.2.3.1, Figure 5.2.3.1). The mid-point (28,500) of the estimated returns of 2SW salmon to Quebec is the second lowest estimate of returns in the time series (1971–1995) and continues a decline in returns that began in 1989 (Table 5.2.3.2, Figure 5.2.3.2).

Gulf of St. Lawrence SFAs 15-18: The mid-point (60,500) of the estimated returns of 1SW salmon returning to the Gulf of St. Lawrence continues a decline from the high levels estimated in 1992 and is the lowest return estimated since 1984 (Table 5.2.3.1, Figure 5.2.3.1). The mid-point (41,500) of the estimate of 2SW returns is slightly higher than the estimate for 1994. The average return of 2SW salmon for 1992–1995 is slightly higher than the average for 1987–1991 and may reflect the reductions in fishing mortality due to the closure of the Newfoundland commercial fishery (Table 5.2.3.2, Figure 5.2.3.2).

Scotia-Fundy, SFAs 19-23: The mid-point (14,000) of the estimate of the 1SW returns to the Scotia-Fundy Region is slightly higher than the 1994 estimate; however it is the second lowest observed since 1972 (Table 5.2.3.1, Figure 5.2.3.1). The decline in returns began in 1991. The mid-point (7,000) of the 2SW returns is slightly higher than the returns in 1994; however it is the second lowest observed in the time series, 1971–1995 (Table 5.2.3.2, Figure 5.2.3.2). A continual decline in returns has been observed since 1985.

USA

Returns of 1SW salmon to USA rivers for the period 1971-1995 were estimated in the same manner as returns of 2SW salmon (Anon 1989/Assess 12). In the State of Maine, reporting rates of 0.9 (for Carlin tagged salmon) and 0.8 (for untagged salmon) were used for 1SW salmon taken in the sport fishery; and a 0.85 fish passage efficiency was used for the Penobscot River trapping facilities. For southern New England rivers, actual counts of 1SW salmon were utilized. Maine and southern New England returns were summed to obtain the total estimated 1SW returns to USA rivers. Returns of 2SW salmon to Maine rivers in 1995 were estimated by summing documented returns to counting facilities. Counts of Penobscot River salmon were adjusted using a 0.85 fish passage efficiency. Since the harvest of salmon is no longer permitted in Maine, and many rivers do not contain fish counting facilities, run sizes for several small rivers in Maine continue to be underestimated.

The total estimated 1SW returns to USA rivers in 1995 is 213 fish, which is the lowest estimated figure since 1978 (Table 5.2.3.1, Figure 5.2.3.1). The estimated 2SW returns to USA rivers is 1,717 fish which is slightly higher than the estimated 1994 returns (Table 5.2.3.2, Figure 5.2.3.2). However, the 1995 estimate of 2SW returns is the second lowest since 1976.

North America: The mid-point estimate of the total number of 1SW salmon returning to North America in 1995 (300,000) is slightly lower than the estimate for 1994 and is the lowest observed in the time series, 1971-95 (Table 5.2.3.1). However, the estimates of returns are quite variable up to 1988 and subsequently decline to the 1995 level. The mid-point of the estimated 2SW returns (117,000) is similar to the total returns for 1993 and 1994 but has declined from about 200,000 in the late 1970s.

5.2.4 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 the fishery area exploitation rates for West Greenland. The data required to estimate exploitation rates are also used to estimate pre-fishery abundance, which serves as the basis of abundance forecasts used in the provision of catch advice. On the basis of a recommendation by the Working Group in 1995, the time series was extended to include the years 1971–1973 and 1SW salmon were included for the first time. The catch statistics used to derive returns and spawner estimates have been updated from those used in Anon., 1995/Assess:14. (Table 5.2.4.1).

Non-maturing 1SW salmon

The non-maturing component of 1SW fish destined to be 2SW returns is represented by the pre-fishery abundance estimator for year i designated as [NN1(i)]. Definitions of the variable are given in Table 5.2.4.2. It is constructed by summing 2SW returns in year i+1 [NR2(i+1)], 2SW salmon catches 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)]. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the back-calculated 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. 5.2.4.1 $$NN1(i) = (NR2(i+1) / S1 + NC2(i+1))/S2 + NC1(i) + NG1(i)$$

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.* (1993).

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. Thus, 1993 and 1994 catches used in the run-reconstruction model for the West Greenland fishery and Newfoundland fishery were set to zero in order to remain consistent with catches used in other years in both of these areas (see Section 5.1.1).

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 1994. The minimum and maximum values of the catches and returns for the 2SW cohort are summarized in Table 5.2.4.3. The 1994 abundance estimates ranged between 102,000 and 181,000 salmon. The mid-point of this range (141,000) is only slightly higher than the 1993 value (140,000) which is the lowest in the 20 years time series (Figure 5.2.4.1). The results suggests at best a levelling off of the decline, and pre-fishery abundance remains at historic low levels. The Working Group expressed concern about the continued decline in estimates of pre-fishery abundance and its impact on spawner levels.

The low numbers observed in 1978 and 1983–1984 were followed by large increases in pre-fishery abundance. However, if the data are divided into sets above and below the 24 year mean, the likelihood of a poor year (i.e. below mean) being followed by a good year (i.e. above the mean) is low as illustrated in the following table:

	Pre-fishery abundance in year i+1	
Pre-fishery abundance in year i	Poor	Good
Poor	9	2
Good	3	9

These results suggest that salmon abundance tends to persist in "poor" and "good" states for several years. Moreover, the likelihood of reversing from poor to good in a single year appears to be about 20%.

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. Since 1993, the Working Group has been providing estimates of pre-fishery abundance estimates of non-maturing 1SW salmon, and these have been used for providing catch advice and investigating the relationships between survival in freshwater and the sea, changes in population characteristics, and spawning stock levels. With this in mind, it was recommended that estimates should also be made of maturing 1SW salmon. This would provide estimates of the total stock size of all sea age groups.

The commercial catches in Newfoundland and Labrador are reported as numbers and weight of fish in "small" and "large" size categories. Salmon less than 2.7 kg whole weight are graded as small; salmon >2.7 kg are graded as "large". 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 Anon. 1991/Assess:12. The "large" category in SFAs 1-7,14B consists of 0.1 - 0.3 1SW salmon (Rago *et al.* 1993; Anon. 1993/Assess:10). Salmon catches in SFAs 8-14A are mainly maturing salmon (Idler *et al.* 1979).

The maturing component of 1SW fish destined to be grilse returns 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 Atlantic Canada and catches in year i from fisheries on maturing 1SW salmon in Newfoundland and Labrador [MC1(i)]. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the back-calculated numbers between the fishery on 1SW salmon and returns to the rivers (1 month) as shown below:

Eq. 5.2.4.2. $MN1(i) = MR1(i) / S1 + MC1(i)$

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

Eq.5.2.4.3 $MC1(i) = [(1\text{-}f\_imm)(H\_s(i)_{\{1\text{-}7,14b\}} + q{*}H\_l(i)_{\{1\text{-}7,14b\}})] + H\_s(i)_{\{8\text{-}14a\}}$

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, 1993 and 1994 catches used in the run-reconstruction model for the Newfoundland fishery were set to zero in order to remain consistent with catches used in other years in both of these areas (see Section 5.1.1).

The minimum and maximum values of the catches and returns for the 1SW cohort are summarized in Table 5.2.4.4 and the mid point values are shown in Figure 5.2.4.1. The mid-point of the range of pre-fishery abundance estimates for 1995 (311,000) is about the same as that of 1994 (315,000). Estimates for 1994 and 1995 decreased markedly below the previous two years. The low values observed in 1978 and 1983–1984 were followed by large increases in pre-fishery abundance. However, if the data are divided into sets above and below the 20 year mean, the likelihood of a poor year (i.e. below mean) being followed by a good year (i.e. above the mean) is low as illustrated in the following table:

	Pre-fishery abundance in year i+1	
Pre-fishery abundance in year i	Poor	Good
Poor	9	3
Good	3	9

These results suggest that salmon abundance tends to persist in "poor" and "good" states for several years. Moreover, the likelihood of reversing from poor to good in a single year appears to be about 25%.

Total 1SW recruits (maturing and non-maturing)

Figure 5.2.4.2 shows the pre-fishery abundance of 1SW maturing and 1SW non-maturing salmon from North America for the period 1971 to 1994 and Figure 5.2.4.3 shows these data combined to give the total 1SW recruits to the fisheries. The steady decline in recruits over the last 10 years is alarming. The Figure 5.2.4.2 also shows the steady increase in the proportion of the North American stock maturing as 1SW fish. This proportion has risen from about 45% at the beginning of the 1970s to around 70% in the last three years. The Working Group expressed serious concerns about these stock trends.

5.2.5 Spawning escapement and egg deposition

Canada

Egg depositions exceeded or equalled the specific river targets in 22 of the 73 rivers which were assessed and were less than 50% of target in 22 other rivers (Figure. 5.2.5.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 12 rivers assessed had egg depositions which were less than 50% of target.

Escapements over time relative to targets have improved in some areas of Atlantic Canada but have declined in others (Figure 5.2.5.2). The Bay of Fundy/Atlantic coast of Nova Scotia rivers status has declined. Most of the rivers received egg depositions in 1994 which were less than half of the target whereas in previous years, some of these rivers met or exceeded target, the most important example being the Saint John River (SFA 23). In spite of having received egg depositions which were greater than 50% of target, returns to the Bay of Fundy rivers continue to decline or stay low. For these rivers, the spawning stock is not replacing itself, the causes of which remain uncertain. In the Gulf of St. Lawrence, the number of rivers which received egg depositions less than 50% of target has increased since 1992. In the major river, the Miramichi (SFA 16), target egg deposition has been exceeded in 8 of the last 10 years. An improvement in egg depositions in Newfoundland has been noted in recent years; during 1989 to 1991, more than 50% of the rivers assessed received less than 50% of the target egg requirements.

Run Reconstruction estimates of spawning escapement

Estimates for 2SW spawners were derived in Anon., 1993/Assess:9 and updated at the current meeting for the six geographic regions referenced in Section 5.2.2 (Table 5.2.5.1). Estimates of 1SW spawners, 1971-95 are provided in Table 5.2.5.2. These estimates were derived by subtracting the in-river removals from the estimates of returns to rivers. A comparison between the numbers of spawners, returns and spawning targets for 1SW and 2SW salmon are shown in Figures 5.2.3.1 and 5.2.3.2 respectively (there are no spawning targets for 1SW salmon).

Labrador: The mid-point of the estimated numbers of 2SW spawners (23,900) in Labrador in 1995 is the highest estimated spawning escapement during the period 1971-95 and approximates 69% of the total 2SW spawner requirements for all rivers in Labrador (Figure 5.2.3.2). The 2SW spawning escapement declined during the period 1980 to record low levels in 1991. Subsequent to 1991 the spawning escapement appears to have increased each year, which is consistent with increasing restrictive management measures in the commercial fisheries. The spawning escapement of 1SW salmon have remained relatively constant at fairly low levels since 1990 (Figure 5.2.3.1).

Newfoundland: The mid-point of the estimated numbers of 2SW spawners (4,900) in Newfoundland, in 1995 is 120% of the total 2SW spawner requirements for all rivers. This year is the second time that the spawner target has been met since 1984 (Figure 5.2.3.2). The mid-point of the estimates of 1SW spawners in 1995 is slightly higher than the estimate for 1994 (Figure 5.2.3.1). There has been a general increase in both 2SW and 1SW spawners during the period 1992-95 and is coincident with the closure of the commercial fisheries in Newfoundland.

Quebec: The mid-point of the estimated numbers of 2SW spawners (18,400) in Quebec in 1995 is 30% of the total 2SW spawner requirements for all rivers (Figure 5.2.3.2). The spawning escapement in 1995 is the lowest number estimated since 1979. Estimates of the numbers of spawners in Quebec have consistently been about one third of the spawner target over the time series (1971-95). The estimated 1SW spawners declined in 1995 (Figure 5.2.3.1).

Gulf of St. Lawrence: The mid-point of the estimated numbers of 2SW spawners (32,100) in Gulf of St. Lawrence in 1995 is 105% of the total 2SW spawner requirements for all rivers in this region (Figure 5.2.3.2). The spawner targets have been exceed for the past six years. The spawning escapement of 1SW salmon declined in 1995 for the third consecutive year and is the lowest observed since 1984 (Figure 5.2.3.1).

Scotia Fundy: The mid-point of the estimated numbers of 2SW spawners (6,700) in Scotia Fundy area, in 1995, is 31% of the total 2SW spawner requirements for all rivers in this region (Figure 5.2.3.2). The estimated number of 2SW spawners in 1995 is slightly higher than in 1994, but is the second lowest since 1983. The 2SW spawning escapement has been declining since 1985. The 1SW spawners in 1995 is also slightly higher than the 1994 escapement and has been declining since 1990 (Figure 5.2.3.1).

The overall target for Canada could have been met or exceeded in only 3 of the past 21 years (considering the mid-points of the estimates) (1974, 1977, 1980). In the remaining years, spawning targets could not have been met even if all in-river harvests had been eliminated.

USA

The estimated 2SW returns (1,717) to rivers in the USA, in 1995, is 6% of the target spawner requirements for the total of all USA rivers (Figure 5.2.3.2). The number of spawners in 1995 is slightly higher than that estimated for 1994, but is the second lowest observed since 1979. There were an estimated 213 1SW spawners in 1995 and is the lowest level observed since 1978 (Figure 5.2.3.1).

The estimated spawning escapement in the Penobscot River in 1995 was about the same as in 1994 (5% of target). Attainment of spawning targets for the Connecticut and Merimack rivers were also similar to recent previous years (< 2 %).

Figures 5.2.5.3 and 5.2.5.4 show releases of hatchery-reared fry, parr and smolts in USA rivers since 1980 and documented adult salmon returns during the same period. Releases of smolts in New England rivers during 1995 declined to levels experienced in the early 1980's, while releases of fry continued to increase (to more than 11 million). Adult returns from the increased emphasis upon fry stocking should be seen in the 1997-1999 adult returns to USA rivers.

Escapement variability in North American stock complexes

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 pre-fishery abundance taking into consideration the 11 months of natural mortality at 1% per month. These values, along with total North American 2SW returns, spawners and targets are shown in Figure 5.2.4.1 and indicate that the overall North American spawner target could have been met in all years except 1993 and 1994. The difference between the projected returns and actual 2SW returns reflect the extent to which fisheries at West Greenland and in SFAs 1-14 have reduced the populations. The difference between the actual 2SW returns and the spawner numbers reflects in-river and coastal removals.

In 1994, the Working Group (Anon. 1994/Assess:16) undertook a preliminary analysis of the effects of escapement on potential fishery yield. It was noted that the stock-recruitment relationship ultimately defines the sustainable level of harvesting and its expected variability over time, although spawning stock size is often not a significant variable in models relating recruitment to stock and environmental variables. The establishment of strong correlations between recruits and an environmental variable is sometimes used to support the notion that spawning stock size is unimportant. However, it was concluded that if environmental variability regulates survival in a density-independent fashion, then the importance of stock size is enhanced.

Following on the technique outlined in Anon. 1994/Assess:16 and Anon. 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. 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). Since the 1995 2SW spawners to North America are known, the spawning stock contributing to the pre-fishery abundance up to 1998 is known. The estimates of the 2SW lagged spawners to each geographic area in North America are used in the assessment in Section 9.2.

The relative contribution of the stocks in the geographical areas to the total spawning escapement of 2SW salmon has varied over time. The reduced potential contribution of Labrador and the increasing importance of the spawning stock from the Gulf rivers to future recruitment is most evident (Figure 5.2.3.2).

Spawning escapement to several stock complexes has been well below target (Labrador, Scotia-Fundy, Quebec and USA) and decreasing (Scotia-Fundy, Quebec and USA) since the late 1980s (Figure 5.2.3.2). Thus abundance of non-maturing 1SW salmon would not be expected to increase dramatically in most areas of North America even if the sea survival improves. Only the Gulf stock complex has received spawning escapement which has been close to target, all other stock complexes are well below target and some have declined even further.

5.2.6 Survival indices

Canada

Counts of smolts are available from 6 rivers in Newfoundland, 3 rivers from Quebec, and 2 tributaries of rivers in the Maritime Provinces. These provide direct measurements of the outputs from the freshwater habitat. Annual smolt output from a river can vary by five times but in the counts for entire rivers, smolt output has generally varied in magnitude by about a factor of two.

Generally, the number of smolts leaving the rivers depends upon the number of eggs deposited. The production among river systems is also not necessarily synchronized and it is not possible to calculate how many smolts in total leave the rivers of Atlantic Canada for any given year. Data from the six rivers for which estimates smolt output area available for the last five years, indicate that in 1995, the smolt numbers were similar to the previous five-year average, except for St. Jean River where smolt output was at 50% of the previous five-year average output.

Counts of smolts and adult salmon returns enable estimates of marine survival to be derived. Examination of trends over time provide insight into the impact of changes in management measures or other factors that can influence the production of salmon. Information from 11 rivers in Atlantic Canada with smolt counts and corresponding adult counts are available; 3 are hatchery stocks and 8 are wild populations. Geographically, populations for which data were available ranged from the Saint John River (SFA 23- Bay of Fundy) in the south, La Have River (SFA 21) and Liscomb River (SFA 20) along the Atlantic coast of Nova Scotia, Saint Jean (Q2) in the Gaspé region, de la Trinité (Q7) in the Quebec north shore, Bec-Scie (Q10) in Anticosti Island, and other populations from southern (SFAs 9 and 11), eastern and northern Newfoundland (Figure 5.2.6.1).

In general, survival of hatchery stocks is lower (avg. by river over all years from 1.13% to 1.38%) than that of wild stocks (avg. over all years of 1.53% to 5.44%). Similarly, survival of hatchery stocks is more variable (C.V. from 64.4% - 74.6%) than wild stocks (C.V. from 19.7% - 52.5%). The three hatchery stocks from the Bay of Fundy / Atlantic coast of Nova Scotia show a declining trend in survival over time which has become particularly acute in recent years.

Sea survivals in the Gulf of St. Lawrence stocks have also declined from the peak values of the 1989 smolt migration. Survivals of the 1994 smolt migration improved for all the Newfoundland stocks with smolts from Western Arm Brook (SFA 14A) and Northeast Brook (Trepassey) (SFA 9) showing a consistent increase over the past three years.

On Newfoundland rivers, small salmon returns prior to 1992 would have been affected by the commercial fishery. Since then, survivals would have been expected to have increased as a result of the commercial salmon fishery moratorium. A rank ordering of survival values indicated that of the 10 rivers:

- 3 had the lowest survival recorded in the 1994 smolt year-class (adult returns in 1995);
- 9 had either the lowest or second lowest sea survivals survival coinciding with the moratorium years (i.e. adult returns in 1992 to 1995).

Given the large scale reductions in marine exploitation that have occurred over the past several years, sea survival of the salmon populations from the Maritime and Québec stocks has not increased in the manner expected.

Environmental conditions in the ocean have been clearly less favourable since 1989 than in the previous decade. More localized factors may add more variability to the annual variation in survival rate imposed by the high seas conditions. Marine conditions in 1994/95 would have affected the small salmon returning to the rivers in 1995 while conditions in 1993/94 and 1994/95 would have affected the large salmon stocks. Limited surface layer temperature data suggests that the waters in the Labrador Sea, including the Labrador and northern Newfoundland shelves, were generally cold in 1995 but warmer than 1994. Similar cold conditions persisted on the northeastern Scotian Shelf and along the Atlantic coast of Nova Scotia. In contrast, the Gulf of Maine region (believed to be utilized by 1SW salmon stocks from the inner Bay of Fundy) appeared to have been warmer than normal in 1995. The cold conditions in the Labrador Sea in 1995 and the warm temperatures in the Gulf of

Maine reflect no change in the marine conditions from recent years and have paralleled the low marine survival experienced by "North Atlantic" and "inner Bay of Fundy" stocks in recent years.

USA

The survival of hatchery-reared smolts released into the Penobscot River in 1993 was slightly higher than that observed for the 1992 smolt class (0.2 vs. 0.1%, Figure 5.2.6.2).

Recruits per spawner for the wild salmon stock in the Narrraguagus River in Maine were examined for the 1989 and 1990 cohorts. Partitioning the survivorship into freshwater and marine components revealed that freshwater survival compared favorably with earlier studies of juvenile salmon survival in North America. However, the mean smolt-to-adult survival rates of 0.75% and 0.91%, respectively (Table 5.2.6.1) were considerably lower than previously reported for North American rivers. At the observed recruits: spawner of 0.36 and 0.34 it is likely that the river will remain in a spawner deficit, with no surplus for harvest.

5.2.7 Summary of status of stocks in North American Commission Area

The closure of the commercial fisheries in the New Brunswick, Nova Scotia and Prince Edward Island in 1985 resulted in a noticeable increase in returns of small and large salmon to the rivers. The effect of this reduced marine exploitation and the reduced in-river mortality, as a result of the mandatory hook and release in the recreational fishery of large salmon in many areas of eastern North America, has been increased egg depositions in many rivers and increased juvenile abundance. In some areas, such as the Bay of Fundy and New England, the increased escapement has not been sustained; returns to these rivers are now lower than they were prior to 1984. Entry of mature aquaculture-origin salmon to all rivers of the Bay of Fundy could be significant in 1996. A more thorough assessment of the impact of aquaculture escapees on wild salmon stocks is urgently required in the context of the growing abundance of escapees within rivers and the low abundance of the wild stocks.

The commercial fishery moratorium in Newfoundland introduced in 1992 and maintained through 1995 has had the most noticeable impact on the escapement to rivers of Newfoundland and Labrador. Areas in Newfoundland (SFAs 11 to 13) which showed little or no improvement in escapement to the rivers during the moratorium years have either early run stocks and/or the exploitation on these stocks had already been reduced by the delayed opening of the commercial seasons in 1978 and 1984. Generally, the proportion of large salmon in the returns to the rivers during the moratorium years were higher than in the period 1986 to 1991. While returns of large salmon showed an overall improvement in the last four years, higher returns had been observed at several monitoring facilities in years prior to the moratorium. It was generally felt that, had the moratorium not been in effect, severe over-exploitation of many Atlantic salmon stocks would have occurred in 1995.

The marked decline in recreational catches and the failure of the Labrador commercial fishery to achieve its reduced quota in 1995 indicate that the large salmon abundance in Labrador remains low. Consequently, exploitation on Labrador stocks and in particular the large salmon component, which contributes substantially to egg deposition, should be as low as possible.

5.3 Possible Predators and Natural Mortality of Salmon in the North American Commission Area

NASCO has asked for specific information on how changes in natural mortality may affect salmon abundance in each Commission area. The Working Group has considered available information on possible predators of Atlantic salmon in both freshwater and marine areas and, where possible, has documented changes in the abundance of these predators.

Canada

Almost nothing is known about predation on salmon in the sea. However, there is good evidence that marine mammals, especially seals, prey on salmon at some stage in their life history (Hislop and Shelton, 1993). Hislop and Shelton (1993) list grey, harbour, and ringed seals as known predators on salmon and all of these species occur in Canada.

In Newfoundland and Labrador, there are six species of seals, viz. harp, harbour, hooded, grey, bearded, and ring seals (Stenson, 1994). Data on stomach contents are available from harp seals only (Lawson *et al.*, 1995).

The grey, harp and harbour seals are also found further south in other Canadian Atlantic provinces. The mainly crustacean diet of bearded seals would exclude this species as a potential predator. The nearshore diet of harp seals was reconstructed by examining the contents of 1,490 stomachs (Lawson *et al.* 1995). There were no salmonids found in the 1,167 stomachs containing prey although most of the sampling was collected in late winter and early spring in areas where salmon would not be expected to be present at that time. The harp seal population is estimated to have been 4.8 million in 1994. In recent years, the population has been increasing by an average of about 5 % each year. It is estimated that in 1994 the harp seal population ate about 7 million tonnes of marine prey. Hooded seals are considerably less abundant than harp seals, estimated at about 400,000 animals in 1990.

Seals have been observed in inshore areas around Newfoundland and Labrador eating salmon although most of the observations occurred concurrently with commercial salmon fisheries and it is possible that the salmon were removed from commercial nets and were not free swimming. However, seals have been observed eating salmon at times when the commercial fishery was closed. Unfortunately, the scale of the mortality is unknown.

Grey seals are found in two areas of Atlantic Canada. The 1993 population estimate was 144,000 (82,000 from the Sable Island rookery off Nova Scotia and 62,000 from the Gulf of St. Lawrence). Populations have been increasing in these areas at 13% and 8 % per year respectively. There was no information available to the Working Group on consumption of salmon by grey seals in these areas.

A recent study (Bowen and Harrison, 1996) reported on diet studies in harbour seals (*Phoca vitulina*) in the lower Bay of Fundy and along the northeastern coast of Nova Scotia. Prey remains were found in 250 of 470 harbour seal stomachs collected mainly from May to September between 1988 and 1992. The only anadromous fish parts found in these stomachs were otoliths from 3 blueback herring (*Alosa aestivalis*). No salmon were found although they would have been present in the area as both smolts and adults at this time although at much lower densities than the most common prey consumed by the harbour seals. Atlantic herring, Atlantic cod, pollock and short-finned squid accounted for 84% of the biomass of prey consumed in the two areas combined. Estimated mean lengths of the prey consumed ranged from 17 to 35 cm and median masses from 55 to 469 g.

Various fish species may also prey on salmon in marine areas. Bay D'Espoir, Newfoundland is the site of an aquaculture industry utilizing rainbow (steelhead) and Atlantic salmon. Production of these two species was 410 t and 20 t, respectively, in 1995. An estimated 20,000 rainbow trout escaped in 1995. Test fisheries for these escapees were conducted in Bay D'Espoir during May and September 1995. Results, particularly from the fall survey, suggest a high abundance of escaped rainbow trout in the Bay D'Espoir area. No evidence of rainbow trout predation on salmon smolts and post-smolts was noted from the 1995 surveys, although no information was available on the densities of salmon in the bay at the time of sampling. Escaped salmon and rainbow trout have entered at least four local rivers but no information is available on their possible predation on salmon parr.

Various studies suggest that cormorants and mergansers may consume substantial numbers of juvenile salmon in New Brunswick, Nova Scotia and Prince Edward Island, at least at some times and places. However, the impact of avian predation on salmon populations is unknown. Models reviewed by the Working Group indicate that the majority of juvenile salmon mortality is not caused by birds. The intricate and poorly-understood factors which cause this mortality may act in compensatory ways; hence the removal of a single mortality source (e.g. avian predation) will not necessarily lead to higher adult numbers.

USA

During the past 20 years the number of harbour seals in Maine has doubled, with the current population estimated at 29,000 animals. Similarly, the population of grey seals has increased from approximately 30 animals in 1980 to between 600-1,200 in recent years (NMFS 1996).

The incidence of seal bite injuries observed on adult Atlantic salmon in the Penobscot River has also increased in recent years, from less than 0.5% in the 1970's to an average of about 2.0% in the 1990's (Baum 1996). Seal bite injuries are also frequently reported by anglers fishing for salmon in Maine, with anglers reporting that up to 70% of the salmon caught in one river (in 1986) exhibited evidence of attacks by seals. The narrow, shallow estuaries of the small rivers in eastern Maine, in addition to their proximity to large aquaculture operations, may contribute to the vulnerability of those salmon runs to seal predation (Baum 1996).

The double-crested cormorant *(Phalcrocorax auritus),* once extirpated by European settlers in New England, started renesting along the eastern Maine coast in the mid-1920's. The population expanded rapidly and by 1944 the breeding population had increased to about 10,000 nesting pairs. In 1977 there were an estimated 15,333 breeding pairs of cormorants located on 103 colonies in Maine; by 1985 the number had increased by 87% to 28,760 pairs on 121 colonies (Krohn, *et al.* 1995). In recent years there appears to have been a levelling off of the population, to 28,000 breeding pairs located on 135 colonies along the Maine coast. Additionally, a small breeding population has recently become established on the largest freshwater lake in Maine.

A recent Ph.D. thesis published at the University of Maine (Blackwell, 1996) estimated that cormorants consumed less than 7% of the hatchery-reared smolts stocked in the Penobscot River during the period 1992-1994, and that most of the predation occurred in the head ponds of various mainstem hydro dams. While the head ponds of mainstem Penobscot River dams accounted for less than 1 % of the cormorant feeding areas, about 43 % of the predation occurred there.

While several studies of cormorant predation in Maine have demonstrated that predation upon individual groups of hatchery-reared smolts in freshwater and estuarine areas can be significant, there is virtually no evidence of predation upon wild Atlantic salmon smolts (Baum, 1996). In the marine environment, Maine cormorants have been shown to feed mostly upon 5 organisms - sculpins, sand shrimp, wrymouth, rock gunnel and cunner.

The successful striped bass (*Morone saxatilis*) restoration program along the east coast of the US has resulted in the possibility of increased predation upon Atlantic salmon smolts. In the Connecticut River it has been suggested that the increased abundance of striped bass has contributed to recent declines in the abundance of river herring and American shad populations. Modelling the bioenergetics of striped bass in the Connecticut River by Schulze (1994) concluded that the species poses a potential threat to both shad and salmon. Large increases in the striped bass population have also been observed in the Merrimack River and some of the rivers in southern Maine.

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

1. Evaluate possible reasons for the apparent declines in 2SW returns to SFAs 15 -23 and Q1 - Q10.

2. Develop estimates of total recruits prior to all fisheries for each SFA for which estimates have not been made.

3. There is a need for improved habitat surveys for rivers in Labrador so that spawner requirements can be developed based on habitat characteristics.

4. Review possible changes in the biological characteristics (mean weight, sex ration, sea-age composition) of returns to rivers, spawning stocks, and total recruits prior to fisheries. As new information becomes available, refine estimates of spawning requirements in USA and Canada by incorporating new information such as on biological characteristics for individual stocks, habitat measurements and stock and recruitment analysis.

5. Annual estimates of smolt-to-adult salmon survival rates need to be obtained for Labrador, New Brunswick and Nova Scotia. Examine sea survival rates of hatchery and wild salmon to determine if changes in survival of hatchery releases can be used as an index of sea survival of wild salmon.

6 FISHERIES AND STOCKS IN THE WEST GREENLAND COMMISSION AREA

6.1 Description of Fishery at West Greenland

6.1.1 Catch and effort in 1995

After the suspension of the commercial fishery in 1993 and 1994, the salmon fishery at West Greenland (NAFO Sub-area 1) was re-opened for the period 14 August–15 October 1995. However, catches in the first two weeks approached the full quota (77 t) and so the fishery was closed on 1 September. The preliminary nominal catch figure is 68 t (Table 6.1.1.1) which is the lowest recorded catch since 1960 (excluding the years when fishing was suspended).

The geographical distribution of the nominal catches by Greenland vessels is given in Table 6.1.1.2 for the years 1977–1995. In 1995, the majority of the catch was landed in Divisions C–E (77 %), and very few fish were caught in the northernmost areas, probably due to the early closure of the fishery.

Only vessels of less than 42 ft (<12.8 m) were permitted to participate in the commercial salmon fishery in Greenland coastal waters in 1995. The commercial fishery was conducted under quotas, distributed at the community level and assessed through daily licensee reports to the License Control Office. Entry into the fishery was limited to professional fishers or hunters, fishing their own gear (single hook and line; 2,000 knot, 140 mm stretched mesh fixed or drifting gill net of any length) within 40 nautical miles of the west coast or 12 nautical miles of the east coast. Licenses for salmon fishing are not issued to vessels with licenses for the shrimp fishery.

Fishing for private consumption was restricted to residents of Greenland, using hook and line or a single fixed, 2,000 knot, 140 mm stretched mesh gill net, or a similar 30 fathom drift net, tended daily. Salmon taken by this fishery were not permitted to be sold and were not counted against the quota. No firm information on the magnitude of this fishery is available, but the catch has been estimated from local information to be less than 10 t.

Permits may be issued for tourists to fish with hook only. There is no daily catch limit but the catch may not be sold. Few tourist licenses were sold.

6.1.2 Origin of catches at West Greenland

The Working Group examined the 1995 composition and origin of Atlantic salmon caught at West Greenland based on discriminant analysis of characteristics from 1,168 scale samples from NAFO Divisions 1C (obtained between August 18 and 25), 680 samples from Division 1D (August 18-30), and 621 samples from Division 1E (August 16-24). A random sampling design was used to obtain samples from salmon landed by commercial vessels fishing in these areas.

The database used to develop the discriminant function consisted of 790 North American and 789 European known-origin salmon collected at West Greenland from 1980 to 1992. These samples were used because there were no known-origin samples available from the 1995 catches. Scale samples, which were independent of the discriminant analysis, were used to test the discriminant functions. Assumptions of between-group difference for discriminators used in the analysis, homogeneity of variance of within-group discriminators and normality of the distributions of discriminator values were tested before analysis proceeded. Assessment of misclassification rate based on a known prior probability of 0.5, indicated an overall misclassification rate of 14.9% with a bias in the error rate of ± 0.2% in favour of the European group classification.

Classification of salmon caught at West Greenland in 1995 by the discriminant function indicated that 65% (95%CI = 61%, 69%) were of North American origin (propNA) compared with 54% in 1992. The proportions of North American fish in catches in Divisions 1C, 1D and 1E were 65%, 72% and 59% respectively. These proportions were not significantly different from the overall proportion ($P<0.01$). Similar data for 1969 to 1995 are summarised in Table 6.1.2.1. The proportion of North American salmon in catches in 1995 is the second highest of the data series, and there has been an increasing trend over the period.

Applying the discriminant function to the reported catch indicated that 43t (17,200 salmon) of North American origin and 25t (9,250 salmon) of European origin were landed at West Greenland in 1995. The data for 1969 to 1995 are summarised in Table 6.1.2.2.

A risk based estimate of the harvest of Penobscot River salmon in West Greenland appears in Section 5.1.3.

6.1.3 Biological characteristics of the harvest

Biological characteristics (length, weight, and age) were recorded from 1,987 samples of commercial catches from NAFO Divisions 1C, 1E and 1F in 1995 using the results of discriminant analysis to divide samples into North American and European components. The data for 1995 are compared with those for previous years in Tables 6.1.3.1 to 6.1.3.4.

Analysis of variance was used to compare mean fork lengths and mean whole weights of salmon separately by sea-age and origin (Table 6.1.3.1). This analysis showed that the 1SW salmon of North American origin were significantly shorter ($F=66.1$, $P<0.0001$) and lighter ($F=81.9$, $P<0.0001$) than the European-origin salmon. The 2SW salmon of European-origin were shown to be significantly lighter ($F=22.5$, $P<.0004$) and shorter ($F=9.93$ $P<.0036$) than the 2SW North American-origin salmon.

The downward trend in mean length of both European and North American 1SW salmon since 1969, continued in 1995 (Table 6.1.3.1). The mean length of European 1SW fish (62.6 cm) was the shortest observed mean length in the 1969-1995 series. The mean length of North American 1SW fish (62.1 cm) was the same as that recorded in 1985, and is the lowest value observed in the series. Similar observations were made for the mean weights of 1SW salmon at West Greenland in 1995. Mean length and weight of 2SW salmon remained unchanged from those observed between 1969 and 1992.

Distribution of the catch by river age in 1995 as determined from 1,903 scale samples is shown in Table 6.1.3.2. The proportion of the European origin salmon that were river-age-1 (14.7%) was well below the mean of 20.1%, while the proportion of river-age-3 fish (27.5%) was greater than the mean of 16.8%. This may indicate some change in the stock composition in the area. Proportions of river ages of North American origin salmon were not appreciably different from the 1968 to 1992 means (Table 6.1.3.2).

The proportionate distribution by weight categories (1.1-3.3kg, 3.3-5.6kg and >5.6kg) of salmon caught at West Greenland in 1995 gave a higher proportion in the smallest category than for any year between 1987 and 1992, although the distribution was similar to that observed in 1991 (Table 6.1.3.3).

The sea-age composition (%) of the samples collected from the 1995 West Greenland commercial fishery showed the highest proportion of 1SW fish (97.3%) in the North American component in the 1985 to 1995 series (Table 6.1.3.4). The proportion of 1SW salmon in the European component in 1995 was similar to proportions observed since 1985.

6.1.4 Exploitation rates at West Greenland in 1992

No recent data are available for exploitation at Greenland. However, data from tagging studies carried out in Ireland and relating to exploitation in the West Greenland fishery in the 1992 season (prior to the suspension of commercial fishing) were considered by the Working Group. A total of 292,000 salmon smolts were microtagged and released of from the River Shannon in Ireland in 1991. Tags were recovered in the West Greenland fishery from 1SW salmon in 1992. Details of the tag recoveries have been provided previously (Anon. 1993/Assess:10) and raising factors used to estimate the total number of tagged fish of this group in the fishery are given by Russell *et al.* (1993). Details of the tag recovery programme in Ireland and estimates of the total stock are given by Browne *et al.* (1994).

Estimates of exploitation rates were generated from the Run Reconstruction Model (Potter and Dunkley, 1993) and indicate that approximately 18% of the non-maturing 1SW fish from the Shannon were exploited at West Greenland. This is at the high end of the previously assumed range of exploitation values for European stocks at West Greenland and compares with estimates of 34-51% for non-maturing 1SW North American salmon (potential 2SW) based on the 'constraints model' (Anon. 1992/Assess:15 and Anon 1993/Assess:10).

6.1.5 Harvest in Greenland in 1993

In 1993, commercial fishing for salmon was suspended but an allowance of 12 t, or approximately 4,000 fish, was made for consumption in Greenland (local consumption). During that same year, Carlin-tagged 1SW salmon from the Penobscot River were at large and available for exploitation in the North Atlantic area. As described in section 5.1.3 and 5.1.4, the harvest and exploitation estimates derived from a simplified harvest model using only data from the Penobscot River stock were more precise than anticipated. The magnitude of the Greenland harvest of the Penobscot stock (nearly 300 fish) was sufficiently high to raise concerns over the level of harvest for local consumption. Considering that the conservation goal for full spawning escapement was met with a quota of only 83 t, a local consumption catch in excess of 30 t, which is feasible considering the tagging data, represents a significant proportion of the quota.

The Working Group considered a risk based estimate of the likely range of harvest for local consumption in West Greenland during 1993 and framed its conservation implications in light of recent quota levels for the fishery.

The distribution of the 1993 harvest estimate for the Penobscot stock at West Greenland (see section 5.1.3) was combined with a series of raising parameters modelled as randomly sampled distributions to compute the likely level of local harvest in the fishery. This local consumption harvest can be modelled by the following equation:

$$A = ((B \times C) + (D \times E)) \times F$$

where: $B = (G \times H \times I) \div J$

where: $D = B \times ((1 - K) \div K)$

and where the variables define either computed sums or parameter distributions:

A: 1993 Greenland local consumption harvest in t (computed)
B: 1993 Greenland harvest of NA 1SW salmon in numbers (computed)
C: mean weight of North America 1SW salmon in kg (distribution)
D: 1993 Greenland harvest of European 1SW salmon in numbers (computed)
E: mean weight of European 1SW salmon in kg (distribution)
F: age correction factor to raise tonnage to total weight of all ages (distribution)
G: 1993 Greenland harvest of 1SW Penobscot fish in numbers (section 5.1.3)
H: raising factor for Greenland Penobscot 1SW, river age 1 harvest to total US 1SW, river age 1 harvest (distribution)
I: raising factor from Greenland US 1SW, river age 1 harvest to total NA 1SW, river age 1 harvest (distribution)
J: the percent of river age 1 NA fish in the North American component of the fishery (distribution)
K: percent NA 1SW in the fishery (distribution)

The parameter distributions used in the calculations is given in Table 6.1.5.1. Ranges of the distributions match those used in the quota calculation where appropriate (ACFM 1993) and were determined from empirical data for North American hatchery stocks. Parameter H was based on a ratio of 630 2SW returns to the Penobscot compared to a total return of 895 2SW fish to all US rivers in 1994. Likewise, parameter I was based on a ratio of 895 US returns to a total of 2529 river age 1 returns to North America (i.e. including returns of Canadian hatchery fish). The estimates were collected for 500 realisations of equation 1 by randomly varying the uniform distributions above and those described in section 5.1.3. A sensitivity analysis was carried out by regressing output values to input parameters and by rank correlation of the two variables. Sensitivity model coefficients and correlation coefficient are reported in Table 6.1.5.1.

The empirically derived distribution of Penobscot stock harvest values in the West Greenland fishery during 1993 are presented in Figure 6.1.5.1. Values range from 242 to 355 fish and the empirical 90% confidence interval is from 254 to 334 fish. These results suggest the harvest model is robust to the assumptions about parameters and that the harvest is estimated with relatively good precision.

The empirically derived distribution of the harvest for local consumption during 1993 are presented in Figure 6.1.5.1. These values range from 50 to 148 t with a mean of 87 t, and the empirical 90% confidence interval is from 60 to 121 t The sensitivity of both the Penobscot stock harvest and the local consumption calculation can be found in Table 6.1.5.2. The local sale summary calculation was most sensitive to raising factor parameters: the percent of river age 1 NA fish in the North American component of the fishery and percent North American 1SW fish in the fishery. The fourth most important parameter was the tag loss rate which relates to the estimate of Penobscot stock harvest and was found to an important parameter for the harvest time series (see Section 5.1.3). It is important to remember that two factors affect the role of parameters, how they are used in model formulation and the distributions used to represent them. The Working Group expressed concern over the assumption that all other North American stocks were distributed similarly to the Penobscot stock during 1993 feeding migration. If Penobscot fish were more abundant in the Greenland area, a positive bias would occur and would overestimate the harvest for local consumption; alternatively, if Penobscot fish were less abundant, local consumption harvest would be under estimated.

These calculations suggest that the local consumption harvest in Greenland was of the order of 80 t in 1993. This estimate of local sale harvest is approximately equal to the quota (83 t) (assuming 40% allocation to Greenland) that would have been required to achieve target spawning escapement in that year (ACFM 1993). While stock abundance remains at the depressed levels observed in recent years, local consumption harvest of this size and expansion of the sport fishery (Steensen 1995) pose a threat to achieving conservation goals.

6.2 Status of Stocks in the West Greenland Area

The salmon caught in the West Greenland area are non-maturing 1SW salmon or older, nearly all of which would return to homewaters in Europe or North America as MSW fish if they survived. The most abundant European stocks in West Greenland are thought to originate from the UK and Ireland. Returns of the MSW component of most of these stocks to homewaters have declined during the past 5 years (see Section 4.3). Similar declines in abundance have been noted in many North American MSW stocks that contribute to the West Greenland fishery (Section 5.2).

The forecast of pre-fishery abundance of North American origin 1SW salmon for 1996 remains similar to the low levels indicated in recent years (see Section 9.2, Figure 9.2.2.2). A downward trend in mean length and weight since 1969 for both North American and European 1SW salmon, continued in 1995 (see Section 6.1.3). The proportion of European origin salmon in the 1995 catch at West Greenland with a river-age of 1 year decreased compared to the average for 1968-1992 while the proportion with a river-age of 3 years increased. There was no corresponding change in river-age proportions for North American origin salmon. The proportion of North American origin 1SW salmon in catches in 1995 was the highest in the 1985-1995 time series. The overall status of stocks contributing to the West Greenland fishery remains poor, and as a result, the status of stocks within the West Greenland area are thought to be low compared to historic levels.

6.3 Data Deficiencies and Research Need for the West Greenland Commission Area

1. The mean weights, sea ages and proportion of fish originating from North America and Europe are essential parameters used by the Working Group to provide catch advice for the West Greenland fishery. As these parameters are know to vary over time, the Working Group recommends that the sampling programme which occurred in 1995 should be continued.

2. Efforts should be made to improve the annual estimates of the harvest of salmon taken for local consumption at West Greenland.

7 SIGNIFICANT RESEARCH DEVELOPMENTS

7.1 Possible Explanations for Changes in Sea-Age at Maturity

7.1.1 Background

The sea-age at which each salmon becomes sexually mature is determined by both genetic and environmental factors. In a biological context, environment is defined to include all sources of non-genetic variation affecting growth, development and sexual maturity. Both environmental and genetic factors may affect individuals at every stage of life. Effects evident in the fisheries or among spawners may result from causes at any of the earlier stages of life.

Assessing the relative importance of environmental or genetic effects on sea-age at maturity in natural stocks or populations is difficult because the effects are not independent. Complex patterns of variation may exist because of interactions among effects occurring at different stages of the life-cycle. The same effects on sea-age at maturity may be generated by different routes.

The sexes differ in their tendency to become mature at particular ages in fresh water and in the sea. Many males become sexually mature as parr. Parr maturity is associated with additional natural mortality that causes the sex ratio among smolts to be biased in favour of females. The extent of this effect in single locations and the extent of geographical and temporal variation (e.g. associated with juvenile densities in freshwater) are unknown although both may be substantial.

Mortality of mature male parr is not total and microtagging studies indicate that some survive to become smolts and to become adults. The effects of male mortality on sea-age at maturity for mixed sex groups, or of maturity among males in fresh water on their subsequent maturity patterns at sea are not known.

In many populations and stocks males are more prevalent among 1SW fish than females and females predominate in the older classes. Sex is usually undocumented in catch data but determination of the relative frequencies of the sexes among catches is a possible approach to considering the mechanisms that generate observed changes in sea-age composition.

Differences in sea-age at maturity are evident among fish at different locations or for single locations over time. However few long time series of data exist. Those that are available are unlikely to be representative of the whole stock. In general, data sets are available only for decadal or shorter periods of time and sea-age at maturity can be investigated only on these scales.

For all these reasons, analysis of the causes of variation in life-history parameters as reflected in sea-age at maturity is expected to be complex. In particular cases, however, the effect of single factors may be sufficiently large to be isolated and identified with available data sets.

7.1.2 Quantitative genetic effects

Aquaculture studies have demonstrated genetic differences among groups (aquaculture strains) in the frequency with which members become sexually mature after one sea-winter (grilse) or defer maturity until a later year. Formal heritability estimates are available for sea-age at maturity in farmed strains of salmon. These values are sufficiently large to indicate that sea-age at maturity can be altered by selection. Indeed, rates of grilse maturity in farmed fish have been reduced by selective breeding.

It should be noted that heritability estimates are specific for the environments in which they are determined: values determined in aquaculture cannot be transferred directly to maturity rates attained in natural environmental conditions. However, the relatively large estimates for heritability in aquaculture fish strongly suggest that a substantial genetic component is likely to exist for sea-age at maturity in all salmon - including wild salmon in natural environments.

7.1.3 Population genetic effects

A substantial amount of circumstantial evidence exists for genetic effects on sea-age at maturity at the population level. However, alternative environmental hypotheses can be constructed to explain the observed variation in every case.

In an alternative approach, experimental study of genetic variation at the single MEP-2 genetic locus has proved informative. The studies summarised below link environmental change, natural selection and genetic change with changes in sea-age at maturity.

The frequency of the alternative alleles for the MEP-2 protein gene vary geographically within and among rivers, in a manner that correlates with the temperature of juvenile habitat in spring and early summer. In Spain, for example, salmon contain only the so-called 100 allele for the MEP-2 gene. In Labrador, all fish contain only the alternative 125 form. At intermediate latitudes, both alleles are present in the same populations. This is the case for the Rivers Shin and Dee (Scotland). Among different populations within each of these rivers the alternative alleles are again distributed in relation to the spring temperature of juvenile habitat: more fish contain the 125 allele in cooler locations (Verspoor and Jordan, 1989).

In the River Shin, the relative frequencies of the alternative alleles appear to have been altered by natural selection in favour of the 125 allele, as a result of cooling of juvenile habitat in the spring months (Verspoor *et al*, 1991). Lower spring temperatures are associated with the construction in 1958 of the dam that is now the river's source, because of draw-down of stored winter water during the spring months.

Changes to the Shin population can be linked with changes in growth and age at sexual maturity through parallel studies of the MEP-2 gene conducted at other sites. Thus, growth of juveniles varies among fish containing the different MEP-2 alleles in the Girnock Burn (Scotland) (Jordan and Youngson, 1991). Further, in a separate effect, sea-age at maturity varies among adults bearing different alleles that enter the Rivers Dee and Tay (Scotland) (Jordan *et al*, 1990).

7.1.4 Physical environmental effects

The physical environment is likely to affects sea-age at maturity mainly through somatic growth which in turn affects the events that lead to sexual development. Life-history theory suggests that rates of energy accumulation will determine the options for maturity available to individuals at any stage of their lives. Growth and development in each successive phase of life is partly related to the outcome of prior phases. Indeed, sea-age at maturity shows some dependence on juvenile development (Chadwick *et al*, 1987).

The freshwater locations occupied by juvenile salmon populations show strong geographical trends in physical environmental parameters. Geographical environmental variation tends to track the genetic relatedness of populations because geographical and genetic distances among populations are correlated (Jordan *et al.* 1992). In addition, different genetic populations that eventually occur together on the ocean feeding grounds get there by way of extensive migrations through environments that differ grossly (e.g. the marine routes that Maine and Labrador smolts or Spanish and eastern Scottish smolts must follow to reach West Greenland). Effects like these confound the interpretation of the effects of clinal environmental variation on variation in sea-age composition among stocks or populations.

Among pre-adult fish the final triggers for sexual maturation include proximal environmental cues. Day-length change, for example, is an important cue for reproduction in many species. For salmon distributed among the ocean feeding grounds, rates of day-length change are latitude dependent (spatial variation). In addition, the timing of the onset of sexual maturity differs among populations (temporal variation). Again, this emphasises the potential complexity of the causes of differences observable in sea-age maturity rates among population or stock groups.

7.1.5 Fishery effects

Age-class composition data obtained in home-waters is relevant to the management of spawning escapement. However, in considering the causes of variation in sea-age at maturity, it must be noted that value of the available data sets is set by the stages of life and therefore the locations in which they have been obtained. In particular, data obtained from size-selective fisheries or after size-selective fisheries have acted will produce biased estimates of the underlying age-class composition.

Sea-age at maturity is best defined as the potential contribution of all the surviving members of each cohort to the 1SW and 2SW (or MSW) sea-age classes, estimated near the onset of maturity but prior to recruitment to the fisheries. Ideally, estimates for two or more populations should be considered because of genetic differences among populations that contribute to the exploitable stock. In general, data are not available on recruits to the fisheries, and variation or trends in sea-age class composition must be considered using data sets obtained in home-waters.

Finally, because of the genetic component of variation in sea-age at maturity, it is expected that fisheries that are selective for sea-age (size) will alter the genetic composition of populations at spawning. The genetic make up of the next generation is expected to change as a consequence. The magnitude of these changes is expected to relate to the intensity of the fisheries, the extent of the bias of fishery mortality on the different sea-age classes and the magnitude of the genetic effect being expressed in sea-age at maturity.

7.1.6 Recent developments

Data based on home-water fisheries can be used to examine various aspects of the relationships between survival, growth and sea-age at maturity. The relationships evident at specific times and in specific locations can be used to speculate about the general causes of variation. This approach is used in Section 14 of this Report.

With respect to pre-fishery trends in sea-age at maturity, recent research has concentrated on the development and the use of marine environmental habitat indices. These are being developed for both the north-west and the north-east Atlantic areas (Section 9.2.2). It is considered possible that the extent of suitable ocean habitat limits the growth, survival and sexual development of pre-adults. These effects may be evident in sea-age composition estimates obtained among survivors available to the ocean fisheries.

In addition, some trends in sea-age composition that are evident in home-water catches may be generated through long-term changes in genetic composition of populations. It has been suggested that changes in reproductive fitness among sea-age classes resulting from environmental change may have changed the population structure of the River Tweed (Scotland) and that the numbers and proportions of sea-age classes in the fishery may have changed as a result (Youngson, 1995). This effect is being explored for other, similar fisheries.

To date, no direct experimental evidence is available regarding the magnitude of genetic effects on sea-age at maturity in wild fish because of the extreme difficulties of providing adequate experimental design. This problem is potentially resolved following the recent development of new DNA methods that can be used to generate genetic tags for free-living fish of groups based on families or larger units (Prodohl *et al*, 1995; McConnell *et al*, 1995).

A powerful approach to examining the causes of variation in sea-age at maturity is to examine maturation-related events earlier in life from permanent records of growth-dependent effects laid down permanently in hard body parts, such as otoliths and scales. This approach is documented in Section 7.4.

7.2 Criteria for Defining Salmon Stocks

The definition of what constitutes a fish stock is problematic. Different authors have created their own terminologies to meet their own needs, generating much confusion.

Some examples of the many definitions of stock include:

1) " ..a population of organisms which, sharing a common environment and participating in a common gene pool, is sufficiently discrete to warrant consideration as a self-perpetuating system which can be managed." (Larkin 1972, p. 11).

2) "an intra-specific group of randomly mating individuals with temporal or spatial integrity." (Ihssen *et al.* 1981).

3) "Following the recommendations of the 1938 Conference, the term stock is used here to describe the fish spawning in a particular lake or stream (or portion of it) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season. What constitutes a 'substantial degree' is open to discussion and investigation, but I do not mean to exclude *all* exchange of genetic material between stocks, nor is it necessary in order to maintain distinctive stock characters that increase an individual's expectation of producing progeny in each local habitat. In some rivers a number of stocks can be grouped together on the basis of similarity of migration times. The word *run* will be used for such groupings. Thus we may speak of a fall run of chinook salmon or steelhead, for example. Each run may comprise a considerable number of stocks." (Ricker 1972, p. 29).

4) "The part of a fish population which is under consideration from the point of view of actual or potential utilization." (Ricker 1975, p. 5).

5) ".. stock is used to mean an exploited or managed unit." (Royce 1984, p. 215).

Thus some scientists involved in fishery management have felt that any definition of stock requires the inclusion of genetic considerations, whereas others have adopted practical, management-oriented approaches.

The terms "stock" and "population" are often used interchangeably, further adding to the confusion. Dobzhansky *et al.* 1977 employed the term "mendelian population" to describe a group of sexually outbreeding individuals which possess a common gene pool (Dobzhansky *et al.* 1977). The term "mendelian" was included because in popular usage the term "population" is often applied to "assemblages of individuals which do not constitute reproductive communities". Concerning a mendelian population, Dobzhansky *et al.* state: "More precisely, it is an array of subordinate mendelian populations interconnected by regular or occasional gene flow." Of note here is the need for genetic considerations in the formation of the definition.

The salmon's homing behavior results in relatively closed groups of individuals returning to reproduce in their natal rivers. Within any given river, subgroups may also develop (e.g. within tributaries). Natural selection acts to adapt the salmon of these groups to the conditions they will face in the home river and along their migration routes, and they become the best equipped to survive and reproduce. The subgroups which occur within the same river system are best described as 'mendelian populations'.

The Working Group noted that some salmon biologists have previously used the terms "stock" and "population" interchangeably, whereas others have used stock to mean a mixture of populations. Standardizing the terms used will alleviate confusion, and bring salmon biologists more in line with terminology used by other population ecologists.

In the past, the Working Group has proposed that salmon fisheries prosecuted outwith rivers, in areas where populations are likely to be mixed in differing proportions, should ideally be managed to minimize the risk of over-exploiting individual river populations (Anon 1989/Assess:12). Quotas would be set for each river, and designed to ensure that the harvest on each population remained within safe biological limits. However, at present this is not generally practical, and management of the West Greenland fishery, for example, is currently based upon the abundance estimates for all North American salmon populations combined. This approach is also unsatisfactory because there is an increased probability that some individual populations will be over-exploited. Indeed, the larger the number of population included within such a management unit, the greater will be the probability that one or more of them could be over-exploited by a common fishery, even at low levels of overall exploitation.

Thus there is a need to define units of a size (encompassing one or more populations) which provides a practical basis for the fishery manager, while still helping to ensure the conservation of the contributing populations. These units may be termed "stocks" and should be defined by managers after considering the following criteria *(No attempt has been made to prioritize these concerns)*:

1. The number and size of populations in the fishery area - (i.e. the more populations, the greater the risk of over-exploiting any individual population).

2. The proportion of fish from each population in the area - (i.e. this will affect the relative levels of exploitation on each population).

3. The number of fish in each population required to meet spawning targets - (i.e. more productive stocks or stocks experiencing less natural mortality can be exploited more heavily).

4. The proposed levels of exploitation on each population - (i.e. at high exploitation rates, smaller stock units are required to protect individual populations).

5. The percent of catches that are expected to be taken in mixed stock fisheries in distant and homewaters, and/or in-river fisheries - (i.e. if a lower percentages of the total catch is taken in mixed stock fisheries, then larger stock units may be used).

6. Population structures and distribution (i.e. populations with greater temporal and spatial distribution are less vulnerable to the risk of extinction caused by local changes in natural or fishing mortality).

7. The probability of making management errors due to unanticipated or unavoidable events - (e.g. errors in assessments, unpredictable shifts in environmental conditions, etc.).

8. Jurisdictional considerations (e.g. competing claims for resource use, problems in mounting effective enforcement).

In certain circumstances, stocks and mendelian populations may be identical. This could occur where harvests are undertaken exclusively within rivers as the fish return for spawning. Population conservation can be much more readily assured in these circumstances. However, management error can also pose a significant risk to conservation when exploitation is conducted near spawning times.

7.3 A New Method for Identifying Reared Salmon

Escaped farmed salmon in fisheries and stocks are usually identified by external morphology and scale analysis (Lund *et al.* 1989; Lund & Hansen, 1991). The latter method is labour intensive and costly when large numbers of salmon are screened. Since about 1990 intra-abdominal vaccination against different diseases using oil adjuvanted vaccines has been widely adopted in seawater aquaculture of Atlantic salmon, and in Norway more than 90% of the farmed salmon produced are vaccinated intra-peritoneally with such vaccines as pre-smolts. As a side effect, these vaccines leave durable intra-abdominal lesions which may serve as a marker.

In a Norwegian study with vaccinated, non-vaccinated and placebo treated salmon, it was shown that as a result of the vaccination, numerous fibrous adhesions developed between the internal organs and the peritoneum. In salmon kept 16-17 months (3 groups), and 35 months (2 groups) after vaccination, the marker was clearly visible in 95–100% of the fish. In four groups of returns of salmon ranched as one year old smolts, adherences were visible in 87–100% of the fish 21–22 months after vaccination. In one group of ranched fish injected with placebos 21 months before they returned to the river, adherences were present in 25% of the fish. In the group of farmed salmon not vaccinated (0.6–2.2 kg whole weight), adherences could not be detected. Abdominal adherences can also be detected a relatively short time after vaccination. In 4 groups of post-smolts, 93–100 % of the fish had developed adherences 3–7 months after vaccination.

It was concluded that intra-peritoneal vaccination in commercial rearing produces a visible marker permitting simple and rapid discrimination of farmed and wild salmon on internal examination. This could be a valuable method for estimating the contribution of reared fish to fisheries and stocks.

7.4 Use of Sr:Ca Ratios in Otoliths to Determine Maturation Status

Elements are often differentially deposited in the hard body parts of an organism during the chronology of its life. Fish species contain a number of different hard body parts that have been scrutinised for elemental signals (Bagenal *et al.* 1973; Lapi and Mulligan 1981; Mulligan *et al.* 1983; Yamada *et al.* 1987; Coutant and Chen 1993). However, it has been the otoliths of fish that have yielded some of the most interesting results to date due to their resistance to chemical remodelling and stability during analysis (Gunn *et al.* 1992). A number of studies have ascribed interpretation of elemental signals in otoliths to environmental variables such as temperature and salinity (Radtke *et al.* 1990; Townsend *et al.* 1992). But, recent studies suggest that physical parameters may be less influential than physiological mechanisms, such as growth and maturation, in influencing chemical composition of otoliths (Kalish 1989, 1991; Gallahar and Kingsford 1992; Sadovy and Severin 1992; Fuiman and Hoff 1995). In the case of maturation, chemical composition of otoliths may reflect sexual readiness and spawning events and thus provide a record of the variation that occurs between individuals and populations. Otolith microchemistry may become an important tool in the study of maturation in fish populations.

The maturation mechanism in Atlantic salmon is complex and has important consequences for the generational contribution of gametes (Saunders and Schom 1985; Myers 1986; Randall 1989). Though the physiology of maturation has been described (Rowe *et al.* 1991; Thorpe 1994), the influence and interaction of stock genetics (Saunders *et al.* 1983; Herbinger and Newkirk 1987), growth (Svedang 1991; Thorpe 1994; Friedland and Haas 1996), and environmental factors (Martin and Mitchell 1985; Scarnecchia *et al.* 1989) on the proportion of a cohort that matures annually is still poorly understood.

Salmon populations in the Northwest Atlantic follow maturation schedules that produce runs of predominately 1SW and 2SW salmon (Power 1981; Saunders 1981). Post-smolts of these populations migrate from a wide latitudinal range and utilise feeding areas as far north as the Labrador Sea by their first summer at sea (Reddin and Short. 1991). It is assumed that most post-smolts overwinter in the vicinity of the Grand Banks, probably moving into this area in response to changes in water temperature and the availability of food resources (Reddin 1985; Reddin and Friedland 1993). After the overwintering period, some 1SW fish return to their natal rivers to spawn. However, other 1SW fish migrate to feeding areas in the Labrador Sea and are concentrated along the Newfoundland and Greenland coasts (Møller Jensen 1990; May 1993). These do not mature until the following year.

It is generally assumed that salmon destined to sexually mature undergo physiological changes that separates them from the immature component of the cohort (Thorpe 1988). It is also assumed that the homing behaviour of maturing salmon is specific since the homing ability is so precise (Hansen, *et al.* 1993). Therefore, the maturation process is probably related to the migration process.

The abundance of North American salmon that mature after two sea-winters has been correlated to the areal extent of thermal habitat in the Northwest Atlantic, thus suggesting a related link to the maturation process (Friedland *et al.* 1993). The Working Group reviewed the maturity state of salmon caught in Newfoundland-Labrador fisheries during the period 1985-1988 and found that many fish believed to be on feeding migrations were in a state of sexual readiness. To attempt to clarify the meaning of these data, chronological transects of strontium:calcium ratios from the otoliths of maturing and immature 1SW fish were examined. Salmon captured in Greenland were found to have declining Sr:Ca ratios (Figure 7.4.1). The ratios for immature fish suggested that sexual readiness was achieved during the feeding migration and that maturation regression occurred in the absence of migrational cues to begin a spawning migration. Maturing fish were found to have similar Sr:Ca ratios to the immature fish of the same stock during the post-smolt period. A hypothesis is developed that post-smolts that make a northerly migration after their first sea winter are influenced by environment to not mature as 1SW fish. The Working Group will continues to explore these relationships.

8 EVALUATION OF THE EFFECTS OF MANAGEMENT

8.1 Quota and Closures Implemented after 1991 in Canadian Salmon Fisheries

In 1992, a five-year moratorium was placed on the commercial Atlantic salmon fishery in insular Newfoundland while in Labrador and Québec North-Shore and Ungava, fishing continued under quota or allowance catch. In conjunction with the commercial salmon moratorium, a commercial licence retirement program went into effect in insular Newfoundland, in SFAs 1, 2 and 14B of Labrador, and in Q7, Q8 and a part of Q9 in Québec; there were no changes in the management measures in Q11. The commercial quotas, number of licensed fishermen, and landings are shown below:

		Licensed fishermen		Landings	
Year	Quota	Number	% change from previous year	Weight (t)	% change from previous year
Labrador	(t)				
1992	273	495	-13%	204	+70%
1993	178	288	-42%	112	-45%
1994	92	213	-26%	93	-17%
1995	73.5	213	0%	55	-41%
Ungava	(t)				
1992	15	2[1]	0%	2	0%
1993	15	2[1]	0%	2	0%
1994	15	2[1]	0%	3	+50%
1995	15	2[1]	0%	2	-33%
Q7-Q9	(number)				
1992	23,400	147	-3%	73	0%
1993	15,325	94	-35%	47	-36%
1994	15,225	90	-4%	47	0%
1995	15,225	90	0.0%	46	-0.2%

[1] Communal Licenses

The opening of the commercial salmon fishing season in Labrador (SFAs 1,2,14B) in 1995, was delayed from June 5 to July 3 which would further reduce the exploitation of large and small salmon. The moratorium on the commercial cod fishery in 1992–1995 would also have reduced the by-catch of salmon.

Newfoundland: The effect of the management measures taken in coastal waters of insular Newfoundland was evaluated by estimating the total returns of salmon to rivers and estimating the numbers of salmon that would not have returned if the management measures had not been taken. For SFAs 3-14A a range in the total returns of small and large salmon to rivers, 1992–1995, were obtained from Appendix 3 Section 5.2.3). The numbers of fish released from the fishery were estimated by assuming that the commercial exploitation rate prior to 1992 was 0.5 for small salmon and 0.7 for large salmon. The results are as follows:

Year	Total returns small (,000)	Total returns large (,000)	Salmon released due to commercial closure Small salmon (,000)	Large salmon (,000)
1992	116-232	16-32	58-116	11-22
1993	131-262	8-16	66-131	6-11
1994	95-191	8-16	48-92	6-11
1995	111-224	9-18	56-112	6-13

The above values for salmon released from the commercial fisheries in 1992 to 1994 are slightly less than amounts provided in Anon. (1995/Assess:14) due to an update of angling catches and recalculation of the total returns to Newfoundland rivers.

Counts of small and large salmon and proportion of large salmon were examined for 13 rivers throughout insular Newfoundland. Mean counts for the commercial salmon moratorium period, 1992–1995 were compared to means for the pre-moratorium period, 1986-91, using the GLM Procedure of SAS (SAS Institute 1985). Analyses were performed on rank transformed data using the Rank Procedure of SAS. Comparisons of mean counts of small and large salmon for the same moratorium and pre-moratorium periods on an individual river basis are shown in Table 8.1.1. Significant increases in returns of small and large salmon occurred 1992-95 in SFAs 4, 5, and 14A. For southern SFAs (SFAs 9-11) returns of small and large salmon decreased in three rivers and increased in three rivers during the 1992-95 period. These results imply that southern stocks may not have benefited by the closure of the fisheries to the same extent as northern stocks. However, other factors such as natural mortality may have contributed to the decline in returns. The proportion of large salmon increased at all monitoring facilities in SFAs 4, 5, 10, 13, and 14A; decreases in proportion were observed in three of the four rivers in SFAs 9 and 11.

Figure 5.2.6.1 shows increases in the smolt to adult salmon returns subsequent to 1992 to several rivers, which is consistent with a decline in marine fishing mortality. Quantification of changes in fishing mortality from these data is not possible since natural mortality may have changed over the time series.

Labrador: The effects of the management changes in Labrador (SFAs 1, 2, & 14B) commercial fisheries are more difficult to evaluate because of the lack of information on escapement to rivers and the low exploitation by the recreational fishery. However, some information can be provided for SFA 2 based on the counting facility at Sandhill River in 1970-73 and 1994-95 (Table 8.1.2). It is estimated that the exploitation on large salmon has decreased from 96%, 1970-73, to 45% in 1994-95. Similarly the exploitation on small salmon has decreased from 62% in 1970-73 to 12% in 1994-95. These changes are mainly attributable to reductions in fishing effort in Labrador, delays in the opening of the commercial season, the moratorium the commercial salmon fishery in Newfoundland, and reductions in quotas in Labrador and at West Greenland.

As in Anon (1994/Assess:16), the reduction in commercial fishing exploitation (U) in Labrador since 1992 can be estimated from the equation $U = 1\text{-}e^{-aF}$ where a = the fraction of the 1991 licensed effort remaining in 1993-95, and F is the fishing mortality in 1991. The commercial exploitation rate in 1991 was assumed to be 0.7 to 0.9 for large salmon and 0.3 to 0.5 for small salmon (Anon 1993/Assess:9). There were 570 commercial fishermen licensed to fish for salmon in 1991. The number of fishing licenses is assumed to be to provide a measure of the effective fishing effort. The licensed effort in 1992, 1993, 1994 and 1995 was 87 %, 55%, 37%, and 37% respectively, of the 1991 level. The calculations of the new exploitation rates also took into account the closure of the commercial fisheries in Newfoundland (1992-95) and the delay in opening of the commercial salmon fishing season in Labrador to July 3 in 1995. The estimated exploitation rates for large and small salmon are:

Year	Exploitation Rate Large salmon	Exploitation Rate Small salmon
1991	0.7 - 0.9	0.3 - 0.5
1992	0.58 - 0.83	0.22 - 0.39
1993	0.38 - 0.62	0.13 - 0.25
1994	0.25 - 0.43	0.1 - 0.2
1995	0.1 - 0.33	0.08 - 0.15

This reduction in fishing exploitation would imply that the returns to the rivers in 1993 to 1995 are two to three times higher than would have occurred if there were no management changes.

The impact of the shortened season on 1995 salmon landings was examined using weekly landings from 1993-94 in SFAs 1, 2, and 14B. The years 1993-94 were chosen as base reference years because marine environmental conditions appeared to be similar to 1995. The percentage of landings that would have occurred in the shorter season was calculated as the proportion of summed landings during the weeks of the shorter season and landings actually made for that year in the longer season. The average landings of small salmon in the reduced season, 1993–1994, would have been 99.2% of the actual landings in SFA 1, 80.9% in SFA 2, and 83.9% in SFA 14B (1993–1994). Thus, landings of small salmon in 1995 may have been reduced by < 1 t in SFA 1; 2 t in SFA 2, and < 1 t in SFA 14B. Average landings of large salmon in the reduced season, 1993-94, would have been 91.5% of the actual landings in SFA 1, 52.0% in SFA 2, and 50.8% in SFA 14B. Thus, landings of large salmon in 1995 may have been reduced by < 1 t in SFA 1; 27 t in SFA 2; and 1 t in SFA 14B. Average total salmon landings in the reduced season would have been 93.8% of the actual landings in SFA 1, 59.0% in SFA 2, and 56.5% in SFA 14B. In general, landings of small salmon were reduced less than landings of large salmon and proportionally the landings in SFA 14B was affected the most and SFA 1 affected the least by the shorter season. Thus, the shorter 1995 commercial salmon fishing season in Labrador may have resulted in a reduction in landings of small salmon of 2.2 t (1,026 salmon) and large salmon 29.4 t (7,485 salmon) for a total of 31.6 t (8,511 salmon), an overall reduction in landings of 36%.

Quebec: Effects of the management changes in Quebec North Shore is also difficult to evaluate. In zones Q7 and Q8, the commercial exploitation rate in 1990–1992 was calculated to be 3%–4% for small salmon and 26%–33% for large salmon. The closure of the fishery in 1994 may have resulted in 86 to 121 small salmon and 866 to 1103 large salmon not being caught, assuming that exploitation rates in 1995 would have been the same as in 1990–1992, if there had been no management change.

Other Areas: Anon (1995/Assess:14) indicated that there was an increase in size-at-age and in the proportion of previously spawned 1SW and 2SW salmon in the returns to the Miramichi River. This observation is consistent with reduced commercial exploitation. Similar trends to those reported for the Miramichi have been reported for the Restigouche River. However, other factors such as natural mortality may have contributed to the decline in returns.

Although the Newfoundland and Labrador commercial salmon fisheries used to harvest small and large salmon with origins in Nova Scotia, New Brunswick, Québec, and USA, the benefits in returns to these provinces cannot be quantified. The estimates of returns of 2SW salmon to SFAs 19-23, Q1-Q11, and USA from 1992-95 are lower than the returns 1987-91 (Figure 5.2.3.2) which is inconsistent with a reduction in marine fishing mortality.

8.2 Suspension of Commercial Fishing Activity at Faroes since 1991

Since 1991, the Faroese fishermen have agreed to suspend commercial fishing for the salmon quota set by NASCO in exchange for compensation payments. The number of fish saved as a result of this suspension is the catch that would have been taken if the fishery had operated minus the catch in the research fishery (Table 4.1.2.1). The maximum catch that would have been taken is given by the quota, but in the three years prior to the suspension of fishing (1988-1990) the quota was not taken in full. If the fishery had operated in the 1991/1992–1993/1994 seasons, the quota is only likely to have been taken if there had been an increase in the availability of salmon in the area; an increase in the number of vessels operating or the amount of gear used; or more favourable fishing conditions permitting increased effort by each vessel.

The abundance of salmon in the fishery area does not appear to have changed significantly because there was no significant difference between the mean monthly CPUE for the three seasons before and after the suspension of commercial fishing (Table 4.1.3.1). (The CPUE data for the 1994/1995 season were not considered to be directly comparable because of changes in fishing practices.) The number of licences issued for salmon long-lining could not have been increased because the mean number issued between the 1988/1989 and 1990/1991 seasons (15.3) was approximately equal to the maximum of 15 licences allowable during the period of the suspension.. Although not all the licensed vessels actually fished in the period 1988/1989 to 1990/1991, it is not thought that a greater proportion of licensees would have fished in the period 1991/1992 to 1993/1994. Finally there is no evidence that conditions have been any better for fishing since 1991 than in previous years. In fact, in each year between 1992 and 1994, research fishing was impossible during January and parts of February due to poor weather.

The Working Group therefore considered that the mean annual catch for the 1988/1989 to 1990/1991 seasons (87,484 fish) provides the best estimate of the expected catch in each of the subsequent four seasons. The expected discard rate is obtained from the proportion of the research vessel catches that were below the minimum landing size of 60 cm (total length) (Table 4.1.2.3), and the mortality rate for these fish is assumed to be 80% (Anon. 1987/Assess:12). The mean number of fish killed in the research fishery in each of the last four seasons is estimated from the total catch (including undersized fish which were retained) minus the tagged fish which were released (Table 4.1.4.2). (The tagging mortality is unknown and is therefore ignored.)

Recent studies have indicated that, in some years, a substantial proportion of the fish caught in the Faroes fishery has been escapees from fish farms (Table 4.1.6.1). Since 1991, these fish have been estimated to comprise between 17% and 37%% of the fish caught in the area each year. Little is known about the origin of these fish or their behaviour, and it is unclear whether they will return to freshwater as readily as the wild fish. They are therefore treated separately in this analysis.

The expected age composition of the catch of wild fish may be estimated from the research vessel sampling conducted in the 1991/92 to 1994/95 seasons (Table 4.1.4.3). On the basis of an analysis of serum hormone levels in fish caught in the fishery, it has been estimated that 78% of the 1SW and two-sea-winter (2SW) fish, and 100% of older fish, in the Faroes area will mature in the same year (Anon. 1984/Assess:16). It is assumed that 97% of these will survive to reach home waters if they are not caught (assuming a natural mortality rate of 1% per month). The remaining 1SW and 2SW fish are assumed to mature in the following year, with 86% surviving to return to home waters.

The data described above have been used to estimate the expected additional numbers of salmon returning to home waters as a result of the compensation arrangements in the Faroes fishery (Table 8.2.1). This suggests that between 1,600 and 10,000 extra 1SW salmon and between 40,000 and 68,000 extra MSW salmon returned each year from 1992 to 1995. In addition, nearly 90,000 extra farmed fish are expected to have been saved from the Faroes fishery in the four seasons of the suspension. It is not known whether these fish will have returned to the areas from which they escaped. If so, and assuming the number of escapees is proportional to the production in each country, about 70% of the survivors might be expected to return to Norway and 20% to Scotland.

Estimates of the total numbers of MSW salmon returning to homewaters in the NEAC area and to countries in Northern and Southern Europe separately are provided in Table 10.2.1 to 10.2.3. The additional returns of MSW fish represent 2% to 5% of the total estimated returns to homewaters in the NEAC area in 1992, increasing to 5% to 10% of the returns in 1995. However, analyses of smolt tagging data (e.g. Anon. 1993/Assess 10) and preliminary results from the adult tagging studies (Table 4.1.5.3) suggest that the majority of the MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. Assuming that 75% of the saved wild fish returned to these countries, they will have represented 3% to 7% of the returns of MSW fish in 1992, increasing to 7% to 14% in 1995. Total catches will have been expected to increase by approximately the same proportions in the respective areas.

Catches in homewater fisheries in four areas of Europe (Table 8.2.2) were examined to see whether here had been a significant change following the suspension of fishing at Faroes in 1991. The only significant change was a reduction in catches of 1SW salmon in Norway (Rcrit, p = 0.988) and in southern Europe (Ireland UK(England & Wales, UK(Scotland) and France) (Rcrit, p = 0.902). (It should be noted that catches of MSW salmon in Europe in 1994 and 1995 should also have been affected by the suspension of salmon fishing in Greenland). Although the additional returning fish are expected to have contributed to catches and spawning stocks, it appears that any increase in catches has been too small to be detected as a statistically significant change above the normal annual variation or has been masked by other factors such as changes in marine survival or exploitation rates in homewaters.

8.3 Suspension of Commercial Fishing Activity during 1993 and 1994 at West Greenland

Since 1993, the quotas set for the West Greenland fishery have been calculated using the formula developed by the Working Group and agreed by NASCO. The fishermen suspended commercial fishing activity in 1993 and 1994 in accordance with an agreement between the Organisation of Hunters and Fishermen in Greenland and the North Atlantic Salmon Fund, although a small subsistence fishery was allowed to continue.

The 1993 quota agreed by NASCO for the West Greenland fishery was 213 t, based on a predicted pre-fishery abundance of 258,000 North American non-maturing 1SW fish. The actual abundance was subsequently estimated to be between 100,000 and 201,000. Although this pre-fishery abundance was very low, it is reasonable to assume that the quota could have been taken, because a catch of 237 t was taken when the estimated pre-fishery abundance was between 123,000 and 232,000 in 1992. In 1994, the quota was further reduced to 159 t, although the predicted pre-fishery abundance of North American 1SW fish had increased to 280,000. Thus it is assumed that this quota could also have been taken in full.

The following parameters were used to estimate the numbers of North American and European fish that would have been landed in the fishery if it had operated. Because no sampling took place in the fishery in 1993 and 1994, these values have been derived from sampling programmes conducted in earlier years.

The proportion of N American fish =	PropNA =	0.54
The mean wt of N American 1SW fish =	WT1SWNA =	2.525 kg
The mean wt of European 1SW fish =	WT1SWE =	2.660 kg
Combined mean weight =	(PropNA*WT1SWNA + (1-PropNA)*WT1SWE) =	2.587 kg
Age correction factor =	ACF =	1.121

The catch is divided by ACF to estimate the weight of MSW fish that would have been caught. The weight is then divided by the mean weight of 1SW fish (2.587 kg) to give the total number of 1SW fish saved. This number needs to be raised to take account of non-catch fishing mortality. Unrecorded catches in the subsistence fishery continued in 1993 and 1994, but unseen mortalities resulting from the operation of the drift nets (e.g. fall-out and haul back losses) should be added to the estimated catch. Estimates of some of these losses have been provided previously by the Working Group (Anon. 1982/Assess:19). Based upon the mid-points of the ranges given, the additional losses are thought to be of the order of 16% of the total fishing mortality. About 95% of the West Greenland catch comprises 1SW fish, the remainder being older fish or previous spawners. The total number of fish saved is therefore estimated by dividing the number of 1SW fish by 0.95.

The proportion of fish farm escapees found in catches of salmon taken at West Greenland have been negligible (~1%) (Anon. 1994/Assess:16) and so no account of these is taken in this assessment.

All of the salmon saved from the Greenland fishery would be expected to return to home waters as MSW fish in the year after the fishery. Fish are assumed to take an average of 11 months to return to home waters, and so the survival rate for returning fish is estimated to be about 90% (assuming a natural mortality rate of 0.01 per month).

The data described above have been used to estimate the numbers of additional salmon returning to home waters in 1994 and 1995 as a result of the suspension of fishing in the West Greenland fishery in 1993 and 1994 (Table 8.3.1). These results suggest that around 45,000 additional fish should have returned to North America in 1994 and 33,000 in 1995 about 95% of which would have been 2SW fish. These values represent 30% to 52% of the estimated return of 2SW salmon to North America in 1994 and 21% to 38% in 1995.

The additional numbers of salmon returning to Europe are estimated to have been about 38,000 and 28,000 respectively. The results of smolt tagging experiments conducted over the past 25 years and adult tagging studies in the early 1970s suggest that the majority of the European salmon would have returned to rivers in UK(Scotland), UK(England & Wales) and Ireland. Assuming that all of the saved wild fish returned to these countries, they will have represented 5% to 10% of the returns of MSW fish in 1994, and 4% to 9% in 1995.

The total catch in these countries would have been expected to increase by approximately the same proportions, assuming that all populations make the same proportional contribution to the West Greenland stock and there were no changes in the fisheries. Catches of MSW salmon in homewater fisheries in northern and southern Europe were examined to see whether here had been a significant change in 1994 and 1995 following the suspension of fishing at Greenland in 1993 and 1994 (Table 8.2.2). No significant changes were detected. Data for North America were not analysed because any increase was likely to be masked by the changes in management measures in recent years. Although the additional returning fish are expected to have contributed to catches and spawning stocks, it appears that any increase in catches has been too small to be detected as a statistically significant change above the normal annual variation or has been masked by other factors such as changes in marine survival or exploitation rates in homewaters.

9 ASSESSMENT ADVICE FOR WEST GREENLAND COMMISSION AREA

9.1 Spawning Targets for North American Stocks

9.1.1 Review of age specific target spawning level in Canadian rivers

In eastern Canada, conservation for salmon is defined as follows:

> "That aspect of renewable resource management which ensures that utilisation is sustainable and which safeguards ecological processes and genetic diversity for the maintenance of the resource concerned. Conservation ensures that the fullest sustainable advantage is derived from the resource base and that facilities are so located and conducted that the resource base is maintained". (CAFSAC 1991).

The operational translation of conservation for eastern Canada and USA is based on an egg deposition rate of 240 eggs.100 m^2 of fluvial rearing habitat and in addition for insular Newfoundland, 368 eggs.ha^1 of lacustrine habitat; for the Northern Peninsula of Newfoundland (SFAs 3 and 14A) and Labrador, 105 eggs.ha^1 of lacustrine habitat is used. Targets for rivers are defined in terms of eggs and can be translated into numbers of adults using average values of biological characteristics of the stock.

In 1993, the Working Group provided estimates of target numbers of large salmon spawners required in North America (Anon. 1993/Assess 10). Egg targets are generally derived using habitat information from rivers and also, in the case of insular Newfoundland, lakes. Derivation of optimal spawning numbers of 2SW salmon continues to be problematic because it requires some estimate of the desired sea-age composition of spawners. Table 9.1.1.1 shows targets for Canada updated from those presented in Anon. (1995/Assess 14).

Targets for Labrador were updated by using new catch statistics for SFAs 1 and 2 and including SFA 14B for the first time. Spawner requirement was calculated for the three SFAs as a unit and subdivided on the basis of the proportionate parr-rearing habitat in each SFA. The proportions of total parr rearing habitat for SFAs 1, 2, and 14B are 0.23, 0.73, and 0.04, respectively. The recruit:spawner value of 0.3 used in the Labrador calculations was maintained since there was no new information forthcoming that warranted changing this parameter.

For some SFAs, target estimates are presented for 2SW salmon the first time; previously used values were for the large salmon category as a whole. The amount of lacustrine habitat has been determined for rivers in SFAs 4, 5, 9, and 10, and consequently, target estimates derived from Anon. (1986) for these areas have been replaced.

Estimates for the remaining SFAs and for zones Q1-Q10 in Quebec, are adjusted using updated habitat measurements and/or biological data. For the Restigouche River (SFA 15), Quebec waters are removed from the target estimate. Estimates of targets for pH impacted areas in SFAs 20 and 21 have been included this year as well as an estimate for SFA 22. The target for SFA 23 does not include St. Croix River, which is included in estimates for USA. Estimates provided this year are point estimates and do not include minimum and maximum values as was the case in the past.

The overall target number of 2SW spawners for Canada is now 151,296. This represents a marginal decrease (4%) from the target of 157,287 used in 1995 (Anon. 1995/Assess 14). Most (84%) of the 2SW North American target spawner escapement is required for rivers in Canada. The revised overall target for North America is

180,495, a decrease of 3% from the previous estimate (186,486). These 2SW target requirement estimates result from an extensive review of the best information available at the present time.

9.1.2 Managing fisheries based on fixed escapement targets

Atlantic salmon in eastern Canada are managed on the basis of fixed escapement targets. For individual rivers, an egg deposition requirement is established. Since the management of fisheries involves managing for fish escapement, the target eggs are converted to the number of salmon required to achieve that egg deposition using the average biological characteristics of the stock, including the proportion of female fish. For example, if 50% of the salmon returning to a river are female and the river requires 100 females to achieve the target egg deposition, then the required number of spawners to meet target eggs is 200 fish (100 / 50%). The management of fisheries must consider the probability of obtaining at least the required number of fish to achieve the required egg deposition. Since only females contribute eggs, managers should consider managing fisheries to ensure that the appropriate number of females are available for spawning.

The conservation definition considers the importance of stock complexes and the probabilities of attaining the minimum spawning escapement to all rivers.

The Working Group reviewed a theoretical analysis of the probabilities of achieving female spawning escapement for different stock sizes and stock complexes. The derivation of the probabilities is based on the binomial probability of a fish released from a fishery being female. The calculation of the exact probabilities is not direct when the question relates to the probability of obtaining at least two females, at least three females, etc. in a sequence of fish released from a fishery. These probabilities were approximated using Monte Carlo techniques.

The Monte Carlo analysis involves simulating the release of a number of fish into the river. For a river comprised of only one stock, we are only concerned with whether the fish released is a female. As the fish are released, the sex is determined using simple binomial probability (Table 9.1.2.1). In the examples, a sex ratio of 80% female was assumed; this represents the sex ratio of the 2SW spawning group in most stocks of North America. After all the fish are released, the total females released is calculated and a score of 1 is assigned if the target females is achieved or exceeded, 0 if female escapement is below target. This is repeated a large number of times (500 to 1000 times) and the probability of achieving the target escapement for a given number of fish released is simply the sum of the large realisations divided by the total.

For the multiple stocks example, when a fish is released from the fishery, it is assigned to a stock as follows:

Stock 1: $0 < a <= (1/n)$
Stock 2: $(1/n) < a <= 2*(1/n)$

Stock n: $(n-1)(1/n) < a <= 1$

where a = uniform random number
n = number of stocks in the river

Stocks of different size are accommodated by adjusting the probability intervals according to the relative size of the stocks. After the fish is assigned a stock designation, its sex is assigned as in the single stock scenario (Table 9.1.2.1).

Effect of target population size on relative additional spawners to be released

There is essentially no chance of obtaining at least the target number of females if the total fish released equals the number of females required (Figure 9.1.2.1). Releasing the number of salmon equal to the number of females required divided by the expected sex ratio for females provides a 50% probability of obtaining at least the minimum number of females. This is independent of the target population size (Figure 9.1.2.2). To reduce the risk of female spawner underescapement, more fish must be released, the additional releases being a relatively decreasing proportion of the target escapement level for the river as the size of the stock (target number of fish) increases.

Effect of stock complexes

In this scenario, it was assumed that all the areas of the river are producing to their potential. When we partition the river into subcomponents which may describe genetically distinct populations or simply production areas within a large river, then the number of fish which must be released from the fisheries to ensure that all the subcomponents receive at least the minimum required number of females also increases (Figure 9.1.2.3). As in the single stock example, as the absolute target size increases, the relative increase in required escapement from the fisheries declines (Figure 9.1.2.4).

The total 2SW spawner target for North America is 180,495 fish (Table 9.1.1.1). Using the weighted sex ratio for the six major areas of North America, 0.72 female proportion (Table 9.1.2.2), the target number of females for North America is 129,956 fish. For this single stock unit, releasing 130,000 fish to the rivers results in no chance of meeting the female target escapement (Figure 9.1.2.5). Releasing 180495 fish results in a 50% chance, the expected value, of meeting minimum female targets. For a probability level of 0.75 of meeting or exceeding the female target escapement, 180,700 fish must be released (0.1% increase) while at the 0.90 probability level, 184750 fish would have to be released (0.2% increase).

Considering the six main geographic areas in North America (Labrador, Insular Newfoundland, southern Gulf, Quebec, Scotia-Fundy, and USA) releasing 180495 fish (the North American target) to the river results in no chance of meeting the target female escapement in all geographic areas. At the 50% probability level, 182250 fish must be released, a 1% increase from the same probability level if North America is treated as one stock unit. For 75% and 90% probability levels, 1.5% and 2.4% more respectively must be released. Canadian 2SW targets could be divided on yet finer scales. Canada has 23 Salmon Fishing Areas (SFA) and 11 Fishing Zones in Quebec. Using 24 stocks (combining all the SFAs of insular Newfoundland into one unit, except for SFA 13), the probability of achieving the minimum number of females in each stock unit is 0.5 at an escapement level of 188,500 fish. A total of 191500 fish are required for a probability level of 0.75 and almost 194000 fish are required at a 0.90 probability level (Figure 9.1.2.5).

The analysis incorporated the variance associated with a fish being male or female. This variation is greatest when the sex ratio is almost 50:50 (variance of a binomial variable is proportional to $p * q$ where p = probability of being female and q is probability of not being female). For several of the 2SW stocks, the proportion female is in the order of 0.75 to 0.85. A proportion female of 0.72 was used in the North America 2SW modelling which partly explains why the probability increased so rapidly over a narrow range of fish escapements. This variation represents only part of the annual variation in biological characteristics of Atlantic salmon. There is ample evidence to suggest that characteristics such as proportion female varies annually within a stock. Other stochastic variation which should and could be simultaneously considered include variance in size and fecundity. This additional uncertainty has implications on the probabilities of meeting or not meeting the target egg deposition for the current year, even under perfect regulation of fisheries.

Acknowledging that conservation can only be achieved when production is occurring in all the available habitat (or by all the sub-stocks in the river), consideration should be given to the complexity of the river system and the number of distinct production areas which must be seeded. As the number of these areas increases, the required number of fish which should be released from the fisheries must also increase to reduce the risk of violating the conservation objectives.

9.2 Development of Catch Options for 1996 and Assessment of Risks

9.2.1 Overview

The Working Group was asked to continue with the development and evaluation of methods to advise on catch levels based upon maintaining adequate spawning biomass. The problems of estimating the total allowable catch (TAC) for salmon have been examined by the Working Group in previous years (Anon., 1982/Assess:19, 1984/Assess:16, 1986/Assess:17, 1988/Assess:16) and were repeated in the two last Working Group reports (Anon., 1993/Assess:14, 1994/Assess:16, 1995/Assess:14). Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed stock fisheries are still relevant. In principle, reductions in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mean mortality on the contributing populations. However, benefits that might result for particular stocks would be difficult to demonstrate, in the same way that detriments 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 (Anon. (1993/Assess:10); Sections 5.3 and 5.4). The aim of management would be to limit catches to a level that would facilitate achieving overall spawning escarpment equivalent to the sum of spawning targets 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 limitation introduced.

The advice for any given year is 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. Commercial gill net fisheries in Greenland and Labrador harvest one-sea winter (1SW) salmon about one year before they mature and return to spawn in North American rivers. This component has also been harvested on their return as 2SW salmon in commercial fisheries in Labrador and Québec, angling and native fisheries throughout eastern Canada and angling fisheries in the northeastern USA.

The Working Group has advocated models based on thermal habitat in the northwest Atlantic to provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, which was the first year that catch advice was provided, the models themselves have varied slightly over the years. The changes have been made to these models in attempts to improve the prediction and add more biological reality. Alternate models discussed in Anon. (1995/Assess:14) included the possibility of including spawners in the predictive relationship. Thus, the prediction of pre-fishery abundance could be moderated during periods of high levels of habitat and low levels of spawning stock or for the alternate case. The Working Group continued the process of model improvement at this meeting. Previous years models included using the following as predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; and 1995 - thermal habitat in January, February, and March.

Biological rational for catch advice model

The Working Group had previously addressed in some detail the wide range of factors both abiotic and biotic that could influence survival of salmon in the sea (Anon. 1993/Assess:10, Anon. 1994/Assess:16). The first of these factors began with possible influence of freshwater phase on subsequent marine survival by varying size and condition of salmon smolts that enter the sea. Furthermore, factors at work in coastal areas and finally those that would influence survival in the open sea over their entire life history are also shown. As can be seen by reference to (Section 5.2.4) sea survival in many stocks continues to be at near or record low levels in many of the time series available to the Working Group.

The Working Group briefly reviewed the biological rational for the catch advice model first used in Anon. (1993/Assess:10) and updated in Anon. (1995/Assess:14). The hypothesis tested was that the marine habitat available for salmon in the northwest Atlantic at some time prior to the end of their first winter at sea directly related to the numbers of 2SW salmon produced. In this analysis, a relative index of marine habitat thought suitable for salmon (termed thermal habitat) was determined for the months of January, February, and March by weighting salmon catch rates from experimental fishing and sea surface temperature data. Analysis of variance indicated that pre-fishery abundance was significantly related to thermal habitat in all of these months. At the 1995 meeting, the Working Group examined the possibility of using the summed thermal habitat for January, February, and March (winter) which would have the advantage of broadening the basis for the predictive relationship and would be less subject to variations in the monthly habitat data (Anon. 1995/Assess:14. The relationship using thermal habitat summed for the months of January, February, and March also was chosen for prediction because it had the best correlation.

However, it is recognized that we have not identified biological mechanisms to account for the observed relationship with changes in abundance.

North American Run-Reconstruction Model

The Working Group has used the North American Run-Reconstruction Model to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West

Greenland fishery (See Section 5.2.2). Region-specific estimates of 2SW returns are listed in Table 5.2.3.2. Estimates of 2SW returns in Labrador are derived from estimated 2SW catches in the fishery using a range of assumptions regarding exploitation rates and origin of the catch. For 1993, 1994, and 1995 returns, the estimates were further adjusted to account for reductions in licensed fishing effort in Labrador (See Section 8.1).

Update of thermal habitat

The Working Group has been using the relationship between marine habitat and pre-fishery abundance to provide catch advice for the west Greenland fishery Anon. (1993/Assess 10, 1994/Assess 16, 1995/Assess14). Marine habitat is measured as a relative index of the area suitable for salmon overwintering, 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 Anon. 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 1996 data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in both the February and winter thermal habitat data (Table 9.2.2.1 and Figure 9.2.1.1). Available habitat has increased in 1996 over 1995 in both the February and winter data. The 1996 value is the highest value in the previous six years of the time series. The relationship between thermal habitat in February and winter months is linear (Figure 9.2.1.1).

9.2.2 Forecast model for pre-fishery abundance of North American 2SW salmon

Previous models used by the Working Group to forecast pre-fishery abundance were based on regression analysis to predict the pre-fishery abundance of non-maturing 1SW fish prior to the start of the Greenland fishery using thermal habitat summed for January, February, and March as a predictor variable (Anon. 1995/Assess: 14). 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 (Scarnecchia, 1984; Reddin and Shearer, 1987; Friedland *et al*, 1993). Consequently, the model used in 1995 was updated to reflect the addition of the 1971-73 and 1996 values to the time series of pre-fishery abundance estimates.

The results of fitting the new values to the model used in 1995 shows an improvement in fit (Figure 9.2.2.1). The relationship being tested is between pre-fishery abundance and winter thermal habitat summed for January, February, and March as predictor variables (termed H123) and was significant at less than the 5% level (R^2=0.63, $F(1,22)$=36.9). The predicted values for pre-fishery abundance by the winter thermal habitat method and the observed abundance for 1971–1994 are shown in Table 9.2.2.1 and Figure 9.2.2.2. The predicted values are shown to fit the observed data quite well except during the period of low abundance in 1978 and in the late 1980s and 1990s when abundance was low. The forecasted estimate of pre-fishery abundance for 1996 using this model are about 342,000 at the 50% probability level (Table 9.2.2.1).

Concern was expressed by the Working Group that in all but one year since 1988 the residual values have been negative (Table 9.2.2.1 and Figure 9.2.2.2); indicating that the actual values are considerably lower than those predicted. If this trend continues in 1996 then the actual pre-fishery abundance will be considerably lower than the forecasted value of 342,000 fish. Consequently, the Working Group examined alternate models that could be used to better predict pre-fishery abundance and reduce the pattern of negative residuals in the last few years. Several models were examined but the best of these alternate models was one that included an index of lagged spawners (Anon 1993/Assess:10 and Anon 1994/Assess:14) from Scotia-Fundy, Newfoundland, Labrador and Quebec and thermal habitat in February (labeled H2-SNLQ) (R^2=0.68, $F(2,14)$=14.8). Lagged spawners were not included for Gulf of St. Lawrence rivers due to the lack of a significant relationship. The Working Group viewed the spawner variable as an indicator of the change in potential smolt production for the complex. The exclusion of Gulf spawners did not seem unreasonable since that area has achieved target egg deposition in recent years. However, the other regions that were included have not achieved target egg depositions in recent years and the variation in spawner number below the targets would be expected to be resulting in a more variable level of smolt production.

Based on the superior pattern of residuals in the last six years (Table 9.2.2.1 and Figures. 9.2.2.1, 9.2.2.2 & 9.2.2.3) the Working Group advocated that the latter model be used to provide catch advice. The H123 model predicted a 7-year average (1988-94) of about 324,242 fish while the H2-SNLQ predicted 267,970 fish which compared much better to the actual average of 234,944 pre-fishery abundance. Another perceived advantage of this alternate model is that it includes the influence of the spawning stock level in the predictive relationship for pre-fishery abundance. Thus, the prediction of pre-fishery abundance would be moderated during periods of high levels of habitat and low levels of spawning stock. The alternate case would be an increase in predicted pre-fishery abundance when stocks were high and thermal habitat was low.

Stochastic Analyses

Although the exact error bounds for the estimates of N1(i) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Monte Carlo methods, implemented in the software package Risk (Pallisade, 1992), were used to simulate the probability density function of N1(i).

Simulated values of N1(i) were also used to evaluate the distribution of mean values for the regression models between pre-fishery abundance and winter thermal habitat.

To estimate the composite error distribution of the 200 realizations, it was assumed that the forecast was distributed normally, with a mean equal to the forecast and variance equal to the mean square error of the estimate. The composite sampling distribution for the forecast was estimated as the sum of the underlying distributions for each stochastic realization j:

Eq. 9.2.2.1 $$F_C(N1_{FOR}(1996), s_C^2) = S_{j=1,200}\, F_j(N1_{FOR}(1996)_j, s_j^2)\,/200$$

where F( ) is the normal probability density function. As previously, integration of the normal distributions was approximated using the trapezoidal rule (Press *et al.* 1986).

The sampling distribution of the composite stochastic forecast, i.e. $F_C(N1_{FOR}(1996), s_C^2)$ was used to compute forecast values in 5% percentile steps from 25% to 75%. The 5% percentiles are used for computation of alternative quotas under varying levels of risk where risk refers to the probability that the spawning target $R2_T$ will not be met.

The stochastic forecasts permitted the estimation of the cumulative distribution function for each forecast (Table 9.2.2.2 and 9.2.2.3). These estimates can be used to quantify the probability that the actual stock is above the relative probabilities of attaining spawning targets for the stock under different allocation schemes. Managers may also use this information to determine the relative risks borne by the stock (i.e. meeting spawning targets) versus the fishery (e.g. reduced short-term catches).

9.2.3 Development of catch options for 1996

Development of Catch Advice

To prevent recruitment overfishing, the goal in Atlantic salmon management is to ensure adequate numbers of spawners in each river population. In mixed stock fisheries, this is not possible owing to varying migration patterns and exploitation rates experienced by individual stocks. Nonetheless, it is possible to define a composite spawning target for the North American stock complex by summing the spawning targets of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawning targets are provided in Anon. (1993/Assess:9) and in Section 9.1 of this report.

The procedure used to compute an allowable harvest is unchanged from the previous assessment and is shown in Appendix 14.

The assessment models used for the provision of catch advice are based almost entirely upon data for North American stocks. While it is believed that European stocks are generally less vulnerable to the West Greenland fishery than North American stocks, there has been evidence of a more rapid decline in these stocks, in the West Greenland area at least, than the North American stock (Anon., 1993/Assess:10). The Working Group therefore emphasised the importance of continued development of similar assessment methods for the stocks in the North East Atlantic area.

Catch Advice for 1996

The fishery allocation for West Greenland is for 1SW fisheries in 1996, whereas the allocation for North America can be harvested in 1SW fisheries in 1996 and/or in 2SW fisheries in 1997. To achieve the spawning management goal, a pool of fish must be set aside prior to fishery allocation in order to meet spawning targets and allowing for natural mortality in the intervening months between the fishery and spawning migration. The Working Group identified 180,495 fish as the spawning target for all North American rivers (Table 9.1.1.1). Thus, 201,483 pre-fishery abundance fish must be reserved (180,495 / exp(-.01*11)) to ensure achievement of the target after natural mortality.

By using the probability density function of the pre-fishery abundance, the probability of the true stock abundance being greater or lower than the value selected can be estimated. This probability level also provides a measure of the probability of reaching escapement targets assuming fishery allocations are taken without error. The mean estimate of the forecast represents a reference point at which there is a 50% chance that the true abundance is lower than required to achieve the spawning target. Likewise, the forecast value at the 25th percentile, or the value with a 25% chance that the abundance is lower and the forecast value at 75th percentile, or the value with a 75% chance that the abundance is lower, characterise the range of decision with lower and higher risks, respectively.

Quota computation (Eq. 9.2.2.1) for the 1996 fishery requires an estimate of pre-fishery abundance [N1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea age composition of the total landings [ACF]. Exponential smoothing model forecasts utilising data collected during the 1995 fishery and using interpolated values for 1993 and 1994, with approximate 50% confidence limits, are summarised below.

Parameter	Forecast	Minus 1SE	Plus 1SE
PropNA	0.592	0.506	0.678
WT1SWNA	2.420	2.268	2.572
WT1SWE	2.620	2.430	2.810
ACF	1.133	1.030	1.236

The Working Group recommends that as these parameters have changed in the past, they should be updated with new data from sampling programs to insure the greatest possible accuracy in the quota calculation.

Greenland quota levels for both the H123 and H2-SNLQ forecasts of pre-fishery abundance were computed. The quota values based on the H123 forecast between interquartile limits of the probability density function are presented in Table 9.2.3.1. For the point estimate level (i.e. 50% level) and the stochastic regression estimate using NN1, the quota options ranged from 0 to 1,094 t, depending on the proportion allocated to West Greenland (Fna). For the Fna level used in recent management measures for the West Greenland Commission (0.4), the quota is 271 t at the 50% risk level. The lower pre-fishery abundance forecast realised with the H2-SNLQ model resulted in a set of lower quota levels (Table 9.2.3.2). The range of quota values was 0 to 275 t and the quota based upon an Fna value of 0.4 also at the 50% risk level would be zero. Considering the improved model diagnostics and the incorporation of the stock size variable, the Working Group advocates the use of the H2-SNLQ model for the 1996 1SW and 1997 2SW fisheries.

The 50% risk level is intended to produce spawning escapements in North America that will meet the target level for all rivers combined 50% of the time. Even if this overall target is achieved, it is likely that some stocks will therefore fail to meet their individual target spawner requirements while others will exceed target levels. This may result from random variation between years or from systematic differences in the patterns of exploitation on fish from different rivers or regions. In the latter case, adoption of a 50% risk approach may result in some stocks failing to meet target levels over an extended period if the full TAC is harvested. This would be likely to result in the long-term decline in those stocks.

The Working Group reiterates the advice given in 1995, that it is evident from both the indicators of stock status and the extremely low quota levels computed under either forecast model, that the North American stock complex is in tenuous condition. We are observing record low abundance despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below target spawning escapements for 2SW salmon, and some of the lowest marine survival rates for monitored stocks. The increasing advantage associated with each additional spawner in under-seeded river systems make a strong case for a conservative management strategy.

9.2.4 Risk assessment

In addition to the uncertainty in the pre-fishery abundance forecast, there is a risk to conservation of not meeting target escapement for North American stocks. This risk involves the selection of the spawning target, the expected recruitment back to the stock areas and additional management error.

Management of the West Greenland fishery is currently based upon treating North American salmon as part of a single stock. In Section 9.1.2 we have considered the effect of basing management upon a larger number of stocks (6 or 24). When 6 stocks were considered for North America, the total target spawning escapement should be increased to 182,250 fish at the 50% risk level of achieving minimum female escapement(relative to 180,495 for one stock complex) but the target levels rises slightly to 184,750 fish at the 90% risk level. The more diverse stock complex comprising 24 groups requires an escapement from the fisheries of 188,500 fish at the 50% risk level, 191,500 at the 75% risk level or 194,000 at the 90% risk level (Section 9.1.1).

In terms of deciding the amount of fish to be harvested, consideration should be given to the expectation of meeting spawning escapement targets in North America based on the estimated pre-fishery abundance and the relative proportions of the stocks contributing to the recruitment. The estimation of the lagged North American spawner abundance contributing to the pre-fishery abundance in 1996 was presented in Section 5.2. Within the stocks from Canada, the southern Gulf stocks are expected to contribute just under 50% of the recruitment and Quebec about 23% (Table 9.2.4.1). The proportion of the 2SW target fish expected in the absence of fisheries can be derived directly from the pre-fishery abundance values, the proportion of the lagged spawners in each stock area and the target for these areas. Examples are presented in Table 9.2.4.1.

Perhaps of more value is what the escapement levels to North America should be in 1996 (for the 1997 2SW spawning escapement) to ensure that all the stock areas attain the spawning targets (Figure 9.2.4.1). For the 5 stocks of Canada, the 50% risk level of achieving spawning escapement in all the areas requires a total escapement of 464000 fish and almost 468000 for a 90% chance of meeting all the Canadian targets. The USA contributions are so low and were excluded from this analysis. When included, the required pre-fishery abundance required to meet all 6 area targets is essentially unattainable. Releasing these fish to the rivers will result in some stocks just meeting target while several others would be immensely over-populated (Table 9.2.4.1). These surpluses to targets could be fished closer to home without impacting on the populations in the areas which are under-escaped.

Consideration must be given to releasing fish to rebuild the under-escaped areas. The quota advice should consider the impact of harvesting fish versus releasing them to homewaters on the anticipated proportion of stock areas which will approach or exceed their targets.

This analysis indicates that the allowable catch would have to be decreased to increase the probability of achieving desired numbers of female MSW salmon in separate stock areas in North America. The Working Group recommends that this method is given further consideration.

10 ASSESSMENT ADVICE FOR THE NORTH-EAST ATLANTIC COMMISSION AREA

10.1 Estimates of Age Specific Spawning Targets

10.1.1 Progress with the development of targets in countries in the NEAC area

In Section 4.3.1, data are presented on 7 rivers for which spawning targets have been established in the NEAC area. The Working Group reviewed the current status of programmes to develop spawning targets in countries in the North East Atlantic area.

Finland: There are no immediate plans to develop spawning targets for Finnish rivers.

France: Spawning targets have been set in 1995 for 25 rivers in Brittany and southern Normandy, an area where 80% of the salmon are caught in France, and for the River Nivelle in the south-west. The method used to define these targets is described below. Targets for the River Scorff and Nivelle, where escapement data are available have been met in all years since the beginning of the data set. It is expected that targets will be available for most rivers in France in 1996, including the Loire, Garonne and Dordogne, and a few in northern Normandy.

Iceland: Habitat surveys are currently being carried out to estimate productivity in some Icelandic rivers, with a view to developing spawning targets for these rivers at least. However, in the short term it will not be possible to estimate a total spawning stock target for Icelandic rivers.

Ireland: Stock and recruitment of estimates have been developed for Burrishoole River catchment based on a full upstream and downstream counting facility. These estimates have proved problematical in applying to other Irish river systems due to problems within the catchment which may have altered the relationship over the time period examined.

The concept of managing salmon stocks by Total Allowable Catch (TAC) and quotas based on spawning target estimates for individual rivers is being considered at present. While it is recognised that there is a lack of basic information for the majority of Irish Rivers, progress has been made in developing tentative targets for approximately 40 Irish rivers mainly in the Northern Region and using the spawning targets derived for the River Bush (UK, N. Ireland).

There are currently at two studies being undertaken to establish catchment management plans for Irish rivers using Geographical Information Systems to describe the basic habitat types available in each catchment, the juvenile productivity and the likely spawning target applicable based on the results of habitat surveys and electrofishing surveys. One of these projects is a joint project with UK (N. Ireland) on the River Erne system, one of the largest catchments in Ireland.

Norway: A spawning target is being developed for the Imsa and work is being carried out on the relationship between smolt production and targets. However, as there are over 600 salmon rivers in Norway, it is acknowledged that there will be substantial work involved to complete the task.

Sweden: Attempts have been made to set spawning targets for a tributary of the River Ätran. Due to inconsistencies in the data this has proven difficult. However, the data give no evidence that the relatively low number of smolts in recent was due to a lack of spawners.

UK (England and Wales): Salmon management in England and Wales already includes the concept of managing on the basis of targets. Preliminary targets have already been developed for all Welsh rivers and a number of English rivers on the basis of estimates derived for the River Bush (UK, N. Ireland). A particular problem in the Welsh region is that both salmon and sea trout share the available habitat and this may mean that the preliminary targets are too high.

UK (N. Ireland): Spawning targets have been established for the River Bush and it is envisaged that further targets will be developed for other rivers within N. Ireland and those rivers which are jointly managed by Ireland and N. Ireland.

UK (Scotland): Spawning targets cannot be set for the majority of Scottish rivers because there is a lack of information on adult returns, juvenile productivity and available habitat for production. Considering the number of rivers, it would require significant effort and resources to obtain this information.

The Working Group noted that the forthcoming Workshop on Spawning Targets to be held in France in June 1996 should provide assistance to workers developing spawning targets in the NEAC area.

10.1.2 Spawning targets and catch advice for the rivers of Brittany and Lower Normandy (Massif Armoricain) in France

Starting in 1996, a new management system has been set up in France for the rivers of the Massif Armoricain (Brittany and Lower Normandy). Founded on the definition of spawning targets and Total Allowable Catch (TAC) on a river per river basis, it includes an in-season management procedure, the TACs being adjusted during the fishing season according to the information available on the abundance of the adult returns of the current year. The TAC is a considered a removable surplus, i.e. the production above the spawning target and the corresponding targets is the egg deposition which maximises the long term average surplus. The methodology and procedures used are described by Prevost and Porcher (1996) and Porcher and Prevost (1996) and are summarised in Figure 10.1.2.1.

This new system attempts to conform to two principles :

- provide the best advice possible based on the scientific knowledge in hand; and
- give maximum opportunities for improvement if more accurate information becomes available.

For each river system, a spawning target is defined by taking into account:

- its size, *i.e.* the surface area available for juvenile production, its carrying capacity, *i.e.* its maximum average production per unit of juvenile rearing habitat.
- its productivity, *i.e.* its ability to convert an egg deposition into a production of fish available for exploitation, (which in turn depends mainly on survival rates from egg to adult back to freshwater).

The size of the system is quantified into standard units (m^2 of riffle/rapid, the preferred habitat for juveniles). This standardisation of the way of measuring the size of each river is derived from current scientific knowledge about habitat preferences of salmon juveniles in the rivers of the Massif Armoricain. The wetted surface area of each system is partitioned into three categories:

- the deep and very slow flowing sections, *i.e.* the pools.
- the running water sections with laminar flow, *i.e.* the glides or flats.
- the running water sections with turbulent flow, *i.e.* the riffle/rapids.

Based on the ratio of juvenile densities (electrofishing data), it is considered that 1 m^2 of riffle/rapid is equivalent to 5 m^2 of glide. The pools are neglected because they are regarded as not contributing to juvenile production. The size of each river system can be estimated from field habitat survey data or, failing that, by means of a linear regression of the wetted surface area expressed in m^2 of riffle/rapid equivalent against the catchment surface area.

Carrying capacity and productivity were examined using an analysis of the stock/recruitment data currently available from the Oir River (Tables 4.3.2.1 and 4.3.3.1). Based on this analysis, surplus production is maximised (on average in the long term) at an egg deposition of 4.75 eggs/m^2 of riffle/rapid equivalent. This figure is considered to be conservative because the productivity of the Oir system is lowered by human activity impact.

The spawning target of each river system of the Massif Armoricain is then obtained by multiplying its size in m^2 of riffle/rapid equivalent by 4.75 eggs/m^2. Together with spawning targets, catch advice is also provided to managers for each stream, taking into account:

- the long term average removable surplus obtained when escapement is at the spawning target level, which corresponds to an excess production of 3.5 eggs/m^2 of riffle/rapid equivalent.
- the average status of each stock, to separate the stocks where escapement is considered above target in most years from the stocks where escapement is chronically below target.
- the yearly status of the stock, allowing good, average and bad years to be distinguished.

Based on these elements, catch advice follows three steps:

1. the long term average removable excess production expressed in eggs is converted into fish numbers, what gives a *theoretical TAC*. A range of options are provided according to the grilse/salmon ratio, *i.e.* the bigger the proportion of grilse the bigger the number of fish corresponding the excess production of eggs.

2. before the beginning of the season, a *provisional TAC* is set for each river according to the previous year composition of the catch. For the stocks that are considered chronically not to achieve their spawning targets,

the *provisional TAC* is 50% of the *theoretical TAC*. For the others, the *theoretical TAC* becomes the *provisional TAC*.

3. on the first of July (*i.e.* after the MSW salmon run and at the beginning of the grilse run), the *final TAC* is established. The *provisional TAC* is adjusted according to the information available on the abundance of the returns of the current year. No increase of the *provisional TAC* is allowed for the rivers where escapement is considered to be chronically below target.

All the measures and procedures of this new management regime have been approved by an ad-hoc regional committee in which all interested parties are represented (fishing associations, administrations, local communities etc.). This committee meets at least twice a year and will examine any new measure or procedure proposed to improve the system. It is also within the competence of this committee to break any TAC into quotas allocated to different categories of fishermen when required.

It is important to notice that this new management regime requires a continuous in-season estimation of the catch on a river per river basis. In France, every salmon caught has to be officially declared and a tag must be affixed on each fish captured. The data coming from this official declaration scheme will be combined with estimates of non-declared captures provided by local fishery officers to follow the evolution of the catch during the fishing season. Based on the catch estimates, fishing has to be closed when the TAC is reached. A date of imperative closure is fixed for each river (no later than early November) in case the TAC cannot be attained before spawning time.

The Working Group considered this to be a useful example of a method for applying spawning targets to the management of river fisheries and asked to be kept informed of developments.

10.2 Development of Catch Options for 1996 and Assessment of Risks

10.2.1 Pre-fishery abundance estimates for the NEAC area

The Working Group revised and extended the preliminary estimates of the pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area prepared in 1995. Estimates of pre-fishery abundance were compiled based on the catch in numbers of 1SW and MSW salmon in each country. These were raised to take account of minimum and maximum estimates (or guess-estimates) of non-reported catches and exploitation rates on the two age groups. Finally they were raised to take account of maximum and minimum estimates of the natural mortality between the first sea winter and the mid-point of the national fisheries.

Thus the minimum and maximum estimates of pre-fishery abundance for each age class in each country were estimated as follows:

$$PFA_{i(min)} = C_i / (1 - R_{i(min)}) / E_{i(max)}) / S_{i(max)}$$

and

$$PFA_{i(max)} = C_i / (1 - R_{i(max)}) / E_{i(min)} / S_{i(min)}$$

where: C_i = catch in numbers of salmon sea age group 'i' (maturing 1SW or non-maturing 1SW)

$R_{i(min)}$ and $R_{i(max)}$ = minimum and maximum guess-estimates of the proportion of the total catch of age group 'i' salmon that is unreported.

$E_{i(min)}$ and $E_{i(max)}$ = minimum and maximum estimates of the average level of exploitation on age group 'i' salmon in the country.

$S_{i(min)}$ and $S_{i(max)}$ = minimum and maximum estimates of the survival from beginning of first sea winter to mid point of homewater fishery for age group 'i' salmon (assuming values of M of 0.05 and 0.015 per month) and maximum and minimum times between homewater fisheries and the time of recruitment.

Data were derived for all countries in the NEAC area for the period 1971-1995. For some countries, catches for some earlier years were only available as total weights. In these cases, the catch in numbers by sea age group was estimated using the mean weight and mean age composition of catches for the five subsequent years.

The minimum and maximum estimates of the pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area for the period 1970 to 1994 are shown in Tables 10.2.1.1 and Figures 10.2.1.1 and 10.2.1.2. It must be noted that the approximation procedures described above for some data will have resulted in the summed results for earlier results being progressively less reliable. The Working Group expressed caution about using of the mid point of the calculated ranges as reliable estimates of the pre-fishery abundance until further efforts had been made to improve the estimates. As a result it is not possible to be sure that there has been any clear change in the pre-fishery abundance of maturing or non-maturing 1SW fish, although there is some indication of possible downward trends.

Salmon originating from rivers in different areas are known to be differently distributed in the sea. In particular a much greater proportion of the salmon from Scandinavian countries and Russia are thought to feed in the Norwegian Sea, while a greater proportion of fish from Southern European countries migrate to West Greenland. As a result separate estimates of the pre-fishery abundance of maturing and non-maturing 1SW salmon have been compiled for the two groups of counties described below:

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

Because the majority of fish taken in the Faroes area are thought to originate from Scandinavia Russia and Finland, the abundance estimates derived from the Faroese catches were included in this group. Similarly, because most of the European salmon caught at West Greenland are thought to originate from Southern European countries, the European component of catches from West Greenland were included in the Southern European group. The Working Group noted that the above separation represents only a simple geographic division of national groups and may not be the most appropriate separation for fisheries management purposes. The pre-fishery abundance estimates for the areas are shown in Tables 10.2.1.2 to 10.2.1.3 and Figures 10.2.1.3 to 10.2.1.6.

The range of these estimates of pre-fishery abundance are wide, but the data still appear to show some indication of trends. Overall it appears that both maturing and non-maturing components of the Southern European group have probably declined, with the non-maturing component declining more rapidly (Figures 10.2.1.3 and 10.2.1.4). The maturing 1SW component from Northern European countries has remained relatively stable, although abundance may have been reduced in 1978 and 1982 rapidly (Figures 10.2.1.5 and 10.2.1.6). The non-maturing 1SW component appears to have declined in 1977, then increased rapidly to 1980 and declined again thereafter.

The Working Group recommended that work on this model should continue and efforts should be made to refine the estimates of parameters used in order to narrow the range between maximum and minimum estimates. In some countries this might be achieved by using data for two or more regions rather than for the whole country. Simulation techniques should also be used to provide a clearer indication of trends in the estimates.

10.2.2 Relationship between thermal habitat and pre-fishery abundance for European stocks

Despite the previously expressed concern about the use of the mid-point values of the pre-fishery abundance, the Working Group went ahead with an exploratory analysis of the effect of thermal habitat on the southern European non-maturing stock component. The time series of stock abundance was correlated to a set of thermal habitat indices stratified by area, longitudinal spatial breadth, and time. This filter produced significant correlation between thermal habitat in the area between Iceland and Greenland that persisted over the winter months. The best relationships emerged between pre-fishery abundance and the area of 6 to 8°C water from the area between 29°W to 51°W during January of the 1SW year (Figure 10.2.2.1). The regression line between abundance and habitat reveals a strong positive relationship with reasonable confined limit on the regression (Figure 10.2.2.2). However, the regression had some fundamental problems revealed in the residual analysis. The observed and predicted estimates of pre-fishery abundance are presented in Figure 10.2.2.3. The pre-fishery abundance is best estimated during the 1970s period, but the relationship is less good in the 1980s and abundance is overestimated at the end of the time series. This is also seen in the time series of residuals which appear to be serially correlated (Figure 10.2.2.4). There are a number of statistical issues that need to be addressed before these data can be applied in predictive models.

This relationship is remarkably similar to the relationship observed for the North American non-maturing stock complex. The overlap in the location of critical thermal habitat area suggests that non-maturing stocks from both continents are being acted upon by the same oceanic conditions by their first winter at sea. The same analysis was performed for the Northern European complex which yielded weaker correlation. However, the areas of greater relevance to the life history of northern stocks were not thoroughly investigated. The Working Group recommends that investigation of the relationship between ocean climate and pre-fishery abundance of European stocks be continued.

10.2.3 Development of catch advice

The assessment of pre-fishery abundance provides only a rough indication of trends in stock abundance and no predictions can be provided for the forthcoming season. In addition, the Working Group is still not able to provide spawning targets for all rivers in the NEAC area. As a result no mechanism is available for providing managers with numerical catch options. However, it appears likely from the pre-fishery abundance estimates that stocks of non-maturing 1SW salmon, the component forming the majority of the catch in the Faroes area, have shown an overall downward trend over the past 15 years despite measures being taken to reduce exploitation in most areas. As a result the Working Group recommends that managers should adopt a conservative approach in setting quotas until information is available to show that an alternative strategy will adequately safeguard salmon populations.

11 COMPILATION OF TAG RELEASE AND FINCLIP DATA FOR 1995

Data on releases of tagged and finclipped salmon in 1995 were provided by the Working Group and will be compiled as a separate report. A summary of national markings is given in Table 11.1. In 1995, a total of just over 3.35 million salmon were marked, a substantially lower number than in 1994 (4.42 million). The number marked was also low compared to 1993 (3.62 million). Finclips (2.29 million fish) and microtags (0.91 million) were the most frequent marks used. Most marks were applied to reared parr and smolts (3.27 million) and with only small numbers of wild parr and smolt (0.065 million) and adult fish (0.019 million) being marked.

An additional 1783 salmon were tagged at sea in the Faroes area with Norwegian Lea tags. These have not been included in the tables.

12 DEFINITION OF WILD SALMON

Aquaculture, sea ranching and large scale enhancement and re-establishment programs are taking place throughout the natural distribution area of Atlantic salmon resulting in the presence of artificially bred fish in the wild. It would be advantageous to be able to unambiguously distinguish among these various groups of salmon; unfortunately, this is not currently possible. Since these salmon of different origins occur throughout the North Atlantic, it is important to establish a common understanding of what is meant by the term wild salmon, and to define the other stock components that might occur. Declines in the abundance of wild salmon may be masked by an increase in abundance of intentionally or accidentally stocked salmon unless it is possible to distinguish stocked from wild fish.

The Working Group defined the following classes of salmon, based upon parental origin and how much of their life cycle was spent in the wild:

> ***Wild salmon*** are fish that have spent their entire life cycle in the wild and originate from parents which were also spawned and continuously lived in the wild.
>
> ***Native salmon*** are wild salmon which are members of a population with no known effects from intentional or accidental releases.
>
> ***Naturalized salmon*** are fish that have spent their entire life cycle in the wild and originate from parents, one or both of which, which were not wild or native salmon.

Stocked salmon are fish that have had artificial spawning and/or rearing techniques applied at some point of their life cycle and/or originate from intentional releases to the wild.

Escaped salmon are fish that have spent some or all of their life cycle undergoing artificial propagation and originate from accidental or unplanned releases into the wild.

Although the analytical tools are not currently available to distinguish between native and wild salmon beyond the parental generation, the Working Group recommends that native salmon populations be given special consideration.

Native, wild, naturalized, stocked and escaped fish are potential components of a salmon population. Native and wild salmon, in that order, are the most valuable because of their genetic robustness and the value society places upon them. However, naturalized and stocked salmon may be genetically similar to wild salmon, although lacking the full benefits derived from natural selection.

Escaped salmon are most likely to negatively affect native, wild, naturalized and stocked salmon populations because of the unplanned and uncontrolled nature of their arrival in the wild. Where unacceptable risks or impacts are identified, appropriate actions should be taken to eliminate or limit future escapes, and, where possible, to remove escaped fish from the wild.

13 EVALUATION OF METHODS USED IN THE ESTIMATION OF UNREPORTED LANDINGS

The processes utilised in collecting information on unreported salmon catches in the North Atlantic as well as the types of information gathered were identified and are summarised in Table 13.1. In most countries the values provided are based upon the local knowledge of fishery managers or bailiffs who are familiar with the fisheries. The values are generally termed 'guess-estimates', indicating that they are not derived from annual surveys of fisheries or analyses of catch data. However, these guess-estimates are usually supported, in part at least, by observations of landings, knowledge of legal and illegal fishing activity, recoveries of illegal fishing gear, prosecutions, etc. In Canada, Ireland, UK(England & Wales) and UK(Scotland) estimates are the sum of values obtained for different fishery areas.

Various surveys have been conducted in Canada, Norway, UK(Scotland), UK(Northern Ireland) and UK(England & Wales) to estimate the proportion of catches reported by netsmen and anglers. This has involved comparing the reported catches with independent estimates of the landings in certain fisheries obtained by fisheries managers, regional staff and observers using log-books and other surveys. In several countries observations made during microtag scanning programmes have been used to estimate the accuracy of reported catches. In UK(England & Wales) estimates of catch reporting rates by anglers have been obtained from the analysis of catches reported after repeat reminders were sent to licence holders.

The Working Group was unable to evaluate the accuracy of the methods used for developing the estimates of unreported catches, although it considered that the data provided represented the best available information. It is important that assessments are based upon estimates of the total fishing mortality and this should therefore include unreported catches wherever possible. The Working Group recommended that all countries should continue to improve their estimates of unreported catches based upon surveys and sampling programmes.

14 CHANGES IN GROWTH RATE, MEAN WEIGHT AT AGE AND PROPORTION OF DIFFERENT SIZE GROUPS

This Section is related to Section 7.1. The context in which inter-relationships among growth rate, size at age and sea-age at maturity must be considered and the possible confounding effects of other variables are described there.

14.1 Growth Rate

No full data sets for growth rate are available. Although growth rates can be inferred from mean weight estimates at specific sea-ages, the underlying growth patterns are not evident in these sets. Life-history theory suggests that these patterns may be important in the pre-maturity growth phase. In addition, size-specific mortality is expected to distort the relationships between growth, mean weight and age in fish surviving to the pre-exploitation stage. Size-specific exploitation in fisheries is expected to further distort the underlying relationships for data sets obtained at later stages of life.

14.2 Proportion of Different Size (Sea-Age) Groups at Maturity

Sea-age at first maturity is strongly associated with sex. In general males tend to mature at a younger age than females (including precocity) and in some locations, at some times they dominate the 1SW catch. Reciprocally, females are often more prevalent among 2SW catches although males again dominate catches of the oldest sea-age classes (e.g. 4SW). In general, however, sex determinations are not available to aid the interpretation of variation in the sea-age composition of sexually maturing fish.

Time series for age-class composition at maturity for mixed-sex groups are available, as below.

NEAC area: Mid-point estimates of the proportion of non-maturing recruits for the European stock at the first sea-winter stage are available for the years since 1970. Values vary among years. No trends are evident and current (1994) values are about average. Separate estimates are available for the Northern and the Southern European stocks. For the Northern component, current values (1990–1994) are in the lower part of the range. No trend is evident for the Southern component.

Faroes: An increase in the proportion of larger, heavier fish was observed between the 1990/1991 and 1992/1993 fishing seasons (Table 4.1.4.4 and Figure 4.1.4.3). However, scale sample analysis suggests that the most likely explanation was that a greater proportion of MSW salmon were present rather than a change in growth rates.

Finland: A time series for 1SW and MSW salmon from smolt cohort years 1972-1992 is available for River Tenojoki. Relative returns of MSW fish have declined over the series (Figure 14.2.1). Annual catches have tended to increase in recent years for both groups but to a greater extent for 1SW fish.

France: A time series for sea-age class composition for the French national catch is available from 1985 (Figure 14.2.2). Catch numbers of all sea-age classes have declined since 1987 and in 1995 values were the lowest in the series. Catches of MSW salmon have declined to a greater extent than those of 1SW fish and were least in 1995. As a consequence the proportion of 1SW fish in the catch has increased in a trend extending back to 1988.

Iceland: The numbers of 1SW and 2SW salmon derived from single cohorts of smolts for the Nordura, Vididalsa and Hofsa rivers vary among years and among rivers. Relative numbers of both sea-age classes vary among years. Numbers of 1SW fish in any year correlate with 2SW salmon numbers in following year for each of the three rivers (Gudjonsson *et al*, 1995).

Norway: A time series for returns of wild fish tagged as smolts leaving the River Imsa and returning to the Norwegian coast is available from 1976. Returns as 1SW salmon are variable but no trends are evident. Returns as 2SW salmon have declined markedly over the course of the series and have been consistently low since 1990. Recent relative return rates for 2SW fish against 1SW fish were lowest for the 1993 smolt year, the latest year for which information is available.

USA: A time series for 1SW and 2SW salmon extending back to 1969 is available for the Penobscot River. The proportion of 2SW salmon has declined although they still dominate the catch.

14.3 Mean Weight at Sea-Age

In order to examine the underlying biological interrelationships between weight (growth) and maturity that drive the fisheries it is desirable to obtain data sets that relate to both variables at the pre-exploitation stage near the inception of maturity. Data derived from samples obtained in the ocean fisheries conform most closely to this target although mean weights relate only to fish surviving to this stage.

In addition, all the ocean fisheries are on mixed populations. Age/ weight relationships derived from fish surviving to be exploited in the ocean fisheries are likely to reflect the geographical stock origins of the catch. The geographical origins of mixed population fisheries are likely to vary among fishing locations within years and, among years, as individual population distribution patterns change. Finally, the ocean fisheries may be size selective in the way that they exploit the total stock available to capture by passive (gill-nets) or active methods (long-lining), distorting estimates of mean values.

Time series for weight at sea-age are available for ocean fisheries, as below.

West Greenland: A data series is available for non-maturing fish at the 1SW stage from 1968 (Figure 14.3.1). Downward trends in weight are evident for both European and North American groups.

Weight data derived from home water fisheries are affected by all the factors described for ocean fishery data. In addition, they are affected by prior size-selective fisheries and by changed growth patterns or even losses of weight in the intervening migratory phase from the ocean to home-waters.

Time series for weight at sea-age in home-water fisheries are available, as below.

Canada: Moore *et al* (1995) have performed ANOVA on time series for size by sex for the Miramichi river. Although there are significant effects of year on size for both maiden 1SW and 2SW fish and for both sexes, the trends are attributed to regulatory changes in the fisheries. There is no evidence for trends in ocean growth, as reflected in the size of fish returning to the Miramichi River.

UK(Scotland): Time series for numbers of 1SW and MSW salmon and mean weight data are available for the Scottish fixed-engine catches from 1952. Catches of 1SW fish increased until around 1973 and have declined irregularly since. Catches of MSW fish have declined irregularly since the start of the series. Interpretation of these observations is complicated by declining trends in fishing effort during the series. However, the increase in 1SW numbers before about 1973, despite decreasing effort, points to an increased abundance of this sea age class. Trends are evident in the mean value for body weight in catches of both main sea-age groups. Weights of 1SW salmon tended to increase in parallel with 1SW catches from 1952 until 1973. Weights of 1SW fish have tended to decrease since 1973. Mean weights of MSW fish have tended to increased through the time series as catches have declined. This is attributed to the selective removal of early season effort on small (spring) MSW salmon.

14.4 Relationships between Body Weight and Sea-Age at Maturity

Explorations of the relationships described under sections 14.2 and 14.3 above can be combined to investigate possible relationships between changes in growth and the age at which sexual maturity is attained, for data sets for which size variation cannot be attributed to regulatory changes in the fisheries. Relevant time series for both size and sea-age composition at single locations are available, as below.

North American Commission Area Area: Mean size of North American 1SW fish at West Greenland, overall abundance, and the separate abundance of the maturing and non-maturing groups all show downward trends (Figure 5.2.4.2). Values for the ratio of maturing: non-maturing fish show an upward trend. A number of factors may contribute to this. There may have been a change in age at maturity but there may also have been a more rapid decline of MSW stocks compared with 1SW stocks either within or between rivers.

Iceland: The mean weight of 1SW fish and the 1SW:MSW ratio was examined for the Rivers Sela (Figure 14.4.1) and Nordura (1986-95): the trends are positive and in both cases they approach statistical significance. This suggests that marine growth and survival limit returns of both sea-winter groups, although the time-series are relatively short and the relationships are marginally not statistically significant ($p>0.05$). No trend is evident for absolute numbers of 1SW. MSW salmon numbers appear to be tending to decline.

Sweden: Mean weight of 1SW fish and the 1SW:MSW salmon ratio both show upward trends for the Lagan (1969-93). The relationship between them is significant (Figure 14.4.2). Return rates for released reared fish declined in both sea-age groups from release year 1988 onwards.

UK(Scotland): Between 1952 and 1974, catches of 1SW salmon tended to increase and catches of MSW fish to decrease over a period when fishing effort was declining steadily. Over the same period weights of 1SW fish tended to increase. No trends are evident in MSW salmon weights over the same period.

14.5 Conclusions

Trends in 1SW: MSW salmon ratios vary among the available data sets but in many cases the ratios have tended to increase with time. In some cases, the absolute abundance of MSW salmon can be shown to have declined. In most cases, the abundance of MSW salmon relative to 1SW fish has declined.

In data sets for Rivers Lagan (Sweden) and Sela (Iceland) trends towards greater weight among 1SW fish are associated with increased relative abundance, and in Iceland with increased absolute abundance. In the NAC marine area, a declining trend in weight at the 1SW stage is associated with decreasing abundance of both maturing and non-maturing fish. The trends evident in these relationships link size with changes in the abundance of 1SW and MSW salmon and are therefore of particular value in the context of mechanisms regulating sea-age at maturity.

15 RECOMMENDATION

15.1 Fisheries

1. The Working Group reiterates the advice given in 1995 that it is evident from both the indicators of stock status and the extremely low quota levels computed under either forecast model, that the North American stock complex is in tenuous condition. We are observing record low abundance despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below target spawning escapements for 2SW salmon, and some of the lowest marine survival rates for monitored stocks. The increasing advantage associated with each additional spawner in under-seeded river systems make a strong case for a conservative management strategy. (Section 9.2.3).

2. Stocks of non-maturing 1SW salmon, the component forming the majority of the catch in the Faroes area, have shown an overall downward trend over the past 15 years despite measures being taken to reduce exploitation in most areas. As a result the Working Group recommends that managers should adopt a conservative approach in setting quotas until information is available to show that an alternative strategy will adequately safeguard salmon populations. (Section 10.2.3).

3. Although the analytical tools are not currently available to distinguish between native and wild salmon beyond the parental generation, the Working Group recommends that native salmon populations be given special management consideration.

15.2 Meetings

1. The Working Group recommends that it should meet in 1997 to address questions posed by ACFM, including those posed by NASCO to ICES. The length of the meeting will have to depend on the questions asked, but if it is to be reduced to less than 10 days, the work-load on the Working Group will have to be reduced. In view of the fact that sea surface temperature data required to provide to catch advice for West Greenland is not expected to be available until 7 April 1996, the group should meet as soon as possible after that date. (However, it should be noted that a number of members of the Working Group will be involved in the Symposium on Interactions between farmed and wild salmon in Bath, England from 17–24 April).

2. The Working Group welcomed the forthcoming Workshop on Spawning Targets to be held in France in June 1996 and recommends that a half day joint session be held with the Baltic Salmon and Trout Assessment Working Group in Copenhagen in 1997 to discuss the implementation of the conclusions of the Workshop (Section 10.1).

15.3 Data Deficiencies and Research Needs

1. The Working Group supports the continuation of the research fishing programme in the Faroes area and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North East Atlantic (Section 4.1).

2. Norwegian scientists have obtained important preliminary information on the distribution of post-smolts in the North East Atlantic area. Continued and enhanced efforts should be made by all parties to provide more information on post-smolt biology. (Section 4.4).

3. Spawning targets still have to be developed for the majority of salmon rivers in the NEAC area. To facilitate this more information is required on juvenile production in rivers based on fry/parr surveys and smolt counting. More effort is also needed in quantifying habitat types in order to use spawning targets derived from rivers which have established stock and recruitment relationshiops to rivers where this information is not available (Section 4.3.1 and 10.1).

4. Further work should be conducted on methods for discriminating farm origin and reared salmon in catches, with particular reference to the use of intra-abdominal lesions (see Section 7.3).

5. Information on fishing effort should be collected in more fisheries in the NEAC area in order to develop time series of CPUE data (Section 4.2.2).

6. Estimates of unreported catches should be improved for all fisheries (Section 13.1).

7. The estimates of pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area should be improved and possible relationships with environmental variables should be investigated (Section 10.2).

8. Evaluate possible reasons for the apparent declines in 2SW returns to SFAs 15 - 23 and Q1 - Q10 in Canada (Section 5.2.3).

9. Develop estimates of total recruits prior to all fisheries for each SFA in Canada for which estimates have not been made (Section 5.2.4).

10. There is a need for improved habitat surveys for rivers in Labrador so that spawner requirements can be developed based on habitat characteristics (Section 9.1).

11. Review possible changes in the biological characteristics (mean weight, sex ration, sea-age composition) of returns to rivers, spawning stocks, and total recruits prior to fisheries. As new information becomes available, refine estimates of spawning requirements in USA and Canada by incorporating new information such as on biological characteristics for individual stocks, habitat measurements and stock and recruitment analysis (Section 9.1).

12. Annual estimates of smolt-to-adult salmon survival rates need to be obtained for Labrador, New Brunswick and Nova Scotia. Examine sea survival rates of hatchery and wild salmon to determine if changes in survival of hatchery releases can be used as an index of sea survival of wild salmon (Section 5.2.6).

13. The mean weights, sea ages and proportion of fish originating from North America and Europe are essential parameters used by the Working Group to provide catch advice for the West Greenland fishery. As these parameters are know to vary over time, the Working Group recommends that the sampling programme which occurred in 1995 should be continued (Section 6.1.3 and 9.2).

14. Efforts should be made to improve the annual estimates of the harvest of salmon taken for local consumption at West Greenland (Section 6.1.5).

15. Every effort should be made to instigate a surveillance programme to provide reliable estimates of the fishing effort for salmon in international waters. It was noted that a number of countries conduct research vessel cruises in this area and that they could be asked to monitor any salmon fishing activity (Section 2.3.2).

    Efforts should be made to obtain further information on by-catches of post-smolts in the surface trawl fisheries in the Norwegian sea (Sections 2.3.2 and 4.4).

Table 2.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1995. (1995 provisional figures).

Year	Canada (1)	Den.	Faroes	Finland	France	East Grld.	West Grld. (2)	Iceland	Ireland (3, 4)	Norway (5)	Russia	Spain (6)	St. P. & M.	Sweden (West)	UK (E & W)	UK N.Ireland (4,7)	UK (Scotland)	USA	Other (8)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (9)	Total Catch
1960	1636	-	-	-	-	-	60	100	743	1659	1100	33	-	40	283	139	1443	1	-	7237	-		-
1961	1583	-	-	-	-	-	127	127	707	1533	790	20	-	27	232	132	1185	1	-	6464	-		-
1962	1719	-	-	-	-	-	244	125	1459	1935	710	23	-	45	318	356	1738	1	-	8673	-		-
1963	1861	-	-	-	-	-	466	145	1458	1786	480	28	-	23	325	306	1725	1	-	8604	-		-
1964	2069	-	-	-	-	-	1539	135	1617	2147	590	34	-	36	307	377	1907	1	-	10759	-		-
1965	2116	-	-	-	-	-	861	133	1457	2000	590	42	-	40	320	281	1593	1	-	9434	-		-
1966	2369	-	-	-	-	-	1370	106	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-		-
1967	2863	-	-	-	-	-	1601	146	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-		-
1968	2111	-	5	-	-	-	1127	162	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-		-
1969	2202	-	7	-	-	-	2210	133	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-		-
1970	2323	-	12	-	-	-	2146	195	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-		-
1971	1992	-	-	-	-	-	2689	204	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-		-
1972	1759	-	9	32	34	-	2113	250	1804	1568	462	40	-	18	442	210	1727	1	486	10955	-		-
1973	2434	-	28	50	12	-	2341	256	1930	1726	772	24	-	23	450	182	2006	2.7	533	12770	-		-
1974	2539	-	20	76	13	-	1917	225	2128	1633	709	16	-	32	383	184	1708	0.9	373	11957	-		-
1975	2485	-	28	76	25	-	2030	266	2216	1537	811	27	-	26	447	164	1621	1.7	475	12236	-		-
1976	2506	-	40	66	9	<1	1175	225	1561	1530	772	21	2.5	20	208	113	1019	0.8	289	9557	-		-
1977	2545	-	40	59	19	6	1420	230	1372	1488	497	19	-	10	345	110	1160	2.4	192	9514	-		-
1978	1545	-	37	37	20	8	984	291	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-		-
1979	1287	-	119	26	10	<1	1395	225	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-		-
1980	2680	-	536	34	30	<1	1194	249	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-		-
1981	2437	-	1025	44	20	<1	1264	163	685	1656	463	25	-	26	493	101	1233	6	313	9954	-		-
1982	1798	-	865	54	20	<1	1077	147	993	1348	354	10	-	25	286	132	1092	6.4	437	8644	-		-
1983	1424	-	678	58	16	<1	310	198	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-		-
1984	1112	-	628	46	25	<1	297	159	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-		-
1985	1133	-	566	49	22	7	864	217	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-		-
1986	1559	-	530	37	28	19	960	310	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9274	-		9274
1987	1784	-	576	49	27	<1	966	222	1239	1385	564	18	2	47	302	56	922	1.2	-	8160	2788		10948
1988	1311	-	243	36	32	4	893	396	1874	1076	419	18	2	40	395	114	882	0.9	-	7736	3248		10984
1989	1139	-	364	52	14	<1	337	278	1079	905	359	7	2	29	296	142	895	1.7	-	5900	2277		8177
1990	911	13	315	60	15	<1	274	426	586	930	315	10	2	33	338	94	624	2.4	-	4948	1890	180-350	6838
1991	711	3.3	95	70	13	4	472	505	404	876	215	15	1	38	200	55	462	0.8	-	4140	1682	25-100	5822
1992	522	10	23	77	20	5	237	635	630	867	166	16	1.3	49	186	91	600	0.7	-	4136	1962	25-100	6098
1993	373	9	21	70	16	-	-	656	543	923	140	14	1.8	56	270	83	547	0.6	-	3723	1644	25-100	5367
1994	355	6	6	49	18	-	-	448	817	996	138	15	2.7	44	319	91	649	0	-	3954	1276	25-100	5230
1995 (10)	270	-	5	48	9	-	68	439	712	839	129	9	0.4	37	311	83	457	0	-	3416	1050	n/a	4466
Means																							
1990-1994	574	8	92	65	16	5	328	534	596	918	195	14	2	44	263	83	576	1	-	4180	1691	-	5871
1985-1994	980	-	274	55	21	8	625	409	1050	1112	358	15	2	44	310	93	777	1	-	6008	-	-	7638

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Includes catches made in the West Greenland area by Norway, Faroes, Denm
3. Until 1994, includes only those catches sold through dealers.
4. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
5. Before 1966, sea trout and sea charr included (5% of total).
6. Weights estimated from 1994 mean weight. Early years may be underestimates.
7. Not including angling catch (mainly 1SW).
8. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
9. Estimates refer to season ending in given year.
10. Includes provisional and incomplete data

Table 2.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1995. (1995 provisional figures).
S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). Sm = small. Lg = large. T = S + G or Lg + Sm

Year	Canada (1)			Finland			France	Iceland	Ireland (2,3)			Norway (4)			Russia	Spain (5)	Sweden (West)	UK (E&W)	UK(N.I.) (3, 6)	UK(Scotland)			USA	Total (7)
	Lg	Sm	T	S	G	T	T	T	S	G	T	S	G	T	T	T	T	T	T	Lg	Sm	T	T	T
1960	-	-	1636	-	-	-	-	100	-	-	743	-	-	1659	1100	33	40	283	139	971	472	1443	1	7177
1961	-	-	1583	-	-	-	-	127	-	-	707	-	-	1533	790	20	27	232	132	811	374	1185	1	6337
1962	-	-	1719	-	-	-	-	125	-	-	1459	-	-	1935	710	23	45	318	356	1014	724	1738	1	8429
1963	-	-	1861	-	-	-	-	145	-	-	1458	-	-	1786	480	28	23	325	306	1308	417	1725	1	8138
1964	-	-	2069	-	-	-	-	135	-	-	1617	-	-	2147	590	34	36	307	377	1210	697	1907	1	9220
1965	-	-	2116	-	-	-	-	133	-	-	1457	-	-	2000	590	42	40	320	281	1043	550	1593	1	8573
1966	-	-	2369	-	-	-	-	106	-	-	1238	-	-	1791	570	42	36	387	287	1049	546	1595	1	8422
1967	-	-	2863	-	-	-	-	146	-	-	1463	-	-	1980	883	43	25	420	449	1233	884	2117	1	10390
1968	-	-	2111	-	-	-	-	162	-	-	1413	-	-	1514	827	38	20	282	312	1021	557	1578	1	8258
1969	-	-	2202	-	-	-	-	133	-	-	1730	801	582	1383	360	54	22	377	267	997	958	1955	1	8484
1970	1562	761	2323	-	-	-	-	195	-	-	1787	815	356	1171	448	45	20	527	297	775	617	1392	1	8206
1971	1482	510	1992	-	-	-	-	204	-	-	1639	771	436	1207	417	16	18	426	234	719	702	1421	1	7575
1972	1201	558	1759	-	-	32	34	250	200	1604	1804	1064	514	1578	462	40	18	442	210	1013	714	1727	1	8357
1973	1651	783	2434	-	-	50	12	256	244	1686	1930	1220	506	1726	772	24	23	450	182	1158	848	2006	2.7	9868
1974	1589	950	2539	-	-	76	13	225	170	1958	2128	1149	484	1633	709	16	32	383	184	912	716	1628	0.9	9567
1975	1573	912	2485	-	-	76	25	266	274	1942	2216	1038	499	1537	811	27	26	447	164	1007	614	1621	1.7	9703
1976	1721	785	2506	-	-	66	9	225	109	1452	1561	1063	467	1530	772	21	20	208	113	522	497	1019	0.8	8051
1977	1883	662	2545	-	-	59	19	230	145	1227	1372	1018	470	1488	497	19	10	345	110	639	521	1160	2.4	7856
1978	1225	320	1545	-	-	37	20	291	147	1082	1229	668	382	1050	476	32	10	349	148	781	542	1323	4.1	6514
1979	705	582	1287	-	-	26	10	225	105	922	1027	1150	681	1831	455	29	12	261	99	598	478	1076	2.5	6341
1980	1763	917	2680	-	-	34	30	249	202	745	947	1352	478	1830	664	47	17	360	122	851	283	1134	5.5	8120
1981	1619	818	2437	-	-	44	20	163	164	521	685	1189	467	1656	463	25	26	493	101	834	389	1223	6	7342
1982	1082	716	1798	49	5	54	20	147	63	930	993	985	363	1348	364	10	25	286	132	596	496	1092	6.4	6275
1983	911	513	1424	51	7	58	16	198	150	1506	1656	957	593	1550	507	23	28	429	187	672	549	1221	1.3	7298
1984	645	467	1112	37	9	46	25	159	101	728	829	995	628	1623	593	18	40	345	78	504	509	1013	2.2	5883
1985	540	593	1133	38	11	49	22	217	100	1495	1595	923	638	1561	659	13	45	361	98	514	399	913	2.1	6668
1986	779	780	1559	25	12	37	28	310	136	1594	1730	1042	556	1598	608	27	54	430	109	745	526	1271	1.9	7763
1987	951	833	1784	34	15	49	27	222	127	1112	1239	894	491	1385	564	18	47	302	56	503	419	922	1.2	6616
1988	633	677	1310	27	9	36	32	396	141	1733	1874	656	420	1076	419	18	40	395	114	501	381	882	0.9	6593
1989	590	549	1139	33	19	52	14	278	132	947	975	469	436	905	359	7	29	296	142	464	431	895	1.7	5093
1990	486	425	911	41	19	60	15	426	-	-	586	545	385	930	315	10	33	338	94	423	201	624	2.4	4344
1991	370	341	711	53	17	69	13	505	-	-	404	535	342	876	215	15	38	200	55	177	285	462	0.8	3564
1992	323	199	522	49	28	77	20	635	-	-	630	566	301	867	166	16	49	186	91	362	238	600	0.7	3860
1993	214	159	373	53	17	70	16	656	-	-	543	611	312	923	140	14	56	270	83	320	227	547	0.6	3692
1994	216	139	355	38	11	49	18	448	-	-	817	581	415	996	138	15	44	319	91	400	248	649	0	3939
1995 (8)	148	122	270	37	11	48	9	439	-	-	712	590	249	839	129	9	37	311	83	287	170	457	0	3343
Means																								
1990-94	322	253	574	47	18	65	16	534	-	-	596	568	351	918	195	14	44	263	83	336	240	576	1	3880
1985-94	510	470	980	39	16	55	21	409	-	-	1039	682	430	1112	358	15	44	310	93	441	336	777	1	5213

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Until 1994, includes only those catches sold through dealers.
3. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
4. Before 1966, sea trout and sea charr included (5% of total).
5. Weights estimated from 1994 mean weight. Early years may be underestimates.
6. Not including angling catch (mainly 1SW).
7. 0.08t reported by Portugal not included in 1987
8. Includes provisional and incomplete data

Table 2.2.1 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1994 may be provisional or incomplete. Methods used for estimating age composition given in footnotes.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,731
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,311
	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	72,389	122	-	-	-	-	-	-	-	-	33,224	148	-	-	105,613	270
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/86	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/87	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/88	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/89	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/90	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/92	16	-	7,611	-	837	-	-	-	-	-	-	-	-	-	8,464	31
	1992/93	-	-	4,212	-	1,203	-	-	-	-	-	-	-	-	-	5,415	22
	1993/94	-	-	1,866	-	206	-	-	-	-	-	-	-	-	-	2,072	7
	1994/95	-	-				-	-	-	-	-	-	-	-	-	1,963	7
Finland	1982	2,598	5	-	-	-	-	-	-	-	-	5,408	49	-	-	8,406	54
	1983	3,916	7	-	-	-	-	-	-	-	-	6,050	51	-	-	9,966	58
	1984	4,899	9	-	-	-	-	-	-	-	-	4,726	37	-	-	9,625	46
	1985	6,201	11	-	-	-	-	-	-	-	-	4,912	38	-	-	11,113	49
	1986	6,131	12	-	-	-	-	-	-	-	-	3,244	25	-	-	9,375	37
	1987	8,696	15	-	-	-	-	-	-	-	-	4,520	34	-	-	13,216	49
	1988	5,926	9	-	-	-	-	-	-	-	-	3,495	27	-	-	9,421	36
	1989	10,395	19	-	-	-	-	-	-	-	-	5,332	33	-	-	15,727	52
	1990	10,084	19	-	-	-	-	-	-	-	-	5,600	41	-	-	15,684	60
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49
	1995	7,786	11	-	-	-	-	-	-	-	-	5,344	38	-	-	13,130	49

Table 2.2.1 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
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,124	3	1,971	9	311	2	-	-	-	-	-	-	-	-	3,406	14
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
	1991	1,362	3	1,935	9	190	1	-	-	-	-	-	-	-	-	3,487	13
	1992	2,490	7	2,450	12	221	2	-	-	-	-	-	-	-	-	5,161	20
	1993	3,581	10	987	4	267	2	-	-	-	-	-	-	-	-	4,835	16
	1994	2,810	7	2,250	10	40	1	-	-	-	-	-	-	-	-	5,100	18
	1995	1,669	4	1,073	5	22	0	-	-	-	-	-	-	-	-	2,764	9
Iceland	1982	23,026	58	-	-	-	-	-	-	-	-	18,119	89	-	-	41,145	147
	1983	33,769	85	-	-	-	-	-	-	-	-	24,454	113	-	-	58,223	198
	1984	18,901	47	-	-	-	-	-	-	-	-	22,188	112	-	-	41,089	159
	1985	50,000	125	-	-	-	-	-	-	-	-	16,300	94	-	-	66,300	217
	1986	67,300	174	-	-	-	-	-	-	-	-	22,300	136	-	-	89,600	310
	1987	42,550	114	-	-	-	-	-	-	-	-	18,840	108	-	-	61,390	222
	1988	112,000	288	-	-	-	-	-	-	-	-	19,000	108	-	-	133,500	396
	1989	70,817	158	-	-	-	-	-	-	-	-	20,037	115	-	-	90,854	278
	1990	98,241	-	-	-	-	-	-	-	-	-	34,267	-	-	-	132,508	426
	1991	144,639	-	-	-	-	-	-	-	-	-	30,510	-	-	-	175,149	505
	1992	149,783	-	-	-	-	-	-	-	-	-	34,683	-	-	-	184,466	590
	1993	185,188	-	-	-	-	-	-	-	-	-	32,188	-	-	-	217,649	657
	1994	98,782	271	-	-	-	-	-	-	-	-	30,331	177	-	-	129,113	448
	1995	111,803	318	-	-	-	-	-	-	-	-	24,150	122	-	-	135,953	440
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330,558	1,079
	1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	194,785	586
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,600	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,153	630
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,282	543
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	290,731	817
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	259,735	712

Table 2.2.1 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	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	235,703	491	-	-	-	-	-	-	-	-	153,554	894	-	-	389,257	1,385
	1988	217,617	420	-	-	-	-	-	-	-	-	120,367	656	-	-	337,984	1,076
	1989	220,170	436	-	-	-	-	-	-	-	-	80,880	469	-	-	301,050	905
	1990	192,500	385	-	-	-	-	-	-	-	-	91,437	545	-	-	286,466	930
	1991	171,041	342	-	-	-	-	-	-	-	-	92,214	535	-	-	263,255	876
	1992	151,291	301	-	-	-	-	-	-	-	-	92,717	566	-	-	244,008	867
	1993	153,407	312	62,403	284	35,147	327	-	-	-	-	-	-	-	-	251,957	923
	1994	-	415	-	319	-	262	-	-	-	-	-	-	-	-	-	996
	1995	134,341	249	71,552	341	27,104	249	-	-	-	-	-	-	-	-	232,977	839
Russia	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	139,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,066	419
	1989	78,023	-	23,123	-	4,118	-	26	-	-	-	-	-	2,187	-	107,477	359
	1990	70,595	-	20,633	-	2,919	-	101	-	-	-	-	-	2,010	-	96,258	315
	1991	40,603	-	12,458	-	3,060	-	650	-	-	-	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	-	-	-	-	824	-	47,452	166
	1993	28,100	-	11,780	-	4,280	-	377	-	-	-	-	-	1,470	-	46,007	140
	1994	30,877	-	10,879	-	2,183	-	51	-	-	-	-	-	555	-	44,545	138
	1995	27,775	62	9,642	50	1,803	15	6	0	-	-	-	-	385	2	39,611	129
Sweden	1989	3,181	7	-	-	-	-	-	-	-	-	4,610	22	-	-	7,791	29
	1990	7,428	18	-	-	-	-	-	-	-	-	3,133	15	-	-	10,561	33
	1991	8,987	20	-	-	-	-	-	-	-	-	3,620	18	-	-	12,607	38
	1992	9,850	23	-	-	-	-	-	-	-	-	4,656	26	-	-	14,507	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,695	44
	1995	9,761	22	-	-	-	-	-	-	-	-	2,770	14	-	-	12,531	37
UK (England & Wales)	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296
	1990	53,143	-	-	-	-	-	-	-	-	-	33,533	-	-	-	86,676	338
	1991	34,596	-	-	-	-	-	-	-	-	-	17,053	-	-	-	51,649	199
	1992	33,038	-	-	-	-	-	-	-	-	-	15,130	-	-	-	48,168	186
	1993	43,506	-	-	-	-	-	-	-	-	-	31,802	-	-	-	75,308	270
	1994	61,590	-	-	-	-	-	-	-	-	-	26,396	-	-	-	87,986	319
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-		311

Table 2.2.1 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
UK (Scotland)	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	81,094	201	-	-	-	-	-	-	-	-	87,924	423	-	-	169,018	624
	1991	73,608	177	-	-	-	-	-	-	-	-	65,193	285	-	-	138,801	462
	1992	101,676	238	-	-	-	-	-	-	-	-	82,841	361	-	-	184,517	600
	1993	94,517	227	-	-	-	-	-	-	-	-	71,726	320	-	-	166,243	547
	1994	99,459	248	-	-	-	-	-	-	-	-	85,404	400	-	-	184,863	649
	1995	69,076	170	-	-	-	-	-	-	-	-	62,161	287	-	-	131,237	457
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1.0	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
	1990	52	0.1	562	2.2	12	-	-	-	-	-	-	-	16	-	642	2.4
	1991	48	0.1	185	0.7	1	-	-	-	-	-	-	-	4	-	238	0.8
	1992	54	0.1	138	0.6	1	-	-	-	-	-	-	-	-	-	193	0.7
	1993	17	-	133	0.5	-	-	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	0	-	-	-	-	-	-	-	-	-	-	-	12	-
	1995	0	0	0	0	-	-	-	-	-	-	-	-	-	-	0	0
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,478	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,052	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,381	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1995	25,595	-	457	-	-	-	-	-	-	-	-	-	392	-	26,438	68

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

In Scotland, misclassification may be very high in some years. In Norway, catches shown as 3SW refer to salmon of 3SW or greater.

Table 2.3.1 Guess-estimates of unreported catches in tonnes within national EEZs in the North-East Atlantic, North American and West Greenland Commissions of NASCO, 1986-1995.

Year	Unreported catches (tonnes)			
	North-East Atlantic	North American	West Greenland	Total
1986	-	315	-	315
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	<10	1,050
Mean 1990-1994	1,557	129	-	1,691

Table 3.1.1 Production of farmed salmon in the North Atlantic area (in tonnes round fresh weight), 1980-1995.

Year	Norway	UK (Scot.)	Faroes	Canada	Ireland	USA	Iceland	UK (N.Ire.)	Russia	Total
1980	4,153	598	-	11	21	-	-	-	-	4,783
1981	8,422	1,133	-	21	35	-	-	-	-	9,611
1982	10,266	2,152	70	38	100	-	-	-	-	12,626
1983	17,000	2,536	110	69	257	-	-	-	-	19,972
1984	22,300	3,912	120	227	385	-	-	-	-	26,944
1985	28,655	6,921	470	359	700	-	91	-	-	37,196
1986	45,675	10,337	1,370	672	1,215	-	123	-	-	59,392
1987	47,417	12,721	3,530	1,334	2,232	365	490	-	-	68,089
1988	80,371	17,951	3,300	3,542	4,700	455	1,053	-	-	111,372
1989	124,000	28,553	8,000	5,865	5,063	905	1,480	-	-	173,866
1990	165,000	32,351	13,000	7,810	5,983	2,086	2,800	<100	5	229,035
1991	155,000	40,593	15,000	9,395	9,483	4,560	2,680	100	0	236,811
1992	140,000	36,101	17,000	10,380	9,231	5,850	2,100	200	0	220,862
1993	170,000	48,691	16,000	11,115	12,366	6,755	2,348	<100	0	267,275
1994	215,000	64,066	14,789	12,441	11,616	6,130	2,588	<100	0	326,630
1995*	295,000	70,000	9,000	12,550	13,500	10,020	2,880	250	0	413,200
Mean 1990-1994	169,000	44,360	15,158	10,228	9,736	5,076	2,503	150	1	256,123

* Data for Scotland and Canada are provisional

Table 3.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight), 1980-1995

Year	Iceland commercial ranching	Ireland River[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		90
1986	69	22.9	22		114
1987	38	6.4	7		51
1988	179	11.5	12	4	207
1989	136	16.3	17	3	172
1990	280	5.7	5	6	297
1991	375	3.6	4	5	388
1992	460	9.4	11	10	490
1993	496	9.7	8	11	525
1994	308	15.2	0.4	9.5	333
1995	289	16.8	1.2	2	309
Mean 1990-94	384	9	6	8	407

[1] Total yield in homewater fisheries and rivers

Table 4.1.2.1. Nominal landings of Atlantic salmon by Faroes vessels in years 1982 to 1995 and the 1981/1982 to 1994/1995 fishing seasons.

Year	Catch (t)	Season	Catch (t)
1982	606	1981/1982	796
1983	678	1982/1983	625
1984	628	1983/1984	651
1985	566	1984/1985	598
1986	530	1985/1986	545
1987	576	1986/1987	539
1988	243	1987/1988	208
1989	364	1988/1989	309
1990	315	1989/1990	364
1991	95	1990/1991	202
	Research fishery		
1992	23	1991/1992	31
1993	23	1992/1993	22
1994	6	1993/1994	7
1995	5	1994/1995	7

Table 4.1.2.2. Catch of salmon in number by month in the Faroes fishery in the 1983/1984 to 1994/1995 fishing seasons.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1983/1984	8,680	24,882	12,504	26,396	32,712	12,486	6,849	-	124,509
1984/1985	5,884	20,419	14,493	24,380	26,035	25,471	19,095	-	135,777
1985/1986	1,571	27,611	13,992	50,146	25,968	21,209	14,057	-	154,554
1986/1987	1,881	19,693	5,905	15,113	35,241	21,953	39,153	1,365	140,304
1987/1988	4,259	27,125	5,803	9,387	9,592	4,203	4,642	-	65,011
1988/1989	17,019	24,743	2,916	4,663	12,457	31,698			93,496
1989/1990	13,079	40,168	5,533	11,282	11,379	29,504	570		111,515
1990/1991	6,921	28,972	3,720	7,996	6,275	3,557	-		57,441
		Research fishery excluding discards and tagged fish							
1991/1992	-	3,842	-	931	3,039	652	-	-	8,464
1992/1993	1,282	334	-	-	3,799	-	-	-	5,415
1993/1994	876	560	-	178	458	-	-	-	2,072
1994/1995	437	382	-	456	688	-	-	-	1,963

Table 4.1.2.3. Estimation of discard rates in the Faroes fishery in the 1982/1983 to 1994/1995 fishing seasons.

	No. of samples	Number sampled	Number <= 60 cm	Discard rate %	Range %
1982/1983	7	6,820	472	6.9	0 - 10.4
1983/1984	5	4,467	176	3.9	-
1984/1985	12	9,546	1.289	13.5	3 - 32
1985/1986	7	14,654	286	1.8	0.6 - 13.8
1986/1987	13	39,758	2.849	7.2	0 - 71.3
1987/1988	2	1,499	235	15.6	-
1988/1989	9	17,235	1.804	10.7	0.4 - 31.9
1989/1990	5	16,375	1.533	9.4	3.6 - 18.5
1990/1991	3	4,615	681	14.8	9.9 - 17.5
1991/1992	6	9,350	825	8.8	2.4 - 15.9
1992/1993	3	9,099	853	9.4	5.1 - 32.3
1993/1994	4	3,035	436	14.4	1.5 - 48.6
1994/1995	5	4,187	634	15.1	5.0 - 39.7

Table 4.1.3.1. Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery south of 65°30'N in the 1981/1982 to 1994/1995 fishing seasons.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1981/1982	-	38	41	49	58	51	34	-	46
1982/1983	19	120	-	61	50	39	36	40	48
1983/1984	85	80	86	58	45	28	26	-	51
1984/1985	38	38	32	32	37	39	40	-	36
1985/1986	64	52	68	54	48	78	61	-	56
1986/1987	31	43	34	44	70	111	102	-	64
1987/1988	56	51	-	47	34	25	22	-	43
1988/1989	63	80	48	68	61	76	-	-	71
1989/1990	81	86	38	56	87	77	-	-	76
1990/1991	81	97	-	35	39	51	-	-	67
1991/1992	-	93	-	72	77	50	-	-	79
1992/1993	77	54	-	-	92	-	-	-	84
1993/1994	68	53	-	15	45	-	-	-	44
1994/1995	29	34	-	34	50	-	-	-	36

Table 4.1.4.1. Faroes salmon sampling data in the 1994/1995 fishing season (number of fish).

Trip	Measured	Scales	Stomachs	Weight	Extern tags	Adipose fincl.	Micro tags	Tagged & released
20-11-94	851	355	452	482	6	29	9	351
01-12-94	439	146	179	190	2	17	3	147
22-12-94	554	186	117	168	1	19	6	185
25-02-95	930	421	395	466	11	35	7	411
31-03-95	1413	647	428	463	2	41	7	689
Total	4187	1755	1571	1769	22	141	32	1783

Table 4.1.4.2. Catch in number by sea age class by month in the Faroes Faroes salmon fishery in the 1994/1995 fishing season.
(Including discards and excluding reared and tagged fish.)

	Sea age								
Month	1	%	2	%	3	%	4+	%	Total
Nov-Dec	175	19.3	710	78.2	23	2.5	0	0	908
Feb-Mar	31	3.0	857	83.0	143	13.9	0	0	1,032
Total	207	10.6	1,569	80.8	169	8.6	0	0	1,940

Table 4.1.4.3. Catch in number by sea age class in the Faroes salmon fishery in the 1991/1992 to 1994/1995 fishing seasons.
(Including discards and excluding reared and tagged fish.)

Season	1	%	2	%	3	%	4	%	Total
1991/1992	248	4	4,686	83	743	13	+	+	5,677
1992/1993	521	12	2,646	61	1,120	26	68	2	4,355
1993/1994	320	16	1,288	64	376	19	16	1	2,000
1994/1995	207	10.6	1,569	80.8	169	8.6	0	0	1,940

Table 4.1.4.4. Percentage distribution by weight category (kg) of salmon landed at Faroes in the 1983/1984 to 1994/1995 fishing seasons.
(Wild and farmed fish combined.)

	Weight category (kg)						
Season	<2.5	2.5-3	3-4	4-5	5-7	7-9	> 9
1983/1984	9.7	20.1	41.5	14.2	4.7	6.2	3.6
1984/1985	13.3	21.4	42.3	11.7	3.6	4.9	2.8
1985/1986	9.6	18.3	46.4	16.4	5.3	2.8	1.2
1986/1987	24.4	26.5	30.9	9.1	4.1	3.5	1.5
1987/1988	35.8	26.6	24.3	5.6	4.6	2.3	0.8
1988/1989	26.4	26.2	33.9	7.9	3.2	2.0	0.4
1989/1990	24.4	23.8	37.8	8.9	3.2	1.5	0.4
1990/1991	13.2	20.1	38.8	13.0	7.6	4.8	3.0
1991/1992	13.0	14.1	31.1	11.0	10.0	13.1	7.7
1992/1993	7.2	15.5	24.3	9.7	18.5	17.8	6.9
1993/1994	21.3	26.4	31.2	5.6	6.3	7.3	1.9
1994/1995	25.0	28.0	30.0	7.6	4.8	4.0	0.6

Table 4.1.4.5. Smolt age compositions (%) of wild salmon in samples from the Faroese fishery in the 1994/95 season. (Indet = number of fish not possible to age; n = number of fish examined).

	Smolt age							
Period	1	2	3	4	5	6	Indet	n
Nov-Dec	6.1	49.6	26.9	17.4	0	0	5	115
Feb-Mar	0.6	40.5	41.1	16.0	1.8	0	8	163
Total	2.9	44.2	35.3	16.6	1.0	0	13	278

Table 4.1.4.6. Smolt age distribution (%) from samples taken in the Faroes fishery in the 1984/1985 to 1994/1995 fishing seasons.

Season	Smolt age 1	2	3	4	5	6	Unknown	Total
			Wild and farm origin fish					
1984/1985	1.5	37.9	46.9	12.3	1.5	0.1	0	2194
1985/1986	0.8	20.4	52.7	24.4	1.7	0	0	951
1986/1987	0.2	16.2	48.5	31.8	3.1	0.2	0	575
1987/1988	1.2	35.9	49.5	13.2	0.4	0	0	680
1988/1989	3.5	47	40.5	7	0.3	0	1.8	798
1989/1990	3.9	52.2	35.5	6.7	1.1	0	0.6	358
1990/1991	-	-	-	-	-	-	-	-
			Wild fish only					
1991/1992	2.6	38.7	43.5	5.2	0.4	0	9.5	271
1992/1993	4.3	39.9	46.6	8.6	0.6	0	24.1	145
1993/1994	7.6	40.8	37.5	14.1	0.0	0	18.6	180
1994/1995	2.9	44.2	35.3	16.6	1.0	0	4.5	278

No samples taken in 1990/91

Table 4.1.4.7. Sampling details of salmon stomachs sampled at Faroes in the 1992/1993 to 1994/1995 fishing seasons.

	1992/1993		1993/1994		1994/1995	
Number:	Number	%	Number	%	Number	%
Sampled	1273		1073		1571	
Analysed so far	1273		615		1521	
Empty or containing only bait	319	25	207	34	563	37
With food	954	75	408	66	958	63

Table 4.1.4.8. The frequency (%) with which the main food groups occurred in salmon stomachs containing food at Faroes in the 1992/1993 to 1994/1995 fishing seasons.

Main prey groups	1992/93	1993/94	1994/95	Principal prey genera
Crustaceans	80.4	88.7	91.5	Euphausiids. Hyperiid amphipods and Shrimps
Fish	75.7	44.4	45.0	Lantern fishes. Silversides & Barracudinas
Squid	1.4	1.2	1.0	Gonatus sp.

Table 4.1.5.1 Estimated numbers of discards, 1SW and 2SW microtagged salmon caught in the Faroese fishery from smolts released between 1984 and 1993 (year of fishery for 2SW fish is yr(n+1))

Year of smolt migration yr (n)	Country of origin	Number released	Discards yr(n)	No. in catch 1SW yr(n)	all 1SW yr(n)	2SW yr(n+1)	Total	Recaps/ releases x 10^{-3}
1984	Faroe Islands	19,602	-	-	-	9	9	0.46
	Ireland	260,816	246	-	246	15	261	1.00
	N. Iceland	72,352	33	-	33	-	33	0.45
	UK (E & W)	39,780	-	-	-	3	3	0.08
	UK (Scotland)	30,040	49	-	49	-	49	1.64
1985	Faroe Islands	30,079	-	-	-	87	87	2.89
	Ireland	220,000	86	-	86	3	89	0.40
	UK (E & W)	53,347	-	-	-	12	12	0.22
	UK (Scotland)	13,497	-	-	-	3	3	0.22
1986	Faroe Islands	43,000	-	-	-	54	54	1.26
	Ireland	143,866	30	-	30	11	41	0.29
	UK (E & W)	177,071	8	-	8	8	16	0.09
	UK (N. Ireland)	26,320	15	-	15	-	15	0.58
	UK (Scotland)	16,217	8	-	8	-	8	0.47
1987	Ireland	162,189	154	3	157	4	161	0.99
	N. Iceland	27,978	-	3	3	27	30	1.06
	UK (E & W)	195,373	51	-	51	25	77	0.39
	UK (N. Ireland)	20,145	-	-	-	2	2	0.09
	UK (Scotland)	20,876	-	-	-	4	4	0.17
	USA	640,000	-	-	-	2	2	<0.01
1988	Canada	13322	6	-	-	-	6	0.45
	Faroe Islands	43,481	12	-	12	69	81	1.87
	Ireland	165,841	104	-	104	7	111	0.67
	UK (E & W)	189,913	12	0	12	14	26	0.14
	UK (Scotland)	31,331	12	-	12	-	12	0.39
1989	Faroe Islands	26943	-	-	-	8	8	0.28
	Ireland	185,439	105	-	105	-	105	0.57
	N. Iceland	85452	-	-	-	4	4	0.04
	UK (E & W)	256,342	23	-	23	15	38	0.15
	UK (Scotland)	30288	-	-	-	4	4	0.13
1990	Faroe Islands	11820	-	-	-	3	3	0.25
	Ireland	153,821	44	-	44	1	45	0.29
	UK (E & W)	250,024	15	-	15	1	16	0.06
	UK (N. Ireland)	29,875	15	-	15	-	15	0.49
	UK (Scotland)	41,390	15	-	15	2	17	0.40
1991	Faroe Islands	n/a	1	-	1	-	1	n/a
	Ireland	471,152	19	-	19	4	23	0.05
	UK (E & W)	231,205	3	-	3	4	7	0.03
	UK (Scotland)	45,752	-	-	-	1	-	<0.01
	France	21,376	1	-	1	-	1	0.05
1992	Ireland	298,968	11	1	12	4	16	0.05
	Norway	34,700	-	-	-	6	6	0.17
	UK (E & W)	401,085	1	1	2	1	3	0.01
1993	Iceland	314,147	1	-	1	2	3	<0.01
	Ireland	362,854	6	-	6	-	6	0.02
	Norway	66,000	-	-	-	13	13	0.20
	UK (N. Ireland)	14,669	-	-	-	1	1	0.07
	UK (Scotland)	25,452	-	-	-	2	2	0.08
	Spain	N/A	1	-	1	-	1	n/a
1994	Ireland	269,166	14	-	14	-	14	0.05

n/a = not available

Table 4.1.5.2 Comparison of the tag recoveries (CWT and External tags) from fish of all ages in the Faroes fishery per 1,000 released in each country. External tag reporting rate 1975-1990 = 0.75, 1991-1993 = 1.

Year of	**Coded Wire Tags**										**External tags**		
smolt				Northern			UK	UK	UK		UK(Scot)		
migration	Canada	Faroes	France	Iceland	Ireland	Norway	(E&W)	(N.Ire.)	(Scot.)	USA	N. Esk	Sweden	Norway
1975												0.23	
1976												0.53	
1977												2.63	
1978												6.00	
1979												3.57	
1980											1.16	8.03	3.11
1981											2.83	16.09	9.39
1982											3.37	13.19	8.37
1983											0.92	10.20	4.04
1984	-	0.46		0.45	1		0.08		1.64		0.61	4.43	5.36
1985	-	2.89		-	0.4		0.22		0.22	-	0.85	4.24	3.97
1986	-	1.26		-	0.29		0.09	0.58	0.47	-	-	7.31	1.13
1987	-	-		1.06	0.99		0.39	0.09	0.17	<0.01	-	9.55	2.16
1988	0.45	1.87		-	0.67		0.14	-	0.39	-	0.69	1.45	2.27
1989	-	0.28		0.04	0.57		0.15	-	0.13	-	0.80	4.11	2.49
1990	-	0.25		-	0.29		0.06	0.49	0.4	-	0.08	0.57	0.34
1991	-	-	0.05	-	0.05		0.04	-	<0.01	-	0.11	0.81	0.38
1992	-	-	-	-	0.05	0.17	0.01	-	-	-	-	0.43	0.20
1993	-	-	-	0.01	0.02	0.2	-	0.07	0.08	-	0.21	0.14	0.20
*1994	-	-	-	-	0.05	-	-	-	-	-	-	-	0.02

\- = tagged fish released in this year but no recoveries reported in Faroese fishery
* = data not complete yet

Table 4.1.5.3 Recaptures in 1993, 1994 and 1995 of salmon tagged and released into the open sea at Faroes during the 1992/1993 to 1994/1995 fishing seasons.

Country	Tagged 1992/93		Tagged 1993/94		Tagged 1994/95		Total	
	Rec.93	Rec.94	Rec.94	Rec.95	Rec.95	Rec.96	No	%
Norway	31	2	4		21		58	59
Scotland	8		1		3		12	12
Ireland	3		2		4		9	9
Sweden	4				1		5	5
Russia	1	1	3				5	5
Canada	1				3		4	4
Denmark	2						2	2
England	1						1	1
Iceland	1						1	1
Spain	1						1	1
Total	53	3	10	0	32	0	98	99

Table 4.1.6.1. Proportion of farmed salmon in samples from the Faroes salmon fisheries in the 1980/1981 to 1994/1995 seasons.
(Indet.= number of fish not possible to classify.)

Season	Sampling period	Wild	Farmed	Indet.	Total	% farmed
1980/81	Jan-Mar 1981	277	7	6	290	2
1981/82	Jan-April 1982	210	4	2	216	2
1982/83	Feb-Apr 1983	174	2	8	184	1
1983/84	Jan-Feb 1984	199	9	7	215	4
1984/85	Jan-Apr 1985	243	20	7	270	7
1985/86	Jan-Apr 1986	180	8	7	195	4
1986/87	Mar-Apr 1987	203	3	3	209	1
1987/88	Jan-Apr 1988	200	17	6	223	8
1988/89	Nov 1988-Apr 1989	249	55	16	320	17
1989/90	Jan-Feb 1990	142	119	18	279	43
1990/91	Dec 1990	49	42	8	99	42
1991/92	Dec 1991-Apr 1992	271	166	18	455	37
1992/93	Nov 1992-Mar 1993	191	87	41	319	27
1993/94	Nov 1993-Apr 1994	221	51	28	300	17
1994/95	Nov 1994-Mar 1995	291	72	10	373	19

Table 4.1.7.1 Estimated exploitation rates of 1SW and 2SW salmon in the Faroes Fishery. Estimates are based on recoveries of external tags (Norway, Scotland, Sweden) or micro tags (Ireland, UK N. Ireland).

	Exploitation Rates %														
	Ireland		Norway						Scotland			Sweden		UK (N. Ireland	
	R Burrishole		R. Drammen		River Isma				North Esk			R. Lagan		R Bush	
Season	Hatchery		Hatchery		Wild		Hatchery		Wild			Hatchery		Wild/Hatchery	
	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	1SW	2SW	1SW	2SW
1981/82	0	0	-	-	0	-	1	-	0	**6**	0	-	-	-	-
1982/83	0	0	-	-	0	**25**	**2**	**38**	1	**10**	6	-	-	-	-
1983/84	0	0	-	-	0	50	1	**45**	0	**10**	18	-	-	0	-
1984/85	1	0	**5**	-	0	33	**2**	**39**	0	9	10	0	-	0	0
1985/86	<1	0	0	**30**	0	38	0	**30**	**<1**	5	0	3	22	0	0
1986/87	<1	0	0	3	0	13	1	**28**	0	6	0	2	0	<1	0
1987/88	1	0	0	6	0	5	1	21	0	0	0	0	9	0	0
1988/89	<1	0	0	**36**	0	3	0	**10**	4	0	0	0	13	<1	0
1989/90	1	0	0	**45**	0	5	0	**15**	2	0	0	1	21	0	0
1990/91	0	0	1	**13**	0	13	0	**36**	<1	2	0	1	**18**	<1	0
1991/92	0	0	-	2	0	4	**<1**	1	<1	0	0	1	3	0	0
1992/93	0	<1	0	-	0	6	1	5	-	0	0	0	12	0	0
1993/94	<1	0	0	0	0	0	1	3	0	0	0	0	11	0	0
1994/95	<1	0	0	7	-	0	2	0	0	<1	0	0	0	0	<1
Mean 1987/88 to 90/91	<1	0	0	25	0	7	0	21	2	1	0	1	11	<1	0
Mean 1991/92 to 92/93	0	<1	0	3	0	2.5	1.2	2.2	<1	0	0	1	6.5	0	0

Reporting rates from external tags:

Estimates based on more than 10 tag returns are shown in bold type.

Faroes: 0.75 in 1981/82-1990/91; 1.00 in 1991/92-1992/93
Scotland (N. Esk and Montrose Bay): 1.0
Norway: 0.50
Sweden: 0.65
Elsewhere: 0.50

Table 4.2.1.1 Numbers of gear units licensed or authorised by country and gear type.

Year	UK (England and Wales)				UK (Scotland)		UK (N. Ireland)				Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Fixed engine[1]	Net and coble	Driftnet	Draftnet	Bagnets and boxes	Rod licences	Bagnet	Bendnet	Liftnet	Driftnet (No. Nets)
1966					11,750	859					7,101		55	
1967					12,697	833					7,106	2,827	48	11,498
1968					12,561	966					6,588	2,613	36	9,149
1969					12,306	847	139	311	17		6,012	2,756	32	8,956
1970					11,097	772	138	306	17		5,476	2,548	32	7,932
1971					10,105	800	142	305	18		4,608	2,421	26	8,976
1972					10,995	806	130	307	18		4,215	2,367	24	13,448
1973					9,646	882	130	303	20		4,047	2,996	32	18,616
1974					14,332	773	129	307	18		3,382	3,342	29	14,078
1975					13,520	764	127	314	20		3,150	3,549	25	15,968
1976					10,814	746	126	287	18		2,569	3,890	22	17,794
1977					14,502	971	126	293	19		2,680	4,047	26	30,201
1978					11,358	686	126	284	18		1,980	3,976	12	23,301
1979					12,862	742	126	274	20		1,835	5,001	17	23,989
1980					12,074	666	125	258	20		2,118	4,922	20	25,652
1981					11,750	652	123	239	19		2,060	5,546	19	24,081
1982					8,385	644	123	221	18	14,784	1,843	5,217	27	22,520
1983	232	209	333	149	10,605	664	120	207	17	14,145	1,735	5,428	21	21,813
1984	226	223	354	149	7,711	634	121	192	19	13,529	1,697	5,386	35	21,210
1985	223	230	375	144	5,775	529	122	168	19	15,209	1,726	5,848	34	20,329
1986	220	221	368	139	4,788	590	121	148	18	15,332	1,630	5,979	14	17,945
1987	213	206	352	143	6,243	574	120	119	18	-	1,422	6,060	13	17,234
1988	210	212	284	145	2,115	393	115	113	18	18,012	1,322	5,702	11	15,532
1989	201	199	282	150	1,837	353	117	108	19	-	1,888	4,100	16	0
1990	200	204	292	144	2,232	338	114	106	17	-	2,375	3,890	7	0
1991	199	187	264	142	1,836	295	118	102	18	-	2,343	3,628	8	0
1992	203	158	267	141	1,799	292	121	91	19	-	2,268	3,342	5	0
1993	187	151	259	89	1,847	264	120	73	18	-	n/a	n/a	n/a	0
1994	177	158	257	81	1,621	245	119	68	18	-	n/a	n/a	n/a	0
1995	162	156	249	74	n/a	a/a	122	68	16	-	n/a	n/a	n/a	n/a

[1] Annually (number of fixed engine counted together from February to September).

Continued...

Table 4.2.1.1 (cont'd) Numbers of gear units licensed or authorised by country and gear type.

	Ireland				Finland				France		
					The Teno River			R.Näätämö			
	Driftnets No.	Draftnets	Other nets	Rod	Recreational fishery		Commercial fishery	Recreational fishery	Rod and line licences	Com. nets in freshwater[3]	Licences in estuary[3,4]
Year					Fishing days	Fishermen	Fishermen	Fishermen			
1966	510	742	214	11,621							
1967	531	732	223	10,457							
1968	505	681	219	9,615							
1969	669	665	220	10,450							
1970	817	667	241	11,181							
1971	916	697	213	10,566							
1972	1,156	678	197	9,612							
1973	1,112	713	224	11,660							
1974	1,048	681	211	12,845							
1975	1,046	672	212	13,142							
1976	1,047	677	225	14,139							
1977	997	650	211	11,721							
1978	1,007	608	209	13,327							
1979	924	587	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[1]	58[1]	86
1987[1]	-	-	-	-	22,487	7,759	754	689	5,804[2]	87[2]	80
1988	836	-	-	11,539	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	16,484	24,118	8,681	742	696	3,826	83	78
1990	756	525	189	15,395	19,596	7,677	728	614	2,977	71	76
1991	707	504	182	15,178	22,922	8,286	734	718	2,760	78	71
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71
1993	673	497	161	23,875	29,461	10,198	755	705	2,111	53	55
1994	732	519	176	24,488	26,517	8,985	751	671	1,680	17	59
1995	773	446	176	25,000	24,951	8,141	687	716	1,881	17	59

1 Common licence for salmon and seatrout.

2 Introduction of quotas/fisherman, obligation to declare the catches.

3 The number of licences 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.

4 Adour estuary only southwest of France).

5 Incomplete figures for 1993

Table 4.2.2.1 CPUE for salmon rod fisheries in Finland (1974-94), France (1987-94) and on the River Bush (UK(N.Ireland))

	Finland (Teno River)				France		UK(N.Ire.) (R.Bush)	
	Catch per angler season		Catch per angler day		Catch per angler season		Catch per rod day	
Year	kg	5 yr mean	kg	5 yr mean	Number	5 yr mean	Number	5 yr mean
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	**3.1**	1.1	**1.1**				
1983	3.4		1.2				0.248	
1984	2.2		0.8				0.083	
1985	2.7		0.9				0.283	
1986	2.1		0.7				0.274	
1987	2.3	**2.2**	0.8	**0.8**	0.39	**0.6**	0.194	**0.2**
1988	1.9		0.7		0.73		0.165	
1989	2.2		0.8		0.55		0.135	
1990	2.8		1.1		0.71		0.247	
1991	3.4		1.2		0.60		0.396	
1992	4.5	**3.4**	1.5	**1.2**	0.94	**1.1**	0.258	**0.3**
1993	3.9		1.3		0.88		0.341	
1994	2.4		0.8		2.31		0.205	
1995	2.7		0.9		2.30		0.206	

Table 4.2.2.2 CPUE data for net and fixed engine salmon fisheries by National River Authority (NRA) Region in UK (England and Wales), 1988-1995.

Data expressed as catch per licence-day.

	NRA Region				
Year	Northumbria	Yorkshire	Southern	Welsh	North West
1988	6.85	2.24	10.15	-	-
1989	5.38	2.16	16.8	0.90	0.82
1990	6.64	2.94	8.56	0.78	0.63
1991	3.98	1.28	6.40	0.62	0.51
1992	3.48	0.80	5.00	0.69	0.40
1993	7.26	3.39	-	0.68	0.63
1994	7.62	5.63	-	1.02	0.71
1995	9.15	2.52	-	1.00	0.79
Mean 1990-94	5.80	2.81	-	0.76	0.58

Table 4.2.2.3 CPUE data for Scottish net fisheries. Catch in numbers of fish per unit of effort.

Year	Net and Coble	Fixed engines
	Catch/crew month	Catch/trap month [1]
1952	156.87	33.94
1953	122.09	33.16
1954	162.67	29.34
1955	202.53	37.11
1956	117.48	25.72
1957	178.70	32.60
1958	170.39	48.37
1959	159.34	33.32
1960	177.97	30.68
1961	155.34	31.02
1962	248.30	43.89
1963	182.86	44.29
1964	247.11	57.94
1965	189.20	43.73
1966	211.08	44.92
1967	330.99	72.69
1968	199.29	47.07
1969	328.42	65.58
1970	242.85	50.42
1971	232.19	57.26
1972	249.28	57.62
1973	241.14	73.93
1974	258.44	63.62
1975	236.94	53.76
1976	152.81	43.04
1977	190.35	45.70
1978	197.50	54.10
1979	158.25	42.31
1980	159.57	37.80
1981	182.45	49.53
1982	181.05	62.02
1983	205.28	56.02
1984	159.97	58.70
1985	155.66	54.27
1986	202.44	75.70
1987	146.37	66.18
1988	202.97	51.74
1989	264.21	71.44
1990	146.61	33.21
1991	104.19	35.87
1992	154.07	59.65
1993	125.00	52.69
1994	138.05	93.23

[1] - Excludes catch and effort data for Solway Region

Table 4.2.4.1 Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic.

Country	Catches of Salmon						
	Year/ Season	Wild	Farmed		Total Farmed	Ranched	Total
Norway	1989	707.0	FW	29			
			SEA	166	195	3	905
	1990	709.8	FW	29			
			SEA	185	214	6.2	930
	1991	682.5	FW	20			
			SEA	169	189	5.5	877
	1992	653.7	FW	27			
			SEA	176	203	10.3	867
	1993	707	FW	18			
			SEA	191	209	7	923
	1994[2]	781	FW	18			
			SEA	187	205	10	996
	1995	645	FW	13			
			SEA	170	187	2	839
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
	1992/1993	16.1			5.9	0	22
	1993/1994	5.8			1.2	0	7
	1994/1995	5.7			1.3	0	7
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
	1993	70			<1	0	70
	1994	49			<1	0	49
	1995	48			<1	0	48
France	1991	13			0	0	13
	1992	20			0	0	20
	1993	16			0	0	16
	1994	18			0	0	18
	1995	9			0	0	9
Iceland	1991	130			3	375	505
	1992	175.5			+	412	590
	1993	160			-	496	656
	1994	140			-	308	448
	1995	150			-	289	439
Ireland[4]	1991	398.7			1.7	3.6	404
	1992	618.3			2.3	9.4	630
	1993	532.2			1.1	9.7	543
	1994	799.2			2.6	15.2	817
	1995	694.5			0.7	16.8	712
Russia	1991	215			0	0	215
	1992	166			0	0	166
	1993	140			0	0	140
	1994	138			0	0	138
	1995	129			0	0	129
Sweden	1991	23			1	14[1]	38
	1992	24			1	24[1]	49
	1993	35			1	20[1]	56
	1994	15			1	29[1]	45
	1995	12			1	24[1]	37
UK (E&W)	1991	200			0	0	200
	1992	186			0	0	186
	1993	274			0	0	274
	1994	319			0	0	319
	1995	311			0	0	311
UK (N.Ire)	1991	54			<1	-	55
	1992	85.3			1.1	2.6	89
	1993	80.5			0.2	2.3	83
	1994	90.1			0.5	0.4	91
	1995[2]	80.6			1.5	0.9	83
UK (Scot)	1991	448			14	0	462
	1992	569			31	0	600
	1993	515			31	0	546
	1994[3]	644			5	0	694
	1995[2]	455			1	0	456

[1] Fish released for mitigation purposes and not expected to contribute to spawning.
[2] Provisional figures.
[3] 1994 data as reported in catch statistics; previous years' data calculated from sampling programmes.
[4] Smolts released for enhancement of stocks or rod fisheries are included in wild.

Table 4.2.4.2 Salmon farm escapees identified during microtag recovery programmes in the Republic of Ireland and Northern Ireland

		Fishing Area					
		UK	Ireland				
		N.Ireland			Galway	South	
	Year	**Total**	Donegal	Mayo	Limerick	West	**TOTAL**
No. examined	**1995**	12,513	56,329	30,785	23,676	14,407	125,197
No. escapees		505	9	42	6	28	85
% in sample		4.03	0.02	0.14	0.03	0.19	0.07
Raised to total catch		505	9	94	10	112	225
% examined		100	100	45	60	25	*48*
No. examined	**1994**	11,703	78,021	16,270	21,853	18,859	135,003
No. escapees		138	106	17	18	203	344
% in sample		1.18	0.14	0.10	0.08	1.08	0.25
Raised to total catch		143	106	73	28	676	883
% examined		*97*	*100*	*23*	*64*	*30*	*46*
No. examined	**1993**	6,092	62,291	29,801	17,298	1,425	110,815
No. escapees		16	53	81	11	15	160
% in sample		0.26	0.09	0.27	0.06	1.05	0.14
Raised to total catch		28	18	151	13	180	362
% examined		*57*	*100*	*53*	*78*	*4*	*53*
No. examined	**1992**	6,018	73,828	23,787	9,771	7,119	114,505
No. escapees		224	18	403	10	1	432
% in sample		3.72	0.02	1.69	0.1	0.01	0.38
Raised to total catch		425	18	713	20	6	757
% examined		*53*	*100*	*33*	*33*	*17*	*46*
No. examined	**1991**	n/a	59,891	29,245	3,853	5,621	98,610
No. escapees		n/a	0	338	15	0	353
% in sample		n/a	0	1.16	0.39	0	0.36
Raised to total catch		n/a	0	524	38	0	562
% examined			*100*	*64*	*29*	*23*	*73*

n/a = not available

Table 4.2.4.3 Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989-1994. n=number of salmon examined.

	Coast				Fjords			
Year	n	No.localities	%	Range	n	No.localities	%	Range
1989	1217	7	45	7 - 66	803	4	14	8 - 29
1990	2481	9	48	16 - 64	940	5	15	6 - 36
1991	1245	6	49	29 - 63	336	3	10	6 - 16
1992	1162	7	44	4 - 72	307	1	21	-
1993	1477	7	47	1 - 60	520	4	20	7 - 47
1994	1087	7	34	2 - 62	615	4	19	2 - 42
1995	976	7	42	2 - 57	745	4	17	2 - 47

Table 4.2.4.4 Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June-18 August) and brood stock catches (18 August–30 November) in 1989–1994. n=number of salmon examined. R= number of rivers sampled.

	1 June–18 August				18 August–30 November			
Year	n	R	%	Range	n	R	%	Range
1989	5744	39	7	0 - 26	1791	16	38	2 - 77
1990	5380	39	7	0 - 55	2004	21	33	2 - 82
1991	3707	27	5	0 - 23	1563	22	25	0 - 82
1992	4034	31	5	0 - 24	1394	19	27	0 - 71
1993	2314	20	4	0 - 22	1032	16	21	0 - 64
1994	2414	14	5	0 - 19	1602	16	21	0 - 61
1995	1419	17	4	0 - 19	1312	18	23	0 - 69

Table 4.2.4.5 Salmon farm escapees in R. Bush (UK, N.Ireland)based on operation of total trap throughout the year

(Note 1994 data includes 14 escapees entering in January 1995)

	Year				
	1991	1992	1993	1994	1995
Total run					
(excl. ranched)	2344	2570	3253	2064	1527
No. escapees	3	24	18	54	6
% in sample	0.13	0.93	0.55	2.62	0.39

Table 4.2.5.1 Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Ireland and UK)

	Ireland[1]			UK (England + Wales)[2]				UK (Northern Ireland) [1]				UK (Scotland)[2]	
	Burrishoole	Corrib		Dee	Itchen		Test	River Bush				North Esk	
	net	net	net	rod	net	rod	rod	net	net	net	net	In-river netting	
Year	HR	W	W	W	W	W	W	W	W/HR	HR1+	HR2+	W	W
	1SW	1SW	2SW	(all ages)				1SW	2SW	1SW	1SW	1SW	2SW
1985	86	66	11							93		23	35
1986	86	52	34							82	75	40	29
1987	78	-	5					69	46	94	77	29	37
1988	75	29	-				39	65	36	72	57	35	37
1989	82	43	35		9	45	29	89	60	92	83	25	26
1990	52	31	45		20	51	36	61	38	63	70	37	37
1991	65	19	19	6	30	45	26	65	43	57	46	10	15
1992	71	24	28	16	0	27	25	56	33	74	75	28	27
1993	71	31		13	0	42	28	41	12	67	71	25	19
1994	73			17	0	50	32		40	71	64	19	25
1995[3]	84			9	0	27	28	67	42	69		14	13
Mean													
1990 - 94	66	26	31	13	10	43	29	56	33	66	65	24	25

[1] Estimate based on microtag recoveries raised to total catch and including estimate of non-catch fishing mortality.
[2] Estimate based on counter and catch figures.
[3] Provisional figures.
[4] Probably underestimated.
HR = Hatchery reared.
W = Wild.

Continued..........

Table 4.2.5.1 (cont'd) Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Iceland, Norway, Sweden and Russia)

	Iceland[1]	Norway[2]						Sweden[3]		Russia[1,6]		
	Ellidaar	Drammen		Imsa				Lagan		Ponoy	Kola	Tuloma
Year	W	HR[4]		W		HR4		HR+2[7]		W	W+HR	W
	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	all sea ages		
1985	40	57		73	94	81	100	81		47	90	47
1986	34	81	50	79	82	78	90	93	82	50	77	50
1987	54	64	52	56	95	83	95	78	55	48	91	49
1988	45	70	47	51	80	78	91	73	91	77	87	51
1989	41	40	59	65	74	44	65	76	86	78	84	50
1990	44	23	40	42	42	47	68	80	82	50	80	50
1991	37	54	59	37	72	50	66	91	92	20	58	48
1992	48		51	61	76	74	91	73	98	11	77	45
1993	41	20		53	80	85	89	89	82	10	79	39
1994	49	41	33	55	80	66	94	70	100	0	73	42
1995[5]	43	36	40		86	55	88	58	66	3	77	49
Mean												
1990- 94	44	35	46	50	70	64	82	81	91	18	73	45

[1]Estimate based on counter and catch figures.
[2]Estimates based on external tag recoveries and counter figures.
[3]Estimate based on external tag recoveries and before 1994 on assumed 50% exploitation in the river brood stock fishery.
[4]HR in R. Drammen and R. Imsa are pooled groups of 1+ and 2+ smolts.
[5]Provisional figures.
[6]Net only.
[7] HR in R. Lagan are pooled groups of 1+ and 2+ smolts released in 1993
W = Wild
HR = Hatchery reared.

Reporting rates for external tags:

Scotland	N. Esk	1.00
	Montrose Bay	1.00
Norway		0.50
Sweden		0.65
Elsewhere		0.50

Table 4.3.1.1 Estimated numbers of spawners and egg deposition and fraction of target attained in rivers in the North East Atlantic area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
FRANCE		**River Scorff**				
Target:			**1.17**			
Observed:						
1994	499	88	1.43			1.22
1995	524	50	1.25			1.07
		River Nivelle				
Target:			**0.22**			
Observed:						
1984	154	23	0.172			0.78
1985	72	43	0.090			0.41
1986	287	40	0.411			1.87
1987	169	46	0.266			1.21
1988	120	40	0.287			1.30
1989	207	55	0.482			2.19
1990	251	39	0.746			3.39
1991	142	39	0.528			2.40
1992	195	44	0.709			3.22
1993	430	35	1.208	-	-	5.49
1994	279	43	0.793			3.60
1995	182	42	0.446			2.03
IRELAND		**River Burrishoole**				
Target:	**616**		**1.29**			
Observed:						
1980	832		1.75	1.35		1.36
1981	348		0.73	0.56		0.57
1982	510		1.07	0.83		0.83
1983	602		1.26	0.98		0.98
1984	319		0.67	0.52		0.52
1985	567		1.19	0.92		0.92
1986	495		1.04	0.80		0.81
1987	468		0.98	0.76		0.76
1988	458		0.96	0.74		0.74
1989	662		1.39	1.07		1.08
1990	231		0.49	0.38		0.38
1991	547		1.15	0.89		0.89
1992	360		0.76	0.58		0.59
1993	528		1.11	0.86		0.86
1994	516		1.08	0.84		0.84
1995	561		1.18	0.91		0.91

Table 4.3.1.1 (cont'd) Estimated numbers of spawners and egg deposition and fraction of target attained in rivers in the North East Atlantic area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
UK(ENG. & WALES)		**River Dee**				
Target:			**24.64**			
Observed:						
1992	2461	1147	11.24			0.46
1993	6425	1509	23.89			0.97
1994	3206	885	11.80			0.48
1995	3442	1087	13.69			0.56
UK(N.IRELAND)		**River Bush**				
TARGET			**2.31**			
Observed						
1985			3.53			1.53
1986			4.79			2.07
1987			3.43			1.48
1988			4.60			1.99
1989			1.06			0.46
1990			2.44			1.06
1991			2.97			1.29
1992			2.57			1.11
1993			3.00			1.30
1994			2.25			0.97
1995			1.46			0.63
UK(SCOTLAND		**North Esk**				
Target:	**2334**	**1658**	**12.78**			
Observed:						
1981	4975	3773	35.23	2.13	2.28	2.76
1982	5251	2495	26.96	2.25	1.50	2.11
1983	5800	2654	30.00	2.49	1.60	2.35
1984	4635	1962	21.69	1.99	1.18	1.70
1985	5548	3488	40.13	2.38	2.10	3.14
1986	3609	2717	26.45	1.55	1.64	2.07
1987	4409	1966	24.20	1.89	1.19	1.89
1988	7638	2575	31.56	3.27	1.55	2.47
1989	7234	2981	36.97	3.10	1.80	2.89
1990	2334	1658	12.78	1.00	1.00	1.00
1991	5785	2561	29.15	2.48	1.54	2.28
1992	7370	2334	38.32	3.16	1.41	3.00
1993	5426	4288	33.77	2.32	2.59	2.64
1994	7588	3688	38.76	3.25	2.22	3.03
1995	5784	3958	32.48	2.48	2.39	2.54

Table 4.3.1.1 (cont'd) Estimated numbers of spawners and egg deposition and fraction of target attained in rivers in the North East Atlantic area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
RUSSIA		**River Tuloma**				
Target:	**830**	**3530**	**42.19**			
Observed:						
1982	320	535	5.41	0.39	0.15	0.13
1983	330	1956	20.89	0.40	0.55	0.50
1984	573	1996	26.10	0.69	0.57	0.62
1985	412	1665	17.90	0.50	0.47	0.42
1986	235	1010	13.40	0.28	0.29	0.32
1987	210	803	8.43	0.25	0.23	0.20
1988	168	669	6.41	0.20	0.19	0.15
1989	255	1251	12.21	0.31	0.35	0.29
1990	276	1691	14.47	0.33	0.48	0.34
1991	470	2265	21.50	0.57	0.64	0.51
1992	142	1222	21.40	0.17	0.35	0.51
1993	200	1207	12.04	0.24	0.34	0.29
1994	189	544	7.80	0.23	0.15	0.18
1995	305	674	10.00	0.37	0.19	0.24

Table 4.3.1.2 Status of stocks in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations)

Type of data	Test No.	Rivers (Countries)	Life stage	Period (years)	'p' value	Trend
Section 4.3.1 Egg deposition	1.	Bush (UK NI), North Esk (UK Scot), Nivelle (Fra), Burrishoole (Ire), Tuloma (Rus)	Eggs	10	0.082	**Up**
	2.	Bush (UK NI), North Esk (UK Scot), Nivelle (Fra), Burrishoole (Ire), Tuloma (Rus)	Eggs	5	>0.1	Nt
Section 4.3.2 Smolt counts	3.	Oir (Fra), Imsa + Orkla (Nor), Burrishoole (Irl), Bush (UK NI),North Esk + Girnock (UK Scot),	Smolts	10	>0.1	Nt
	4.	Oir (Fra), Imsa + Orkla (Nor), Burrishoole (Irl), Bush (UK(NI)),North Esk , Girnock and Baddoch (UK Scot), Hogvadsan (Swe),Ellidaar + Versturdalsa (Ice), Ylapulmankijoki +Tsarsjoki (Fin)	Smolts	5	>0.1	Nt
Section 4.3.3 Adult counts	5.	Burrishoole (Irl), North Esk + Girnock (UK Scot),Bush (Irl), Mourne + Faughan (UK NI), Imsa (Nor), Oir + Bresle (Fra)	Adults	10	0.019	**Up**
	6.	Burrishoole (Irl), Usk (UK E&W), North Esk, Girnock + Baddoch (UK Scot), Bush, Mourne + Faughan (UK NI), Imsa (Nor),Ellidaar (Ice), Hogvadsan (Swe), Oir, Bresle + Nivelle (Fra)	Adults	5	>0.1	Nt
	7.	Russia (Tuloma, Ponoy, Kola, Zap Litca + Yokanga)	Adults	30	<0.001	**Up**
	8.	Russia (Tuloma, Ponoy, Kola, Zap Litca + Yokanga)	Adults	20	>0.1	Nt
	9.	Russia (Tuloma, Ponoy, Kola, Zap Litca + Yokanga)	Adults	10	0.036	**Dn**
	10.	Russia (Tuloma, Ponoy, Kola, Zap Litca, Yokanga, Varzuga + Keret)	Adults	5	>0.1	Nt
Section 4.3.4 Wild smolt survival	11.	Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot)	1SW return to homewaters	10	0.058	**Dn**
	12.	Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot), Elidaar (Ice)	1SW return to homewaters	5	>0.1	Nt
	13.	Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	10	0.037	**Dn**
	14.	Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	5	0.059	**Dn**
Section 4.3.4 Hatchery smolt survival	15.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	10	<0.001	**Dn**
	16.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	5	>0.1	Nt
	17.	Kollafjordur (Ice), , Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	10	0.01	**Dn**
	18.	Kollafjordur (Ice), Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	5	0.049	**Dn**

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

Table 4.3.2.1 Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Finland, Norway and Sweden)

Year	Finland							Norway		Sweden
	River Teno	River[1] Inarijoki	River[1] Utsjoki	River[2] Ylapulmankijoki	River[2] Tsarsjoki	River[2] Karigssjoki	River[2] Kuoppilssjoki	River Imsa	River Orkla	River Hogvadsån
	Juvenile Survey[3]	Juvenile Survey[3]	Juvenile Survey[3]	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total Count	Smolt Estimate	Smolt Partial Count[4]
1964										9,771
1965										2,610
1966										367
1967										627
1968										1,564
1969										4,742
1970										242
1971										-
1972										-
1973										1,184
1974										184
1975										363
1976										247
1977										-
1978										38
1979	19.9	18.0	93.2							103
1980	26.4	37.2	46.2							1,064
1981	13.4[5]	17.9	52.3					3,214		500
1982	36.6	19.7	70.5					736		1,566
1983	53.4	51.8	86.5					1,287	121,000	2,982
1984	39.1	40.6	70.7					936	183,000	4,961
1985	60.8	40.8	84.2					892	173,000	4,989
1986	52.0	40.5	41.5					477	227,000	2,076
1987	45.1	45.5	70.8					480	238,000	3,173
1988	33.4	46.2	49.0					1,700	152,000	2,571
1989	36.1	37.9	81.3	2,500	2,495			1,194	-	882
1990	35.3	51.1	101.5	3,058	2,615	2,576		1,822	323,000	1,042
1991	40.7	53.2	32.3	2,447	1,828	1,349	739	1,995	243,000	1,235
1992	25.8[5]	48.2	51.2	3,538	4,219	435	257	1,500	262,534	1,247
1993	34.0	41.5	66.7	2,825	3,078	189[5]	70	398	297,264	1305
1994	50.8	60.9	96.9	1,268	2,794	706	142	-	165,875	993
1995	45.7	40.5	63.9	-	-	-	-	338	174,677	1525
Mean '90-94	40.2	59.1	69.7	2627	2907	1267	302	1429	258,334	1164

[1] Major tributary of River Teno
[2] Tributary of River Teno
[3] Juvenile survey represents mean fry and parr abundance (number 100 m^2 caught by electrofishing) at 35, 10 and 12 sites respectively.
[4] Smolt trap catch represents part of the run.
[5] Incomplete data. Minimum numbers due to high water levels.

Continued.....

Table 4.3.2.1 (Cont'd) Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Iceland, France, Ireland, UK(N.Ireland), UK(E&W),UK(Scotland)

Year	Iceland		France			Ireland	UK (N Ireland)		UK (E&W)			UK (Scotland)		
	River Ellidaar	River Vesturdalsa	River Nivelle	River Oir	River Bresle	River Burrishoole	River Bush		River Avon	River Frome	River Piddle	River North Esk	Girnock Burn	Baddock Burn
	Smolt Estimate	Smolt Estimate	Juvenile Survey[6]	Smolt est.	Smolt est.	Smolt Total trap	Smolt Total Trap	Juvenile Survey[7]	Juvenile Survey[6]	Juvenile Survey[6]	Juvenile Survey[6]	Smolt est.	Smolt Total trap	Smolt Total trap
1964												275,000		
1965												183,000		
1966												172,000		
1967												98,000	2,057	
1968												227,000	1,440	
1969												-	2,610	
1970												-	2,412	
1971												167,000	2,461	
1972												260,000	2,830	
1973												165,000	1,812	
1974							43,958					106,000	2,842	
1975							33,365					173,000	2,444	
1976							21,021					93,000	2,762	
1977							19,693					-	3,679	
1978							27,104					-	3,149	
1979							24,733					-	2,724	
1980						11,208	20,139					132,000	3,074	
1981						9,434	14,509					195,000	1,640	
1982					1,860	10,381	10,694					160,000	1,626	
1983					1,880	9,383	26,804	32.6				-	1,747	
1984					1,250	7,270	30,009[8]	19.5				225,000	3,247	
1985	29,000		882	529	2,550	6,268	30,518[8]	7.6				130,000	2,716	
1986	-		6,881[9]	1,325	1,245	5,376	18,442	11.3				-	2,091	
1987	-		11,039[9]	379	-	3,817	21,994	10.3				199,000	1,132	
1988	23,000	14,642	9,946[9]	454	-	6,554	22,783	8.9				-	2,595	
1989	22,500	14,642	6,658[9]	858	-	6,563	17,644	16.2				141,000	1,360	
1990	24,000	11,115	2,505[9]	817	-	5,968	17,133	5.6	2.42	10.86	19.21	175,000	2,042	1907
1991	22,000	9,300	5,287[9]	210	-	3,804	18,218	12.5	4.87	12.04	6.4	236,000	1,503	2582
1992	27,700	19,100	3,452	678	690	6,926	10,021	13.0	1.08	6.74	5.62	-	2,572	2029
1993	18,000	-[11]	2,640	233	810	5,429	(11,583[10])	7.8	3.13	6.93	7.37	-	2,147	-
1994	14,500	-[11]	8,092[9]	647	1,870	5,971	14,145	11.5	3.63	15.42	5.32	148,000	1,223	1280
1995	-	-[11]	-	736	(150[10])	5,989	5,718	8.5	0.51	3.56	4.33	138,000	2,056	1789
Mean '90-94	21,240	12,879	4395	517	1123	5620	14220	10.1	3.03	10.4	8.8	186,333	1897	1950

[6] Estimate of 0+ parr population size in autumn.
[7] Juvenile surveys represent index of fry (0+) abundance (number per 5 minutes electrofishing) at 137 sites, based on natural spawning in the previous year.
[8] These smolt counts show effects of enhancement.

Table 4.3.3.1 Wild adult counts to various rivers in the North East Atlantic area. (Scandinavia and Russia)

Year	Iceland	Norway	Sweden	Russia	Russia	Russia	Russia	Russia	Russia	Russia
	River Ellidaar	River Imsa	River Högvadsån	River Tuloma	River Varzuga	River Keret	River Ponoy	River Kola	River Yokanga	R. Zap. Litca
	Estimate	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap
1952	3792			4800						
1953	2526			2950						
1954	2794		364	4010						
1955	4118		210	4600				4855		
1956	2911		144	4800				2176		
1957	2965		126	4300				2949		
1958	3057		632	6228				1771		1051
1959	4773		197	6125				2790		1642
1960	4815		209	10360				5030		2915
1961	3779		229	11050	55480			5121		2091
1962	3126		385	10920	69388			5776	3655	2196
1963	4031		217	7880	64210			3656	3253	1983
1964	4526		390	4400	21424		23666	3268	2642	1664
1965	3249		442	5600	63812		12998	3676	4482	1506
1966	4274		375	3648	21086		10333	3218	2488	787
1967	4839		90	9011	20534		11527	7170	4993	1486
1968	3024		172	6277	47258		18352	5008	3357	1971
1969	3580		321	4538	53048		9267	6525	1437	2341
1970	2187		610	6175	55556		9822	5416	1117	2048
1971	2590		173	3284	71400		8523	4784	2300	1502
1972	4627		281	6554	48858		10975	8695	1620	1316
1973	6014		100	9726	45750		20553	9780	869	1319
1974	6925		270	12784	39360		24652	15419	280	2605
1975	7184		138	11074	89836		41666	12793	736	2456
1976	3331		65	8060	57246		44283	9360	2767	1325
1977	3756		49	2878	35354		37159	7180	2488	1595
1978	4372		23	3742	18483		24045	5525	1715	766
1979	4948		15	2887	40992		17920	6281	598	700
1980	2632		260	4087	43664		15069	7265	1052	548
1981	2656		512	3467	32158		11670	7131	472	477
1982	4275	66	572	4252	26824		9585	5898	1200	889
1983	3257	14	447	9102	59784		15594	10643	1769	1254
1984	1659	32	629	10971	39636		26330	10970	2498	1859
1985	2896	31	768	8067	48566		38787	6163	1774	1563
1986	2651	22	1632	7275	71562	3230	32266	6508	3212	1815
1987	2191	9	1475	5470	137419	3427	21212	6300	3468	1498
1988	3730	44	1283	8069	72528	3294	20620	5203	2270	575
1989	2921	83	480	8413	65524	3531	19214	10929	2850	2613
1990	1822	67	879	11594	56000	2520	37712	13383	3376	1194
1991	1881	43	534	7174	63000	690	21000	8500	1704	2081
1992	2917	70	345	5476	61300	536	26600	14670	5208	2755
1993	2578	39	603	4520	68300	687	26800	11400	2600	2267
1994	1894	-	640	3320	77800	753	20500	9730	2500	2100
1995	1467	-	156	4737	42290	1066	23000	6051	1153	1916
Mean 90-94	2218	55	600	6417	65300	1037	26522	57083	3078	2079

Continued....

Table 4.3.3.1 Cont'd Wild adult counts to various rivers in the NE Atlantic area. (Ireland, UK and France)

Year	Ireland	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (NI)	UK (NI)	UK (NI)	UK (Scotl.)	UK (Scotl.)	UK (Scotl.)	France	France	France
	Burrishoole	Usk	Frome	Test	Itchen	Kent	Leven	Bush	Faughan	Mourne	N. Esk	Girnock	Baddoch	Nivelle	Oir	Bresle
	Total trap	Counter	Counter	Counter + catch	Counter + catch	Counter	Counter	Total trap	Counter	Counter	Counter	Total trap	Total trap	Trap est.	Trap est.	Trap est.
1966									6792	15112		269				
1967									1723	7087		214				
1968									1657	2147		196				
1969									1195	1569		49				
1970									3214	5050		90				
1971									1758	4401		125				
1972									1020	1453		137				
1973								2614	1885	2959		225				
1974								3483	2709	3630		184				
1975								3366	1617	1742		121				
1976								3124	2040	2259		164				
1977								1775	2625	2419		115				
1978								1621	2587	5057		38				
1979								1820	3262	2226		82				
1980	832							2863	3288	3146		203				
1981	348							1539	3772	2399	9025	67				
1982	510							1571	2909	4755	8121	73				
1983	602							1030	2410	1271	8972	63				
1984	319							672[1]	2116	1877	7007	106		33	295	98
1985	567							2443	9077	8149	9912	67		61	301	148
1986	495							2930	4915	6295	6987	156		204	204	211
1987	468							2530	907	2322	7014	293		138	128	188
1988	458	7073	4093	1507	1336			2832	3228	7572	11243	187	150	130	235	89
1989	662	6076	3186	1730	791	1137		1029	8287	9497	11026	108	191	263	235	214
1990	231	3700	1880	790	367	2216		1850	6458	11541	4762	58	144	291	121	126
1991	547	2746	805	538	152	1861	667	2341	4301	7987	9127	97	118	184	46	211
1992	360	2177	900	614	357	1816	394	2546	7375	7420	10795	73	88	240	45	243
1993	528	4098	1182	1249	852	1526	469	3235	8655	17855	10887	42	63	472	161	74
1994	516	3193	1078	775	374	2072	562	2010	7439	19908	11341	81	149	263	99	77
1995	561	6898	1016	647	880	2762	370	1521	5838[2]	7547	9864	124	46	195	133	100
Mean '90-94	436	3183	1169	793	420	1898	418	2396	6846	12942	9382	70	112	290	94	146

[1]Minimum count.
In the UK(Scotl.)Girnock, the trap is located in the Girnock Burn, a tributary in the upper reaches of the River Dee (Aberdeenshire). In the UK(Scotl.) N. Esk, counts are recorded upstream of the in-river commercial fishery and most important angling fishery. Thus, the counts do not necssarily reflect the numbers of fish entering the river.

[2]River Faughan (UK, NI) counts for 1995 is not believed to be accurate for counter information

Table 4.3.4.1 Estimated survival of wild smolts (%) to return to homewaters (prior to coastal fisheries) for various monitored rivers in the NE Atlantic area.

Smolt migration year	Iceland[1]			UK (N.Ireland)	Norway[2]		UK (Scotland)[2]			France		
	Ellidaar	R.Vesturdalsa[4]		R. Bush	R. Imsa		North Esk			Oir[5]	Nivelle[6]	Bresle
	1SW	1SW	2SW	1SW3	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20											
....												
1981					17.3	4	13.7	6.9	0.3			
1982					5.3	1.2	12.6	5.4	0.2			
1983		2			13.5	1.3	-	-	-	3.2		8.5
1984					12.1	1.8	10	4.1	0.1	7.7		16.3
1985	9.4				10.2	2.1	26.1	6.4	0.2	7.5		12.2
1986				31.3	3.8	4.2	-	-	-	3.9	15.8	19.4
1987				35.1	17.3	5.6	13.9	3.4	0.1	9.3	2.6	-
1988	12.7			36.2	13.3	1.1	-	-	-	2.3	2.4	-
1989	8.1	1.1	2	25.0	8.7	2.2	7.8	4.9	0.1	2.4	3.5	-
1990	5.4	1	1	34.7	3.0	1.3	7.3	3.1	0.2	6.1	1.8	-
1991	8.8	4.2	0.6	27.8	8.7	1.2	11.2	4.5	-	13.2	9.2	-
1992	9.6	2.4	0.8	29.0	6.7	0.9	-	-	-	4.9[7]	8.9	10.2[7]
1993	9.8	-	-	-	15.6	1.8	-	-	-	14.5[7]	8.1[7]	13.8[7]
1994	9.0	-	-	27.1	-	-	17.1	-	-	-	4.9[7]	10.0[7]
Mean 1989-93	8.34	2.2	1.1	29.1	8.5	1.5	8.8	4.2	0.2	-	-	-

[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.
[-] Incomplete returns.

Table 4.3.4.2 Estimated survival of wild smolts (%) into freshwater for various monitored rivers in the NE Atlantic area.

Smolt year	Iceland[1] River Ellidaar	Iceland[1] River Vesturdalsa[5]		Ireland River Corrib		Ireland River Burrishoole	UK(N.Ireland) River Bush		Norway[2] River Imsa		UK (Scotland)[1] North Esk[4]			France Oir[3]	France Nivelle[6]	France Bresle
	1SW	1SW	2SW	1SW	2SW	1SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20.8															
1979	-					7.3										
1980	-			2.6	0.8	3.1										
1981	-			3.3	1.76	5.4	9.5	0.9	2.1	0.3	4.2	2.0	0.2			
1982	-			5.7	1.56	5.8	7.8	0.8	0.7	0.1	4.9	2.2	0.2			
1983	-	2.0		3.2	0.68	3.4	1.9[3]	1.7	2.4	0.1	-	-	-	3.2		5.5
1984	-	-		4.5	0.66	7.8	6.4	1.4	3.2	0.3	3.9	2.1	0.1	7.7		11.7
1985	9.4	-		4.0	0.84	7.9	7.9	1.9	2.1	0.1	5.9	2.9	0.2	7.5		9.6
1986	-	-				8.7	9.7	1.9	1.7	0.8	-	-	-	3.9	15.7	14.4
1987	-	-		6.0	0.43	12.0	12.0	0.4	8.3	1.5	6.7	2.1	0.1	9.3	2.7	-
1988	12.7	-		3.7	0.14	10.1	3.9	0.8	4.5	0.6	-	-	-	2.3	2.2	-
1989	8.1	1.1	2.0	2.5	0.44	3.5	9.3	1.4	4.9	0.6	3.5	2.7	0.1	2.4	3.5	-
1990	5.4	1.0	1.0	2.3	0.6	9.2	11.8	1.7	1.7	0.3	4.2	2.1	0.2	6.1	1.8	-
1991	8.8	4.2	0.6	2.52		9.5	12.0	2.2	3.4	0.2	5.2	2.3	-	13.2	9.2	-
1992	9.6	2.4	0.8	2.73		7.6	16.8	2.0	3.1	0.2	-	-	-	4.9[7]	8.9	8.6
1993	9.8	-	-			9.5	15.1	2.0	7.0		-			14.5[7]	8.1[7]	10.0[7]
1994	9.0	-				9.4	8.9				4.9				4.9[7]	6.4[7]

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Minimum estimate.
[4] Before in-river netting.
[5] Assumes 50% exploitation in rod fishery.
[6] Survival of 0+parr to adults.
[7] Incomplete returns.

Table 4.3.4.3 Estimated survival of hatchery smolts (%) to adult return to homewaters, (prior to coastal fisheries) for various monitored rivers and experimental facilities in the NE Atlantic area.

	Iceland[1]		Ireland[1]			N. Ireland[1]		Norway[2]				Sweden[2]	
Smolt year	Kollafjordur		R.Burri-shoole[3]	R. Shannon		R. Bush (1SW)		R Imsa		R Drammen		R. Lagan	
	1SW	2SW	1SW	1SW	MSW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981	5.6	3.1	10.5			-	-	10.1	1.3	-	-	-	-
1982	8.7	1.6	9.7			-	-	4.2	0.6	-	-	-	-
1983	1.2	0.9	3.64			1.9	8.1	1.6	0.1	-	-	-	-
1984	4.5	0.5	25.1			13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	7.3	0.7	28.9			15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	no release		9.4			2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	8.9	0.7	13.6			6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988	1.0	0.7	17.9			4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	1.0	0.5	5.1			8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	2.7	0.4	10.5			5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	3.2	0.9	8.4	5.4	0.19	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	5.1	0.7	7.5	3.51	-	6.0	7.8	3.8	0.7	0.4	0.6	1.5	0.4
1993	2.0	0.1	12.3	-	-	1.1	5.8	6.5	0.5	3.0	1.0	2.6	0.8
1994	3.34		11.5	-		1.6		5.1		1.1		4.1	

[1]Microtagged.
[2]Carlin tagged, not corrected for tagging mortality.
[3]Return rates to rod fishery with constant effort.

Table 4.3.4.4 Estimated survival of hatchery smolts (%) to adult return to freshwater, for various monitored rivers and experimental facilities in the NE Atlantic area.

Smolt year	Iceland[1] Kollafjordur		Ireland[1] R.Burri-shoole[3]	R.Shannon		N. Ireland[1] R. Bush (1SW)		Norway[2] R Imsa		R Drammen		Sweden[4] R Lagan	
	1SW	2SW	1SW	1SW	MSW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981	5.6	3.1	1.3			-	-	2.0	0.1				
1982	8.7	1.6	1.7			-	-	0.2	0.03				
1983	1.2	0.9	1.7			0.1	0.4	0.1	0.0				
1984	4.5	0.5	3.4			0.9		0.6	0.03	2.5	1.2		
1985	7.3	0.7	4.0			2.8	4.3	1.3	0.13	0.6	0.9		
1986	no release		2.1			0.1	2.1	1.1	0.07	2.2	1.1		
1987	8.9	0.7	3.4			1.8	8.2	2.1	0.3	0.5	0.3		
1988	1.0	0.7	3.3			0.4	1.0	4.8	0.2	0.3	0.2		
1989	1.0	0.5	2.5			2.9	6.8	1.5	0.3	1.4	0.6		
1990	2.7	0.4	3.7			2.4	3.0	1.3	0.1	0.1	0.2		
1991	3.2	0.9	2.5	1.26	0.1	1.4	2.2	0.8	0.1	-	-		
1992	5.1	0.7	2.2	1.45	-	2.0	2.3	0.6	0.1	0.3	0.4	-	0.1
1993	2.0	0.1	3.3	-	-	0.3	2.0	2.2	0	1.7	0.6	1.1	0.5
1994	3.34		1.8	-		0.5		2.5		0.7		3.1	

[1]Microtagged.
[2]Carlin tagged, not corrected for tagging mortality.
[3]Return rates to rod fishery with constant effort.
[4]Carlin tagged, not corrected for tagging mortality. Return rate to broodstock and rod fishery. Estimated exploitation in broodstock fishry in 1994 and 1995 : 49% and 27%.

Table 5.1.3.1 Input data for estimation of harvests and exploitation rates of Penobscot River (USA) salmon.
Homewater tag, angler, and trap counts for 2SW and 3SW salmon, and tag returns by fishery region and sea age.

Year i	2SW Run Year i				3SW Run Year i+1				1SW Tag Returns Year i-1				2SW Tag Returns Year i					
	Ta	Ua	Tt	Ut	Ta	Ua	Tt	Ut	Nfld	Lab	W.Grld	E. Grld	Nfld	Lab	W.Grld	E. Grld	Mar	USAC
1971	0	3	26	62	1	3	0	0	12	4	17	0	2	1	2	0	0	0
1972	2	2	199	118	1	1	0	0	23	7	247	6	2	0	5	0	5	1
1973	1	14	155	122	14	10	0	0	5	7	82	0	5	2	12	0	2	3
1974	5	19	177	316	5	6	0	0	18	7	117	0	1	0	6	0	4	3
1975	22	47	355	501	1	2	0	1	98	5	357	4	8	1	10	0	1	4
1976	11	30	145	397	0	4	0	0	82	20	127	0	0	1	0	0	0	0
1977	21	157	60	346	1	8	1	2	56	24	39	0	3	0	0	0	2	1
1978	17	278	64	1243	0	2	0	1	13	3	11	0	1	0	1	0	0	0
1979	5	127	25	522	0	3	0	1	1	4	9	0	0	1	0	0	0	0
1981	61	570	169	1672	0	18	0	3	131	34	36	0	4	3	0	0	0	0
1982	52	855	182	2852	1	5	0	1	27	14	40	0	4	1	3	0	2	1
1983	18	122	92	524	0	7	0	1	64	21	49	0	0	2	4	0	1	0
1984	3	316	49	1126	0	5	0	2	17	9	7	0	0	0	1	0	0	0
1985	20	297	136	2617	1	14	0	2	23	16	23	0	1	2	0	0	0	0
1986	12	329	250	3361	4	21	1	8	70	23	58	6	2	1	2	1	0	0
1987	5	138	95	1401	0	3	0	3	13	8	72	2	0	0	0	0	0	0
1988	6	127	258	1666	1	4	0	1	32	16	166	0	3	1	3	0	0	1
1989	11	233	149	1710	1	4	1	11	10	10	106	9	2	1	1	0	0	2
1990	13	348	127	2298	0	3	0	1	24	30	106	0	0	1	1	0	0	0
1991	3	145	21	1343	0	1	0	0	6	2	15	0	1	0	0	0	0	0
1992	2	103	22	1283	0	8	0	0	15	0	19	1	0	0	0	0	0	0
1993	1	107	30	1233	0	2	0	0	2	2	14	0	0	0	0	0	0	0
1994	0	0	7	716	0	0	0	7	0	1	2	0	0	0	0	0	0	0

Table 5.1.3.2. Input data for estimation of harvests and exploitation rates of Penobscot River (USA) salmon.
Time series estimates of lottery effect scalar and tag reporting rate in Greenland.

Year i	Scalar	Base Rate
1971	0.5	0.8
1972	0.5	0.8
1973	0.5	0.8
1974	0.5	0.8
1975	0.5	0.8
1976	0.5	0.8
1977	0.5	0.6
1978	0.5	0.6
1979	0.5	0.5
1981	0.5	0.4
1982	0.5	0.5
1983	0.5	0.6
1984	0.5	0.8
1985	0.5	0.8
1986	0.5	0.8
1987	0.5	0.8
1988	0.5	0.8
1989	0.75	0.8
1990	1	0.8
1991	1	0.8
1992	1	0.8
1993	1	0.8
1994	1	0.8

Table 5.1.3.3 Input data for estimation of harvests and exploitation rates of Penobscot River (USA) salmon.
Parameter distributions for Monte Carlo analysis.

Name	Type	Range		
Passage Efficiency	uniform	0.765	-	0.935
HW Return Rate Tagged	uniform	0.81	-	0.99
HW Return Rate Untagged	uniform	0.72	-	0.88
Reporting Rate-Lab	uniform	0.81	-	0.99
Reporting Rate-NFLD	uniform	0.63	-	0.77
Reporting Rate-Greenland	uniform	Base*Scaler±10%		
Non-catch F-Canada	uniform	0.09	-	0.11
Non-catch F-Grld	uniform	0.18	-	0.22
Tag Loss	uniform	0.81	-	0.99
Natural Mortality	uniform	0.108	-	0.132

Table 5.1.3.4 Estimation of harvests and exploitation rates of Penobscot River (USA) salmon. Mean sensitivety ranks for exploitation model parameters.

Parameter	Mean Rank
Passage Efficiency 2SW Fish	1.57
Reporting Rate Greenland	1.61
Tag Loss	3.65
Non-catch Fishing Mortality Greenland	3.87
Reporting Rate Newfoundland	4.87
Non-catch Fishing Mortality Canada	6.61
Natural Mortality	6.70
Reporting Rate for 2SW Tagged Fish in Homewaters	8.65
Reporting Rate Labrador	8.74
Reporting Rate for 3SW Untagged Fish in Homewaters	10.70
Reporting Rate for 2SW Untagged Fish in Homewaters	10.78
Reporting Rate for 3SW Tagged Fish in Homewaters	11.57
Passage Efficiency 3SW Fish	11.70

Table 5.1.3.5 Proportion of salmon of aquaculture origin from the Magaguadavic River (Canada).

Year	1sw	Prop 1SW from Aqua	2SW	Prop 2SW from Aqua	Total	Prop Total from Aqua
1983	303		637		940	
1984	249		534		783	
1985	169		466		635	
1988	291		398		689	
1992	238	0.35	201	0.31	439	0.33
1993	208	0.46	177	0.29	385	0.38
1994	1064	0.94	228	0.73	1292	0.90
1995	545	0.91	194	0.85	739	0.89

Table 5.2.2.1. Returns of Atlantic salmon to rivers of eastern Canada in 1995 compared to returns during 1985 to 1994.

		Rank of 1995 within 1985 to 1995 period				Rank of 1995 within 1990 to 1995 period		
Size group	**Number of rivers**	**Highest**	**Lowest**	**Median**	**Number of rivers**	**Highest**	**Lowest**	**Median**
	Bay of Fundy / Atlantic coast of Nova Scotia (SFA 19 to 23)							
Small + Large	3	9	10	10	5	3	6	4
Small	3	9	11	9	4	3	6	4
Large	3	10	11	11	4	2	6	5.5
	Southern Gulf of St. Lawrence / Québec (SFA 15 to 18, Q1 to Q10)							
Small + Large	18	1	11	9	19	1	6	5
Small	15	1	11	10	17	1	6	6
Large	15	2	11	6	17	2	6	4
	Newfoundland and Labrador (SFA 1 to 14)							
Small + Large	7	1	9	3	11	1	5	3
Small	7	1	8	4	11	1	4	3
Large	7	1	8	1	11	1	4	1

Rank of the 1995 returns of individual rivers within the last 11 years and within the last 6 years. A rank of 1 means the return in 1995 was the highest of the time series for that river. A rank of 11 in the eleven year time series means that the 1995 return was the lowest observed in 11 years for that river. The median rank represents the rank of the 1995 returns for which half the rivers were above and half were below.

Table 5.2.3.1 Estimated numbers of 1SW returns in North America by geographic regions, 1971-95. Returns in Labrador and Newfoundland refer to returns to rivers, for other areas returns refers to fish returning to coastal waters.

YEAR	Labrador Min	Labrador Max	Newfoundland Min	Newfoundland Max	Quebec Min	Quebec Max	Gulf of St. Lawrence Min	Gulf of St. Lawrence Max	Scotia-Fundy Min	Scotia-Fundy Max	USA	Total Min	Total Max	Total Mid-point
1971	32966	115382	112266	224994	9381	15993	33106	57840	11515	19525	32	199266	433766	316516
1972	24675	86362	108509	217092	7592	13322	42177	73444	9522	16915	18	192494	407154	299824
1973	5399	18897	143729	287832	10066	17719	43585	76049	14766	24823	23	217568	425342	321455
1974	27034	94619	84667	169103	10730	17939	65638	113702	26723	44336	55	214848	439754	327301
1975	53660	187809	111847	223890	11155	19307	58592	101659	25940	36316	84	261277	569064	415171
1976	37540	131391	114787	229853	12238	21323	90251	155080	36931	55937	186	291933	593770	442851
1977	33409	116931	109649	219106	11064	19434	31283	55650	30860	48387	75	216340	459584	337962
1978	16155	56542	97070	194133	10196	18131	25993	45255	12457	16587	155	162026	330803	246414
1979	21943	76800	106791	213327	12395	23165	50527	89556	30875	49052	250	222780	452150	337465
1980	49670	173845	120355	240449	17529	31828	45619	80675	49925	73560	818	283916	601174	442545
1981	55046	192662	156541	312697	23581	44516	69693	122878	37371	62083	1130	343363	735967	539665
1982	38136	133474	139951	279115	13783	25320	79458	139108	23839	38208	334	295501	615560	455530
1983	23732	83061	109378	218548	10859	19217	25296	43486	15553	23775	295	185113	388383	286748
1984	12283	42991	129235	257256	8655	16007	37608	63001	26264	44044	598	214643	423897	319270
1985	22732	79563	120990	241331	11297	20077	61108	108954	27617	47910	392	244136	498227	371182
1986	34270	119945	124604	248802	18100	31970	114485	202340	28404	49416	758	320621	653231	486926
1987	42938	150283	125111	249847	19705	35900	86213	153182	29487	50641	1128	304581	640981	472781
1988	39892	139623	132059	263363	24375	43442	123075	218912	30994	53337	992	351388	719668	535528
1989	27113	94896	59793	119261	16152	29341	72780	128056	32676	55224	1258	209772	428037	318904
1990	15853	55485	98830	197276	22280	40814	83296	151952	30753	53919	687	251699	500134	375916
1991	12849	44970	64016	127698	17313	31003	59404	107919	18502	28800	310	172393	340701	256547
1992	18205	61901	116329	232380	22123	40182	146095	227400	21862	35391	1194	325809	598449	462129
1993	24587	82270	131045	261721	21586	39188	89496	141324	14224	24749	466	281404	549718	415561
1994	16335	55132	95487	190655	20803	37380	55501	116008	6274	9132	436	194836	408742	301789
1995	19551	59517	111839	223658	13513	22826	25954	95427	10911	17054	213	181981	418696	300338
Mean	28239	98174	112995	225736	15059	27014	64649	114754	24170	39165	475	245587	505318	375453

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 5.2.3.2 Estimated numbers of 2SW returns in North America by geographic regions, 1971-95. Returns in Labrador and Newfoundland refer to returns to rivers, for other areas returns refers to fish returning to coastal waters.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	Total		
YEAR	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-point
1971	4312	29279	2385	9104	27320	38152	29510	46780	11187	16410	687	93723	140412	117068
1972	3706	25168	2494	9129	26919	42102	35670	59880	14028	19731	1449	105909	157459	131684
1973	5183	35196	2995	11808	31915	48623	34945	59487	10359	14793	1448	111430	171355	141392
1974	5003	34148	1968	6702	43041	63894	49112	83344	21902	29071	1412	149647	218571	184109
1975	4772	32392	2382	8002	36994	55069	31193	51829	23944	31496	2348	108881	181136	145009
1976	5519	37401	2327	7663	38806	57755	29287	51377	21768	29837	1343	106569	185376	145973
1977	4867	33051	1880	6309	43150	69334	58864	100694	28606	39215	2032	169657	250636	210147
1978	3864	26147	2005	6419	35311	56379	30511	51395	16946	22561	4235	106437	167135	136786
1979	2231	15058	1103	3691	20330	30422	8689	14271	8962	12968	1928	42971	78338	60654
1980	5190	35259	2447	7794	47910	75464	43449	73768	31897	44823	5826	148271	242934	195603
1981	4734	32051	2317	7475	35565	54467	17745	29446	19030	28169	5635	83741	157242	120491
1982	3491	23662	2975	9228	35341	56528	31724	51064	17516	24182	6144	111398	170808	141103
1983	2538	17181	2511	7915	30358	44963	29078	46786	14310	20753	2101	95665	139699	117682
1984	1806	12252	2273	7117	26768	41129	20515	34064	17938	27899	3186	75063	125647	100355
1985	1448	9779	963	3323	30944	47583	23228	43280	22841	38784	5363	85174	148112	116643
1986	2470	16720	1593	5404	37726	57536	36506	70261	18102	33101	5963	120765	188986	154875
1987	3289	22341	1338	4629	36315	53453	22922	47037	11529	20679	2861	89647	151000	120323
1988	2068	14037	1553	5346	39149	61020	26240	49586	10652	20553	3008	98258	153549	125904
1989	2018	13653	704	2452	33503	52110	17430	34774	11894	21683	3137	74223	127809	101016
1990	1148	7790	1341	4562	33188	53090	25324	52664	10248	18871	4859	91184	141836	116510
1991	548	3740	1057	3577	32277	50951	21249	43864	10613	17884	2594	78974	122611	100792
1992	2507	15567	3027	10365	32492	52532	29564	59931	9777	16456	2540	99695	157391	128543
1993	3913	18351	1487	5217	25956	41135	26072	51184	7279	12622	2237	85737	130746	108241
1994	5677	24492	1889	6255	27386	44190	22204	56273	4594	7711	1309	80670	140230	110450
1995	10784	37888	2296	7461	22231	34681	23005	59986	4936	8652	1717	83037	150385	116711
Mean	3723	22904	1972	6678	33236	51302	28961	52921	15234	23156	3014	99869	159976	129923

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 5.2.4.1 Summary of run reconstruction data inputs used to estimate pre-fishery abundance of maturing (M) and non-maturing (N) 1SW salmon of North American origin.
(Variables defined in Table 5.2.4.2)

	{1-7, 14b}		{8-14a}		{1-7, 14b}
1SW Year (i)	H_Small (i)	H_Large (i)	H_Small (i)	H_Large (i+1)	H_Large (i+1)
1971	158896	199176	70936	42861	144496
1972	143232	144496	111141	43627	227779
1973	188725	227779	176907	85714	196726
1974	192195	196726	153278	72814	215025
1975	302348	215025	91935	95714	210858
1976	221766	210858	118779	63449	231393
1977	220093	231393	57472	37653	155546
1978	102403	155546	38180	29122	82174
1979	186558	82174	62622	54307	211896
1980	290127	211896	94291	38663	211006
1981	288902	211006	60668	35055	129319
1982	222894	129319	77017	28215	108430
1983	166033	108430	55683	15135	87742
1984	123774	87742	52813	24383	70970
1985	178719	70970	79275	22036	107561
1986	222671	107561	91912	19241	146242
1987	281762	146242	82401	14763	86047
1988	198484	86047	74620	15577	85319
1989	172861	85319	60884	11639	59334
1990	104788	59334	46053	10259	39257
1991	89099	39257	42721	0	26591
1992	20188	26591	0	0	17096
1993	17074	17096	0	0	15213
1994	8508	15213	0	0	10213
1995	7188	10213	0	-	-

Table 5.2.4.2 Definitions of key variables used in continental run-reconstruction models for North America.

Variable	Definition
i	Year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.01/month)
t1	Time between the mid-point of the Canadian fishery and return to river = 2 months
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp(-M t1)}
H_s(i)	Number of "Small" salmon caught in Canada in year i; fish <2.7 kg
H_I(i)	Number of "Large" salmon caught in Canada in year i; fish >2.7 kg
f_imm	Fraction of 1SW salmon that are immature, i.e., non-maturing; range= 0.1 to 0.2
q	Fraction of 1SW salmon present in the large size market category; range=0.1 to 0.3
MN1	Pre-fishery abundance of maturing 1SW North American salmon
MC1(i)	Harvest of maturing 1SW salmon in Newfoundland and Labrador in year i
i+1	Year of fisheery on 2SW salmon in Canada
MR1(i)	Return estimates of maturing 1SW salmon in Atlantic Canada in year i
NN(i)	Pre-fishery abundance of non-maturing 1SW + maturing 2SW salmon in year i
NR(i)	Return estimates of non-maturing 1SW + maturing 2SW salmon in year i
NC(i)	Harvest of non-maturing 1SW salmon in Nfld + Labrador in year i
NC(i+1)	Harvest of maturing 2SW salmon in Canada
NG(i)	Catch of 1SW salmon in Greenland

Table 5.2.4.3 Run reconstruction data inputs and estimated pre-fishery abundance for non-maturing 1SW salmon (potential 2SW returns) of North American origin.
(Variables defined in Table 5.2.4.2)

	NG1	NC1		NC2		NR2		NN1		
1SW		min	max	min	max	min	max	min	max	point
Year (i)	(i)	(i)	(i)	(i+1)	(i+1)	(i+1)	(i+1)	(i)	(i)	(i)
1971	287672	17881	43730	144008	172907	105909	157459	582931	698262	640596
1972	200784	15768	37316	203072	248628	111430	171355	565368	704156	634762
1973	241493	21150	51412	223422	262767	149647	218571	676611	827293	751952
1974	220584	21187	50243	223332	266337	108881	181136	610132	767372	688751
1975	278839	32385	73371	243315	285486	106569	185376	699089	874653	786870
1976	155896	24285	57005	225424	271703	169657	250636	618698	792958	705828
1977	189709	24323	57902	146535	177644	106437	167135	494792	630508	562649
1978	118853	11796	29813	86644	103079	42971	78338	274372	350033	312202
1979	200061	19478	42242	202634	245013	148271	242934	608996	784267	696631
1980	187999	31132	70739	186367	228568	83741	157242	518577	686871	602723
1981	227727	31000	70441	125578	151442	111398	170808	521864	656206	589035
1982	194715	23583	52338	104116	125802	95665	139699	440152	542028	491090
1983	33240	17688	39712	76554	94103	75063	125647	219324	317209	268266
1984	38916	13255	30019	74062	88256	85174	148112	229100	331807	280453
1985	139233	18582	40002	97329	118841	120765	188986	400186	521535	460860
1986	171745	23343	50988	121610	150859	89647	151000	429559	558015	493787
1987	173687	29639	65127	74996	92205	98258	153549	395892	512120	454006
1988	116767	20709	44860	75300	92364	74223	127809	303549	406375	354961
1989	60693	18139	39691	53173	65040	91184	141836	239384	330593	284988
1990	73109	11072	24518	37739	45590	78974	122611	214046	284880	249462
1991	110680	9302	20175	18614	23932	99695	157391	251841	332996	292418
1992	41855	2285	5633	11967	15386	85737	130746	153071	210441	181756
1993	0	1878	4441	10649	13692	80670	140230	103698	176108	139902
1994	0	1003	2614	7149	9192	83037	150385	101596	180644	141120
1995	17064	821	2050					17885	19114	

Table 5.2.4.4 Run reconstruction data inputs and estimated pre-fishery abundance for maturing 1SW salmon (grilse) of North American origin. **(Variables defined in Table 5.2.4.2)**

1SW Year (i)	MC1 min (i)	max (i)	MR1 min (i)	max (i)	MN1 min (i)	max (i)	mid point (i)
1971	213987	267720	199266	433766	415256	705846	560551
1972	237286	279064	192494	407154	431715	690309	561012
1973	346109	408260	217568	425342	565864	837877	701870
1974	322772	379370	214848	439754	539779	823543	681661
1975	351015	422105	261277	569064	614919	996888	805903
1976	313060	375300	291933	593770	607927	975038	791482
1977	252058	318032	216340	459584	470572	782234	626403
1978	132546	172340	162026	330803	296201	506467	401334
1979	218442	252711	222780	452150	443462	709405	576434
1980	343344	412617	283916	601174	630113	1019833	824973
1981	308670	377651	343363	735967	655484	1121015	888249
1982	265678	312538	295501	615560	564148	934284	749216
1983	197184	234389	185113	388383	384157	626675	505416
1984	158852	187900	214643	423897	375652	616057	495855
1985	227928	259284	244136	498227	474518	762518	618518
1986	278654	321357	320621	653231	602497	981153	791825
1987	319510	375472	304581	640981	627152	1022895	825023
1988	240291	276488	351388	719668	595210	1003390	799300
1989	205998	239495	209772	428037	417878	671834	544856
1990	134630	156382	251699	500134	388858	661542	525200
1991	117141	133509	172393	340701	291267	477635	384451
1992	18278	25349	325809	598449	347361	629812	488586
1993	15027	19983	281404	549718	299259	575226	437242
1994	8023	11765	194836	408742	204818	424615	314716
1995	6567	9227	181981	418696	190377	432130	311254

Table 5.2.5.1 Estimated numbers of 2SW spawners in North America by geographic regions, 1971-95

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	Total		
YEAR	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-point
1971	3963	28930	1810	8230	3888	11665	4330	8185	4496	9032	550	19037	66591	42814
1972	3393	24855	1985	8358	6243	18729	17832	32941	7459	12699	1159	38070	98740	68405
1973	4464	34477	2275	10720	6711	20132	20535	38068	3949	7844	1188	39121	112427	75774
1974	4380	33525	1534	6043	8151	24453	31736	57859	9526	15979	1214	56540	139072	97806
1975	4531	32151	1959	7355	7087	21261	18500	33167	11861	18830	2034	45972	114798	80385
1976	4901	36784	2003	7160	7428	22284	14848	29636	11045	18337	1189	41414	115390	78402
1977	3913	32098	1134	5131	10995	32985	32577	60111	13578	23119	1594	63791	155037	109414
1978	3284	25566	1564	5728	8805	26415	11565	22725	6517	11428	3518	35254	95381	65318
1979	1762	14589	992	3506	3980	11940	3600	6762	4683	8234	1581	16599	46612	31605
1980	4544	34614	1894	6928	11396	34188	20001	37546	14270	25628	4600	56706	143503	100105
1981	4351	31667	1935	6874	7629	22887	4670	9867	5870	13353	4614	29068	89262	59165
1982	3018	23189	2635	8691	8867	26601	11119	20255	5656	11335	4994	36289	95066	65678
1983	2225	16867	2167	7364	5694	17082	7478	14178	1505	6529	1790	20859	63810	42334
1984	1427	11873	2082	6829	5814	17442	15363	27132	14245	23650	2646	41577	89571	65574
1985	1229	9559	963	3323	6741	20223	21280	39739	18185	33580	4830	53228	111254	82241
1986	2130	16380	1593	5404	7964	23892	33267	64337	15435	30120	5480	65869	145614	105742
1987	2831	21884	1338	4629	6633	19899	20119	42251	10235	19233	2632	43789	110528	77158
1988	1554	13523	1553	5346	8967	26901	23478	44506	9356	19104	2809	47716	112188	79952
1989	1681	13316	704	2452	7615	22845	14864	30317	11644	21404	2809	39317	93142	66229
1990	889	7531	1341	4562	8330	24990	22905	49228	9688	18245	4298	47451	108854	78153
1991	482	3674	1057	3577	7737	23211	19839	41393	9356	16479	2409	40880	90743	65812
1992	1932	14991	3027	10365	8452	25356	27897	53025	8725	15280	2403	52436	121420	86928
1993	3648	18086	1487	5217	6308	18925	25522	45714	6599	11862	2104	45669	101908	73789
1994	5337	24152	1889	6255	7078	21234	20411	53338	4315	7399	1308	40338	113686	77012
1995	10395	37499	2296	7461	5108	15325	21403	57601	4814	8516	1717	45734	128119	86927
Mean	3291	22471	1729	6300	7345	22035	18606	36795	8920	16289	2619	42509	106509	74509

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 5.2.5.2 Estimated numbers of 1SW spawners in North America by geographic regions, 1971-95

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	Total		
YEAR	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-point
1971	29032	111448	85600	198328	2882	8646	19866	35429	4800	12810	30	142210	366692	254451
1972	21728	83415	84107	192690	2535	7605	24303	43109	2992	10385	17	135682	337221	236452
1973	0	11405	108247	252350	3391	10173	28044	50429	8658	18715	15	148354	343086	245720
1974	24287	91872	58182	142618	3107	9321	48321	84387	16209	33822	43	150150	362063	256106
1975	49688	183837	78457	190500	3582	10746	42655	74741	18232	28608	70	192684	488502	340593
1976	31814	125665	80324	195390	4006	12018	55984	99328	24589	43595	158	196875	476153	336514
1977	28815	112337	75297	184754	3705	11115	14020	27242	16704	34231	58	138599	369738	254168
1978	13464	53851	68451	165514	3533	10599	13759	25350	5678	9808	132	105017	265254	185135
1979	17825	72682	75622	182158	4896	14688	29546	54411	18577	36754	247	146713	360940	253826
1980	45870	170045	84506	204600	6425	19275	26388	49463	28878	52513	741	192808	496637	344722
1981	49855	187471	109871	266027	9553	28659	39069	72947	18236	42948	1033	227618	599086	413352
1982	34032	129370	98080	237244	5209	15627	51752	93578	12179	26548	298	201550	502665	352107
1983	19360	78689	76958	186128	3713	11139	13585	24339	7747	15969	263	121625	316527	219076
1984	9348	40056	89904	217925	3329	9987	17954	33044	16274	34054	552	137361	335618	236490
1985	19631	76462	84386	204727	3908	11724	39477	72974	16365	36658	368	164135	402914	283524
1986	30806	116481	87091	211289	6156	18468	82057	148538	18673	39685	679	225462	535140	380301
1987	37572	144917	100631	225367	7288	21864	59188	108762	19330	40484	1094	225103	542488	383795
1988	34369	134100	92218	223522	8498	25494	85330	156657	21290	43633	936	242642	584342	413492
1989	22429	90212	41331	100799	5928	17784	44671	81025	21592	44140	1115	137066	335075	236071
1990	12544	52176	68863	167309	8359	25077	55927	106823	19567	42733	630	165889	394749	280319
1991	10526	42647	43487	107169	6115	18345	44194	83098	12557	22855	250	117128	274365	195747
1992	15467	59163	93170	209221	8116	24348	118397	186128	14155	27684	1138	250444	507683	379063
1993	22079	79762	106352	237028	7909	23727	70655	113260	10482	21007	448	217925	475232	346579
1994	13678	52475	66528	161696	7415	22245	32579	89223	5389	8247	429	126018	334315	230166
1995	16954	56920	82799	194618	4039	12117	15336	60257	8859	15002	213	128200	339127	233664
Mean	24447	94298	81618	194359	5344	16032	42922	78982	14720	29716	438	169490	413824	291657

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 5.2.6.1 Stock and recruitment statistics for the Narraguagus River (USA)

	Minimum	Maximum	Mean	Std Deviation
1989 Brood Year				
Female Spawners	59.2	103.5	76.9	7.5
Eggs	387,028	815,437	567,685	64,360
Smolt, age 2,3	4,123	11,144	7,238	1,457
Smolt,age 2	3,550	9,627	6,225	1,253
Egg to parr, age 1	0.01422	0.03915	0.02469	0.00319
Egg to smolt	0.00442	0.02197	0.01111	0.00258
Smolt to adult, 2SW	0.00406	0.01132	0.00663	0.00140
Smolt to adult, total	0.00461	0.01286	0.00749	0.00158
Recruits per spawner	0.27546	0.44382	0.36018	0.03086
1990 Brood Year				
Female Spawners	73.7	127.9	94.8	9.5
Eggs	496,355	984,860	700,156	80,301
Smolt, age 2,3	3,686	10,390	6,690	1,358
Smolt,age 2	3,417	9,686	6,221	1,263
Egg to parr, age 1	0.01343	0.02959	0.02000	0.00259
Egg to smolt	0.00442	0.01622	0.00900	0.00208
Smolt to adult, 2SW	0.00530	0.01513	0.08420	0.00177
Smolt to adult, total	0.00569	0.01622	0.00905	0.00190
Recruits per spawner	0.26393	0.41455	0.33881	0.02860

Table 6.1.1.1 Nominal catches of SALMON at West Greenland, 1960-1992 (tonnes round fresh weight)

Year	Norway	Faroes	Sweden	Denmark	Greenland[5]	Total	Quota
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1,539	1,539	-
1965	-[1]	36	-	-	825	861	-
1966	32	87	-	-	1,251	1,370	-
1967	78	155	-	85	1,283	1,601	-
1968	138	134	4	272	579	1,127	-
1969	250	215	30	355	1,360	2,210	-
1970	270	259	8	358	1,244	2,146[3]	-
1971	340	255	-	645	1,449	2,689	-
1972	158	144	-	401	1,410	2,113	-
1973	200	171	-	385	1,585	2,341	-
1974	140	110	-	505	1,162	1,917	-
1975	217	260	-	382	1,171	2,030	-
1976	-	-	-	-	1,175	1,175	1,190
1977	-	-	-	-	1,420	1,420	1,190
1978	-	-	-	-	984	984	1,190
1979	-	-	-	-	1,395	1,395	1,190
1980	-	-	-	-	1,194	1,194	1,190
1981	-	-	-	-	1,264	1,264	1,265[5]
1982	-	-	-	-	1,077	1,077	1,253[5]
1983	-	-	-	-	310	310	1,190
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	)
1989	-	-	-	-	337	337	)2,520[6]
1990	-	-	-	-	274	274	)
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237	237	-
1993	-	-	-	-	0[2]	0[2]	213
1994	-	-	-	-	0[2]	0[2]	159
1995	-	-	-	-	68	68	77

1 Figures not available, but catch is known to be less than the Faroese catch.

2 The fishery was suspended.

3 Including 7 t caught on longline by one of two Greenland vessels in the Labrador Sea early in 1970.

4 For Greenlandic vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non Greenlandic catches from 1969-84 were taken with drift nets.

5 Quota corresponding to specific opening dates of the fishery.

6 Quota for 1988-90 was 2,520 t with an opening date of 1 August and annual catches not to exceed the annual average (840t) by more than 10%. Quota adjusted to 900t in 1989 and 924t in 1990 for later opening dates.

Factor used for converting landed catch to round fresh weight in fishery by Greenland vessels = 1.11.
Factor for Norwegian, Danish, and Faroese drift net vessels = 1.10.

Table 6.1.1.2 Distribution of nominal catches (tonnes) taken by Greenland vessels from 1977 to 1995 by NAFO divisions according to place landed.

Year	Division									
	1A	1B	1C	1D	1E	1F	Un-known	W. Grnld Total	East Greenland	**Greenland Total**
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	0	4	23	5	75	130	-	237	5	242
1993	0	0	0	0	0	0	-	0	0	0
1994	0	0	0	0	0	0	-	0	0	0
1995 [1]	0	10	32	11	11	5	-	68	2	70

[1] The fishery was suspended
\+ Small catch <0.5t
\- No catch

Table 6.1.2.1 Percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82) and from commercial samples (1978-1992).

	Sample size		Continent of origin (%)				
Source	Year	Length	Scales	NA	(95% CI)[1]	E	(95% CI)
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(74,57)
	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)
	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	65	(69,61)	35	(39,31)

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

[2]During fishery.

[3]Research samples after fishery closed.

Table 6.1.2.2. The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland from 1982 to 1992 and 1995. 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	55	45	46,900	38,500
1995	65	35	17,200	9,250

Table 6.1.3.1 Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland 1969-92. Fork length (cm); whole weight (kg). NA= North American; E = European.

	Whole weight (kg)									Fork lenght (cm)					
	1SW		2SW		PS		Total			1SW		2SW		PS	
Year	NA	E	NA	E	NA	E	NA	E	Total	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	2.42	2.62	6.45	5.30	3.80	3.96	2.73	2.58	2.51	61.2	62.6	82.1	78.5	71.5	72.8

Table 6.1.3.2 River age distribution (%) for all North American and European origin salmon caught at West Greenland, 1995

	River age							
Year	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0	0
1969	0	27.1	45.8	19.6	6.5	0.9	0	0
1970	0	58.1	25.6	11.6	2.3	2.3	0	0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0	0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0
1973	2	40.8	34.7	18.4	2	2	0	0
1974	0.9	36	36.6	12	11.7	2.6	0.3	0
1975	0.4	17.3	47.6	24.4	6.2	4	0	0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43	13.6	6	2	0.9	0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0
1981	3.5	31.6	37.5	19	6.6	1.6	0.2	0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0	0.2
1983	3.1	47	32.6	12.7	3.7	0.8	0.1	0
1984	4.8	51.7	28.9	9	4.6	0.9	0.2	0
1985	5.1	41	35.7	12.1	4.9	1.1	0.1	0
1986	2	39.9	33.4	20	4	0.7	0	0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0	0
1988	5.2	31.3	30.8	20.9	10.7	1	0.1	0
1989	7.9	39	30.1	15.9	5.9	1.3	0	0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0
1992	6.7	36.7	34.1	19.1	3.2	0.3	0	0
1995	5.3	29.1	35.2	20.2	8.4	1.9	0	0
Mean	3.3	36.8	36.3	15.9	6.2	1.4	0.1	0.0
European								
1968	21.6	60.3	15.2	2.7	0.3	0	0	0
1969	0	83.8	16.2	0	0	0	0	0
1970	0	90.4	9.6	0	0	0	0	0
1971	9.3	66.5	19.9	3.1	1.2	0	0	0
1972	11	71.2	16.7	1	0.1	0	0	0
1973	26	58	14	2	0	0	0	0
1974	22.9	68.2	8.5	0.4	0	0	0	0
1975	26	53.4	18.2	2.5	0	0	0	0
1976	23.5	67.2	8.4	0.6	0.3	0	0	0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0	0	0	0
1979	23.6	64.8	11	0.6	0	0	0	0
1980	25.8	56.9	14.7	2.5	0.2	0	0	0
1981	15.4	67.3	15.7	1.6	0	0	0	0
1982	15.6	56.1	23.5	4.2	0.7	0	0	0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0	0
1985	20.2	61.6	14.9	2.7	0.6	0	0	0
1986	19.5	62.5	15.1	2.7	0.2	0	0	0
1987	19.2	62.5	14.8	3.3	0.3	0	0	0
1988	18.4	61.6	17.3	2.3	0.5	0	0	0
1989	18	61.7	17.4	2.7	0.3	0	0	0
1990	15.9	56.3	23	4.4	0.2	0.2	0	0
1991	20.9	47.4	26.3	4.2	1.2	0	0	0
1992	11.8	38.2	42.8	6.5	0.6	0	0	0
1995	14.7	54.9	27.5	3	0	0	0	0
Mean	18.5	61.7	17.1	2.4	0.3	0.0	0.0	0.0

Table 6.1.3.3 Distribution (percent of landings) by sizes of salmon captured at West Greenland, NAFO Division SA1 for the years 1987 to 1992 and 1995

Size Category kg	Year						
	1987	1988	1989	1990	1991	1992	1995
1.1 - 3.3	63.8	56.1	77.5	72.9	82.9	55.3	84.5
3.3 - 5.6	32.1	41.3	18.4	23.5	14.4	41.7	12.4
> 5.6	4.0	2.6	4.1	3.6	2.7	3.0	3.1

Table 6.1.3.4 Sea-age composition (%) of samples from commercial catches at West Greenland, 1985 - 1995.

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
1995	97.3	1.3	1.4	96.0	2.5	1.6

Table 6.1.5.1 Risk based estimate of the likely range of harvest for local consumption in West Greenland in 1993. Variables and parameter distributions.

Name	Definition	Type	Range
A	1993 Greenland local consumption harvest in t.	computed	
B	1993 Greenland harvest of NA 1SW salmon in numbers.	computed	
C	mean weight of North America 1SW salmon in kg .	uniform distribution	2.4 - 2.6
D	1993 Greenland harvest of European 1SW salmon in numbers .	computed	
E	mean weight of European 1SW salmon in kg.	uniform distribution	2.5 - 2.8
F	age correction factor to raise tonnage to total weight of all ages.	uniform distribution	1.07 - 1.17
G	1993 Greenland harvest of 1SW Penobscot fish in numbers (section 5.1.3)	computed	
H	raising factor for Greenland Penobscot 1SW, river age 1 harvest to total US 1SW, river age 1 harvest.	uniform distribution	1.2 - 1.5
I	raising factor from Greenland US 1SW, river age 1 harvest to total NA 1SW, river age 1 harvest .	uniform distribution	2.6 - 3.0
J	the percent of river age 1 NA fish in the North American component of the fishery.	uniform distribution	0.05 - 0.09
K	percent NA 1SW in the fishery.	uniform distribution	0.48 - 0.60

Table 6.1.5.2 Risk based estimate of the likely range of harvest for local consumption in West Greenland in 1993. Results of sensitivity analysis.

Rank	Parameter	Sensitivity (-1 to 1) Regression (Std B)
1	*J*	-0.7793
2	*K*	-0.3168
3	*H*	0.3062
4	Tag loss rate	0.2617
5	Tag reporting rate in Greenland	-0.2567
6	*I*	0.1824
7	*F*	0.1203
8	Non-catch fishing mortality	0.0809
9	*D*	0.0741
10	*C*	0.0582

Table 8.1.1 Comparison of mean counts of small and large salmon during moratorium years 1992-95 with means for the pre-moratorium period 1986-91. The direction of change is denoted by '+' (increase) or '-' (decrease).

	Small			Large			Proportion large		
River	(+/-)	F	P	(+/-)	F	P	(+/-)	F	P
SFA 4									
Exploits River	+	21.33	0.0017	+	12.57	0.0076	+	3.82	0.0864
Gander River	+	15.00	0.0117*	+	15.00	0.0117	+	0.45	0.5301
SFA 5									
Middle Brook	+	21.33	0.0017	+	22.33	0.0015	+	12.57	0.0076
Terra Nova River (Lower)	+	8.16	0.0212	+	21.33	0.0017	+	21.33	0.0017
SFA 9									
Biscay Bay River	-	0.16	0.6953	-	0.16	0.6953	-	0.16	0.6953
Northeast Brook, Trepassey	-	0.53	0.4870	-	1.79	0.2176	-	0.00	1.0000
Rocky River	+	0.05	0.8247	+	21.00	0.0025	+	21.00	0.0025
SFA 10									
Northeast River, Placentia	+	3.82	0.0864	+	21.33	0.0017	+	12.57	0.0076
SFA 11									
Conne River	-	8.16	0.0212	-	3.82	0.0864	-	0.38	0.5543
SFA 13									
Humber River	+	3.82	0.0864	+	3.82	0.0864	+	1.78	0.2191
SFA 14A									
Torrent River	+	8.16	0.0212	+	21.33	0.0017	+	21.33	0.0017
Western Arm Brook	+	12.57	0.0076	+	26.67	0.0009	+	23.41	0.0013

Table 8.1.2 Estimated total production of Atlantic salmon from Sand Hill River, Labrador.

Commercial exploitation rates were 0.83 to 0.97 for large salmon and 0.28 to 0.51 for small salmon in Nfld and Labrador, Greenland exploitation at 0.22, 1970-73. Exploitation rates were adjusted for decreased licensed effort in 1994 & 95, for closure of Newfoundland fishery and for season change in 1995 . Mid-points are in table.

	Total returns to freshwater		Total production prior to commercial fishing		Entrants to freshwater with no commercial change	
Year	Small	Large	Small	Large	Small	Large
1970	3600	138	6173	3469	3600	138
1971	3596	266	6167	6687	3596	266
1972	2038	175	3495	4399	2038	175
1973	4761	504	8164	12670	4761	504
1994	2159	730	2482	1525	1447	61
1995	2781	559	3159	924	1842	37
Av.1970-73	3499	271	6000	6806	3499	271
SD 1970-73	1118	165	1916	4136	1334	165
CL-95%	2235	329	3833	8272	2749	329

Table 8.2.1 Assessment of the effects of the suspension of commercial fishing at Faroes on the numbers of salmon returning to home waters.

		1991/92	1992/93	1993/94	1994/95
Expected No. fish **landed** if fishery operated =		87,484	87,484	87,484	87,484
Discard rate =		8.8%	9.4%	14.4%	15.1%
Discard mortality =		80.0%	80.0%	80.0%	80.0%
Expected No. fish **killed** if fishery operated =		94,237	94,745	99,258	99,932
No. fish killed in research fishery =		9,350	9,099	3,035	4,187
Total number of fish saved per year =		84,887	85,646	96,223	95,745
Proportion of farmed fish in catch =		37.0%	27.0%	17.0%	19.0%
Number farm escapees saved =		31,408	23,125	16,358	18,191
Number of wild fish saved =		53,479	62,522	79,865	77,553
Sea age composition of wid fish:	1SW	4.0%	12.0%	16.0%	10.6%
	2SW	83.0%	61.0%	64.0%	80.8%
	2SW+	13.0%	27.0%	20.0%	8.6%
Additional salmon expected to have returned:		**1992**	**1993**	**1994**	**1995**
	1SW	1,618	5,852	9,967	6,412
	MSW	40,327	55,466	64,207	67,936
Estimated MSW returns	Min	821,553	768,425	760,496	671,137
to all European homewaters:	Max	1,643,356	1,574,279	1,564,254	1,393,593
% MSW returns derived from suspension	Min	5%	7%	8%	10%
of commerial fishing at Faroes:	Max	2%	4%	4%	5%
(Assuming all from Europe)					
Estimated MSW returns	Min	462,172	457,940	380,976	352,823
to Northern European homewaters:	Max	872,708	795,202	725,093	714,585
% MSW returns derived from suspension	Min	7%	9%	13%	14%
of commerial fishing at Faroes:	Max	3%	5%	7%	7%
(Assuming 75% from N. Europe)					

Table 8.2.2 Effects of suspension of commercial fisheries at Faroes (March 1991 onwards) and West Greenland (1993 & 1994) on homewater fisheries.

Effects of suspension of Faroes commercial salmon fishery

Type of data	Area considered	Periods compared	p value	Effect
1SW catches in Northern Europe	Finland, Sweden, Norway, Iceland	1987-91 vs 1992-95	0.47	Not seen
	Norway only	1987-91 vs 1992-95	0.988	**Lower catch**
1SW catches in Southern Europe	Ireland (total catch), UK(Scot), UK (E&W), France	1987-91 vs 1992-95	0.902	**Lower catch**
MSW catches in Northern Europe	Finland, Sweden, Norway, Iceland	1987-91 vs 1992-95	0.554	Not seen
	Norway only	1987-91 vs 1992-95	0.707	Not seen
MSW catches in Southern Europe	UK (Scot), UK (E&W), France	1987-91 vs 1992-95	0.845	Not seen
Russian adult counts All ages	R. Varzuga, Ponoy, Kola, Yokanga, Zap Litca, Tuloma	1987-91 vs 1992-95	0.737	Not seen

Effects of suspension of West Greenland fishery

Type of data	Area considered	Period compared	p value	Effect
MSW catches in Northern Europe	Finland, Sweden, Norway, Iceland	1987-93 vs 1994-95	0.49	Not seen
MSW catches in Southern Europe	UK (Scot), UK (E&W), France	1987-93 vs 1994-95	0.54	Not seen

Table 8.3.1 Assessment of the effects of the suspension of fishing at West Greenland on the numbers of salmon returning to home waters.

			Years	
			1993	1994
Expected catch (tonnes) if the fishery had operated (quota) =			213	159
Age correction factors =			1.121	1.121
Expected weight of 1SW fish that would have been caught =			190	142
Mean weight of all fish caught (1990-92) =			2.587	2.587
Expected numbers of 1SW fish that would have been caught =			73,448	54,827
NCFM (excluding subsistence fishery) =			16%	16%
Total number of fish saved =			87,438	65,270
Survival on return migration to home waters =				
(assuming M=0.01 and t=11 months)			90%	90%
Proportion of 1SW fish in Greenland catch =			95%	95%
Extra MSW salmon returning to home waters =			82,452	61,549
Proportion North American			54%	54%
Additional MSW salmon expected to have returned to homewaters in:			**1994**	**1995**
	To:	**North America**	44,524	33,236
		Europe	37,928	28,312
Total estimated 2SW returns		Min.	80,670	83,037
to North American homewaters:		Max.	140,230	150,385
% of 2SW returns derived from suspension		Min.	52%	38%
of commerial fishing at West Greenland:		Max.	30%	21%
(Assuming 95% 2SW)				
Estimated MSW returns		Min.	379,520	318,315
to Southern European homewaters:		Max.	839,161	679,008
% MSW returns derived from suspension		Min.	10%	9%
of commerial fishing at West Greenland:		Max.	5%	4%

Table 9.1.1.1 Summary of spawning target estimates for North America by geographical region.

Region[1]	2SW Target	Documentation
SFA 1	8000	Estimates for SFAs 1, 2, and 14B combined are imputed from the minimum and maximum values of total catches (recreational + commercial + native) and part of the catch in Greenland for the period 1974-1978. Min. value = {((Average of the minimum 2SW salmon returns for 1974- 1978 in SFAs 1, 2 and 14B combined)) + [(Average catch of North American origin 1SW salmon with river age > 3 caught at Greenland (1973-1977), discounted for 10 months of natural mortality (10%), = 59381) * (Assumed fraction of Labrador origin salmon (> 3), = 0.7)] * (Average fraction of 2SW salmon in the spawning run of total returns, = 0.30)} * (Habitat factor) = {((50030+47715+55186+48669+38644)/5)+(59381*0.9*0.7)} *0.3 * 0.23. Max. value = {((Average of the maximum 2SW salmon returns for 1974-1978 in SFAs 1, 2,, and 14B combined) + [(other terms listed for minimum value)}. = {((113827+107974+124671+110171+87155/5)+59381*0.9 *0.7)}*0.3 *0.23. Total spawner requirements for all of Labrador were subdivided into each SFA on the basis of the proportionate parr-rearing habitat in each SFA (0.23 for SFA 1). See O'Connell et al. (1996). Mean value = (Min. + Max.)/2. Values rounded to nearest 100.
SFA 2	25300	See SFA 1. Parr-rearing habitat factor for SFA 2 = 0.73.
SFA 3	240	Updated from Anon. (1986); target refers to 2SW salmon and not large salmon, as presented in Anon. (1995)/Assess 14 - See O'Connell et al. (1996).
SFA 4	488	Updated incorporating new values for lacustrine habitat; target refers to 2SW salmon and not large salmon, as presented in Anon. (1995)/Assess 14 - See O'Connell et al. (1996).
SFA 5	233	See SFA 4.
SFA 6	6	See SFA 3.
SFA 7	5	See SFA 3.
SFA 8	2	See SFA 3.
SFA 9	49	See SFA 4.
SFA 10	19	See SFA 4.
SFA 11	96	See SFA 3.
SFA 12	48	See SFA 3.

Table 9.1.1.1 continued Summary of spawning target estimates for North America by geographical region.

Region[1]	2SW Target	Documentation
SFA 13	2544	See SFA 3.
SFA 14A	292	SFAs 14A and 14B separated; they were treated as a single unit in Anon. (1995)/Assess 14 - See O'Connell et al. (1996). Habitat factor = 0.04.
SFA 14B	1400	See SFA 1 and SFA 14A.
SFA 15	5656	Values in Anon. (1995)/Assess 14 are for large salmon. Current target value is the sum of 8 rivers in SFA 15. Quebec waters of the Restigouche are excluded. Restigouche targets are recalculated using recent (1984-94) age composition data. See O'Connell et al. (1996).
SFA 16	21050	Values in Anon. (1995)/Assess 14 are for large salmon. Miramichi River habitat area represents 91% of total SFA 16 area. See O'Connell et al. (1996).
SFA 17	537	Values in Anon. (1995)/Assess 14 are for large salmon. Cairns (1995). Target represents Morell, Mill, Dunk, West, and Valley Field rivers. See O'Connell et al. (1996).
SFA 18	3233	Values in Anon. (1995)/Assess 14 are for large salmon. Proportionate drainage to proximate measured habitat; Margaree River proximate survey and biological data. See O'Connell et al. (1996).
SFA 19	3130	Values in Anon. (1995)/Assess 14 are for large salmon. Remote sensed areas, North, Sydney, and Grand rivers and biological data from Anon. (1978). See O'Connell et al. (1996).
SFA 20	1676	Values in Anon. (1995)/Assess 14 are for large salmon. Remote sensed areas and biological data, Liscomb and St. Mary's rivers; pH impacted areas included. See O'Connell et al. (1996).
SFA 21	4792	Values in Anon. (1995)/Assess 14 are for large salmon. Remote sensed areas, LaHave biological data; pH impacted areas included. See O'Connell et al. (1996)
SFA 22	211	Remote sensed areas, Stewiacke and Gaspereau rivers. See O'Connell et al. (1996).
SFA 23	11539	Values in Anon. (1995)/Assess 14 are for large salmon. Remote sensed area, proximate measured area, biological data, Saint John and Nashwaak rivers. Excludes 1529 2SW fish for St. Croix River. See O'Connell et al. (1996).
Q 1	5002	Updated using new biological data. See O'Connell et al. (1996)
Q 2	3116	See Q 1.
Q 3	3596	See Q 1.
Q 5	1326	See Q 1.
Q 6	1966	See Q 1.
Q 7	6461	See Q 1.

Table 9.1.1.1 continued Summary of spawning target estimates for North America by geographical region.

Region[1]	2SW Target	Documentation
Q 8	20026	See Q 1.
Q 9	7794	See Q 1.
Q 10	3963	See Q 1.
Q 11	7500	Anon. (1986).
Canadian Total	151296	
USA Rivers		
Connecticut	9727	See Table 8.2.1, Anon. (1995)/Assess 14.
Merrimack	2599	See Table 8.2.1, Anon. (1995)/Assess 14.
Penobscot	6838	See Table 8.2.1, Anon. (1995)/Assess 14.
Other Maine	9668	Kennebec River has been excluded because its habitat is not accessible. Estimates include areas accessible via trap and truck operations - See Table 8.2.1, Anon. (1995)/Assess 14.
Paucatuck	367	
USA Total	29199	
Grand Total	180495	

[1]SFA = Salmon Fishing Area of Atlantic Canada, Zones in Quebec are designated by Q prefix.

Table 9.1.2.1 Example of assigning sex designation and stock association based on bionomial probabilities.

Single stock example assuming stock contains 80% female.
Target fish = 10, target females = 0.8 X 10 = 8

	Fish Released	Random number (rand)	Assign to female (rand<=0.8) then 1, else 0
	1	0.975	0
	2	0.513	1
	3	0.959	0
	4	0.215	1
	5	0.479	1
	6	0.583	1
	7	0.300	1
	8	0.835	0
	9	0.052	1
	10	0.735	1
Totals Released	10	Females	7

Target spawners achieved (1 = Yes)
(Females / Released) >= 8 then 1, else 0 — 0

Two stock example assuming each stock contains 80% female.
Target fish = 10 or 5 per stock, target females = 0.8 x 10 = 8 or 0.8 x 5 = 4 per stock.

					Fish to stock		Females to stock	
	Fish Released	Stock Random number (rand1)	Sex ratio Random number (rand2)	Assign to female (rand<=0.8) then 1, else 0	Stock 1 If (rand1) <= 0.5	Stock 2 If (rand1) > 0.5	Stock 1 Female X Stock 1	Stock 2 Female X Stock 2
	1	0.648	0.579	1	0	1	0	1
	2	0.269	0.730	1	1	0	1	0
	3	0.115	0.203	1	1	0	1	0
	4	0.331	0.185	1	1	0	1	0
	5	0.349	0.194	1	1	0	1	0
	6	0.554	0.761	1	0	1	0	1
	7	0.745	0.089	1	0	1	0	1
	8	0.089	0.005	1	1	0	1	0
	9	0.991	0.284	0	0	1	0	0
	10	0.071	0.132	1	1	0	1	0
Totals Released	10		Females	9		Females	6	3

Target spawners achieved for one stock (1 = Yes)
(Females / Released) >= 8 then 1, else 0 — 1

Target spawners achieved for two stocks (1 = Yes)
k 1 >= 4) X (Females stock 2 >= 4) — 0

Table 9.1.2.2. Parameter value inputs for risk analysis of North American spawning target.

Salmon Fishing Area or Zone		Proportion Female	2SW Target Area/ zone*	2SW Target 6 Stocks	2SW Target 24 Stocks
	1		8000		8000
	2		25300		25300
	14B		1400		1400
Labrador		**0.75**		**34700**	
	3		240		:
	4		488		:
	5		233		:
	6		6		:
	7		5		:
	8		2		1478
	9		49		:
	10		19		:
	11		96		:
	12		48		:
	13		2544		:
	14A		292		2544
Newfoundland		**0.75**		**4022**	
	15		5656		5656
	16		21050		21050
	17		537		537
	18		3233		3233
Gulf		**0.85**		**30476**	
	19		3130		3130
	20		1676		1676
	21		4792		:
	22		211		5003
	23		11539		11539
Scotia		**0.85**		**21348**	
	Q1		5002		5002
	Q2		3116		3116
	Q3		3596		3596
	Q5		1326		1326
	Q6		1966		1966
	Q7		6461		6461
	Q8		20026		20026
	Q9		7794		7794
	Q10		3963		3963
	Q11		7500		7500
Québec		**0.70**		**60750**	
USA		**0.50**		**29199**	**29199**
North America		**0.72**		**180495**	

* From Table 9.1.1.1

Table 9.2.2.1 Thermal habitat derived from satellite sea surface temperature data for January, February & March, Prefishery abundance and lagged spawners. A comparison of predicted values and residuals from the H123 and H2-SLNQ prefishery abundance prediction models.

Year	Prefishery abundance midpoint	Thermal habitat Jan	Feb	Mar	Total	Lagged spawners	Prefishery abundance from H123 Predicted	Residual	Prefishery abundance from H2 & SNLQ spawners Predicted	Residual
1971	640596	2049	2011	1819	5879		655818	-15222		
1972	634762	2034	1990	1914	5938		669610	-34848		
1973	751952	2007	1708	1896	5611		593169	158783		
1974	688751	1926	1862	1746	5534		575169	113582		
1975	786870	1761	1827	1842	5430		550858	236012		
1976	705828	1795	1676	1953	5424		549456	156372		
1977	562649	1780	1915	1994	5689		611403	-48754		
1978	312202	1892	1951	1979	5822	43284	642493	-330291	452312	-140110
1979	696631	1925	2058	1999	5982	51166	679895	16736	598639	97992
1980	602723	1799	1823	2088	5710	53198	616312	-13589	537571	65152
1981	589035	1746	1912	1807	5465	55314	559040	29995	599527	-10492
1982	491090	1800	1703	1621	5124	54354	479327	11763	507980	-16890
1983	268266	1526	1416	1369	4311	48110	298277	-30011	315973	-47707
1984	280453	1436	1257	1209	3902	46603	193668	86785	235863	44590
1985	460860	1371	1410	1397	4178	45202	258187	202673	274574	186286
1986	493787	1832	1688	1547	5067	46360	466002	27785	394755	99032
1987	454006	1711	1627	1471	4809	45536	405691	48315	360720	93286
1988	354961	1747	1698	1622	5067	47060	466002	-111041	407930	-52969
1989	284988	1807	1642	1552	5001	50634	450574	-165586	434962	-149974
1990	249462	1526	1503	1491	4520	47601	338134	-88672	341854	-92392
1991	292418	1403	1357	1519	4279	41742	281797	10621	208075	84343
1992	181756	1474	1381	1378	4233	40228	271044	-89288	196728	-14972
1993	139902	1441	1252	1242	3935	45268	201382	-61480	216020	-76118
1994	141120	1487	1329	1373	4189	42681	260758	-119638	210178	-69058
1995		1444	1310	1279	4033	39431	224291		159294	
1996		1674	1470	1419	4563	36356	341874		178099	
Average 1988-94	234944						324242	-85674	267970	-53029

Table 9.2.2.2. Estimate of pre-fishery abundance in 1996 forecasted by H123 regression model of probabilitylevels between 25 and 75%

Cumulative Density Function %	Forecast
25	256,000
30	274,000
35	292,000
40	310,000
45	325,000
50	343,000
55	358,000
60	376,000
65	391,000
70	409,000
75	430,000

Table 9.2.2.3 Estimate of pre-fishery abundance in 1996 forecasted by H2-SNLQ regression model of probabilitylevels between 25 and 75%

Cumulative Density Function %	Forecast
25	119,000
30	136,000
35	149,000
40	163,000
45	175,000
50	190,000
55	202,000
60	217,000
65	229,000
70	244,000
75	259,000

Table 9.2.3.1 Quota options (in tonnes) for 1996 at West Greenland based on H123 regression forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	26	52	78	104	130	157	183	209	235	261
30	0	35	69	104	139	174	208	243	278	312	347
35	0	43	87	130	173	217	260	303	347	390	433
40	0	52	104	156	208	260	312	364	415	467	519
45	0	59	118	177	236	296	355	414	473	532	591
50	0	68	135	203	271	339	406	474	542	610	677
55	0	75	150	225	300	375	449	524	599	674	749
60	0	84	167	251	334	418	501	585	668	752	835
65	0	91	181	272	363	453	544	635	726	816	907
70	0	99	199	298	397	497	596	695	794	894	993
75	0	109	219	328	437	547	656	766	875	984	1,094

Sp. res = 201,483
Prop NA = 0.59224
WT1SWNA = 2.42
WT1SWE = 2.62
ACF = 1.133

Table 9.2.3.2 Quota options (in tonnes) for 1996 at West Greenland based on H2-SNLQ regression forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	1	1	1	1	2	2	2	2
60	0	7	15	22	30	37	45	52	59	67	74
65	0	13	26	40	53	66	79	92	105	119	132
70	0	20	41	61	81	102	122	142	163	183	203
75	0	28	55	83	110	138	165	193	220	248	275

Sp. res = 201,483
Prop NA = 0.59224
WT1SWNA = 2.42
WT1SWE = 2.62
ACF = 1.133

Table 9.2.4.1. Proportion of North American 2SW spawning target achieved in 1997 relative to the estimates of pre-fishery abundance for 1996, spawning targets and lagged spawners contributing to the 1997 spawning escapement.

Fish surplus to spawning requirements (prefishery abundance - target)

Cumulative Density Function %	Forecast Prefishery Abundance		North America 1 Stock	Assuming 6 stocks in North America: Probability levels of achieving spawning target 0.5	0.75	0.9
		Target spawners =	**180495**	**182250**	**183250**	**184750**
0.895834135		Pre-fishery requirement =	**201483**	**203442**	**204558**	**206232**
25	256000		54517	52558	51442	49768
30	274000		72517	70558	69442	67768
35	292000		90517	88558	87442	85768
40	310000		108517	106558	105442	103768
45	325000		123517	121558	120442	118768
50	343000		141517	139558	138442	136768
55	358000		156517	154558	153442	151768
60	376000		174517	172558	171442	169768
65	391000		189517	187558	186442	184768
70	409000		207517	205558	204442	202768
75	430000		228517	226558	225442	223768

Releases to North America after Greenland fishery removes 40% of surplus (discounted for natural mortality)

Cumulative Density Function %	North America 1 Stock	0.5	0.75	0.9
25	209798	210500	210900	**211500**
30	219473	220175	220575	221175
35	229148	229850	230250	230850
40	238823	239525	239925	240525
45	246886	247588	247988	248588
50	256561	**257263**	257663	258263
55	264623	265325	265725	266325
60	274298	275000	275400	276000
65	282361	283063	283463	284063
70	292036	292738	293138	293738
75	303323	304025	304425	305025

Anticipated proportion of target 2SW spawners achieved in 6 stock areas of North America for 1997 based on lagged spawner proportions of expected stock composition

	Lagged Spawners Estimated	Prop. of Canada	Simulated estimates: Median	Minimum	Maximum
@ 257263					
Labrador	5301	0.075	0.54	0.52	0.55
Newfoundland	2673	0.038	2.34	2.25	2.44
Quebec	16009	0.226	0.93	0.91	0.94
southern Gulf	33509	0.473	3.87	3.84	3.90
Scotia-Fundy	13349	0.188	2.20	2.16	2.23
USA	*	*	0.29	0.27	0.29
@ 211500					
Labrador			0.44	0.43	0.45
Newfoundland			1.92	1.85	2.00
Quebec			0.76	0.75	0.78
southern Gulf			3.18	3.15	3.21
Scotia-Fundy			1.81	1.78	1.84
USA			0.23	0.22	0.24

To estimate percent of target achieved for other stock levels, multiply prop. of lagged spawners by fish abundance and d by target for the stock area (from Table 9.1.1.1). 1F

Table 10.2.1.1 Maximum and minimum estimates (x1,000) of pre-fishery abundance of maturing and non-maturing 1SW recruits in the North East Commission area

Year	Catch (numbers)		Estimated returning stock 1SW		Estimated returning stock 2SW		Estimated maturing 1SW recruits		Est. non-maturing 1SW recruits		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
							Mat (min)	Mat (max)	Non-mat (min)	on-mat (max)		
1971	1,171	1,017	2,746	5,722	1,639	2,929	2,803	6,142	1,842	3,494	4,645	9,636
1972	1,272	1,050	2,962	6,045	1,828	3,369	3,023	6,493	2,074	3,862	5,097	10,354
1973	1,410	1,184	3,289	6,700	2,060	3,718	3,354	7,166	1,788	3,364	5,141	10,530
1974	1,426	986	3,323	6,681	1,760	3,197	3,391	7,162	2,038	3,626	5,429	10,789
1975	1,381	1,118	3,177	6,240	1,959	3,502	3,249	6,746	1,365	2,420	4,614	9,166
1976	1,075	761	2,460	4,813	1,356	2,347	2,508	5,144	1,411	2,680	3,919	7,824
1977	1,033	796	2,385	4,870	1,401	2,592	2,432	5,210	1,196	2,427	3,628	7,638
1978	944	627	2,200	4,564	1,187	2,341	2,243	4,887	1,370	2,585	3,613	7,472
1979	1,009	799	2,161	4,638	1,362	2,509	2,302	4,914	1,665	3,022	3,967	7,936
1980	854	917	1,822	3,953	1,652	2,918	1,928	4,217	1,812	3,305	3,740	7,522
1981	717	1,065	1,614	3,847	1,798	3,182	1,692	4,115	1,340	2,398	3,032	6,513
1982	847	794	1,823	4,090	1,330	2,319	1,921	4,351	1,397	2,674	3,318	7,025
1983	1,210	730	2,660	5,792	1,385	2,566	2,819	6,254	1,180	2,261	3,998	8,515
1984	908	610	1,981	4,603	1,170	2,169	2,103	4,859	1,319	2,400	3,422	7,259
1985	1,149	742	2,259	4,928	1,310	2,311	2,431	5,293	1,465	2,680	3,897	7,973
1986	1,175	823	2,416	5,254	1,455	2,592	2,573	5,634	1,170	2,081	3,743	7,715
1987	978	648	1,876	4,189	1,161	2,011	2,113	4,450	1,149	2,109	3,263	6,559
1988	1,132	638	2,431	4,652	1,140	2,025	2,595	5,032	965	1,703	3,560	6,735
1989	912	454	1,975	4,369	957	1,643	2,163	4,612	892	1,700	3,055	6,311
1990	637	446	1,448	3,039	885	1,641	1,588	3,222	801	1,493	2,389	4,715
1991	501	400	1,301	2,641	796	1,456	1,322	2,783	827	1,685	2,149	4,468
1992	611	337	1,630	3,222	822	1,643	1,659	3,423	774	1,626	2,433	5,049
1993	576	263	1,456	2,945	768	1,574	1,483	3,138	767	1,614	2,249	4,751
1994	665	295	1,632	3,094	760	1,564	1,666	3,300	677	1,438	2,343	4,739
1995	584	241	1,394	2,579	671	1,394	1,423	2,754	0	0	1,423	2,754

Table 10.2.1.2 Maximum and minimum estimates (x1,000) of pre-fishery abundance of maturing and non-maturing 1SW recruits in Southern European Countries (UK, Ireland, France)

Year	Catch (numbers)		Estimated returning stock 1SW		Estimated returning stock 2SW		Estimated maturing 1SW recruits		Est. non-maturing 1SW recruits		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
1971	882	705	2,211	4,770	1,131	2,156	2,268	5,190	1,215	2,521	3,483	7,712
1972	912	676	2,290	4,846	1,202	2,403	2,352	5,294	1,304	2,706	3,656	8,000
1973	985	735	2,490	5,306	1,292	2,570	2,555	5,771	1,099	2,317	3,654	8,088
1974	1,032	596	2,580	5,381	1,073	2,154	2,649	5,862	1,288	2,518	3,937	8,380
1975	991	685	2,446	4,970	1,210	2,400	2,518	5,475	704	1,413	3,221	6,889
1976	713	390	1,780	3,606	695	1,344	1,828	3,937	839	1,769	2,667	5,706
1977	689	475	1,740	3,717	830	1,683	1,786	4,057	780	1,769	2,567	5,826
1978	668	389	1,693	3,691	772	1,685	1,736	4,013	774	1,595	2,510	5,608
1979	586	446	1,501	3,259	766	1,523	1,538	3,535	838	1,867	2,376	5,402
1980	469	422	1,189	2,628	828	1,774	1,223	2,892	938	2,108	2,161	5,000
1981	436	504	1,158	2,900	928	2,003	1,186	3,168	610	1,393	1,796	4,561
1982	612	323	1,484	3,340	604	1,330	1,518	3,601	642	1,667	2,160	5,267
1983	846	276	2,097	4,589	633	1,571	2,156	5,051	493	1,294	2,649	6,345
1984	544	201	1,394	3,343	486	1,211	1,424	3,598	629	1,460	2,053	5,058
1985	749	330	1,640	3,572	622	1,380	1,687	3,937	682	1,585	2,369	5,523
1986	809	343	1,844	4,022	675	1,508	1,894	4,401	554	1,218	2,447	5,619
1987	601	286	1,359	2,960	548	1,158	1,394	3,221	660	1,439	2,054	4,660
1988	817	366	1,935	3,583	652	1,361	1,995	3,963	459	1,070	2,454	5,033
1989	581	211	1,365	2,950	453	1,017	1,398	3,192	374	924	1,772	4,116
1990	344	168	907	1,796	369	874	934	1,978	313	667	1,247	2,645
1991	251	157	742	1,485	309	636	763	1,627	364	809	1,127	2,436
1992	381	162	1,042	2,083	359	771	1,072	2,285	315	830	1,388	3,115
1993	356	123	944	1,964	310	779	971	2,157	386	888	1,356	3,045
1994	455	155	1,135	2,095	380	839	1,169	2,302	324	723	1,494	3,025
1995	388	117	919	1,646	318	679	948	1,821	0	0	948	1,821

Table 10.2.1.3 Maximum and minimum estimates (x1,000) of pre-fishery abundance of maturing and non-maturing 1SW recruits in Northern European Countries (Scandinavia, Finaland, Russia, Iceland)

Year	Catch (numbers)		Estimated returning stock 1SW		Estimated returning stock 2SW		Estimated maturing 1SW recruits		Est. non-maturing 1SW recruits		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
1971	289	311	535	952	509	773	535	952	628	972	1,162	1,924
1972	360	374	672	1,199	626	966	672	1,199	769	1,155	1,441	2,354
1973	425	449	799	1,394	768	1,148	799	1,394	688	1,048	1,487	2,442
1974	394	390	742	1,300	687	1,043	742	1,300	750	1,109	1,492	2,409
1975	390	433	731	1,270	748	1,102	731	1,270	661	1,007	1,392	2,277
1976	362	371	680	1,206	660	1,003	680	1,206	572	912	1,252	2,118
1977	345	322	645	1,153	571	909	645	1,153	416	658	1,061	1,812
1978	275	238	507	873	415	656	507	873	596	990	1,103	1,863
1979	423	353	660	1,379	595	986	764	1,379	827	1,155	1,591	2,534
1980	385	495	633	1,326	824	1,144	705	1,326	874	1,197	1,579	2,522
1981	280	561	456	947	870	1,179	506	947	730	1,005	1,236	1,952
1982	235	470	339	750	726	989	402	750	755	1,007	1,157	1,757
1983	364	453	563	1,203	752	995	663	1,203	686	967	1,349	2,170
1984	365	410	586	1,260	684	958	679	1,260	691	941	1,369	2,201
1985	400	413	619	1,356	688	931	744	1,356	783	1,095	1,528	2,451
1986	366	480	572	1,233	781	1,083	680	1,233	616	864	1,295	2,096
1987	377	363	517	1,229	613	854	720	1,229	489	670	1,209	1,899
1988	316	272	496	1,069	488	664	600	1,069	506	633	1,106	1,702
1989	331	243	611	1,420	504	626	764	1,420	518	776	1,283	2,196
1990	294	278	541	1,243	516	767	654	1,243	489	827	1,143	2,070
1991	250	242	559	1,156	487	819	559	1,156	463	876	1,022	2,032
1992	230	174	587	1,138	462	873	587	1,138	458	796	1,045	1,934
1993	220	140	512	981	458	795	512	981	381	726	893	1,707
1994	209	140	497	999	381	725	497	999	353	715	849	1,713
1995	195	124	474	933	353	715	474	933	0	0	474	933

Table 11.1 Number of microtags, external tags and finclips applied to Atlanti salmon by . countries for 1995. ('Hatchery' and 'wild' refer to smolts or parr; adults are 'wild' and/or 'hatchery')

Country	Origin	Marking method: Microtags	Visible implant & PIT	External tags	Brands Dyemarks etc	Finclips	Auxilliary tags, finclips
Canada	Hatchery	-	-	24,217	-	1,721,926	4,000
	Wild	-	-	610	-	2,133	-
	Adult	-	-	9,580	-	-	577
	TOTAL	-	-	34,407	-	1,724,059	4,577
France	Hatchery	-	-	148	1,619	327,613	-
	Wild	-	-	-	1,577	-	13,120
	TOTAL	-	-	148	3,196	327,613	13,120
Iceland	Hatchery	335,663	-	1,000	-	5,000	335,663
	Wild	7,268	-	36	-	-	7,268
	TOTAL	342,931	-	1,036	-	5,000	342,931
Ireland	Hatchery	293,275	-	-	-	59,428	293,275
	Wild	5,032	-	-	-	-	5,032
	Kelts	-	-	541	-	-	541
	TOTAL	298,307	-	541	-	59,428	298,848
Norway	Hatchery	-	-	79,579	-	118,361	-
	Wild	-	-	3,868	-	-	-
	Adult	-	-	1,965	-	-	-
	TOTAL	-	-	85,412	-	118,361	-
Russia	Hatchery	-	-	-	-	-	-
	Wild	-	-	-	-	-	-
	Adult	-	-	1,200	-	-	-
	TOTAL	-	-	1,200	-	-	-
Spain	Hatchery	20,500	-	-	-	-	-
	Wild	106,500	-	-	-	-	-
	Adult	-	-	-	-	-	-
	TOTAL	-	-	-	-	-	-
Sweden	Hatchery	-	-	6,723	-	-	-
	Wild	-	-	426	-	-	-
	Adult	-	-	49	-	-	-
	TOTAL	-	-	7,198	-	-	-
UK(England & Wales)	Hatchery	194,551	-	-	-	58,968	194,551
	Wild	14,720	-	-	-	-	14,720
	Adult	-	-	1,840	-	-	-
	TOTAL	209,271	-	1,840	-	58,968	209,271
UK(Northern Ireland)	Hatchery	40,298	-	-	-	-	40,298
	Wild	237	-	-	-	-	237
	Adult	-	-	-	327	-	327
	TOTAL	40,535	-	-	327	-	40,862
UK(Scotland)	Hatchery	-	-	-	-	-	-
	Wild	20,308	-	5,873	-	-	26,181
	Adult	-	-	205	-	-	6
	TOTAL	20,308	-	6,078	-	-	26,187
USA	Hatchery	-	-	-	-	-	-
	Wild	-	3,566	-	-	-	-
	Adult	-	-	3,618	-	-	-
	TOTAL	-	3,566	3,618	-	-	-
TOTALS	**Hatchery**	**884,287**	**0**	**111,667**	**1,619**	**2,291,296**	**867,787**
	Wild	**154,065**	**3,566**	**10,813**	**1,577**	**2,133**	**66,558**
	Adult	**0**	**0**	**17,158**	**327**	**0**	**1,451**
	GRAND TOTAL	**1,038,352**	**3,566**	**139,638**	**3,523**	**2,293,429**	**935,796**

OVERALL TOTAL MARKED: 3,478,508

Table 13.1 Processes used to obtain unreported catch data for salmon fisheries in the North Atlantic.

Commission Area	Country	Processes and information
NAC	Canada	Discussions with local fisheries managers; based on knowledge of infractions, presence of illegal nets, etc.; surveys have also been conducted to establish the proportion of anglers reporting catches.
	USA	A Unreported landings are thought to have been negligible; total catch (~1 t) should have been released in 1995.
NEAC	Faroes	No known sources of unreported catch.
	Finland	Guess-estimate based on small percentage of catch.
	France	Unreported catch is thought to be small and is guess-estimated.
	Iceland	Proportion thought to be very low because most catches are taken in ranching stations or by anglers in closely controlled fisheries. The percentage is guess-estimated.
	Ireland	Guess-estimates are based on local knowledge of fisheries; separate values are summed for net fisheries in 7 regions.
	Norway	Surveys conducted in 1970s provided estimates of the percentage of catches that were not reported. Recent values have been reduced as a result of changes in the methods of collecting catch statistics.
	Sweden	Guess-estimate.
	Russia	No information available on method used.
	UK(E&W)	Guess-estimates are made separately for net and rod fisheries in 8 regions based on local knowledge of fishery managers and surveys conducted in some areas.
	UK(N.I.)	Guess-estimates based upon local knowledge of fisheries and sampling conducted during microtag scanning programmes.
	UK(Scot)	The proportion of the catch that is not reported is estimated using information obtained from investigations in the late 1980's.
WGC	Greenland	Guess-estimates of local consumption.

Figure 2.1.1 Nominal catches of salmon in four North Atlantic regions 1960-95

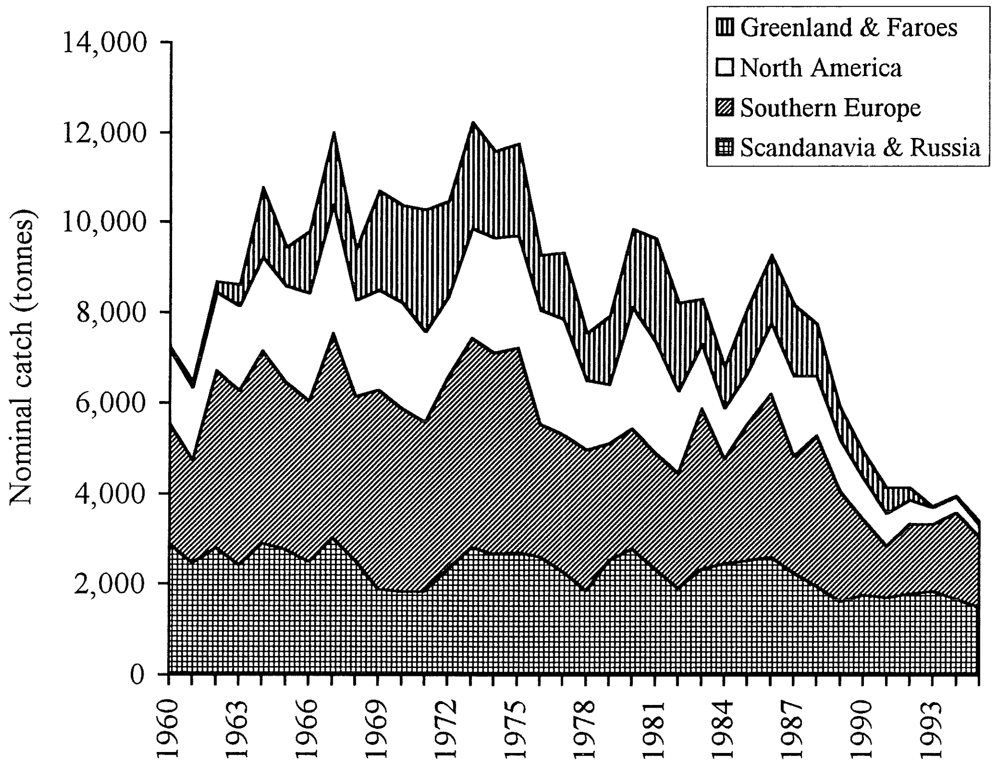


Figure 3.1.1 Production of farmed salmon (tonnes round fresh weight) in the North Atlantic, 1980-1995

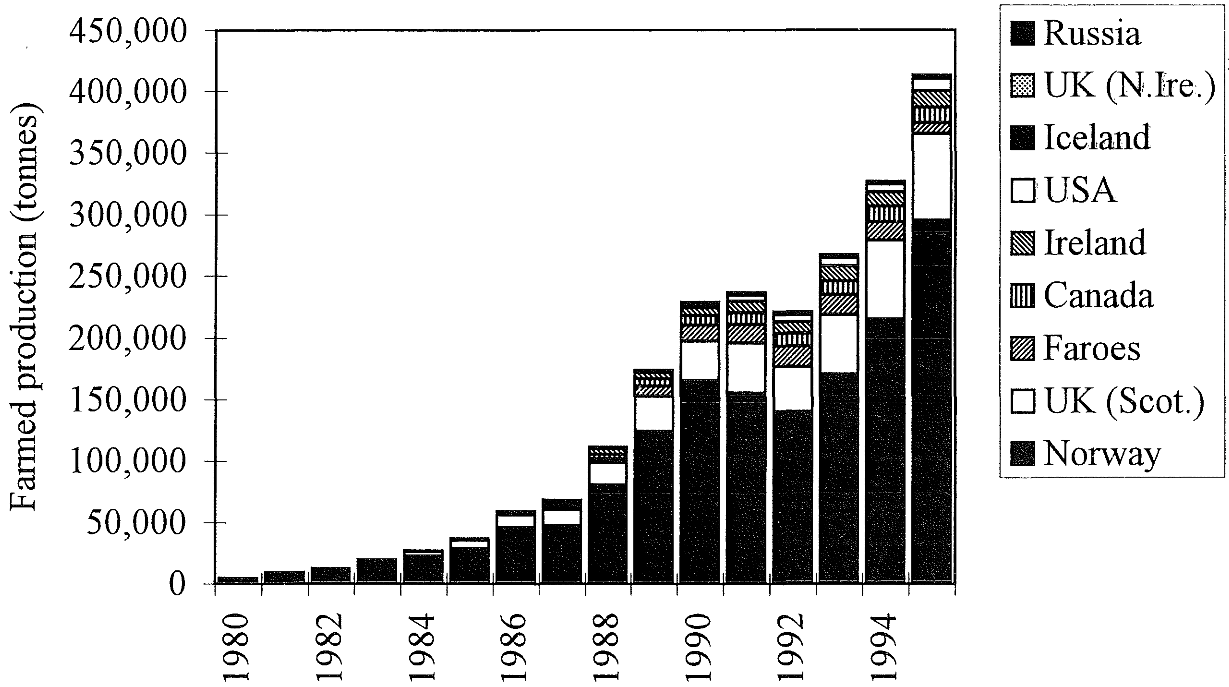


Figure 3.2.1 Production of ranched salmon (tonnes round fresh weight) in the North Atlantic, 1980-1995

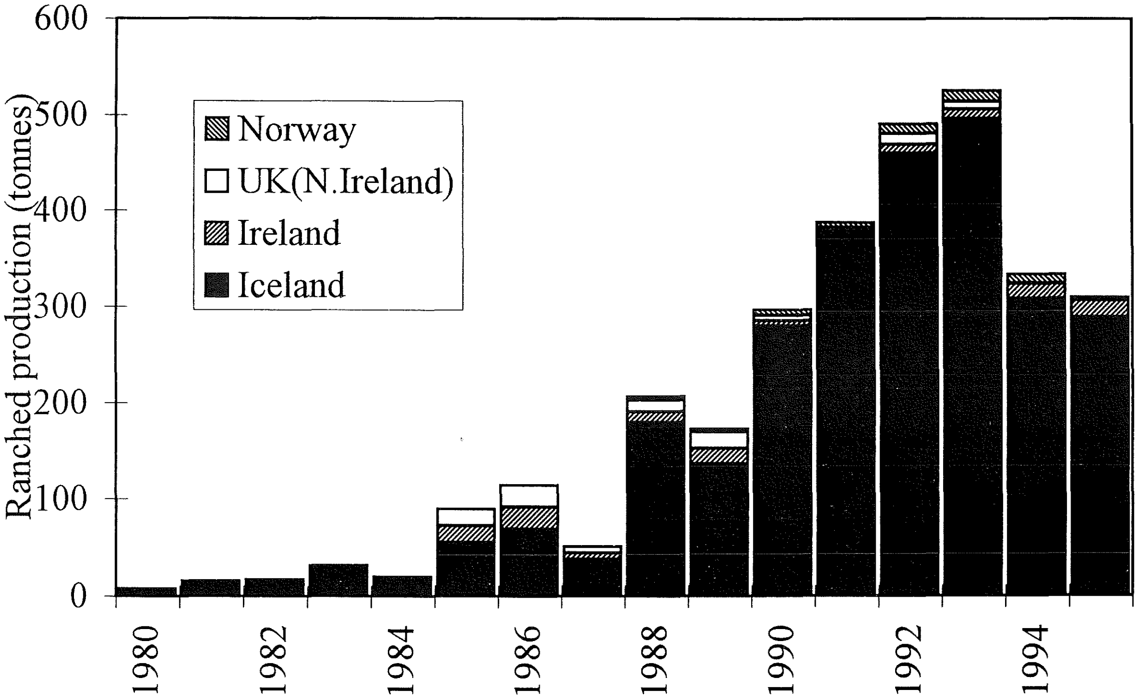


Figure 4.1.3.1 The Faroes EEZ and catch per 1000 hooks (CPUE) by statistical rectangle in the 1994/1995 fishing season.

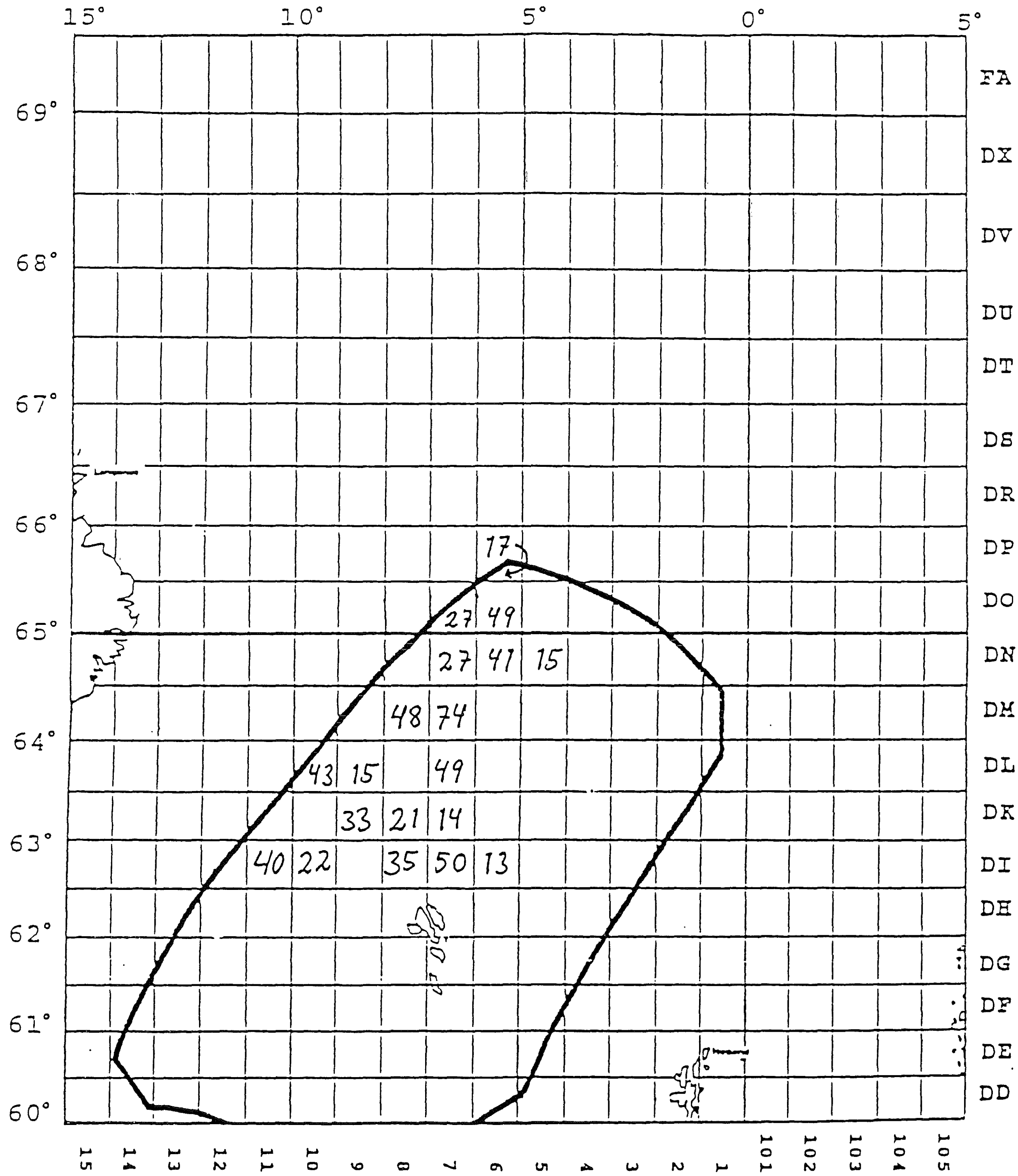


Figure 4.1.3.2. Catch per 1000 hooks (CPUE) in the Faroese fishery inside the EEZ since the 1982/83 fishing season. The catch is broken into wild and farmed fish.

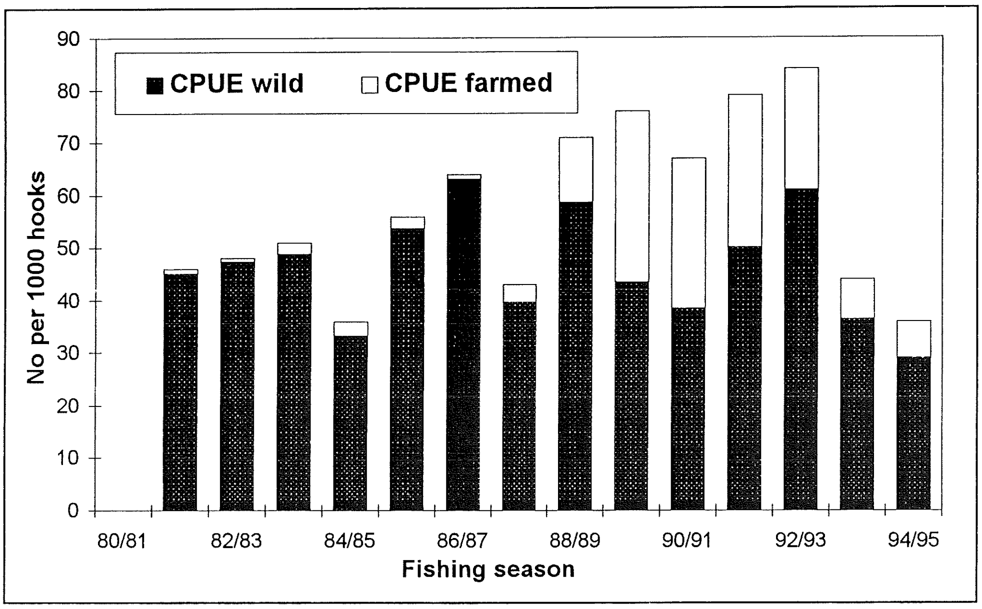


Figure 4.1.4.1. Fork length distribution of salmon sampled at Faroes in the 1994/1995 season by month. Wild and reared fish combined. Sea-age groups are indicated based on length splits.

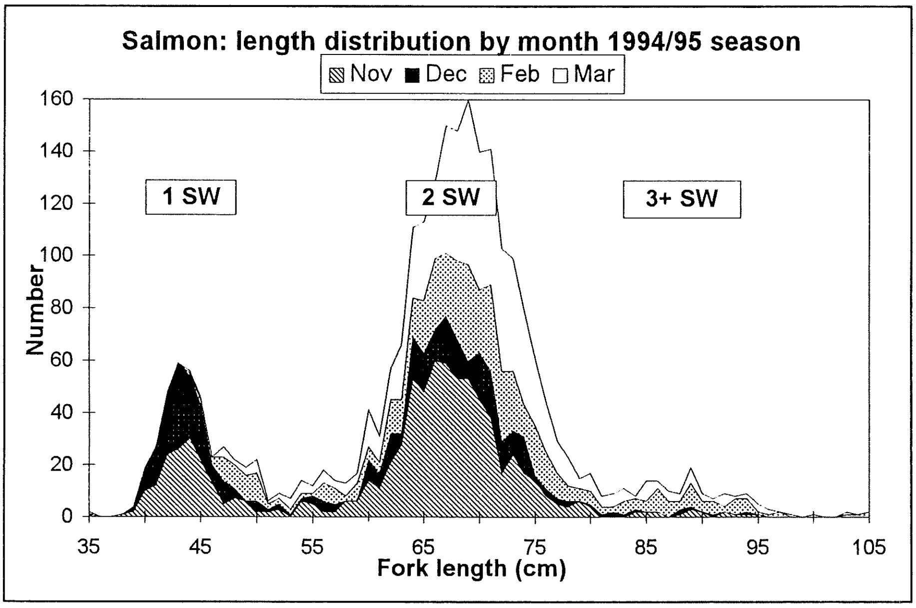


Figure 4.1.4.3. Percentage distribution by weight category (kg) of salmon landed in the Faroese fishery since the 1983/84 fishing season.

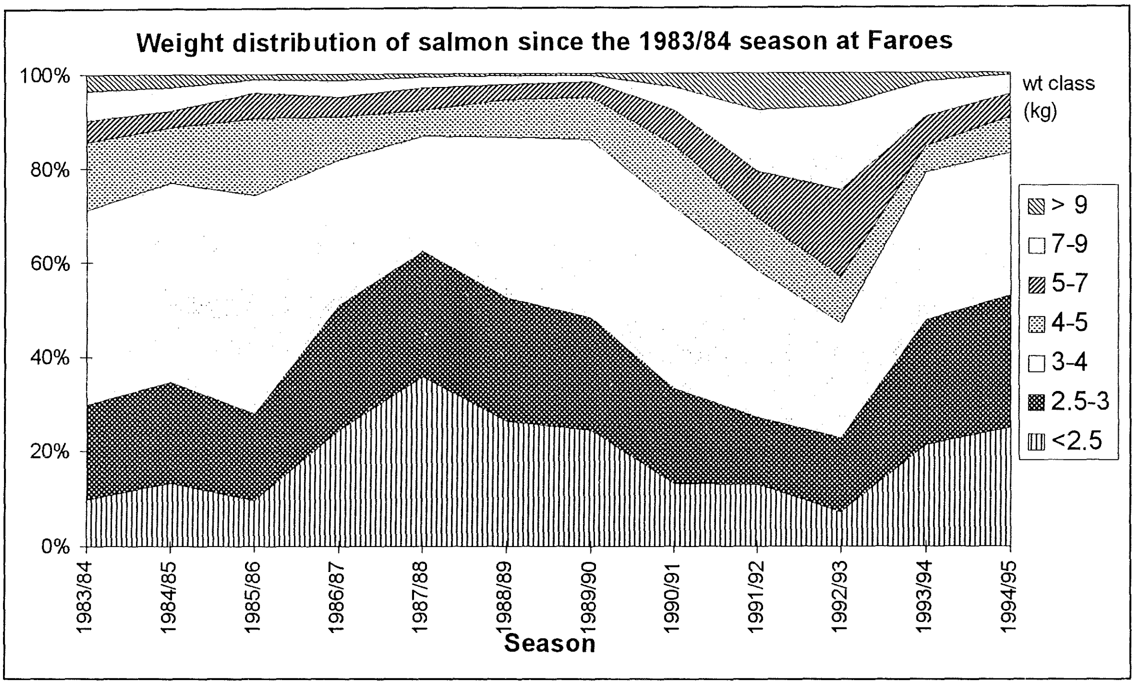


Figure 4.1.6.1. Proportion of fish farm escapees from scale samples collected in the Faroese fishery since the 1982/1983 season.

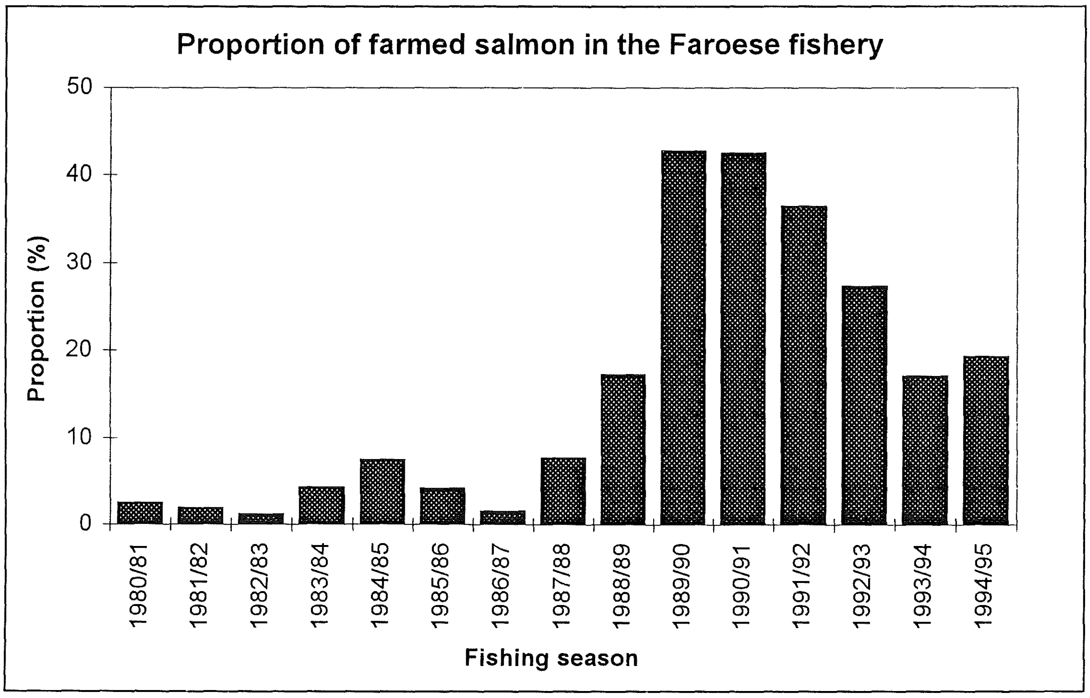
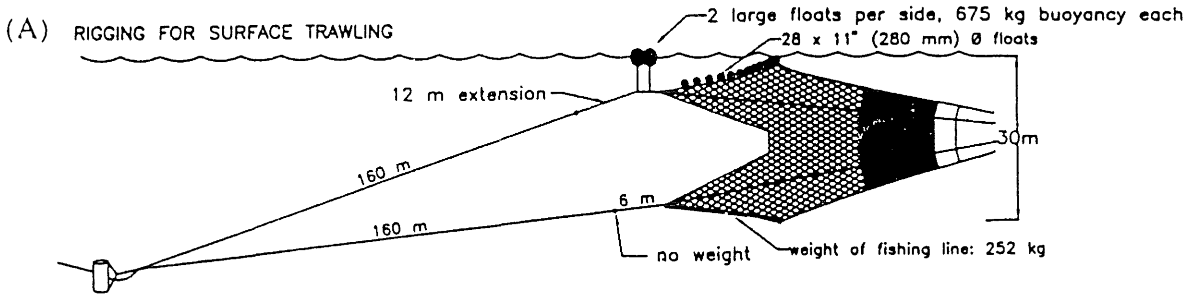


Fig. 4.4.1. Rigging of t he Akra experimental pelagic trawl for surface (A) and midwater (B) trawling (from Valdemarsen and Misund 1995).



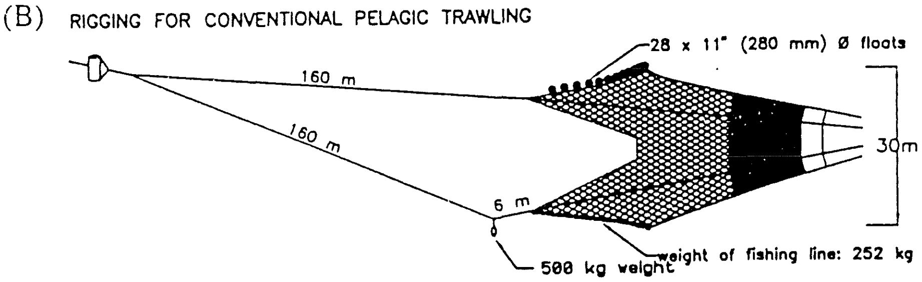


Fig.4.4.2. Postsmolt catches in surface trawl hauls during three research cruises in 1995. Stars show position of trawl stations without smoltcatches while numbers indicate position and numbers of smolts caught. Stations south of 62°N were sampled in June. Stations north of that latitude were sampled in July. (From: Holm et al.1996).

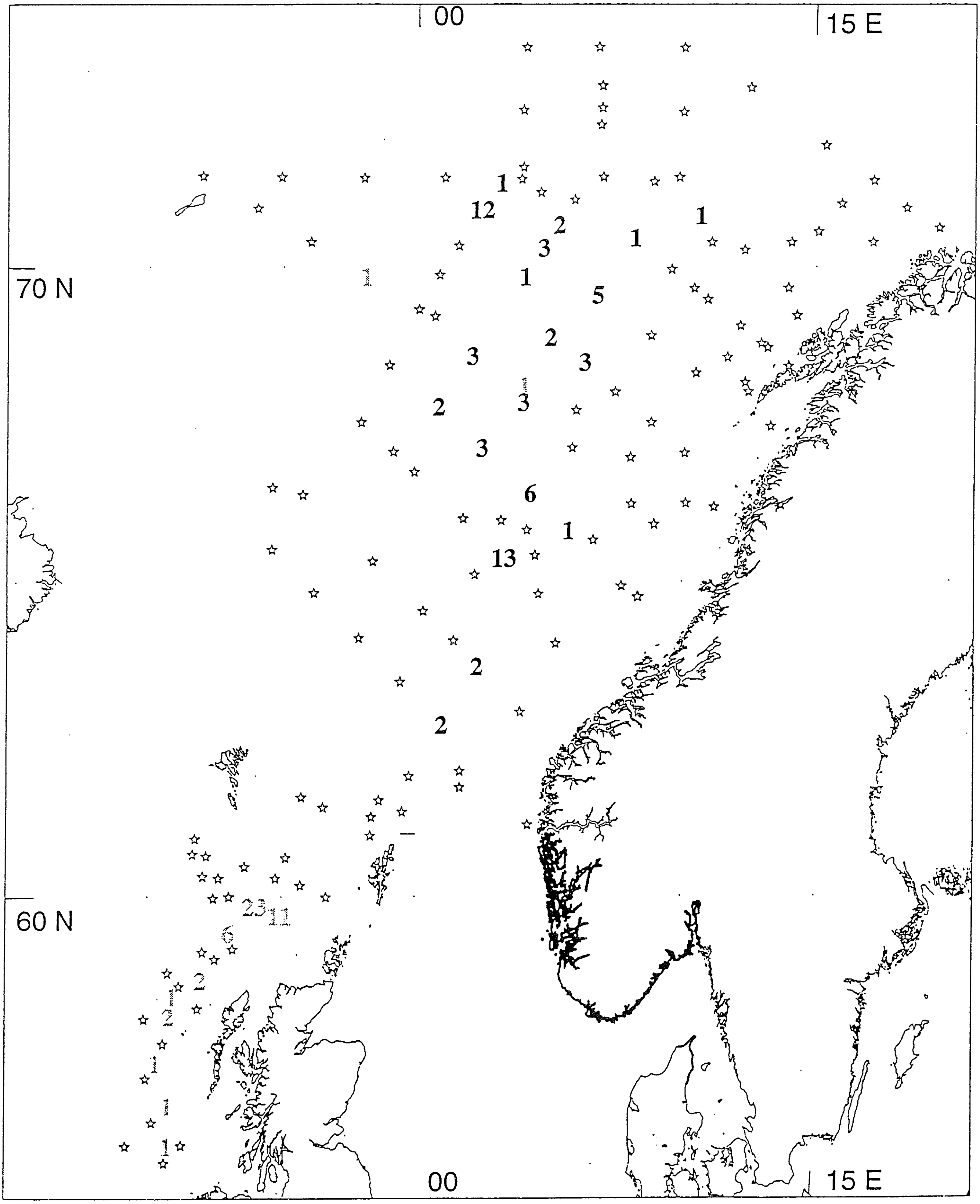


Figure 5.1.1.1 Map of Salmon Fishing Areas (SFAs) In Canada.

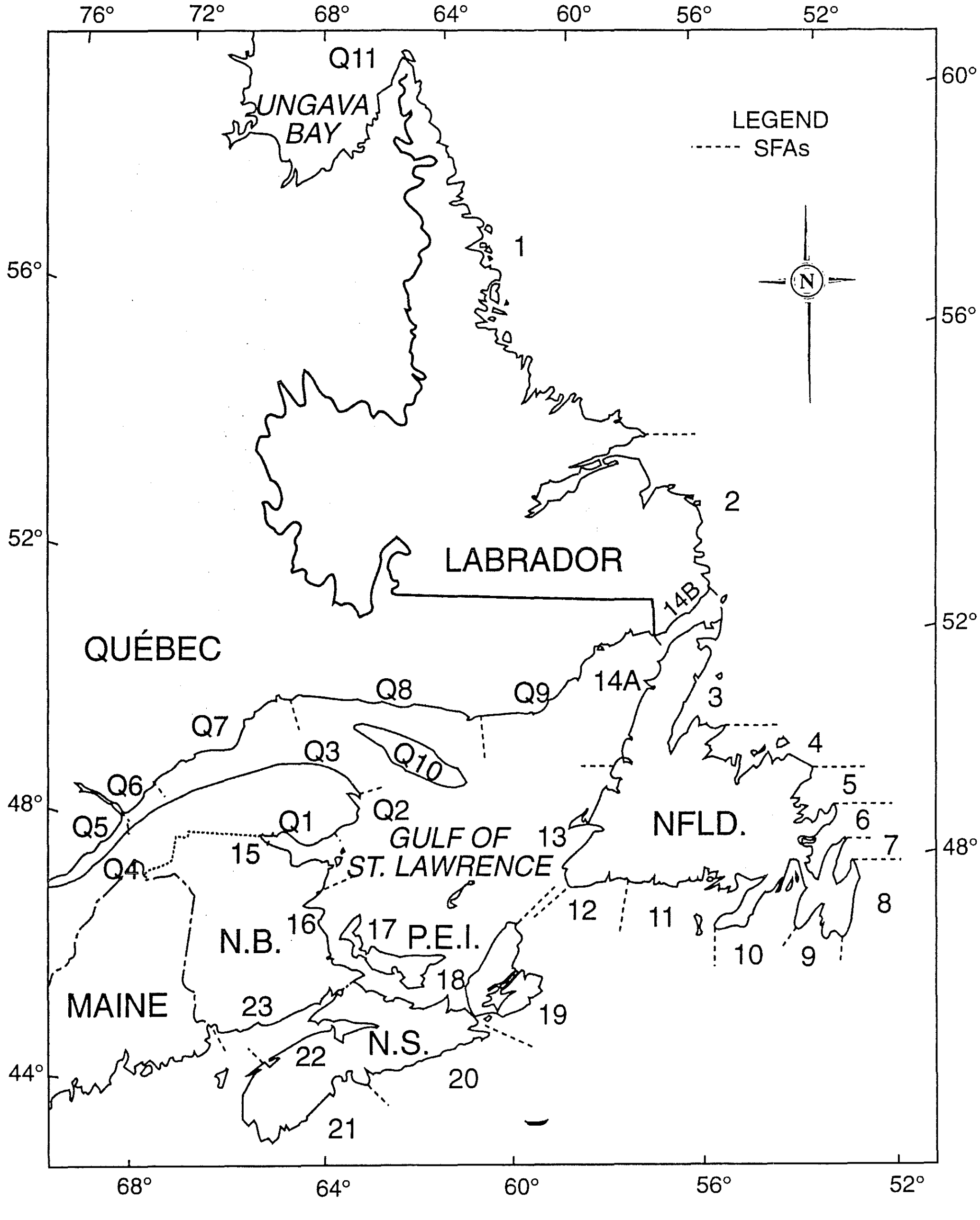


Figure 5.1.2.1 Harvest of small and large salmon and total harvest in Canada, 1960-1995.

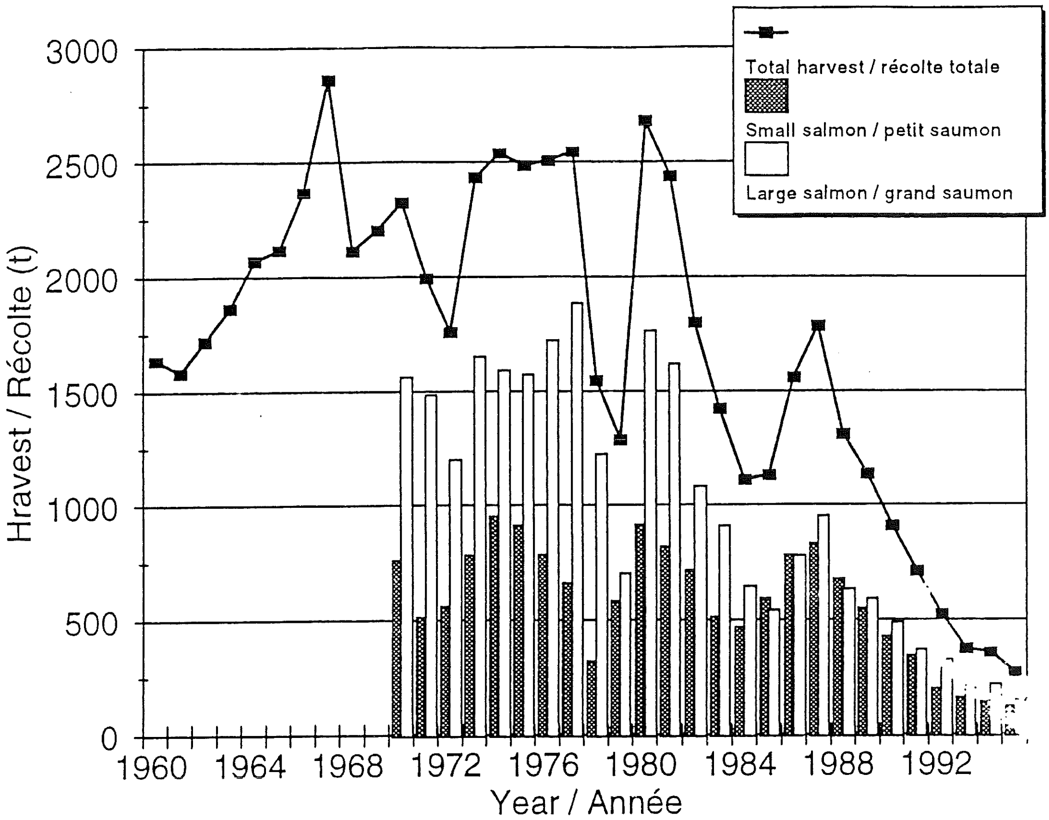


Figure 5.1.2.2 Harvest of small and large salmon in recreational fisheries and total recreational harvest in Canada, 1960-1995.

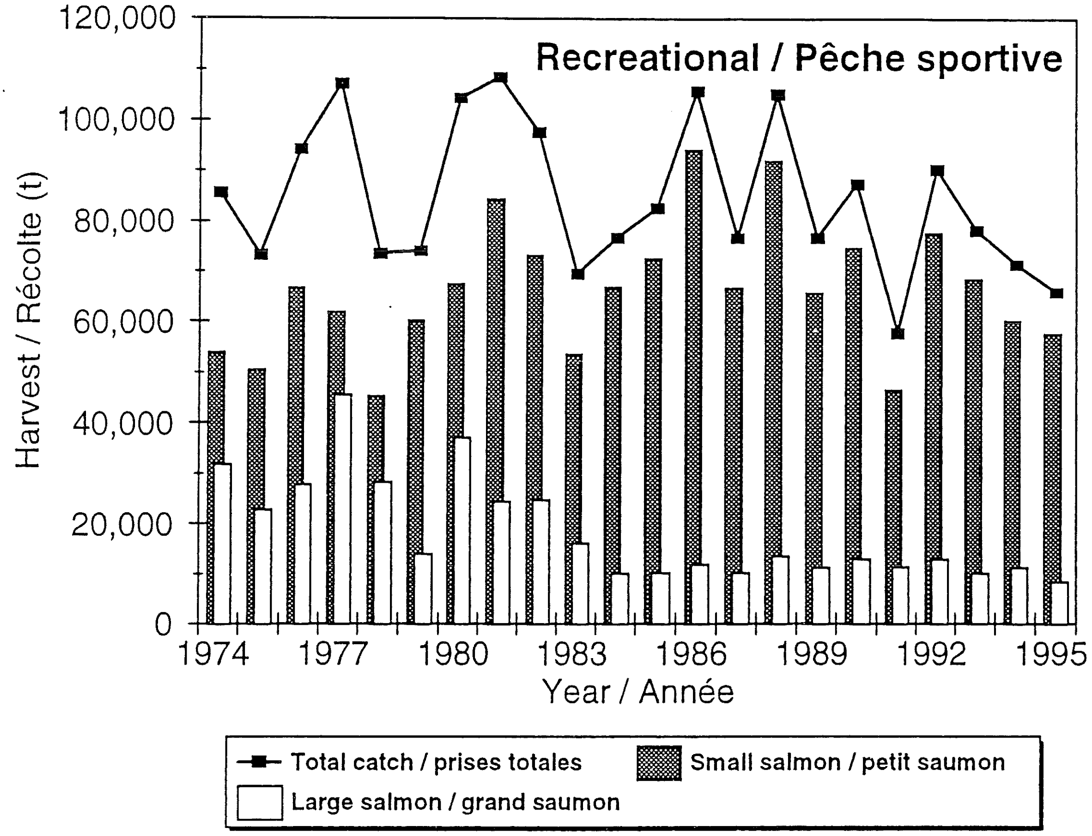
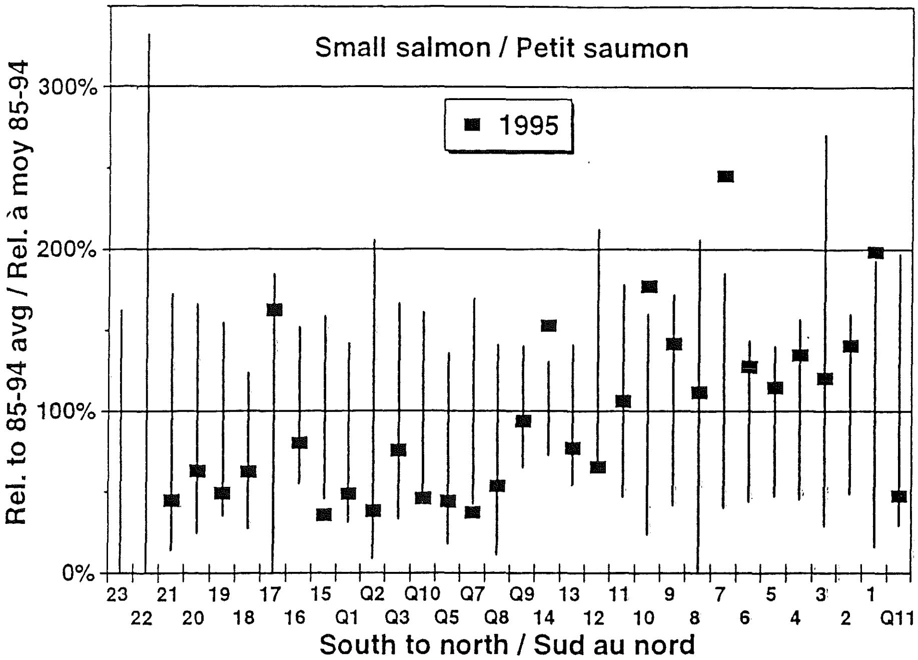


Figure 5.1.2.3 Angling catches of small and large salmon by management area in 1995 expressed as a percentage of the average catches for the period 1985-1994 (black square). The vertical lines represent the minimum and maximum range.



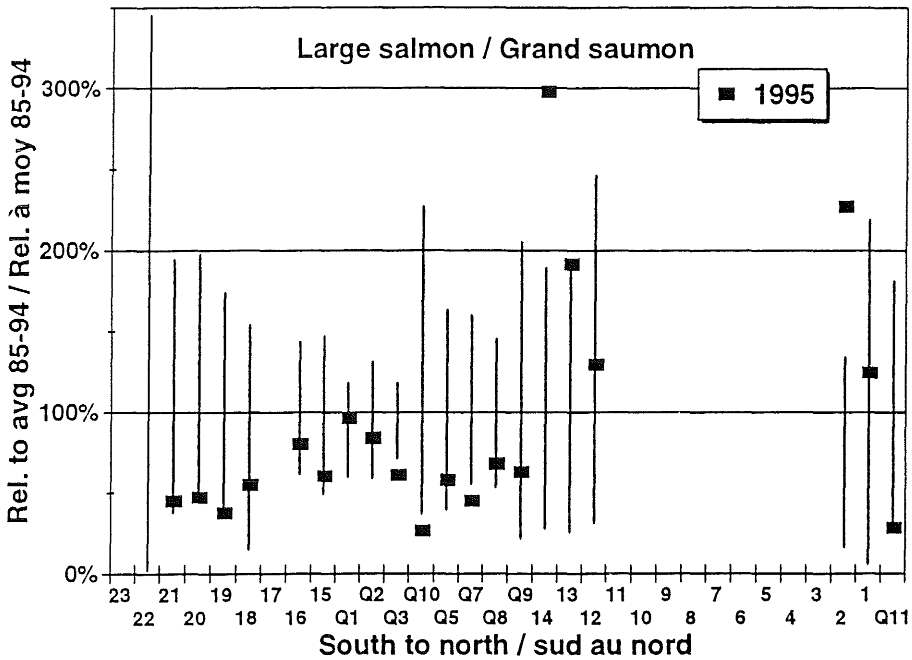


Figure 5.1.24 Harvest of small and large salmon in commercial fisheries and total commercial harvest in Canada, 1960-1995.

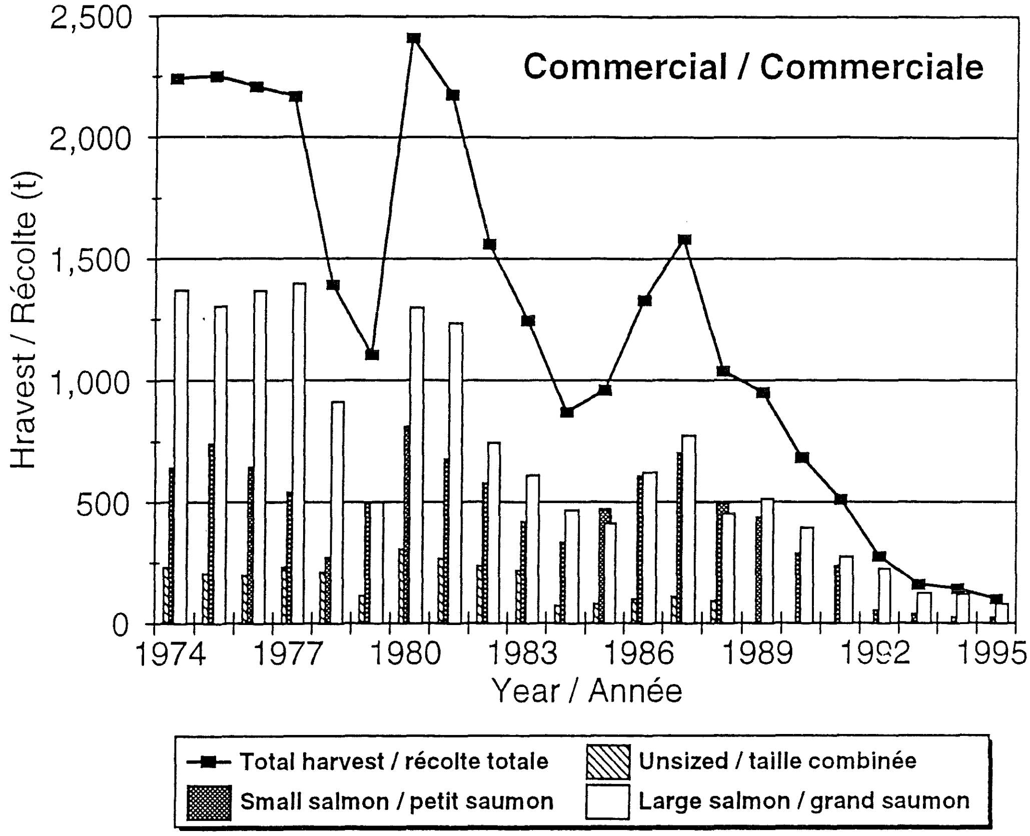


Figure 5.1.3.1 Time series of 1SW harvest in Canada and Greenland (including East Greenland) for the non-maturing component of the Penobscot stock. Results of 500 realizations of harvest model yielding empirically derived confidence intervals.

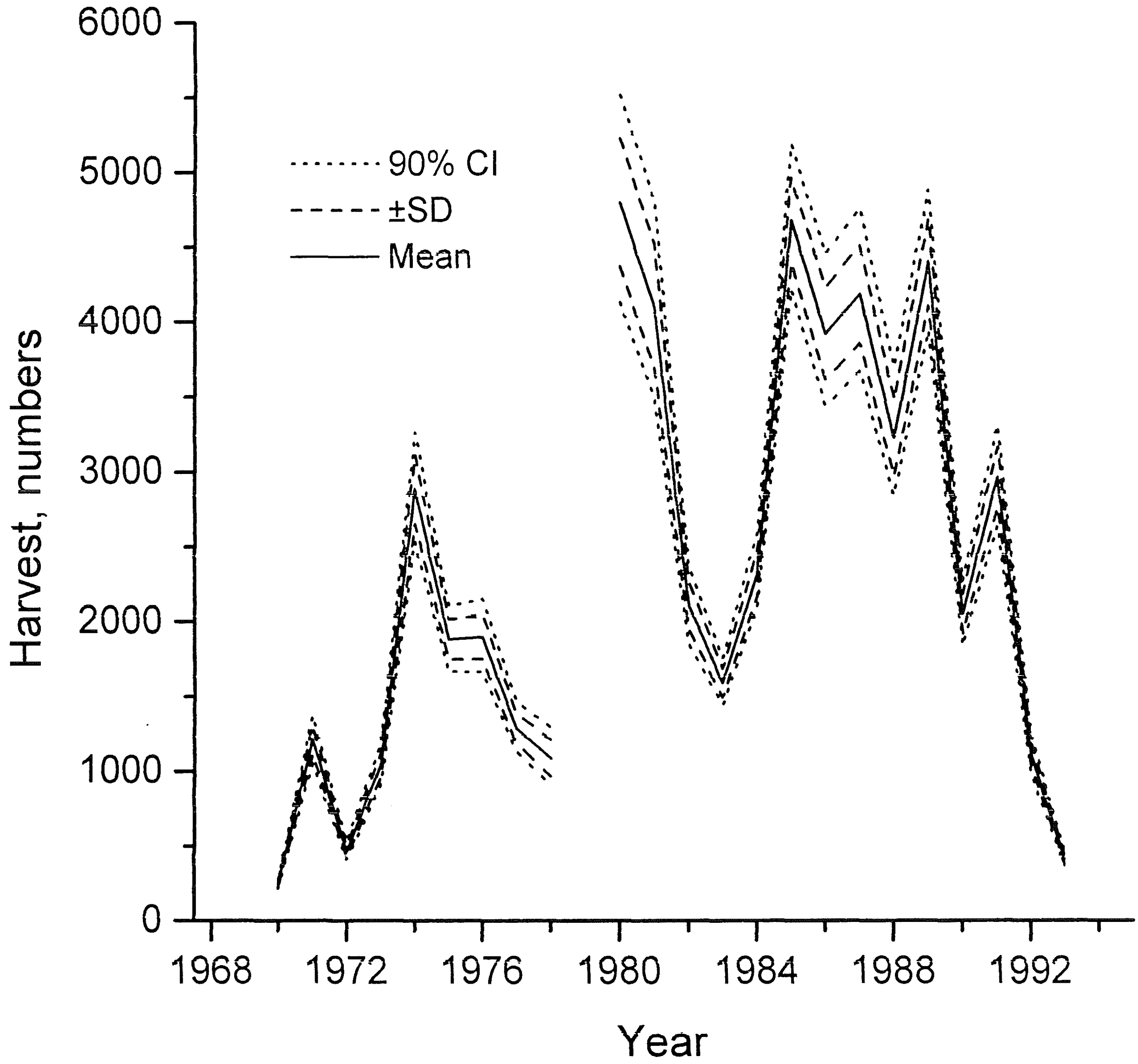


Figure 5.1.3.2 Time series of 1SW harvest in West Greenland (A) and Newfoundland-Labrador (B) for the non-maturing component of the Penobscot stock. Results of 500 realizations of harvest model yielding empirically derived confidence intervals.

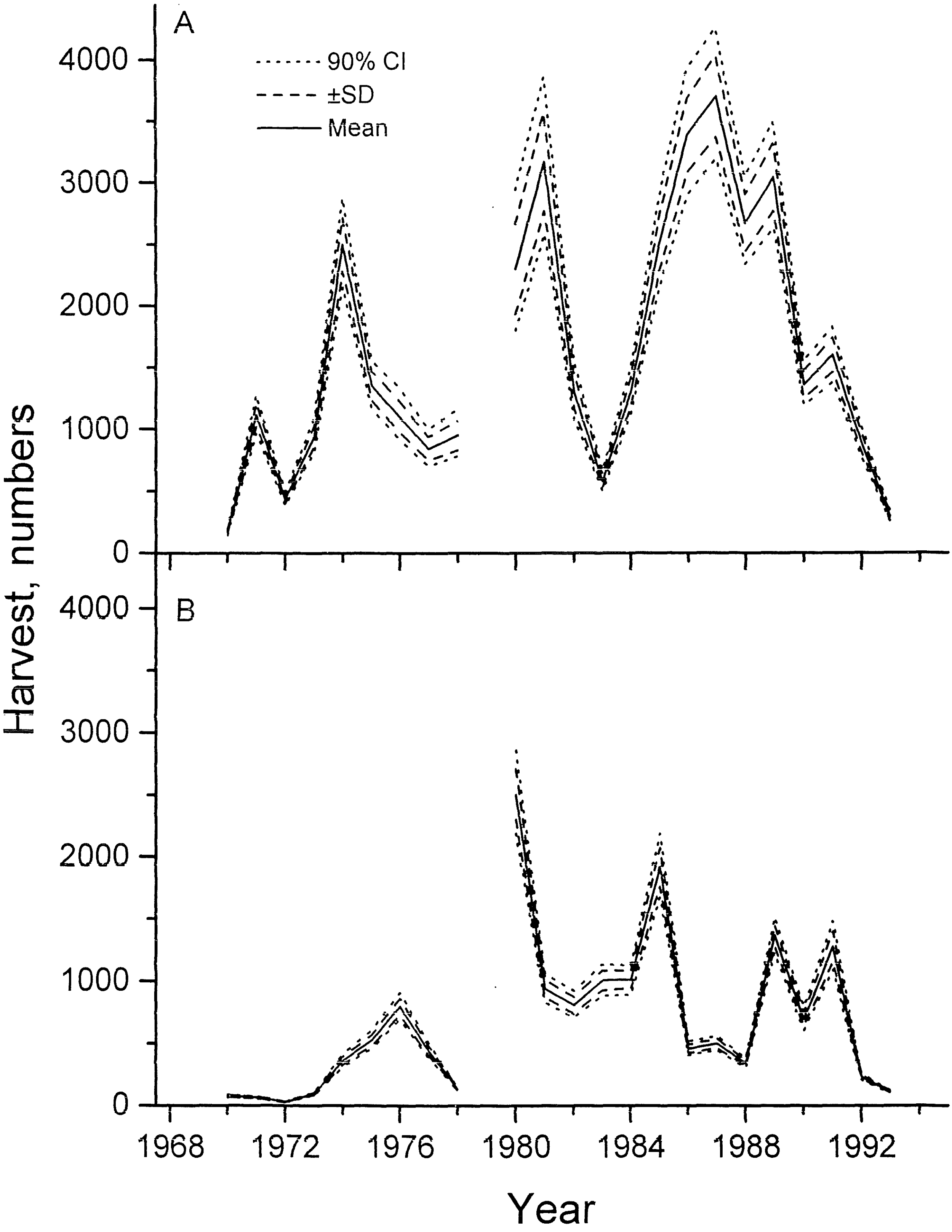


Figure 5.1.3.3. Origin of salmon returning to rivers of eastern Canada in 1995.

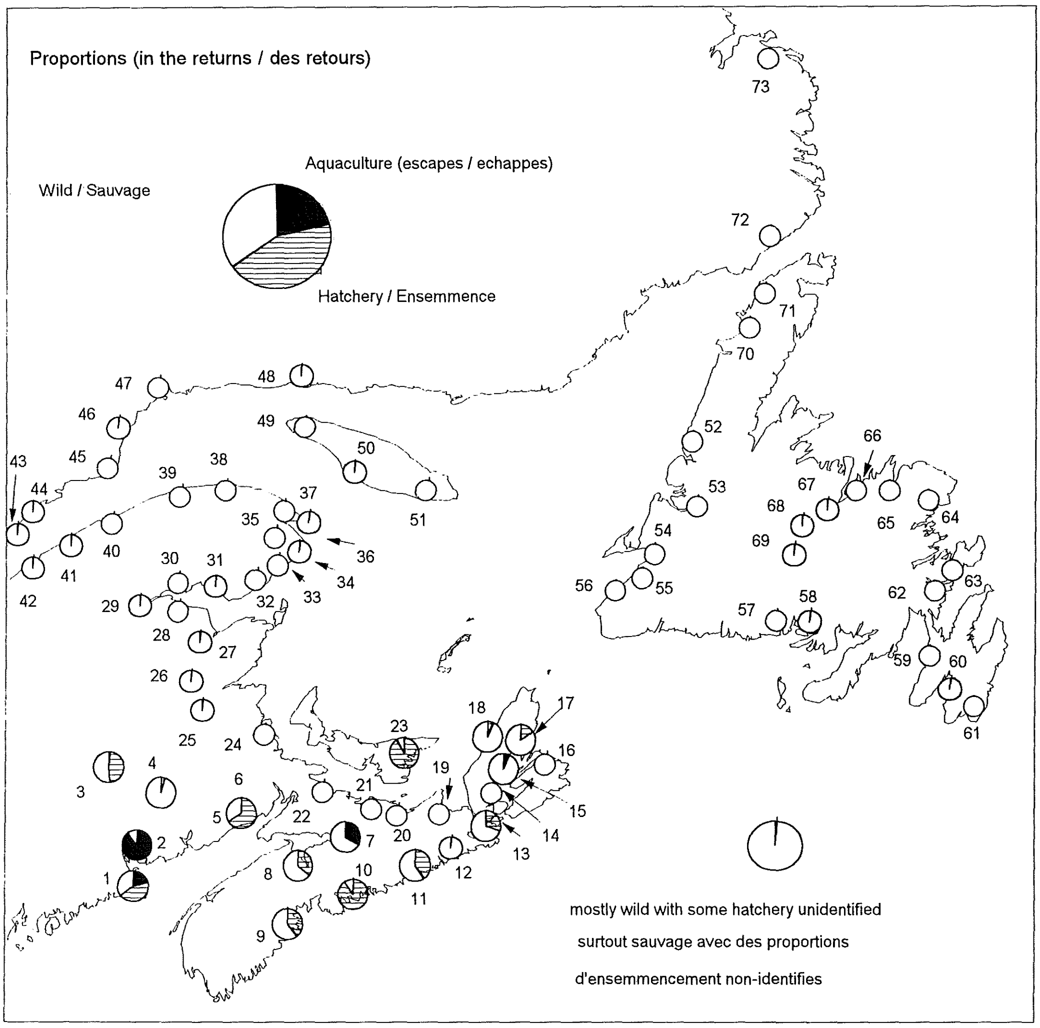


Figure 5.1.4.1 Time series of 1SW extant exploitation for the non-maturing component of the Penobscot stock. Results of 500 realizations of exploitation model yielding empirically derived confidence intervals.

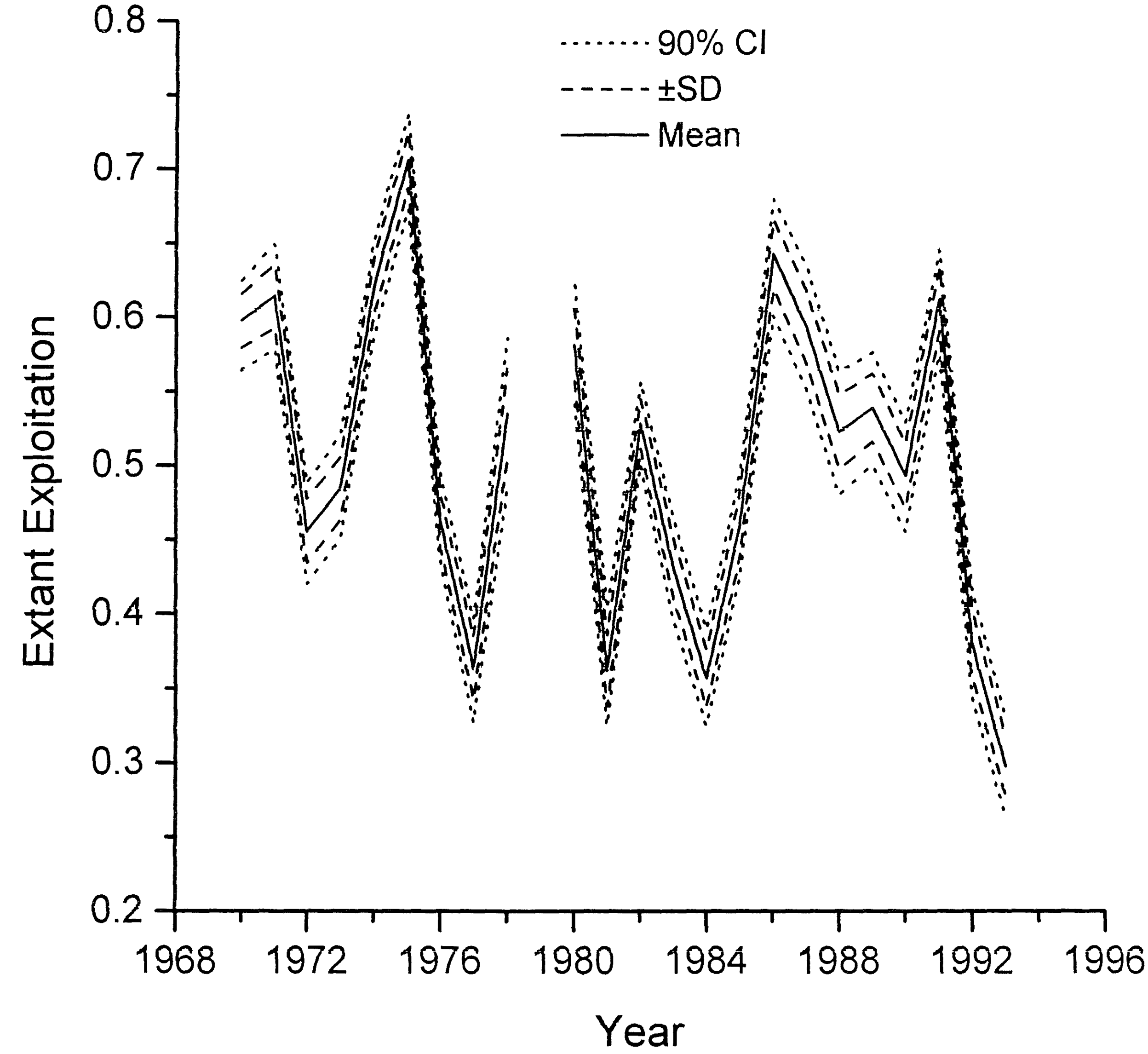


Figure 5.1.4.2 Time series of mean extant exploitation for Penobscot stock and comparable time series for Maine rivers assessment (Anon. 1995).

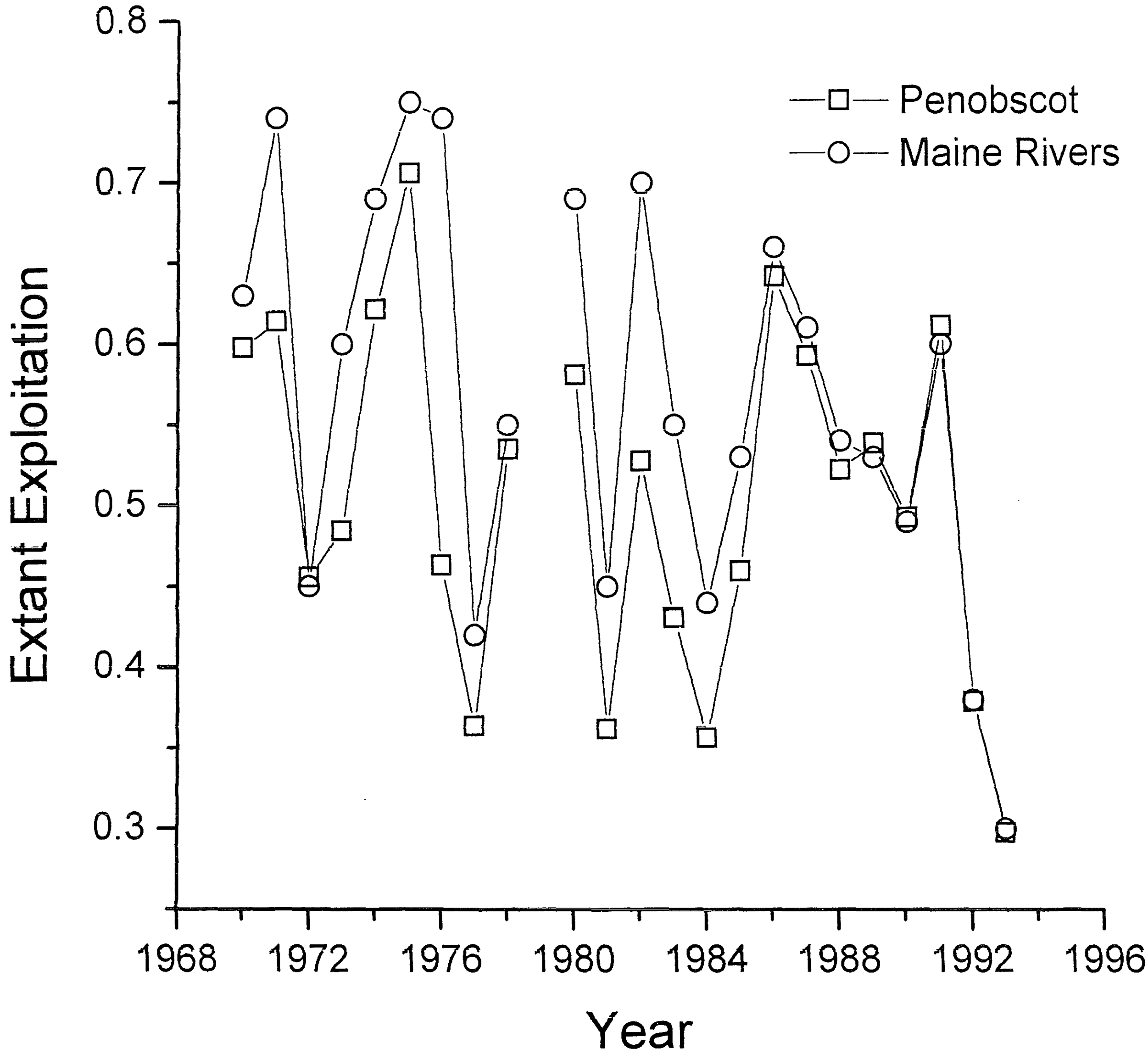


Figure 5.2.2.1. Returns of small and large salmon to 28 rivers of eastern Canada, 1984 to 1995. These in-river returns do not account for removals in the commercial fisheries.

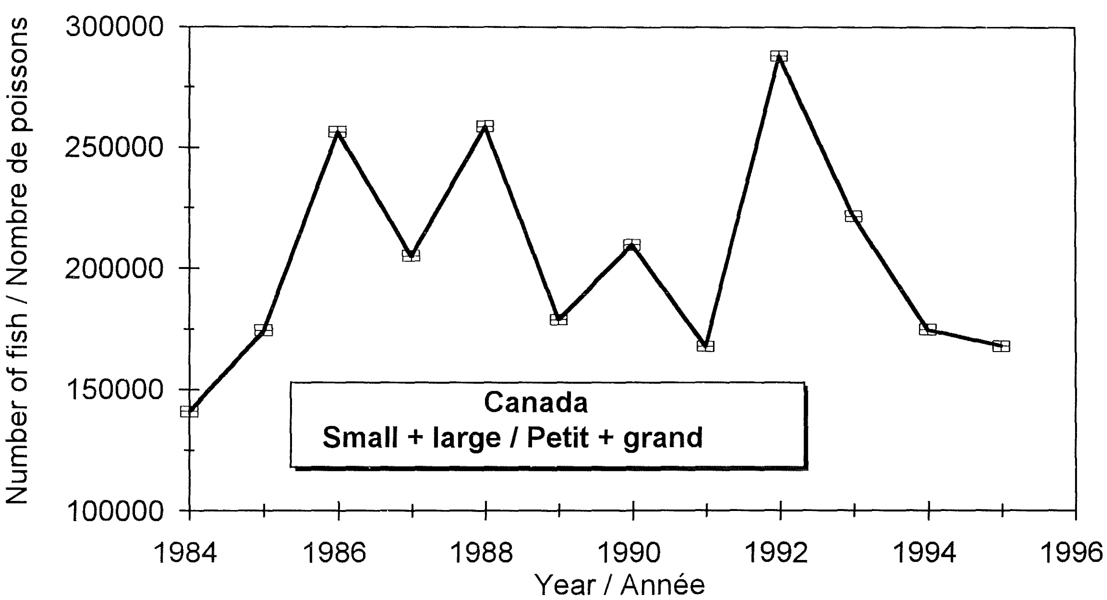


Figure 5.2.2.2. In-river returns of small salmon and large salmon for 22 monitored rivers in four geographic areas of eastern Canada from 1984 to 1995. These in-river returns do not account for removals in the marine fisheries.

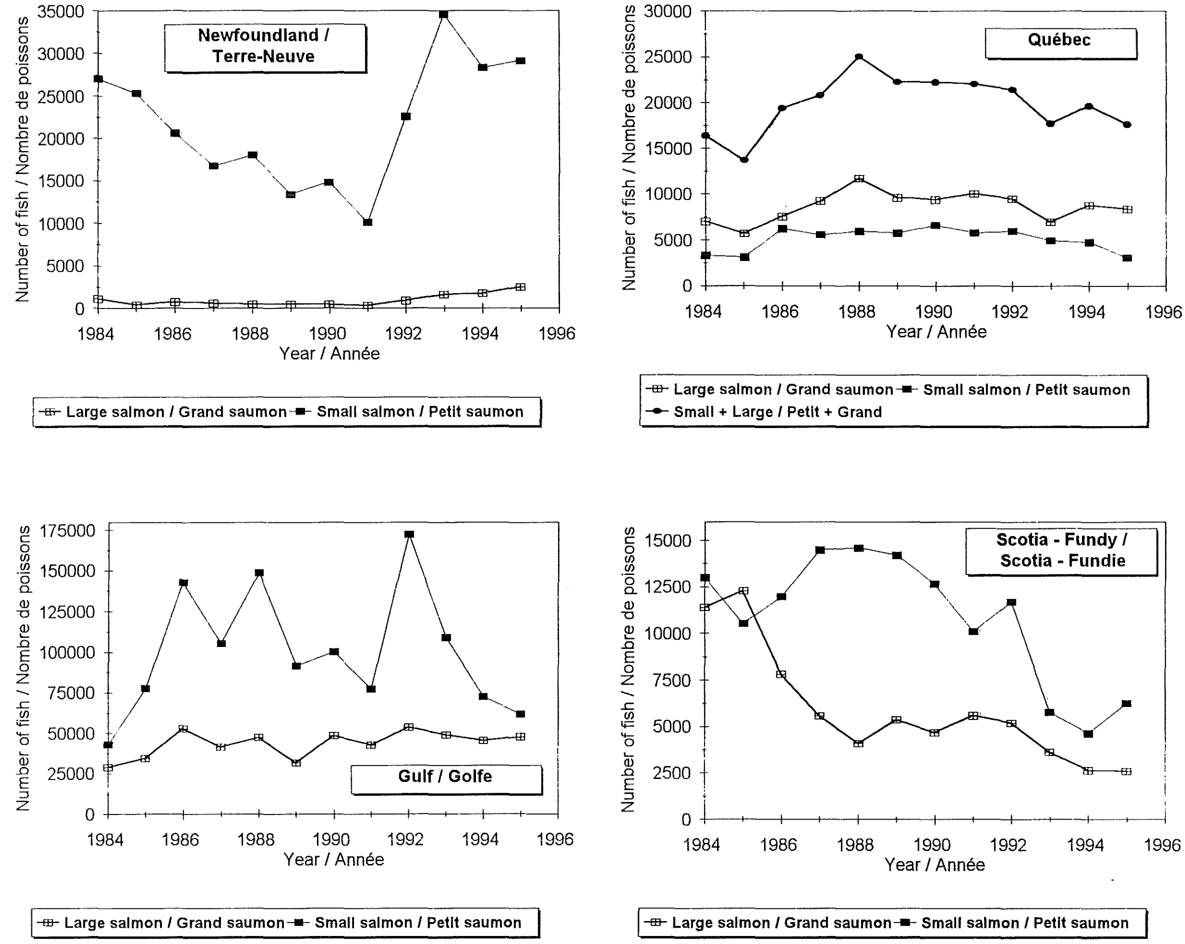
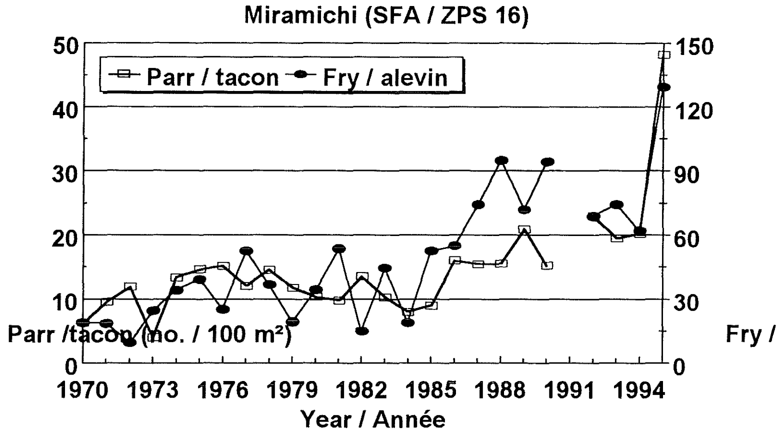
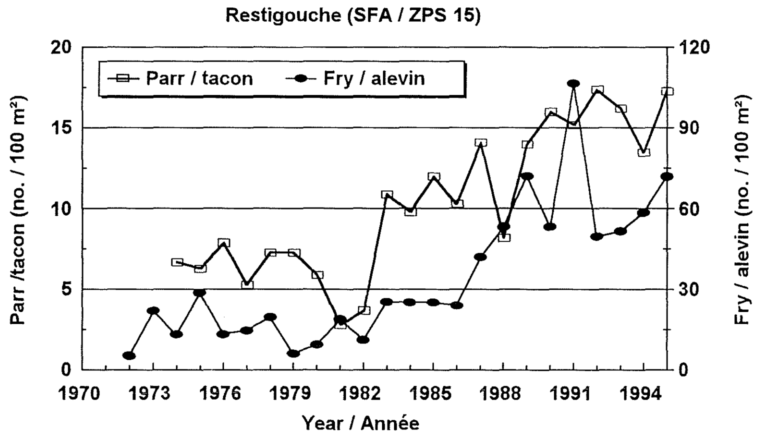


Figure 5.2.2.3 Juvenile Atlantic salmon densities in the Miramichi River (SFA 16), Restigouche River (SFA 15) and the Stewiacke River (SFA 22), Canada based on sampling at standard index sites in each river.





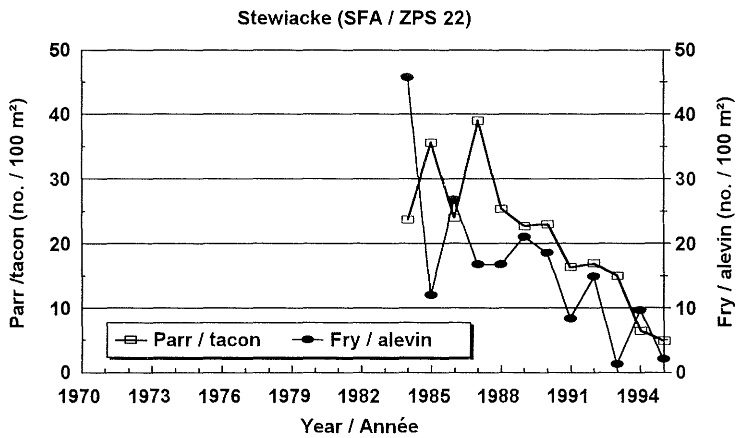


Figure 5.2.3.1 Comparison of estimated mid-points of 1SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 1SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 1SW spawners (squares).

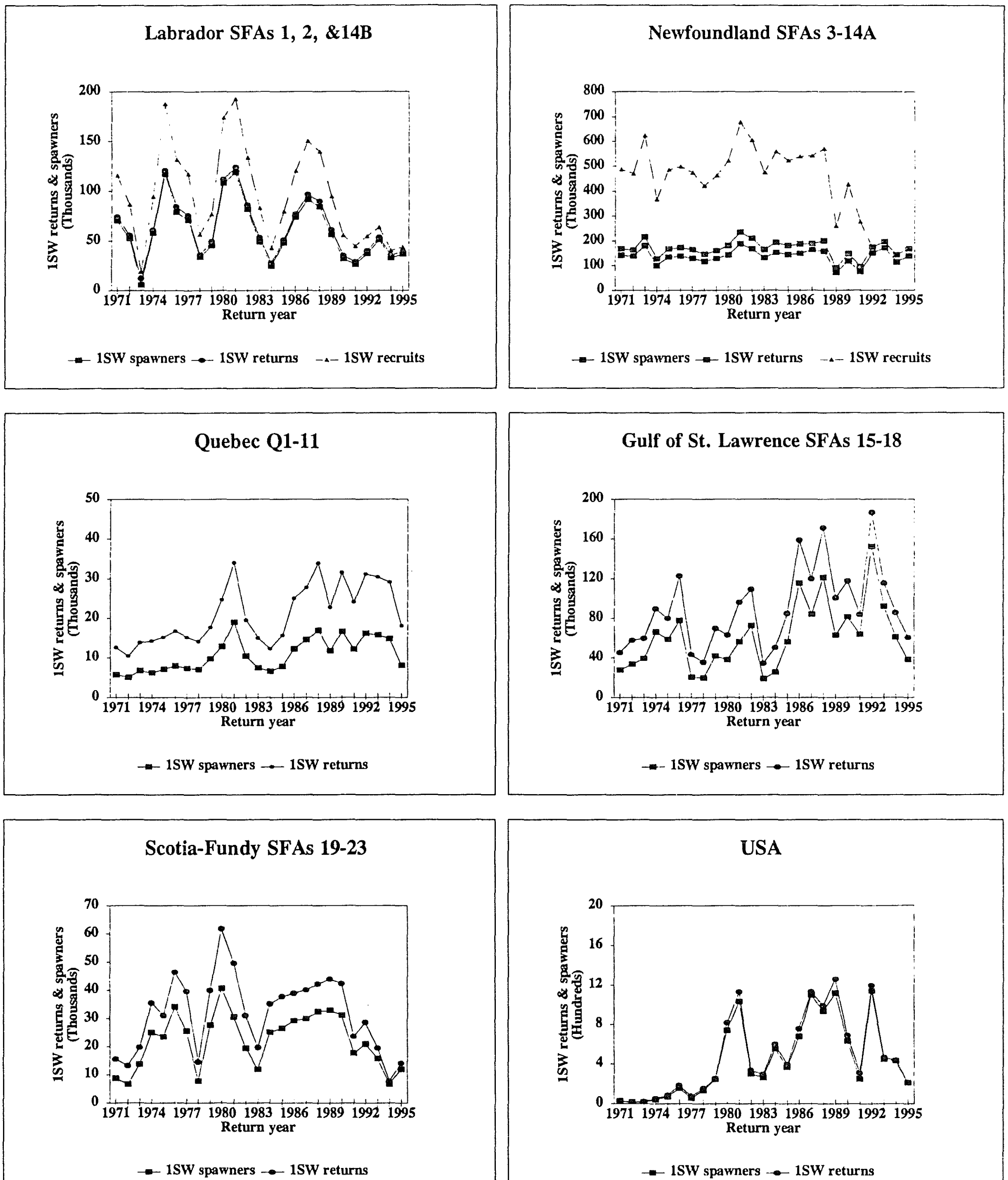


Figure 5.2.3.2 Comparison of estimated mid-points of 2SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 2SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 2SW spawners (squares) and 2SW spawning targets (triangles) for 1971-95 return years.

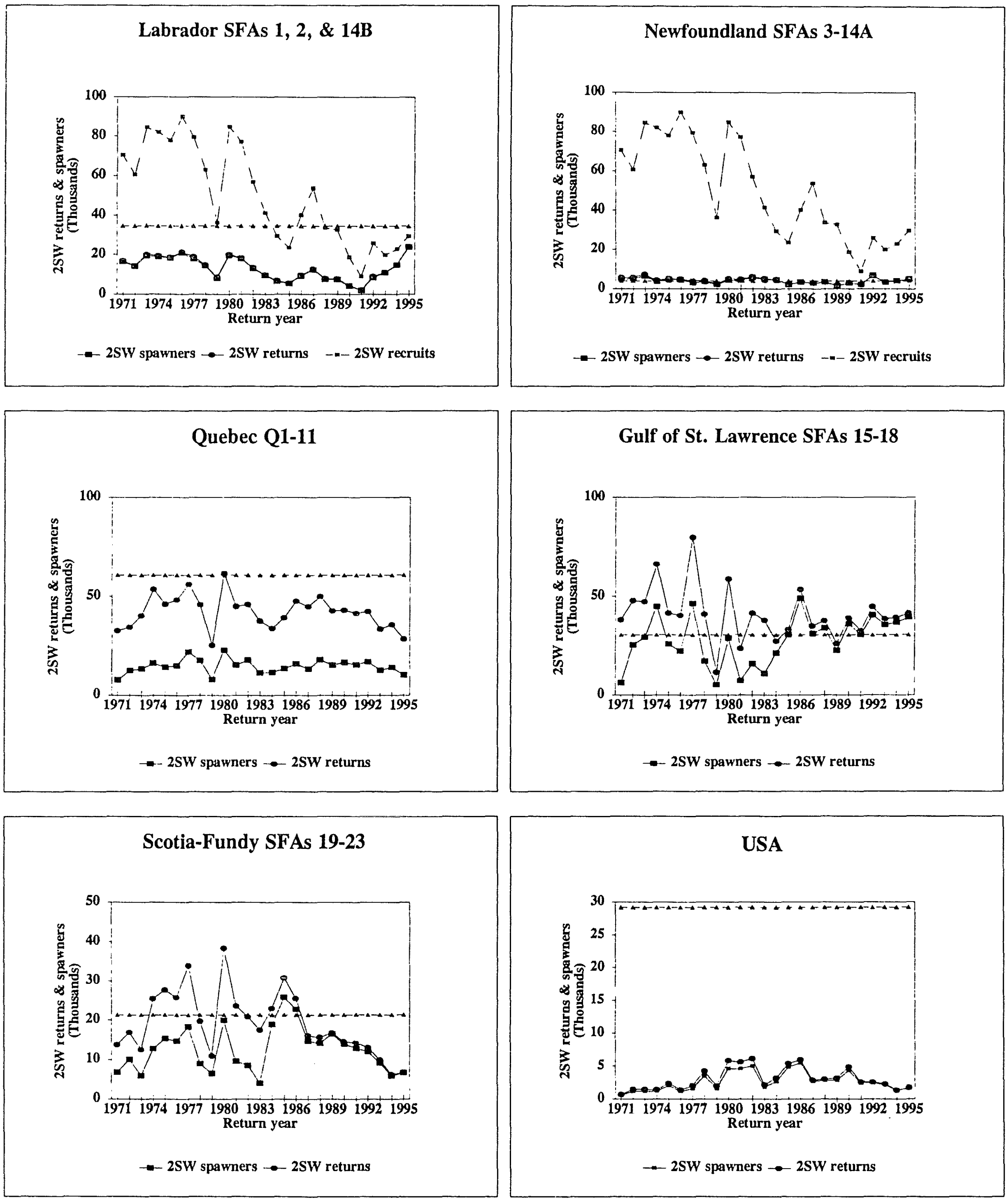
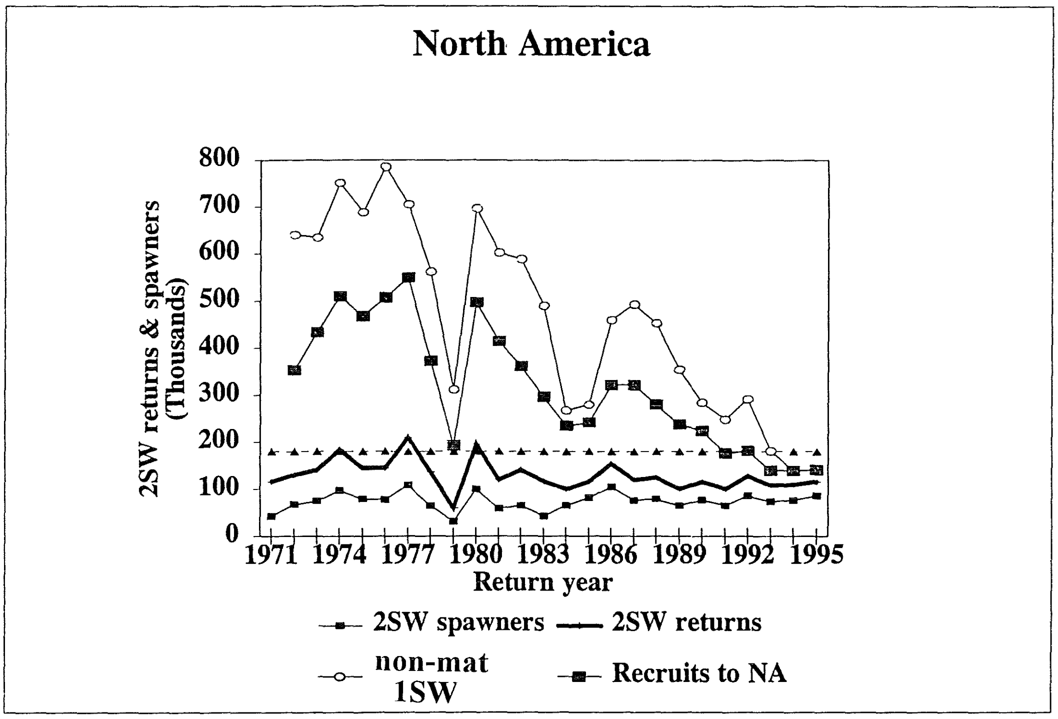


Figure 5.2.4.1 Top panel: comparison of estimated of potential 2SW production prior to all fisheries, 2SW recruits available to North America and 2SW returns and spawners for 1971-95. Triangles indicate the 2SW spawner target.
Bottom panel: comparison of potential maturing 1SW returns (solid line) and returns and 1SW spawners (squares) for 1971-95 return years.



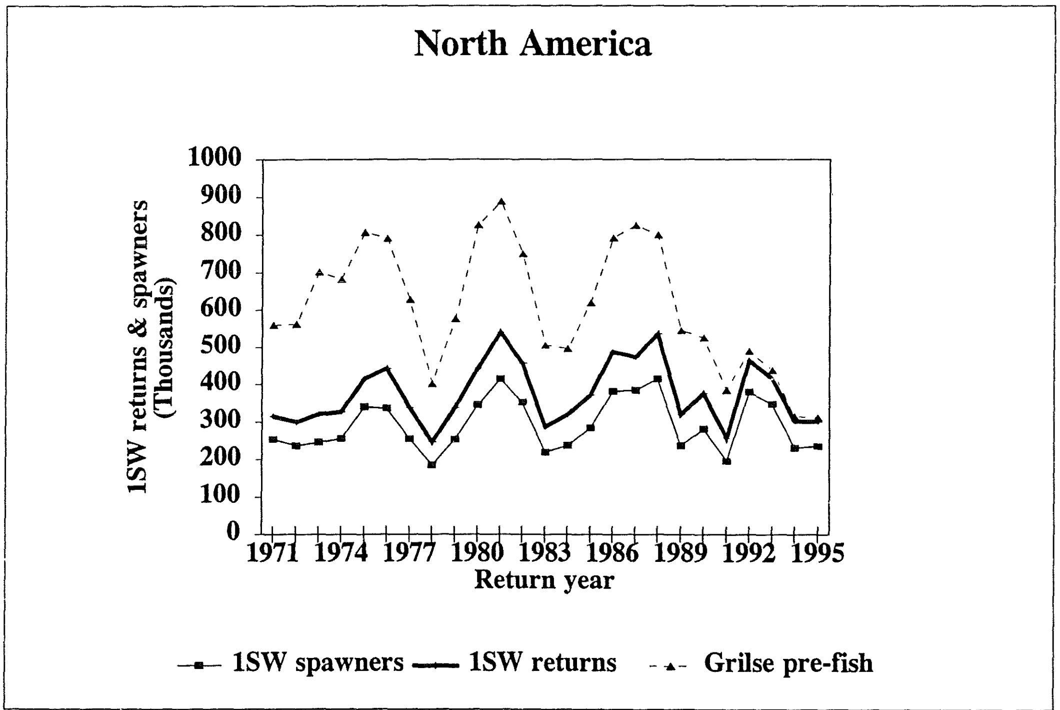


Figure 5.2.4.2 Pre-fishery abundance of maturing and non-maturing salmon in North America. (A) Total abundance and (B) proportion of the smolt class maturing after 1SW.

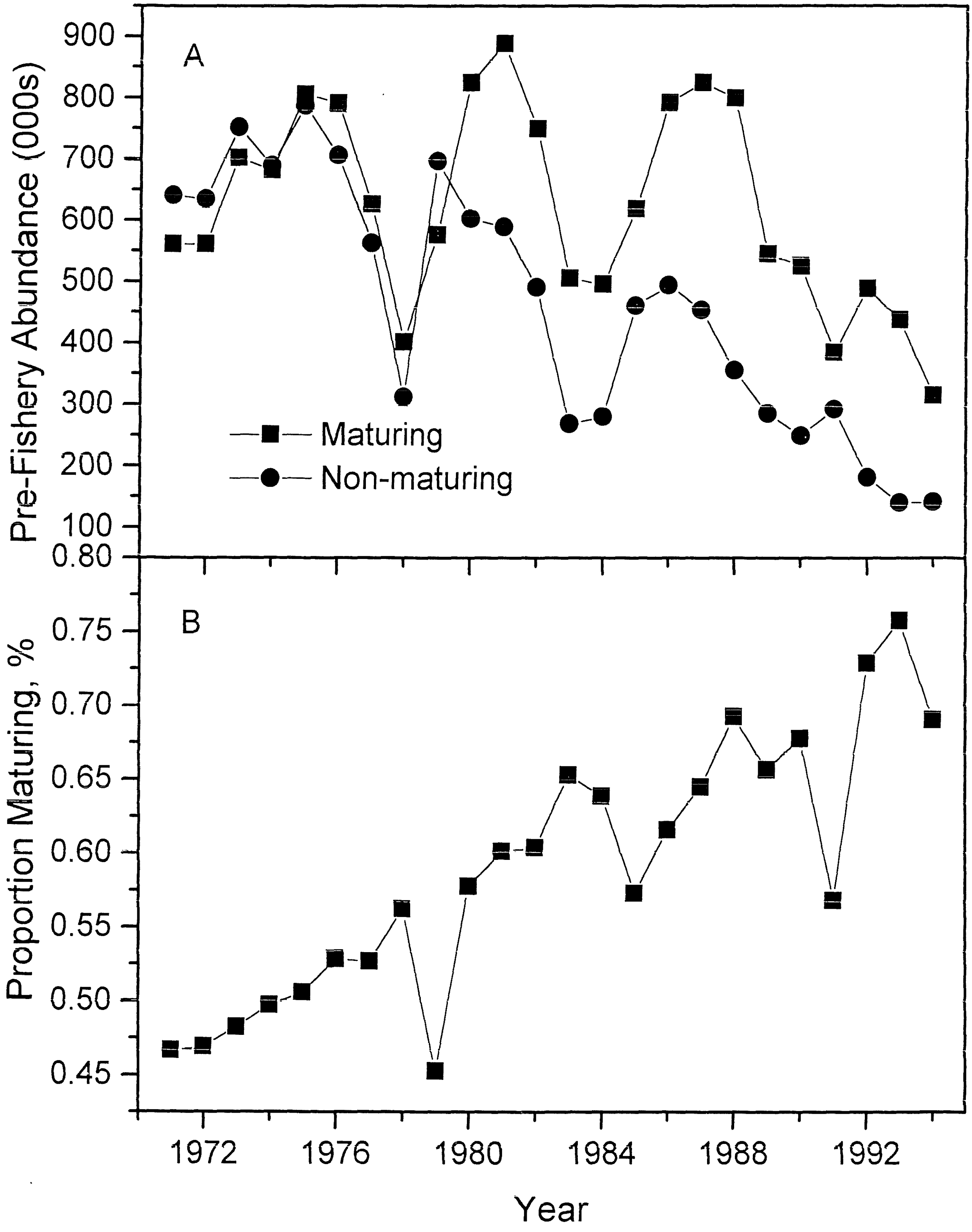


Figure 5.2.4.3 Total 1SW recruits (Maturing and non-maturing) originating in North America immediately prior to fisheries, 1971-1994.

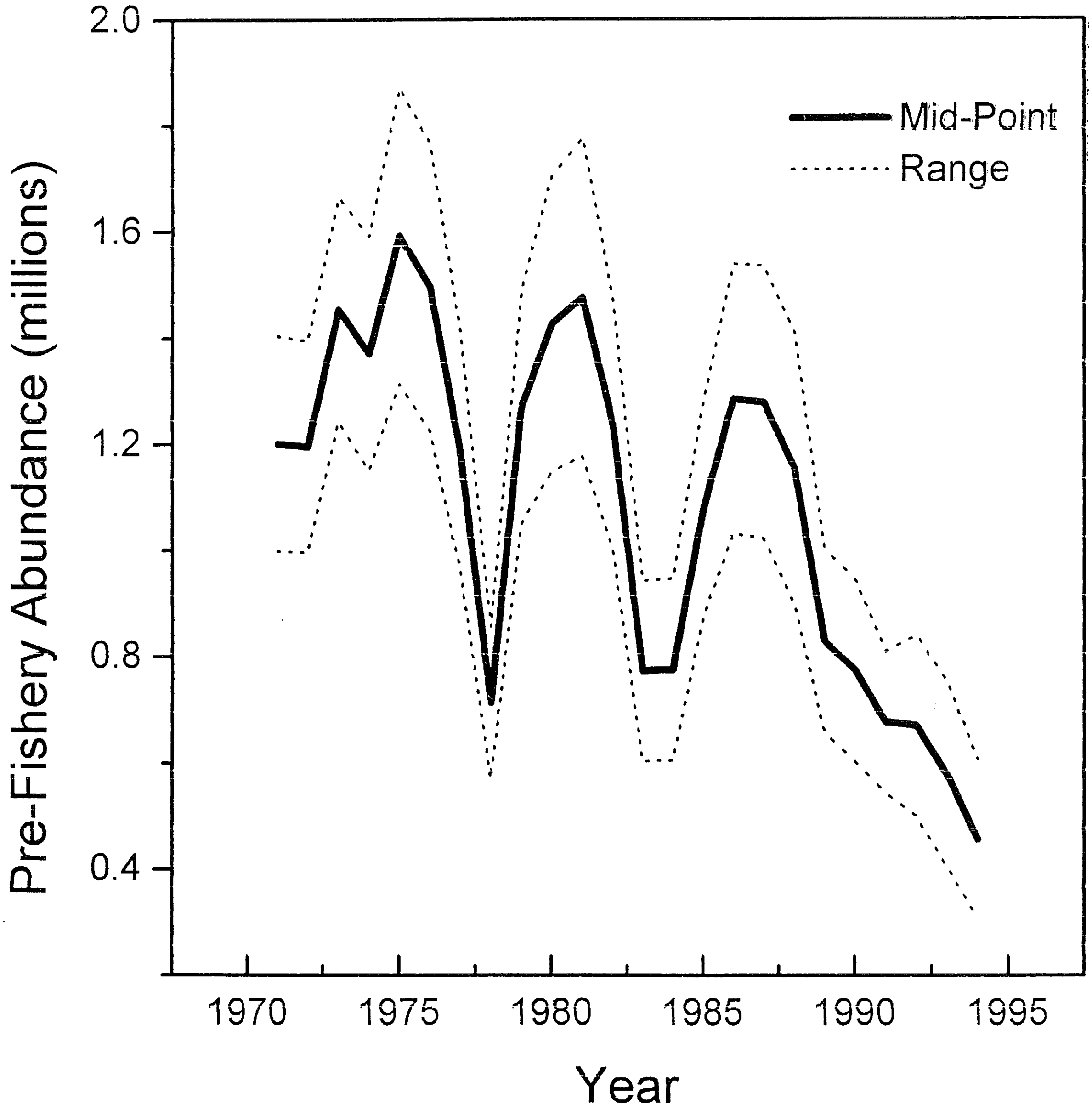


Figure 5.2.5.1. Egg depositions in 1995 relative to target in 73 rivers of eastern Canada.

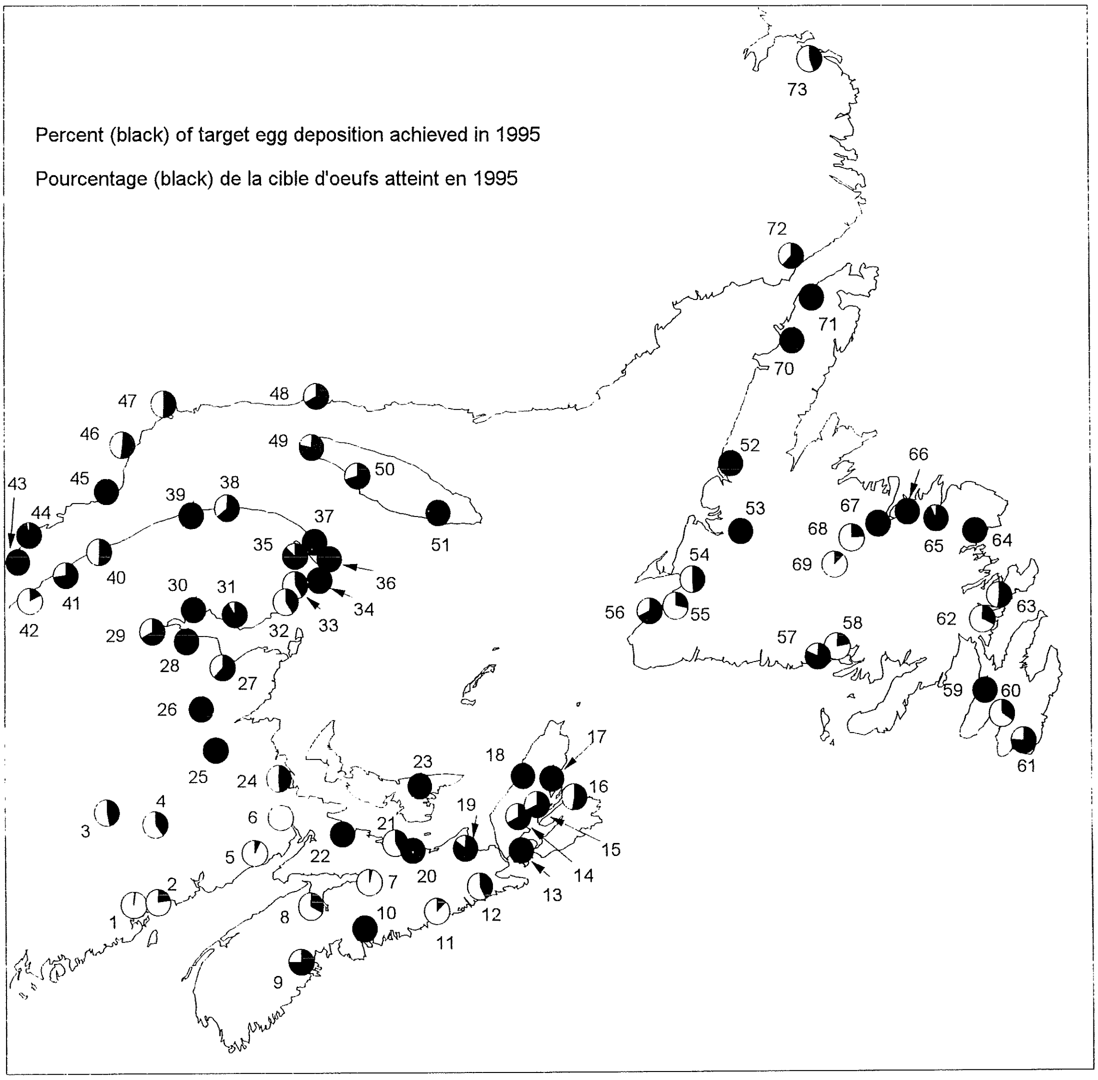


Figure 5.2.5.2. Proportion of egg deposition target attained in the rivers assessed in four geographic areas of eastern Canada, 1984 to 1995. The vertical line represents the range, the rectangle represents the interquartile range and the horizontal line is the median. The number above the range line indicates the number of rivers assessed in each year.

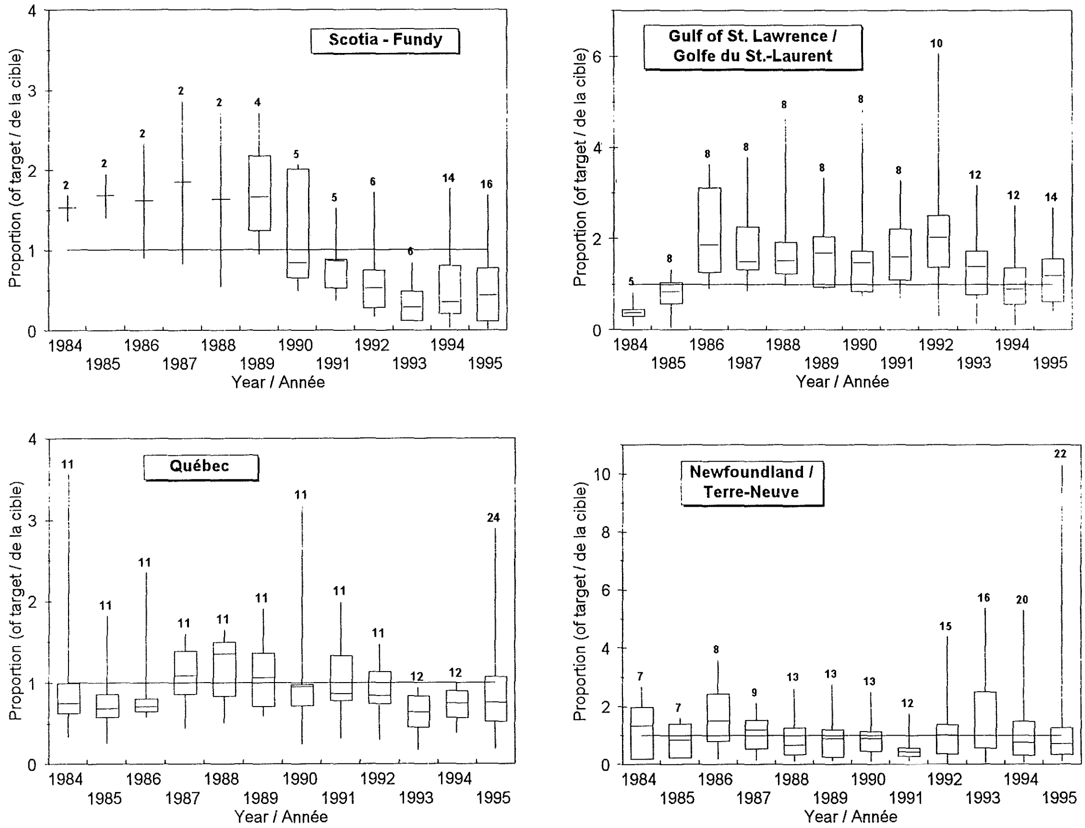


Fig 5.2.5.3 Number of Atlantic salmon stocked in USA rivers.

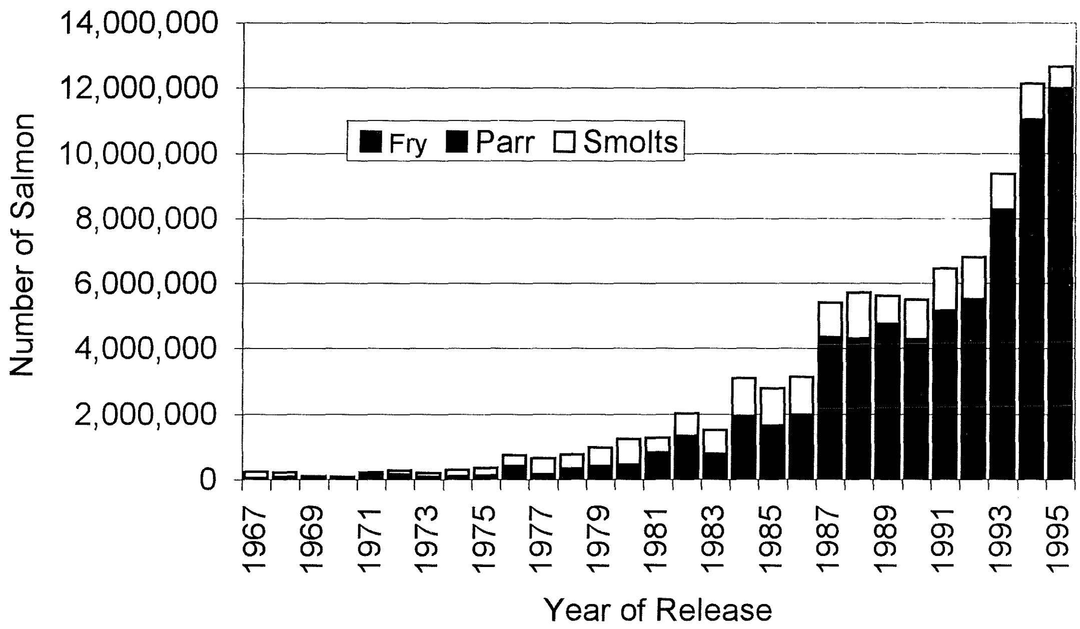


Fig 5.2.5.4 Atlantic salmon returns to USA rivers.

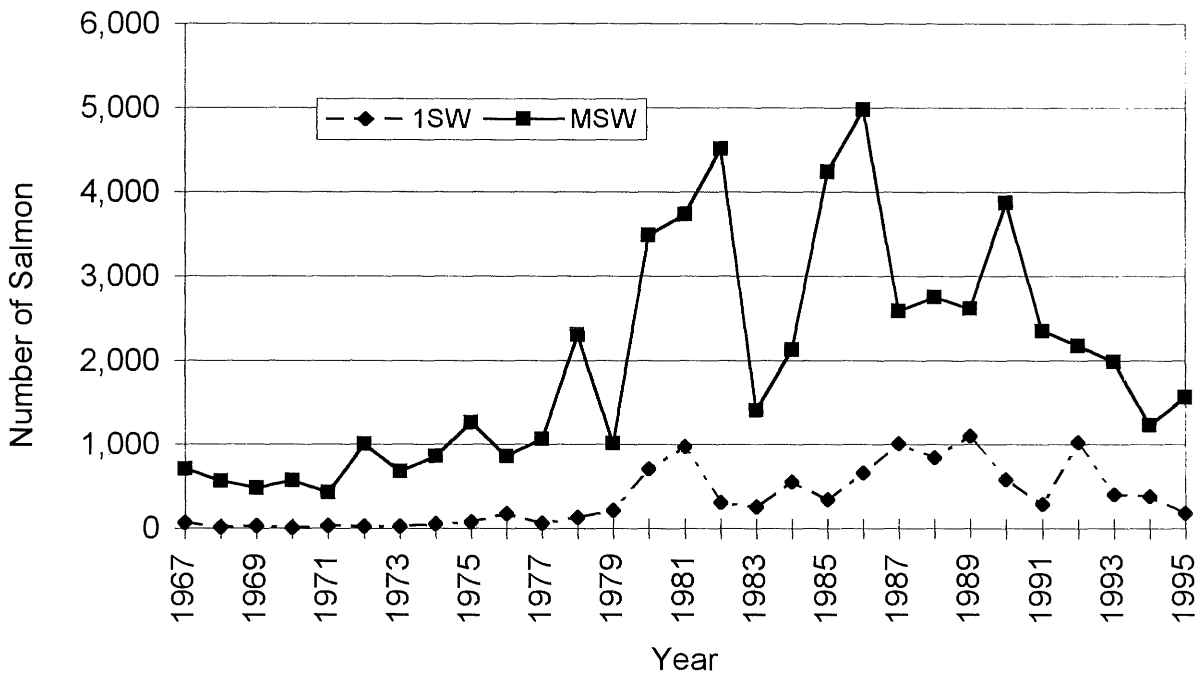


Figure 5.2.6.1 Trends in survival rates of hatchery (Saint John, LaHave, and Liscomb rivers) and wild smolts to 1SW and the entire cohort returns in river to eastern Canada. Year refers to the year of smolt migration.

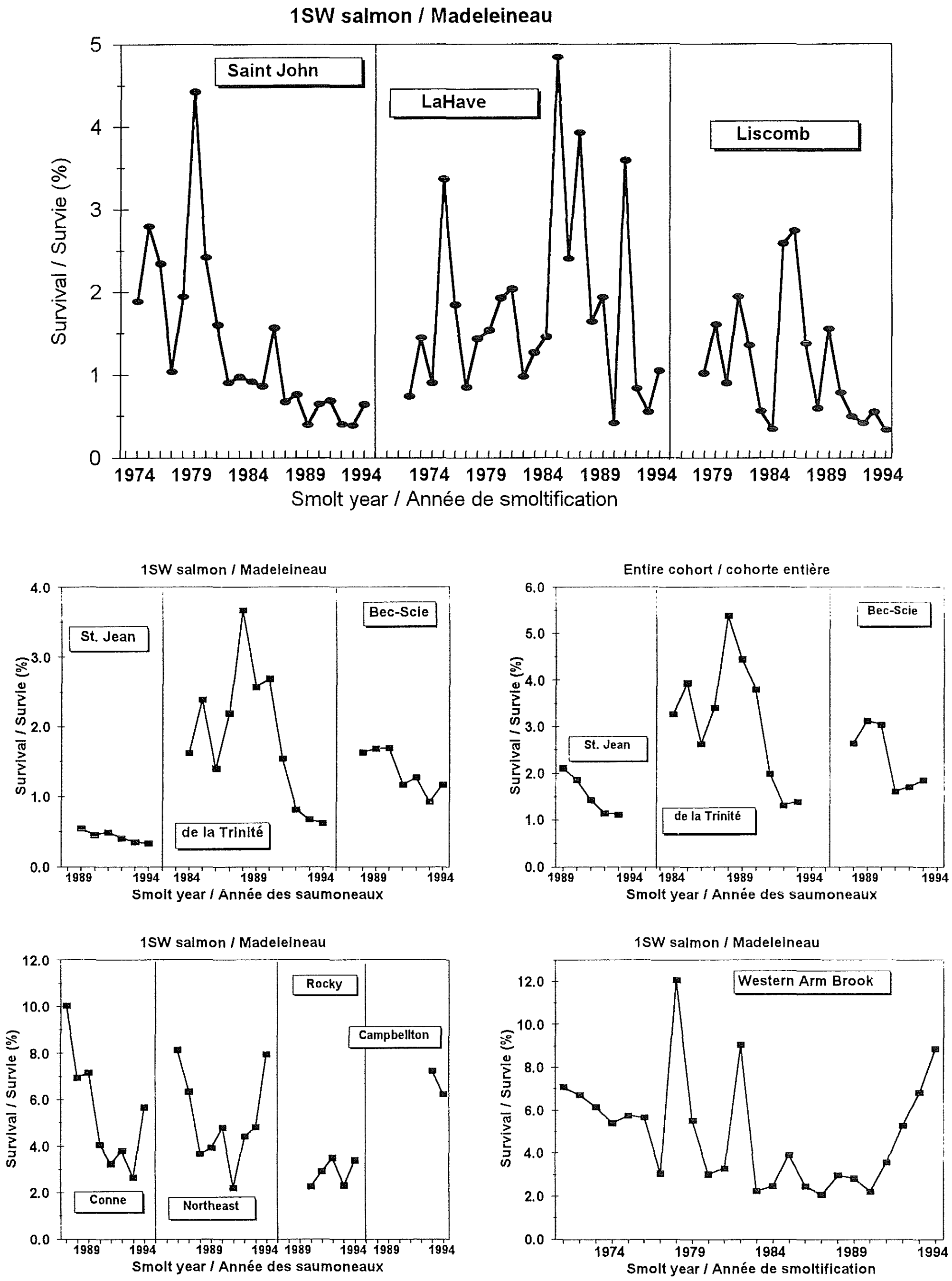


Fig 5.2.6.2 Marine survival of hatchery-reared Atlantic salmon smolts released into the Penobscot River, Maine, USA.

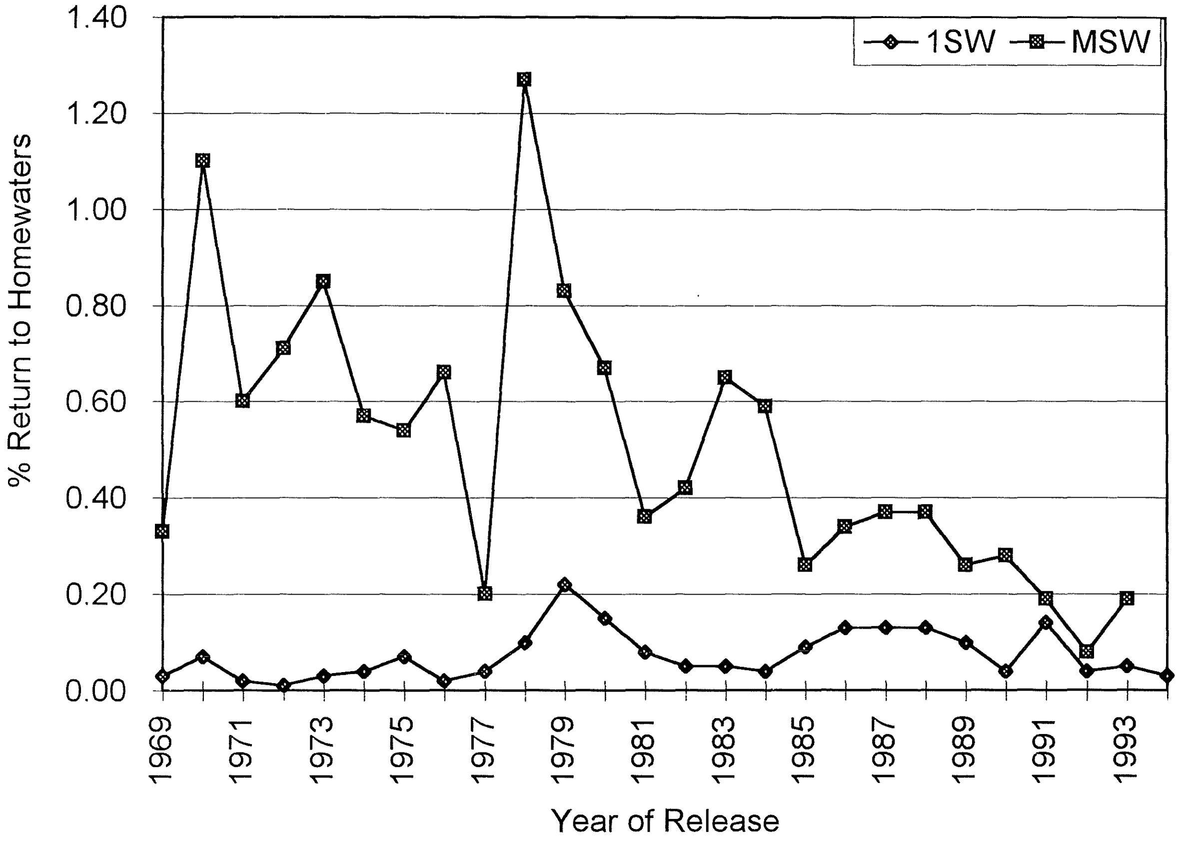


Figure 6.1.5.1 Probability histogram of (A) Penobscot stock harvest in Greenland, 1993, and (B) local consumption harvest in Greenland, 1993.

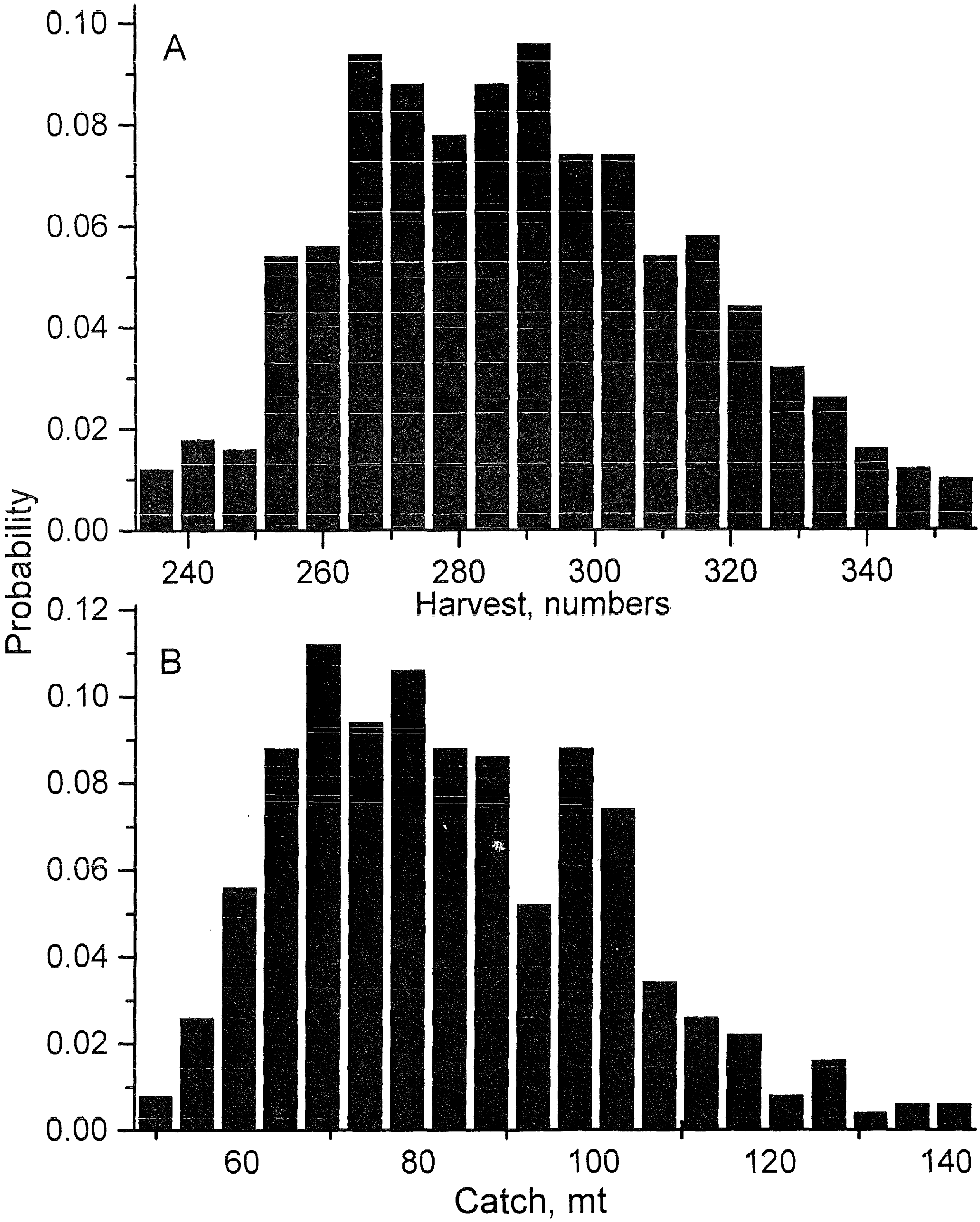


Figure 7.4.1. Strontium:calcium ratio versus standardized position for two immature North American 1SW salmon (A) and two immature European 1SW salmon (B). Vertical line marks the average length of standardized transects of a sample of smolts.

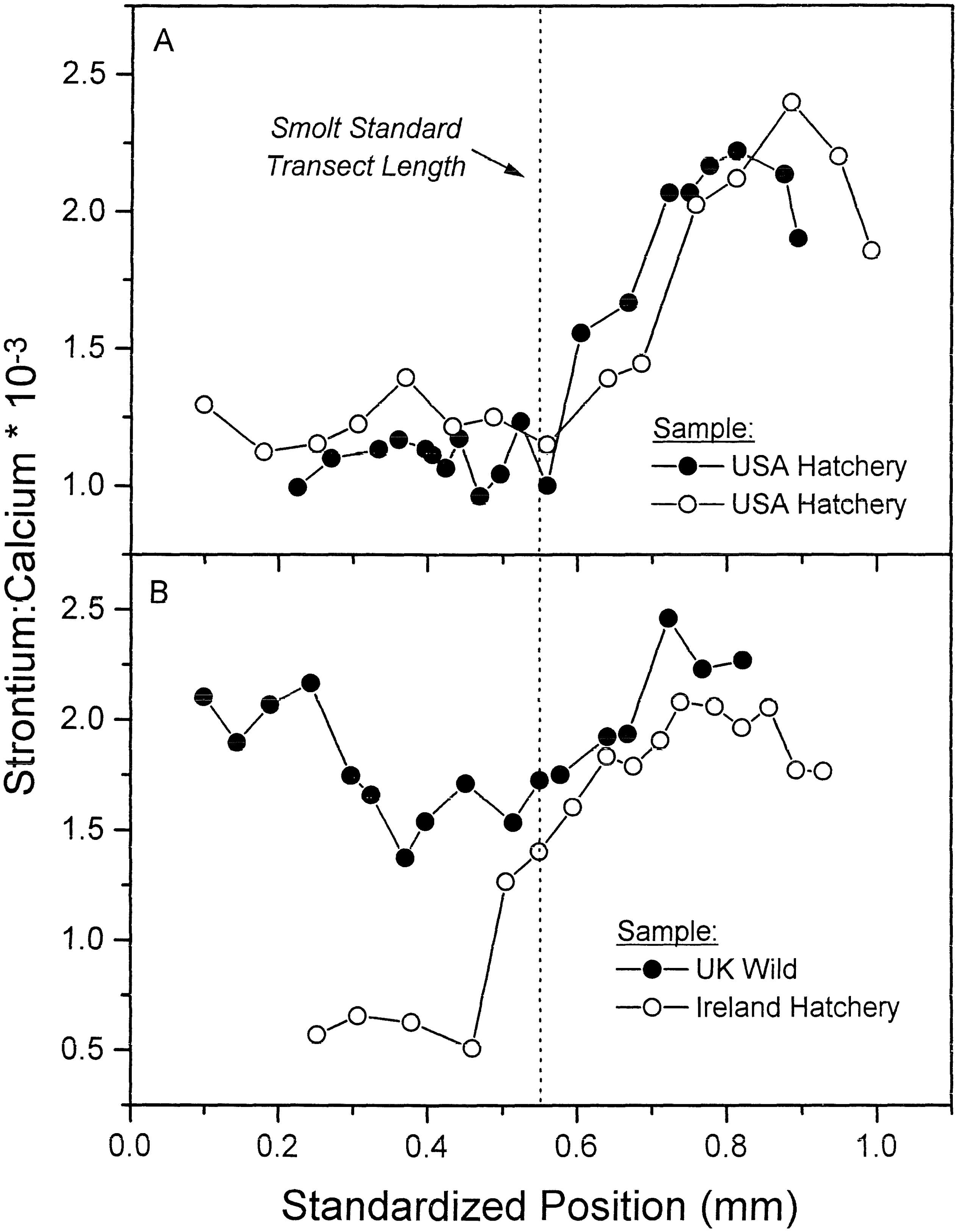


Figure 9.1.2.1 Estimates of probability of achieving target number of female salmon with a given release of fish to the river. (Assuming sex ratio 80% female)

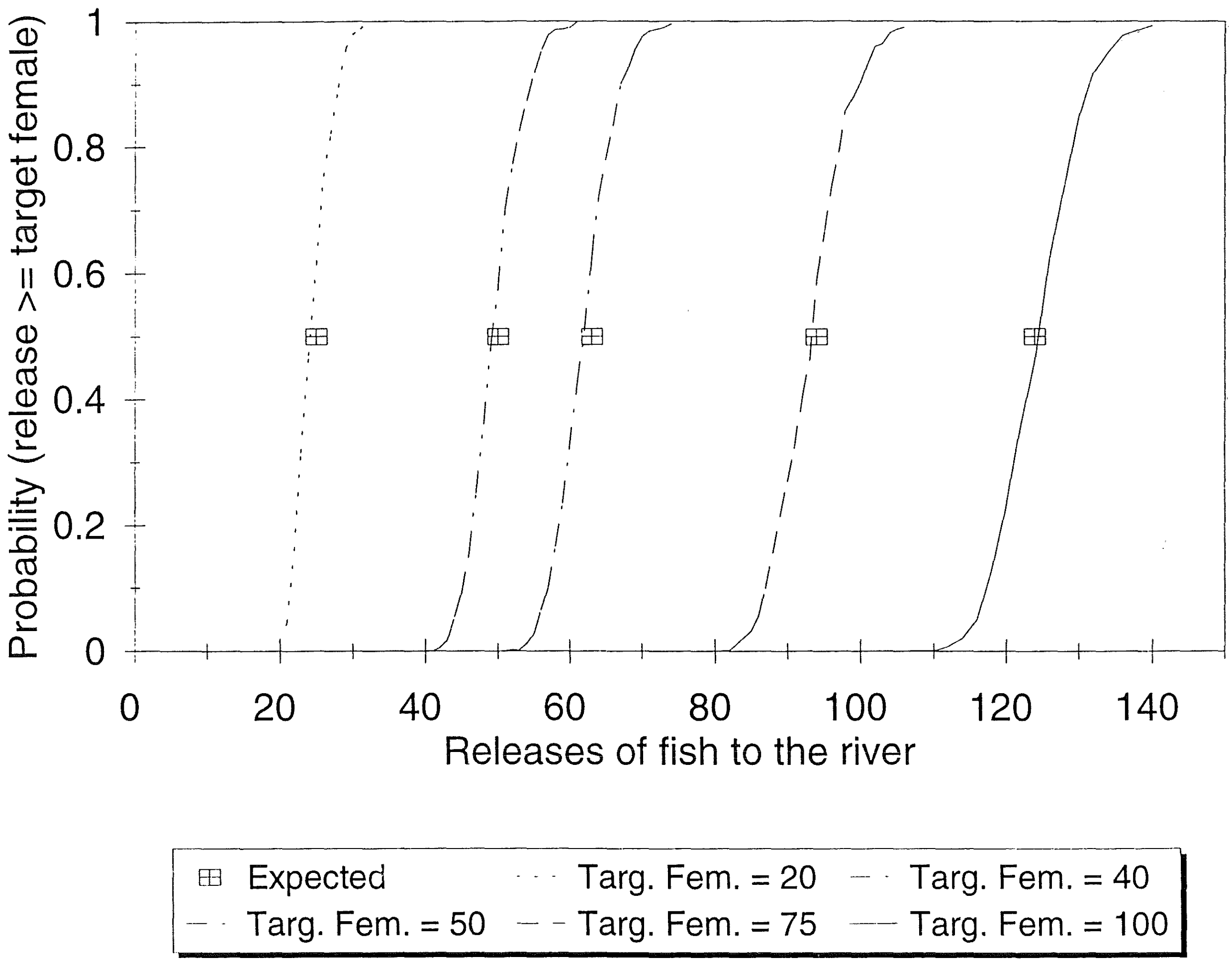


Figure 9.1.2.1

Figure 9.1.2.2 Estimates of the amount the escapement target would have to be raised by to have a given probability (0.5, 0.75, 0.9 & 0.95) of meeting female spawner requirements within different total spawning targets (Assuming 80% females).

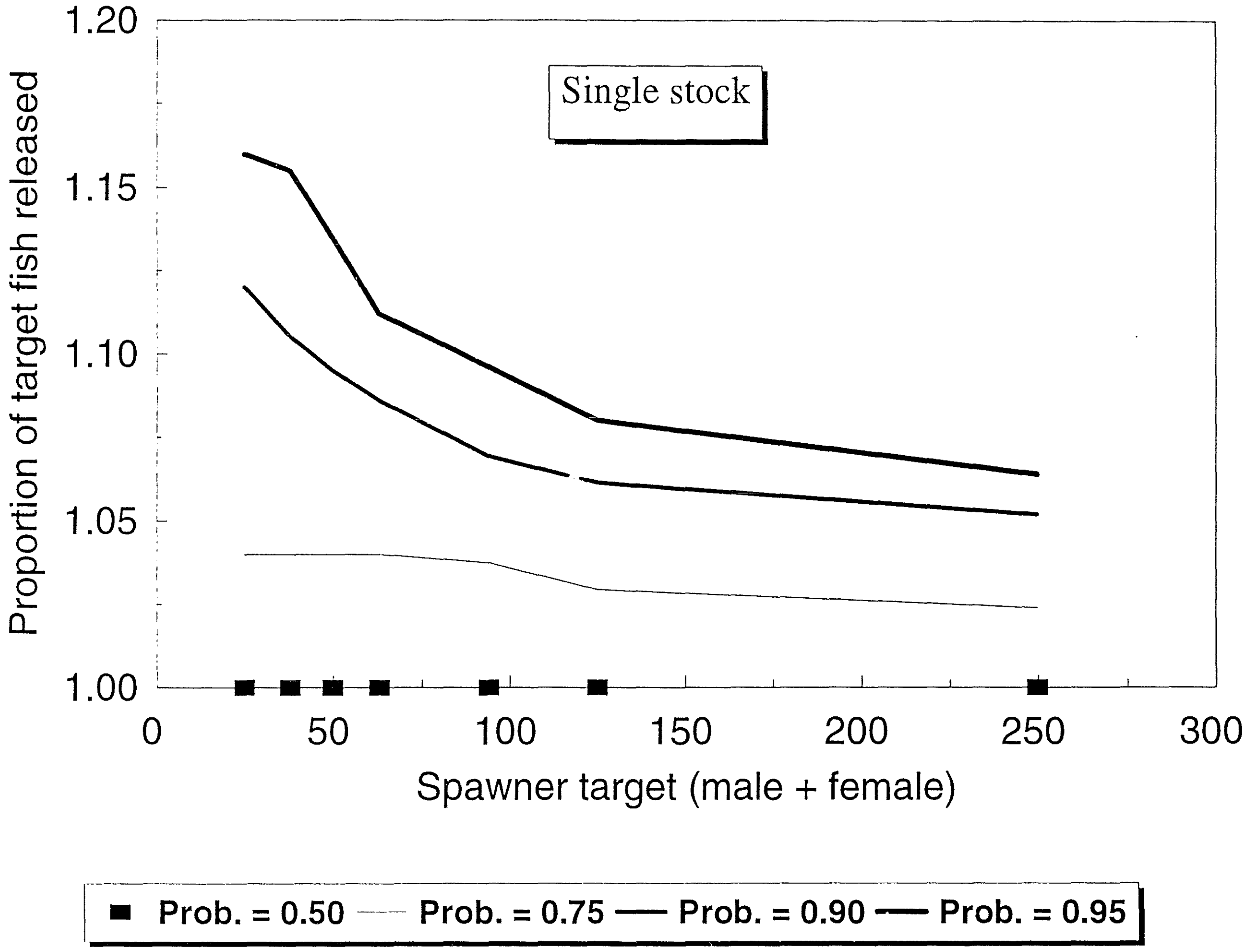


Figure 9.1.2.2

Figure 9.1.2.3 Estimates of the probability of achieving the target number of female salmon in one, two or three sub-stocks with a given release of fish to the river.

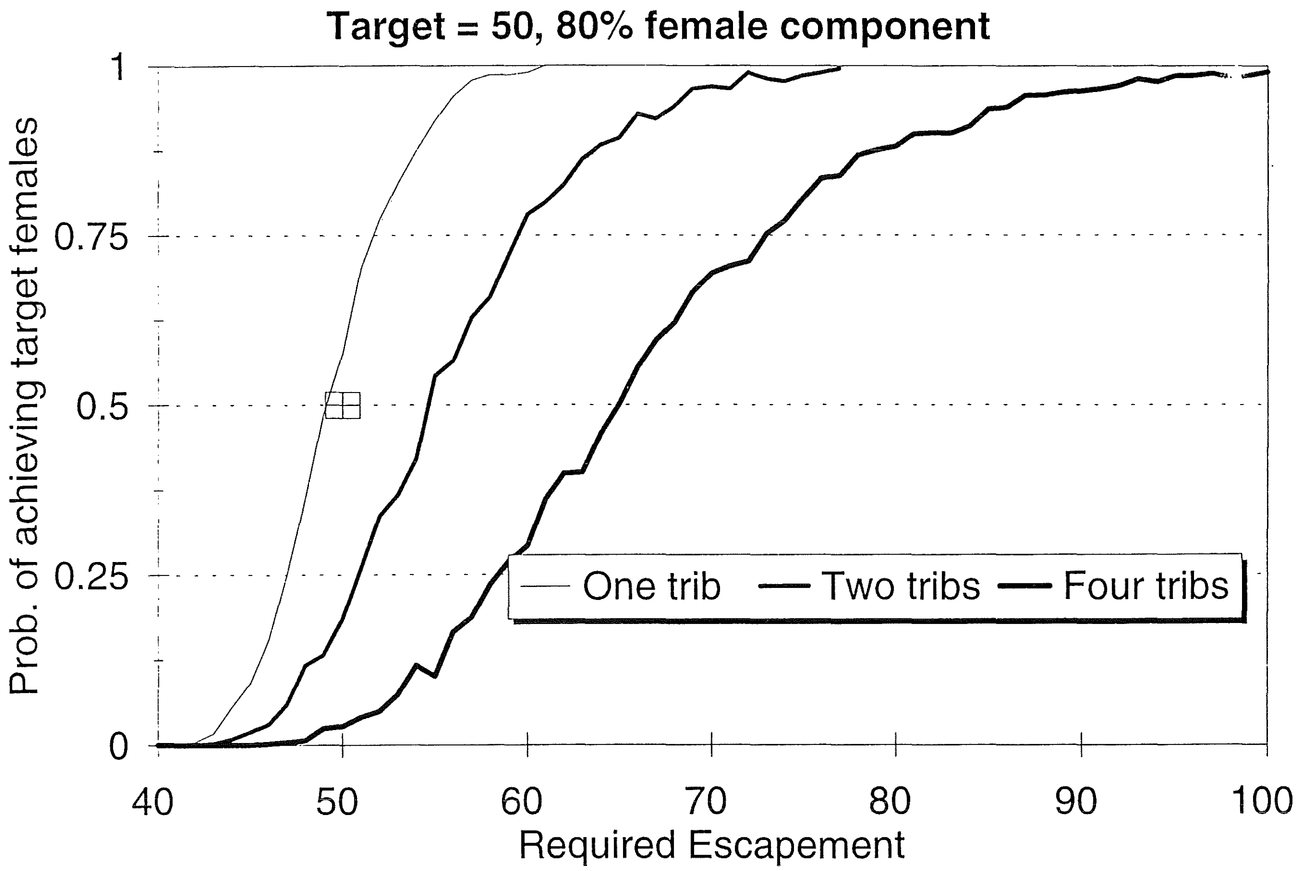


Figure 9.1.2.3

Figure 9.1.2.4 Estimates of the amount the escapement target would have to be raised by to have a given probability (0.5, 0.75, 0.9 & 0.95) of meeting female spawner requirements within different total spawning targets in four sub-stocks (Assuming 80% females).

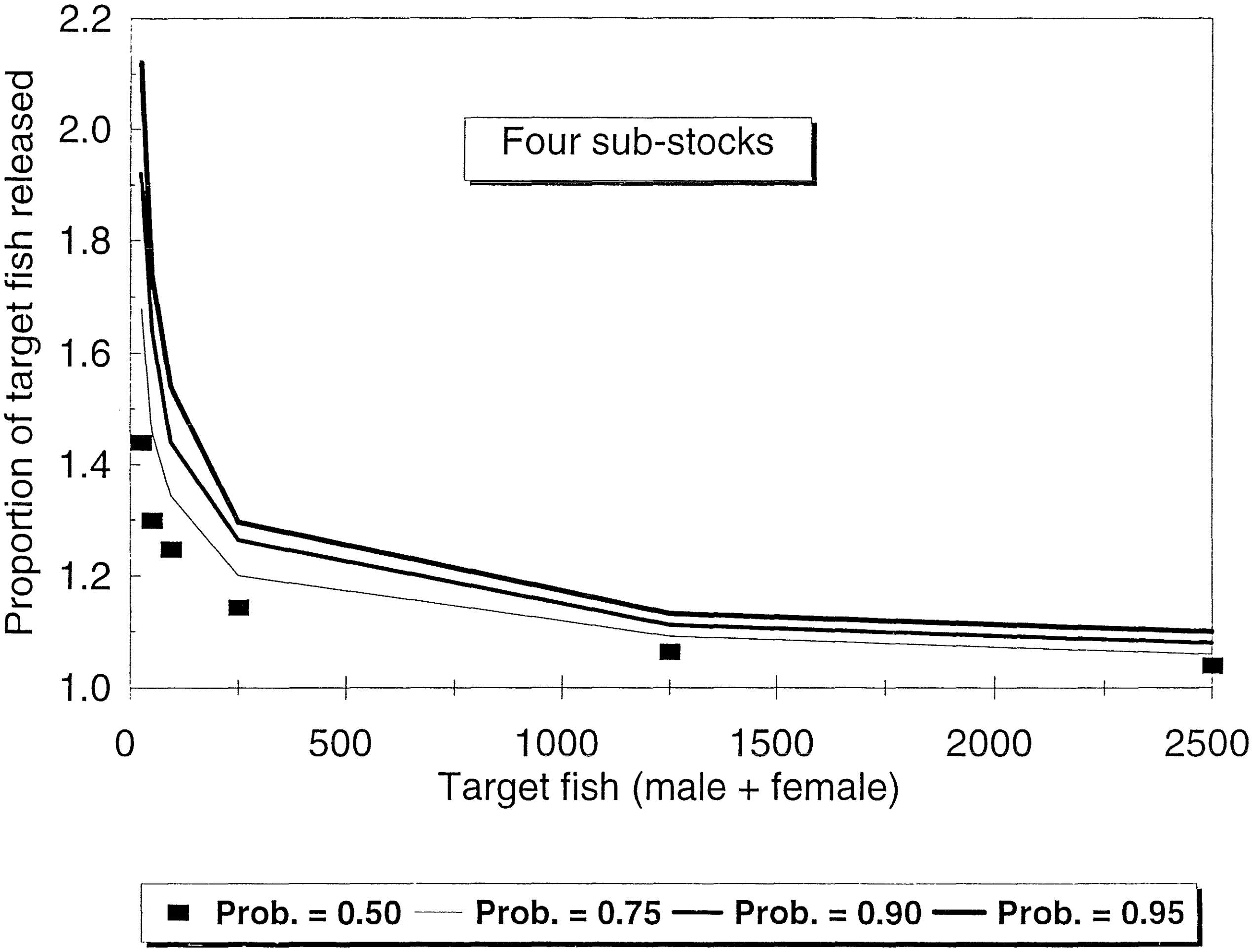


Figure 9.1.2.4

Figure 9.1.2.5 Estimaates of probability of achieving target numbers of female salmon in Canadian 2SW spawning escapements if they are treated at 1, 6 or 24 stocks. (Assuming sex ratio 80% female).

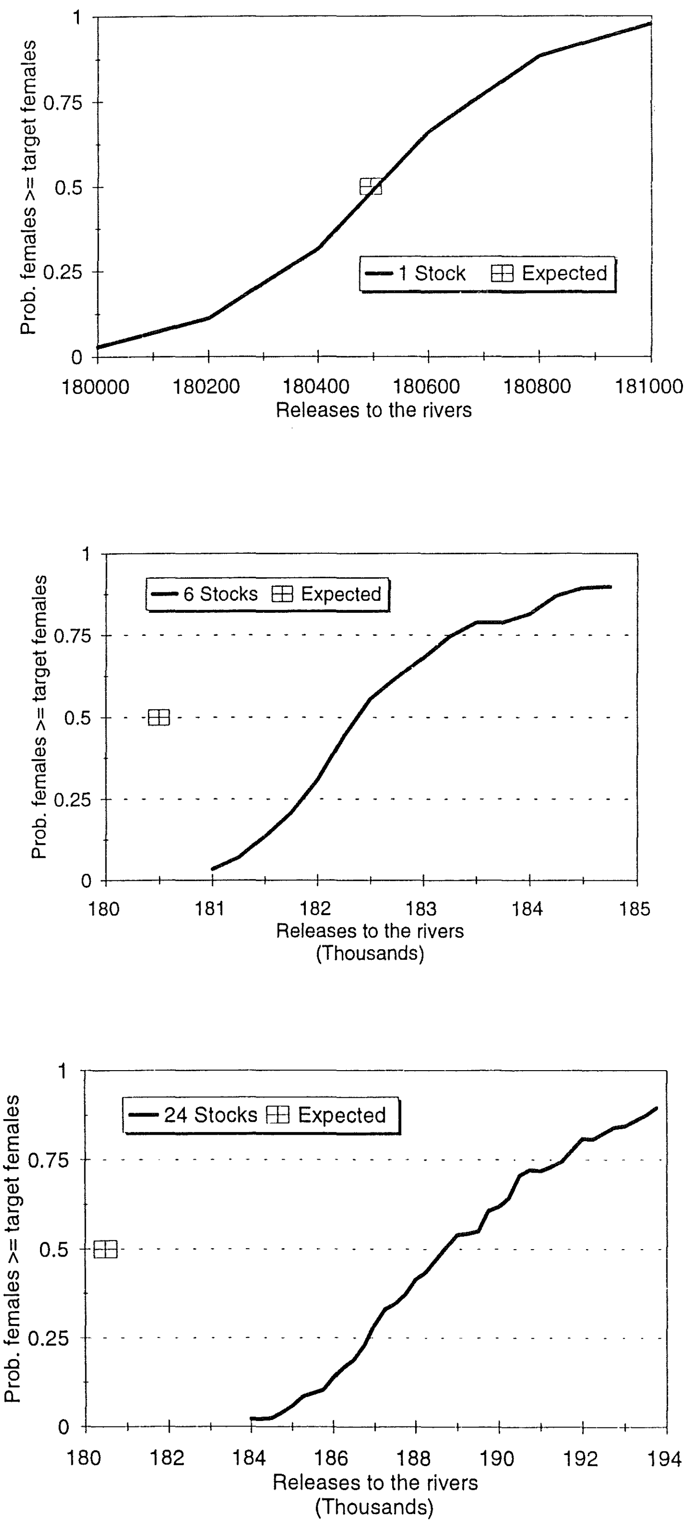


Figure 9.1.2.5

Figure 9.2.1.1. Thermal habitat versus year in January, February, and March (H123) and February (H2), inset: scatterplot of H2 and H123.

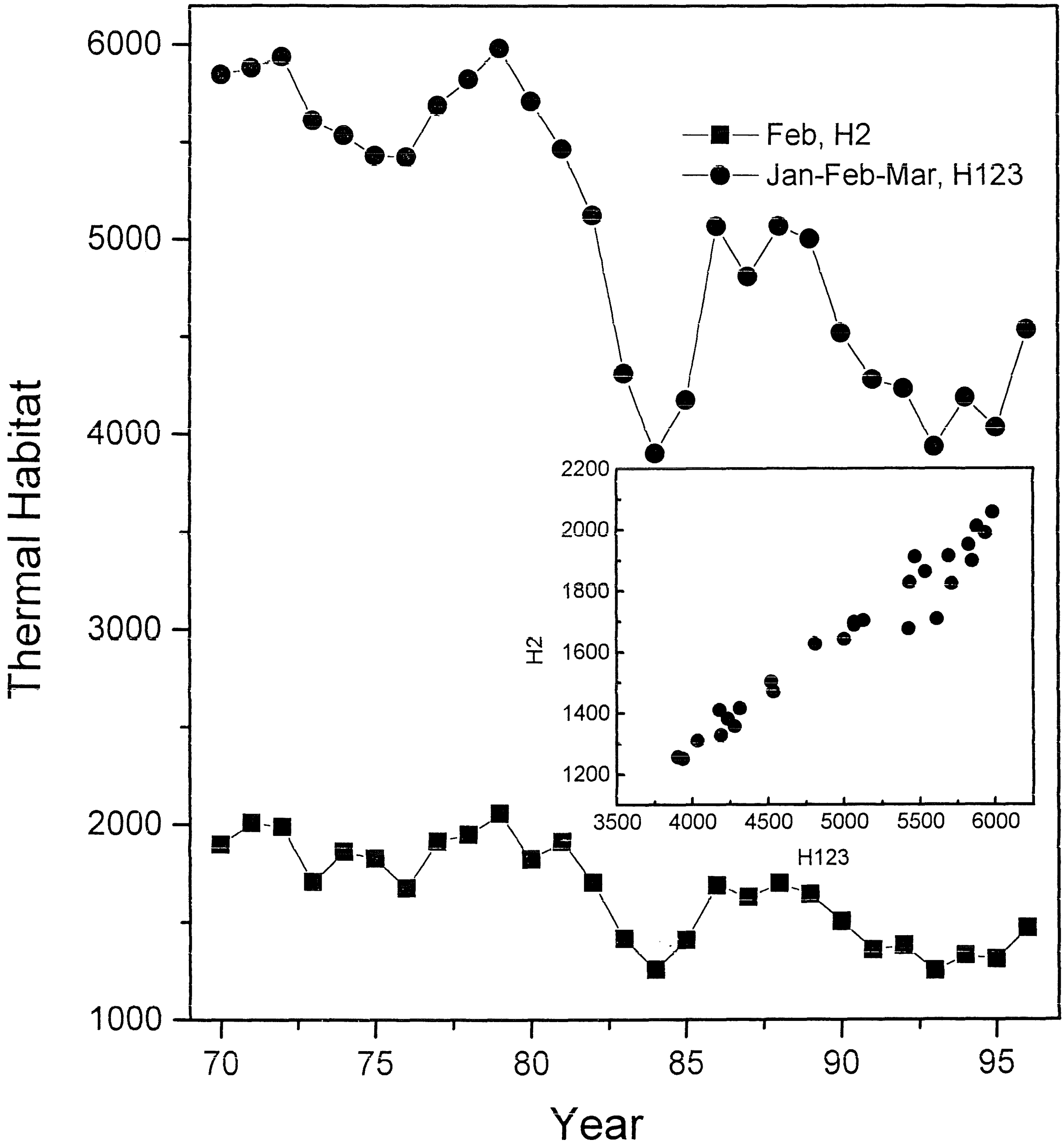


Figure 9.2.2.1. Residual for pre-fishery abundance prediction models. H123 refers to single variable model using January, Febuary, and March thermal habitat index. H2-SNLQ refers to two variable model using February thermal habitat and lagged spawner index. Inset: residuals in recent years.

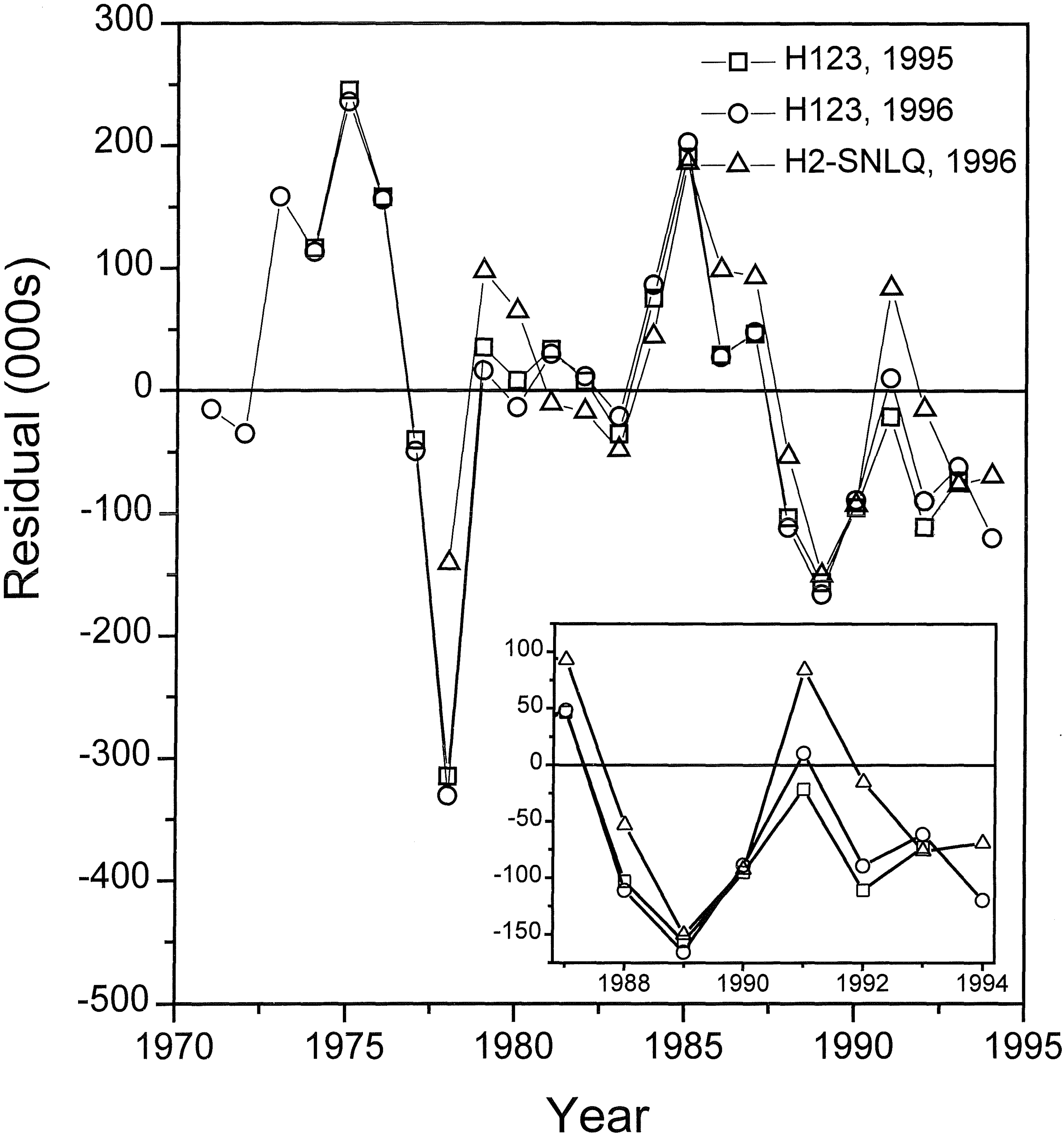


Figure 9.2.2.2. Observed versus predicted pre-fishery abundance from prediction models. (A) H123 single variable model using January, Febuary, and March thermal habitat index. (B) H2-SNLQ two variable model using February thermal habitat and lagged spawner index.

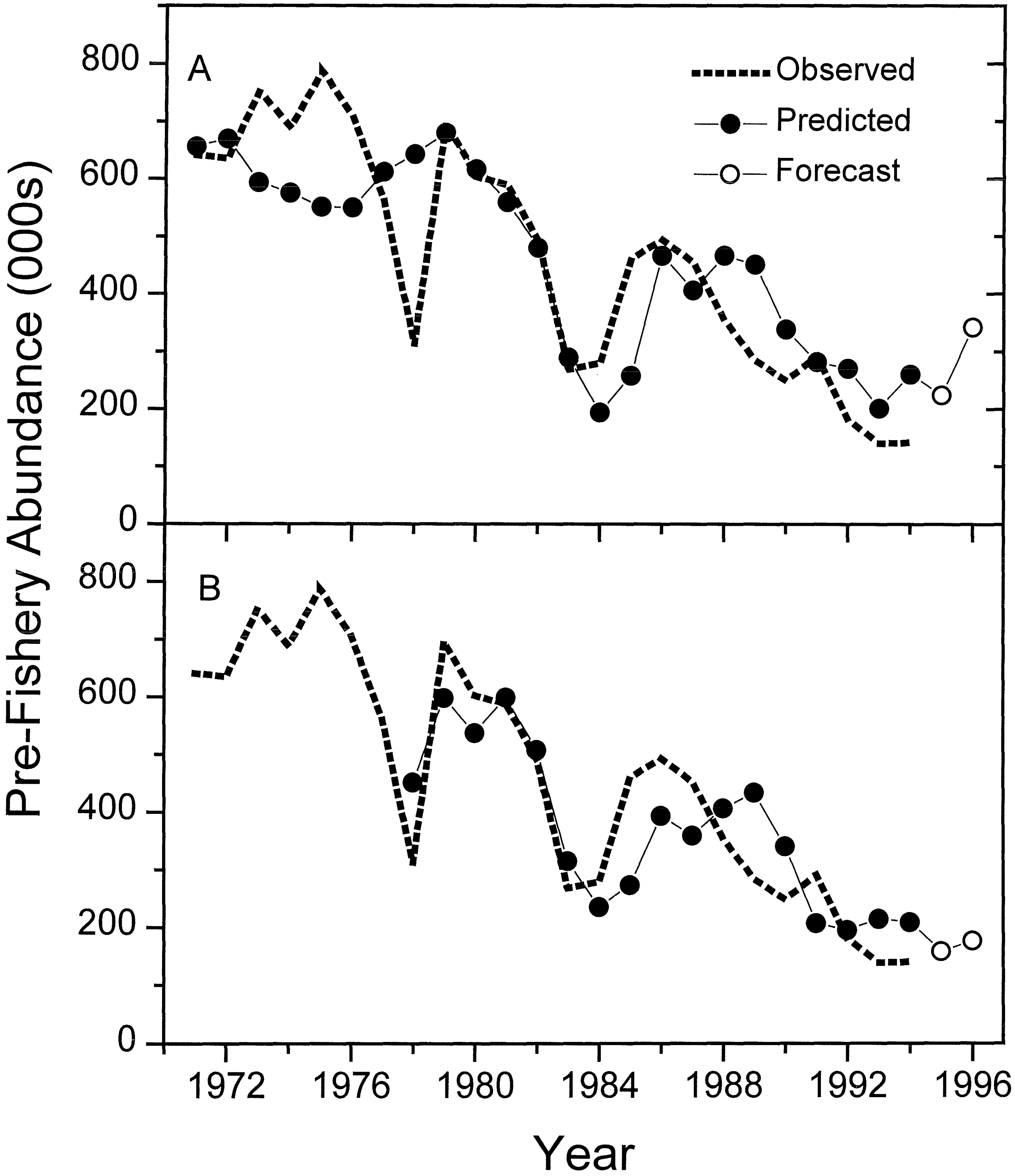


Figure 9.2.2.3. Residual versus pre-fishery abundance. (A) H123 single variable model using January, Febuary, and March thermal habitat index. (B) H2-SNLQ two variable model using February thermal habitat and lagged spawner index.

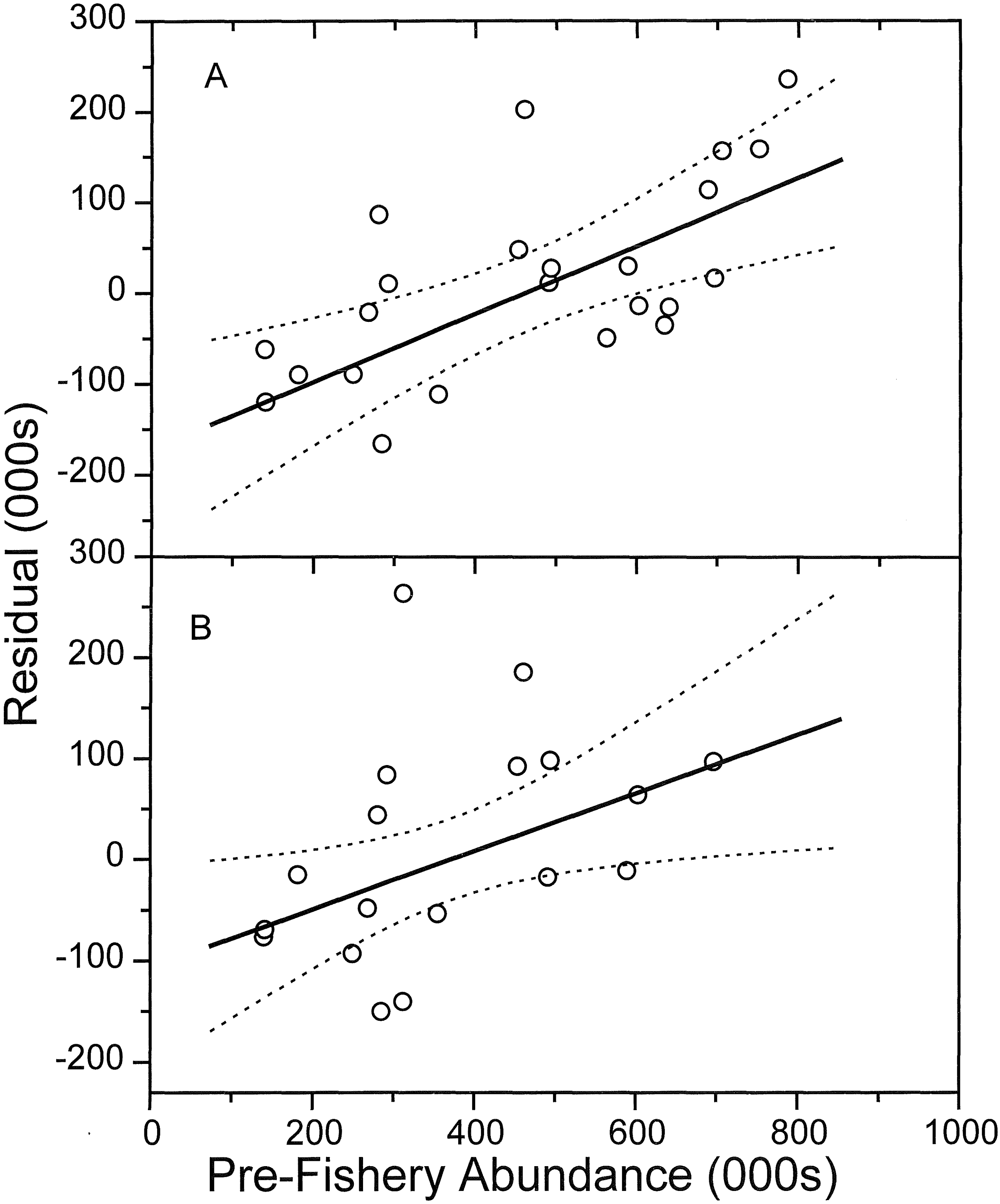


Figure 9.2.4.1 Estimated total 2SW spawning escapement required to have a given probability of meeting the female spawner targets in 5 stocks in Canada.

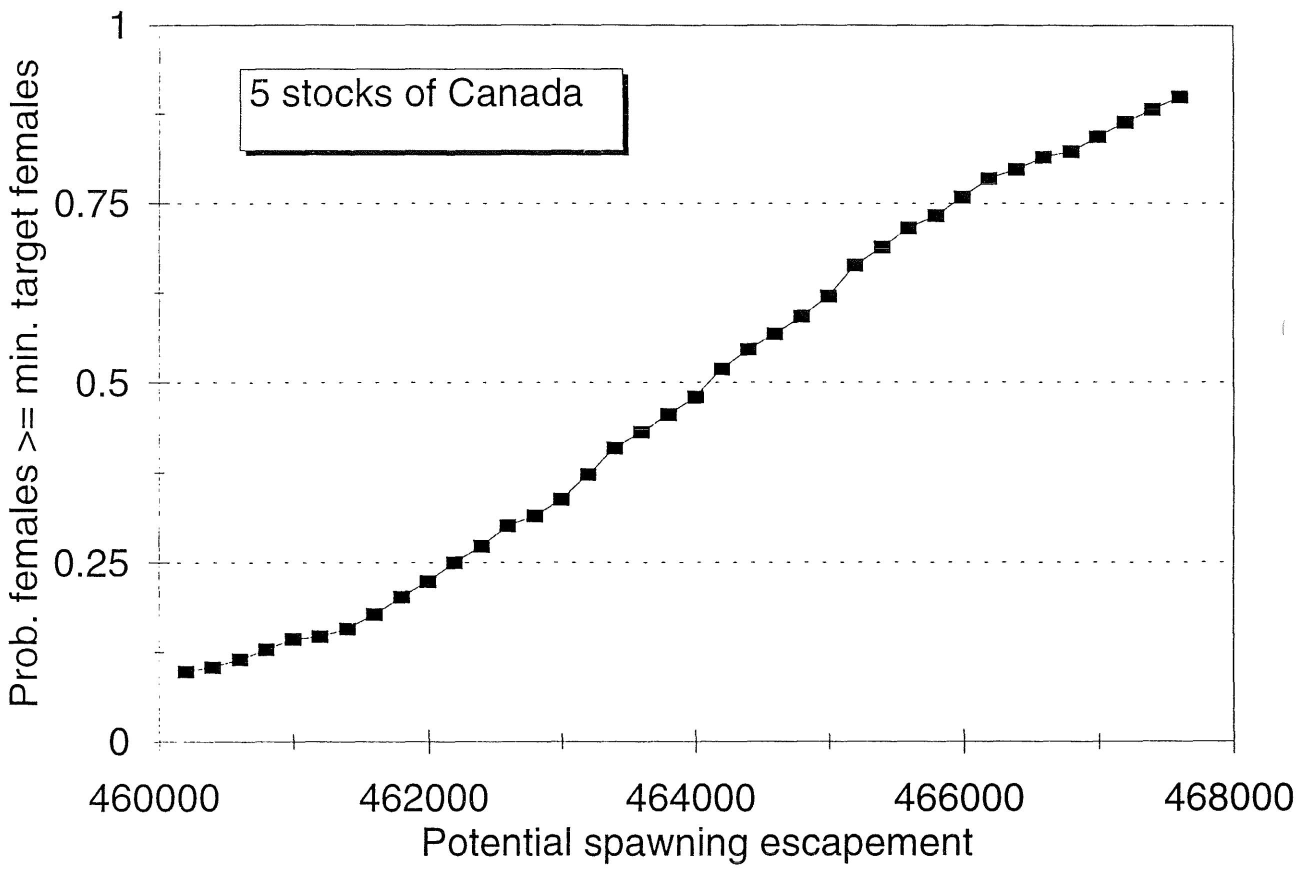


Figure 9.2.4.1

Figure 10.1.2.1 Spawning targets and catch advice in France.

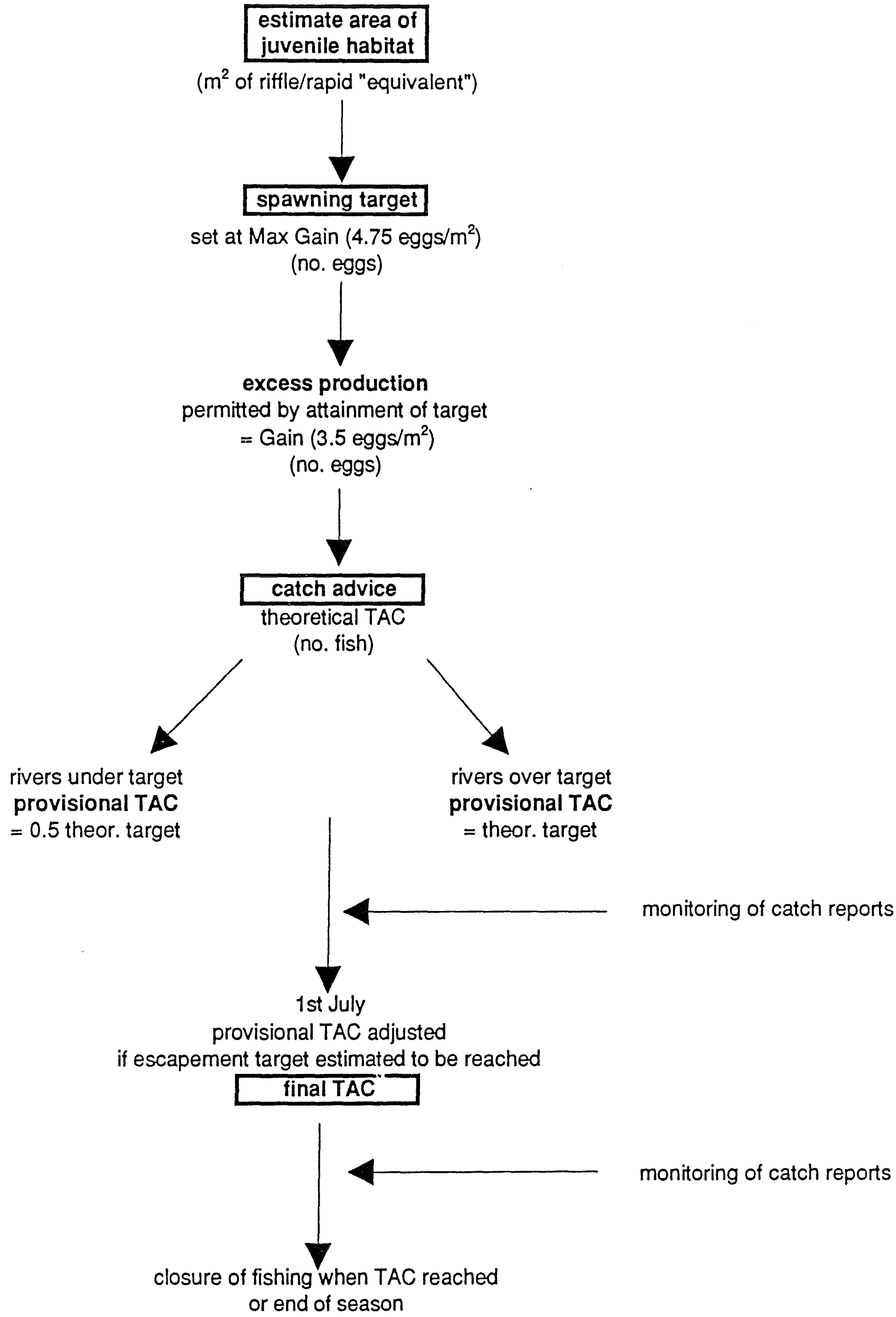


Figure 10.2.1.1 Maximum and minimum estimates of recruitment of maturing 1SW salmon in the North-East Atlantic Commission Area

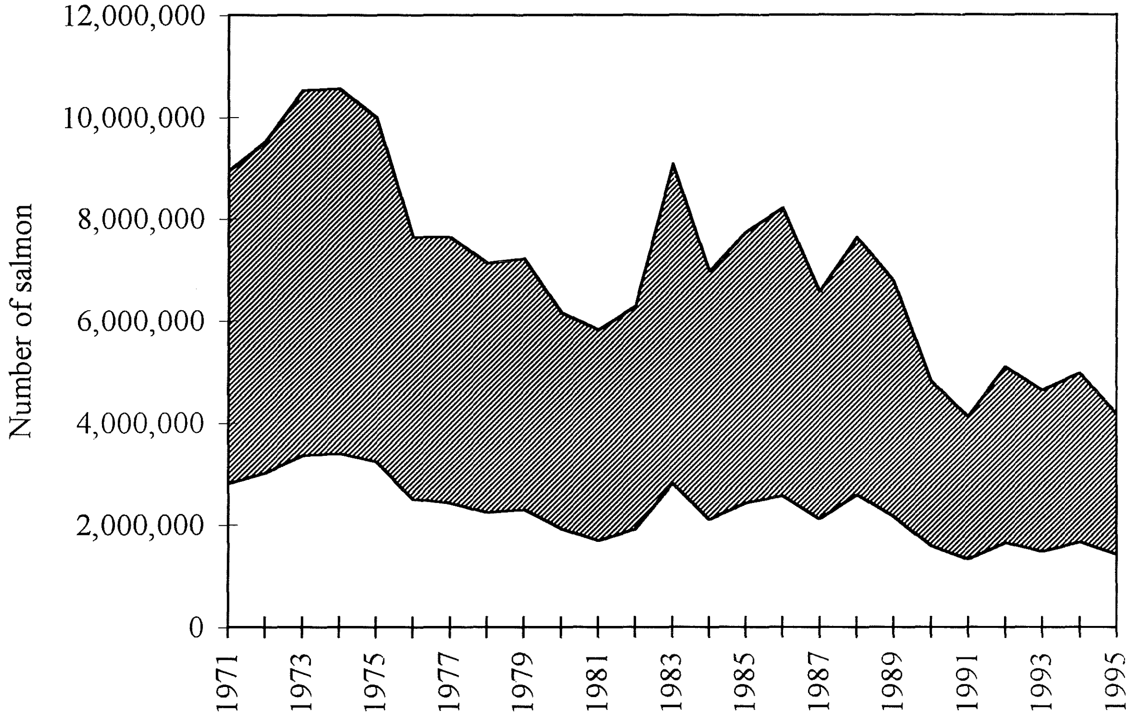


Figure 10.2.1.2 Maximum and minimum estimates of recruitment of non-maturing 1SW salmon in the North-East Atlantic Commission Area

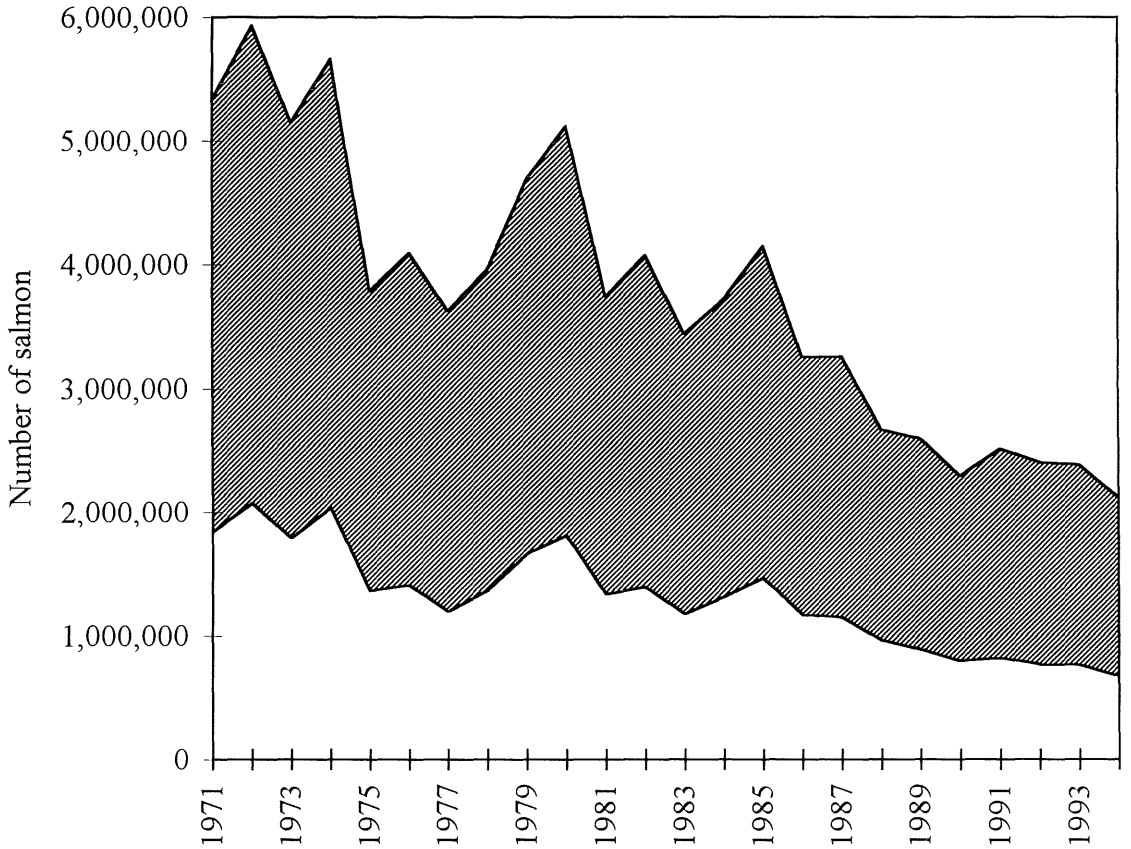


Figure 10.2.1.3 Maximum and minimum estimates of recruitment of maturing 1SW salmon in Southern European countries.

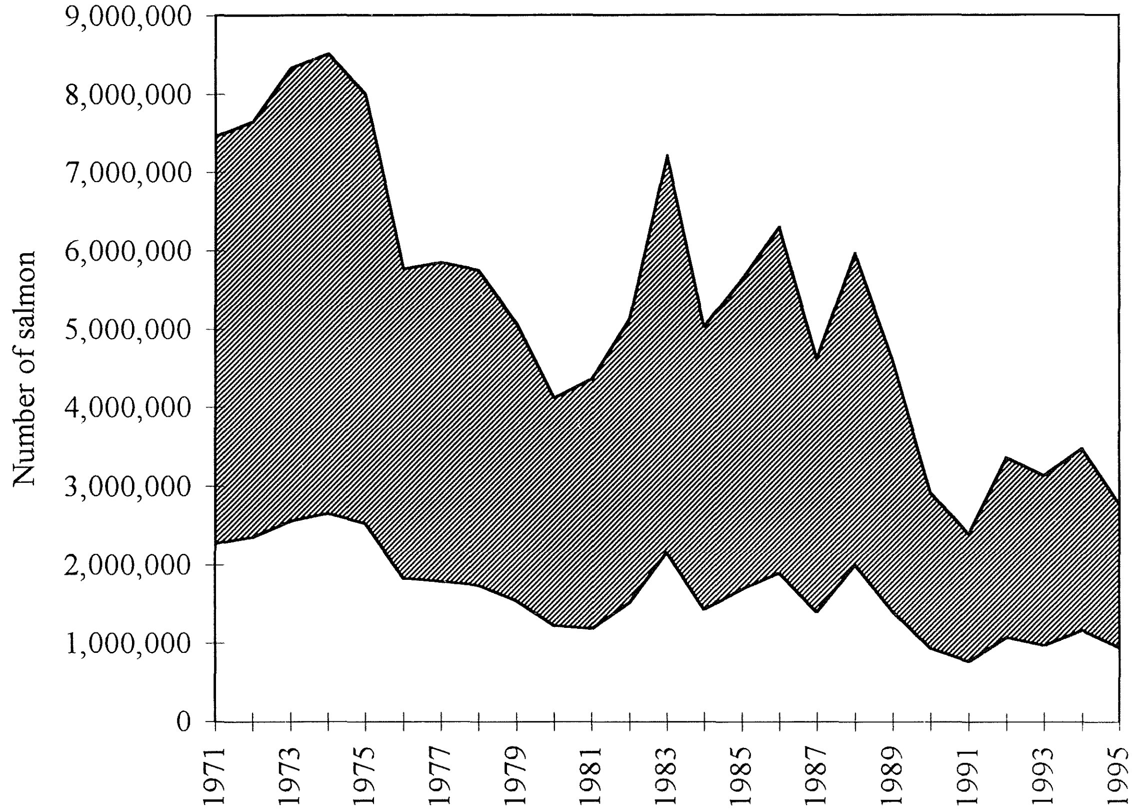


Figure 10.2.1.4 Maximum and minimum estimates of recruitment of non-maturing 1SW salmon in Southern European counties.

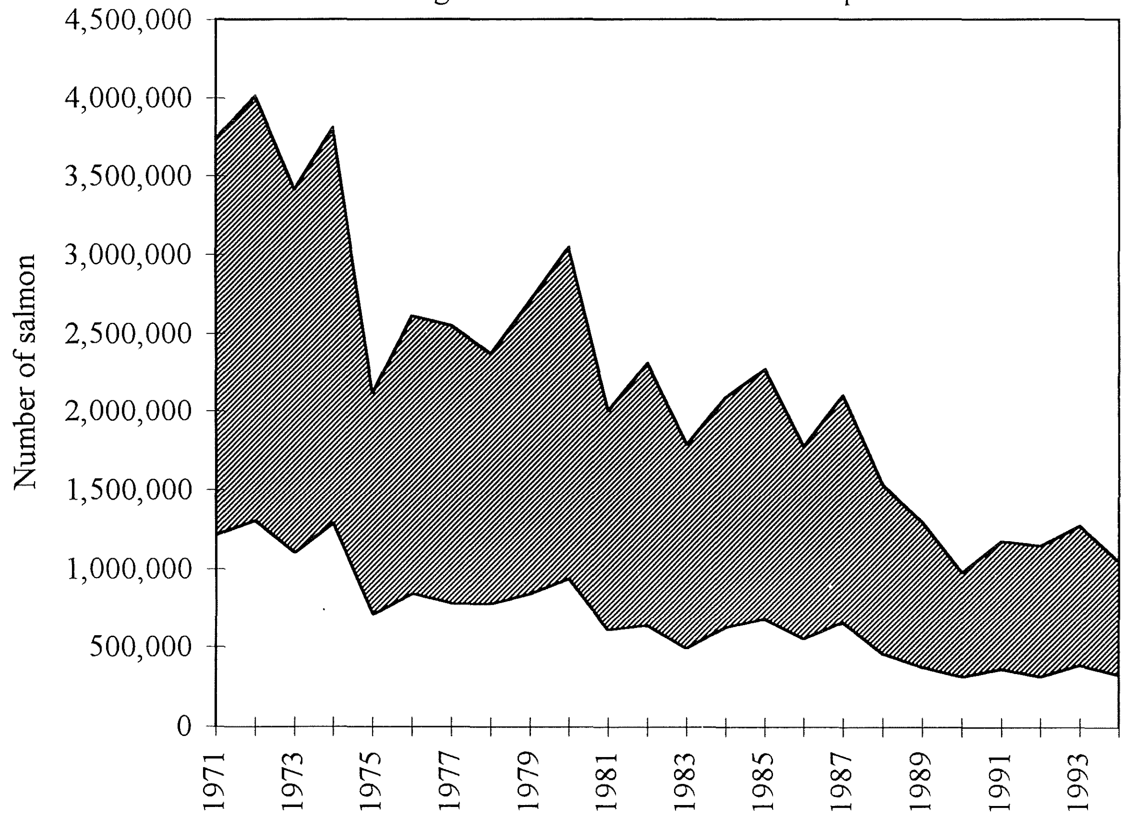


Figure 10.2.1.5 Maximum and minimum estimates of recruitment of maturing 1SW salmon in Northern European countries.

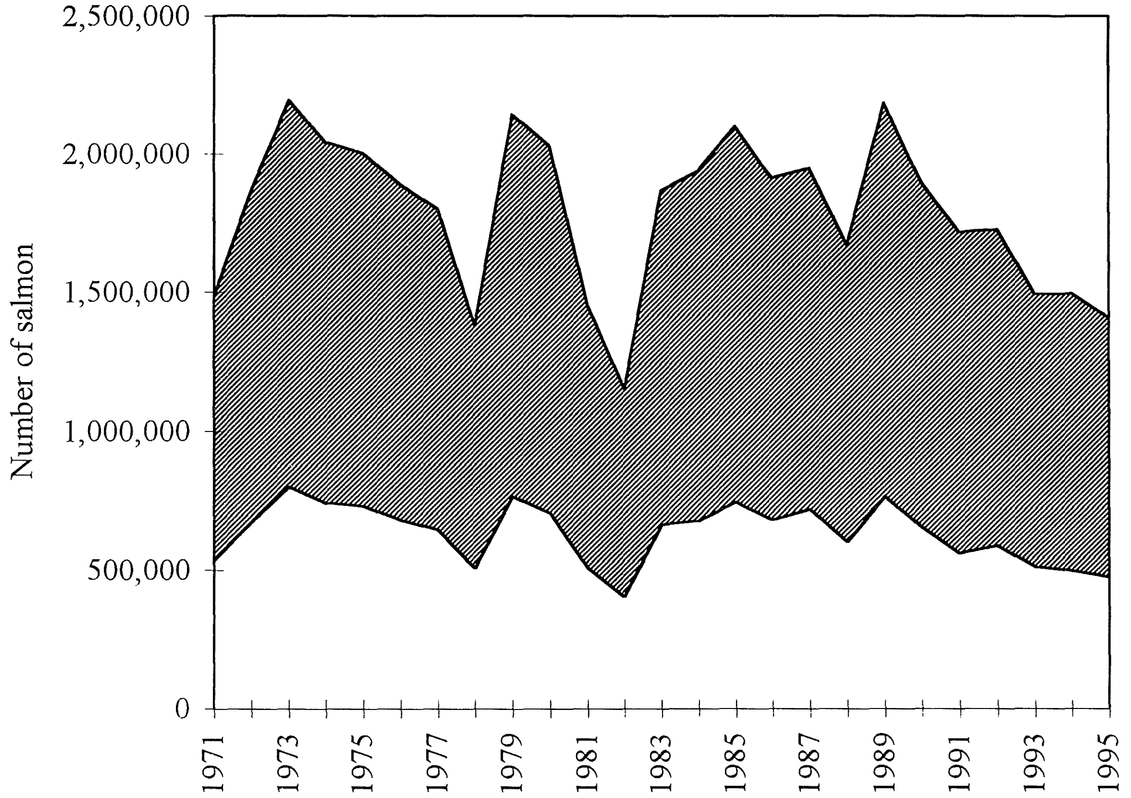


Figure 10.2.1.6 Maximum and minimum estimates of recruitment of non-maturing 1SW salmon in Northern European countries.

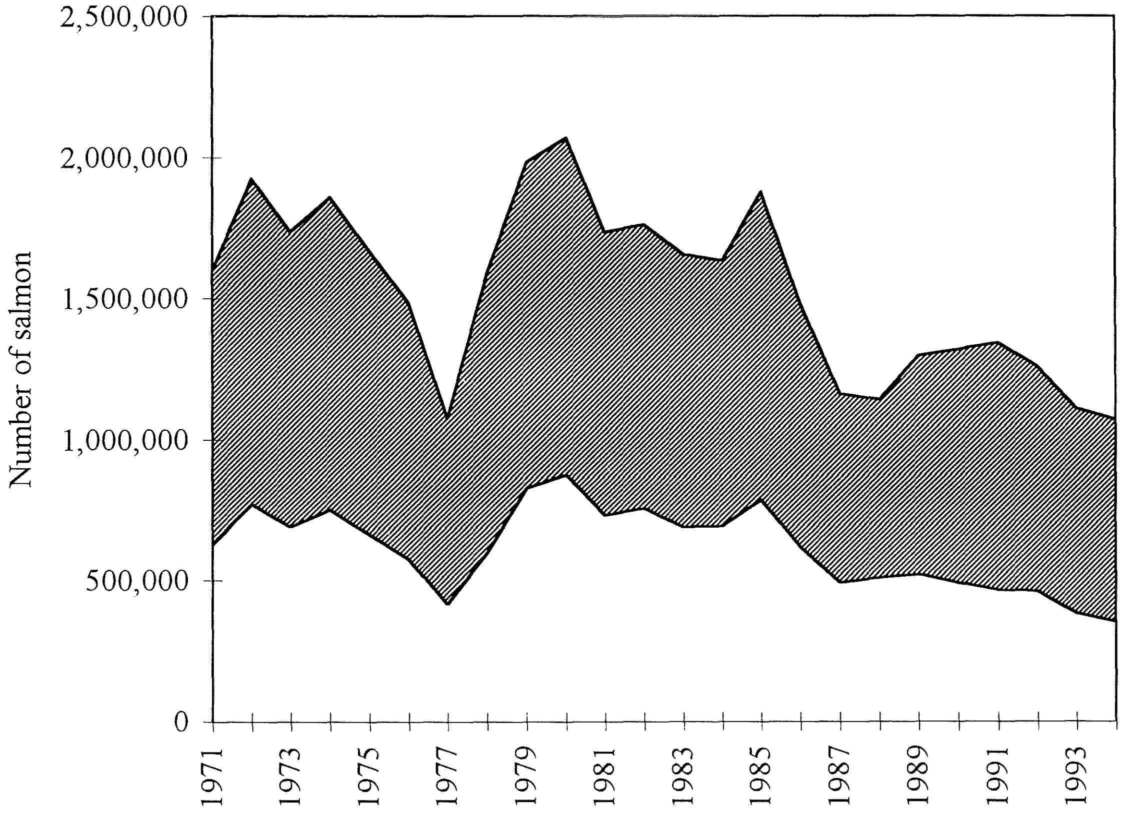


Figure 10.2.2.1 Time series trends of thermal habitat area and the abundance of non-maturing stock from southern Europe.

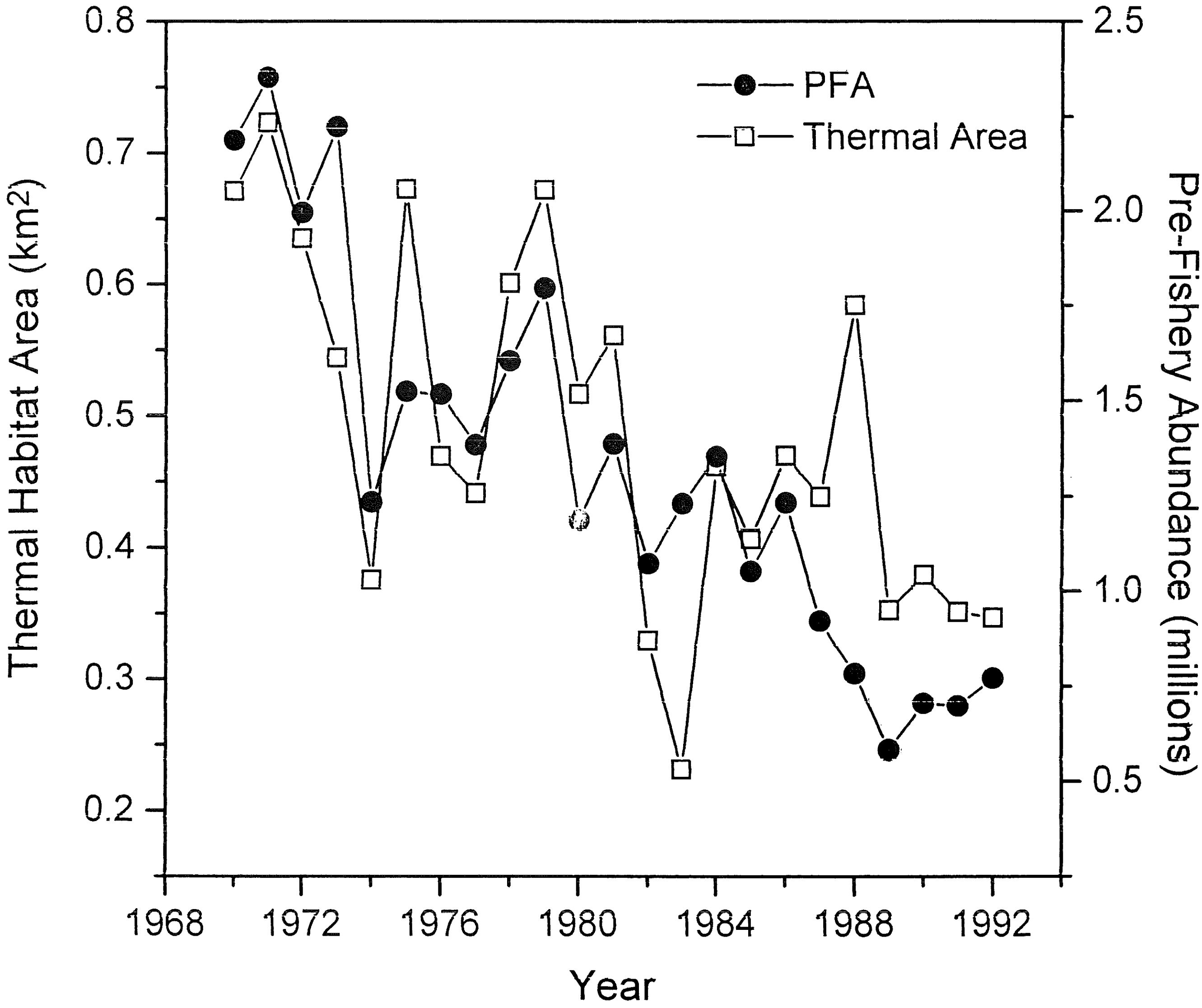


Figure 10.2.2.2 Relationship between thermal habitat area and the abundance of non-maturing stock from southern Europe.

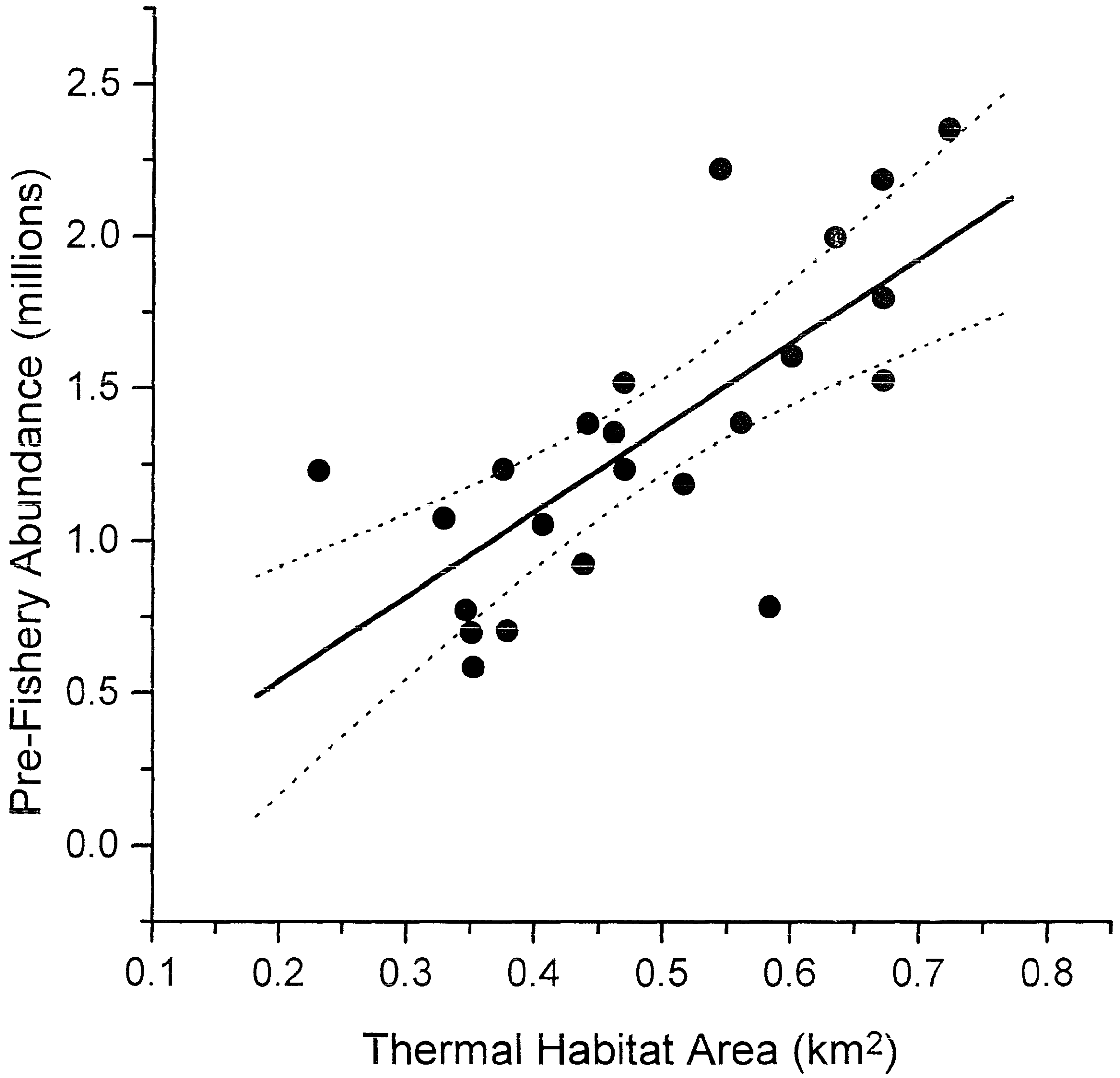


Figure 10.2.2.3 Observed and predicted estimates of abundance of non-maturing stock from southern Europe.

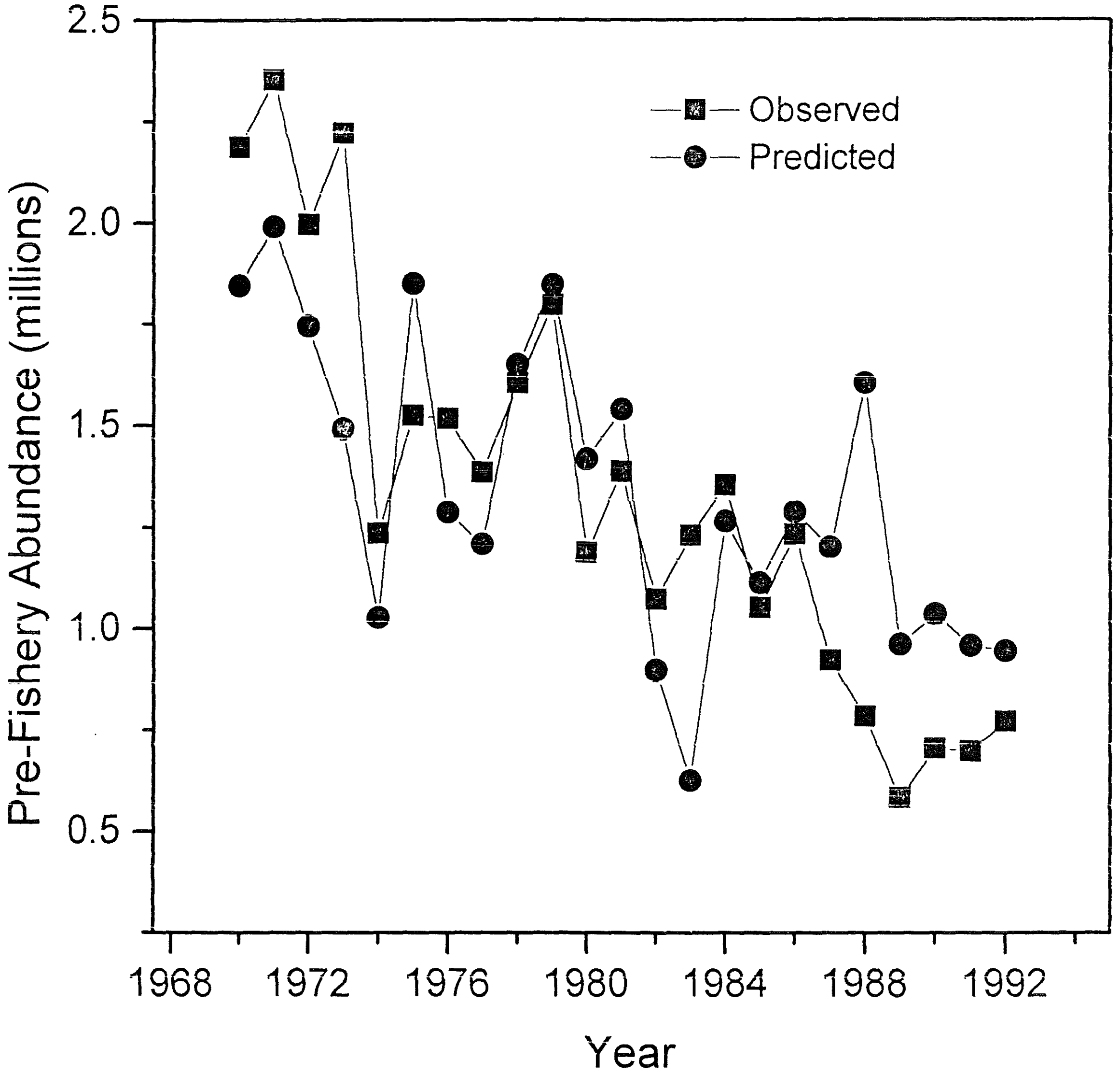


Figure 10.2.2.4 Residual analysis of the relationship between thermal habitat area and the abundance of non-maturing stock from southern Europe.

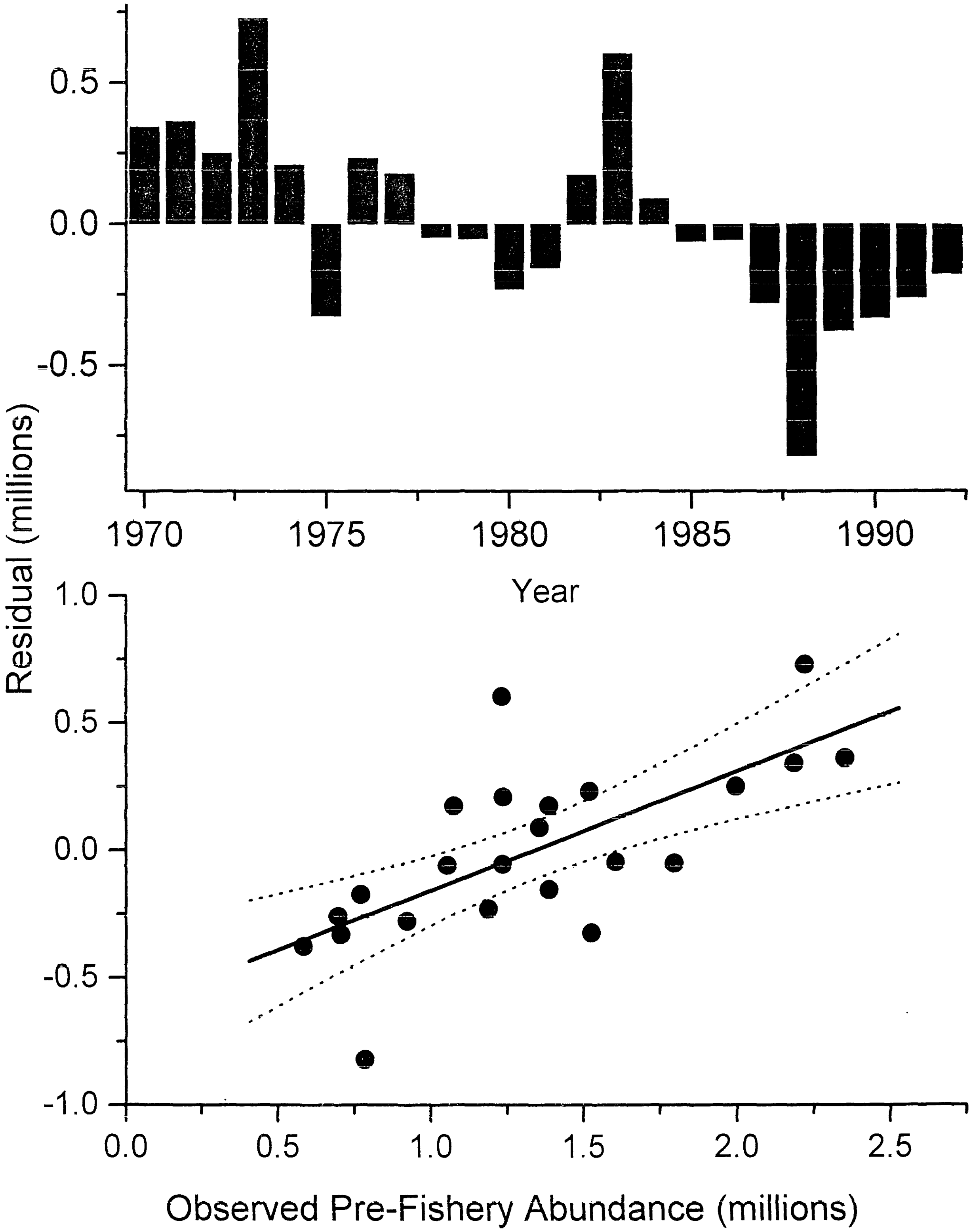


Figure 14.4.2 Spawning run to the River Lagan by smolt year class (1969 - 1993). Proportion of Grilse vs. Grilse Weight

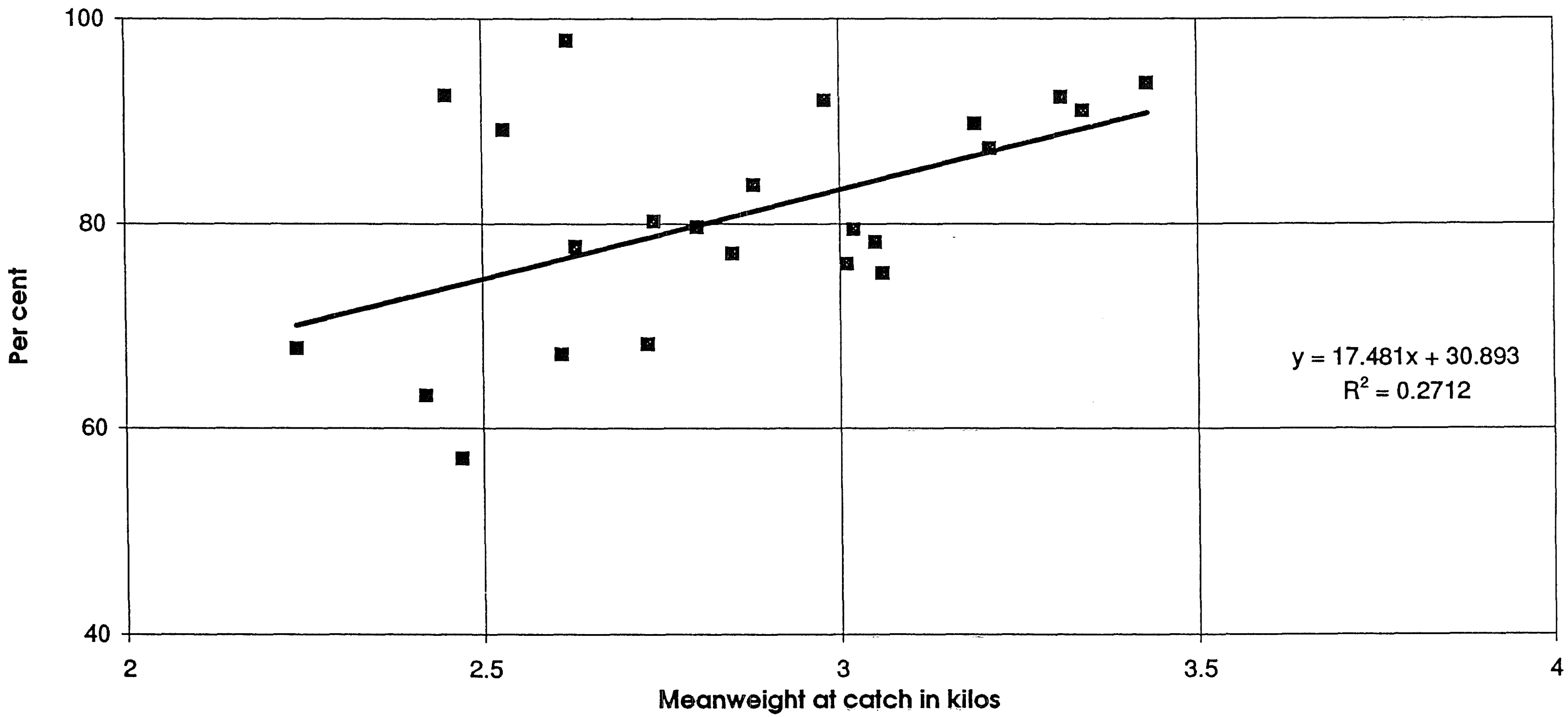
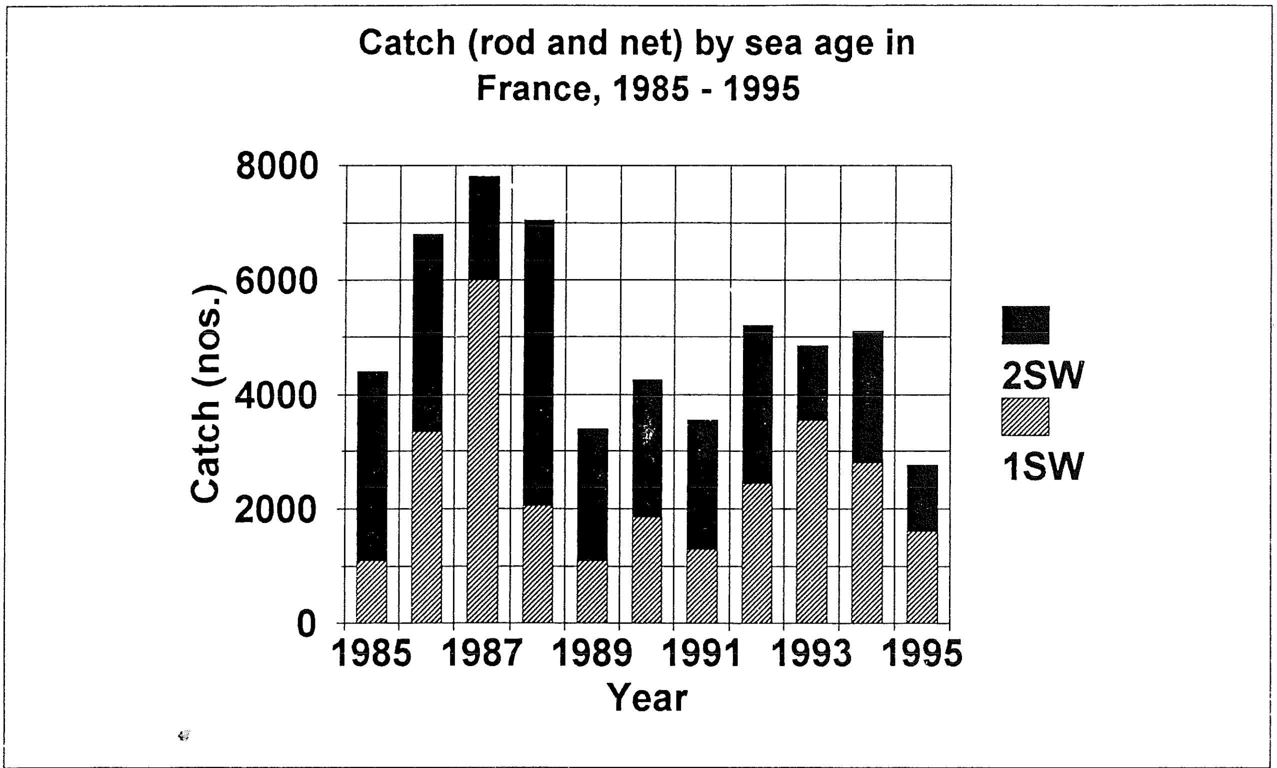
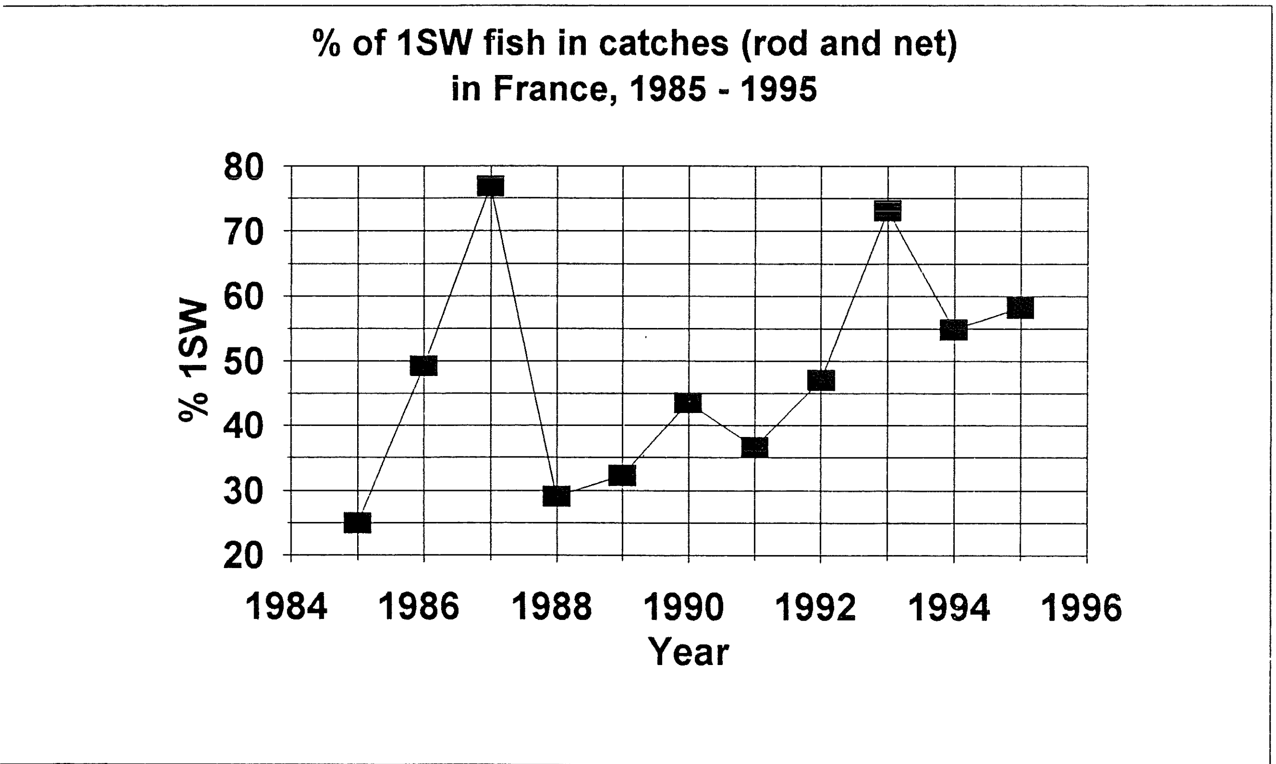


Figure 14.2.1 Proportion of MSW salmon surviving from each smolt year class in the R.Tenojoki (Finland) based on the age distribution of the rod catch.

Figure 14.2.2 Changes in sea-age composition of catches (rod and net) in France, 1985-95.





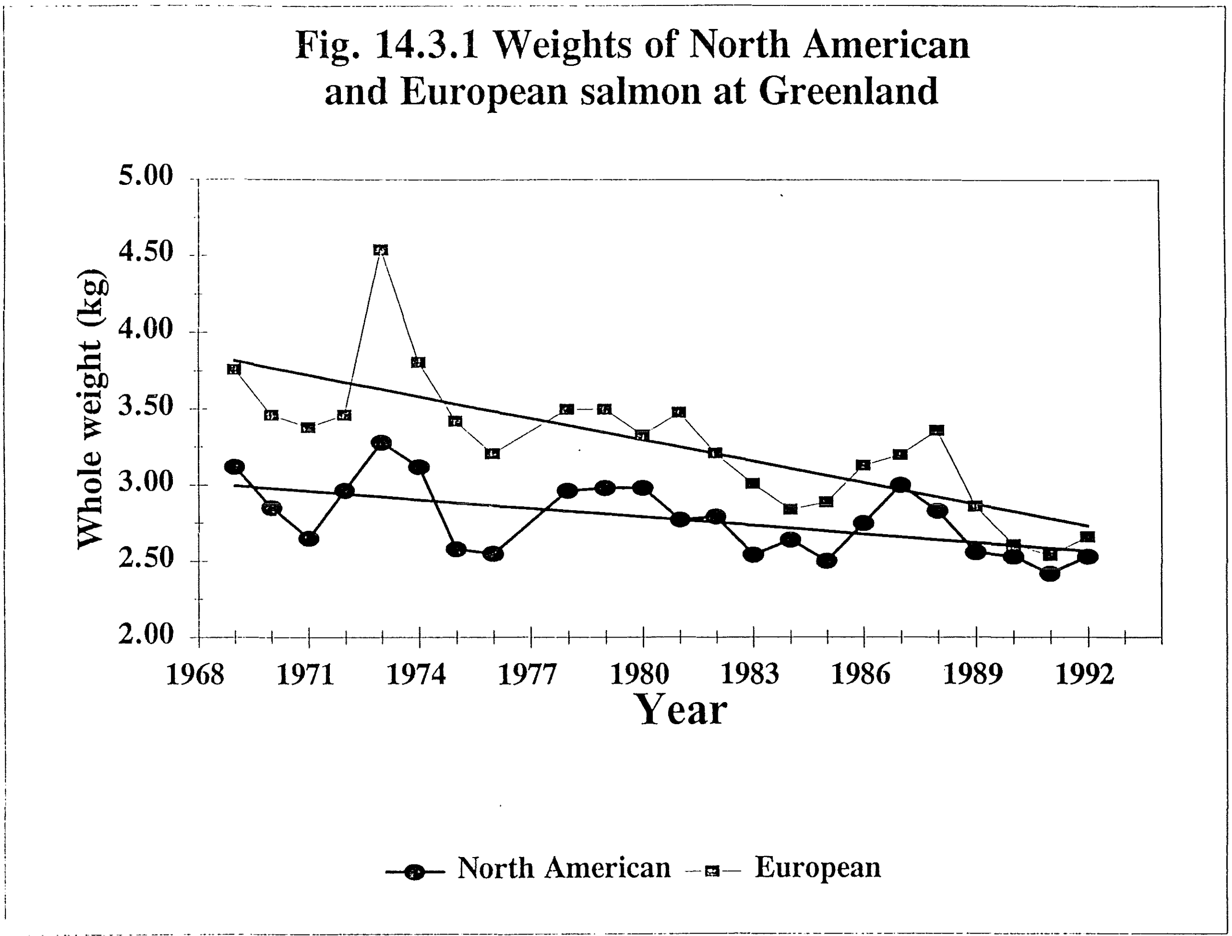
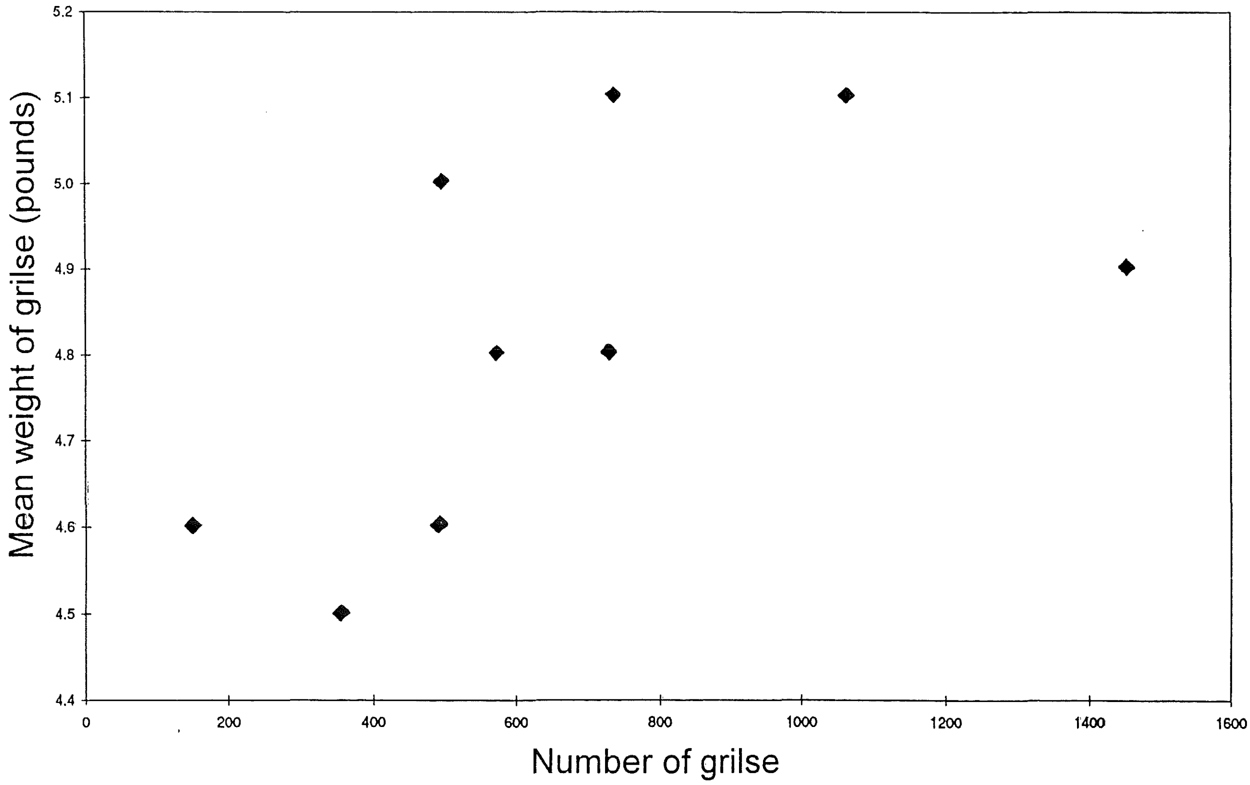


Fig. 14.3.1 Weights of North American and European salmon at Greenland
5.00
4.50
4.00
3.50
3.00
2.50
2.00
Whole weight (kg)
1968
1971
1974
1977
1980
1983
1986
1989
1992
Year
North American
European

Figure 14.4.1 Relationship between the annual number of grilse returning to the River Sela (Iceland) and their mean weight.



APPENDIX 1

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP ON NORTH ATLANTIC SALMON, 1995.

Doc. No. 1	Maclean, J. National Report for UK (Scotland).
Doc. No. 2	Cairns, D. Avian consumption of juvenile Atlantic salmon in the Maritime Provinces of Canada.
Doc. No. 3	Lund, R. and L.P. Hansen. Farmed Atlantic salmon in Norwegian home waters.
Doc. No. 4	Lund, R., L.P. Hansen and J.A. Jacobsen. Smolt age and sea age of Atlantic salmon sampled in the research fishery at Faroes in the 1994/95 fishing season.
Doc. No. 5	Lund, R., P. Midtlyng, and L.P. Hansen. Post-vaccination intra-abdominal adherances in farmed Atlantic salmon, *Salmon salar* L., as a marker to identify escapees from fish farms.
Doc. No. 6	Holst, J.C., L.P. Hansen and M. Holm. Preliminary observations of abundance, stock composition, body size and food of postsmolts of Atlantic salmon caught with pelagical trawls in the NE Atlantic in the summers 1991 and 1995.
Doc. No. 7	Jacobsen J.A., L-P. Hansen, A. Isaksson, and L. Karlsson. The salmon research programme at Faroes: Preliminary results of the tagging experiment and the stomach sampling in 1994/95.
Doc. No. 8	O'Maoileidigh, N., A. Cullen, T. McDermott, N. Bond, and G. Rogan. National Report for Ireland - The 1995 salmon season.
Doc. No. 9	Baum, E. 1995 USA fisheries, stock status and aquaculture production.
Doc. No. 10	Beland, K. and K. Friedland. Estimation of population statistics for the Narraguagus River Atlantic salmon cohorts spawned in 1989 and 1990.
Doc. No. 11	Friedland, K., D. Reddin, N. Shimizu, and R. Haas. Patterns of sexual maturation in Atlantic salmon suggested by Strontium:Calcium ratios in otoliths and gonadosomal indices.
Doc. No. 12	Friedland, K., P. Rago and R. Spencer. Risk based estimates of harvest and exploitation of Penobscot River stock salmon from 1970 to 1993.
Doc. No. 13	Friedland, K. Risk based estimates of local salmon harvest in West Greenland during 1993.
Doc. No. 14	Identification of North American and European Atlantic salmon (*Salmon salar* L.) caught at West Greenland in 1995.
Doc. No. 15	Length, weight, and age characteristics of Atlantic salmon (*Salmo salar* L.) of North American and European origin caught at West Greenland in 1995.
Doc. No. 16	Chaput, G., F. Caron, L. Marshall, D. Meerburg, C. Mullins, and M. O'Connell. Report on the status of Atlantic salmon stocks in eastern Canada in 1995.
Doc. No. 17	Chaput, G. Managing fisheries based on fixed escapement targets.

Doc. No. 18 Russell, I.C. National Report for UK (England and Wales).

Doc. No. 19 Potter, T. Increases in returns of salmon to home waters following the reduction in fishing at Faroes and Greenland.

Doc. No. 20 Reddin, D., F. Caron, G. Chaput, L. Marshall, and A. Locke. Two-sea winter returns and spawner estimates for Atlantic Canada salmon stocks.

Doc. No. 21 O'Connell, M., F. Caron, L. Marshall, C. Mullins, and D. Reddin. Canadian 2SW spawner requirements.

Doc. No. 22 Hindar, K. Definition of "stocks" and "wild salmon" for scientific and management purposes.

Doc. No. 23 O'Maoileidigh, N. and J Browne. Introducing reared migratory salmonids into the wild.

Doc. No. 24 Crozier, W. Summary of salmon fisheries and status of stocks in UK (Northern Ireland) for 1995.

APPENDIX 2

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Anon. 1994/Assess 16 Report of the North Atlantic Salmon Working Group. Reykjavik, 6-15 April 1994. ICES, Doc. C.M. 1994/Assess 16, Ref:M

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APPENDIX 3

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Appendix 4 Numbers of 2SW salmon returns estimated for Labrador.

Year	Commercial catches of large salmon			Labrador Origin Large returns before commercial fishery					
	SFA 1	SFA 2	SFA 14B	SFA 1		SFA 2		SFA 14B	
				Min	Max	Min	Max	Min	Max
*1969	18929	48822	10300	12620	21634	32548	55797	6867	11772
*1970	17633	45479	9595	11755	20152	30319	51976	6397	10966
*1971	25127	64806	13673	16751	28716	43204	74064	9115	15626
*1972	21599	55708	11753	14399	24685	37138	63666	7835	13432
*1973	30204	77902	16436	20136	34519	51935	89031	10957	18784
1974	13866	93036	15863	9244	15847	62024	106327	10575	18129
1975	28601	71168	14752	19067	32687	47445	81335	9835	16859
1976	38555	77796	15189	25703	44063	51864	88910	10126	17359
1977	28158	70158	18664	18772	32181	46772	80181	12443	21330
1978	30824	48934	11715	20549	35227	32623	55925	7810	13389
1979	21291	27073	3874	14194	24333	18049	30941	2583	4427
1980	28750	87067	9138	19167	32857	58045	99505	6092	10443
1981	36147	68581	7606	24098	41311	45721	78378	5071	8693
1982	24192	53085	5966	16128	27648	35390	60669	3977	6818
1983	19403	33320	7489	12935	22175	22213	38080	4993	8559
1984	11726	25258	6218	7817	13401	16839	28866	4145	7106
1985	13252	16789	3954	8835	15145	11193	19187	2636	4519
1986	19152	34071	5342	12768	21888	22714	38938	3561	6105
1987	18257	49799	11114	12171	20865	33199	56913	7409	12702
1988	12621	32386	4591	8414	14424	21591	37013	3061	5247
1989	16261	26836	4646	10841	18584	17891	30670	3097	5310
1990	7313	17316	2858	4875	8358	11544	19790	1905	3266
1991	1369	7679	4417	913	1565	5119	8776	2945	5048
1992	9981	19608	2752	7215	13767	14174	27046	1989	3796
1993	3825	9651	3620	3702	8053	9340	20318	3503	7621
1994	3343	11013	857	4012	9222	13216	30381	1028	2364
1995	1873	8028	312	4322	9989	18526	42816	720	1664

Year	Labrador 2SW Returns prior to commercial fishery						Labrador 2SW Returns SFAs 1,2 &14B		Labrador 2SW to rivers SFAs 1,2 &14B		Labrador 2SW spawners SFAs 1,2 &14B Angling catch subtracted	
	SFA 1		SFA 2		SFA 14B							
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
*1969	8834	19470	19529	44637	4120	9418	32483	73525	3248	22058	2833	21642
*1970	8229	18137	18191	41581	3838	8773	30258	68490	3026	20547	2620	20141
*1971	11726	25845	25922	59251	5469	12501	43117	97596	4312	29279	3963	28930
*1972	10080	22216	22283	50933	4701	10746	37064	83895	3706	25168	3393	24855
*1973	14095	31067	31161	71225	6574	15027	51830	117319	5183	35196	4464	34477
1974	6471	14262	37214	85061	6345	14503	50030	113827	5003	34148	4380	33525
1975	13347	29418	28467	65068	5901	13488	47715	107974	4772	32392	4531	32151
1976	17992	39657	31118	71128	6076	13887	55186	124671	5519	37401	4901	36784
1977	13140	28963	28063	64144	7466	17064	48669	110171	4867	33051	3913	32098
1978	14385	31705	19574	44740	4686	10711	38644	87155	3864	26147	3284	25566
1979	9936	21899	10829	24752	1550	3542	22315	50194	2231	15058	1762	14589
1980	13417	29571	34827	79604	3655	8355	51899	117530	5190	35259	4544	34614
1981	16869	37180	27432	62703	3042	6954	47343	106836	4734	32051	4351	31667
1982	11290	24883	21234	48535	2386	5455	34910	78873	3491	23662	3018	23189
1983	9055	19957	13328	30464	2996	6847	25378	57268	2538	17181	2225	16867
1984	5472	12061	10103	23093	2487	5685	18063	40839	1806	12252	1427	11873
1985	6184	13631	6716	15350	1582	3615	14481	32596	1448	9779	1229	9559
1986	8938	19699	13628	31151	2137	4884	24703	55734	2470	16720	2130	16380
1987	8520	18779	19920	45531	4446	10161	32885	74471	3289	22341	2831	21884
1988	5890	12982	12954	29610	1836	4197	20681	46789	2068	14037	1554	13523
1989	7588	16726	10734	24536	1858	4248	20181	45509	2018	13653	1681	13316
1990	3413	7522	6926	15832	1143	2613	11482	25967	1148	7790	889	7531
1991	639	1408	3072	7021	1767	4038	5477	12467	548	3740	482	3674
1992	5051	12390	8505	21636	1194	3037	14749	37063	2507	15567	1932	14991
1993	2591	7247	5604	16254	2102	6097	10297	29599	3913	18351	3648	18086
1994	2808	8300	7929	24305	617	1891	11355	34496	5677	24492	5337	24152
1995	3026	8990	11116	34253	432	1331	14573	44574	10784	37888	10395	37499

Estimates are based on:

EST LARGE RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8, EXP RATE-SFAs1,2&14B=.7-.9(69-91),.58-.83(92),.38-.62(93),.25-.43(94), .12-.33(95)

EST 2SW RETURNS - (EST LARGE RETURNS*PROP 2SW), PROP 2SW SFAs1=.7-.9,SFA2&14B=.6-.8

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 Numbers of 1SW salmon returns estimated for Labrador.

Year	Commercial catches of small salmon			Labrador origin small returns before commercial fishery						Labrador grilse returns prior to commercial fishery						Grilse Returns		Grilse to rivers		Labrador grilse spawners	
	SFA 1	SFA 2	SFA 14B	SFA 1		SFA 2		SFA 14B		SFA 1		SFA 2		SFA 14B		SFA 1,2&14B		SFA 1,2&14B		SFA 1,2&14B	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
*1969	10774	21627	6321	12929	28730	25952	57672	7585	16856	10343	25857	20762	51905	6068	15171	37173	92933	18587	65053	15476	61942
*1970	14666	29441	8605	17600	39110	35329	78509	10326	22947	14080	35199	28263	70658	8261	20652	50604	126509	25302	88556	21289	84543
*1971	19109	38359	11212	22931	50958	46031	102291	13454	29898	18345	45862	36825	92062	10763	26908	65933	164832	32966	115382	29032	111448
*1972	14303	28711	8392	17164	38141	34454	76563	10070	22378	13731	34327	27563	68907	8056	20140	49350	123374	24675	86362	21728	83415
*1973	3130	6282	1836	3756	8346	7539	16753	2203	4896	3004	7511	6031	15077	1763	4407	10798	26995	5399	18897	0	11405
1974	9848	37145	9328	11818	26261	44574	99053	11194	24875	9454	23635	35659	89148	8955	22387	54068	135170	27034	94619	24287	91872
1975	34937	57560	19294	41924	93165	69072	153493	23153	51451	33540	83849	55258	138144	18522	46306	107319	268298	53660	187809	49688	183837
1976	17589	47468	13152	21107	46904	56962	126581	15782	35072	16885	42214	45569	113923	12626	31565	75081	187702	37540	131391	31814	125665
1977	17796	40539	11267	21355	47456	48647	108104	13520	30045	17084	42710	38917	97294	10816	27041	66818	167045	33409	116931	28815	112337
1978	17095	12535	4026	20514	45587	15042	33427	4831	10736	16411	41028	12034	30084	3865	9662	32310	80774	16155	56542	13464	53851
1979	9712	28808	7194	11654	25899	34570	76821	8633	19184	9324	23309	27656	69139	6906	17266	43885	109714	21943	76800	17825	72682
1980	22501	72485	8493	27001	60003	86982	193293	10192	22648	21601	54002	69586	173964	8153	20383	99340	248350	49670	173845	45870	170045
1981	21596	86426	6658	25915	57589	103711	230469	7990	17755	20732	51830	82969	207422	6392	15979	110093	275232	55046	192662	49855	187471
1982	18478	53592	7379	22174	49275	64310	142912	8855	19677	17739	44347	51448	128621	7084	17710	76271	190678	38136	133474	34032	129370
1983	15964	30185	3292	19157	42571	36222	80493	3950	8779	15325	38314	28978	72444	3160	7901	47463	118658	23732	83061	19360	78689
1984	11474	11695	2421	13769	30597	14034	31187	2905	6456	11015	27538	11227	28068	2324	5810	24566	61416	12283	42991	9348	40056
1985	15400	24499	7460	18480	41067	29399	65331	8952	19893	14784	36960	23519	58798	7162	17904	45465	113662	22732	79563	19631	76462
1986	17779	45321	8296	21335	47411	54385	120856	9955	22123	17068	42670	43508	108770	7964	19910	68540	171350	34270	119945	30806	116481
1987	13714	64351	11389	16457	36571	77221	171603	13667	30371	13165	32914	61777	154442	10933	27334	85876	214690	42938	150283	37572	144917
1988	19641	56381	7087	23569	52376	67657	150349	8504	18899	18855	47138	54126	135314	6804	17009	79785	199462	39892	139623	34369	134100
1989	13233	34200	9053	15880	35288	41040	91200	10864	24141	12704	31759	32832	82080	8691	21727	54227	135566	27113	94896	22429	90212
1990	8736	20699	3592	10483	23296	24839	55197	4310	9579	8387	20966	19871	49678	3448	8621	31706	79265	15853	55485	12544	52176
1991	1410	20055	5303	1692	3760	24066	53480	6364	14141	1354	3384	19253	48132	5091	12727	25697	64243	12849	44970	10526	42647
1992	9588	13336	1325	14751	34865	20517	48495	2038	4818	11801	31379	16414	43645	1631	4336	29845	79360	18205	61901	15467	59163
1993	3893	12037	1144	9343	23957	28889	74074	2746	7040	7475	21561	23111	66666	2196	6336	32782	94564	24587	82270	22079	79762
1994	3214	4492	802	9642	25712	13476	35936	2406	6416	7714	23141	10781	32342	1925	5774	20419	61258	16335	55132	13678	52475
1995	2990	3981	217	11960	29900	15924	39810	868	2170	9568	26910	12739	35829	694	1953	23002	64692	19551	59517	16954	56920

Estimates are based on:
EST SMALL RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8, EXP RATE-SFAs1,2&14B=.3-.5(69-91),.22-.39(92),.13-.25(93),.1-.2(94),.08-.15(95)
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 1SW SPAWNERS = EST 1SW RETURNS TO FRESHWATER - 1SW ANGLING CATCHES
*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

Appendix 6 Atlantic salmon returns to freshwater, total recruits prior to the commercial fishery and spawners summed for Salmon Fishing Areas 3-14A, insular Newfoundland, 1969-1995.
Ret. = reatined fish; Rel. = released fish

Year	Small catch Ret.	Small returns to river Min	Small returns to river Max	Small returns Min	Small returns Max	Small spawners Min	Small spawners Max	Large returns to river Min	Large returns to river Max	Large returns Min	Large returns Max	Large catch Ret.	Large spawners Min	Large spawners Max	2SW returns to river Min	2SW returns to river Max	2SW spawners Min	2SW spawners Max	2SW recruits Min	2SW recruits Max
1969	34944	108807	217349	217613	724497	73863	182405	10484	26767	34946	267666	2310	8174	24457	2245	9324	1408	8054	7483	93240
1970	30437	139570	279594	279139	931980	109133	249157	12627	30508	42091	305081	2138	10490	28371	3184	11851	2384	10642	10613	118509
1971	26666	112266	224994	224532	749980	85600	198328	9857	24146	32856	241462	1602	8255	22544	2385	9104	1810	8230	7951	91039
1972	24402	108509	217092	217018	723640	84107	192690	10046	23996	33485	239955	1380	8666	22616	2494	9129	1985	8358	8314	91288
1973	35482	143729	287832	287457	959438	108247	252350	13292	33061	44308	330613	1923	11369	31138	2995	11808	2275	10720	9982	118082
1974	26485	84667	169103	169335	563676	58182	142618	10821	21662	36069	216616	1213	9608	20449	1968	6702	1534	6043	6559	67021
1975	33390	111847	223890	223694	746300	78457	190500	12222	24478	40741	244782	1241	10981	23237	2382	8002	1959	7355	7940	80018
1976	34463	114787	229853	229573	766175	80324	195390	10756	21550	35855	215501	1051	9705	20499	2327	7663	2003	7160	7758	76630
1977	34352	109649	219106	219299	730354	75297	184754	9750	19493	32499	194933	2755	6995	16738	1880	6309	1134	5131	6267	63094
1978	28619	97070	194133	194141	647109	68451	165514	7873	15786	26243	157860	1563	6310	14223	2005	6419	1564	5728	6682	64194
1979	31169	106791	213327	213582	711091	75622	182158	5549	11113	18496	111128	561	4988	10552	1103	3691	992	3506	3677	36906
1980	35849	120355	240449	240709	801497	84506	204600	9325	18691	31084	186909	1922	7403	16769	2447	7794	1894	6928	8157	77936
1981	46670	156541	312697	313083	1042325	109871	266027	9553	19144	31845	191442	1369	8184	17775	2317	7475	1935	6874	7723	74746
1982	41871	139951	279115	279902	930383	98080	237244	9528	19097	31758	190971	1248	8280	17849	2975	9228	2635	8691	9915	92276
1983	32420	109378	218548	218756	728495	76958	186128	8911	17871	29703	178711	1382	7529	16489	2511	7915	2167	7364	8372	79148
1984	39331	129235	257256	258469	857521	89904	217925	8007	15995	26691	159955	511	7496	15484	2273	7117	2082	6829	7576	71166
1985	36604	120990	241331	241980	804438	84386	204727	3616	7687	12054	76874	0	3616	7687	963	3323	963	3323	3210	33230
1986	37513	124604	248802	249207	829339	87091	211289	6851	14107	22838	141068	0	6851	14107	1593	5404	1593	5404	5311	54043
1987	24480	125111	249847	250222	832825	100631	225367	6357	13067	21190	130675	0	6357	13067	1338	4629	1338	4629	4461	46288
1988	39841	132059	263363	264119	877877	92218	223522	6369	13330	21231	133299	0	6369	13330	1553	5346	1553	5346	5177	53459
1989	18462	59793	119261	119587	397537	41331	100799	3260	6752	10865	67518	0	3260	6752	704	2452	704	2452	2347	24517
1990	29967	98830	197276	197659	657588	68863	167309	5751	11868	19170	118675	0	5751	11868	1341	4562	1341	4562	4470	45620
1991	20529	64016	127698	128032	425661	43487	107169	4449	9173	14831	91734	0	4449	9173	1057	3577	1057	3577	3524	35771
1992	23159	116329	232380	116329	232380	93170	209221	15825	31955	15825	31955	0	15825	31955	3027	10365	3027	10365	3027	10365
1993	24693	131045	261721	131045	261721	106352	237028	7955	16227	7955	16227	0	7955	16227	1487	5217	1487	5217	1487	5217
1994	28959	95487	190655	95487	190655	66528	161696	7915	16099	7915	16099	0	7915	16099	1889	6255	1889	6255	1889	6255
1995	29040	111839	223658	111839	223658	82799	194618	8968	18176	8968	18176	0	8968	18176	2296	7461	2296	7461	2296	7461

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 SFAs 3 - 12 + 14A

SR (Small recruits) = SRR/(1-Exploitation rate commercial (ERC)) where ERC=0.5-0.7, 1969-91 & ERC=0, 1992-95.
SS (Small spawners) = SSR-SC
RL (RATIO large:small) in Bay St. George and Humber River salmon populations
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, 1992-95.
LS (Large spawners) = LRR-large catch retained (LC)
2SW-RR (2SW returns to river)= LRR*proportion 2SW of 0.4-0.6
2SW-S (2SW spawners) = LS * proportion 2SW of 0.4-0.6
2SW-R (2SW recruits) = LR * proportion 2SW of 0.4-0.6

Appendix 7(a) Total catch of salmon in Quebec by recreational, commercial and native fishermen, 1969-1995.

Year	Sport 1SW	Sport 2SW	Sport 3SW+repeat	Sport TOTAL	Commercial 1SW	Commercial 2SW	Commercial 3SW+repeat	Commercial TOTAL	Native 1SW	Native 2SW	Native 3SW+repeat	Native TOTAL
1969	5,035	6,347	2,985	14,367	4,065	25,612	10,977	40,654	118	247	15	380
1970	3,409	6,559	4,878	14,846	4,087	25,749	11,035	40,872	173	363	22	558
1971	2,882	3,888	2,031	8,801	2,541	16,008	6,861	25,410	228	478	29	736
1972	2,535	6,243	5,353	14,131	1,611	10,148	4,349	16,108	252	1,588	1,594	3,434
1973	3,391	6,711	5,087	15,189	2,162	13,618	5,836	21,616	252	1,588	1,772	3,612
1974	3,107	8,151	6,197	17,455	3,018	19,013	10,683	32,714	504	3,175	2,630	6,309
1975	3,582	7,087	4,838	15,507	2,499	15,744	9,279	27,522	504	3,175	2,808	6,487
1976	4,006	7,428	3,914	15,348	2,648	16,682	9,681	29,011	504	3,175	2,986	6,665
1977	3,705	10,995	5,328	20,028	2,190	13,791	8,245	24,226	504	3,175	3,360	7,039
1978	3,533	8,805	6,160	18,498	1,757	11,069	7,237	20,063	504	3,175	3,360	7,039
1979	4,896	3,980	2,432	11,308	1,121	7,062	5,022	13,205	504	3,175	4,531	8,210
1980	6,425	11,396	6,425	24,246	2,727	17,180	11,492	31,399	504	3,175	6,686	10,365
1981	9,553	7,629	5,455	22,637	2,141	13,488	9,830	25,459	504	3,175	6,815	10,494
1982	5,209	8,867	4,397	18,473	1,743	10,979	6,197	18,919	504	3,175	3,691	7,370
1983	3,713	5,694	2,972	12,379	1,997	12,578	7,388	21,963	504	3,175	3,971	7,650
1984	3,329	5,814	2,489	11,632	794	9,210	3,947	13,951	508	3,197	1,370	5,075
1985	3,908	6,741	2,880	13,529	2,093	11,633	4,986	18,712	424	2,672	1,146	4,242
1986	6,156	7,964	3,416	17,536	3,707	14,622	6,267	24,596	523	3,294	1,411	5,228
1987	7,288	6,633	2,843	16,764	2,992	15,922	6,824	25,737	517	3,256	1,359	5,132
1988	8,498	8,967	3,843	21,308	4,760	13,825	5,925	24,510	548	3,453	1,480	5,481
1989	5,928	7,615	3,264	16,807	2,615	12,709	5,447	20,770	347	2,188	923	3,458
1990	8,359	8,330	3,567	20,256	3,425	11,264	4,828	19,517	321	2,021	1,129	3,471
1991	6,115	7,737	3,318	17,170	3,282	11,460	4,911	19,653	340	2,142	1,530	4,012
1992	8,116	8,452	3,616	20,184	3,849	11,096	4,755	19,700	215	1,357	1,404	2,976
1993	7,909	6,308	3,250	17,467	3,627	7,957	3,410	14,994	357	2,820	1,208	4,385
1994	7,415	7,078	3,646	18,139	3,870	7,291	3,125	14,285	357	3,291	1,410	5,058
1995	4,039	5,108	2,632	11,779	3,915	7,027	3,011	13,953	284	2,754	1,180	4,218
Mean	5,261	7,279	3,971	16,511	2,787	13,435	6,724	22,945	400	2,535	2,216	5,151

TOTAL included 3SW and repeat spawner

Sport landings: 1sw = fish below 2.2kg (5pounds)
2sw = fish from 2.2kg to 5.4 kg (5 to 12 pounds)

Commercial before 1984 1sw = 10% of the total commercial catch
2sw = 63% of the total commercial catch (or 70% of the msw)

Commercial since 1984 1sw = fish below 2.2kg (5pounds)
2sw =70% of the msw

Native harvest before 1984 = average values,1984-1992

Native harvest before 1972: conducted with commercial permits (data included in commercial harvest) except for Q11

Appendix 7(b) Total return estimation of salmon in Quebec, 1969-1995.

Year	Low estimation 1SW	2SW	3SW+repeat	TOTAL	High estimation 1SW	2SW	3SW+repeat	TOTAL
1969	15,636	43,385	19,058	78,078	27,089	60,910	27,123	115,122
1970	12,229	44,131	23,204	79,563	20,197	62,149	35,351	117,697
1971	9,381	27,320	12,290	48,990	15,993	38,152	17,689	71,834
1972	7,592	26,919	18,343	52,855	13,322	42,102	30,744	86,168
1973	10,066	31,915	19,688	61,669	17,719	48,623	31,767	98,109
1974	10,730	43,041	28,634	82,405	17,939	63,894	43,954	125,786
1975	11,155	36,994	24,302	72,450	19,307	55,069	36,517	110,892
1976	12,238	38,806	22,982	74,026	21,323	57,755	33,297	112,375
1977	11,064	43,150	24,801	79,015	19,434	69,334	37,997	126,765
1978	10,196	35,311	25,431	70,938	18,131	56,379	40,264	114,774
1979	12,395	20,330	16,215	48,939	23,165	30,422	22,877	76,464
1980	17,529	47,910	34,718	100,158	31,828	75,464	51,259	158,551
1981	23,581	35,565	30,870	90,016	44,516	54,467	45,095	144,078
1982	13,783	35,341	20,825	69,949	25,320	56,528	31,762	113,610
1983	10,859	30,358	19,453	60,670	19,217	44,963	27,546	91,727
1984	8,655	26,768	11,466	46,889	16,007	41,129	17,615	74,751
1985	11,297	30,944	13,243	55,484	20,077	47,583	20,355	88,015
1986	18,100	37,726	16,174	72,000	31,970	57,536	24,670	114,176
1987	19,705	36,315	15,522	71,542	35,900	53,453	22,862	112,215
1988	24,375	39,149	16,778	80,302	43,442	61,020	26,151	130,613
1989	16,152	33,503	14,343	63,997	29,341	52,110	22,316	103,767
1990	22,280	33,188	14,519	69,987	40,814	53,090	23,082	116,985
1991	17,313	32,277	14,541	64,130	31,003	50,951	22,641	104,596
1992	22,123	32,492	14,858	69,473	40,182	52,532	23,556	116,270
1993	21,586	25,956	12,298	59,840	39,188	41,135	19,978	100,301
1994	20,803	27,386	13,054	61,243	37,380	44,190	21,574	103,144
1995	13,513	22,231	10,478	46,222	22,826	34,681	16,765	74,272
Mean	14,950	33,655	18,809	67,413	26,752	51,720	28,757	107,228

Low estimation = landings (sport+comm.+native) + spawner (= 1 * sport) + unreported (= .15* total landing)

High estimation = landings (sport+comm.+native) + spawner (= 3 * sport) + unreported (= .30* total landing)

Appendix 7(c) Totals of recruits and spawners for Atlantic Canada (Québec only)

	Small salmon				Large salmon				2SW salmon			
	Recruits		Spawners		Recruits		Spawners		Recruits		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1969	15635.93	27088.66	5035	15105	62442.22	88033.64	9332	27996	43384.6553	60910.2906	6347.3406	19042.0218
1970	12228.557	20196.934	3409	10227	67334.843	97499.866	11437	34311	44130.639	62149.218	6558.9628	19676.8884
1971	9380.834	15992.508	2882	8646	39609.216	55841.592	5919	17757	27319.5109	38152.3217	3888.2818	11664.8454
1972	7592.47	13322.14	2535	7605	45262.48	72845.76	11596	34788	26919.059	42102.0779	6243.0758	18729.2274
1973	10066.29	17718.98	3391	10173	51602.26	80390.12	11798	35394	31914.5674	48623.0549	6710.5002	20131.5006
1974	10730.35	17938.7	3107	9321	71674.35	107847.7	14348	43044	43040.85	63893.7	8151	24453
1975	11154.75	19306.5	3582	10746	61295.65	91585.3	11925	35775	36993.9	55068.8	7087	21261
1976	12237.7	21323.4	4006	12018	61787.9	91051.8	11342	34026	38805.75	57754.5	7428	22284
1977	11063.85	19433.7	3705	11115	67951.1	107331.2	16323	48969	43150.15	69334.3	10995	32985
1978	10196.1	18131.2	3533	10599	60741.9	96642.8	14965	44895	35311.35	56378.7	8805	26415
1979	12395.15	23165.3	4896	14688	36544.3	53298.6	6412	19236	20329.55	30422.1	3980	11940
1980	17529.4	31827.8	6425	19275	82628.1	126723.2	17821	53463	47909.65	75464.3	11396	34188
1981	23580.7	44516.4	9553	28659	66434.8	99561.6	13084	39252	35564.8	54466.6	7629	22887
1982	13783.4	25319.8	5209	15627	56165.9	88289.8	13264	39792	35341.15	56528.3	8867	26601
1983	10859.1	19217.2	3713	11139	49810.7	72509.4	8666	25998	30358.05	44963.1	5694	17082
1984	8654.65	16007.3	3329	9987	38234.05	58744.1	8303	24909	26768.035	41129.17	5814	17442
1985	11296.75	20076.5	3908	11724	44187.7	67938.4	9621	28863	30944.245	47583.19	6741	20223
1986	18099.9	31969.8	6156	18468	53900.1	82206.2	11380	34140	37726.345	57536.39	7964	23892
1987	19704.55	35900.1	7288	21864	51837.4	76314.8	9476	28428	36315.075	53452.65	6633	19899
1988	24374.9	43441.8	8498	25494	55926.95	87170.9	12810	38430	39148.75	61019.5	8967	26901
1989	16151.5	29341	5928	17784	47845.75	74425.5	10879	32637	33503.225	52109.95	7615	22845
1990	22279.75	40813.5	8359	25077	47706.85	76171.7	11897	35691	33187.71	53090.02	8330	24990
1991	17312.55	31003.1	6115	18345	46817.7	73592.4	11055	33165	32276.505	50951.31	7737	23211
1992	22123	40182	8116	24348	47350	76088	12068	36204	32492.405	52532.11	8452	25356
1993	21585.95	39187.9	7909	23727	38253.95	61112.9	9558	28674	25955.777	41135.054	6308.28	18924.84
1994	20803.3	37379.6	7415	22245	40440	65764	10724	32172	27385.736	44190.272	7077.84	21233.52
1995	13512.7	22826.4	4039	12117	32708.8	51445.6	7740	23220	22230.52	34680.64	5108.4	15325.2

TOTAL included 3SW and repeat spawner

Sport landings:
1sw = fish below 2.2kg (5pounds)
2sw = fish from 2.2kg to 5.4 kg (5 to 12 pounds)

Commercial before 1984
1sw = 10% of the total commercial catch
2sw = 63% of the total commercial catch (or 70% of the msw)

Commercial since 1984
1sw = fish below 2.2kg (5pounds)
2sw =70% of the msw

Native harvest before 1984 = average values,1984-1992
Native harvest before 1972: conducted with commercial permits (data included in commercial harvest) except for Q11

Low estimation
landings (sport+comm.+native) + spawner (= 1 * sport) + unreported (= .15* total landing)

High estimation
landings (sport+comm.+native) + spawner (= 3 * sport) + unreported (= .30* total landing)

Appendix 8: Small, large and 2SW return and spawner estimates for SFA 15.

Year	Small salmon				Large salmon				Proportion of 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

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, 1971, 1995: the mean value of 0.65 is used here. (Note: Mean of 1984-1994 was 0.62).
Salmon in the Quebec portions of the Restigouche River (Matapedia River, portions of the Patapedia and Kedgwick rivers) were subtracted from the total numbers. Quebec-New Brunswick boundary waters were included in SFA 15.
The returns and spawners estimates thus derived for the SFA 15 portion of the Restigouche were then multiplied by the minumum (1.117) and maximum (1.465) ratios of angling catch in SFA15:SFA 15 portion of Restigouche catch to obtain estimates for SFA 15.

Appendix 9(a) Returns and escapements of large salmon to SFA 16

			Returns to SFA 16		Returns to the Miramichi River					
	2SW returns to SFA 16				Large	0.80	1.33	Prop. 2SW	2SW Returns to Miramichi	
Year	Min.	Max.	**Min.**	**Max.**	returns	Min.	Max.		Min	Max
1971	19,697	32,746	21,645	35,985	24,407	19,526	32,461	0.92	17,924	29,799
1972	24,645	40,972	27,082	45,024	29,049	23,239	38,635	0.97	22,427	37,284
1973	22,896	38,065	25,161	41,829	27,192	21,754	36,165	0.96	20,835	34,639
1974	33,999	56,523	37,361	62,113	42,592	34,074	56,647	0.91	30,939	51,436
1975	21,990	36,558	24,164	40,173	28,817	23,054	38,327	0.87	20,011	33,267
1976	17,118	28,459	18,811	31,274	22,801	18,241	30,325	0.85	15,578	25,898
1977	43,160	71,753	47,428	78,850	51,842	41,474	68,950	0.95	39,275	65,296
1978	18,539	30,822	20,373	33,870	24,493	19,594	32,576	0.86	16,871	28,048
1979	5,484	9,117	6,027	10,019	9,054	7,243	12,042	0.69	4,991	8,297
1980	30,332	50,426	33,331	55,413	36,318	29,054	48,303	0.95	27,602	45,888
1981	9,489	15,775	10,427	17,335	16,182	12,946	21,522	0.67	8,635	14,355
1982	21,875	36,368	24,039	39,965	30,758	24,606	40,908	0.81	19,907	33,095
1983	19,762	32,854	21,716	36,103	27,924	22,339	37,139	0.81	17,983	29,897
1984	12,562	20,884	13,804	22,950	15,137	12,110	20,132	0.94	11,431	19,005
1985	15,861	26,369	17,430	28,977	20,738	16,590	27,582	0.87	14,434	23,996
1986	23,460	39,003	25,781	42,860	31,285	25,028	41,609	0.85	21,349	35,493
1987	13,590	22,594	14,935	24,829	19,421	15,537	25,830	0.80	12,367	20,561
1988	15,599	25,933	17,142	28,498	21,745	17,396	28,921	0.82	14,195	23,599
1989	9,880	16,426	10,857	18,050	17,211	13,769	22,891	0.65	8,991	14,948
1990	15,474	25,725	17,004	28,270	28,574	22,859	38,003	0.62	14,081	23,410
1991	15,929	26,482	17,504	29,101	29,949	23,959	39,832	0.61	14,495	24,098
1992	19,062	31,690	20,947	34,824	37,000	29,600	49,210	0.59	17,346	28,838
1993	21,662	36,012	23,804	39,574	35,200	28,160	46,816	0.70	19,712	32,771
1994	14,589	37,531	16,031	41,243	27,450	18,278	47,023	0.73	13,276	34,154
1995	17,360	44,262	19,077	48,640	32,627	19,747	50,348	0.80	15,798	40,278

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 and 1995, min and max are 5th and 95th percentiles from the assessment.
Prop. 2SW are from scale ageing. For 1995, prop. 2SW is from an age-length key.

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 9b Escapement for SFA 16 calculated by same procedure as used to calculate returns.

	Escapement of 2SW to SFA 16		Escapement to SFA 16		Escapements to the Miramichi River				Escapement of 2SW	
						0.8	1.33	Prop.		
Year	Min	Max	Min.	Max.	Large	Min.	Max.	2SW	Min	Max
1971	3508	5832	3855	6409	4347	3478	5782	0.918	3192	5307
1972	14992	24924	16474	27389	17671	14137	23502	0.965	13643	22681
1973	17134	28486	18829	31303	20349	16279	27064	0.958	15592	25922
1974	27495	45711	30215	50232	34445	27556	45812	0.908	25021	41597
1975	16366	27209	17985	29900	21448	17158	28526	0.868	14893	24760
1976	10760	17889	11824	19658	14332	11466	19062	0.854	9792	16279
1977	27404	45560	30115	50066	32917	26334	43780	0.947	24938	41459
1978	8197	13627	9007	14975	10829	8663	14403	0.861	7459	12401
1979	2751	4573	3023	5025	4541	3633	6040	0.689	2503	4161
1980	15762	26204	17321	28796	18873	15098	25101	0.95	14343	23846
1981	2702	4492	2969	4936	4608	3686	6129	0.667	2459	4088
1982	9429	15676	10362	17226	13258	10606	17633	0.809	8581	14265
1983	5986	9951	6578	10935	8458	6766	11249	0.805	5447	9056
1984	12189	20264	13394	22268	14687	11750	19534	0.944	11092	18440
1985	15390	25586	16912	28116	20122	16098	26762	0.87	14005	23283
1986	22659	37670	24900	41396	30216	24173	40187	0.853	20619	34280
1987	12635	21006	13885	23084	18056	14445	24014	0.796	11498	19116
1988	15050	25021	16539	27496	20980	16784	27903	0.816	13696	22769
1989	8921	14831	9803	16298	15540	12432	20668	0.653	8118	13496
1990	14940	24838	16418	27294	27588	22070	36692	0.616	13595	22602
1991	15472	25721	17002	28265	29089	23271	38688	0.605	14079	23406
1992	18856	27416	20721	30128	35927	29281	42573	0.586	17159	24949
1993	21755	31632	23907	34761	34702	28282	41122	0.7	19797	28785
1994	14213	37156	15619	40831	27147	17808	46553	0.726	12934	33812
1995	16869	43771	18537	48100	32093	19188	49789	0.8	15350	39831

Appendix 10 Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1955-1995.

	Small recruits		Small spawners		Large recruits		Large spawners		2SW recruits		2SW spawners		PEI comm.
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	catch (nos.)
1970	0	0	0	0	0	0	0	0	0	0	0	0	
1971	0	0	0	0	0	0	0	0	0	0	0	0	29
1972	0	0	0	0	0	0	0	0	0	0	0	0	385
1973	4	8	2	6	0	0	0	0	0	0	0	0	206
1974	0	0	0	0	0	0	0	0	0	0	0	0	386
1975	0	0	0	0	0	0	0	0	0	0	0	0	345
1976	13	23	7	17	2	4	1	3	2	4	1	3	573
1977	0	0	0	0	0	0	0	0	0	0	0	0	606
1978	0	0	0	0	0	0	0	0	0	0	0	0	N/A
1979	2	4	1	3	4	8	2	6	4	8	2	6	454
1980	11	19	6	14	2	4	1	3	2	4	1	3	1697
1981	235	415	127	307	36	64	32	60	36	64	32	60	217
1982	159	281	86	208	14	26	6	18	14	26	6	18	416
1983	15	27	8	20	15	27	13	25	15	27	13	25	326
1984	15	27	8	20	12	22	12	22	12	22	12	22	46
1985	102	181	55	134	7	13	7	13	7	13	7	13	
1986	513	908	277	672	5	9	5	9	5	9	5	9	
1987	1035	1831	559	1355	60	107	60	107	60	107	60	107	
1988	1398	2473	755	1830	87	154	87	154	87	154	87	154	
1989	363	642	196	475	135	240	135	240	135	240	135	240	
1990	1670	2954	902	2186	257	455	257	455	257	455	257	455	
1991	1428	2527	771	1870	170	301	170	301	170	301	170	301	
1992	1698	3004	917	2223	86	152	86	152	86	152	86	152	
1993	1158	2048	625	1516	20	36	20	36	20	36	20	36	
1994	193	342	104	253	156	276	156	276	156	276	156	276	
1995	1050	1858	567	1375	85	150	84	149	85	150	84	149	
70-85 X	35	62	19	46	6	10	5	9	6	10	5	9	
86-95 X	1051	1859	567	1375	106	188	106	188	106	188	106	188	

Notes CPUE is retained catch per rod-day.

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 1981-1995, percent small is calculated from numbers of small and large salmon taken at the Leard's Pond trap.

Small recruits are calculated as small retained salmon/exploitation rate. Angler exploitation was calculated in 1995 as 36% of estimated small salmon returns. No other exploitation rates have been measured. The min and max numbers of small recruits are calculated using 0.36 + or - 0.1, i.e. 0.26 and 0.46.

Small spawners = number of small recruits - number of small retained

Large spawners = number of large recruits - number of large retained

Large recruits = (number of small recruits/(0.01*percent small))-number of small recruits

It is asssumed that large salmon and 2SW salmon are equivalent

The commercial salmon fishery had much higher catches than the concurrent sports fishery, and

During the years of the commercial fishery, commercial landings were far greater than estimated local runs, and commercial catches were widely distributed along the north shore of PEI. For these reasons it appears likely that most fish taken by the commercial fishery were destined for mainland rivers.

Appendix 11(a) Total 2SW returns and spawners, SFA 18, 1970-1995.

	LARGE RETURNS						*Commercial catch*			*TOTAL 2SW*		*SPAWNERS*				*TOTAL*	
	Margaree		SFA 18		*2SW RETURNS*			2SW fish		RETURNS				SFA 18		*SPAWNERS*	
	Large salmon		1.381	2.151	0.77	0.87	Zone 6	0.77	0.87	(inc comm.)		Margaree		1.381	2.151	0.77	0.87
Year	Min	Max	Min	Max	Min	Max	(kg)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1970	581	1,000	803	2,151	618	1,871	30,440	4,262	4,815	4,880	6,686	657	1,145	908	2,462	699	2,142
1971	254	437	351	940	270	818	12,001	1,680	1,898	1,950	2,716	256	446	354	959	272	834
1972	284	488	392	1,050	302	914	31,840	4,458	5,037	4,759	5,950	272	474	376	1,019	289	887
1973	316	544	437	1,170	336	1,018	27,694	3,877	4,381	4,213	5,399	287	499	396	1,074	305	934
1974	289	498	399	1,070	308	931	37,437	5,241	5,922	5,549	6,853	318	554	440	1,191	339	1,036
1975	173	298	239	641	184	558	23,631	3,308	3,738	3,492	4,296	214	372	295	800	227	696
1976	222	381	307	819	236	713	18,361	2,571	2,904	2,807	3,617	267	465	369	1,000	284	870
1977	378	651	522	1,400	402	1,218	26,221	3,671	4,148	4,073	5,366	393	683	543	1,469	418	1,278
1978	427	735	590	1,581	454	1,375	30,216	4,230	4,780	4,684	6,155	510	888	705	1,909	543	1,661
1979	219	377	303	811	233	705	7,917	1,108	1,252	1,341	1,958	265	461	366	991	282	863
1980	378	651	522	1,400	402	1,218	24,412	3,418	3,862	3,820	5,080	497	865	687	1,860	529	1,618
1981	375	647	518	1,391	399	1,211	15,562	2,179	2,462	2,578	3,672	451	785	623	1,688	480	1,469
1982	484	833	669	1,791	515	1,559	26,664	3,733	4,218	4,248	5,776	555	965	766	2,076	590	1,806
1983	402	693	555	1,490	428	1,297	24,280	3,399	3,841	3,827	5,137	480	834	663	1,794	510	1,561
1984	327	583	452	1,254	348	1,091	15,140	2,120	2,395	2,467	3,486	296	532	409	1,144	315	995
1985	1,109	2,217	1,532	4,768	1,180	4,148		0	0	1,180	4,148	1,025	2,133	1,416	4,587	1,090	3,991
1986	2,738	5,680	3,782	12,216	2,912	10,628		0	0	2,912	10,628	2,583	5,525	3,568	11,882	2,747	10,338
1987	2,976	6,540	4,111	14,065	3,165	12,237		0	0	3,165	12,237	2,860	6,424	3,951	13,816	3,042	12,020
1988	1,286	2,494	1,776	5,364	1,368	4,666		0	0	1,368	4,666	1,143	2,351	1,579	5,056	1,216	4,399
1989	1,708	3,693	2,359	7,942	1,817	6,910		0	0	1,817	6,910	1,583	3,568	2,187	7,673	1,684	6,676
1990	3,939	8,353	5,441	17,964	4,190	15,629		0	0	4,190	15,629	3,483	8,315	4,811	17,883	3,704	15,558
1991	1,853	5,785	2,560	12,441	1,971	10,824		0	0	1,971	10,824	1,692	5,624	2,337	12,095	1,800	10,523
1992	4,875	9,375	6,734	20,162	5,185	17,541		0	0	5,185	17,541	4,722	9,222	6,523	19,833	5,022	17,255
1993	2,408	6,158	3,326	13,244	2,561	11,522		0	0	2,561	11,522	2,274	6,024	3,141	12,955	2,419	11,271
1994	2,350	4,500	3,246	9,678	2,500	8,420		0	0	2,500	8,420	2,209	4,359	3,051	9,375	2,350	8,156
1995	1,742	4,474	2,406	9,622	1,853	8,371		0	0	1,853	8,371	1,685	4,417	2,328	9,499	1,792	8,264

	SFA	Marg-	
Yr	18	aree	Ratio
84	449	305	1.47
85	1706	1215	1.40
86	4448	2636	1.69
87	3012	1857	1.62
88	3078	1932	1.59
89	3206	1570	2.04
90	2391	1507	1.59
91	3470	1757	1.97
92	3315	1938	1.71
93	2370	1102	2.15
94	2043	1479	1.38
95	1599	1040	1.54
		Min	1.381
		Max	2.151

Margaree returns, 1970-84, equal catch /min (0.215) or max (0.37) exploitation rate.
Return of large salmon (MIN) and (MAX)to all SFA 18 equals Margaree returns * ratio
Margaree catch to SFA 18 catch.
Margaree returns 1984-1995 based on various Margaree CAFSAC Research Documents.
Margaree catch to SFA 18 catch; MIN _MAX 2SW based on the ratio 0.77-0.87 2SW fish among MSW fish.
Margaree escapements 1970-1983 = returns minus removals; 1984-1995 from various Margaree CAFSAC
Research Documents by Claytor and Chaput; 2SW equal 0.77-0.87 of MSW fish; Margaree raised to SFA by respective ratios in sport catch.

Appendix 11(b) Total 1SW returns and spawners, SFA 18, 1970-1995.

	RETURNS				*SPAWNERS*			
	Margaree		SFA 18		Margaree		SFA 18	
	0.37	0.21	1.000	1.405			1.000	1.405
Year	Min	Max	Min	Max	Min	Max	Min	Max
1970	230	395	230	556	145	310	145	436
1971	57	98	57	137	36	77	36	108
1972	114	195	114	275	72	153	72	215
1973	449	772	449	1,085	283	606	283	852
1974	162	279	162	392	102	219	102	308
1975	97	167	97	235	61	131	61	185
1976	259	447	259	627	163	351	163	493
1977	186	321	186	451	117	252	117	354
1978	68	116	68	163	43	91	43	128
1979	1,614	2,777	1,614	3,902	1,017	2,180	1,017	3,063
1980	451	777	451	1,092	284	610	284	857
1981	2,430	4,181	2,430	5,876	1,531	3,282	1,531	4,613
1982	1,868	3,214	1,868	4,516	1,177	2,523	1,177	3,545
1983	184	316	184	444	116	248	116	349
1984	400	688	400	967	158	446	158	627
1985	634	1,167	634	1,640	125	658	125	925
1986	838	1,420	838	1,995	56	638	56	897
1987	1,143	1,865	1,143	2,621	166	888	166	1,248
1988	1,674	2,911	1,674	4,091	795	2,032	795	2,855
1989	591	977	591	1,373	30	416	30	585
1990	940	5,077	940	7,134	291	4,428	291	6,222
1991	794	3,891	794	5,468	42	3,139	42	4,411
1992	1,258	2,419	1,258	3,399	701	1,862	701	2,617
1993	1,489	3,851	1,489	5,412	906	3,268	906	4,592
1994	573	1,101	573	1,547	255	783	255	1,100
1995	596	1,146	596	1,610	346	1,062	346	1,492

Recreational ctch			
Year	SFA 18	Marg-aree	Ratio
1984	242	242	1.00
1985	509	509	1.00
1986	957	782	1.22
1987	1069	977	1.09
1988	1113	879	1.27
1989	694	561	1.24
1990	912	649	1.41
1991	904	752	1.20
1992	944	678	1.39
1993	836	777	1.08
1994	435	429	1.01
1995	436	323	1.35
		Min	1.000
		Max	1.405

Margaree returns, 1970-83, equal catch divided by MIN (0.215) and MAX (0.37) exploitation rate. Return of small salmon to all SFA 18 equals Margaree returns * MIN and MAX ratio of Margaree catch to SFA 18 catch. Margaree returns, 1984-1995, based on annual assessments in CAFSAC and DFO Atl. Fish. Res. Docs, eg., Claytor et al 1995.

Spawners for 1970-1983 equal returns minus removals; 1984-1995 from various Margaree CAFSAC and Atl. Res. Docs, eg., Claytor et al 1995.

Appendix 12 Total 1SW returns and spawners, SFAs 19, 20, 21 and 23, 1970-1995.

	RETURNS						TOTAL RETURNS			SPAWNERS					TOTAL SPAWNERS	
	River returns SFA 19-21		Comm-ercial	SFA 23 Wild	SFA 23 Wild		SFA 19,20,21,23		angled	Spawners 19-21		SFA 23 H+W rtns		Harvest	19,20,21,23	
Year	Min	Max	19-21	Min	Max	Htch	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	10,708	22,366	0	14,105	20,227	1,451	26,264	44,044	4,724	5,984	17,642	15,556	21,678	5,266	16,274	34,054
1985	14,561	29,982	0	11,038	15,910	2,018	27,617	47,910	6,360	8,201	23,622	13,056	17,928	4,892	16,365	36,658
1986	14,130	29,233	0	13,412	19,321	862	28,404	49,416	6,182	7,948	23,051	14,274	20,183	3,549	18,673	39,685
1987	16,129	32,979	0	10,030	14,334	3,328	29,487	50,641	7,056	9,073	25,923	13,358	17,662	3,101	19,330	40,484
1988	14,613	30,253	0	15,131	21,834	1,250	30,994	53,337	6,384	8,229	23,869	16,381	23,084	3,320	21,290	43,633
1989	15,097	30,703	0	16,240	23,182	1,339	32,676	55,224	6,629	8,468	24,074	17,579	24,521	4,455	21,592	44,140
1990	16,933	34,743	0	12,287	17,643	1,533	30,753	53,919	7,391	9,542	27,352	13,820	19,176	3,795	19,567	42,733
1991	5,461	11,115	0	10,602	15,246	2,439	18,502	28,800	2,399	3,062	8,716	13,041	17,685	3,546	12,557	22,855
1992	8,299	16,987	0	11,340	16,181	2,223	21,862	35,391	3,629	4,670	13,358	13,563	18,404	4,078	14,155	27,684
1993	7,629	15,713	0	5,439	7,880	1,156	14,224	24,749	3,327	4,302	12,386	6,595	9,036	415	10,482	21,007
1994	1,136	2,320	0	3,880	5,554	1,258	6,274	9,132	493	643	1,827	5,138	6,812	392	5,389	8,247
1995	4,329	8,879	0	3,675	5,268	2,907	10,911	17,054	1,900	2,429	6,979	6,582	8,175	152	8,859	15,002

SFAs 19,20,21: Returns 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 et. al. 1985).

SFA 22: Inner Fundy stocks (primarily 1SW fish) do not go to the North Atlantic.

SFA 23: Similar approach as for 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 exploitation rates, Marshall (1992) (commercial harvest, bycatch etc., incl. in estimated returns); hatchery returns attributed to above Mactaquac only; 1SW production in remainder of SFA (outer Fundy) omitted.

Spawners equal river returns minus in-river removals.

Appendix 13(a) Total 2SW returns SFAs 19, 20, 21 and 23, 1970-1995.

Year	*SFA 19* Min	Max	*SFA 20* Min	Max	*SFA 21* Min	Max	2SW Comm-ercial 19-21	*SFA 23* Wild Min	Wild Max	Htch Min	Htch Max	*TOTAL RETURNS* SFAs 19,20,21,23 Min	Max
	2SW=0.7-0.9 Exp. rate=0.2-0.45		2SW=0.6-0.9 Exp. rate=0.2-0.45		2SW=0.5-0.9 Exp. rate=0.2-0.45			2SW= 0.85-0.95 p. abv= 0.4-0.6		2SW= 0.85-0.95			
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	2,809	6,181	2,022	4,730	1,105	2,945	0	3,936	5,836	780	861	10,652	20,553
1989	2,202	4,676	1,501	3,484	1,631	4,086	0	6,159	8,994	401	443	11,894	21,683
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	4,470	6,504	363	402	7,279	12,622
1994	833	1,845	236	552	305	773	0	2,790	4,066	430	475	4,594	7,711
1995	753	1,614	648	1,496	519	1,306	0	2,504	3,670	512	566	4,936	8,652

SFAs 19,20,21: Returns 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 et. al. 1985).

SFA 22: Inner Fundy stocks do not go to north Atlantic.

SFA 23: 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, Marshall (1992) (commercial harvest, bycatch etc., incl. in estimated returns) + est. 0.85-0.95 * MSW hatchery returns to Mactaquac; 2SW production in remainder of SFA ignored.

Appendix 13(b) Total 2SW spawners SFAs 19, 20, 21 and 23, 1970-1995.

	SFA 19		*SFA 20*		*SFA 21*						*SFA 23 H + W*		*SFA 23 H + W*		*2SW SPAWNERS*	
	River returns		River returns		River returns		*Angled (19-21)*		*Spawners (19-21)*		River returns		Harvests		SFA19,20,21,23	
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	0	0	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	0	0	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	0	0	4,607	10,636	6,922	10,043	1,294	1,446	10,235	19,233
1988	2,809	6,181	2,022	4,730	1,105	2,945	0	0	5,936	13,856	4,716	6,697	1,296	1,449	9,356	19,104
1989	2,202	4,676	1,501	3,484	1,631	4,086	0	0	5,334	12,246	6,560	9,437	250	279	11,644	21,404
1990	2,406	5,178	1,085	2,515	1,271	3,260	0	0	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	0	0	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	0	0	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	0	0	2,446	5,716	4,833	6,906	680	760	6,599	11,862
1994	833	1,845	236	552	305	773	0	0	1,374	3,170	3,220	4,541	279	312	4,315	7,399
1995	753	1,614	648	1,496	519	1,306	0	0	1,920	4,416	3,016	4,236	122	136	4,814	8,516

River returns from App.......; river returns minus in-river removals equal spawners

APPENDIX 14

COMPUTATION OF CATCH ADVICE FOR WEST GREENLAND

The North American Spawning Target (SpT) for 2SW salmon has been revised to 180,495 fish in 1996.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. $SpR = SpT * (exp(11*M)$ (where $M = 0.01$)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. $MAH = PFA - SpR$

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. $NA1SW = f_{NA} * MAH$

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] [1]. Thus:

Eq. 4. $E1SW = (NA1SW / PropNA) - NA1SW$

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric tonnes, it is necessary to incorporate the mean weights (kg) of salmon for North America [WT1SWNA][1] and Europe [WT1SWE][1] and age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon [ACF][1]. The quota (in tonnes) at Greenland is then estimated as

Eq. 5. $Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000$

[1] New sampling data from the 1995 fishery at West Greenland were used to update the forecast values of the proportion of North American salmon in the catch (PropNA), mean weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF] in 1996.