Advisory Committee on
Fisheries Management

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REPORT OF THE

WORKING GROUP ON NORTH ATLANTIC SALMON

ICES Headquarters
7–16 April 1997

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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 1996 Statutory Meeting, ICES resolved (C. Res. 1996/2:14:13) that the Working Group on North Atlantic Salmon (Chairman: Dr T.L. Marshall, Canada) will meet at ICES Headquarters from 7–16 April, 1997 to consider questions which include those posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO) and by the Oslo and Paris Commissions (OSPAR). ICES also resolved that a half day joint session will be held with the Baltic Salmon and Trout Assessment Working Group (Co-Chairmen: T.L. Marshall and L. Karlsson) on 12 April 1997 to consider questions posed by ICES. The terms of reference and sections of the report in which the answers are provided, follow.

a) With respect to Atlantic salmon in the North Atlantic area:	Section
i. provide an overview of salmon catches, including unreported catches, and production of farmed and ranched salmon in 1996;	2.1 & 2.2
ii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.3
iii. describe the causes of long-term changes in sea-age composition of salmon stocks;	2.4
iv. describe the causes of changes in abundance of salmon with special reference to changes in natural mortality and ocean climate;	2.5
v. provide a compilation of microtag, finclip and external tag releases by ICES member countries in 1996;	2.6
vi. propose a definition of safe biological limits using target reference points based, where appropriate, on biomass, fishing mortality, maturity, growth, age structure, exploitation pattern, geographic distribution and other relevant parameters; based on the above parameters, propose limit reference points to be avoided with a high probability;	2.7
vii. provide information on quantities of discards by gear type and area for the stocks of fish and fisheries considered by this group [OSPAR 1997/5.3] and report to WGECO.	2.8
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	
i. describe the events of the 1996 fisheries and the status of the stocks;	3.1- 3.4
ii. update the evaluation of the effects on stocks and homewater fisheries of the suspension of commercial fishing activity at Faroes since 1991;	3.5
iii. develop age specific spawning targets;	3.6
vi. provide catch options with an assessment of risks relative to the objective of achieving spawning targets;	3.7
v. evaluate the potential by-catch of post-smolts in pelagic fisheries;	3.8
vi. identify relevant data deficiencies and research requirements.	3.9
c) With respect to Atlantic salmon in the North American Commission area:	
i. describe the events of the 1996 fisheries and the status of the stocks;	4.1, 4.2
ii. update the evaluation of the effects on US and Canadian stocks and fisheries of quota management and closures implemented after 1991 in the Canadian commercial salmon fisheries;	4.3
iii. update age-specific spawning targets based on new information as available;	4.4
iv. provide catch options with an assessment of risks relative to the objective of achieving spawning targets;	4.5
v. provide multi-year projections of salmon abundance;	4.6
vi. identify relevant data deficiencies and research requirements.	4.7
d) With respect to Atlantic salmon in the West Greenland Commission area:	
i. describe the events of the 1996 fisheries and the status of the stocks;	5.1
ii. provide catch options with an assessment of risks relative to the objective of achieving spawning targets;	5.2
iii. identify relevant data deficiencies and research requirements.	5.3

e) provide information on the scale of escapes from fish culture operations and quantify the expected effects at the population level [OSPAR 1997/4.1].	6
A half-day joint session will be held with the **Baltic Salmon and Trout Assessment Working Group** in Charlottenlund (revised ICES) on 14 April 1997:	
a) to discuss current progress with the implementation of spawning targets with reference to the conclusions of the Workshop on Spawning Targets held in France in June 1996;	7 & App. 1
b) define the term "wild salmon".	App. 1

The minutes of the Joint WGNAS and WGBAST Session appear in Appendix 1.

The Working Group considered 36 Working Documents submitted by participants (Appendix 2); other references cited in the report are given in Appendix 3.

1.2 Participants

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Jacobsen, J.A.	Faroes
Kanneworff, P.	Greenland
Länsman, M.	Finland
MacLean, J.	U.K. (Scotland)
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Roche, P.	France
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Whoriskey, F.	Canada
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Zubchenko, A.	Russia

A full address list for the participants is provided in Appendix 4.

2 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

2.1 Catches of North Atlantic Salmon

2.1.1 Nominal catches of salmon

Total nominal catches of salmon reported by country in all fisheries for 1960–1996 are given in Table 2.1.1.1, and nominal catches in homewater fisheries, divided into size or age categories where such data are available, are given in Table 2.1.1.2. Catch statistics in the North Atlantic also include fish farm escapees and, in some north-east Atlantic countries, ranched fish (see Section 3).

In contrast to previous years' reports, the nominal catch of salmon reported for Iceland has been altered (from 1960) to exclude ranched salmon. The rationale for this unilateral decision was that as the ranched component of the previously reported nominal catch was large (66% in 1995) trends in the catch of wild salmon were masked. Although there are several definitions of "ranching," Iceland takes the view that it is defined as "... [large] scale releases of salmon smolts by private companies with the intent of harvesting all the salmon, upon their return, [at the release site.] ..." (Isaksson, 1994). On this basis, the Working Group considered that while it was appropriate to remove the ranched component from the Icelandic catch it was also appropriate to leave in the ranched component in other countries catches where ranching was on a smaller scale, experimental or where harvesting was not conducted solely at the release site.

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

The updated total nominal catch for 1995 of 3,339 t is 289 t less than the total for 1994 of 3,628 t. Catches in most countries remain below the averages of the previous 5 and 10 year averages. Figures for 1996 (2,860 t) are provisional and incomplete, but the final total is unlikely to exceed the 1995 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 most countries have decreased fishing effort and this accounts for some of the decline in catches in recent years.

2.1.2 Catches in numbers by sea-age and weight

Reported nominal catches for several countries by season and weight are summarised in Table 2.1.2.1. As in Tables 2.1.1.1 and 2.1.1.2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1996 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 2.1.2.1. The composition of catches in different areas is discussed in more detail in Sections 3, 4 and 5.

2.1.3 Unreported catches

Unreported catches by year and Commission Area are presented in Table 2.1.3.1. A discussion of the methods used to evaluate the unreported catches is provided in Section 13 of last years report (ICES 1996/Assess:11). The total unreported catch in NASCO areas in 1996 was estimated to be 1,123 t, an increase of about 6% compared with 1995 but a decrease of about 26% on the 1991–95 mean of 1525 t.

The unreported catch estimated for the North East Atlantic Commission Area in 1996 was 947 t, a 32% reduction on the mean for 1991-95 of 1,390 t, and that for the North American Commission Area was 156 t, 24% above the 1991–95 mean of 126 t. There was no change in the small estimated unreported catch for the West Greenland Commission Area of around 20 t.

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 1995/1996 season. A total of 24 surveillance flights was reported to have been undertaken by the Icelandic and Norwegian Coastguards between late autumn and early summer, and no salmon fishing was observed in the area.

2.2 Farming and Sea Ranching of Atlantic Salmon

2.2.1 Production of farmed salmon

The production of farmed salmon in the North Atlantic area in 1996 was 450,394 t (Table 2.2.1.1 and Figure 2.2.1.1). This was the highest production in the history of the farming industry and represented a further 9% increase compared to 1995 (411,580 t) and a 54% increase on the 1991–95 average (292,632 t). The countries with the largest production were Norway and Scotland, which accounted for 68% and 18% of the total respectively. Proportional increases in production in the other seven countries were limited to between 0% and 4%. The production of farmed salmon in 1996 was over 150 times the nominal catch of salmon in the North Atlantic.

2.2.2 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) (ICES 1994/M:16). The total production of ranched salmon in countries bordering the North Atlantic in 1996 was 266t which is the lowest value since 1989 (Table 2.2.2.1 and Figure 2.2.2.1). The majority (89%) of the ranching is conducted in Iceland, where the production is almost double the nominal catch. Production at experimental facilities in Ireland, U.K. (N. Ireland) and Norway has remained low. 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.

2.3 Significant Development towards Management of Salmon

2.3.1 Stock discrimination at West Greenland

The Atlantic salmon (*Salmo salar* L.) fishery along the west coast of Greenland presents a complex problem, in that this fishery is based mainly on salmon originating from rivers in North America and Europe. These salmon belong to the multi-sea-winter components of the stocks involved and, in recent years, the catch has predominantly consisted of 1-sea-winter (1SW) salmon that, if not caught, would have returned to home waters as 2-sea-winter (2SW) salmon. Since 1969, discriminant analysis based on scale characters has been used to determine the proportions of the two continental stock groups in this fishery. Both scale characters and protein polymorphisms have been used extensively to discriminate between stocks or groupings of stocks of Atlantic salmon (Payne and Cross 1977; Cook and Lord 1978; Lear and Sandeman 1980; Cross and Healy 1985). The genotypic approach using protein polymorphisms has the advantage over the phenotypic approach using scale characters, in that it is not subject to annual variation. However, its routine use for discriminating North American from European salmon at Greenland is precluded because it is impossible to obtain the necessary tissue samples from a large enough sample of fish caught in the Greenland fishery. Beginning in 1986, a combined genotypic/phenotypic approach was used whereby a subset of the samples obtained from the Greenland fishery was also sampled for liver and muscle tissue, from which continent of origin was determined using genetic protein polymorphisms (Reddin *et al.* 1987a). The scale characters from this subset were used as a database for discriminant analysis to determine the proportions of North American and European salmon in all of the samples from this fishery.

Samples of muscle tissue were taken from salmon landed at the fish plant in Nuuk, Greenland during the 1995 sampling programme at Greenland. A total of 132 salmon were systematically sampled from the West Greenland fishery on two days, viz. August 21 and 22.

Genetic analyses

Microsatellite markers: In North America only 5 animals out of more than 480 sampled exhibited alleles of less than 266 base pairs. All five animals were from the Gander River. Therefore, anything with allele size less than 266 will be called European/North American.

Mitochondrial DNA markers: There were no contradictions among the NADH and D-loop markers. The pattern is either one (1 = North America) or the other (2 = Europe). The only D-loop haplotype observed in Europe (about 160 animals) is a 122 pattern. Any animal with a 2 for ALU (the first number in the haplotype) is called North America. Similarly, any animal with a 1 for Mse or Tsp 509 was called North American.

The samples were run through the same discriminant analysis as was used to determine the continent of origin in 1995. In 1995, the discriminant analysis was based on river age and CS1S, and CS1W scale character variables. The assumption is that the DNA analysis provides an absolute marker for continent of origin while the scale analysis has an associated level of misclassifications. Comparison of the results from the discriminant analysis of scale characters and the DNA analysis provides information on the reliability of classifications. Out of the 132 samples collected there were 12 samples with DNA of poor quality for which a continent of origin could not be determined. In total, from samples collected in 1995 for which origin could be determined by DNA analysis, there were 107 (89%) North American and 13 (11%) European. Of these, there were 10 samples with scales of insufficient quality for scale reading. In total, for the samples with results from both scales and DNA classifications, there were 99 (90%) North American and 11 (10%) European salmon. The results of classifying test samples indicated misclassification rates of 14.5% and error rates of ± 9.1%. This is an acceptable level of misclassifications given the low number of European salmon in the test sample. The two samples from which the tissue samples for DNA analysis were taken were classified as 74–77% North American origin.

The Working Group continues to recognise the importance of in-season identification to continent of origin using genetic techniques to calibrate scale-based identification of the fishery catch at Greenland. The need for these data arose when it was found that scale-based growth features deposited during the post-smolt year that differentiate the continental groups can converge, thus making continent of origin identification less reliable. This problem can be rectified by in-season genetic sampling, however, the Working Group recommended that other methods be explored which may be used to evaluate the scale-based method without the added expense and difficulty of the present genetic sampling. Specifically, the Working Group recommends that an investigation of environmental predictors of the scale-based features used in the classification be undertaken. Further to the larger problem of accurately identifying larger segments of the catch to continent of origin, the Working Group encourages the development of new genetic techniques that can be applied to larger quantities of catch than present methods. The Working Group continues to support and encourage existing genetic monitoring programs identifying continent of origin of in-season samples from W. Greenland.

2.4 Causes of Long-Term Changes in Sea-Age Composition of Salmon

Material discussed in the 1996 WGNAS (Sections 7.1, 7.4 and 14; Section 7.1, Possible explanations for changes in sea-age at maturity) summarised the likely roles of genetic and environmental (including fishery) effects in determining sea-age at maturity in stocks, populations or individuals. Section 7.4 (Use of Sr:Ca ratios in otoliths to determine maturation status) described a new method that may permit indirect examination of the events leading up to sexual maturity. Section 14 (Changes in growth rate, mean weight at age and proportion of different size groups) collated national data sets for weight, age and maturity rate in salmon stocks.

The Report stressed differences between the sexes and the multiplicity of possible interactive effects acting at every level and throughout life to determine age at maturity. The available field data sets lacked sufficient robustness to test general hypotheses. In particular, data sets that combine measures of absolute abundance with measures of maturity rate are not generally available.

This poses particular difficulties for determining the mechanisms which interact to determine when fish mature, and the causes of long-term trends. Long-term trends in the frequency of maturing fish at any sea-age in any stock or population might arise from:

1. changes in the absolute abundance of the maturing class being considered,

2. changes in the absolute abundance of other classes,

3. changes in the absolute abundance of both groups,

In turn, these component changes might be caused by:

4. changes in the development of genetically unchanged individuals in response to environmental change,

5. differential mortality among population or stock groupings that are unequally exposed or unequally susceptible to environmental change (in particular differing effects in the fresh water and marine environment),

6. changes of balance among population groups, as stronger groups expand to exploit resources vacated by weaker ones.

Unlike 1–4 above, points 5 and 6 are population-based concepts that have not been explored in relation to salmon. Phenomena such as those described in points 5 or 6 are capable of generating long-term trends in characteristics like sea-age at maturity that are partly determined by genetics and that vary among populations. The same concepts are potentially informative in relation to long-term trends in abundance considered in Section 2.5.

2.5 Causes of Changes in Abundance of Salmon

Temporal changes in marine abundance at any sea-age may relate to variation in marine survival or to variation in smolt recruitment. Causes of marine mortality were discussed in the 1996 Report of the WGNAS (Sections 4.5 and 5.3). No new information on the effects on abundance of diseases, pathogens or predators has been made available to the WGNAS.

2.5.1 Mortality and ocean climate

This rapidly developing area has been the subject of intense study. Recent attention has been directed at modelling the responses of Northeast Atlantic salmon populations to marine environmental change. Trophic studies off the Faroes (Jacobsen and Hansen 1996) indicate that feeding cycles and possible prey abundance are changing, which will affect salmon growth and survival (see also Section 3.2.4 of this report).

Sea Surface Temperatures and Post-smolt Survival in the Northeast Atlantic

The first year of ocean life of Atlantic salmon is shaped by natural mortality and sexual maturation (Thorpe 1994; Friedland and Hass 1996; Friedland *et al.* 1996). However, it is clear that populations have differing maturity schedules and that stocks can show dramatic variation in maturity rate (Power 1981, Saunders 1981, Shearer 1990, Summers 1995). Marine natural mortality in salmonids is believed to be most severe on populations during the first weeks to months at sea (Fisher and Pearcy 1988; Holtby *et al.* 1990, Eriksson 1994, Salminen *et al.* 1995). It is also believed that mortality effects are growth mediated during this period due to either variation in ocean productivity, interspecific competition, or intraspecific interactions (Ricker 1962; Neilson and Geen 1986; L'Abée-Lund *et al.* 1993; Friedland *et al.* 1996). Therefore, broad scale processes that may affect salmon growth are of particular interest.

Ocean climate appears to be intimately linked to mortality and maturation mechanisms in salmon. Wild salmon smolts have been tagged in the rivers Figgjo (southern Norway) and North Esk (eastern Scotland) (Figure 2.5.1) since 1965. A study was presented to the working group where return rates of tagged one and two seawinter salmon from these rivers were used to evaluate survival conditions for this region. Survival rates were correlated between rivers and among sea ages (Figure 2.5.2). Survival rates were compared to the areal extent of thermal habitat in the Northeast Atlantic Ocean. The strongest correlations between survival rate and areal extent of thermal habitat occurred during the month of May (8–10°C water), and were positive. A reciprocal negative correlation was also found between survival and 5–7°C water in the same month (Figure 2.5.3), and significant correlations to cold water habitat were also observed for June data. An analysis of sea surface temperature distributions for periods of good versus poor salmon survival showed that when cool surface waters dominate the Norwegian coast and North Sea during May, salmon survival has been poor (Figure 2.5.4). Conversely, when the 8°C isotherm extended northward along the Norwegian coast during May, survival was good. Thus, it is the variation in temperature conditions for this segment of the Norwegian coast which is most critical to the post-smolts. This section of the Norwegian coast is dominated by a coastal current that travels to the northeast at a mean seasonal rate of 15–20 cm sec^{-1} (Hopkins 1991). Jonsson *et al.* (1993) reported on the migration of post-smolts in this current. Migratory speeds averaged 7.45 km day^{-1} and post-smolts rarely moved southward against the prevailing currents. Thus, salmon post-smolts from the Figgjo and North Esk would be expected to occupy this thermally dynamic segment of the coast.

In this study, it was not possible to ascertain when during the post-smolt year the highest mortalities occurred. Eriksson (1994) reported that the highest post-smolt mortalities in the Baltic Sea occurred during the first weeks at sea. This suggests that the important period is when Figgjo and North Esk salmon would first be entering the marine environment, which is consistent with the results of the sea surface temperature correlation analysis. Interestingly, survival fluctuated similarly for both 1SW and 2SW salmon for both populations, thus the contribution of maturation mechanisms to the observed return rates can be discounted.

Indirect linkages between environmental conditions and smolt survival could be tested with retrospective growth analyses. Friedland *et al.* (1996) demonstrated a relationship between post-smolt growth and survivorship in hatchery stocks from North America.

Developing research on the Kola Peninsula

Climate mediated recruitment patterns may be occurring in this region. To study the impact of climate on quantitative characteristics of salmon populations, mean yearly water temperatures in the 0–200 m depth interval along the Kola Meridian transect in the Barents Sea and data on the abundance of recruitment and spawning stock of the Tuloma River (Figure 2.5.5) have been analysed. A Ricker curve was fitted to the stock-recruit data. A linear relationship has been established between the abundance of this spawning stock and water temperature at sea (Figure 2.5.6).

In the light of this relationship all salmon year-classes that had fully gone through the fisheries were analysed. A comparison of the strength of recruitment from those year classes and water temperatures at sea and in the river showed cyclical variations of recruits and temperature regime (e.g. Figures 2.5.7 and 2.5.8). This relationship is rather weak ($r^2 = 0.24$), however, these two time series have a common cycle, revealed by a harmonic analysis, with a period close to 7 years. Rich year classes appeared in the years when mean yearly water temperature at sea was about 4°C or warmer.

2.5.2 Smolt recruitment

The number of salmon at sea depends on several variables, including the number of smolts which leave the river systems. Smolt production is susceptible to the effects of adult numbers through levels of egg deposition. Declines in spawner numbers caused by declining trends in marine survival have the potential to feed-back negatively on marine abundance.

For example, in recent years marine mortality has become the driving variable in determining smolt recruitment for the Girnock Burn, a tributary of the River Dee (U.K., Scotland). Trap counts indicate that smolt numbers are declining in response to a sequence of years in which egg deposition has been marginal or inadequate in relation to a threshold value (ca. 40 females). This threshold has been derived empirically from a long time series of data (1966–present) relating smolt output to estimates of egg deposition based on trap counts of female spawners. Fishing effort has been reduced in the oceans and in coastal homewaters and in-river mortality for the River Dee, specifically, has been reduced by the introduction of an advised catch-and-release policy for Dee anglers. Recent high levels of mortality among pre-spawners are therefore attributed to non-fishing causes. At spawning, the Girnock Burn population is composed of early-running 2SW, and a small proportion of early-running 1SW fish. In recent years, early-running 2SW fish generally have suffered high rates of marine mortality, as evidenced by strong declining rod catch trends for early-running 2SW (i.e. spring) salmon in all the major U.K. rivers (Youngson 1995).

In the case of the Girnock Burn, the extra marine mortality of recent years has reduced smolt production. This effect will feed back on future recruitment of spawners.

The Girnock Burn produces mainly 2- or 3-year-old smolts. Interactions among juvenile cohorts and changes in mean age composition at smolting provide some robustness to single episodes of inadequate spawning. Smolt production is not expected to be robust in a series of marginal or inadequate spawning years.

The full effects of increased mortality among pre-spawners have been lessened by the introduction of a voluntary but effective catch-and-release policy for the River Dee. In 1996, for example, eight of the 41 female spawners captured at the Girnock trap (20%) showed evidence of being released after capture by angling. Seven showed evidence of hook damage to the mouthparts. Another fish with no obvious hook wound had been radiotagged after capture by angling.

2.6 Compilation of Tag Release and Finclip Data for 1996

Data on releases of tagged and finclipped salmon in 1996 were provided by the Working Group and will be compiled as a separate report. A summary of national markings is given in Table 2.6.1. In 1996, a total of nearly 3.4 million salmon were marked, nearly equal to the number marked in 1995 (3.5 million). Finclips (1.63 million) and microtags (0.82 million) were the most frequently used marks. Most marks were applied to reared parr and smolts (3.33 million) with only small numbers of wild parr and smolt (0.049 million) and adult fish (0.020 million) being marked.

2.7 Safe Biological Limits

Proper management of Atlantic salmon requires that the spawning populations of each river (and possibly subcatchments within the river) be conserved. This necessitates setting a minimum threshold below which populations should not fall, and a higher target reference level for managing fisheries. However, the life cycle of the salmon and the nature of the fisheries limit the possible management approaches and tools. Anadromous Atlantic salmon leave their rivers to undertake feeding migrations to the ocean. Most are at sea for 1 (1SW or Grilse) or 2 (2SW) years before returning to spawn, with the fish returning after 2 or more years (MSW) undertaking more distant migrations than those that return after 1 year. In the ocean, fish from many different populations mix together and catches are probably not evenly distributed among individuals from all the contributing populations. Grilse and MSW cohorts are for the most part exploited by sea and home water fisheries in a single year (similar to a short lived species, see ICES 1993/Assess:12). Independent verifications of projections of prefishery abundances are not available until after the fisheries, and age-structured methodologies like VPA are not applicable. In addition, the salmon will not react like many other species in that if disproportionate catches on one river's population are taken, compensatory shifts in growth and recruitment among the juveniles in other rivers will not occur. Taking these considerations into account, the Working Group has established the following biological reference points:

2.7.1 Conservation limit

Within the North Atlantic Salmon Working Group, there is general acceptance of the MBAL (minimal biologically accepted level) as a threshold below which spawning biomasses should not fall (ICES 1995/Assess:14). MBAL has been defined by the Working Group as the stock level that produces maximum gain (MSY) (ICES 1995/Assess:14). The Working Group selected this point because it could be defined unambiguously from fitted stock/recruit relationship. Methodologically consistent MBAL values can therefore be derived wherever appropriate data are available. This choice is also consistent with ACFM's advice approach, where "... MBAL can be defined by the level of spawning stock below which the data indicated that the probability of poor recruitment increases as the spawning stock size decreases. Any action that was expected to reduce spawning stock size below this level would, therefore, be outside biological limits."

In Canada, wherever possible this threshold is derived from stock-recruit relations on a river-by-river basis. Originally, CAFSAC (1991) suggested as conservation levels an egg deposition rate of 2.4 eggs/m^2 of fluvial habitat and for areas of Newfoundland where many juveniles rear in lakes, an additional 368 eggs/ha of lacustrine habitat (105 eggs/ha in SFAs 1, 2, and 14a,b which include Labrador and the Great Northern Peninsula). A recent revaluation of these figures concluded that they were a fair approximation of MBAL. To calculate egg needs, river habitat area is multiplied by the appropriate deposition value, then fecundity values are used to determine the number of females (usually MSW) necessary to deposit the requisite number of eggs. Where possible, one male is provided for each female. Spawner requirements can then be summed by region, or country. A similar approach is used in the U.S.A.

Countries in the North East Atlantic are in various stages of developing MBALs (Table 3.6.1), and are focusing on ensuring appropriate egg deposition rates. Long term data bases for calculating stock-recruit relations are rare and from geographically limited areas, and it is difficult to extrapolate from them to the very different river structures and climates found throughout the North East region. However, in the U.K. (England and Wales), detailed methodologies have been developed to use data from rivers with established stock/recruit relationships and reference points to establish reference points for other systems (Environment Agency 1996). The Workshop on Salmon Spawning Targets in the North-East Atlantic recommended that "Spawning targets should be applied on a whole river basis unless evidence of suitability of more local (i.e. tributary based) targets were available." (ICES 1994/Assess:16). However, runs with unique characteristics (e.g. "springers" and "normal salmon") may be present within one system, and genetics studies are revealing substructures within catchment populations which may require approaches at sub-catchment levels. This complicates the task of setting any reference points.

2.7.2 Target reference point

The Working Group has used a fixed escapement policy to provide advice. Where MBALs are valid and met, then in theory all fish exceeding this number are available for harvest. However, this may not always be an appropriate management practice. In practice, natural perturbations and imperfect management and enforcement tools do not permit us to manage so precisely. MBAL is a threshold which should not be crossed because spawning escapements below this point will on average produce poorer recruitments and harvest potentials.

Setting the target point at higher levels will reduce the risk of falling below MBAL. The target is best set locally by scientists and managers who are most familiar with the biological characteristics of the population, the stock-recruit relation, and the realities of implementing and enforcing the management plan. Managers of in-river fisheries have the final responsibility of ensuring compliance with the targets, but they must also allocate surpluses among the needs of competing user groups. They are also in the difficult position of being the final guardians of MBAL, having to curtail in-river fisheries to compensate for management failures in sea fisheries and/or environmental conditions which have reduced anticipated fish returns.

2.7.3 Problems and constraints

To cope with unexpected events, the number of fish required to insure that spawning escapement exceeds a set MBAL may have to be considerably higher than the theoretical minimum. For example, straying may reduce the numbers of fish which enter spawning tributaries within a river, fish will be lost to predation, and physiological problems may block maturation for some fish. Another problem is that conservation limits based on genetics considerations may require higher MBALs. Where distinct populations exist within a catchment, more spawning fish may be required to maintain genetic diversity than would be called for by a simple reference point based on whole catchment egg depositions.

Furthermore, fisheries for Atlantic salmon that operate on a mixture of populations are by definition high risk (i.e. non-precautionary), particularly when reference points for individual stocks are combined. Accepting the individual river as our management unit, then the management goal becomes insuring that sufficient escapement occurs such that all rivers meet their conservation limits. Where mixed population fisheries are occurring, reference points need to be conservative.

As reference points are defined on increasingly fine scales (e.g. smaller and smaller tributaries), the number of fish required to escape all fisheries rapidly increases.

2.7.4 Salmon assessments from the perspective of the precautionary principle

The ICES Study Group on the Precautionary Approach to Fisheries Management has indicated that the precautionary approach requires that the risk of exceeding limit reference points must be kept very low (ICES 1997/Assess:7). To them, this meant that "the probability of exceeding the limit should be no more than 5% in any given year". Where a stock or population is at risk of or actually falls below the limit, then conservation or management action should be initiated to facilitate stock recovery (ICES 1997/Assess:7). Given the fixed escapement strategy used in salmon management, it is critical to keep salmon populations from falling below MBAL. Present assessments have a high risk of failing to do this, for several reasons. The Working Group notes that present salmon management practice pays too little heed to the confidence limits about the calculated prefishery abundance (pfa) estimates. This is evident from the use of the calculated mid point pfa value to set quotas, which gives a risky 50% probability of failing to reach the conservation escapement point. Variations in the proportions of females and the origin of the fish in the fishery will also increase the probability of falling below MBALs. For this reason, new methodologies are being developed within the group to give catch advice based on the risk of not meeting spawner requirements.

2.8 Discards

No new information was presented to the Working Group on quantities of discards (by gear type and area). The only area for which discards were routinely reported by the Working Group was for the Faroes fishery. These reports ceased with the discontinuation, in 1991/92, of the Faroes commercial long line fishery for Atlantic salmon. In the seasons 1982/83–1990/91 discards (salmon <60 cm total length) were estimated to be comprised of comprised 0–9.9% of the seasonal catch (ICES 1993/Assess:13).

In 1993, the Working Group on North Atlantic salmon was asked to evaluate the by-catch and mortality of salmon in non-salmonid fisheries. At that time (ICES 1993/Assess:13) the Working Group noted with respect to the North East Atlantic that:

> "landing of salmon caught in fisheries targeting other species was illegal in most countries of the North East Commission except France, where it is authorised, and Sweden, where landing is allowed during the regular fishing season (March -September). In some of the countries where the by-catch cannot be landed legally, and in France where they are not consistently requested, these catches are included in the estimates of unreported catches.

> Small numbers of salmon may be caught in shore-based gill net fisheries for species such as mullet and bass (England and Wales), lumpsuckers (Iceland) and mackerel (Norway). In Iceland, the authorities are currently negotiating the closure in June and July of the of the fishery for male (small) lumpsuckers in order to protect salmon. In Norway, fishing experiments with mackerel gill nets showed a relatively high catch efficiency also for small salmon. Norwegian authorities are currently discussing regulations on mesh sizes and a closed season in June and July for the mackerel season in order to protect salmon.
>
> There are only occasional instances of salmon being reported as taken in near- or off-shore fisheries with purse seines or pelagic trawls. This information is confirmed by the low frequency of such catches on research vessel cruises. The by-catch of salmon from these fisheries is considered to be negligible.
>
> The Working Group noted a report from NASCO in which information was given on the incidental catch of salmon in a pelagic trawl fishery for mackerel and horse mackerel during June to August 1991 in international waters close to the Norwegian EEZ. It was not possible with information available to determine whether such catches are regular occurrences."

As an update, the Working Group noted that the lumpsucker fishery in Iceland is now closed in June and July. In the U.K. (England and Wales) local regulations have been introduced concerning the operations of fixed nets to limit catches of migratory salmonids.

In the northwest Atlantic area, landing of by-catch in non-salmon fisheries is illegal in Canada and the U.S.A. By-catch was examined by searching tagging, sea sampling, commercial catch, and research vessel databases (ICES 1993/Assess:10). Results for U.S.A. and Canada were as follows:

> "By-catch of Maine-origin Atlantic salmon in non-salmon directed fisheries has been estimated by Carlin tag return data. The by-catch is almost exclusively 2SW salmon that are captured along the Maine coast. By-catch in Maine waters has occurred in gill nets, mackerel traps, pound nets, and saltwater weirs; however, it should be noted that only 40% of the tag recoveries from coastal fisheries can be attributed to a specific gear. The by-catch prior to 1988 averaged 10 fish; there were no reports of by catch since 1988."
>
> "In Canada, the Working Group examined over 20 years of records of catches by domestic and foreign off-shore commercial fishing vessels, as reported by government observers, and records from research vessel cruises for up to 30 years. There were only 12 salmon reported from commercial offshore vessels and 5 salmon from the research vessel cruises which indicated that the catch of salmon in the offshore fisheries is negligible. Two percent of the tag returns in the Scotia-Fundy Region from 1996–1991 were returned from non-salmon gear; primarily mackerel, herring, shade, cod, gaspereau, and bass.
>
> By-catch of juvenile and adult Atlantic salmon also occurs in the gaspereau and eel fishing gear in the Gulf region and eel fisheries of insular Newfoundland. The trap nets and fyke nets used in these fisheries are of such a small size that mortalities from meshing are considered minimal; bur mortality of juvenile salmon are reported to be high in some rivers in insular Newfoundland.
>
> The Working Group concluded that adult salmon appear to be caught in low frequencies in non-directed fisheries. The tonnage appears to be negligible relative to the unreported catch in salmon gear. Estimates of by-catch loss are partially addressed in the estimates of unreported catches, when these arise from illegal landings in non salmon gear."

The Working Group noted that the previous search for by-catch of salmon in Canada had principally been among landings of trawl fisheries and that there where opportunities for by-catch in the extensive in-shore fixed gear fisheries for pelagic species and ground fish. Recent closures of many of these in shore fisheries, beginning in 1992, and reduced abundances of Atlantic salmon suggest that the opportunity to discard/by-catch salmon has likely further diminished. In the U.S.A., juvenile and adult salmon are occasionally taken in various sport and commercial fisheries for other species that occur in freshwater and saltwater. Examples of such fisheries include those for the trout, striped bass, gaspereau and eel. The numbers retained (which is not legal) are thought to be negligible.

By-catch in West Greenland can occur in gill nets set in fjords for charr but is thought to be negligible because of the different timing of these fisheries.

3 FISHERIES AND STOCKS IN THE NORTH EAST ATLANTIC COMMISSION AREA

3.1 Fishing at Faroes in 1995/1996 and 1996/1997

The Faroese salmon quota has been bought out since 1991, however, the Faroes Government continued sampling inside the 200 mile EEZ. The aims were to monitor the salmon present in the Faroese area and to update time series of catch, catch per unit effort (CPUE), size and weight distributions of the fish, and of the proportion of discards (i.e. salmon below 60 cm total length). The small annual catches in recent years of less than 30 t have been the result of this activity.

No commercial fishery took place in 1995/1996. The research vessel M/S "Hvítiklettur", which was used previously in the research program, went to other fishing after the sampling was finished in spring 1995. As prospects for the future of the salmon fishery appeared poor, the skipper was not able to invest in new gear which would have been required to continue the research fishery. As a result a new vessel had to be contracted to conduct the research fishing. After negotiations, the M/S "Polarlaks" was hired. However, the crew had little previous experience of salmon fishing and the only available gear was several years old. Trials were carried out with this vessel in December 1995, but they only caught 282 salmon during one trip lasting two weeks (8 sets or fishing days). Such a catch might have been expected in a single set under normal circumstances. Financial limitations and the inexperience of the crew are considered to be the main reasons for the low catches in December and no further fishing was performed for the rest of the season.

The catch of 282 salmon (1 t) taken in December 1995 (Tables 3.1.1 and 3.1.2) is too small to be considered representative of the size and age distribution of fish in the area, of catch rates (CPUE) that might have been expected in all or part of the 1995/1996 season. Consequently no further use will be made of the samples from December 1995 to represent catch or catch rates at Faroes in the 1995/1996 season. No fishing has taken place in the 1996/97 season.

The analysis of data collected in the research programme conducted in the 1991/92 to 1994/95 seasons is discussed in Section 3.2. Information on the level of exploitation in the Faroes fishery on various river stocks is presented in Section 3.7.

3.2 The Research Programme at Faroes

Since 1992 a joint Nordic research programme has been carried out on the salmon stocks north of the Faroes. The intention was to gain more knowledge about salmon in the Norwegian Sea and the aims were to investigate the migration to and from the feeding areas in the sea north of the Faroes, feeding habits of salmon during the winter months, growth in the sea, presence of escaped farmed salmon in the sea, parasites on wild and farmed salmon, and population structures (e.g. smolt and sea ages).

In the following four sections the analysis of parts of the data collected in the research fishery is discussed. Throughout Sections 3.2.1–4 the term autumn refers to the fishing period from November to December in any given fishing season and the term winter refers to the period January to April. In some fishing seasons, particularly in recent years the winter period is shorter and lasts from February to March.

3.2.1 Smolt age and sea age distribution in the Faroese fishery

Smolt age and sea age of Atlantic salmon sampled in the research fishery at Faroes in the 1991/1992 to 1994/1995 fishing seasons were examined in order to estimate the age composition of wild salmon. The scale samples were collected from the dorso-lateral area of the fish as recommended by Shearer (1992).

Escaped farmed fish and fish which could not be positively identified as wild fish on the basis of scale analysis (Lund and Hansen 1991) were excluded from the analysis. Scales which showed incomplete annual zones or which could not be accurately assigned to a specific age group were also excluded from the analysis. The proportion of the indeterminate fish in the samples varied between 2 and 39% for smolt age material and between 0 and 2% for sea age material.

Total sample size for different fishing seasons varied from 143 to 278 for smolt age and from 190-290 for sea age analysis (Table 3.2.1.1 and 3.2.1.2).

Chi-square tests were used to test for differences in smolt and sea age distributions between seasons and periods.

Age composition in samples from the four fishing seasons showed similar trends. Both smolt age and sea age tended to be lower in the earlier part of the fishing season than in the later part of the season.

Smolt age varied between 1–4 years in most samples and included some smolts which were five years old. These were added to smolt age group 4+ (Table 3.2.1.1). Mean smolt age during the four fishing seasons varied between 2.3–2.6 years in the autumnal samples and between 2.6–2.8 years in the spring samples (Table 3.2.1.3). Smolt age distribution was significantly different between the autumn and spring samples in only two of the fishing seasons (1992/93: df=3; p<0.001) and (1994/95: df=3; p<0.001).

Sea age varied mainly between 1–3 years. Some samples included a few specimens of sea age 4–6 and they were added to the sea age group 3+ (Table 3.2.1.2). Mean sea age during the four fishing seasons varied between 1.8–2.0 years in the autumn samples and between 2.1–2.4 years in the spring samples (Table 3.2.1.4). Sea age distribution was significantly different between the autumn and spring samples in all fishing seasons (1991/92: df=2, p<0.001; 1992/93: df=2, p<0.001; 1993/94: df=2, p<0.01; 1994/95: df=2; p<0.001).

The lower smolt age and sea age distributions during the autumn suggests that a large proportion of the salmon stocks in Faroes area during this period originate from southern European countries, where stocks are predominantly grilse and smolts are of age 1 to 3. Recoveries of microtagged fish from Ireland and Scotland, especially during the autumn, are consistent with the southern origin hypothesis. In the Feb-Mar part of the fishing season the results indicate a higher proportion of salmon from northern European countries. External tag recoveries from Norway and Russia also support this (ICES 1996/Assess:11).

3.2.2 Origin of wild and farmed salmon tagged north of the Faroes

Atlantic salmon are distributed over large areas in the Northeast Atlantic. Two sea winter salmon have been exploited for a relatively long period of time in the area north of the Faroes, although some 1SW and 3SW fish are also caught. Recaptures at Faroes of salmon tagged as smolts have revealed that salmon from many countries are present in the area. However, it has been suggested that the majority of these recaptures are of Norwegian origin (ICES 1996/Assess:11). A tagging experiment was carried out during the period 1969 to 1976 where in total 1,946 salmon was tagged and released back into the sea around the Faroes. In total 90 fish were recovered: 33 in Scotland, 31 in Norway, 15 in Ireland, 8 in other European countries, and 3 at West Greenland. The total recapture rate was 4.6%; in the early years the tagging was conducted further south than the tagging from the recent Faroese research programme. The great majority of the tags were reported the same year as they were tagged, suggesting that many fish were sexually maturing. However, it is interesting to note that some fish were reported from West Greenland later the same year.

In recent years large numbers of farmed salmon have been observed at Faroes (Hansen *et al.* 1993a), accounting for a significant proportion of the Faroese salmon catch (Section 3.2.3). There is direct evidence that farmed salmon escaping from net pens in Norway enter this area (Hansen *et al.* 1987).

To examine the origin of the fish utilising the Faroese area between the years 1992 and 1995 wild and farmed Atlantic salmon caught on long-lines were tagged and released back into the sea. The fishing took place between November and March during the three fishing seasons 1992/93, 1993/94 and 1994/95. The areas fished during the autumn and the winter of the different fishing seasons are shown in Figure 3.2.2.1. Over 5,000 fish were tagged and released during the period 1992 to 1995 (Table 3.2.2.1).

Salmon were tagged either after being unhooked, or in the case of about one-third of the fish, with the hook remaining in the fish (unhooking of these fish would have created more damage). Fish tagged with hook-in-place had cut to the shortest possible length. After tagging the snood and before release, fish were allowed to recover in a tank supplied with a continuous inflow of sea water. All fish were classified as being of wild or farmed origin on the basis of fin erosion (Lund *et al.* 1989) and scale characteristics (Lund and Hansen 1991).

The sea age distributions of the tagged fish is shown in Figure 3.2.2.2.

To estimate the proportion of fish originating from the different countries, farmed or reared salmon was excluded from both the released and recaptured material. Furthermore, the observed distribution by country was corrected using the respective maximum and minimum exploitation rates for 2SW salmon in homewaters provided by national representatives for the assessment of pre-fishery abundance (ICES 1996/Assess:11). Furthermore, the recaptures from each country were adjusted for the best estimates of the respective homewater tag reporting rates, plus and minus 10% error (as provided by the North Atlantic Salmon Working Group members, 1997). The variance on the numbers of tags recovered in each country were estimated using a binomial function. "At Risk" simulations (1000 runs) were used to introduce error estimates (95%'ile limits) on the estimated proportion of fish returning to different countries.

After four fishing seasons (i.e. 1993–1996) a total of 104 tagged fish have been reported recaptured in 10 different countries in the North Atlantic. No tags were recovered from the research fishery at Faroes nor from West Greenland. The overall recapture-rate of the salmon tagged was small (1.9%). Of wild fish 2.2% were recaptured whereas 1.2% of the fish identified as fish farm escapees were recovered. The analysis suggests that the recapture rate of fish of farmed origin is lower than for wild fish (c^2= 6.8, df= 1, p= 0.009).

There is a significantly higher recapture rate of large salmon (2 and 3+SW) among the recaptures than of 1SW fish (Figure 3.2.2.3) (G= 15.4, df= 2, p< 0.001). However, the power of the test might be questioned, as only one 1SW fish was recovered. 1SW fish were observed to loose more scales and tolerate less stress than larger salmon during unhooking and tagging. Presumably, small salmon are also more vulnerable to predation than larger fish. An alternative explanation can be that 1SW fish are less vulnerable to homewater exploitation than larger salmon. However, this seems not to be the case since the exploitation rates in Norwegian index rivers do not differ markedly with respect to sea ages (ICES 1996/Assess:11).

Of the wild fish, 8 individuals of a total of 85 fish recaptured (9.4%) probably stayed an additional year in the sea before returning to home waters. All 8 salmon stayed in the ocean for the whole period of time as inferred by their growth.

The recapture rates of both wild and farmed salmon were lower for fish tagged in the autumn (1.4%) than in winter (2.7%) (c^2= 7.3, df= 1, p= 0.007).

Among the salmon tagged, 30% were estimated to be of farmed origin. This figure is slightly higher than reported in recent years in the Faroese fishery (Section 3.2.3). The reason for this may be that fish farm escapees are used to being handled, and are thus less vulnerable than wild fish to capture and tagging procedure.

In total, 19 of the 1,637 fish farm escapees tagged were recaptured (1.2%). Eighteen salmon were recovered from Norway, and one was recovered from the west coast of Sweden, at Ugglarp. This suggests that most of the tagged farmed salmon in the present experiment were recaptured in Norway and may suggest that these fish escaped from Norwegian fish farms.

For 2SW fish the recovery rate was significantly higher for fish with the hook left in the fish compared to fish without hooks when they were released (c^2= 7.6, df= 1, p= 0.006). This might suggest that the damage caused by removing the hook has a greater effect than leaving the hook in. It is likely that the hook eroded or was expelled by the fish shortly after tagging. In future tagging experiments, the size and design of the hook should be considered carefully. The hook should not be too large to cause excess mortality and the barb should be small or absent. Furthermore the hook should not be galvanised or durable, in case the hook is left in the fish oesophagus or stomach at release.

The results of the estimated proportions of wild salmon from different countries based on the recoveries (Figure 3.2.2.4) show that Norway accounts for the major part (42%), although there are significant numbers also from Scotland, Russia and Ireland (Table 3.2.2.2). This mainly reflects the distribution of MSW salmon, because the reported recapture rate of tagged 1SW salmon was significantly lower than for tagged 2W and 3SW fish (only a single 1SW salmon was recaptured). Because 1SW salmon account for most of salmon runs in Ireland, it is reasonable to suggest that the total Irish contribution to the Faroes catches may be underestimated. This might also apply to other southern European countries. This is further supported by previous occurrence of microtagged 1SW salmon reported from the Faroes fishery, particularly during Nov-Dec part of the fishing seasons (ICES 1996/Assess:11).

The Working Group noted that 4 recaptures were reported from Canada, one tagged in March 1993 and recaptured in Miramichi River September 1993, three tagged in February/March 1995 and two subsequently recaptured in the Miramichi in September 1995 and one in Kouchibouguac River (close to Miramichi) in October 1995.

3.2.3 Incidence of escaped farmed salmon in the Faroese fishery and estimates of catches of wild salmon

In recent years salmon farming industry has expanded considerably. In 1996, 450,394 t were produced in the Atlantic, with Norway and Scotland accounting for the majority of the production (Section 2.2.1). The total nominal landings of salmon in commercial fisheries in the north Atlantic in 1996 was only 2,860 t (Section 2.2.1).

Evidence from the Norwegian fish farming industry indicates that losses from the cages can occur at any time after the fish are placed in the sea and at all life stages. The escaped fish are caught in fisheries, and when sexually mature, they enter freshwater to spawn (e.g. Hansen *et al.* 1987; Gausen and Moen 1991; Lura and Sægrov 1991a; Webb *et al.* 1991).

The spread of fish farm escapees into all areas of the north Atlantic where wild salmon are also found, poses several possible problems. First, the interbreeding of farmed and wild salmon has been suggested to have negative effects on wild stocks (e.g. Hindar *et al.* 1991). Second, the transmission of parasites and diseases from farmed to wild stocks may cause problems (Johnson and Jensen 1994), thirdly, catch records from fisheries comprising both wild and farm escapees will complicate the assessment of the status of wild stocks. It is therefore of great importance to identify farmed fish and adjust catch records accordingly.

Norwegian tagged farmed salmon, released directly into coastal waters, were recaptured in the high seas fishery at Faroes (Hansen *et al.* 1987), and in a recent paper, Hansen *et al.* (1993a), demonstrated that large numbers of escaped farmed Atlantic salmon were present in oceanic waters in the north east Atlantic ocean and accounted for a significant part of the commercial salmon catch at Faroes.

Since the 1980/1981 fishing season, scale samples have been systematically collected from salmon caught in the long-line fishery for salmon north of the Faroes and in the Norwegian Sea (Figure 3.2.3.1). Identification of farmed salmon from scale patterns has been used to estimate the number of farmed and wild salmon caught in the Faroese fishery (Lund *et al.* 1989; Lund and Hansen 1991). From the 1980/81 fishing season to the end of 1990 sampling was carried out from commercial salmon catches, whereas from 1991 to 1995 sampling was carried out from research catches when only one vessel was operating.

This method has been developed by analysis of a series of "test" scales from Norwegian salmon of known reared and wild origin, using the following characters: smolt size, smolt age, transition zone from freshwater to saltwater, the position of sea winter bands, the number of summer checks and the proportion of replacement scales at the marine stage. Salmon of unknown origin were defined as reared if at least two out of the six scale characters examined were classified as reared characteristics. While this method has been shown to give good separation between adult farmed and wild salmon, fish at earlier life stages are difficult to detect accurately (Lund and Hansen 1991). The method will also detect some salmon released for ranching or as smolts in stock enhancement programmes. However, a large part of these fish carry external or internal tags, often combined with fin clips. The salmon analysed in the present material were screened for tags, and tagged fish were not included in the analysis. Furthermore, the number of hatchery reared smolts released into rivers in the east Atlantic is relatively small compared with the number of wild salmon present, except in Iceland where ranching has been established as an industry. However, very few fish tagged in Icelandic ranching operations have been reported from the Faroese fishery, suggesting that they exploit other feeding areas. This suggests that deliberately released salmon smolts are a small component of the salmon sampled, and that escaped farmed salmon account for the major proportion.

Table 3.2.3.1 shows the number of scale samples collected on a monthly basis since 1980. Sampling was not carried out all months throughout the fishing seasons. In 11 out of 16 seasons only one part of the season was sampled, i.e. either the autumn (Nov-Dec) or the winter part (Jan-Mar), and in two of those only one months was sampled. The detailed estimates of the proportion of farmed salmon in the Faroes fishery between the 1980/81 and the 1995/96 fishing seasons are shown in Table 3.2.3.1. Monthly variations within each fishing season in the proportion of farmed fish were examined using chi-squared tests. The only significant difference occurred in the 1991/1992 fishing season, whereas in the 13 other fishing seasons where data from two or more months were available, no significant differences were detected. To split the total catch of salmon at Faroes by season into wild and farmed salmon, it was therefore found appropriate to use the mean estimated proportions by season of fish from these two groups in the calculations.

Figure 3.2.3.2 shows the time series of the proportion of farmed fish in the Faroes fishery and the total production of farmed salmon in the Northeast Atlantic superimposed. The proportion was relatively low from the 1980/1981 to 1986/87 fishing seasons, and increased considerably thereafter and reached a peak in the 1989/1990 fishing season. Then the proportion declined, and in the past three fishing seasons the proportion of farmed fish was estimated to be around 20%.

Adjusted catches at Faroes from the 1982/1983 fishing season and onwards were divided into wild and farmed salmon components are (Figure 3.2.3.3). The catches dropped rapidly after the Faroese salmon fishermen's organisation agreed to be compensated for their quota in the beginning of 1991. At the same time the proportion of escaped farmed salmon dropped from a record high level of about 40% to about 20% (Figure 3.2.3.2).

The variation in the proportion of farmed salmon between seasons in the salmon fisheries at Faroes is relatively consistent with the increase in overall production of farmed salmon in the Northeast Atlantic. The total production of farmed salmon in the Atlantic in 1995 was 413,200 t (ICES 1996/Assess:11). Of this, 95% were produced in Europe, and of the total production Norway and Scotland accounted for 71% and 17%, respectively. The production at Faroes was 9,000 t which represents about 2% of total production in the Atlantic (ICES 1996/Assess:11). Salmon escape from cages in all areas was farms are present, and the largest number of fish that escape are from Norwegian farms.

Systematic releases of tagged farmed salmon during their first year in sea cages have shown that the survival to sexual maturity is highest when the fish are released in the spring. When released in late summer and autumn, the survival is lower (Hansen and Jonsson 1989). Furthermore, in most cases these fish return, generally, to the marine area from where they escaped. However, when fish escaped in March they were observed to stray to rivers far away from the site of escape, although they were not reported in countries other than Norway and the west coast of Sweden (Hansen and Jonsson 1991). The high proportion of farmed salmon observed in Norwegian home water fisheries (Section 3.3.7), combined with the fact that Norway accounts for the major production of farmed salmon in the Atlantic, strongly suggest that most farmed salmon occurring in the Norwegian Sea are of Norwegian origin. This is supported by the fact that tagged farmed salmon released on the Norwegian coast were recaptured in the Faroese fishery (Hansen *et al.* 1987). However, it is possible that farmed fish escaping from cages in Scotland, Faroes and Ireland also contribute to the Faroese fishery.

When assessing salmon fisheries and wild salmon stocks, it is important to estimate the farmed and ranched component. If high proportions of unidentified farmed salmon are present in catches the wild stocks will be overestimated. The increase in the Faroese catches in the 1988/1989 and 1989/1990 fishing seasons might partly be explained by an increase in the proportion escaped farmed salmon in the catches. However, the results should be interpreted with caution as seasonal variations in the percentage of reared salmon in the catches may exist.

3.2.4 The food of Atlantic salmon north of the Faroes

Results from the analysis of 3,848 stomachs sampled in November-March during the three consecutive fishing seasons 1992/93, 1993/94 and 1994/95 in the research fishery north of the Faroes were reported by Jacobsen and Hansen (1996). They found that crustaceans of the genus *Themisto*, euphausiids and shrimps were most frequently found in the stomachs, followed by pelagic and mesopelagic fish consisting of lantern fishes, pearlsides and barracudinas (Figure 3.2.4.1). In total number the crustaceans accounted for more than 80% of the food. In weight more than 60% of the food was fish consisting of the same mesopelagic fish as previous but few herring, blue whiting and mackerel which were not well represented in numbers contributed significantly to the weight. Generally the average prey size in the stomachs did not depend on fish size, except for *Themisto libellula*, where a significant positive relationship was observed.

The proportion of stomachs containing food increased significantly from November-December (53%) to February-March (78%) (Figure 3.2.4.2), and the average stomach content in weight also increased during the season mainly due to an increase of fish species in the diet (Figure 3.2.4.3).

On the assumption that the proportion of empty stomachs is indicative of the intensity of feeding (Rae 1967), salmon feed more intensively in February-March than in November-December. The significantly higher average food content in weight per salmon (of the stomachs containing food) in the February-March period compared to the November-December period each season, emphasises the lower feeding rate of salmon observed during late autumn. This observation is consistent with work in the Baltic, where a tendency of decreasing food quantities in the salmon stomachs was observed during autumn until January-February when it again increased (Christensen

1961, Thurow 1966). Salmon sampled in the Labrador Sea had less food in their stomachs in the autumn than in the spring (3.1 g and 5.7 g food per kg of salmon respectively) and were feeding less actively (28% and 8% empty stomachs respectively) (Lear and Christensen 1980). The low feeding rate in late autumn could be an indication of low food availability, implying that salmon growth and survival may be decreased in the sea in this period. Survival of salmon in the sea has been shown to depend in some way on the environment (i.e. sea-surface temperatures (see Section 2.5). This may in part be the result of temperature dependence or preference of the available prey for salmon, as indicated by the low feeding rate in November-January.

There seems also to be a trend with time in the proportion of empty stomachs which increased from 25% in 1992/1993 to 34% and 37% respectively during the next two seasons. The frequency with which fish species were found in the stomach samples fell from 76% to 44% and 45% during the same period (ICES 1996/Assess:11).

Early in the fishing season (Nov-Dec) the crustaceans dominated the stomachs whereas fish were most abundant during Feb-Mar (Figure 3.2.4.4).

The available prey sampled from 15 plankton tows at 0–50 m depth, generally included the same species as were found in the stomachs, although salmon did not feed on *Sagitta* spp. and *Calanus finmarchicus* which were observed in the plankton samples (Jacobsen and Hansen 1996).

3.3 Homewater Fisheries in the NEAC Area in 1996

3.3.1 National reports

This section provides a general overview of the homewater fisheries in each country in the NEAC area in 1996. Further analysis of these data is included in Sections 3.3.2 to 3.3.9.

Finland

No significant change in gear was reported in 1996. There were minor fishing regulation changes for the river Teno concerning a reduction in recreational fishing time. Effort in the recreational fishery on the Teno continued to decline more prominently. Anglers and angling days decreased about 30% and recreational salmon catch decreased about 20% from year 1995. The effort in the native net fishery was about the same as in 1995.

The reported salmon catch of the river Teno was 43 t and of the river Näätämö 1 t. The river Teno salmon catch was 9% less than in 1995. Salmon catches have been decreasing since 1993. In the river Teno and the river Näätämö, the salmon run was about two weeks late in 1996. For the river Teno salmon catch, the proportion of grilse was greater and proportion of females decreased. A pronounced decrease was also observed in numbers of 3SW salmon. The age distribution was based on the river Teno mainstream mixed salmon population.

The river Teno salmon catch included 0.1% escapees from cage rearing. Escapees were caught in late August, near the end of the fishing season. The status of stocks in the river Teno and river Näätämö region was still quite "healthy" considering the presence of salmon cage rearing and the intensive river fishery. Some decline is shown in the parr densities, especially in the river Inarijoki tributary, which is about 250 km from the sea.

France

There was no significant change in the fishing gear used in 1996. The number of angling licences decreased slightly (4%) compared to 1995 but it was still higher than in 1994, the lowest number observed in a 9-year continuous decline. The number of commercial licences (Adour) increased by 20% compared to 1995, but it is not clear whether the real effort increased in the same proportion. The sport and commercial fisheries in the Loire basin, closed in 1994 in order to protect the very low remaining stock, have not been re-opened. Angling effort on grilse is still increasing in Brittany and Normandy with a later closure of the fishing season in some rivers (a measure that started in 1993 and is being extended to a number of rivers in the area). In these regions, where the most important rod and line fishery takes place, a Total Allowable Catch (TAC), based on the attainment of a spawning reference point, was set for most rivers in 1996 in order to manage stocks on a river basis.

The total catch was 14 t in 1996, 56% more than in 1995 but representing only 67% of the mean catch of the 10 previous years. The anglers' share was 9 t and the commercial fishery's 5 t. In Brittany, anglers took only 38% of their Total Allowable Catch. The average catch per angler was 1.57 salmon, about 40% more than in 1995 and 1994. The grilse component of the global catch was 51%; 57% in the rod fishery, and 38% in the net fishery. The proportion of grilse in the last 3 years has been higher that the 5-year average. Part of the reason is a later closure of the angling season in Brittany since 1993 and the closure of the fishery in the Loire since 1994 (stock mainly composed of MSW). The decreasing trend in the abundance of spring salmon is continuing. Data on exploitation rates are only available for the Brittany area and two other monitored rivers. Exploitation rates in freshwater for 1SW salmon in the river Scorff were 14% in 1996 and 8% in 1995. Exploitation rates of MSW were 11% in 1996 and 15% in 1995, lower than the 1992–1993 average for Brittany, estimated between 19 and 37%. Exploitation rates in freshwater for the monitored rivers were 12% in the river Bresle and 2.7% in the river Nivelle.

A matter of concern is the finding of *Gyrodactylus salaris* for the first time in 1996 on trout raised in France. The parasite may already have disseminated in some rivers through brown or rainbow trout stocking. It poses a serious threat to French salmon stocks since salmon are killed by the parasite if the strain is not resistant. Resistance tests will be conducted with French strains as soon as possible. In the light of the Norwegian experience, where more than 20 stocks were definitely lost, strict prevention measures should be taken in order to protect French and European salmon stocks from infection and spreading of the parasite.

Iceland

In 1996, one the of five coastal locations with gillnet fisheries was bought out permanently, one was leased by angling clubs and thus not operated, and one was only operational in August. Two locations are still operated where nets are set from land.

The total catch of wild origin salmon was 122 t. The reported catch in the rod fishery was 95 t which is about 14% lower than in 1995 (108.9 t), 19% below the previous 5-year average and 25% below the previous 10-year average. The reported catch in the gill-net fishery was 27.7 t, 33% lower than in 1995 (41.3 t), 21% lower than the previous 5-year average and 35% lower than the previous 10-year average). The lower net catch is related to the buy-out of coastal gill-nets. Catch-and-release by anglers has been increasing. In the 1996 season, 2.3% of the rod catch was released. Tagging experiments indicate that around 30% of the released fish are caught more than once.

The contribution of 1SW fish to rod and net catches was 73% and 27% respectively for 2SW fish. This is about the average for the previous 5 years. The total number of 1SW fish was 28,067 (69 t) and for 2SW 9,983 fish (53 t).

Some ranched fish stray into salmon rivers and this is more common in rivers close to ranching operations. In the River Ellidaar ranched fish comprised 12.9% of the catch but no fish farm escapees were detected. There are also some wild salmon taken in ranching stations. Only a few fish farms are now rearing salmon in sea cages, most using land based facilities. As a result there are few escapees. The harvest of ranched salmon was 236 t and the fish farm production was 2772 t. This is a decrease from previous years.

The exploitation rate in the river Ellidaar was 56%, which is higher than in the previous 5 years. The 5-year exploitation rate for the rod fishery on the River Nupsa and River Blanda is 84% and 61%, respectively. The exploitation rate on 2SW fish is higher than on grilse.

Ireland

While fishing conditions were generally favourable, there was a slow start to the commercial drift net season with poor landings recorded by the boats which did fish. The situation improved later in the season, although most regions experienced a lower catch than in the previous year. Some rivers were reported to have had a poor early grilse run following a relatively good spring run, but again this situation did not appear to persist throughout the season. The declared catch in 1996 (685 t) was lower than in 1994 (817 t) and 1995 (790 t). This reflected decreases in most fishing sectors. Catches remain higher than the five year average but lower than the ten year average. The majority of the commercial catch (>90%) is assumed to be comprised of grilse. Fish farm production of salmon in 1995 was 11,811 t and increased to 13,500 t in 1996. Three major escapes from fish farms were recorded of 5,000-8,000 in the South West, 11,200 fish >1kg in the West and approximately 9,500 smolts in the North West in 1996. Overall the rate of escapees in Irish catches is very small (<3%,).

Exploitation by commercial nets on wild and hatchery fish has increased in recent years and is approximately 50% and 80% respectively. This exploitation rate has returned to values experienced in the early and middle 1980s. Survival of Corrib wild and Burrishoole hatchery smolts returning to the Irish coast has followed a similar pattern since 1980. A period of high survival is noted from 1983 to 1988 followed by lower survival since this time. In general, survival of wild salmon to the river is higher than hatchery reared fish; the range for both groups is between 2 and 9%. The main production and release of reared fish is of fry (fed and unfed). Approximately 3 million fry were released in 1995 and again in 1996. Stocking with parr also takes place with up to half a million stocked into Irish rivers. Smolt production for stock enhancement and fishery improvement is about half a million and this includes microtagged, finclipped and unmarked fish.

Major changes in the management of the Irish net fisheries for the 1997 season and subsequent years have been indicated following the recommendations of the Salmon Management Task Force Report (Government of Ireland, 1996)

Norway

In 1996, there was no significant change in salmon fishery regulations in Norway, and there was no significant change in effort. It should be noted, however, that since 1990 small reductions in the salmon fishing season in different areas of the country have contributed to gradually reducing the overall fishing effort. It was recently decided to establish new regulations in the 1997 fishing season. The purpose is to reduce the overall fishing effort on salmon, and especially on MSW fish. These measures include a total ban on the use of bend nets in most of the country, and a reduction of the fishing season with bag nets. In freshwater, significant measures are going to be introduced to reduce angling effort in 1997.

Nominal catches of salmon in Norway in 1995 and 1996 are shown in Table 2.1.1.1. The figures are final. Total catches both in weight and numbers declined from 1995 (839 t) to 1996 (787 t). The catch in 1996 is the lowest recorded since 1960. The total number of salmon caught by anglers in the River Alta has increased in recent years, however the proportion of grilse in the catches has significantly increased. Work has been initiated to estimate unreported catches in Norway, and it is suggested that the unreported catches of salmon in Norway may be significant. No CPUE data are currently available. There was a slight increase in marine catches compared with 1995, whereas freshwater catches were reduced. The reduction was mainly due to lower catches of 1SW fish (Table 2.2.2.1).

Farmed salmon were estimated to comprise 54% of the catch in coastal bag nets and fjord bag net fisheries. In rod catches the estimated proportion of farmed salmon was 7%, and in spawning populations 31%. These figures are slightly higher than in 1995.

Table 3.3.9.1 shows marine exploitation rates of wild- and hatchery-reared Atlantic salmon from the River Imsa and hatchery fish from the River Drammen since 1985. For wild and hatchery fish from the Imsa, the exploitation rates on the 2SW components are significantly higher than for 1SW fish. This does not appear to be the case for the River Drammen fish. The rod exploitation rate in the River Drammen was 47%.

Russia

There were no changes in fishing gears and fishing effort compared to the last three years.

The total catch in 1996 was 131 t, and remained at the previous year's level (130 t). In the recreational fishery the catch was 12,696 salmon, including 10,745 which were released. In general, in the last 4 years, catches of salmon stabilised, while a reduction of the commercial catch compared to the 1980s was associated with a cessation of fishery on the Pechora river and development of recreational fisheries.

Grilse accounted for about 80% of the catch which was 10% higher than the average for the last 5 years. This was probably related to a delayed commencement of the fishery as a result of which a considerable proportion of the MSW salmon escaped the fishery.

Catches were composed mainly of wild salmon. Only catches from the Kola and Keret rivers contained 24% and 56% of hatchery origin salmon, respectively.

Sweden

In 1996, the salmon catches on the Swedish west coast were lower than both the 5-year and 10-year means and declined in numbers by almost 25% from 1995. The decrease was mainly caused by a decline in the grilse catch of nearly 40%, while the catch of MSW salmon increased by a little more than 25%. As a result the catch in weight decreased by about 10%. The decline could not be correlated to changes in exploitation as no new regulations or other major changes in the fishery were implemented.

Besides the decline in grilse catch, concern was also expressed about increasing catches of large salmon which had paler flesh than expected for normal salmon from the west coast. Both the size and the pale flesh suggest that they were strayers from the Baltic. The assumption was underlined by some recaptures on Sweden's west coast of tagged salmon originally delayed-released from the Danish Islands and the island of Bornholm.

U.K. (England & Wales)

There were no significant changes in the fishing gear used in 1996. The number of licences issued for nets and fixed engines has continued to decline due mainly to the continued phase-out of the drift net fishery on the north-east coast. A number of rod and net fisheries in south-west Wales were closed for part of the season as a result of an oil spill. The fishing effort has decreased in some areas because an increase in net licence fees has resulted in reduced up-take of licences. In 1996, dry weather and low flows were reported in most areas during the summer months. Rod catches were poor and effort low in this period. Netting effort increased in one fishery in the south-west because a compensation arrangement lapsed; 12 seine nets resumed fishing and accounted for 67% of the total declared net catch in the region. Bag limits for rods also ceased on two rivers in 1996 and this may have increased the catch on those rivers.

The provisional salmon catch for 1996 is estimated at 193.8 t (63% of the catch in 1995), comprising 129.3 t by nets and fixed engines and 64.5 t by rods. The overall net and fixed engine catch was very poor (about half that recorded in 1995 and 37% below the average of the previous 5 years). The estimated catch by rods is thought to be similar to both the 1995 catch and the average of the previous 5 years. Catches were generally felt to be poor in the middle part of the season due to low flows and adverse fishing conditions, but were better in the early and late parts of the season. CPUE for nets was below the five-year average. There has been increasing use of catch-and-release by salmon anglers in recent years, but the impact of this on overall exploitation is difficult to quantify.

Anecdotal reports indicate that grilse still comprise the majority of the catch in most regions, but the proportion of multi-sea-winter fish is thought to have increased in a number of areas. There is no salmon farming and no ranching programmes in England and Wales. The catch of salmon in England and Wales is therefore thought to be made up entirely of wild and stocked fish, although no surveys have been conducted to confirm this in recent years.

Exploitation rate estimates are available for rod fisheries on six rivers indicating rates from 5 to 56%. In some rivers (Itchen, Frome and Leven) these were markedly higher than in other recent years for which data are available.

U.K. (Northern Ireland)

The number of commercial fishing licences issued in 1996 (195) was slightly lower than in 1995 (206). There were no changes in fishing season bye-laws or gear regulations. The provisional declared catch in 1996 fishery (77 t) was lower than for the 1995 season (83 t) and lower than the 5-and 10-year averages. Angling catches have been collected for the Foyle system, a total of 1444 fish being reported. Anglers reported only an average season although some rivers did well. Reliable rod CPUE estimates are available for the lower R Bush. CPUE was higher in 1996 (0.267 fish per rod day) than in 1995 (0.206), despite the lower adult run compared to the previous year.

Ranched fish, released from the R Bush experimental station, comprised 2.3 t of the nominal catch. Anecdotal evidence suggests that the incidence of farm escapees in the net catch was lower than in recent years. Only 2 fish (0.18%) entering the R Bush trap were farm escapees.

In 1996, the exploitation rate in the net fishery on hatchery reared 1SW fish (81% for 1+ smolts and 77% for 2+ smolts) was considerably higher than the average for the previous 5 years. No estimates are available for other smolt groups.

U.K. (Scotland)

In the last year, there have been restrictions implemented in two Salmon Fishery Districts with regard to the type of bait permitted. Prawns and shrimps have been banned on the rivers Ythan and Forth with the aim of reducing the effectiveness of angling. Effort indices for the net and coble and fixed engine fisheries in 1996 showed a 23% and 5% decrease respectively compared to 1995. The final reported catch for 1995 was 587.9 t, 2% greater than the previous 5-year average (1990–1994) but 24% less than the previous 10-year average (1985–1994). The partial 1996 figure (caught and retained) is 380.4 t. It is likely that the final figure for 1996 will not only be lower than that recorded in 1995 but, the lowest on record. In 1996, the fixed engine CPUE decreased by 26% and the net and coble CPUE decreased by 11% compared with 1995. In 1996, 38% 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 proportion of grilse is always greater than the reported figure as a result of 1SW fish being misreported as MSW fish. The errors in classification are neither consistent between regions, nor between years. Of the 380.4 t caught and retained in 1996, 379.8 t was reported as wild salmon and 0.7 t was reported as farmed fish. The only fishery in Scotland for which there is a time series of exploitation rates is the North Esk net and coble fishery. In 1996, the exploitation rates for 1SW and MSW fish were 19% and 10% respectively. In general, exploitation rates have declined, particularly since 1991 when there was a major reduction in effort.

3.3.2 Gear

Regulations have been introduced in many countries in the NEAC area to reduce the efficiency of fishing methods in order to lower exploitation rates. In some rod fisheries, certain baits have been banned on some rivers or only certain methods (e.g. fly-fishing) are allowed at some times of year. In net fisheries, restrictions have been imposed on the materials from which nets may be constructed, and their dimensions and mesh sizes. No new restrictions on fishing gear were reported in 1996.

3.3.3 Effort

For the NEAC area, available data on effort, as described by numbers of gear units licensed or authorised, are listed in Table 3.3.3.1. In general, fishing effort has been declining substantially over the years for commercial fisheries although rod and line has been increasing in some areas. The number of gear units used in U.K. (England & Wales), U.K. (Scotland), Ireland and U.K. (N. Ireland) has been declining fairly steadily. In almost all fisheries, the number of gear units licensed or authorised in 1996 was lower (by up to 53%) than the 5-year mean and also lower (by up to 66%) than the 10-year mean. Increases on the 5-year mean were only recorded for the Irish drift nets (3%) and rods in Ireland (32%) and on the R. Näätamö (Finland) (18%). Further descriptions of the fishing effort for individual countries are provided in Section 3.3.1.

3.3.4 Catches

NEAC catch data are presented in Table 3.3.4.1. Figure 3.3.4.1 shows the percentage change of the 1996 NEAC homewater catch data relative the previous 5-year mean (1991–1995) and the previous 10-year mean (1986–1995). For all 11 countries, the 1996 catch was below (by up to 57%) the 1986–1995 mean and only the 1996 Ireland catch exceeded the 1991–1995 mean (by 8%). Clearly, current catch levels are markedly lower than in the recent past. This is believed to reflect both reductions in fishing effort (Section 3.3.3) and reductions in stocks (Section 3.7.2).

Catch and release is being practised in a number countries. In some areas, fish that are released are still reported in the catch statistics. In other areas although they are not counted as part of the catch, no account is generally taken of fishery induced mortalities. The Working Group considered that efforts should be made to standardise the way that these catches are handled in the catch statistics.

3.3.5 Catch per unit effort (CPUE)

Catch per unit effort data where available for the NEAC area are presented in Tables 3.3.5.1, 3.3.5.2 and 3.3.5.3. A route regression analysis was used to examine trends in the data and the results are shown in Table 3.3.5.4.

Catch per unit effort in rod fisheries in Finland, France and on the River Bush (U.K., Northern Ireland) show no trend for catch per angler day for the last 10 years. However, there is a significant upward trend in CPUE for the whole season for rod fisheries in Finland and France for the same period ($p<0.002$). This may reflect increasing rod effort. CPUE for fixed engine fisheries in England and Wales show no trend. For Scotland, there is a significant downward trend in CPUE in the net fishery ($p<0.001$). Changes in CPUE for different countries are described in Section 3.3.1.

3.3.6 Age composition of catches

The age composition of the catches are presented in Figure 3.3.6.1 for those countries where a time series of data exists. The proportion of 1SW fish in the 1996 catches is presented as a percentage, the 1991–1995 mean and the 1986–1995 mean proportions. In Finland and Russia, the proportion of 1SW fish in the catch has increased compared to the 1991–1995 and 1986–1995 mean proportions. In France, Norway and Sweden, the opposite is true with the proportion of 1SW fish having decreased. The current level of 1SW fish in the Scottish catch differs little from any of the standards it was compared to. Caution should be observed in interpreting these results as the split between the reported 1SW and MSW fish may be based on a weight categorisation as a proxy of sea age and may therefore not be accurate in all cases. However, even in these cases the data provide an index of real changes in growth and/or maturation.

3.3.7 Farmed and ranched salmon in catches

The contribution of wild, farm origin and ranched salmon to national catches in the North-East Atlantic in 1991–1996 is shown in Table 3.3.7.1. Farmed salmon continue to represent a large percentage of the national reported catch in both Norway (28%) and Faroes (20%) (see Section 3.2.3) and ranched salmon now account for 65% of the national catch in Sweden. Although Iceland produces a large tonnage of ranched salmon, practically all this is harvested at the production sites.

The occurrence of farmed salmon in several Norwegian net fisheries is shown in Table 3.3.7.2. Although the level has remained relatively stable over the period, in coastal fisheries, the incidence of farmed salmon (34–54%) is consistently higher than that recorded in fjord fisheries (10–21%). Furthermore, the incidence of farmed salmon in angling catches (4–7%) is less than that in fjord fisheries. However, in broodstock samples, taken after the closure of the angling season, the incidence varied from 21–38% (Table 3.3.7.3).

Farmed fish formed less than 3% of the national catches in Ireland, U.K. (Northern Ireland) and U.K. (Scotland). The incidence of farmed salmon in the River Bush, U.K. (N Ireland), based on the operation of a total trap throughout the year, for the period 1991–1996 are given in Table 3.3.7.4. The occurrence of farmed salmon throughout the period has remained below 1% and the 1996 value of 0.18% is the second lowest recorded in this series.

The significance of these results is discussed further in Section 6.

3.3.8 National origin of catches

No new data on the national origin of salmon catches for the NEAC area were presented. While it is known that there are fish from neighbouring countries in homewater catches, no new analyses on the distribution or number of these fish has been carried out since 1994 (ICES 1994/Assess:16). These estimates were regarded as very approximate and so further effort should be made to provide a more accurate estimates of the level of catch by each country of stocks from other countries.

3.3.9 Exploitation rates in homewater fisheries

Exploitation rates for 11 wild stocks, 4 hatchery stocks and 3 mixed stocks are shown in Table 3.3.9.1. Increases in exploitation rates on stocks from Irish and U.K. (N. Ireland) rivers have been shown in recent years while a decrease is noted for one river in U.K. (Scotland) and one river in Russia. No other notable differences are shown. Although reported exploitation in some fisheries have changed, route regression analyses indicates that there has been no overall trend in exploitation in fisheries over the last 10-year or 5-year periods for either 1SW or 2SW stocks (Table 3.3.5.4).

3.3.10 Summary of homewater fisheries in the NEAC area

There has been a continuation in the trend to reduce commercial fishing effort in the Northeast 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 1996.

Provisional figures suggest that nominal catches of salmon in North East Atlantic countries in 1996 were generally below the 1995 values and for most countries they are still below the previous 5- and 10-year averages. In general, fishing effort in terms of licences issued has been declining substantially over the years for commercial fisheries and increasing for recreational fisheries. CPUE was shown to increase in Finland and France for the rod fisheries and decrease for Scottish net and coble fisheries. No significant trend was noted for other fisheries in the NEAC area.

The proportions of 1SW fish in catches has increased for Russia and Finland, and decreased for Norway, Sweden and France. 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.

Farmed salmon continue to represent a large proportion of the catch in Sweden (65%), Norway (28%) and Faroes (20%). The incidence in catches is < 3% for samples taken in U.K. (N. Ireland) and is <1% for catches in all other countries. Ranched fish continue to comprise the majority of the Icelandic catch (over 60%) and some straying is observed into rivers. Ranched salmon comprise only a small proportion (<3%) of the catches in Norway, Ireland and U.K. (N Ireland).

Reported exploitation rates in some fisheries have changed, but no trend in fisheries is noted over the previous 5- or 10-year periods.

3.4 Status of Stocks in the NEAC Area

3.4.1 Attainment of spawner reference levels

Progress with the development of biological reference levels for stocks in the NEAC area is discussed in Section 3.6.

Spawner requirement reference levels and time series of compliance data have been provided for seven rivers in the NEAC Area (Table 3.4.1.1). Most of these are monitored rivers where stock-recruitment data have been collected over a number of years. Where possible, threshold levels have been set at the MBAL for the stocks (max. gain on the appropriate stock-recruitment relationship) according to guidelines presented in Section 8.1.1 of the 1995 Working Group Report (ICES 1995/Assess:14). These should therefore be regarded as a threshold levels and not as targets. For the Tuloma river (Russia), however, the reference point is a target for the number of female spawners required to give optimal recruitment.

Spawning thresholds have only been exceeded in the rivers Scorff and Nivelle (France) and N Esk (U.K. (Scotland)) in 1996. No significant trend in attainment of spawner requirements has been noted for the last 10 years (Table 3.4.1.2). However, a significant downward trend is shown for the last 5 years for all rivers combined. This is principally due to decreases in the egg deposition for the Burrishoole (Ireland), Bush (U.K. (N. Ireland)) and the Tuloma (Russia).

It should be stressed that no information is available on the majority of the river stocks in the NEAC Area and those for which data are provided are not necessarily indicators of the status of stocks in other areas.

3.4.2 Measures of juvenile abundance

Counts or estimates of juvenile abundance are available for 23 rivers (Table 3.4.2.1) and full counts are shown for eight of these. Values in 1996 were lower than the means for the last 5 years for Icelandic, U.K. (Scotland), Norwegian and Swedish rivers while values were higher than the mean for the previous 5 years for French rivers.

There is no evidence that freshwater productivity has declined in the NEAC area from these data. Route regression analyses show no significant trends in juvenile production in these rivers over the last 10- or 5-year period (Table 3.4.1.2).

3.4.3 Measures of spawning escapement

Adult counts or estimates are available for 28 rivers in the NEAC area (Table 3.4.3.1). The counts in 1996 were generally lower than the mean for the last 5 years for rivers in Russia, Ireland, U.K. (Scotland) and U.K. (N. Ireland). Higher estimates were obtained for some U.K. (England and Wales) rivers.

Due to differences in the size of stocks considered and their migration patterns, route regression analyses were carried out separately for adult counts in Russian rivers and other NEAC rivers (Table 3.4.1.2). An increasing trend is shown for Russian adult counts over the last 30- and 20-year periods. A significant downward trend is indicated for the last 10 years while there has been no significant trend in the most recent 5 years in the data series.

There was no trend noted for the other rivers in the NEAC area over the last 10- or 5-year periods.

3.4.4 Survival indices

Estimates of marine survival for wild smolts from nine stocks returning to homewaters (i.e. before homewater exploitation) and for eight stocks returning to freshwater in 1996 are presented in Tables 3.4.4.1 and 3.4.4.2 respectively. In Table 3.4.4.2, indices of return rates are also provided from autumn 0+ parr for the Nivelle river (France). 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 six hatchery stocks are given in Tables 3.4.4.3 and Tables 3.4.4.4. 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. No clear trends in survival were noted for any individual stock. However, route regression analyses of combined river data showed a significant downward trend for the last 10 years for wild 1SW and 2SW fish and hatchery 1SW fish, but no trend for the last 5 years (Table 3.4.1.2). For 2SW hatchery fish, there was no trend shown for either period.

3.4.5 Summary of status of stocks in the NEAC area

Estimates of spawner requirements were presented for seven rivers in the NEAC area. In 1996, spawning thresholds were only exceeded in the Scorff and Nivelle (France) and the North Esk (U.K. (Scotland)). A significant downward trend in egg deposition was noted for the previous five-year period for all rivers combined.

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 Northeast Atlantic as a whole. Adult runs in western European rivers showed no significant trend in run size over the last 10 years. An increasing trend in spawning escapement was noted for Russian rivers over the previous 20- and 30-year period. Over the most recent 10-year period a decreasing trend has been noted. No trend is apparent for the previous 5-year period for these Russian rivers.

Survival indices for combined river data for the NEAC area indicate a downward trend in survival to homewaters for the last 10 years for 1SW and 2SW wild stocks and 1SW hatchery stocks. No trend was noted in the most recent 5-year period.

An assessment of pre-fishery abundance for stocks in the NEAC Area is provided in Section 3.7.2.

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

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 3.1.2). 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.

The Working Group has previously examined the likelihood of the full quota being taken at Faroes in the 1991/92–1993/94 fishing seasons if the fishery had operated (ICES 1996/Assess:11). It was felt that the quota might 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. However there was no evidence that such changes had occurred. The Working Group therefore considered that the mean annual catch for the 1988/89 to 1990/91 seasons (87,484 fish) provided the best estimate of the expected catch in each of the subsequent four seasons. In the absence of any new data the Working Group considered that this was also the best available estimate of the likely catch in the 1995/96 season.

Data on the expected discard rate, the proportion of farm escapees in catches, the expected age composition of the catch, and the expected time to return were obtained from research vessel catches in the 1991/92 to 1994/95 seasons and previous published data (ICES 1996/Assess:11). No new values of these parameters were available for the 1995/96 season and so means for the previous four seasons were used. The assessment is shown in Table 3.5.1.

This suggests that between 1,600 and 10,000 extra 1SW salmon and between 40,000 and 71,000 extra MSW salmon returned to homewaters each year from 1992 to 1996. In addition, nearly 107,000 extra farmed fish are expected to have been saved from the Faroes fishery in the five 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 (means of 1000 simulations) of the total numbers of MSW salmon returning to homewaters in the NEAC area and to countries in Northern and Southern Europe are provided in Table 3.7.2.1. The additional returns of MSW fish represent 3% to 7% of the estimated returns to homewaters between 1992 and 1996. However, analyses of smolt tagging data (e.g. ICES 1993/Assess:10) and results from the adult tagging studies (Section 3.2.2) show that the majority of the MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. The estimates from the adult tagging studies suggest that about 65% of the saved wild MSW fish might have returned to these countries; if this were the case they might have represented 4% to 9% of the returns of MSW fish between 1992 and 1996. If stocks and fisheries had remained stable, total catches would have been expected to increase by approximately the same proportions in the respective areas.

Catches in homewater fisheries in four areas of Europe (Table 3.5.2) 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, $p = 0.004$) and in southern Europe (Ireland, U.K. (England & Wales), U.K. (Scotland), and France) (Rcrit, $p = 0.02$). No detectable change was noted for 1SW catches in Northern Europe (Finland, Sweden and Norway) or for adult counts to Russian rivers in the same period. (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.

3.6 Development of Age Specific Spawning Targets

In its 1995 report to NASCO, the ICES Advisory Committee on Fishery Management (ACFM) recommended that "all countries should establish preliminary spawning targets for all their rivers as soon as possible" (NASCO 1995). Subsequently, NASCO requested ICES to "Provide estimates of *age specific* spawning targets" (NASCO 1995, p. 102). In order to be consistent with present ICES terminology, we have used the term conservation (or limit) reference points instead of "spawning targets" (see Section 2.5 of this report). Furthermore, the two requests were not identical. In the latter, a request for "age specific" reference points was specified. The Working Group advises against defining conservation points only on an age specific basis. In some catchments, genetically distinct populations inhabiting subcatchments within a river system have been identified. Age specific reference points are not sufficient to provide adequate protection for these populations, and other approaches will also need to be developed.

Member countries from the North East Atlantic Commission Area have generally accepted the need for developing biological reference points (MBALs and target fishing levels) for salmon, and some have made considerable progress toward this end (Table 3.6.1). However, certain countries are faced with complicating factors (see below) and do not foresee having significant numbers of reference points in place within the next 5 years.

Complicating factors include:

- Data bases for calculating stock-recruit relationships or long term trends are rare;
- Extrapolation of information from the limited number of rivers where relatively complete information is available, to other rivers of different physical characteristics or in different geographic areas is questionable in some areas;
- The salmon runs entering a river may be composed of discrete populations, which occupy spatially distinct areas within the system, differ in their biological characteristics and do not interbreed (e.g. spring salmon versus autumn salmon). Hence conservation limits may have to be set for each discrete population;

It will take time, additional resources and research to develop the necessary information to set population conservation points for all rivers. Section 2.6 of this report discusses these issues further.

Progress with the development of reference points for rivers in the NEAC area includes:

Russia: Target reference points have been established for the Tuloma River, based on a stock recruit relationship derived for this system and estimates of the production potential of the river. The reference points are being used to provide management advice in the Tuloma fisheries. In the next five years, it is hoped that points will also be established for the Ponoy and Kola rivers as well. All these systems are on the Kola peninsula.

Norway: Biological reference points are being developed for the River Imsa. Eventually, it is hoped to establish reference points for all Norwegian river, but this will take more than 5 years.

Sweden: An attempt is being made to establish reference points for the River Högvadsån. At present, there is no evidence that the spawning biomass regulates salmon production in the river. More work will be carried out on the system, as it is the only one where the necessary data can be obtained at present.

Iceland: Habitat surveys are currently being carried out to estimate the productivity of two Icelandic rivers, with the goal of developing spawner levels at least for these rivers. However, in the short term (5 years), it may not be possible to extrapolate from these sites to other Icelandic rivers and values from these sites are not appropriate for all Icelandic rivers.

U.K. (Northern Ireland): Biological reference points from a monitored river (Bush) are available and methods are being developed to extrapolate from this and other information to set reference points for all significant salmon rivers. Reference points will also be established for major tributaries within some river systems.

Ireland: Biological reference points from a monitored river (Burrishoole) are available, and methods are being developed to extrapolate from this and other information to set reference points for all significant salmon rivers. This has been called for in Ireland's new salmon strategy (Salmon Management Task Force 1996). To this end resources are available to establish accurate reference points for a further 16 rivers.

U.K. (England and Wales): The development of biological reference points for all salmon stocks is and established part of the Environment Agency's salmon management strategy (Environment Agency 1996), and methodologies have been developed to transfer reference point data from the River Bush (U.K. (N. Ireland)) (Environment Agency 1996). Preliminary MBAL levels have been set for all rivers (Table 3.6.2) and these will be reviewed and updated with the preparation of Salmon Action Plans for all salmon producing rivers over the next four years.

France: Methodologies have been developed to extrapolate reference points from a monitored river (Oir) to other systems (ICES 1996/Assess:11). In some cases, data collection has begun in other rivers so that stock/recruit relationships can be calculated (e.g. the Scorff). As more appropriate data become available, existing reference points will probably be modified. Table 3.6.3 summarises the present reference points for French rivers.

3.7 Catch Options with an Assessment of Risk

3.7.1 Introduction

It has previously been suggested that the Working Group would attempt to work towards developing a model for salmon stocks in NEAC countries (as one or more groups) similar to that for North American stocks which is used to provide catch advice for the WGC Area and NAC Area. This requires the development of spawning escapement reference levels for all stocks in the area and a capability to predict the pre-fishery abundance of the stocks prior to the fisheries commencing. Considerable progress is being made with setting MBAL levels for spawner escapement in a number of countries and others have indicated that they intend to develop such data in the next few years. However, this is an immense task in some areas; Norway for example will have to set reference levels for 669 rivers. In addition, some countries have indicated that the development of spawner reference levels is not currently planned; this includes major salmon producing countries in both southern and northern Europe. In the absence of such data it will not be possible to provide catch options for the NEAC area using similar methodology to the WGC.

Nevertheless, the Working Group considered that the description of trends and, if possible, prediction of pre-fishery abundance of stocks in the NEAC area was useful. The work commenced in 1995 and 1996 has therefore been further developed below. The Working Group has also considered additional information on levels of exploitation which may provide a rational basis for the consideration of quotas in the distant water fisheries.

3.7.2 Pre-fishery abundance estimates for the NEAC area

The Working Group considered developments in the methods to estimate the pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area. The model developed in 1995 estimated pre-fishery abundance from the catch in numbers of 1SW and MSW salmon in each country, which were then 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.

In 1996, minimum and maximum estimates of pre-fishery abundance were derived for all countries in the NEAC area for the period 1971–1995 (ICES 1996/Assess:). These estimates were given in the report, although the Working Group expressed caution about using 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.

The Working Group recognised that the minimum to maximum range shown previously overstated the uncertainty in the estimates as values near the extremes were less likely to occur than those nearer the mid-points.

(Values near the extremes will only occur if all parameter values are near one extreme, but values near the middle will occur both if parameter 'a' is near the maximum and parameter 'b' is near the minimum or *vice versa*).

The Working Group employed @Risk in Excel to generate estimated distributions of pre-fishery abundance values by simulating repeated runs of the model. The same parameter values were used as in 1996, except where these were updated or corrected; these values were considered likely to encompass the full range of true values. Each unknown parameter was entered as an @Risk function using the uniform distribution (RiskUniform). A single @Risk function was used for series of years where the min-max range of a parameter remained the same. The model was run separately to estimate the total numbers of maturing and non-maturing 1SW recruits in the NEAC area and the numbers in the southern and northern European countries (see table below); each run was based on 500 simulations.

Southern European countries:	Northern European countries:
Ireland	Iceland
France	Finland
U.K. (England & Wales)	Norway
U.K. (Northern Ireland)	Russia
U.K. (Scotland)	Sweden
(Greenland catches)	(Faroes catches)

The Working Group recognised that the split between northern and southern European salmon producing countries is somewhat arbitrary, although a greater proportion of the salmon from Scandinavian countries and Russia are believed to feed in the Norwegian Sea, and a greater proportion of fish from southern European countries migrate to West Greenland. In particular, it was emphasised that wherever a split is made the stocks from rivers on either side of this artificial boundary are likely to behave in a similar manner. This has been demonstrated by the correlation in smolt to adult survival for fish from the R. Figgio (southern Norway) and N. Esk (Scottish east coast) (Section 2.). Nevertheless, salmon stocks in the NEAC area are spread over a very wide range of habitat types and are exposed to differing environmental factors; they are therefore likely to exhibit different trends. The Working Group agreed that the division used in 1996 (based upon the oceanic divide of the North Sea) provided the simplest split at present, but recommended that other groupings should be considered in the future.

The results of the @Risk simulation model (mean and 95 percentiles values for 500 simulations) are shown in Table 3.7.2.1 and Figures 3.7.2.1 to 3.7.2.3. They appear to provide a clearer picture of the likely trends in the salmon stocks in the NEAC area. Trendlines have been inserted in figures where the relationship is significant ($p<0.01$), but these should only be regarded as indicative of likely trends as they are based only upon the mean figures).

It appears that the maturing component of the southern European stocks has declined by more than 50% from the early 1970s to the early 1990s, although stocks appear to have stabilised at a low level in recent years. It should be noted, however, that the early 1970s was a period of high grilse abundance, and the data might, in part, be showing the decline from a peak. It is also possible to see the periods of slightly improved abundance in the mid-1980s and the years of poor survival around 1990 which have been noted previously by the Working Group.

The non-maturing 1SW component of the southern European stocks has also declined. The mean estimate has fallen by around 60% over the 25 year time period, and the series is highly correlated with time ($R^2 = 0.77$). There is some evidence that the decline has stabilised since the late 1980s, although the 1997 value is the lowest in the time series. (These data are plotted on the same scale as the maturing recruit figures to aid comparison). This is the component of the NEAC stocks which is expected to contribute to the West Greenland fishery. The lack of additional variation in the data may make the task of developing predictive models very difficult.

The estimates of both maturing and non-maturing pre-fishery abundance for the northern European stocks show less clear trends (it should be noted that these figures are plotted on a larger scale than the data for southern European stocks). Nevertheless there appears to have been a steady decline in the maturing component of the stocks over the last nine years and in a similar period the abundance of non-maturing recruits has dropped to the lowest level in the series.

3.7.3 Levels of exploitation by Faroes fishery

The levels of exploitation in the Faroes fishery of salmon from various monitored rivers in the NEAC area have been estimated from microtag and external tag recoveries for a number of years (Table 3.7.3.1). No new tag recoveries were reported from the research fishery in 1995/96. The data sets for hatchery and wild 2SW salmon from the R. Imsa (Norway) and for wild 2SW salmon from the N. Esk (U.K. (Scotland)) show significant linear correlations between the level of exploitation and the catch in the Faroes fishery (R^2 values 0.69, 0.77 and 0.72 respectively; $p<0.001$ in all cases) (Figure 3.7.3.1). The data for wild Imsa fish may indicate a non-linear relationship, with exploitation rates of <10% for all catch levels below about 300 t; however the choice of a linear relationships is supported by the existence of a very similar linear relationship for the hatchery fish.

There was no significant relationship for either the R. Drammen (Norway) or the R. Lagan (Sweden) 2SW salmon, but this may reflect the fact that many of the exploitation rate estimates were based on few tag recaptures and were therefore likely to be very imprecise. For 1SW salmon from the N.Esk (U.K. (Scotland)) and both 1SW and 2SW salmon from monitored sites in Ireland, U.K. (N. Ireland) and U.K. (England & Wales) the levels of exploitation at Faroes have been too low (generally <1%) to demonstrate a relationship.

Clearly other factors will affect the level of exploitation of specific stocks. However, the three relationships shown can be used to provide rough guidance to managers on the likely impact of different levels of catch at Faroes on stocks from Norway and Scotland. The regression equations for 2SW hatchery and wild salmon from the river Imsa are very similar, suggesting similar patterns of exploitation of these stock components at Faroes; this differs from patterns of exploitation in homewaters where hatchery fish tend to be more heavily exploited than wild fish in coastal fisheries because of delayed entry into fresh-water.

3.7.4 Development of catch advice

The assessment of pre-fishery abundance provides an indication of trends in stock abundance and suggests that numbers of maturing and non-maturing recruits in the NEAC area are around their lowest level in the past 25 years. The maturing components of the northern European stocks appears to show an alarming downward trend in recent years. The southern European stocks (maturing and non-maturing) and the non-maturing component of the northern European stocks may have stabilised at their current depressed levels.

Although these data cannot be compared with spawning requirement data for the relevant regions, they suggest that a precautionary approach is called for in the management of fisheries, particularly where they exploit mixed river stocks.

The relationship between catch at Faroes and levels of exploitation described above can be used to provide guidance on the approximate effects of different quota levels at Faroes on the exploitation of salmon stocks from Norway and Scotland (Table 3.7.4.1). Estimates for wild and hatchery fish from the Imsa have been averaged to provide a single data series. This suggests that the 1997 quota level of 425 t for the Faroes fishery represents a potential exploitation rate of the order of 22–25% on Norwegian (Imsa) stocks and 3–4% on Scottish (N. Esk) stocks. Exploitation rates on 1SW Norwegian and Scottish stocks and on 1SW and 2SW stocks from other southern European countries are likely to be lower (<3%).

3.8 Catches of Post-Smolts in the Norwegian Sea

3.8.1 Results of post-smolt surveys in 1991–96

In 1996 the Working Group reported on a pair-trawling experiment for herring conducted in July/August 1991 in the northern Norwegian Sea which resulted in a by-catch of 34 postsmolts and 2 1SW salmon (ICES 1996/Assess:11). This coincided with the development of a new pelagic research trawl designed to operate in 0–25 m depth. The Institute of Marine Research (IMR, Norway) has now included salmon sampling in their survey programme for pelagic species, which began on an experimental scale, but from 1995 onwards has been conducted on a regular basis as part of a large-scale ecology study in the Norwegian Sea, the so called "Mare Cognitum Programme" (MCP) (Holst *et al.* 1993, Valdemarsen and Misund 1995, and Holm *et al.* 1996b). The successful application of the surface trawl technique for capturing postsmolts led to the method being tested with a similar but smaller trawl by the SOAEFD, Marine lab. with equal success in the area between NW Scotland, the Shetlands and the Faroes in June 1996 (Shelton *et al.* 1996). As it has been anticipated that most of the larger fish (1SW and older) avoid being caught by the trawl, the IMR conducted experiments in 1995 and 1996 with floating long-lines, driftnets and a specially developed otter board trolling device for use on board the 64 m research ship. Six 1SW salmon were caught, but these fishing methods did not catch post-smolts.

From 1991 to 1995, 507 surface trawl hauls have been made covering an area from the south-west of Ireland (50°N) up to 75° N, east of Bear Island. A total of 404 postsmolts and eleven 1SW fish have been caught (Table 3.8.1.1 and Figure 3.8.1.1).

A large number of postsmolts have been recorded in some of the hauls west of the Hebrides and along the Wyville-Thomson Ridge suggesting that post-smolt salmon may form schools in the open sea and that the fish in these areas have been concentrated by a narrow northward flowing slope current along the north-west European continental shelf edge (Holm *et al.* 1996b; Shelton *et al.* 1996). The mean length of postsmolts increased northwards, possibly because the northerly surveys were conducted later in the summer and the fish had been feeding for a longer time. The proportion of 1 year smolts was significantly higher in the northern than in southern areas indicating that a relatively large proportion probably originated from more southerly areas. This observation is supported by the retrieval in 1995 and 1996 of two microtagged fish tagged the same year in south England and Ireland respectively. Both these fish were captured north of 70°N together with other untagged post-smolts (Holst *et al.* 1996).

Some of the post-smolt captures have been plotted in relation to salinity and water temperature. During a cruise in the eastern and northern Norwegian Sea (cruise 1995 b, Table 3.8.1.1) all post-smolts except two were captured in areas where the salinity exceeded 35 ppm (Holm *et al.* 1996a). A similar observation was reported from the Scottish surveys, where all smolts were caught in the warmest and most saline waters during a cruise 1996 along the Wyville- Thomson Ridge.

3.8.2 Potential of by-catch of post-smolts in pelagic fisheries

The fishery for mackerel and Norwegian spring spawning herring are the two major fisheries for pelagic species occurring in the Norwegian Sea during summer. The mackerel fishery uses mainly pelagic trawls similar to that used to sample postsmolts. The herring fishery on the other hand employs predominantly purse seines. The catches of mackerel off the Faroes (Division Vb) and in the Norwegian Sea (Division Ia) has varied from about 50,000–165,000 metric t in the period from 1983–95 (ICES 1997/Assess:3). The fishery as a rule starts in the Faroese zone in early July and moves northward in the international zone with the northward migration of the western mackerel stocks. The fishery for Norwegian spring spawning herring in the Norwegian Sea started in 1994 and has increased rapidly. Only a small tonnage has been taken with pelagic trawls. In 1996 the catches of herring in the Norwegian Sea were more than 300,000 t.

Both the fishery for mackerel and herring in the Norwegian Sea overlap geographically with the anticipated routes of European post-smolts on their northward feeding migration. To some extent the fishery has been observed to coincide with the post-smolt migration paths as a large fleet was observed trawling in international waters just outside the Norwegian EEZ at around 66°N during cruise 1995 b (Table 3.8.1.1) in July. (Holm *et al.* 1996b). A Norwegian Carlin tag from a smolt release in the Trondheimfjord in May 1996 was retrieved by a fisheries control officer during a screening of the mackerel catch on a pelagic trawler in international waters in the Norwegian Sea in the summer 1996. No data on the possible by- catches of post-smolts in purse-seine catches is available.

The data for estimating the size of such by- catches is unavailable at the present. Provided the trawl methods used in the surveys were comparable with those used by the commercial fishery, the catch- rates from the scientific trawl fishery could be used for estimating smolt numbers from the commercial catches. However, so far almost no information about the trawls used, the fishing depth, towing time and speed etc. is available, and thus no estimates are possible. It is also thought that to catch post-smolts the trawl must be operated in the surface mode, i.e. from 0 m down, but it is not known whether the commercial trawls are used in this way.

The pelagic fishery in the area concerned is presently at a high level. Although these fisheries are anticipated to have reached their peak and are expected to decline slowly over the years to come, an effort to investigate the possible interception between those fisheries and post-smolt migrations would be of great importance for a proper assessment of post-smolt mortality.

3.8.3 Potential of by-catch in herring and redfish fisheries

An important trawl fishery for redfish occurs on the Reykjanes Ridge in the Norwegian Sea and there is anecdotal information that post-smolts have been observed among catches. The necessity to quantify possible post-smolt by-catches in this fishery therefore is as high as for the pelagic fisheries.

3.9 Data Deficiencies and Research Needs in the NEAC Area

1. The Working Group recognises the importance of the results generated from the research fishery programme in the Faroes area and would recommend a continuation of the research fishery.

2. Further information is required on the by-catch of post-smolts in marine fisheries. The Working Group strongly endorses the continuation of the post-smolt surveys in the North East Atlantic.

3. Efforts should be made to standardise the way that catch and release data are handled in the catch statistics in order to provide an unbiased estimate of mortalities due to fishing.

4. The Working requires guidance on the way that ACFM and NASCO would like production of ranched fish to be handled in the various catch tables.

5. Further work is required on the development of biological reference points for stocks in the NEAC area. Consideration should be given to the development of population specific concepts with respect to setting and using spawning reference levels.

6. Efforts should be made to provide more accurate estimates of the level of catch by each country of stocks originating from other countries.

7. Relationships between environmental parameters and marine survival of salmon stocks in the NEAC area need to be developed.

4 FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA

4.1 Description of Fisheries

4.1.1 Gear and effort

Canada

The 23 areas for which DFO manages the salmon fisheries directly are called Salmon Fishing Areas (SFA); for Québec, the management is delegated to the Ministère de l'Environnement et de la Faune and the fishing areas are designated by Q1 through Q11 (Figure 4.1.1.1). Harvest (fish which are killed and retained) and catches (including fish caught and released in recreational fisheries) are categorised 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 salmon in Canada in 1996: Native peoples, commercial fishers, and recreational fishers. The following management measures were in effect in 1996.

Native peoples fisheries: In Québec, Native peoples food fisheries took place subject to agreements or through permits issued to the bands. There are nine bands with food fisheries in addition to the fishing activities of the Inuit in Ungava. The permits generally describe gear and fishing effort and catch limits. In the Maritimes and Newfoundland (SFAs 1 to 23), food fishery harvest agreements were signed with several Native peoples in 1996. The signed agreements included allocations of small and large salmon. Data for harvests which occurred both within and outside agreements were obtained directly from the Native peoples. The Conne River (SFA 11) food fishery did not occur in 1994, 1995 and 1996 because the expected returns were below the conservation requirement for the river. Harvest by Native 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 continued in 1996. In Labrador, commercial fishing quotas assigned by SFA were reduced further from 1995 and the number of fishers declined minimally (Table 4.1.1.1). The opening of the Labrador commercial fishery was moved forward to June 20 from the delayed opening of July 3 in 1995. Previously, the Labrador commercial fishery opened on June 5. The delay in 1996 from the pre-1994 opening date was intended to reduce the exploitation rate on the large salmon and improve the escapement to the rivers. The season was to close on October 15 or sooner if the quota was caught. Commercial fisheries in Québec in 1996 occurred in zone Q9 (July 1 to August 23) and in Ungava Bay (zone Q11 by Native peoples). The quota for Q9 in 1996 was reduced by 20% from 1995.

Recreational fisheries: Management in 1996 differed by geographical area (Figure 4.1.1.2). Except in Québec and Labrador, only small salmon could be killed and retained in the recreational fisheries. The seasonal bag limits in the recreational fishery remained at eight small salmon in New Brunswick (SFA 15, 16) and Nova Scotia (SFA 18 and 21) with a daily limit of two retained. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. Catch-and-release fishing for all sizes of Atlantic salmon was in effect in SFA 20 of Nova Scotia and SFA 23 of New Brunswick. SFA 22 was closed to salmon angling. For insular Newfoundland (SFA 2 to 14A), the seasonal bag limit was similar to 1994 and 1995: six fish of which three small salmon could be retained prior to July 31 and three small salmon after that date. After the bag limit of three was reached in each time period, catch-and-release fishing only was permitted. In Labrador (SFA 1, 2 and 14B), there was no seasonal division of the bag limit but the season limit for large salmon was set at one as in 1995 with a daily limit of two fish. In Québec, season and bag limits varied by zone: for Q1 to Q8 and Q10, the season limit was 7 fish of any size. For rivers in zone Q9 and Q11, the season limit was 10 fish. In most rivers of zones Q1 to Q7 and Q10, fishing for the day would end if the first fish kept was a large salmon. If the first fish kept was a small salmon, then fishing could continue until a second fish was caught, regardless of the size of the second fish. Daily limits in zone Q8 were two fish, Q9 it was three fish and in Q11 it was four fish.

U.S.A.

Angling for sea-run Atlantic salmon in the U.S.A. is permitted only in the State of Maine, and in 1996 the sport fishery was again restricted to catch-and-release. Because of the restrictive management measures put into force in recent years license sales have declined by 50%, from an average of 2,873 during the period 1989–1993 to 1,415 in 1996. The number of licenses sold is not a good indicator of angling effort however, since there is little incentive for anglers to purchase a license when salmon must be immediately released.

France (Islands of Saint-Pierre and Miquelon)

For the Saint-Pierre and Miquelon fisheries in 1996, there were 10 professional fishermen using an estimated 10,400 m of surface gillnet, similar to values last reported in 1994. There were 42 licensed recreational gillnet fishermen using an estimated 7,560 m of surface gillnet. In 1994, there were reported to have been 26 recreational fishermen using 13,860 m of gear.

4.1.2 Catch and catch per unit effort (CPUE)

Canada

The provisional harvest of salmon in 1996 by all users was 291 t, an increase of 12% by weight from the 1995 harvest of 260 t (Table 2.1.1). The 1996 harvest represented about 87,141 small salmon and 30,066 large salmon, an increase of 41% for small salmon but a reduction of 12% for large salmon from the 1995 harvests (Table 2.2.1).

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 4.1.2.1). The abundance of salmon has also declined.

The 1996 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 (Table 4.1.2.1). Newfoundland reported the largest proportion of the total harvest of small salmon and Québec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in all the provinces and overall in Canada (81.3%). Commercial fishers took the largest share of large salmon (49.7% by number). Native peoples harvested 4.5% (by number) of the total small salmon and 19.1% of the total large salmon harvests in eastern Canada.

Native Peoples Fisheries: In many cases, Native peoples food fisheries harvests in 1996 were less than the allocations. Harvests in 1996 (by weight) were 21% above the previous year's harvest and 10% above the previous 5-year average harvest. The proportion of the harvest composed of large salmon remained unchanged relative to previous years.

Harvests	1990	1991	1992	1993	1994	1995	1996
Weight (t)	31.9	29.1	34.2	42.6	41.7	32.8	39.8
% Large by weight	78%	87%	83%	83%	83%	82%	84%

Recreational Fisheries: Harvest in recreational fisheries in 1996 totalled 80,438 small and large salmon, 14% above the previous five-year average and 47% above the 1995 harvest level (Figure 4.1.2.2). Harvests of small salmon increased 19% from the previous five-year mean while harvests of 9,598 large salmon were a 10% increase. Harvests of small salmon were 20% above the harvests in 1995 and this size group has contributed more than 86% on average of the total harvests since the imposition of catch-and-release recreational fisheries in the Maritime and insular Newfoundland (SFA 3 to 14B, 15 to 23) fisheries in 1984.

Recreational catches (including retained and released fish) of small salmon in 1996 increased relative to the 1984 to 1993 mean in most fishing areas of Québec, Newfoundland and Labrador (Figure 4.1.2.3). Catches of large salmon were up in the Gulf shore of Nova Scotia (SFA 18) and the Québec/New Brunswick Chaleur Bay area (SFA 15, Q1 and Q2). Catches of large salmon in Labrador (SFA 2) were the highest observed since 1984. Catches in SFA 17 (PEI) were above average but more than 90% of the returns originate from smolt stocking programs.

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. Numerous areas in the Maritimes Region of eastern Canada were closed to all retention of salmon, regardless of size (Figure 4.1.1.2). Caught-and-released fish are not considered equivalent to retained fish and their inclusion in catch statistics further compromises the reliability of interpretation of trends.

Commercial Fisheries: The commercial harvest in 1996 declined to 81.2 t from a peak of more than 2,400 t in 1980 (Figure 4.1.2.4). Commercial harvest in Labrador was the lowest ever (48 t) with large salmon representing less than 50% of the harvests (Table 4.1.1.1). For Québec, the harvest and the proportion of large salmon in the commercial fishery continued to decline in 1996, in part as a result of license retirements and reduced quotas.

U.S.A.

There was no harvest of sea-run Atlantic salmon in the U.S.A. The estimated number of salmon caught-and-released in 1996 was 542 fish, which was 46% higher than in 1995 and 154% higher than in 1994. Much of the increased catch occurred in the Penobscot River, and was attributed to increased salmon abundance and excellent angling conditions throughout the fishing season.

France (Islands of Saint-Pierre and Miquelon)

The harvest of salmon by commercial nets in 1996 is estimated to have been 950 kg and 560 kg by recreational fishermen using gillnets. The commercial catch is approximately two times that reported for 1995. There was no estimate provided for the recreational catch in 1995.

4.1.3 Origin and composition of catches

In the past, salmon from both Canada and U.S.A. have been taken in the commercial fisheries of Labrador. No tags of U.S.A. origin were reported from this fishery in 1996 but there were no releases of external Carlin or coded-wire tagged smolts from U.S.A. rivers in 1995.

Canada

Origin of returns in 1996

Fish designated as being of wild origin are defined as the progeny of fish where mate selection occurred naturally (eggs not stripped and fertilised artificially) and whose life cycle is completed in the natural environment. 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. 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 (Figure 4.1.3.1). Aquaculture escapees were sampled from the returns to several rivers of the Bay of Fundy (St. Croix, Magaguadavic, Saint John in SFA 23) as well as in the Baddeck River (SFA 19). Other salmonid aquaculture escapees, rainbow trout and Atlantic salmon smolts from the Bay d'Espoir aquaculture industry, were observed at Conne River (SFA 11).

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to almost 17,000 t in 1996 (Table 2.2.1.1). Escapes of Atlantic salmon have occurred annually. In 1994, escapes of Atlantic salmon in the Bay of Fundy area were estimated at 20,000 to 40,000 salmon, an amount greater than the total returns of wild and hatchery origin salmon (both small and large) (13,000 to 21,000 fish) to the entire Bay of Fundy and Atlantic coast of Nova Scotia area (SFA 19 to 23) in the same year. The level of escapes in 1993 was similar to that of 1994. Reported estimates of escapes for 1995 and 1996 are low.

Aquaculture escaped fish have increased in abundance in the Magaguadavic River (SFA 23) which is in close proximity to the centre of the aquaculture production area (Table 4.1.3.1). Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of the total counts at the fishway.

U.S.A.

Some salmon that were caught in the sport fishery in 1996 were escapees from aquaculture operations in Maine and New Brunswick (Canada). In addition, a few of those caught and released originated from 322 captive (wild-origin) broodstock released into three rivers in Maine in June. The incidence of aquaculture escapes was low in monitored rivers before 1994. Since 1994, the incidence of aquaculture escapes has increased in the Narraguagus River but has declined or remained high in the other two rivers in eastern Maine (Table 4.1.3.1).

4.1.4 Exploitation rates in Canadian and U.S.A. fisheries

Canada

Within eastern Canada salmon were exploited by three user groups: Native peoples, recreational anglers, and commercial fishers. Exploitation rates can be estimated by dividing the harvests (87,141 small and 30,066 large salmon) by the sum of the estimated recruitment of small (287,664–620,741) and large (108,256–203,416) salmon to eastern Canada. Recruitment was estimated by summing returns of small and large salmon in the sub-areas (Appendix 5) with the harvest of small and large salmon in the Newfoundland and Labrador commercial fishery (Table 4.1.1.1). Calculated in this manner, the exploitation rate on the total recruitment to Canada of small salmon was between 0.14 and 0.30 and for large salmon, between 0.15 and 0.28. The rates on both small and large salmon are down from the 1995 levels.

Overall marine conditions were more temperate in 1996 relative to those of the preceding several years (1990 to 1995). Ice coverage in the winter of 1996 was below the median distribution and ice retreat was earlier in the spring of 1996 than in previous years. In northern Labrador, heavy ice persisted along the coast into August. The warmer conditions in 1996 resulted in adults entering rivers up to two weeks earlier than had been the case in the last few years, both in Newfoundland and in the Maritimes.

Freshwater environmental conditions affect the timing and availability of salmon to the fisheries. Discharges in 1996 were above normal in both winter and summer with no important low flow events. This contrasts with the 1995 water levels when summer flow conditions were exceptionally low. Warm water temperatures in 1996 were not as extreme as in the two previous years. Above-normal discharges and cooler water temperatures provided excellent angling opportunities in those areas where fisheries were open.

Native Peoples Fisheries: The harvest of salmon in eastern Canada by Native peoples in 1996 totalled 3,920 small salmon and 5,747 large salmon. The exploitation rate by Native peoples on small salmon in eastern Canada was about 0.01 and for large salmon between 0.03 and 0.05 of total recruitment to Canada. These rates are similar to those estimated for 1995.

Recreational Fisheries: The recreational harvest of salmon in eastern Canada in 1996 totalled 70,840 small salmon and 9,598 large salmon. The exploitation rate on small salmon was between 0.11 and 0.24 and for large salmon between 0.05 and 0.09. These rates are an increase from 1995 for small salmon but a slight decline for large salmon.

Commercial Fisheries: The commercial harvest of salmon in eastern Canada during 1996 totalled 12,381 small salmon and 14,721 large salmon. The exploitation rate on small salmon was between 0.02 and 0.04 and for large salmon was between 0.07 and 0.14. Both rates declined from the 1995 levels.

U.S.A.

There was no exploitation of U.S.A. salmon in home waters, and no salmon of U.S.A. origin were detected in Canadian catches in 1996.

4.2 Status of Stocks in the North American Commission Area

There are approximately 550 Atlantic salmon rivers in eastern Canada and 21 rivers in eastern U.S.A. 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 by examining trends in returns and escapement relative to the conservation requirements.

4.2.1 Measures of abundance in monitored rivers

Canada

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

A total of 85 monitored rivers were assessed in eastern Canada in 1996. Estimates of total returns of small and large salmon were obtained using various techniques; 47 were derived from counts at fishways and counting fences, 7 were obtained using mark and recapture experiments, 18 using visual counts by snorkeling or from shore, 1 from an acoustic system, and 12 from angling catches or catch rate indices.

Of the 85 stocks for which returns of salmon were determined in 1996, comparable data were collected on 47 of these in 1995 (Table 4.2.1.1). Large salmon returns in 1996 increased from 1995. Small salmon returns were also improved from 1995.

Annual returns of salmon by size group are available for 26 rivers in Atlantic Canada since 1985. These returns do not account for commercial fisheries removals in Newfoundland, Labrador and Greenland and in some rivers include returns from hatchery stocking. Peak return years differed for regions within eastern Canada (Figure 4.2.1.1). The returns during the Newfoundland commercial fishery moratorium years (1992 to 1996) for all areas except Newfoundland are lower than the returns of 1986 to 1988 when there were commercial fisheries in

Newfoundland, Labrador and Greenland harvesting mainland Canada origin salmon. Returns of small salmon to the Gulf rivers have fluctuated annually but have declined between 1994 and 1996 to the lowest levels since 1985. Large salmon of the Gulf rivers have not fluctuated as greatly as the small salmon returns and seem to have levelled off at about 45,000 fish in the eight rivers assessed. Returns to Scotia-Fundy improved from 1994 to 1996 for both large salmon and small salmon but returns of both size groups remain well below the levels observed in the 1980s. Québec returns in 1996 were the third lowest since 1985. The returns to Newfoundland rivers have more than doubled since 1993 from the low levels observed during 1989 to 1991.

Trends in abundance of small salmon and large salmon within the geographic areas show a general synchronicity among the rivers. Although returns in 1996 were generally improved relative to 1995, the returns in all rivers were among the lowest observed since 1985 with the exception of the Newfoundland rivers (Table 4.2.1.1). For the rivers of Newfoundland (there are no rivers from Labrador in the time series), large salmon and small salmon returns were among the highest in the last 12 years as indicated by the high rank of the abundance level for the majority of rivers in 1996 within the 1984 to 1996 time period. Large salmon returns in the Gulf of St. Lawrence and Québec were among the lowest whereas small salmon returns were in the lower third of the time series.

Densities of juveniles have been monitored annually since 1971 in the Miramichi (SFA 16) and Restigouche (SFA 15) rivers. 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 escapements (Figure 4.2.1.2). Densities of parr remained high in 1996 in the Miramichi but fry densities declined. In the Restigouche River, both fry and parr densities declined. The observed declines in both rivers are not attributed to lower spawning escapements but may be related to overwintering conditions during 1995/1996.

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; SFA 22) which have declined since 1984, as a result of reduced spawning escapement. Fry densities in 1996, an index of spawning escapement in 1995, were the lowest in the time series (Figure 4.2.1.2). Except for the rivers along the eastern and southern shores of Nova Scotia (SFA 20 and 21) which have been impacted by acid precipitation and rivers of the inner Bay of Fundy (SFA 22 and part of 23), 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 eastern shores of Nova Scotia 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.

U.S.A.

Documented adult salmon returns to thirteen rivers in New England in 1996 amounted to 2,762 salmon (Figure 4.2.1.3), a 58% increase from 1995. Returns of 1SW salmon increased by 210% (184 to 570), while MSW returns increased by 40% (1,567 to 2,192) from the previous year. The documented adult returns are minimal estimates, since many rivers in Maine do not contain counting facilities and throughout New England not all counting facilities are 100% effective at capturing adult salmon.

Most of the U.S.A. salmon returns were recorded in the rivers of Maine, with the Penobscot River accounting for about 74% of the total. Returns to the Penobscot River (2,045 fish) were 52% higher than the previous year, and 23% higher than the previous 5-year average. However, total returns were 17% lower than the previous 10-year average.

About 9% of the U.S.A. returns (260 salmon) were recorded in the Connecticut River, a 38% increase from the previous year. Returns to the Connecticut River in 1996 were 7% and 2% below the previous 5-year and 10-year averages, respectively.

Salmon returns to the Merrimack River numbered 76 fish. While this represented a 124% increase (42 salmon) from the previous year, the 1996 salmon run was 34% and 38% below the previous 5-year and 10-year averages, respectively.

4.2.2 Estimates of total abundance by geographic area

For assessment purposes, the following regions were considered: Labrador (SFA 1, 2, & 14B), Newfoundland (SFA 3–14A), Québec (Q1–Q11), Gulf of St. Lawrence (SFA 15–18), Scotia-Fundy (SFA 19–23) and U.S.A.

Returns of 1SW and 2SW salmon to each region (Tables 4.2.2.1 and 4.2.2.2; Figures 4.2.2.1 and 4.2.2.2; and Appendix 5) were estimated by updating the methods and variables used by Rago *et al* (1993a) and reported in ICES 1993/Assess:10. The returns for both sea age groups were derived using a variety of methods using data available for individual river systems and management areas. These methods included counts of salmon at monitoring facilities, population estimates from mark recapture studies, and the application of angling and commercial catch statistics, angling exploitation rates, and measurements of freshwater habitat (Appendix 5). 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, including homewater commercial fisheries, except in the case of Newfoundland and Labrador regions where returns do not include commercial fisheries. The catches of Newfoundland and Labrador origin salmon in homewater commercial fisheries have been added to Newfoundland and Labrador returns to show the total "recruits" produced by these regions. Similar procedures to estimate recruits produced by Québec, Gulf of St. Lawrence, Scotia-Fundy and U.S.A. regions were not followed as it was not possible to annually estimate the region of origin of intercepted salmon in the Newfoundland-Labrador commercial fisheries.

Labrador:

The mid-point of the 1SW salmon returns to Labrador rivers in 1996 was about 113,200, which is the third highest in the time series, 1971 to 1996 and approximately double that of 1995 (Figure 4.2.2.1, Appendix 5ii). The abundance (recruits) of 1SW salmon, 1971–88, has been quite variable with low numbers returning in 1973, 1978, and 1984. The mid-point of the estimated number of recruits declined from about 150,000 1SW salmon in 1987 to about 45,000 in 1991 and remained between 43,000 and 57,000 from 1992 to 1995.

The mid-point of the 2SW returns to Labrador rivers in 1996 is about 21,000, a 21% decline from 1995 yet the second highest since 1980 (Figure 4.2.2.2, Appendix 5i). There was a decline in recruits of 2SW salmon from 1980 to 1991, and recruits (mid-points) have remained between 23,000 and 29,000 fish from 1992 to 1996. The low returns and recruits of 1SW and 2SW salmon 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 (214,400) of 1SW salmon to Newfoundland rivers in 1996 is 28% higher than 1995 and 25% higher than the average 1SW returns (171,300) for the period 1992–94 (Figure 4.2.2.1, Appendix 5iii). The 1992–95 1SW returns are higher than the returns in 1989–91, but similar to the returns to the rivers between 1971 and 1988. The 1SW recruits to Newfoundland, before commercial fisheries, have declined significantly from about 500,000 in 1988 to 214,000 in 1996.

The mid-point (5,600) of the estimated 2SW returns to Newfoundland rivers in 1996 is slightly (15%) higher than in 1995 and continues an upward trend since 1992 (Figure 4.2.2.2, Appendix 5iii). The 2SW recruits in 1992–96 are the lowest observed in the time series (1969–96).

Québec:

The mid-point (28,900) of the estimated returns of 1SW salmon to Québec in 1996 is a 59% increase from the returns observed in 1995 and is similar to the years 1992–94 (Figure 4.2.2.1, Appendix 5 iva & ivb).

The mid-point (29,900) of the estimated returns of 2SW salmon to Québec is slightly (5%) higher than 1995 and is the third lowest estimate of returns in the time series (1971–95) and continues a decline in returns that began in 1989 (Figure 4.2.2.2, Appendix 5 iva & ivb).

Gulf of St. Lawrence SFA 15–18:

The mid-point (73,500) of the estimated returns in 1996 of 1SW salmon returning to the Gulf of St. Lawrence was a 20% increase from 1995 and is the first year of an increase since the high levels estimated in 1992 (Figure 4.2.2.1, Appendices 5v, via, vib, vii, viiia, viiib).

The mid-point (31,600) of the estimate of 2SW returns in 1996 is 27% lower than the estimate for 1995 (Figure 4.2.2.1, Appendices 5v, via, vib, vii, viiia, viiib). The average return of 2SW salmon for 1992–95 is slightly higher than the average for 1987–91 and may reflect the reductions in fishing mortality due to the closure of the Newfoundland commercial fishery.

Scotia-Fundy, SFA 19–23:

The mid-point (23,600) of the estimate of the 1SW returns in 1996 to the Scotia-Fundy Region is 43% higher than the 1995 estimate and continues the increase from the low estimate of 1994; it is similar to values during 1991–93 (Figure 4.2.2.1, Appendix 5 ix). The decline in returns began in 1991.

The mid-point (9,900) of the 2SW returns in 1996 is 44% higher than the returns in 1995; however it is the third lowest observed in the time series, 1971–95 (Figure 4.2.2.2, Appendix 5xa, xb). A continual decline in returns has been observed from 1985 to 1995.

U.S.A.

Total salmon returns and spawners for U.S.A. rivers in 1996 were calculated as in the previous year (ICES 1996/Assess:11). Since the harvest of salmon is not permitted in Maine and many rivers do not contain fish counting facilities, run sizes for several small rivers in Maine continue to be underestimated. Additionally, since it is not possible to determine the age and origin of salmon caught in the Maine sport fishery, the number of spawners is considered to be the same as the number of returns.

The total estimated 1SW returns and spawners to U.S.A. rivers in 1996 is 657 salmon. This was the highest estimate since 1992 (Table 4.2.2.1, Figure 4.2.2.1), and represented a 25% increase above the previous 5-year average but a 12% decrease from the previous 10-year average.

The estimated 2SW returns and spawners to U.S.A. rivers is 2,316 salmon (Table 4.2.2.2, Figure 4.2.2.2). This, too, was the highest estimate since 1992, and represented a 41% increase above the previous 5-year average but a 17% decrease from the previous 10-year average.

North America (combined Canada and U.S.A.):

The mid-point estimate of the total number of 1SW salmon returning to North America in 1996 (454,000) is 44% higher than the estimate for 1995 and higher than the average (363,200) of the previous years (1971–95) by 20%. It is the fourth highest observed in the past 10 years and seventh highest in the 26 year time series, 1971–1996 (Table 4.2.2.1). The estimates of returns are quite variable over the time series with no trends indicated.

The mid-point of the estimated 2SW returns (100,300) is 10% lower than the total returns for 1995 and 10% lower than the average (111,200) for the past 10 years. It is similar however to both 1993 and 1994 returns (Table 4.2.2.2). It has declined from a peak of almost 200,000 in the late 1970s.

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

North American Run-Reconstruction Model

The Working Group has used the North American Run-Reconstruction Model to estimate 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. The catch statistics used to derive returns and spawner estimates have been updated from those used in ICES 1996/Assess:11 (Table 4.2.3.1).

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 variables are given in Table 4.2.3.2. It is constructed by summing 2SW returns in year i+1 [NR2(i+1)], 2SW salmon catches in 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. 4.2.3.1 $$NN1(i) = (NR2(i+1) / S1 + NC2(i+1))/S2 + NC1(i) + NG1(i)$$

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.* (1993b).

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, catches used in the run-reconstruction model for the West Greenland fishery (1993 and 1994) and Newfoundland fishery (1992–96) were set to zero in order to remain consistent with catches used in other years in both of these areas (see Section 4.1.1) There were no fisheries in these areas for the years indicated.

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 1995. The minimum and maximum values of the catches and returns for the 2SW cohort are summarised in Table 4.2.3.3. The 1995 abundance estimates ranged between 99,400 and 182,000 salmon. The mid-point of this range (141,000) is only slightly higher than the 1994 value (137,000) which is the second lowest in the 25 years time series (Figure 4.2.3.1). The results suggests at best a levelling off of the decline, and prefishery abundance remains at historic low levels. The Working Group expressed concern about the continued decline in the prefishery abundance and its impact on spawner levels.

The low numbers observed in 1978 and 1983–84 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	8	2
Good	3	11

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 (Grilse)

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.

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 ICES 1991/Assess:12. The "large" category in SFAs 1–7,14B consists of 0.1–0.3 1SW salmon (Rago *et al.* 1993; ICES 1993/Assess:10). Salmon catches in SFAs 8–14A are mainly maturing salmon (Idler *et al.* 1981).

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

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

Eq. 4.2.3.3 $$MC1(i) = [(1\text{-}f\_imm)(H\_s(i)_{\{1\text{-}7,14b\}} + q{*}H\_l(i)_{\{1\text{-}7,14b\}})] + H\_s(i)_{\{8\text{-}14a\}}$$

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, catches used in the run-reconstruction model for the Newfoundland fishery were set to zero for 1992–96 in order to remain consistent with catches used in other years in this area (see Section 4.1.1).

The minimum and maximum values of the catches and returns for the 1SW cohort are summarised in Table 4.2.3.4 and the mid point values are shown in Figure 4.2.3.1. The mid-point of the range of prefishery abundance estimates for 1996 (467,000) is larger than that of 1995 (328,000). Estimates for 1995 and 1994 decreased markedly below the previous two years. The reduced values observed in 1978 and 1983–84 were followed by large increases in pre-fishery abundance. However, if the data are divided into sets above and below the 25 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	10	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 4.2.3.1 shows the prefishery abundance of 1SW maturing and 1SW non-maturing salmon from North America for the period 1971 to 1995 and Figure 4.2.3.2 shows these data combined to give the total 1SW recruits. The steady decline in recruits over the last 10 years is alarming. Although the declining trend appears common to both maturing and non-maturing portions of the cohort, non-maturing 1SW salmon have been declining at a steeper rate. Causes for the differences in rate of decline are uncertain. Figure 4.2.3.1 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. Environmental variation could have resulted in earlier maturation of the salmon or the historically higher exploitation rates on the non-maturing component could have reduced the recruitment of this component. The Working Group expressed concerns about these stock trends and recommended further investigation into their causes.

4.2.4 Spawning escapement and egg deposition

Canada

Egg depositions exceeded or equalled the river specific conservation requirements in 32 of the 85 assessed rivers and were less than 50% of conservation in 22 other rivers (Figure 4.2.4.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 20 rivers assessed had egg depositions which were less than 50% of conservation requirements. Several rivers in Newfoundland and Québec which were deficient in eggs are colonisation programs where salmon have gained access in recent years to previously inaccessible habitat.

Escapements over time relative to conservation requirements have improved in some areas of Atlantic Canada but have declined in others (Figure 4.2.4.2). The Bay of Fundy/Atlantic coast of Nova Scotia rivers status has severely declined, especially since 1991. For the Québec rivers, spawning escapements declined continually from a peak median value in 1988 but recovered in 1995. The Newfoundland rivers have shown the greatest improvement in the proportion of the spawning requirement achieved as a direct result of the commercial salmon and groundfish moratoria instigated in 1992.

Run reconstruction estimates of spawning escapement

Estimates for 2SW spawners were derived in 1996 (ICES 1996/Assess:11) and updated at the current meeting for the six geographic regions referenced in Section 4.2.2 (Table 4.2.4.1). Estimates of 1SW spawners, 1971–96 are provided in Table 4.2.4.2. These estimates were derived by subtracting the in-river removals from the estimates of returns to rivers. A comparison between the numbers of spawners, returns and spawning requirements for 1SW and 2SW salmon are shown in Figures 4.2.2.1 and 4.2.2.2 respectively (there are no spawning requirements defined specifically for 1SW salmon).

Labrador:

The mid-point of the estimated numbers of 2SW spawners (20,700) in Labrador in 1996 is the third highest estimated spawning escapement during the period 1971-96 and approximates 60% of the total 2SW spawner requirements for all rivers in Labrador (Figure 4.2.2.2). It is however a 21% decline from the numbers estimated in 1995. 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 to 1995, which is consistent with increasing restrictive management measures in the commercial fisheries.

The mid-point of the estimated spawning escapement of 1SW salmon (109,800) in 1996 is the third highest value in the time series, 1971–96 and is 122% higher than the mid-point estimated in 1995. Spawning escapements of 1SW salmon have been quite variable over the time series but have generally increased since 1991, consistent with increasing restrictive management measures in the commercial fisheries (Figure 4.2.2.1).

Newfoundland:

The mid-point of the estimated numbers of 2SW spawners (5,500) in Newfoundland in 1996 is slightly higher (15%) than estimated in 1995 and is 137% of the total 2SW spawner requirements for all rivers. This year is the third time that the spawner requirement has been met or exceeded since 1984 (Figure 4.2.2.2).

The 1SW spawners in Newfoundland rivers in 1996 increased by 28% from 138,000 in 1995 to 176,000 in 1996. The 1992–96 1SW spawners are higher then the spawners in 1989–91 and similar to levels in the late 1970s and 1980s (Figure 4.2.2.1).

There has been a general increase in both 2SW and 1SW spawners during the period 1992–96 and is consistent with the closure of the commercial fisheries in Newfoundland.

Québec:

The mid-point of the estimated numbers of 2SW spawners (12,000) in Québec in 1996 is higher (18%) than estimated in 1995 and is about 20% of the total 2SW spawner requirements for all rivers (Figure 4.2.2.2). The spawning escapement in 1996 is the second lowest number estimated since the mid-1980s. Estimates of the numbers of spawners in Québec have consistently been about one-fifth to one-third of the spawner requirement over the time series (1971–96).

The mid-point of the estimated 1SW spawners in 1996 (14,400) was a 78% increase from 1995 (Figure 4.2.2.1) and was one-third higher than the average of the time series 1971–95. Spawning escapement of 1SW fish has generally been higher since the early 1980s than it was before this period.

Gulf of St. Lawrence:

The mid-point of the estimated numbers of 2SW spawners (29,000) in Gulf of St. Lawrence in 1996 is 30% lower than that estimated in 1995 and is about 95% of the total 2SW spawner requirements for all rivers in this region (Figure 4.2.2.2). This is the first time in seven years that these rivers have not exceeded their 2SW spawner requirements.

The mid-point of the estimated spawning escapement of 1SW salmon (46,100) increased by 21% from 1995 and is the first increase seen since 1992 (Figure 4.2.2.1). Spawning escapement has on average been higher since the mid-1980s than it was before this period.

Scotia-Fundy:

The mid-point of the estimated numbers of 2SW spawners (9,500) in Scotia-Fundy area in 1996 is a 41% increase from 1995 and is about 45% of the total 2SW spawner requirements for all rivers in this region (Figure 4.2.2.2). The 2SW spawning escapement has been generally declining since 1985.

The mid-point of the estimated 1SW spawners (20,300) in 1996 is also a 40% increase from 1995 and continues the upward trend from the low spawning escapement in 1994 (Figure 4.2.2.1).

Canada:

The mid-point of the estimated 2SW spawners in 1996 in Canada was 76,219 and is 50% of the total requirement for 2SW spawners of 151,296. This is a decrease from the 59% attained in 1995.

The overall 2SW spawner requirement for Canada could have been met or exceeded in only 3 (1974, 1977, 1980) of the past 25 years (considering the mid-points of the estimates), by adjustments to the terminal fisheries alone. In the remaining years, spawning targets could not have been met even if all in-river harvests had been eliminated.

U.S.A.

The estimated 2SW returns (2,316 salmon) to U.S.A. rivers in 1996 represents 8% of the spawner requirements for all rivers. There were an additional 657 1SW spawners in U.S.A. rivers in 1996. This represented the highest level of both 1SW and 2SW spawners observed in U.S.A. rivers since 1992.

The estimated spawning escapement in the Penobscot River in 1996 was similar to the previous year at about 5% of the required number of 2SW females. Spawning escapements for the Connecticut and Merrimack rivers were less than 1% of spawning requirements.

Escapement variability in North America

The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of the pre-fishery abundance taking into consideration the 11 months of natural mortality at 1% per month. These values, termed potential 2SW recruits, along with total North American 2SW returns, spawners and requirements are shown in Figure 4.2.4.3 and indicate that the overall North American spawner requirement could have been met, in the absence of all fisheries, in all years except 1993, 1994, 1995 and 1996. The difference between the potential 2SW recruits and actual 2SW returns reflect the extent to which mixed stock fisheries at West Greenland and in SFAs 1–14 have reduced the populations. Similarly, the impact of the Greenland fishery can be considered by subtracting the non-maturing 1SW salmon (accounting for natural mortality) harvested there from the total potential 2SW recruits. These values, termed 2SW recruits to North America, are also shown in Figure 4.2.4.3. The difference between the 2SW recruits to North America and the 2SW returns reflects the impact of removals by the commercial fisheries of Newfoundland and Labrador. The 2SW recruits to North America indicate that, even if there had not been a West Greenland commercial fishery, spawner requirements would not have been met in 1979 and since 1990. The difference between the actual 2SW returns and the spawner numbers reflects in-river removals throughout North America and coastal removals in Québec, Gulf and Scotia-Fundy regions.

In 1994, the Working Group (ICES 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 previous reports (ICES 1994/Assess:16, ICES 1995/Assess:14), the spawners in each geographic area were allocated (weighted forward) to the year of the non-maturing 1SW component in the Northwest Atlantic using the weighted smolt age proportions from each area (Table 4.2.4.3). The total spawners for a given recruitment year in each area is the sum of the lagged spawners. Because the smolt age distributions in North America range from one to six years and the time series of estimated 2SW spawners to North America begins in 1971, the first recruiting year for which the total spawning stock size can be estimated is 1979 (although a value for 1978 was obtained by leaving out the 6-year old smolt contribution which represents 4% of the Labrador stock complex (Table 4.2.4.3)). Since the 1996 2SW spawners to North America are known, the spawning stock contributing to the pre-fishery abundance up to 1999 is known for North America and up to 2000 for the stock areas in Canada (Table 4.2.4.4, Figure 4.2.4.4).

Spawning escapement to several stocks complexes has been well below the spawner requirement (Labrador, Québec, Scotia-Fundy, U.S.A.) and decreasing (Labrador, Québec and U.S.A.) since the late 1980s (Figure 4.2.4.4). The relative contributions of the geographic area stocks to the total spawning escapement of 2SW salmon has varied over time (Figure 4.2.4.5). The reduced potential contribution of Labrador and the increased importance of the spawning stock from the Gulf of St. Lawrence rivers to future recruitment is most evident. 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 and Newfoundland stock complexes have received spawning escapements which have been close to requirements, all other complexes are well below requirement and some have declined even further.

4.2.5 Survival indices

Canada

Counts of smolts provide direct measurements of the outputs from the freshwater habitat. Previous reports have documented the high annual variability in the annual smolt output: in tributaries, smolt output can vary by five times but in the counts for entire rivers, annual smolt output has generally varied in magnitude by a factor of two.

The number of wild smolts leaving the rivers depends upon the number of eggs deposited adjusted by variable survival rates throughout the juvenile stages. The production among river systems is also not necessarily synchronised and it is not possible to calculate how many smolts in total leave the rivers of Atlantic Canada for any given year. In the Québec rivers where smolt production has been monitored, the 1996 smolt production was similar to the average production during 1990 to 1995 (Figure 4.2.5.1). In Newfoundland rivers, smolt production increased in three rivers along the South and Southeast coasts of Newfoundland but for the river with the longest time series of smolt counts in Canada, the production of smolts from Western Arm Brook (WAB) was similar to the 1990–95 average.

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 12 rivers in Atlantic Canada with smolt counts and corresponding adult counts are available; four are hatchery stocks and eight are wild populations. Geographically, populations for which data were available ranged from the Saint John River (SFA 23 - Bay of Fundy) in the south, LaHave 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 and aux Rochers (Q7) in the Québec north shore, Bec-Scie (Q10) in Anticosti Island, and other populations from southern (Conne, Northeast and Rocky: SFAs 9 and 11), eastern and northern Newfoundland (Campbellton: SFA 4 and Western arm Brook: SFA 14) (Figure 4.2.5.2).

In general, survival of hatchery stocks is lower and more variable than that of wild stocks (Figure 4.2.5.2). The three hatchery stocks from the Bay of Fundy / Atlantic coast of Nova Scotia show a declining trend over time which has become particularly acute in recent years although two of these stocks showed a marked improvement in sea survival to the 1SW stage in 1996. The single hatchery stock from Québec also shows a declining trend over the shorter time series with very low smolt survivals to both the 1SW and 2SW stages.

Sea survivals in the Québec wild stocks have also declined from the peak survivals of the 1989 smolt migration with a slight improvement in the sea survival of the 1995 smolt migration (Figure 4.2.5.2). Survivals of the 1995 smolt migration improved for all the Newfoundland stocks and have recovered to historical or near-historical levels.

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

Colder oceanic conditions both nearshore and in the Labrador Sea are negatively associated with marine survival of salmon in eastern Canada. Environmental conditions tend to be autocorrelated and the upward trend in warming of the water temperatures in 1994 to 1996 may represent a return to temperate marine conditions favouring salmon production.

U.S.A.

The survival of hatchery-reared smolts released in the Penobscot River in 1994 was slightly higher than that observed for the 1993 smolt class (Figure 4.2.5.3). Both 1SW and MSW salmon returns exhibit a slight upward trend in recent years.

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

The North American Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971–1996. The 1994 estimate of pre-fishery abundance of **non-maturing 1SW salmon** was the lowest on record. Increases from this low value were noted in both 1995 and 1996 (Figure 4.2.3.1) with the 1996 estimate about 8% above the low 1994 estimate. Similarly, the 1994 estimate of pre-fishery abundance of **maturing 1SW salmon** was also the lowest on record and improvement has been noted since then with the 1996 estimate increasing by 46% from the low 1994 estimate. The results suggest a levelling off of a decline to historical low levels and in the case of 1SW maturing salmon, a clear increase. In addition to the steady decline in total recruits over the last 10 years, there has been a 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 four years.

The estimate of the total number of 1SW salmon returning to Labrador and Newfoundland rivers and coastal waters of other areas of North America in 1996 is 44% higher than the estimate for 1995 and higher than the average of the previous years (1971–95) by 20%. It is the fourth highest observed in the past 10 years and seventh highest in the 26 year time series, 1971–1996 (Table 4.2.2.1). The estimates of returns are quite variable over the time series with no trends indicated.

The estimated 2SW returns are 10% lower than the total returns for 1995 but similar to both 1994 returns and the average for the past 10 years (Table 4.2.2.2). They have declined from a peak of almost 200,000 in the late 1970s.

The rank of the estimated returns in 1996 in the 1971–1996 time series for six regions in North American is shown below:

Region	**Rank of 1996 returns in 1971-96 time series (1=highest)**		**Mid-point estimate of 2SW spawners as proportion of escapement requirement**
	1SW	**2SW**	**(%)**
Labrador	3	3	60
Newfoundland	3	6	137
Québec	7	24	20
Gulf	16	22	95
Scotia-Fundy	17	23	44
U.S.A.	8	15	8

In most regions the returns of 2SW fish are near the lower end of the twenty five year time series. However, returns of 2SW salmon to Labrador in 1995 and 1996 were the best in the time series (Table 4.2.2.2). Returns of 1SW salmon improved in all areas in 1996 relative to 1995 and in some regions (Labrador, Newfoundland, and Québec) were near the highest levels in the time series (Table 4.2.2.1).

The text table above also shows the estimated total spawning escapement of 2SW salmon in each region in 1996 expressed as a percentage of the spawning escapement requirement. Only in Newfoundland were requirements exceeded; in the Gulf of St. Lawrence requirements were approached. The overall 2SW spawning escapement requirement for Canada could have been met or exceeded in only 3 (1974, 1977 and 1980) of the past 26 years (considering the mid-points of the estimates) by reduction of in-river fisheries. In the remaining years, spawning requirements could not have been met even if all in-river harvests had been eliminated.

The majority of the U.S.A. returns were recorded in the rivers of Maine, with the Penobscot River accounting for about 74% of the total. Salmon returns to the Penobscot River were 52% higher than the previous year, but were 23% higher than the previous 5-year average and 17 % lower than the previous 10-year average. While U.S.A. salmon returns improved in 1996, returns to most rivers are hatchery-dependent and remain at low levels compared to spawning requirements.

Egg depositions exceeded or equalled the specific river requirements in 32 of the 85 rivers which were assessed in Canada and were less than 50% of requirements in 22 other rivers. Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 20 rivers assessed had egg depositions which were less than 50% of requirements (Figure 4.2.4.1).

North American salmon stocks remain at low levels relative to production in the 1970s. The 1SW non-maturing component continues to be depressed with river returns and total production amongst the lowest recorded. Returns, however, in 1996 of maturing 1SW salmon (grilse) to North American rivers are quite high in many areas, notably Labrador, Newfoundland Québec and U.S.A. which may indicate improved marine survival rates of this cohort. If this is the case, improvement in 2SW salmon returns and spawners may be expected in 1997. Only two areas achieved or came close to achieving their spawning requirements for 2 SW salmon in 1996. They were Newfoundland, where 2SW salmon comprise only a small proportion of salmon production and the Gulf of St. Lawrence where 2SW salmon are a high proportion of production and very important in terms of their contribution to both North American and Greenland fisheries.

4.3 Effects on US and Canadian Stocks and Fisheries of Quota Management and Closure after 1991 in Canadian Commercial 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 presented in Table 4.1.1.1.

The opening of the commercial salmon fishing season in Labrador (SFAs 1, 2, 14B) of July 3, 1995 was moved forward to June 20, 1996. Before 1995, the fishery commenced on June 5. The quota was further reduced by 25% from 73.5 t in 1995 to 55 t in 1996.

The opening of the commercial salmon fishing season in Q9 in 1996, was delayed from June 24 to July 1 and the quota reduced by 20%, which would further reduce the exploitation of large and small salmon. The moratorium on the commercial cod fishery in 1992–96 would also have reduced the by-catch of salmon.

Newfoundland: An index of salmon escapements was used to evaluate the impact of the moratorium relative to premoratorium periods (1984–1991) for various Newfoundland salmon stocks (rivers) and across rivers for certain zones (e.g. northeast, south, and west coasts); this index also allowed inference of past average levels of commercial fishery exploitation separately for small and large salmon. Year 1992 was designated as the reference year for all comparisons. The count of salmon in the reference year divided by itself then receives the value of one (1). Counts for all other years are normalised to the 1992 reference year by dividing respective escapement estimates by the reference year count. This produces a series of numbers relative to the unity value of the reference year. A number less than unity indicates the actual proportion that the year in question is below the reference year. It was expected that the value of the index during the moratorium period would be greater than it was prior to closure of the commercial fisheries.

Indices were calculated for 14 fish counting facilities representing 13 separate salmon populations from the three areas. Regional changes in salmon abundance were derived by averaging index values across rivers for the three areas in a way that each river is given equal weight. To derive an estimate of commercial exploitation for each stock, yearly index values were averaged for the premoratorium and moratorium periods The percentage difference between the two periods provides an overall average exploitation rate.

Small salmon

In general, rivers along the northeast and west coast of Newfoundland showed substantive increases in small salmon stock abundance during the commercial salmon fishery moratorium (Table 4.3.1). For all rivers considered, however, there were some years during the premoratorium period that were as high or higher than the 1992 reference year. The exception to these improvements are found in various south coast rivers; Biscay Bay River, Northeast Trepassey, and Conne River which all have average index values during the moratorium that are lower than the premoratorium period. At Northeast Placentia River, only the 1996 returns were higher than those of the 1992 reference year. This would suggest that overall adult stock production levels were substantially lower during the moratorium period.

Overall regional perspectives show that both the northeast and west coast have shown substantive improvements whereas south coast rivers, as a whole, are not up to even the premoratorium level. There is, however, some suggestion of improvement during the past few years. The 1991 year was the lowest overall for each of the three regional groupings.

Large salmon

Rivers along the northeast and west coast of Newfoundland also showed substantive increases in large salmon stock abundance during the commercial moratorium (Table 4.3.1).

With respect to south coast stocks, only at Northeast Placentia River were there consistent improvements to large salmon escapements during the moratorium period. Dramatic declines were experienced at Northeast Trepassey and Conne rivers.

Returns of large salmon were again among the lowest or second lowest for many rivers in 1991. Exploits River, Salmon Brook, Middle Brook, Northeast Trepassey and Conne River all had significant declines in large salmon returns through to the 1991 period.

Overall regional perspectives for large salmon returns show that both the northeast and west coast have shown substantive improvements whereas south coast rivers, on average, are not up to the premoratorium level. As observed with the regional grouping of small salmon returns, 1991 was again the lowest overall.

Exploitation rate

Estimates of commercial exploitation rates on small salmon during premoratorium years ranged from 29% to 66%, averaging 49% for all areas combined. On large salmon they ranged from 64% to 98% and averaged 76% (Table 4.3.1).

Figure 4.2.5.2 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.

Québec: Effects of the management changes in Québec North Shore are also difficult to evaluate. In zones Q7 and Q8, the mean annual commercial catches in 1984–91 were 389 (130–673) small salmon and 8893 (7288–11004) large salmon (Table 4.3.2). During these years, the annual mean recreational catch was 1596 small salmon and 3167 large salmon. The closure was in effect in 1993, 1992 being a transition year. For years 1993–96, mean recreational fisheries landings were reduced by 20%. Assuming that exploitation rates in commercial fisheries would have declined in the same proportion as the recreational fisheries if there had been no management change, the closure of the commercial fishery in 1993 may have resulted in an annual landing reduction of 311 small salmon and 7195 large salmon.

In zone Q9, commercial quota by numbers was reduced by 20%, from 15175 in 1995 to 12068 in 1996 and the opening date was delayed by seven days from June 24 to July 1. The impact of the quota reduction is assumed to be a reduction of 20% of salmon catch, because more than 90% of the quota was reached in the four previous years and 95% of the quota was reached in 1996. Delays in the opening date could have contributed to reduce the proportion of large salmon in the catch; from 1984–1995 period, large salmon were on average 73% of the landings, the minimum being 68% in 1985. In 1996, the proportion of large salmon dropped to 61% in commercial fisheries, while it remained the same as it was for the five previous year in the recreational fisheries (Table 4.3.3).

Other Areas: ICES 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 U.S.A., the benefits in returns to these provinces cannot be quantified. The estimates of returns of 2SW salmon to SFAs 19–23, Q1–Q11, and U.S.A. from 1992–96 are lower than the returns 1987–91 (Figure 4.2.2.2) which is inconsistent with a reduction in marine fishing mortality.

4.4 Spawning Requirements

In previous years, the word target was used to describe the spawning requirements for rivers in North America. Following the discussion in Section 2.7 (precautionary principles), the spawning requirement is considered as a threshold reference point. In Canada, this threshold reference point has been synonymously defined as the conservation requirement. The conservation requirements for North America have been expressed in terms of the number of 2SW fish required for all production areas of North America. The requirements for U.S.A. rivers were reviewed in 1995 (ICES 1995/Assess:14). A review of the spawner requirements for Canada was conducted in 1996 (ICES 1996/Assess:11). No new requirements for North American rivers have been proposed and therefore the spawners requirements by management zone for Canada and for U.S.A. total 180,495 2SW salmon (Table 4.4.1) as in ICES 1996/Assess:11. The Working Group again recommends that these requirements be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

4.5 Catch Options for the North American Commission Area

This is the first year that the Working Group has been asked to provide catch options for the North American Commission Area. The Working Group, as a preliminary approach, suggests that catch options for the North American Commission Area be considered commencing with the forecast for 1997 of prefishery abundance for 1SW non-maturing salmon. This would mean that, principally, the 1998 fisheries for 2SW salmon in North America would be considered. Only a small proportion of the cohort would be expected to be harvested as 1SW non-maturing salmon in 1997 in the Labrador commercial fishery, if exploitation and stock composition patterns continue as in recent years.

Catch histories for the years 1972–96 are provided in Tables 4.5.1 and 4.5.2 with fishing mortalities of the cohorts exposed to the Greenland fishery all expressed as 2SW salmon equivalents. Maturing 1SW salmon (grilse) are not considered. The Newfoundland-Labrador commercial fisheries have historically harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. The harvest in these fisheries of repeat spawners and older sea-ages has not been considered in the run reconstructions. Harvests of 1SW non-maturing salmon in Newfoundland-Labrador commercial fisheries have been adjusted by natural mortalities of 1% per month for 11 months and 2SW harvests in these same fisheries have been adjusted by 1 month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. Mortalities (principally in fisheries) in mixed stock and terminal fisheries areas in Canada are summed with those of U.S.A. to estimate total 2SW equivalent mortalities in North America (Table 4.5.1). Mortalities within North America peaked at almost

375,000 in 1976 and are now around 30,000 2SW salmon equivalents. In the most recent two years estimated, those taken as non-maturing fish in Labrador comprise only 5% of the total in North America.

The percentage of the cohort destined to be 2SW salmon which were taken in terminal fisheries during 1972–1996 in Canada and the U.S.A. has ranged from as low as 18% in 1973, 1975 and 1987 to the highest value yet of 75% in the 1996 fisheries (Table 4.5.1). The percentage increased significantly with the reduction and closures of the Newfoundland and Labrador commercial fisheries, particularly since 1992.

Table 4.5.2 shows the mortalities expressed as 2SW equivalents in Canada, U.S.A. and Greenland for 1972–1996. Harvests within the U.S.A. of the total within North America approached ½% on a few occasions in the time series and as recently as in 1990. As well as these harvests in the US, U.S.A. origin salmon were also harvested in Canada during the time period indicated. The percentage of the total 2SW equivalents that has been taken in North American waters has ranged from 41–100 %, with the most recent year estimated at 60%. The two years when 100% of the mortality occurred in North America were the years when the Greenland commercial fishery did not operate.

The 50% probability level for the prefishery abundance forecast for 1997 1SW non-maturing salmon is 196,858. (See Section 5.2 for more detailed derivation of the models used, etc.) The text table below, as an example, assumes a 40% Greenland/60 % North America division of the surplus for harvest (after reserving the spawner requirement of 201,483) and expresses catch options as 2SW salmon equivalents for 1998 (by considering 11 months of mortality at 1% per month). As is noted in Section 5.2, there is a wide variability in the forecast and caution is warranted in the use of the 50% level. Precautionary approaches would utilise probabilities much lower than 50%.

Catch Options for 1998 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)

Probability Level	Catch Options in 2SW Salmon Equivalents (no.)
25	0
30	0
35	0
40	0
45	0
50	0
55	6,396
60	15,535
65	24,857
70	34,666
75	45,427

The above table provides catch options for 1998, currently about 15 months in the future. If required, information could be provided at this time next year that would refine the 1998 forecast of the returns of 2SW salmon. Mortalities resulting from fisheries on 1SW non-maturing salmon at Greenland and in North America in 1997 could be subtracted from up-dated forecasts for the cohort using current sampling information. Projected remaining fish, with associated risk levels of achieving spawner goals advised by management, could then be determined.

It should be clear from the above that the numbers provided for catch options refer to the composite North American fisheries. On individual rivers, where spawning requirements are being achieved, there are not biological reasons to restrict the harvest. Managers may however consider doing so for socio-economic reasons.

4.6 Multi-Year Projections of Salmon Abundance

The Working Group was not able to provide quantitative forecasts for abundance beyond projecting pre-fishery abundance for 1SW non-maturing salmon in 1997, which already has wide confidence limits. This is already two years advanced from the most recent estimate (1995) of prefishery abundance. Considering the importance of the habitat factor, projections of abundance to date have only been possible for the current year as we have no models yet for predicting the marine environment.

Juvenile densities in recent years in many monitored rivers have been at record levels and large increases in spawning by 1SW salmon have been occurring in many areas, notably the island of Newfoundland. Spawning by 2SW salmon has increased also in some areas, notably Labrador. As a result of overall low exploitation rates in fisheries on North American stocks, egg deposition has either remained stable or increased in most areas. There seems to be signals that marine survival rates on smolts have increased from the low values seen in the last 5 years. There are therefore indications for optimism for coming years. Further details by country follow.

Recruitment per 2SW lagged spawner was suggested for insight into longer term predictions. As noted in Table 4.2.4.4, this value has ranged from almost 8 2SW fish produced per 2SW spawner for the 1986 prefishery abundance to values below 2 fish per spawner for the three most recently estimated years (1993–95). Lagged spawners producing recruits in 1998 and 1999 were low (70,000–75,000). Based on past ranges of recruits per spawner (2–8), recruits in 1998 and 1999 could be as low as 150,000 but no higher than 600,000.

Canada long-term trends

Newfoundland and Labrador stocks

Sea survival has improved for both Labrador and Newfoundland stocks, and if it continues to do so over the next couple of years, returns will also improve. Specifically, for Labrador the recruitment over the next couple of years will originate from spawners that were the lowest recorded; however, the projected returns may increase over those expected due to the improvement in marine conditions affecting sea survival. Returns from increased levels of spawning in the past two years will not recruit until after 2000. For Newfoundland stocks, particularly on the northwest and northeast coasts, improvement was recorded in spawners starting in 1992 and 1993 (at the start of the commercial salmon fishing moratorium). Recruits from these increases should be seen starting in 1997 and continuing through to 2000. This will probably not be the case on the south coast where returns have actually been lower since the commercial moratorium.

Maritime (Gulf and Scotia-Fundy) stocks

The long-term prospects for Atlantic salmon stocks of the Maritimes (Gulf and Scotia-Fundy) can be categorised geographically.

In the southern Gulf of St. Lawrence (SFA 15, 16 and 18), the abundance of wild salmon is at best at medium levels relative to historical or expected values. The juvenile abundance in the rivers are at medium to high levels and generally increasing over time. Juvenile abundance is high in these rivers for two reasons: 1) they have a high proportion of large salmon in the returns (produce large quantities of eggs), 2) a large portion of the run returns late in the season and are not as heavily exploited as early-run fish, especially in the homewater fisheries. High juvenile abundances have not always translated into high adult returns to date. The ocean environment appears to be an important factor in the low at-sea survivals of Atlantic salmon in eastern Canada because returns to rivers have not increased markedly following closure of fisheries in Newfoundland and reduced fisheries in Greenland. When sea survivals improve, the abundance of salmon is expected to increase above current levels. Atlantic salmon stocks from Prince Edward Island (SFA 17) depend upon hatchery stocking for the large share of the returns. The wild salmon populations are suspected of being negatively affected by land use practices (agriculture and roads) which results in excessive instream siltation and contamination.

Most Atlantic salmon stocks of the Atlantic Coast of Nova Scotia and the Bay of Fundy (SFA 19–23) are not expected to show any important improvements over the next five years. The abundance of wild adult salmon and juveniles is generally low and declining. Sea survival of the salmon from the inner Bay of Fundy stocks is the most important constraint. Returns of wild adult salmon which will meet the conservation requirements are not anticipated in the near future. Returns of hatchery origin salmon may produce returns which approach or even meet the conservation requirements but the long term sustainability of the hatchery initiative is uncertain (from logistic and biological standpoints). The populations of salmon in this area are also impacted by numerous industrial activities: acid rain deposition, fish passage constraints (upstream and downstream), water use practices (regulation of discharge asynchronous with seasonal movements of fish) and escapees from aquaculture facilities.

Québec stocks

Spawning escapements of all sea-age classes in Québec have not increased in recent years hence, unless significant improvements are seen in sea survivals, recruitment of Québec stocks may be expected to remain at low levels compared to spawning requirements (see Section 2.4).

U.S.A. long-term trends

A significant increase in the juvenile stocking program for U.S.A. rivers began in 1987 (Table 4.6.1 and Figure 4.6.1). This was due primarily to the increased planting of fry that occurred in the Merrimack and Connecticut rivers, although fry stocking has also increased in many Maine rivers in recent years. In 1996, as much as 19% of the documented adult returns to some U.S.A. rivers originated from fry stocking, reflecting the increased emphasis upon releases of fry. Additional increases in the level of hatchery fry plants are planned in 1997 and 1998 in the Connecticut River and in several rivers in Maine. A significant decrease in the production and release of hatchery smolts occurred in the U.S.A. in 1995, reflecting the elimination of the hatchery smolt stocking program for the Connecticut River.

The potential for increased smolt output from the fry releases that occurred beginning in 1993 is likely in the future, since fry stocking programs in U.S.A. rivers target vacant or under-utilised juvenile salmon habitat. Although increased MSW returns originating from fry releases were observed in 1996 (smolt migration year of 1994), overall returns to U.S.A. rivers in Southern New England are not expected to change a great deal in 1997 due to the elimination of the hatchery smolt stocking program in the Connecticut River in 1995. This is expected to offset expected increases related to the fry stocking program. However, since the Penobscot River accounts for more than 70% of the documented returns to U.S.A. rivers each year, and marine survival is increasing (Figure 4.2.5.3), overall MSW returns to U.S.A. rivers are expected to continue the gradual upward trend which is illustrated in Figure 4.2.1.3.

A number of new restoration initiatives have been instituted in several Maine rivers in recent years and these programs have the potential to produce marked increases in adult salmon returns in the late 1990s. These initiatives include increased salmon fry production from government and private hatcheries, and the pen rearing of adult salmon by the Maine aquaculture industry to augment spawning escapement.

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

1. In the description of methods used to estimate Labrador returns and spawners (Appendix 5i), inactive fishing effort was removed from the estimation procedures. Changes in licensed fishing effort since 1992 have been used to revise exploitation rate calculations and correspondingly, return estimates. The proportion of effort removed (which was inactive) was not uniform over all SFAs of Labrador. The Working Group considered that it would be informative to estimate returns and escapements of salmon to Labrador by summing the individual estimates for SFAs 1, 2 and 14B calculated from SFA-specific exploitation rates for fishing effort within each of the respective areas and compare to the current values used.

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

3. Review possible changes in the biological characteristics (mean weight, sex ratio, 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 U.S.A. and Canada by incorporating new information such as on biological characteristics for individual stocks, habitat measurements and stock and recruitment analysis.

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

5 FISHERIES AND STOCKS IN THE WEST GREENLAND COMMISSION AREA

5.1 Description of Fishery at West Greenland

5.1.1 Catch and effort in 1996

In 1996, no agreement was obtained in the West Greenland Commission of NASCO on the size of the Greenland quota. However, the Greenland authorities permitted a salmon fishery of up to 174 t for the 1996 season.

The fishery was initiated on August 12, and the season ended on November 11 after a long period with very small catches. The total nominal catches amounted to 92 t (Table 5.1.1.1), the majority being landed in August and September.

The geographical distribution of the nominal catches by Greenland vessels is gives in Table 5.1.1.2 for the years 1977–96. As in recent years the majority of the catch was taken and landed in Divisions C and E (79%). Only minor catches were taken in Divisions A and B.

As in later years only vessels less than 42 ft were permitted to participate in the commercial salmon fishery in Greenland coastal waters in 1996. The fishery was conducted under quotas, distributed at the community level and assessed through daily licensee reports to the Licence Control Office. Entry into the fishery was limited to professional fishers or hunters, fishing their own gear (single hook and line or 2,000 knot 140 mm stretched mesh fixed or drifting gill net of any length) within 40 nautical miles off the west coast or 12 nautical miles off the east coast. Licences for salmon fishing were not issued to vessels with licences 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 that 10 t.

Fishing permits may be issued for tourists to fish with hook and line only. There is no daily catch limit, but the catch may not be sold. Only very few tourist licences were issued in 1996.

5.1.2 Origin of catches at West Greenland

The Working Group examined the 1996 composition and origin of Atlantic salmon caught at West Greenland based on discriminant analysis of characteristics from 2312 samples from NAFO Divisions 1C (August 14 to September 2), 809 samples from Division 1D (August 14 to September 17), and 220 samples from Division 1E (August 21 to 27). A stratified 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 from the 1995–96 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 1996 by the discriminant function indicated that 42% (95% CI = 45%, 38%) were of North American origin (propNA) compared with 65% in 1995. The proportions of North American fish in catches in Divisions 1C, 1D, and 1E were 42%, 49%, and 42%, respectively. Similar data for 1978 to 1996 (no data for 1993-94) are summarised in Table 5.1.2.1. The proportion of North American salmon in catches in 1996 is one of the lowest in the data series.

Applying the results of the above analysis to the reported catch indicated that 37.5 t (12,900 salmon) of North American origin and 54.7 t (19,100 salmon) of European origin were landed in West Greenland in 1996. The data for 1982 to 1996 (no data for 1993–94) are summarised in Table 5.1.2.2 and Figure 5.1.2.1.

Natural production is known to occur in one small river in Greenland (NAFO Division 10); fish from that population have not knowingly been detected by discriminant analysis. Nielsen (1961) indicated that the population was based on egg deposition in only about 60 redds.

A total of seven tags (six Carlin and one spaghetti type) of Canadian origin salmon was captured at West Greenland in 1996 and returned to Canada. The six Carlin-tagged recaptures were tagged as spawning adults in 1995; four originated from the Miramichi River (SFA16; three MSW salmon and one 1SW salmon), and two originated from the Margaree River (SFA18; both were MSW salmon). The spaghetti-tag recapture originated from River Pabos (Zone Q2; broodstock released in the spring 1996). In 1995, over 7,000 small and large salmon were tagged and released to the Miramichi River during the spawning migration. In the Margaree River, just over 500 small and large salmon were tagged and released. Less than 50 kelts were released from River Pabos in 1996.

5.1.3 Biological characteristics of the catches

Biological characteristics (length, weight, and age) were recorded from 3328 samples of commercial catches from NAFO Div. 1C, 1D, and 1E in 1996 using the results of discriminant analysis to divide samples into North American and European components. The data for 1996 are compared with those for previous years in Tables 5.1.3.1 to 5.1.3.3.

The downward trend in mean length of both European and North American 1SW salmon since 1969 changed in 1996, as mean length increased (Table 5.1.3.1). The mean length of European 1SW fish (63.4 cm) was the highest observed mean length in the last five years. The mean length of North American 1SW fish (63.0 cm) is the highest since 1987. Similar observations was made for the mean weights of 1SW salmon at West Greenland in 1996. Mean length and weight of 2SW salmon changed similar to those of the 1SW.

Distribution of the catch by river age in 1996, as determined from 1,297 scale samples, is shown in Table 5.1.3.2. The percentage of the European origin salmon that were river age 3 fish (31.5%) was greater than the mean of 17.3%. This may indicate a continued change in the stock composition in the area. River age 2 fish of North American origin salmon have declined appreciably from the 1968–95 mean of 36.5% to the current 23.5%.

The proportionate distribution by weight categories (1.1–3.3 kg, 3.3–5.6 kg, and >5.6 kg) of the landings to the fish plants in West Greenland 1996 was similar to the distributions from the period 1987–90 and indicated somewhat larger salmon than in 1991 and 1995 (Table 5.1.3.4).

The sea-age composition of the samples collected from the West Greenland commercial fishery showed a lower proportion of 1SW fish in 1996 (92.1%) than in 1995 (97.3%) in the North American component (Table 5.1.3.3). The proportion of 1SW salmon in the European component in 1996 was similar to proportions observed since 1985.

5.1.4 Status of the stocks in the West Greenland Commission 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 U.K. and Ireland. Survival indices for combined river data for the NEAC area indicate a downward trend in survival to homewaters for the last ten years for 2SW wild stocks. No trend was noted in the most recent five year period. This is consistent with the estimates that have been made of the pre-fishery abundance of non-maturing 1SW salmon from southern Europe; these have declined over the past 25 years and now appear to be at their lowest level in the time series.

Conservation reference points have been presented for only seven European stocks and these do not generally provide separate reference levels for 1SW and 2SW salmon. As a result they cannot be used to assess the status of the stock components contributing to the West Greenland fishery.

In general, there has been no significant change in smolt production in the Northeast Atlantic, and adult runs in western European rivers showed no significant trend in run sizes over the last ten years.

For the North American Commission Area the North American Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971–1996. The 1994 estimate of pre-fishery abundance of non-maturing 1SW salmon was the lowest on record. Increases from this low value were noted in both 1995 and 1996 (Figure 4.2.3.1) with the 1996 estimate about 8% above the low 1994 estimate. The results suggest a levelling off of a decline to historical low levels for 1SW non-maturing salmon. In addition to the steady decline in total recruits (both maturing and non-maturing 1SW salmon) over the last ten years, there has been a 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 four years.

The estimate of the total number of 1SW salmon returning to Labrador and Newfoundland rivers and coastal waters of other areas of North America in 1996 is 44% higher than the estimate for 1995 and higher than the average of the previous years (1971–95) by 20%. It is the fourth highest observed in the past 10 years and seventh highest in the 26 year time series, 1971-1996 (Table 4.2.2.1). The estimates of returns are quite variable over the time series with no trends indicated. The estimated 2SW returns are 10% lower than the total returns for 1995 but similar to both 1994 returns and the average for the past 10 years (Table 4.2.2.2). They have declined from a peak of almost 200,000 in the late 1970s.

In most regions the returns of 2SW fish are near the lower end of the twenty five year time series. However, returns of 2SW salmon to Labrador in 1995 and 1996 were the best in the time series. Returns of 1SW salmon improved in all areas in 1996 relative to 1995 and in some regions (Labrador, Newfoundland, and Québec) were near the highest levels in the time series.

The majority of the U.S.A. returns were recorded in the rivers of Maine, with the Penobscot River accounting for about 74% of the total. Salmon returns to the Penobscot River were 52% higher than the previous year, but were 23% higher than the previous 5-year average and 17% lower than the previous 10-year average. While U.S.A. salmon returns improved in 1996, returns to most rivers are hatchery-dependent and remain at low levels compared to spawning requirements.

Egg depositions exceeded or equalled the specific river requirements in 32 of the 85 rivers which were assessed in Canada and were less than 50% of requirements in 22 other rivers. Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 10 of the 20 rivers assessed had egg depositions which were less than 50% of requirements (Figure 4.2.4.1).

North American salmon stocks remain at low levels relative to production in the 1970s. The 1SW non-maturing component continues to be depressed with river returns and total production amongst the lowest recorded. Returns, however, in 1996 of maturing 1SW salmon (grilse) to North American rivers are quite high in many areas, notably Labrador, Newfoundland, Québec and U.S.A. which may indicate improved marine survival rates of this cohort. If this is the case, improvement in 2SW salmon returns and spawners may be expected in 1997. Only two areas achieved or came close to achieving their spawning requirements for 2 SW salmon in 1996. They were Newfoundland, where 2SW salmon comprise only a small proportion of salmon production and the Gulf of St. Lawrence, where 2SW salmon are a high proportion of production and very important in terms of their contribution to both North American and Greenland fisheries.

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

5.2 Catch Options with an Assessment of Risks Relative to the Achieving Spawning Requirements

5.2.1 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 escapements. The problems of estimating the total allowable catch (TAC) for salmon have been examined by the Working Group in previous years (ICES 1982/Assess:19, 1984/Assess:16, 1986/Assess:17, and 1988/Assess:16) and were repeated in the four last Working Group reports (ICES 1993/Assess:10; 1994/Assess:16; 1995/Assess:14; and 1996/Assess:11). Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed stock fisheries are still relevant. In principle, adjustments in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mean mortality on the contributing populations. However, benefits that might result for particular stocks would be difficult to demonstrate, in the same way that 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 (ICES 1993/Assess:10; Sections 5.3 and 5.4). The aim of management would be to limit catches to a level that would facilitate achieving overall spawning escapement equivalent to the sum of spawning requirements in individual North American and European rivers (when the latter have been defined). In order to achieve the desired level of exploitation for a given level of predicted abundance, a TAC could be fixed or some form of effort adjustment introduced.

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 is also 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 U.S.A. The fishery in Greenland harvests salmon from the non-maturing component while the fishery in Labrador harvests a mix from the non-maturing component as well as maturing 1SW and MSW salmon. The commercial fishery in Québec harvests maturing 1SW and MSW salmon.

The Working Group has advocated models based on thermal habitat in the northwest Atlantic to forecast prefishery abundance in order to provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, the models themselves have varied slightly over the years. The changes have been made to these models in attempts to improve the prediction and add more biological reality. The models of previous years included using the following predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; 1995 - thermal habitat in January, February, and March, and 1996 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada.

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 (ICES 1993/Assess:10; ICES 1994/Assess:16). The first of these factors was the possible influence of the freshwater phase on subsequent size and condition of salmon smolts which would subsequently effect their marine survival when they 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 discussed. As can be seen by reference to Section 4.2.5, sea survival in several stocks remains at low levels despite reduced commercial exploitation from closed fisheries is considered (Section 4.2.5). However, in Newfoundland, sea survival improved considerably returning to near historic levels although the survival rates from pre-1992 years include removals from commercial fishing.

The Working Group reviewed the biological rational for the catch advice model first used in ICES (1993/Assess:10) and updated in ICES (1995/Assess:14). The hypothesis tested was that the amount of marine habitat available for salmon in the northwest Atlantic at some time prior to the end of their first winter at sea was 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.

However, it is recognised that we have not identified biological mechanisms to account for the observed climate abundance relationship. Information reported at this meeting (Section 2.5.2) indicates that overall survival of salmon may be related to thermal conditions, this generally supporting the relevance of the forecast model.

North American Run-Reconstruction Model

The Working Group has used the North American Run-Reconstruction Model to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West Greenland fishery (See Section 4.2.3). Region-specific estimates of 2SW returns are listed in Table 4.2.2.2. Estimates of 2SW returns 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 1993–1996 returns, the estimates were further adjusted to account for reductions in licensed fishing effort and season in Labrador (See Section 4.2.2).

Update of thermal habitat

The Working Group has been using the relationship between marine habitat and pre-fishery abundance to forecast prefishery abundance (ICES 1993/Assess:10; 1994/Assess:16; 1995/Assess:14; and 1996/Assess:11). 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 ICES 1995/Assess:14). The SST data were determined by optimally interpolating SSTs from ships of opportunity, earth observation satellites (AVHRR), and sea ice cover data. The area used to determine available salmon habitat encompassed the northwest Atlantic north of 41°N latitude and west of 29°W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland.

Thermal habitat has been updated to include 1997 data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 5.2.1.1 and Figure 5.2.1.1). Available habitat has increased in 1997 over 1996 in the February data. The 1997 February value is the highest value in the previous seven years of the time series.

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

The Working Group reviewed the procedures used to forecast pre-fishery abundance and considered alternate model formulations that may be useful in future assessments. The current model is based on a combination of environmental and stock size variables. A review of potential thermal habitat and lagged spawner variables did not reveal any data relationships not previously detected, nor result in a new linear model significantly more robust than the one currently being used. Therefore, a change in model formulation did not appear warranted at this time. In addition to reviewing the formulation of the current linear model, the Working Group considered other model classes (Information on Other Prediction Procedures below).

The 1996 model used by the Working Group to forecast pre-fishery abundance was 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 for February and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Québec) as predictor variables (ICES 1996/Assess:11). This was justified on the basis of studies showing that salmon stocks over wide geographic areas tend to have synchronous survival rates and that the winter period may be the critical stage for post-smolt survival (Scarnecchia 1983; Reddin and Shearer 1987b; Friedland *et al.* 1993). Consequently, the model used in 1996 was updated to reflect the addition of the 1997 values to the time series of pre-fishery abundance estimates.

The linear fit to the model of pre-fishery abundance versus February thermal habitat and lagged spawners (SNLQ) produced a significant relationship between observed and predicted values at less than the 5% level ($F_{(2,15)}=18.7$). The results show that with the 1995 data added there is an improvement in fit over that of last year ($R^2=0.71$ in 1997 versus 0.68 in 1996). The jackknife and deterministic predicted values for pre-fishery abundance for 1971–1995 are shown in Table 5.2.1.1 and Figure 5.2.2.1. 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 90s when abundance was low. The high correlation between the observed and jackknife prediction (r=+0.744) can be seen in Figure 5.2.2.2a. The residual pattern for the model shows a positive relationship with observed values (r=+0.509) although the positive residuals decrease at the end of the time series (Figure 5.2.2.2b). Also, the Working Group was encouraged by the low residual value shown in 1995, the last observed value in the time series. The residual pattern for the model shows no autocorrelation. The forecasted estimate of pre-fishery abundance for 1997 using the February thermal habitat and lagged spawner model are about 197,000 at the 50% probability level (Table 5.2.2.1).

The advantage of this model is that it considers 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. The former has occurred with the predicted value for 1997, as thermal habitat has increased considerably, the predicted pre-fishery abundance in 1997 is low due to the large decline in spawners producing them (Figure 5.2.1.1).

Investigation of other prediction procedures

One class of model that may be useful in abundance prediction is neural networks which have been widely applied by physical and life scientists. The strength of this class of models is their ability to adapt to a variety of problems and to deal with non-linear relationships between variables (Chitra 1992). Models of physical systems often involve pattern recognition in complex and correlated data fields, much like the situation we face in predicting abundance from fields of thermal habitat data. Neural nets have been found to outperform linear models in predicting water column structure and air sea interaction effects. For example, salinity distributions in estuaries, which are dynamic mixing systems, can be predicted with greater accuracy using neural networks than comparable linear models (DeSilets *et al.* 1992). Dynamic behaviour on global scales can also predicted more effectively using neural networks as demonstrated by models predicting sea surface temperature structure associated with El Nino events in the Pacific Ocean (Derr and Slutz 1994).

Biologists were immediately attracted to neural networks because of their potential application in classification problems and as predictive tools. In a direct comparison between linear discriminate analysis and neural network, Withler *et al.* (1994) found that classification efficiency compared favourably between the two techniques. The predictive capability of these models is now being explored in the context of fishery independent survey predictions and catch forecasting from commercial datasets. Komatsu *et al.* (1994) developed a network model to predict post-larval stages of the Japanese sardine that outperformed linear regression models. Likewise, Hwang *et al.* (1996) forecasted jack mackerel catches also with greater prediction accuracy than simple linear models.

The Working Group examined the efficacy of predicting Atlantic salmon abundance with neural network models as opposed to linear regression models. A Ward, type 2 neural network (Ward Systems Group 1996) was developed using four independent variables or input neurons. Ward nets utilise multiple hidden network slabs with different activation functions. The four input neurons were thermal habitat for March (year i), May, June, and July (year i-1) and were selected based on contribution rates that can be computed from back propagation networks. The model was evaluated with a complete Jackknife, thus predicted values are unbiased. Each jackknifed network was trained for 1500 training epochs.

The neural network produced a significant relationship between observed and predicted values, and furthermore, the residuals were distributed without trend with abundance. Observed and predicted time series can be found in Figure 5.2.2.3a. The network model captured most of the features in the observed time series. Notably, the model estimates well at low abundance, but also fails to respond to the decline in 1978. The residual pattern for the network model shows no autocorrelation and residuals are generally balanced at the end of the time series (Figure 5.2.2.3b). The high correlation between observed and jackknife prediction can be seen in Figure 5.2.2.4a. Lower model residuals result in an absence of trend between residuals and observed values (Figure 5.2.2.4b). This neural network outperforms a linear model fit in respect to two criteria. The network model provides the best reconstruction of observed patterns using unbiased fits and showed no bias associated with the magnitude of residuals in the model. These characteristics are potentially critical at low population levels when estimation error puts the population at greater risk. But, the lack of any underlying distributions for the neural network model does pose a number of technical challenges. With neural network models we lack a closed form to estimate prediction intervals, and thus must rely on the computation or derivation of intervals empirically (Gardner 1988). The Working Group was not equipped to carry this model forward to produce precision estimates.

The management of salmon resources has become increasingly complex requiring scientific advice to meet interrelated conservation and economic goals. This has meant an expanding need for forecast models that are highly accurate and can characterise the risk of various management decisions. For the conservation of Atlantic salmon stocks in the northwest Atlantic, modelling efforts to date have been relatively simple and designed to meet a single conservation goal (Reddin *et al.* 1993). This goal has been to achieve requirement spawning in North American rivers the year after the fishery. This approach does not model economic impacts (Herrmann 1993) and is not truly in-season in that there is a full year to make other compensatory management decisions to meet the goals (Woodey 1987). Inseason management carries with it greater demands for accuracy and precision in forecast models. To meet the challenge of such management systems, an array of estimation procedures have been developed. The impact of non-linear relationships among model variables (Bocking and Peterman 1988), Bayesian probability approaches to predict run sizes (Fried and Hilborn 1988), nonparametric estimators (Noakes 1989), and time series approaches (Noakes *et al.* 1990) have been evaluated. This makes model evaluation and comparison that much more important and demonstrates the value of alternative model formulations. Such formulations should be pursued for Atlantic salmon assessments especially as datasets expand.

The Working Group considered the issue of model evaluation and formulation and weighed the competing issue of striving for biological realism versus the pragmatic goal of producing the model with the most predictive power. Model evaluation begins with setting clear goals and utilising tools equally effective on all modelling approaches. The use of jackknife and Monte Carlo techniques to evaluate forecast models has emerged as an important tool (Claytor *et al.* 1993). A school of thought in operation research suggests that models should be evaluated by a set of criteria that tests their predictive power. Thus, performance of a model should not be based on its ability to simply deal with historical data, but instead evaluate how it deals with actual out of sample data over the full contrast of potential responses (Makridakis 1990). This represents a shift of emphasis from strict adherence to fitting procedures to a more pragmatic approach of simply selecting the best predictor. Alternatively, models can be selected on the basis of documented biological relationship, thus variables would have to have specific biological meaning before they could be included in a model.

The Working Group seeks additional guidance from ACFM on these important issues of model formulation. These issues include the use of neural networks in development of catch advice. Secondly, what is ACFM's view of producing a model with the most predictive power versus an *a priori* model with a biological basis?

Stochastic analyses

Although the exact error bounds for the estimates of NN1(i) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods, implemented in the software package SAS (SAS Institute, 1996), were used to simulate the probability density function of NN1(i).

Simulated values of NN1(i) assuming a uniform distribution were also used to evaluate the distribution of mean values for the regression models between pre-fishery abundance and February (H2) thermal habitat and lagged spawners (SNLQ).

To estimate the composite error distribution of the 1000 realisations, 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 realisation j:

Eq. 5.2.2.1 $$F_C(NN1_{FOR}(1997), s_C^2) = S_{j=1,1000}\, F_j(NN1_{FOR}(1997)_j, s_j^2)/1000$$

where F( ) is the normal probability density function.

The sampling distribution of the composite stochastic forecast, i.e. $F_C(NN1_{FOR}(1997), s_C^2)$ 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 requirement will not be met.

The stochastic forecasts permitted the estimation of the cumulative distribution function (Table 5.2.2.1). These estimates can be used to quantify the probability that the actual stock is above the relative probabilities of attaining spawning requirements 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 requirements) versus the fishery (e.g. reduced short-term catches).

5.2.3 Development of catch options for 1997

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 requirement for the North American stock complex by summing the spawning requirements of Salmon Fishing Areas in Canada and river basins within the U.S.A. Details on the methodology to estimate and update the spawning thresholds are provided in (ICES 1996/Assess:11); values appear in Table 4.4.1 of this report. With these data, it is possible to compute an allowable harvest. This procedure is unchanged from the previous assessment and is shown in Appendix 7.

Catch advice for 1997

The fishery allocation for West Greenland is for 1SW fisheries in 1997, whereas the allocation for North America can be harvested in 1SW fisheries in 1997 and/or in 2SW fisheries in 1998. To achieve the spawning management goal, a pool of fish must be set aside prior to fishery allocation in order to meet spawning requirements and allowing for natural mortality in the intervening months between the fishery and spawning migration. In last years report, a spawning requirement of 180,495 fish was reported for all North American rivers (ICES 1996/Assess:11). Thus, 201,483 pre-fishery abundance fish must be reserved (180,495/exp(-.01*11)) to ensure achievement of the requirement 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 spawning requirements 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 requirement. 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 for the 1997 fishery requires an estimate of pre-fishery abundance [NN1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea age composition of the total landings [ACF]. Exponential smoothing model forecasts utilising data collected during the 1996 fishery and using interpolated values for 1993 and 1994, with approximate 50% confidence limits, are summarised below.

Parameter	Forecast	Minus 1SE	Plus 1SE
PropNA	0.557	0.465	0.649
WT1SWNA	2.647	2.488	2.806
WT1SWE	2.750	2.563	2.937
ACF	1.133	1.034	1.232

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

Greenland quota levels for H2-SNLQ forecast of pre-fishery abundance were computed. The quota values based on this forecast between interquartile limits of the probability density function are presented in Table 5.2.3.1. For the point estimate level and the stochastic regression estimate using NN1, the quota options ranged from 0 to 458 t, depending on the proportion allocated to West Greenland (F*NA*) and was bounded by the 25% to 75% probability levels. For the F*NA* level used in recent management measures for the West Greenland Commission (at the 0.4 allocation rate), the quota is 0 t at the 50% risk level.

The 50% risk level is intended to produce spawning escapements in North America that will meet the requirement level for all rivers combined 50% of the time. Even if this overall requirement is achieved, it is likely that some stocks will therefore fail to meet their individual requirement spawner requirements while others will exceed requirement 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 requirement 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 1996, that it is evident from both the indicators of stock status and the extremely low quota levels computed, that the North American stock complex is in tenuous condition. We are close to record low abundance despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below requirement spawning escapements for 2SW salmon, and the low marine survival rates for some monitored stocks. The increasing advantage associated with each additional spawner in under-seeded river systems make a strong case for a conservative management strategy. However, the Working Group noted that thermal habitat and smolt survival rates in the northwest Atlantic are improving which will be expected to provide future benefits to returns and spawning escapements.

5.2.4 Risk assessment of catch options

The provision of catch advice in a risk framework involves the incorporation of the uncertainty in all the factors used to develop the catch options. The ranges in the uncertainties of all the factors will result in assessments of differing level of precision. The precision of the assessment has a potential effect on the risk approach used by managers. One approach considers the catch options relative to a 50% chance of the undesirable event occurring and ignores the uncertainty in the stock assessment. The reliability of the assessment has very different and profound consequences on the catch options for risk-averse compared to risk-prone approaches (Figure 5.2.4.1). In a theoretical example, two assessments provide the same point estimate (50% probability value) but the precisions are very different. Under a risk-prone management approach, the allowed catch would be greater for the imprecise assessment: at a 70% risk level, the advised catch under the precise assessment would be 500 t but the uncertain assessment would provide for a catch of 800 t (Figure 5.2.4.1). The risk-averse management approach would advise for lower catch options for the imprecise assessment: at a 20% risk level, the precise assessment would provide a catch option of about 400 t but for the imprecise assessment, no catch is advised. Under precautionary management principles (Section 2.7), a risk-averse approach would be favoured for imprecise assessments.

The analysis of risk involves three steps: 1) describing the precision or imprecision of the assessment, 2) the definition of a management strategy, and 3) the evaluation of the probability of an event (either desirable or undesirable) resulting from the fishery action. The management of Atlantic salmon in the North American and Greenland Commission Areas involves managing for a fixed escapement of salmon to rivers in North America. The spawning requirements to North America are considered to be a threshold reference point. All potential recruits in excess of the threshold requirement are considered to be available for harvest. The undesirable event to be assessed is that the spawning escapement to North America will be below the spawner requirements.

A risk analysis of catch options for Atlantic salmon from North America incorporates all the uncertainty in the estimates of the probable returns:

1. the spawning requirement risk plot, and
2. the uncertainty of the prefishery abundance forecast,
3. the uncertainty in the biological parameters used to translate catches (weight) into numbers of North American origin salmon.

Examples for the 1996 and 1976 fisheries are used to illustrate the outputs from this analysis.

Spawner requirement risk analysis

The derivation of the spawning requirement risk plot for North America was similar to the method presented in ICES 1996/Assess:11. Briefly, North America is divided into six stock areas which correspond to the areas used to estimate returns and spawning escapements (Table 4.4.1; Table 5.2.4.1). Point estimates of the proportion female by stock area are from ICES 1996/Assess:11 (Table 5.2.4.1). The annual variability in the proportion female in each stock area was described in terms of a uniform distribution corresponding to values for each stock area. When values for annual variation were not available, the variation was assumed to be of a similar magnitude to other stock areas (Table 5.2.4.1). A total of 1000 simulations was run for each spawning escapement level. The sex ratio varied independently in each stock for each simulation. The risk plots were expressed as the probability of meeting or exceeding the spawning requirements concurrently in all six stock areas. In addition, plots of the probability of meeting or exceeding lower proportions of the spawning requirements were derived as an indication of the magnitude of under-escapement which would be expected for different levels of escapement to North American rivers (Figure 5.2.4.2).

Under the assumption of equal production from all stock areas (i.e. recruitment in direct proportion to the spawner requirement) just over 200,000 fish should escape to North America as spawners to achieve the spawner requirement in all six stock areas at a 50% probability level (Figure 5.2.4.2). This value is higher than the previously calculated 50% risk value of 182,250 fish (ICES 1996/Assess:11) because it includes the annual variation in proportion female and higher than the point estimate of total requirements to North America of 180,495 fish (Table 4.4.1). Substantially fewer fish are required for achieving only a portion (for example 50%) of the spawner requirements in all six areas.

Prefishery forecast abundance uncertainty

Model fitting and the confidence intervals for the prefishery abundance of non-maturing North American origin salmon are described in Section 5.2.2. The required elements for the risk analysis are the distributions of prefishery abundance and their associated probabilities. For purposes of these examples, prefishery abundance forecasts were obtained from the linear regression of winter habitat (sum of January, February and March habitat index) for the 1976 simulation and on February habitat and lagged spawners for the 1996 example (ICES 1996/Assess:11). The probability distribution of the point estimate for the prefishery abundance forecast was derived using the variance formulas for a single predicted value (Figure 5.2.4.3, upper panel).

Uncertainty in the biological characteristics and predicted catches of North American origin salmon

In the previous year's working group report (ICES 1996/Assess:11), the quota options were calculated using a distribution of prefishery abundance forecasts and point estimates for the remaining parameters including: the spawner requirement for North America, proportion of the 1SW catch which would be of North American origin, weight of 1SW North American and European fish, and the age correction factor. The annual estimates of continent of origin and biological characteristics of salmon caught at West Greenland were taken from a previous report (ICES 1992/Assess:15, Tables 5.1.1.1, 5.1.2.1, and 5.1.2.3). The simple assumption that annual variation in characteristics follows a uniform distribution over the range of observed values was used. Using the biological characteristics and the catch options, the total returns to North America after the Greenland fishery were calculated by subtracting the catch of North American 1SW origin salmon from the prefishery abundance forecast and discounting for the 11 months of natural mortality between the time of the Greenland fishery and return to homewaters. An example of the distribution of harvest (numbers) of North American origin salmon for a given quota which incorporated the uncertainty in the biological characteristics is shown in the middle panel of Figure 5.2.4.3. The distribution of returns to North America after harvest at Greenland which incorporates the uncertainty in the prefishery abundance forecast and the uncertainty in harvest numbers is shown in the bottom panel of Figure 5.2.4.3.

Catch options and risk summary examples

The final step in the risk analysis of the catch options involves combining the cumulative risk plots from the spawner requirement calculation with the probability distribution of the returns to North America for different catch options. The sum of the products of the cumulative distribution of spawner requirements and the probability distribution of the corresponding returns to North America equals the risk of meeting the conservation requirements. The risk of not meeting the desired spawner requirement in at least one of the six stock areas is obtained by subtracting from unity the probability of meeting the requirements in all the areas. An analysis of the risk of the severity of the underescapement (for example, the risk of not attaining 50% of the spawner requirement in at least one of the six stock areas) was derived in exactly the same way by substituting the cumulative distribution for a different spawner requirement proportion (Figure 5.2.4.4).

Using the 1996 data, it can clearly be seen that even under the assumptions of equal production rates in all stock areas of North America and no fishery in Greenland, there was a very high probability (0.60) of not meeting the spawner requirements in at least one of the North American stock areas (Figure 5.2.4.4). The relatively shallow rise in risk reflects the imprecision of the prefishery forecast and the variability in the biological characteristics of the salmon at Greenland. In terms of the magnitude of the underescapement which could be expected, there was a >25% chance that the returns to North America would have resulted in an underescapement of 50% of the spawner requirements in at least one stock even in the absence of fisheries in Greenland and North America.

The prefishery abundance in 1976 was much higher than in 1996. For such a high abundance period, catch options of over 1,500 t could have been considered at the risk neutral point (50% level) although risk-averse management would have considered catch options between 1,000 and 1,500 t presuming that no fisheries on the fish occurred in the homewaters of North America (Figure 5.2.4.4).

Such risk analysis could be used for directly assessing the consequences to the spawner requirements of harvest options in both Greenland and in North America. Given the large uncertainty in the prefishery abundance forecast and the annual variability and uncertainty in the biological characteristics of the fish harvested in Greenland, a risk-averse strategy would be advisable.

Catch options and risk summary for 1997

The prefishery abundance forecast distribution for 1997 is described in Section 5.2.2. The expected biological characteristics of the non-maturing 1SW salmon were described from the exponential smoothing forecast (Section 5.2.3) and its associated variance for the predicted values. The variation in biological characteristics was used to generate the probability distribution of North American origin salmon in the West Greenland fishery relative to a range of catch options. The results of the risk analysis are summarised in Figure 5.2.4.5.

The abundance of salmon is expected to be low in 1997. There is a high risk (52%) that the escapement in 1998 will be below the spawning requirement in at least one of the six stock areas in North America, even in the absence of any fisheries-induced mortality in Greenland and North America. There is a high probability (22%) that at least one of the six stocks will be severely underescaped (by 50%). Although the risk profile appears shallow over the range of catch options illustrated (0 to 1000 t), the risk of not meeting spawning requirements provides options for risk-prone management approaches. Risk-averse management would close the fisheries. Considering the uncertainty in the assessment of the abundance of North American salmon in West Greenland in 1997, precautionary principles are advised.

The impact of the combined Greenland and North American fisheries must also be considered. The fisheries exploitation rates in North America in 1996 were estimated to be between 0.15 and 0.28 (Section 4.1.4). Assuming that fisheries management in North America in 1998 would be similar to that of 1996, then it would be expected that 15% to 30% of the 2SW returns to North America would be removed prior to spawning. The impact of such a fishing scenario in North America on the salmon returning to homewaters in 1998, in the absence of any fishery at Greenland in 1997, results in a 65% risk of not meeting the spawning requirements in at least one of the six stock areas (Figure 5.2.4.5). This assumes that salmon will return to each geographic area in proportion to the relative spawning requirements in each area and that the exploitation rates in each of the six stock areas are similar. Although this is not true (see Section 4.2.4), it is the only scenario considered by the Working Group at this meeting.

The cumulative consequences of fisheries at Greenland (1997) and in North America (1998) on the potential spawning escapements to North American stock areas increases the risk of severe underescapement (50% of requirements) in North America. There is a 22% risk of severe underescapement with no fisheries and the risk rises to greater than 50% at a Greenland catch option of 400 t and exploitation rates between 0.15 and 0.28 in North America (Figure 5.2.4.5).

5.3 Data Deficiencies and Research Needed 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 to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme which occurred in 1995 and 1996 be continued and improved to cover as much of the landings as possible.

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

3. The catch options for the West Greenland fishery are based almost entirely upon data derived from North American stocks. In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible.

6 ESCAPES FROM FISH CULTURE OPERATIONS

6.1 Background

In addition to full-scale commercial aquaculture, several classes of salmon culture operations exist including the hatching of eggs and the rearing of fry, parr and smolts for release into the wild in enhancement schemes. Intentional releases of juvenile stages have potential effects on wild populations in addition to intended effects on abundance. Unintended escapes of juveniles probably occur quite frequently although events like these are not generally documented. It should therefore be noted that two categories of aquaculture fish exist among those liberated early in life - fish that are deliberately released at the fry, parr or smolt stages in enhancement or ranching schemes and fish that are released accidentally from aquaculture. In most cases, fish that have been intentionally released as juveniles cannot be distinguished from those which have escaped accidentally.

A number of techniques have been used to distinguish aquaculture fish among wild fish including assessment of morphological defects (Lund *et al.* 1989), scale patterns (Lund and Hansen 1991), otolith reading (Hindar and L'Abee-Lund 1992) and carotenoid pigment (Craik and Harvey 1987a) or genetic analysis (Crozier 1993). None of the methods are totally discriminatory and, in general, fish that escape very early in life cannot be recognised. In the U.S.A. and to a lesser extent Canada, intentional releases of adult fish to the wild are counted as part of the repertoire available to management. In Canada, the same techniques have been used but only on an experimental scale. In general, fish that have been liberated from sea-cages as post-smolts or adults belong to a single category of accidental release.

After escape, fish appear to resume a form of the natural life-cycle. Thus, fish that escape from sea-cages and fish that can be demonstrated to have been reared in hatcheries until near smolting have been shown to be present among wild fish on ocean feeding grounds in the Norwegian Sea (Hansen *et al.* 1987; 1993a) and at West Greenland (Hansen *et al.* 1993a), distant from any possible sources of release. Recently, cultured salmon released as smolts have been detected among wild post-smolts at intermediate latitudes in the north-east Atlantic and presumably in transit to more northern ocean feeding areas (Shelton *et al.* 1976). Later in the life-cycle, near sexual maturity, escaped farmed fish can be detected in coastal and fjord fisheries (Lund *et al.* 1991b; Webb and Youngson 1992) and in rivers (Lund *et al.* 1991b; Webb *et al.* 1991; Heggberget *et al.* 1993). Farmed fish have been observed to spawn among wild fish (Webb *et al.* 1991). The progeny of escaped female salmon have been identified among the progeny of wild fish at or near hatching time by using carotenoid pigment analysis to detect the presence of aquaculture flesh-colorants in the maternal pigment load of ova, alevins or recently emerged fry (Lura and Saegrov 1991a, 1993; Webb *et al.* 1993). Biochemical genetic analysis of juvenile salmon sampled from rivers indicates that, where spawning occurs, the progeny of escaped farmed fish survive among wild fish to contribute to juvenile salmon populations (Crozier 1993). Thus, the evidence from field studies indicates strongly that escaped salmon have the potential to exert permanent, genetic effects where they spawn.

Because of the tendency of many escaped fish to home to the general region of loss (Hansen and Jonsson 1991) those populations that are most exposed to any genetic effects of escaped salmon are in rivers and streams in the countries, regions or localities where salmon farming occurs. Reporting systems for losses from aquaculture exist among the producing nations, however, compliance is frequently lacking and these systems tend to record only large, catastrophic losses. Countries supporting Atlantic salmon aquaculture industries and current and historical production limits in each country are given in Table 2.2.1.1. Additional regional information on the frequency and distribution of escaped farmed fish is available as below. More information is expected to be made available during the Joint ICES/NASCO Symposium on Interactions of Wild and Introduced Salmon to be held in April, 1997 in Bath, U.K.

6.2 National Reports

National reports for the major aquaculture producing nations in the North East Atlantic and North American Commission area follow. Reports are not presented from lesser producing nations where the incidence of escapes is believed to be low.

Norway

Salmon farms are located along the Norwegian coast from the southernmost to the northernmost part of the country. However, the highest density of farms are from the Stavanger area in the south to Lofoten area in the north. The number of fish farms is relatively low in northernmost Norway and in the area between Stavanger, south and eastwards to the Swedish border.

Salmon fisheries and spawning populations in Norway have been screened annually for escaped farmed salmon since 1989. Samples of salmon were obtained from marine bag-net and bend-net fisheries along the Norwegian coast and in fjords during the fishing season (1 June to 5 August). In freshwater, fish were collected during two periods - 1 June to 18 August which corresponds to the angling season in most rivers and 18 August to 30 November when samples were collected from brood stock fisheries. For 1995 and 1996, the figures are prepared separately for the periods before and after 31 August. August 31 corresponds to a change in the dates of the angling season. Identification of escaped fish was by a combination of examination of external morphology and scale analysis (Lund *et al.* 1989; Lund and Hansen 1991).

In Norwegian coastal fisheries the proportion of farmed salmon has varied between 34% and 54% (unweighted means) in the period 1989 to 1996 (Table 3.3.7.2). No sampling was carried in 1996 at the locality in Finnmark county where the proportion of farmed fish in previous years was substantially lower than in other places. The proportions of farmed fish in coastal fisheries are significantly higher than in fjord fisheries where 10–21% of the catch have been of farmed origin. In freshwater the proportion of farmed salmon in angling catches is relatively low, and has varied between 4–7% during the same period. However, when examining catches of brood stock, the proportion is much higher varying between 21–38% (Table 3.3.7.3).

In outer coastal fisheries there was a significant negative correlation between the proportion of reared fish in the catches and mean distance to the ten nearest fish farms (Lund *et al.* 1991a). This correlation indicates that escapees at maturity will enter adjacent rivers near the site of escape. Samples from salmon fisheries on the outer coast showed a positive correlation between the number of smolts released into sea-cages and the proportion of farmed salmon in fisheries in the counties. On the other hand, the proportion of reared salmon in brood stock catches and marine fjord catches showed no correlation with this smolt release. This approach, geographically wider in scope, is less accurate when analysing the influence of the fish farming effort upon the proportion of reared salmon in river catches. Thus, the positive correlation in outer coastal waters provides further support for homing towards the geographical area of escape.

Additionally, Lund *et al.* (1991b) showed that in large fjords, like the Sognefjord and the Trondheimfjord the incidence of fish farm escapees is relatively small. There are very few fish farms in these fjords as a result of established zones restricted from farming.

U.K. (Scotland)

Marine farming takes place in the western coast and islands, the Orkney Islands and the Shetland Islands (Figure 6.2.1). Rivers supporting runs of wild salmon are present on the western, northern and eastern coasts of mainland Scotland and in the western islands. Since 1981, coastal fisheries and rivers have been monitored using a variety of methods to detect the frequency and distribution of escaped farmed salmon (Table 6.2.1).

Samples were obtained from 12 coastal, estuary or rod fisheries at various locations around the Scottish mainland coast (Figure 6.2.2). Coastal and estuary catches were sampled mostly in the late spring and summer months during the main runs of fish. Sampling ceased around the end of August, the start of the legal close-time. However, day-catches on the rod-and-line fishery of the lower River North Esk were monitored after this date, until the beginning of the legal close-time for angling at the end of October. For each fishery, day-catches were sampled at intervals throughout the fishing period in the years indicated in Table 6.2.1. The status of sampled fish was assessed by inspection (Lund *et al.* 1989), scale reading (Lund and Hansen 1991) and/or carotenoid pigment analysis (Craik and Harvey 1987a) as indicated on Table 6.2.1. Additionally, trap catches of adult spawners were monitored at the Baddoch and Girnock Burns, in the upper catchment of the River Dee in eastern Scotland.

Before 1986 escaped fish were not detected at any of the fisheries examined - with the exceptions of very low frequency occurrences (< 0.05%) at Culkein in 1986 and Strathy on the north coast in 1982. In the years after 1986, reared salmon were detected regularly and at the greatest frequencies observed (ranging to 38%) in fisheries in the coastal areas closest to, or shared with, marine aquaculture (i.e. Redpoint, Achiltibuie, Culkein and Strathy). Over the same period, reared fish were often detected at low frequencies (< 1%) in the fisheries at Bonar Bridge and the Spey, which are more remote from areas of aquaculture. In the Dee, North Esk, Tay and Tweed fisheries, which are most distant from sites of aquaculture, reared fish were detected only irregularly, only at very low frequencies (< 0.5%) and only after 1990. At the North Esk, reared fish appeared less frequent in the estuary fishery than in the rod-and-line fishery sampled later in the year. In general, the frequencies of reared fish appear to have declined in recent years, since peaking in the 1993 fisheries. No reared fish were detected in the eastern Scottish rivers after 1994. In the period 1981–1996, totals of 1663 and 1034 adult salmon were examined at the Girnock and Baddoch Burn fish-traps. No reared fish was detected at the Girnock Burn: a single escaped farmed fish was detected at the Baddoch trap in 1990.

The eastern Scottish coast and rivers have been substantially free of escaped farmed salmon since 1981 when monitoring commenced. Before this time, farmed salmon production in Scottish waters was less than 2,000 t per annum. By the early 1990s, when Scottish aquaculture production reached more than 30,000 t per annum, escaped salmon were sometimes frequent among wild salmon in the western fisheries near the main sites of production. In contrast, escaped salmon were infrequent on the eastern coast and most infrequent on the southern part of the east coast which is most distant from aquaculture sites. This uneven distribution probably indicates partial homing to sites of loss from aquaculture, as reported by Hansen and Jonsson (1991).

The same pattern is indicated by the findings of a survey of western and northern Scottish rivers carried out in 1992 in which carotenoid pigment analysis (the presence of the feed-additive canthaxanthin) was used to detect the progeny of escaped female salmon (Webb *et al.* 1993). The progeny of escaped fish were most frequent in the central western and the northern Scottish rivers that are closest to the main sites of marine aquaculture. The geographical distribution of the progeny of farmed fish was in approximate parallel to the frequency distributions of escaped fish reported in the present study.

Fry containing canthaxanthin were detected in samples from 14 of the 16 rivers examined. Among all rivers the frequency of fry bearing canthaxanthin was ca. 5%. All the rivers sampled were chosen to be free of hatchery development. Therefore the presence of escaped fish at spawning is a measure of opportunistic straying rather than homing to particular freshwater sites. Values were greatest in the River Kerry (a western river in the centre of the aquaculture industry) at ca. 18%. All the values underestimate the contribution of escaped farmed fish because a) only 65% of a sample of escaped fish obtained from the western fishery contained canthaxanthin in the year of study and b) only female fish contribute to the carotenoid pigment loading of their progeny.

Ireland

Inshore, coastal catches of salmon for both U.K. (Northern Ireland) and the Republic of Ireland are examined for escaped farmed salmon. Data for both countries (1991–1996) are presented together in Table 6.2.2 because they constitute a continuous part of the species' geographical range.

All the frequency values are regarded as probable under-estimates because detection is by morphological features alone, sampling is limited to the period of the fisheries (summer) and because of local biases in the categorisation and reporting of escaped fish.

Salmon farming in Ireland is mainly concentrated in the Mayo and Galway regions with lesser concentrations in Donegal and the South West. Farming is absent from the South and East. The frequency with which escaped fish have been detected in the coastal fisheries suggests widespread, often low level frequencies of escapes across years. Data obtained in 1996 for the South and East, where salmon farming does not occur, indicated that escaped fish were absent from this region.

No systematic information has been collated for in-river frequencies of escaped fish in rivers of the Republic of Ireland, although numerous independent reports are available. However, the River Bush (U.K., N. Ireland) is monitored for escapees. These figures (1991–1996) are presented in Table 3.3.7.4. Escaped fish have been detected every year: the frequency in every year has been low (< 1%) with the exception of 1994 when the frequency was 2.6%. As for the coastal catches, all frequencies for the River Bush are probably under-estimates, because detection is solely on the basis of morphological characters.

Canada

Hatchery origin fish are identified on the basis of the presence of an adipose-clip, from fin deformations, and/or from scale characteristics. 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 Labrador and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon (Figure 4.1.3.1). Hatchery origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy 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) 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 and Atlantic salmon smolts from the Bay d'Espoir aquaculture industry, were observed at Conne River (SFA 11).

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to almost 17,000 t in 1996. Escapes of Atlantic salmon have occurred annually. In 1994, escapes of

Atlantic salmon in the Bay of Fundy area were estimated at 20,000 to 40,000 salmon, an amount greater than the total returns of wild and hatchery origin salmon (both small and large) (13,000 to 21,000 fish) to the entire Bay of Fundy and Atlantic coast of Nova Scotia area (SFA 19 to 23) in the same year. The level of escapes in 1993 was similar to that of 1994. Reported estimates of escapes for 1995 and 1996 are low.

Aquaculture escaped fish have increased in abundance in the Magaguadavic River (SFA 23) (Table 4.1.3.1) which contains 3 smolt-rearing facilities and which is in close proximity to the centre of the aquaculture production area. Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of the total counts at the fishway.

Other species cultured commercially in eastern Canada include Arctic charr and rainbow (steelhead) trout. The Arctic charr production occurs in Newfoundland, all in shore-based facilities. Rainbow trout are cultured in the Bay of Fundy, Bras d'Or Lakes (SFA 19), and in Bay d'Espoir Newfoundland (SFA 11). In 1996, production of rainbow trout was 750 t from New Brunswick, 530 t from Nova Scotia and over 315 t from Newfoundland. Escapees of both Arctic charr and steelhead trout have been recorded in many rivers in proximity to these production facilities.

U.S.A.

Salmon aquaculture in the U.S.A. (Maine) began in the early 1970s, when coho salmon were cultured to pan size for the Northeast restaurant trade. These early ventures were unsuccessful due to adverse environmental conditions at pen sites, low market values, and a lack of adequate funding to support the industry. In the early 1980s, the successful culture of Atlantic salmon in New Brunswick was followed by rapid growth of the industry on both sides of the US-Canadian border. These operations in Maine were highly successful due to the quality of rearing sites available, warm winter water temperatures in the Passamaquoddy Bay area, favourable market prices, and the proximity to Canadian operations, which provided support in the areas of feed, cage technology, fish health and animal husbandry expertise.

The current industry is composed of 9 companies rearing Atlantic salmon, rainbow trout, and arctic char in Maine, down from 18 companies in 1989. These companies operate 6 smolt rearing facilities which produce about 4 million smolts annually for stocking into Maine marine rearing sites. There currently are about 800 cages that are operated at 25 sites in the eastern parts of the State of Maine. The preferred cage design is the 12 or 15-meter steel net pen manufactured in New Brunswick; however, the use of small and large diameter HDPE circle cages of Norwegian manufacture is increasing.

The principal salmon stocks that are reared originated from the Penobscot and Saint John rivers. Both stocks are reared in about equal proportions, while the Norwegian Landcatch strain accounts for the remaining 10% of the total production. Production has risen from 2,000 mt. in 1990 to about 10,000 t in both 1995 and 1996 (Table 2.2.1.1).

Salmon originating from farming operations have been observed in eight Maine rivers to date. Several other Maine rivers undoubtedly contain aquaculture escapees, although it is difficult to estimate their abundance since there are no fish counting facilities on these rivers. The first documented incidence of farmed salmon in Maine rivers occurred in 1990, when a minimum of 17% (14 of 83 fish) of the rod catch in the East Machias River was of farmed origin. There were few reports of salmon of farmed origin in Maine rivers in 1991 and 1992. In 1993, there were an estimated 20 aquaculture escapees in the Dennys River, which had a total run of about 50 salmon. Since 1994, however, the incidence of aquaculture escapes has been increasing in the three rivers of eastern Maine where there a provisions for fish counting. The incidence of farmed salmon in those rivers is reported in Table 4.1.3.1. Sexually mature escapees were identified in all three rivers in 1996.

6.3 Population Level Effects

Possible effects at the population level can be considered under three categories - disease/parasites, ecological and genetic. Disease and parasite interactions are self-evidently important: well documented effects exist for furunculosis and for *Gyrodactylus salaris* in Norway. Ecological effects relate to competition and environmental modification including predator attractions and fishery effects on mixed groups of wild and escaped fish. Genetic effects have been considered specifically by the Working Group on the Application of Genetics in Fisheries and Mariculture (ICES 1997/F:4).

Salmon populations are genetically heterogeneous for assumed neutral genetic markers (see e.g. Stahl 1987 and following) indicating that homing is sufficient to permit reproductive isolation. Reproductive isolation is a pre-requisite for the development of geographical heterogeneity for genetically-based characters of adaptive significance. Phenotypic variation can be observed among populations for characters that are of possible adaptive significance (Taylor 1991). Although most of the evidence is circumstantial, the number, range and likely importance of the observed effects indicate that some part of total phenotypic variation among populations is likely to be attributable to local genetic adaptation.

Farmed salmon tend to differ genetically from local wild stocks because of their non-local genetic origin and/or because of deliberate and inadvertent selection during culture. Concern has been expressed that the spawning of escaped farmed fish, and the assimilation of their progeny (and genes) into wild populations, will result in losses of natural genetic diversity in wild salmon populations (Hindar *et al.* 1991). Similarly, ranching operations which do not result in a total harvest, or stocking programmes where the intention is to increase returns to rod fisheries and not to enhance spawning populations, may result in significant numbers of cultured fish in rivers interacting with wild populations in a similar manner to fish farm escapees. This is a difficult area - both conceptually and practically - that remains insufficiently explored, as indicated by the Working Group on the Application of Genetics in Fisheries and Mariculture (ICES 1997/F:4).

Nevertheless, some valid general points can be made. The outcome of any interaction between wild and escaped stock will be dependent on:

- the number of escaped fish,
- the genetic constitution of the escaped fish, as it reflects source and selection,
- the character of escaped fish, as it reflects their culture environment prior to release,
- the size of the wild population group,
- the genetic constitution of the wild population group and the individuals of which is composed,
- the character of the wild fish, as reflected in the nature of their interactions with escaped fish.

More generally, the scope for escaped fish to exert effects on wild populations will depend on the relative numbers of escaped and wild fish in the group and patterns of incursion. Small populations that are at risk of large incursions are likely to be most susceptible to change. Large populations may be robust to low rates of straying by escapes - as they are to low level straying among wild populations. The persistence of initial effects will be determined by the relative fitness of the progeny of escaped fish, native fish and hybrid progeny. Any initial genetic effect may be diminished or amplified over time in line with relative fitness. Single annual effects of any kind may be compounded by repeated incursions of escaped fish.

Considering only the general categories of effect listed above and their interactive effects, it seems likely that each interaction between escaped and wild and its outcome will be unique. This poses challenging questions for quantification and the development of generalised predictive models that will adequately describe the response of salmon populations to incursions by escaped farmed fish. However, the Joint ICES/NASCO Symposium scheduled for Bath, U.K. will include detailed, expert syntheses of current understanding of interactive effects at the population level.

7 PROGRESS ON THE IMPLEMENTATION OF SPAWNING TARGETS

The Working Group reviewed the progress in the NEAC area regarding the development and application of spawning requirement reference points. There has been substantial progress in the establishment of reference points in the NEAC area. There were no changes in the spawning requirements for rivers in North America. During a joint session with the Baltic Salmon Working Group (Appendix 1), a summary of the conclusions and recommendations from the spawning target workshop held in Pont-Scorff (FRANCE) in June 1996 was presented. One of the conclusions of the spawning workshop was that further progress in the development and transportation of reference points would occur with collection and analysis of additional data sets rather than refinements in analytical methods. There are few relevant data sets (long-term, large contrast in spawning escapement levels) in either the NAC or the NEAC areas. One of the recommendations of the workshop was the sharing of data sets to foster collaboration and share skills. As a first step, the Working Group compiled a preliminary list of individuals involved in the collection of data relevant to the development of reference points (Appendix 8). The list is preliminary and is intended to encourage the exchange of information and methods. The list could be updated by the Working Group in the future.

8 RECOMMENDATIONS

8.1 Fisheries

1. Considering the state of stocks in the Northeast Atlantic Commission area and trends in the pre-fishery abundance there should be no increase in levels of exploitation. Thus a precautionary approach is called for in the management of all fisheries, and particularly where they exploit mixed stocks.

2. The Working Group reiterates the advice given in 1996, that it is evident from both the indicators of stock status and the extremely low pre-fishery abundance forecasts for Greenland, that the North American stock complex is in tenuous condition. Stock abundance is low despite nearly complete closures of mixed and single stock fisheries. 2 SW salmon are experiencing low marine survival rates and in some monitored stocks are below spawning requirements. The increasing advantage associated with each additional spawner in under-seeded river systems makes a strong case for a conservative management strategy. However, the Working Group noted that thermal habitat and smolt survival rates in the northwest Atlantic are improving which will be expected to provide future benefits to returns and spawning escapements.

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.

8.2 Meetings

1. The Working Group recommends that it should meet in 1998 to address questions posed by ACFM, including those posed by NASCO to ICES. The length of the meeting will have to depend upon questions asked. Recent Terms of Reference have required a 10-day meeting; a reduction in the number of meeting days would require a reduction in the Terms of Reference. In view of the fact that sea-surface temperature data required to provide catch advice for West Greenland is not expected before April 7, 1998, the Working Group should meet as soon as possible <u>after</u> that date.

8.3 Data Deficiencies and Research Needs

1. The Working Group requires guidance on the way that ACFM and NASCO would like production of ranched fish to be handled in the various catch tables.

2. Efforts should be made to standardise the way that catch-and-release data are handled in the catch statistics in order to provide an unbiased estimate of mortalities due to fishing.

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

4. The Working Group supports the continuation of the research 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.

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

6. 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.

7. Further information is required on the by-catch of post-smolts in marine fisheries. The Working Group strongly endorses the continuation of the post-smolt surveys in the North East Atlantic.

8. Further work is required on the development of biological reference points for stocks in the NEAC and NAC areas.

9. Efforts should be made to provide more accurate estimates of the level of catch by each country of stocks originating from other countries.

10. Relationships between environmental parameters and marine survival of salmon stocks in the NEAC area need to be examined.

11. In the description of methods used to estimate Labrador returns and spawners (Appendix 5 i), inactive fishing effort was removed from the estimation procedures. Changes in licensed fishing effort since 1992 had been used to revise exploitation rate calculations and correspondingly, return estimates. The proportion of effort removed (which was inactive) was not uniform over all areas of Labrador. The Working Group considered that it would be informative to estimate returns and escapements of salmon to Labrador by summing the individual estimates for SFAs 1, 2 and 14B by specific SFA exploitation rates adjusted for fishing effort within each of the respective areas and compare to the current values used. (Section 4.7).

12. There is a need for improved habitat surveys for rivers in Labrador and Ungava so that spawner requirements can be developed based on habitat characteristics. (Section 4.7).

13. Review possible changes in the biological characteristics (mean weight, sex ratio, 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 U.S.A. and Canada by incorporating new information such as on biological characteristics for individual stocks, habitat measurements and stock and recruitment analysis. (Section 4.7).

14. Annual estimates of wild smolt-to-adult salmon survival rates need to be obtained for rivers in Labrador, New Brunswick and Nova Scotia. As well, sea survival rates of hatchery and wild salmon should be examined to determine if changes in survival of hatchery releases can be used as an index of sea survival of wild salmon. (Section 4.7).

15. Develop estimates of total recruits to all fisheries for each SFA in Canada for which estimates have not been made.

16. The mean weights, sea ages and proportion of fish originating from North America and Europe are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling program which occurred in 1995 and 1996 be continued and improved to cover as much of the landings as possible. (Section 5.3).

17. Efforts should be made to estimate the annual catches of salmon taken for local consumption at West Greenland. (Section 5.3).

18. The catch options for the West Greenland fishery are based almost entirely upon data derived from North American stocks. In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible (Section 5.3).

19. The Working Group continues to recognise the importance of in-season identification to continent of origin using genetic techniques to calibrate scale-based identification of the fishery catch at Greenland. The need for these data arose when it was found that scale-based growth features deposited during the post-smolt year that differentiate the continental groups can converge, thus making continent of origin identification less reliable. This problem can be rectified by in-season genetic sampling, however, the Working Group recommended that other methods be explored which may be used to evaluate the scale-based method without the added expense and difficulty of the present genetic sampling. Specifically, the Working Group recommends that an investigation of environmental predictors of the scale-based features used in the classification be undertaken. Further to the larger problem of accurately identifying larger segments of the catch to continent of origin, the Working Group encourages the development of new genetic techniques that can be applied to larger quantities of catch than present methods. The Working Group continues to support and encourage existing genetic monitoring programs identifying continent of origin of in-season samples from West Greenland.

Table 2.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1996. (1996 figures include provisional and incomplete data).

Year	Canada (1)	Den.	Faroes (2)	Finland	France	East Grld.	West Grld. (3)	Iceland (4)	Ireland (5,6)	Norway (7)	Russia	Spain (8)	St. P. & M.	Sweden (West)	UK (E & W)	UK N.Ireland (6,9)	UK (Scotland)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100	743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127	707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125	1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145	1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135	1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133	1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	1238	1791	570	42	-	36	387	287	1595	1	-	9790	-	-
1967	2863	-	-	-	-	-	1601	144	1463	1980	883	43	-	25	420	449	2117	1	-	11989	-	-
1968	2111	-	5	-	-	-	1127	161	1413	1514	827	38	-	20	282	312	1578	1	403	9792	-	-
1969	2202	-	7	-	-	-	2210	131	1730	1383	360	54	-	22	377	267	1955	1	893	11592	-	-
1970	2323	-	12	-	-	-	2146	182	1787	1171	448	45	-	20	527	297	1392	1	922	11273	-	-
1971	1992	-	-	-	-	-	2689	196	1639	1207	417	16	-	18	426	234	1421	1	471	10727	-	-
1972	1759	-	9	32	34	-	2113	245	1804	1578	462	40	-	18	442	210	1727	1	486	10960	-	-
1973	2434	-	28	50	12	-	2341	148	1930	1726	772	24	-	23	450	182	2006	2.7	533	12662	-	-
1974	2539	-	20	76	13	-	1917	215	2128	1633	709	16	-	32	383	184	1628	0.9	373	11867	-	-
1975	2485	-	28	76	25	-	2030	145	2216	1537	811	27	-	26	447	164	1621	1.7	475	12115	-	-
1976	2506	-	40	66	9	<1	1175	216	1561	1530	772	21	2.5	20	208	113	1019	0.8	289	9548	-	-
1977	2545	-	40	59	19	6	1420	123	1372	1488	497	19	-	10	345	110	1160	2.4	192	9407	-	-
1978	1545	-	37	37	20	8	984	285	1230	1050	476	32	-	10	349	148	1323	4.1	138	7676	-	-
1979	1287	-	119	26	10	<1	1395	219	1097	1831	455	29	-	12	261	99	1076	2.5	193	8112	-	-
1980	2680	-	536	34	30	<1	1194	241	947	1830	664	47	-	17	360	122	1134	5.5	277	10119	-	-
1981	2437	-	1025	44	20	<1	1264	147	685	1656	463	25	-	26	493	101	1233	6	313	9938	-	-
1982	1798	-	865	54	20	<1	1077	130	993	1348	364	10	-	25	286	132	1092	6.4	437	8637	-	-
1983	1424	-	678	58	16	<1	310	166	1656	1550	507	23	3	28	429	187	1221	1.3	466	8723	-	-
1984	1112	-	628	46	25	<1	297	139	829	1623	593	18	3	40	345	78	1013	2.2	101	6892	-	-
1985	1133	-	566	49	22	7	864	162	1595	1561	659	13	3	45	361	98	913	2.1	-	8053	-	-
1986	1559	-	530	37	28	19	960	232	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9196	315	-
1987	1784	-	576	49	27	<1	966	181	1239	1385	564	18	2	47	302	56	922	1.2	-	8119	2788	-
1988	1311	-	243	36	32	4	893	217	1874	1076	419	18	2	40	395	114	882	0.9	-	7557	3248	-
1989	1139	-	364	52	14	<1	337	140	1079	905	359	7	2	29	296	142	895	1.7	-	5762	2277	-
1990	911	13	315	60	15	<1	274	146	586	930	315	7	2	33	338	94	624	2.4	-	4665	1890	180-350
1991	711	3.3	95	70	13	4	472	130	404	876	215	11	1	38	200	55	462	0.8	-	3761	1682	25-100
1992	522	10	23	77	20	5	237	175	630	867	166	11	1.3	49	186	91	600	0.7	-	3671	1962	25-100
1993	373	9	21	70	16	-	-	160	541	923	140	8	1.8	56	270	83	547	0.6	-	3219	1644	25-100
1994	355	6	6	49	18	-	-	140	804	996	138	10	2.7	44	319	91	649	0	-	3628	1276	25-100
1995	260	-	5	48	9	2	83	150	790	839	129	9	0.4	37	307	83	588	0	-	3339	1060	n/a
1996	291	-	1	44	14	-	92	122	685	787	131	7	1.5	33	194	77	380	0	-	2860	1123	n/a
Means																						
1991-1995	444	7	30	63	15	4	264	151	634	900	158	10	1	45	256	81	569	0	-	3524	1525	-
1986-1995	893	-	218	55	19	7	528	167	968	1040	305	13	2	43	304	92	744	1	-	5292	-	-

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Since 1991, there has only been a research fishery at Faroes.
3. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
4. New figures for entire series. Ranched salmon, previously included in the nominal catch have now been excluded and are reported separately in Table 2.2.2.1.
5. From 1994, includes increased reporting of rod catches.
6. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
7. Before 1966, sea trout and sea charr included (5% of total).
8. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 based on mean wt. from R. Asturias.
9. Not including angling catch (mainly 1SW).
10. Includes catches in Norwegian Sea by vessels from De k, Sweden, Germany, Norway and Finland.
11. Estimates refer to season ending in given year.

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Table 2.1.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1996. (1996 figures include provisional and incomplete data).
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 (2)	Ireland (3,4)			Norway (5)			Russia	Spain (6)	Sweden (West)	UK (E&W)	UK(N.I.) (4, 7)	UK(Scotland)			USA	Total
	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	-	-	-	-	104	-	-	1238	-	-	1791	570	42	36	387	287	1049	546	1595	1	8420
1967	-	-	2863	-	-	-	-	144	-	-	1463	-	-	1980	883	43	25	420	449	1233	884	2117	1	10388
1968	-	-	2111	-	-	-	-	161	-	-	1413	-	-	1514	827	38	20	282	312	1021	557	1578	1	8257
1969	-	-	2202	-	-	-	-	131	-	-	1730	801	582	1383	360	54	22	377	267	997	958	1955	1	8482
1970	1562	761	2323	-	-	-	-	182	-	-	1787	815	356	1171	448	45	20	527	297	775	617	1392	1	8193
1971	1482	510	1992	-	-	-	-	196	-	-	1639	771	436	1207	417	16	18	426	234	719	702	1421	1	7567
1972	1201	558	1759	-	-	32	34	245	200	1604	1804	1064	514	1578	462	40	18	442	210	1013	714	1727	1	8352
1973	1651	783	2434	-	-	50	12	148	244	1686	1930	1220	506	1726	772	24	23	450	182	1158	848	2006	2.7	9760
1974	1589	950	2539	-	-	76	13	215	170	1958	2128	1149	484	1633	709	16	32	383	184	912	716	1628	0.9	9557
1975	1573	912	2485	-	-	76	25	145	274	1942	2216	1038	499	1537	811	27	26	447	164	1007	614	1621	1.7	9582
1976	1721	785	2506	-	-	66	9	216	109	1452	1561	1063	467	1530	772	21	20	208	113	522	497	1019	0.8	8042
1977	1883	662	2545	-	-	59	19	123	145	1227	1372	1018	470	1488	497	19	10	345	110	639	521	1160	2.4	7749
1978	1225	320	1545	-	-	37	20	285	147	1082	1229	668	382	1050	476	32	10	349	148	781	542	1323	4.1	6508
1979	705	582	1287	-	-	26	10	219	105	922	1027	1150	681	1831	455	29	12	261	99	598	478	1076	2.5	6335
1980	1763	917	2680	-	-	34	30	241	202	745	947	1352	478	1830	664	47	17	360	122	851	283	1134	5.5	8112
1981	1619	818	2437	-	-	44	20	147	164	521	685	1189	467	1656	463	25	26	493	101	834	389	1223	6	7326
1982	1082	716	1798	49	5	54	20	130	63	930	993	985	363	1348	364	10	25	286	132	596	496	1092	6.4	6258
1983	911	513	1424	51	7	58	16	166	150	1506	1656	957	593	1550	507	23	28	429	187	672	549	1221	1.3	7266
1984	645	467	1112	37	9	46	25	139	101	728	829	995	628	1623	593	18	40	345	78	504	509	1013	2.2	5863
1985	540	593	1133	38	11	49	22	162	100	1495	1595	923	638	1561	659	13	45	361	98	514	399	913	2.1	6613
1986	779	780	1559	25	12	37	28	232	136	1594	1730	1042	556	1598	608	27	54	430	109	745	526	1271	1.9	7685
1987	951	833	1784	34	15	49	27	181	127	1112	1239	894	491	1385	564	18	47	302	56	503	419	922	1.2	6575
1988	633	677	1311	27	9	36	32	217	141	1733	1874	656	420	1076	419	18	40	395	114	501	381	882	0.9	6415
1989	590	549	1139	33	19	52	14	140	132	947	1079	469	436	905	359	7	29	296	142	464	431	895	1.7	5059
1990	486	425	911	41	19	60	15	146	-	-	586	545	385	930	315	7	33	338	94	423	201	624	2.4	4061
1991	370	341	711	53	17	70	13	130	-	-	404	535	342	876	215	11	38	200	55	177	285	462	0.8	3186
1992	323	199	522	49	28	77	20	175	-	-	630	566	301	867	166	11	49	186	91	362	238	600	0.7	3395
1993	214	159	373	53	17	70	16	160	-	-	541	611	312	923	140	8	56	270	83	320	227	547	0.6	3188
1994	216	139	355	38	11	49	18	140	-	-	804	581	415	996	138	10	44	319	91	400	248	649	0	3613
1995	153	107	260	37	11	48	9	150	-	-	790	590	249	839	129	9	37	307	83	364	224	588	0	3249
1996 (8)	146	145	291	23	21	44	14	122	-	-	685	571	215	787	131	7	33	194	77	237	143	380	0	2765
Means																								
1991-95	255	189	444	46	17	63	15	151	-	-	634	577	324	900	158	10	45	256	81	325	244	569	0	3326
1986-95	472	421	893	39	16	55	19	167	-	-	968	649	391	1040	305	13	43	304	92	426	318	744	1	4643

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. New figures for entire series. Ranched salmon, previously included in the nominal catch have now been excluded and are reported separately in Table 2.2.2.1.
3. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
4. From 1994, includes increased reporting of rod catches.
5. Before 1966, sea trout and sea charr included (5% of total).
6. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 based on mean wt. from R. Asturias.
7. Not including angling catch (mainly 1SW).

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Table 2.1.2.1 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1996 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	1,559
	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	61,940	107	-	-	-	-	-	-	-	-	34,263	153	-	-	96,203	260
	1996	87,141	145	-	-	-	-	-	-	-	-	30,066	146	-	-	117,207	291
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/86	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/87	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/88	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/89	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/90	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/92	16	-	7,611	-	837	-	-	-	-	-	-	-	-	-	8,464	31
	1992/93	-	-	4,212	-	1,203	-	-	-	-	-	-	-	-	-	5,415	22
	1993/94	-	-	1,866	-	206	-	-	-	-	-	-	-	-	-	2,072	7
	1994/95	-	-	1,807	-	156	-	-	-	-	-	-	-	-	-	1,963	6
	1995/96	-	-	268	-	14	-	-	-	-	-	-	-	-	-	282	1
Finland	1982	2,598	5	-	-	-	-	-	-	-	-	5,408	49	-	-	8,406	54
	1983	3,916	7	-	-	-	-	-	-	-	-	6,050	51	-	-	9,966	58
	1984	4,899	9	-	-	-	-	-	-	-	-	4,726	37	-	-	9,625	46
	1985	6,201	11	-	-	-	-	-	-	-	-	4,912	38	-	-	11,113	49
	1986	6,131	12	-	-	-	-	-	-	-	-	3,244	25	-	-	9,375	37
	1987	8,696	15	-	-	-	-	-	-	-	-	4,520	34	-	-	13,216	49
	1988	5,926	9	-	-	-	-	-	-	-	-	3,495	27	-	-	9,421	36
	1989	10,395	19	-	-	-	-	-	-	-	-	5,332	33	-	-	15,727	52
	1990	10,084	19	-	-	-	-	-	-	-	-	5,600	41	-	-	15,684	60
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49
	1995	7,786	11	-	-	-	-	-	-	-	-	5,344	38	-	-	13,130	48
	1996	10,726	21	1,103	5	1,359	13	242	4	13	1	-	-	-	-	13,443	44

Table 2.1.2.1 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
	1996	2,063	5	1,891	9	52	0.4									4,005	14
Iceland	1991	30,011	-	11,935	-	-	-	-	-	-	-	-	-	-	-	41,946	130
	1992	38,955	-	15,416	-	-	-	-	-	-	-	-	-	-	-	54,371	175
	1993	37,611	-	11,611	-	-	-	-	-	-	-	-	-	-	-	49,222	160
	1994	25,480	62	14,408	78	-	-	-	-	-	-	-	-	-	-	39,888	140
	1995	34,046	93	13,380	57	-	-	-	-	-	-	-	-	-	-	47,426	150
	1996	28,039	69	9,971	53	-	-	-	-	-	-	-	-	-	-	38,010	122
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,120	541
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286,266	804
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288,225	790
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	248,901	685

Table 2.1.2.1 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
	1996	110,085	215	69,389	322	27,627	249									207,101	787
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
	1996	33,878	79	7,395	42	1,084	9	40	0.5					41	0.5	42,586	131
Sweden	1989	3,181	7	-	-	-	-	-	-	-	-	4,610	22	-	-	7,791	29
	1990	7,428	18	-	-	-	-	-	-	-	-	3,133	15	-	-	10,561	33
	1991	8,987	20	-	-	-	-	-	-	-	-	3,620	18	-	-	12,607	38
	1992	9,850	23	-	-	-	-	-	-	-	-	4,656	26	-	-	14,507	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,695	44
	1995	9,761	22	-	-	-	-	-	-	-	-	2,770	14	-	-	12,531	37
	1996	6,008	14									3,542	19			9,550	33

Table 2.1.2.1 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 (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	200
	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83,606	307
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49,563	194
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	89,921	224	-	-	-	-	-	-	-	-	78,452	364	-	-	168,373	588
	1996	60,101	143	-	-	-	-	-	-	-	-	51,396	237	-	-	111,497	380
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
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0

Table 2.1.2.1 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
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,478	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,052	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,381	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1995	31,241	-	558	-	-	-	-	-	-	-	-	-	478	-	32,270	83
	1996	30,613	-	884	-	-	-	-	-	-	-	-	-	568	-	32,062	92

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

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

- Scale reading: Faroe Islands, Finland (1996), France, Russia, UK (England and Wales), USA and West Greenland.
- Size (split weight/length): Canada (2.7 kg for nets; 63 cm for rods), Finland up until 1995 (3 kg), Iceland (various splits used at different times and places), Norway (3 kg), UK (Scotland) (3 kg in some places and 3.7 kg in others). All countries except Scotland report no problems with using weight to categorise 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 2.1.3.1 Guess-estimates of unreported catches in tonnes within national EEZs in the North-East Atlantic, North America and West Greenland Commissions of NASCO, 1986-1996.

Year	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	<20	1,060
1996	947	156	<20	1,123
Mean 1991-1995	1,390	126	-	1,525

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Table 2.2.1.1 Production of farmed salmon in the North Atlantic area (in tonnes round fresh weight), 1980-1996.

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	-	236,811
1992	140,000	36,101	17,000	10,380	9,231	5,850	2,100	200	-	220,862
1993	170,000	48,691	16,000	11,115	12,366	6,755	2,348	<100	-	267,275
1994	215,000	64,066	14,789	12,441	11,616	6,130	2,588	<100	-	326,630
1995	295,000	70,060	9,000	12,550	11,811	10,020	2,880	259	-	411,580
1996	305,000	83,300	18,600	16,874	13,500	10,010	2,772	338	-	450,394
Mean 1991-1995	195,000	51,902	14,358	11,176	10,901	6,663	2,519	186	-	292,632

Data for Norway Scotland, and Canada are provisional

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Table 2.2.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight) as harvested at ranching facilities, 1980-1996.

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	203
1989	136	16.3	17	3	169
1990	280	5.7	5	6	291
1991	375	3.6	4	5	383
1992	460	9.4	11	10	480
1993	496	9.7	8	11	514
1994	308	15.2	0.4	9.5	324
1995	289	16.8	1.2	2	307
1996	236	18.5	3	8	266
Mean 1991-95	386	11	5	8	401

[1] Total yield in homewater fisheries and rivers. 1996 figure for Ireland is provisional.

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Table 2.6.1. Number of microtags, external tags and finclips applied to Atlantic salmon by countries for 1996. ('Hatchery' and 'wild' refer to smolts or parr; adults are 'wild' and/or 'hatchery')

		Marking method					
Country	**Origin**	**Microtags**	**Visible implant**	**External**	**Brand Dyemarks etc.**	**Finclips**	**Auxillary tags, Finclips**
Belgium	Hatchery	877	-	877	-	920	877
	Wild	-	-	-	-	-	-
	Adult	-	-	-	-	-	-
	Total	877	-	877	-	920	877
Canada	Hatchery	-	-	16885	-	1082462	5885
	Wild	-	-	3377	-	-	-
	Adult	-	-	10006	-	-	-
	Total	-	-	30268	-	1082462	5885
Denmark	Hatchery	7332	-	3998	-	-	7332
	Wild	-	-	-	-	-	-
	Adult	-	-	-	-	-	-
	Total	7332	-	3998	-	-	7332
Finland	Hatchery	-	-	-	-	-	-
	Wild	-	-	-	-	-	-
	Adult	-	-	32	-	-	-
	Total	-	-	32	-	-	-
France	Hatchery	2000	-	-	47180	101970	-
	Wild	-	275	-	767	-	-
	Adult	-	-	-	-	-	-
	Total	2000	275	-	47947	101970	-
Iceland	Hatchery	205037	-	-	-	-	205037
	Wild	7407	-	-	-	-	7407
	Adult	-	-	129	-	-	-
	Total	212444	-	129	-	-	212444
Ireland	Hatchery	309747	-	-	-	-	309747
	Wild	6963	-	-	-	-	6963
	Adult	-	-	-	-	-	-
	Total	316710	-	-	-	-	316710
Norway	Hatchery	-	-	103582	-	-	-
	Wild	-	-	2375	-	-	-
	Adult	-	-	-	-	-	-
	Total	-	-	105957	-	-	-
Russia	Hatchery	-	-	8078	-	236900	-
	Wild	-	-	2226	-	-	-
	Adult	-	-	1133	-	-	-
	Total	-	-	11437	-	236900	-
Spain	Hatchery	35500	-	-	-	150800	186300
	Wild	-	-	-	-	-	-
	Adult	-	-	-	-	-	-
	Total	35500	-	-	-	150800	186300
Sweden	Hatchery	-	-	5953	-	-	-
	Wild	-	-	148	-	-	-
	Adult	-	-	68	-	-	-
	Total	-	-	6169	-	-	-
UK (England & Wales)	Hatchery	222483	-	-	-	22476	222483
	Wild	3741	-	-	-	-	3741
	Adult	-	-	122	-	-	-
	Total	226224	0	122	0	22476	226224
UK (Northern Ireland)	Hatchery	34828	-	-	-	6366	36042
	Wild	2060	-	-	-	-	2060
	Adult	-	-	-	-	-	-
	Total	36888	-	-	-	6366	38102
UK (Scotland)	Hatchery	3459	-	-	-	-	3459
	Wild	15417	-	4123	-	-	19540
	Adult	-	-	186	-	-	-
	Total	18876	-	4309	-	-	22999
USA	Hatchery	-	-	48400	646140	24900	-
	Wild	-	889	-	-	-	399
	Adult	-	9	5071	-	2847	205
	Total	-	898	53471	646140	27747	604
TOTALS	**Hatchery**	**821263**	**0**	**187773**	**693320**	**1626794**	**977162**
	Wild	**35588**	**1164**	**12249**	**767**	**0**	**40110**
	Adult	**0**	**9**	**16747**	**0**	**2847**	**205**
GRAND TOTAL		**856851**	**1173**	**216769**	**694087**	**1629641**	**1017477**

OVERALL TOTAL MARKED: 3398521

Table 3.1.1. Nominal landings of Atlantic salmon by Faroes vessels in years 1982-1994 and the 1981/1982 to 1996/1997 fishing seasons.

Year	Catch (t)	Quota (t) a	Season	Catch (t)
1982	606		1981/1982	796
1983	678		1982/1983	625
1984	628		1983/1984	651
1985	566	625	1984/1985	598
1986	530	625	1985/1986	545
1987	576	597 b	1986/1987	539
1988	243	597 b	1987/1988	208
1989	364	597 b	1988/1989	309
1990	315	550 c	1989/1990	364
1991	95	550 c	1990/1991	202
		Research fishery		
1992	23	550	1991/1992	31
1993	23	550	1992/1993	22
1994	6	550	1993/1994	7
1995	5	550	1994/1995	6
1996	-	470	1995/1996	1
1997	NA	425	1996/1997	-

a Quotas set by NASCO from 1987
b Three year quota of 1790 t
c Two year quota of 1100 t

Table 3.1.2. Catch of salmon in number by month in the Faroes fishery in the 1983/1984 to 1995/1996 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
1995/1996	-	282	-	-	-	-	-	-	282

Table 3.2.1.1 Smolt age distribution in numbers within age classes (% in brackets) of wild salmon in samples from the Faroes salmon fisheries. Age group 4+ include 5 year old smolts in samples assigned * or ** (see footnote).

			Period 1 (Nov-Dec)					Period 2 (Jan-Apr)					
			Smolt age					Smolt age					Whole
Season	Period 1	Period 2	1	2	3	4+	Total	1	2	3	4+	Total	season
1994/1995	Nov 94	Feb - Mar 95	7 (6)	57 (50)	31 (27)	20 (17)	115	1 (1)	66 (41)	67 (41)	29** (18)	163	278
1993/1994	Nov - Dec 93	Jan - Mar 94	7 (10)	31 (43)	25 (34)	10 (14)	73	4 (4)	40 (37)	47 (44)	16 (15)	107	180
1992/1993	Nov - Dec 92	Mar 93	5 (12)	21 (53)	12 (30)	2 (5)	40	0 (0)	34 (33)	57 (55)	12* (12)	103	143
1991/1992	Dec 91	Feb - Apr 92	3 (4)	32 (48)	27 (40)	5* (8)	67	4 (2)	73 (41)	91 (51)	10 (6)	178	245

* and ** : samples including one and three individuals of smolt age 5 respectively.

Table 3.2.1.2 Sea age distribution in numbers within age classes (% in brackets) of wild salmon in samples from the Faroes salmon fisheries. Age group 3+ include sea age 3 and higher.

			Period 1 (Nov-Dec)				Period 2 (Jan-Apr)				
			Sea age				Sea age				Whole
Season	Period 1	Period 2	1	2	3+	Total	1	2	3+	Total	season
1994/1995	Nov 94	Feb - Mar 95	23 (19)	93 (78)	3 (3)	119	5 (3)	137 (80)	29* (17)	171	290
1993/1994	Nov - Dec 93	Jan - Mar 94	11 (12)	64 (73)	13 (15)	88	30 (23)	63 (48)	38* (29)	131	219
1992/1993	Nov - Dec 92	Mar 93	20 (31)	41 (63)	4* (6)	65	1(1)	75 (60)	49* (39)	125	190
1991/1992	Dec 91	Feb - Apr 92	7 (10)	61 (86)	3 (4)	71	2(1)	159 (80)	37* (19)	198	269

* samples including 1-3 individuals of sea age 4, 5 and 6.

Table 3.2.1.3 Mean smolt age $\overline{x}$ of wild salmon in samples from the Faroes salmon fisheries (1991/92 – 1994/95). n = number of fish examined.

	Period 1 (Nov-Dec)		Period 2 (Jan-Apr)	
Season	$\overline{x}$	n	$\overline{x}$	n
1994/95	2.6	115	2.8	163
1993/94	2.5	73	2.7	107
1992/93	2.3	40	2.7	103
1991/92	2.5	67	2.6	178

Table 3.2.1.4 Mean sea age $\overline{x}$ of wild salmon in samples from the Faroes salmon fisheries (1991/92 – 1994/95). n = number of fish examined.

	Period 1 (Nov-Dec)		Period 2 (Jan-Apr)	
Season	$\overline{x}$	n	$\overline{x}$	n
1994/95	1.8	119	2.2	171
1993/94	2.0	88	2.1	131
1992/93	1.8	65	2.4	125
1991/92	1.9	71	2.2	198

Table 3.2.2.1. Number of wild and escaped farmed salmon tagged by month in Faroese waters November 1992 to March 1995.

Month	No wild salmon	No farmed salmon	Total
November 1992	469	212	681
December 1992	204	62	266
March 1993	1311	793	2104
November 1993	126	50	176
December 1993	102	41	143
February 1994	80	26	106
March 1994	132	57	189
November 1994	392	106	498
December 1994	149	36	185
February 1995	311	100	411
March 1995	535	154	689
Total	3811	1637	5448

Table 3.2.2.2. Results of 'At Risk' simulation to estimate proportion (%) of wild Atlantic salmon tagged at Faroes returning to different countries. Confidence limits (95%) were applied based on 1000 simulations. Recoveries were adjusted for homewater exploitation rates and tag reporting rates as provided by the North Atlantic Salmon Working Group members, 1997.

Country	No.	Tag reporting rate		Exploitation rate		Estimated	Simulation		
	recapt.	min	max	min	max	recapt.	'-5%	Mean(%)	'+95%
Norway	46	0.40	0.60	0.50	0.80	141.5	29.1	41.7	55.5
Scotland	12	0.80	1.00	0.10	0.30	66.7	9.8	20.7	34.3
Russia	5	0.60	0.80	0.10	0.15	57.1	6.2	16.5	28.0
Ireland	9	0.60	0.80	0.50	0.75	20.6	2.8	6.2	10.7
Denmark	2	0.40	0.60	0.14	0.34	16.7	0.0	5.1	12.7
Canada	4	0.65	0.85	0.35	0.55	11.9	0.8	3.5	6.8
England	1	0.40	0.60	0.15	0.35	8.0	0.0	2.4	7.7
Sweden	4	0.55	0.75	0.55	0.90	8.5	0.6	2.5	4.9
Spain	1	0.60	0.80	0.55	0.85	2.0	0.0	0.7	1.8
Iceland	1	0.80	1.00	0.40	0.60	2.2	0.0	0.7	1.9
Total	85					335.2		100.0	

Table 3.2.3.1 The material used for estimation of the proportion of farmed salmon in the Faroese fisheries since 1980 and estimates of the proportion of reared origin. Indet.= number of fish not possible to classify.

Season	Time	Year	Wild	Reared	Indet.	Total	% reared
1980/81	January	1981	153	4	1	158	2
	Mars	1981	124	3	5	132	2
1980/81 *)	Jan-Mars		277	7	6	290	2
1981/82	January	1982	74	3	1	78	4
	February	1982	70	0	0	70	0
	Mars	1982	44	1	1	46	2
	April	1982	22	0	0	22	0
1981/82 *)	Jan-April		210	4	2	216	2
1982/83	February	1983	48	1	1	50	2
	March	1983	63	1	2	66	2
	April	1983	63	0	5	68	0
1982/83 *)	Feb-April		174	2	8	184	1
1983/84	January	1984	147	4	5	156	3
	February	1984	52	5	2	59	9
1983/84 *)	Jan-Feb		199	9	7	215	4
1984/85	January	1985	71	8	1	80	10
	February	1985	47	4	1	52	8
	Mars	1985	90	6	3	99	6
	April	1985	35	2	2	39	5
1984/85 *)	Jan-April		243	20	7	270	7
1985/86	January	1986	52	2	3	57	4
	February	1986	53	4	3	60	7
	April	1986	75	2	1	78	3
1985/86 *)	Jan-April		180	8	7	195	4
1986/87	March	1987	136	2	2	140	1
	April	1987	67	2	1	70	3
1986/87 *)	March-April		203	4	3	210	2
1987/88	January	1988	45	3	2	50	6
	February	1988	73	10	3	86	12
	April	1988	82	4	1	87	5
1987/88 *)	Jan-April		200	17	6	223	8
1988/89	November	1988	75	23	2	100	23
	January	1989	91	20	8	119	17
	April	1989	83	12	6	101	12
1988/89	Nov-April		249	55	16	320	17
1989/90	January	1990	106	87	13	206	42
	February	1990	36	32	5	73	44
1989/90 *)	Jan-Feb		142	119	18	279	43
1990/91 **)	December	1990	49	42	8	99	42
1991/92	December	1991	71	43	5	119	36
	February	1992	76	76	6	158	48
	March	1992	57	20	2	79	25
	April	1992	66	27	5	98	28
1991/92	Dec-April		271	166	18	454	37
1992/93	Nov-Dec	1992	65	26	28	119	22
	March	1993	125	61	14	200	31
1992/93	Nov-March		191	87	41	319	27
1993/94	November	1993	54	13	8	75	17
	December	1993	36	9	3	48	19
	January	1994	15	5	5	25	20
	February	1994	62	13	4	79	17
	March	1994	54	11	8	73	15
1993/94	Nov-April		221	51	28	300	17
1994/95	November	1994	120	34	2	156	22
	February	1995	83	22	1	106	21
	March 1995	1995	88	16	7	111	14
1994/95	Nov-March		291	72	10	373	19
1995/96 **)	December	1995	195	64	11	270	24

*) Samples only from latter part of the season (Jan-Mar); **) Only one month sampled that season.

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

Year	England & Wales				UK (Scotland)		UK (N. Ireland)				Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	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	-	-	-	-	0
1994	177	158	257	81	1,621	245	119	68	18	-	-	-	-	0
1995	162	156	249	74	1,444	223	122	68	16	-	-	-	-	0
1996	147	125	232	70	1,377	170	117	66	12	-	-	-	-	0
Mean 1991-95	185.6	162.0	259.2	105.4	1709.4	263.8	120.0	80.4	17.8	-	-	-	-	0
% 96 of mean	-20.8	-22.8	-10.5	-33.6	-19.4	-35.6	-2.5	-17.9	-32.6	-	-	-	-	-
Mean 1986-95	197.2	185.2	287.4	124.8	2576.2	356.7	118.7	99.6	17.9	-	-	-	-	5071.1
% 96 of mean	-25.5	-32.5	-19.3	-43.9	-46.5	-52.3	-1.4	-33.7	-33.0	-	-	-	-	-100.0

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

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

	Ireland[6]				Finland				France		
					The Teno River			R. Näätamo			
	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	657	240	12,726	-	-	-	-	-	-	-
1980	959	601	195	15,864	-	-	-	-	-	-	-
1981	878	601	195	15,519	16,859	5,742	677	467	-	-	-
1982	830	560	192	15,697	19,690	7,002	693	484	4,145	55	82
1983	801	526	190	16,737	20,363	7,053	740	587	3,856	49	82
1984	819	515	194	14,878	21,149	7,665	737	677	3,911	42	82
1985	827	526	190	15,929	21,742	7,575	740	866	4,443	40	82
1986	768	507	183	17,977	21,482	7,404	702	691	5,919	58 [1]	86
1987	-	-	-	-	22,487	7,759	754	689	5,804 [1]	87 [2]	80
1988	836	-	-	11,539	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	16,484	24,118	8,681	742	696	3,826	83	78
1990	756	525	189	15,395	19,596	7,677	728	614	2,977	71	76
1991	707	504	182	15,178	22,922	8,286	734	718	2,760	78	71
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71
1993	673	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
1996	773	446	176	25,000	17,625	5,743	672	814	1,806	21	69
Mean 1991-95	715.2	500.2	175.6	21760.8	26119.8	8933.6	735.2	737.0	2118.4	44.4	63.0
% 96 of mean	8.1	-10.8	0.2	14.9	-32.5	-35.7	-8.6	10.4	-14.7	-52.7	9.5
Mean 1986-95	748.6	504.7	178.6	18911.0	23999.0	8394.4	734.3	691.3	3353.1	62.2	71.1
% 96 of mean	3.3	-11.6	-1.4	32.2	-26.6	-31.6	-8.5	17.7	-46.1	-66.2	-3.0

[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.

[6] 1996 data for Ireland are provisional.

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Table 3.3.4.1 Nominal catch of SALMON in NEAC Area (in tonnes round fresh weight), 1960-1996.
(1996 figures include provisional and incomplete data)

Year	Homewater countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches	
					NEAC Area	International waters (2)
1960	5540	-	-	5540	-	-
1961	4753	-	-	4753	-	-
1962	6709	-	-	6709	-	-
1963	6276	-	-	6276	-	-
1964	7150	-	-	7150	-	-
1965	6456	-	-	6456	-	-
1966	6050	-	-	6050	-	-
1967	7524	-	-	7524	-	-
1968	6145	5	403	6553	-	-
1969	6279	7	893	7179	-	-
1970	5869	12	922	6803	-	-
1971	5574	-	471	6045	-	-
1972	6592	9	486	7087	-	-
1973	7323	28	533	7884	-	-
1974	7017	20	373	7410	-	-
1975	7095	28	475	7598	-	-
1976	5535	40	289	5864	-	-
1977	5202	40	192	5434	-	-
1978	4960	37	138	5135	-	-
1979	5115	119	193	5427	-	-
1980	5426	536	277	6239	-	-
1981	4893	1025	313	6231	-	-
1982	4454	865	437	5756	-	-
1983	5841	678	466	6985	-	-
1984	4749	628	101	5478	-	-
1985	5478	566	-	6044	-	-
1986	6124	530	-	6654	-	-
1987	4790	576	-	5366	2554	-
1988	5103	243	-	5346	3087	-
1989	3918	364	-	4282	2103	-
1990	3148	315	-	3463	1779	180-350
1991	2474	95	-	2569	1555	25-100
1992	2872	23	-	2895	1825	25-100
1993	2816	21	-	2837	1471	25-100
1994	3271	6	-	3277	1157	25-100
1995	2989	5	-	2994	942	n/a
1996	2474	1	-	2475	947	n/a
Means						
1991-1995	2884	30	-	2914	1390	-
1986-1995	3751	218	-	3968	-	-

1. Since 1991, there has only been a research fishery at Faroes.
2. Estimates refer to season ending in given year.

Table 3.3.5.1 CPUE for salmon rod fisheries in Finland (Teno 1974-96 and Naatamo 1988-96), France (1987-96) and on the River Bush (UK(N.Ireland))

	Finland (Teno River)				Finland (Naatamo River)				France		UK(N.Ire.) (R.Bush)	
	Catch per angler season		Catch per angler day		Catch per angler season		Catch per angler day		Catch per angler season		Catch per rod day	
Year	kg	5 yr mean	kg	5 yr mean	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		1.1									
1983	3.4	**3.7**	1.2	**1.0**							0.248	
1984	2.2		0.8		0.5		0.2				0.083	
1985	2.7		0.9								0.283	
1986	2.1		0.7								0.274	
1987	2.3		0.8						0.39		0.194	
1988	1.9	**2.3**	0.7	**0.8**	0.5		0.2		0.73	**0.8**	0.165	**0.2**
1989	2.2		0.8		1.0		0.4		0.55		0.135	
1990	2.8		1.1		0.7		0.3		0.71		0.247	
1991	3.4		1.2		1.3		0.5		0.60		0.396	
1992	4.5		1.5		1.4		0.3		0.94		0.258	
1993	3.9	**3.4**	1.3	**1.1**	0.4	**0.8**	0.2	**0.3**	0.88	**0.9**	0.341	**0.3**
1994	2.4		0.8		0.6		0.2		1.12		0.205	
1995	2.7		0.9		0.5		0.1		1.15		0.206	
1996	3.0		1.0		0.7		0.2		1.57		0.267	

Table 3.3.5.2 CPUE data for net and fixed engine salmon fisheries by Region in UK (England & Wales), 1988-1996. (Data expressed as catch per licence-day.)

	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
1996	4.70	0.86	-	-	0.72
Mean 1991-95	6.30	2.72	-	0.80	0.61

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Table 3.3.5.3 CPUE data for Scottish net fisheries.
Catch in numbers of fish per unit effort.

Year	Fixed engine	Net and coble CPUE
	Catch/trap month 1	Catch/crew month
1952	33.91	156.39
1953	33.12	121.73
1954	29.33	162.00
1955	37.09	201.76
1956	25.71	117.48
1957	32.58	178.70
1958	48.36	170.39
1959	33.30	159.34
1960	30.67	177.80
1961	31.00	155.17
1962	43.89	242.00
1963	44.25	182.86
1964	57.92	247.11
1965	43.67	188.61
1966	44.86	210.59
1967	72.57	329.80
1968	46.99	198.47
1969	65.51	327.64
1970	50.28	241.91
1971	57.19	231.61
1972	57.49	248.04
1973	73.74	240.60
1974	63.42	257.11
1975	53.63	235.71
1976	42.88	150.79
1977	45.58	188.67
1978	53.93	196.07
1979	42.20	157.19
1980	37.65	158.62
1981	49.60	183.86
1982	62.26	181.89
1983	56.20	206.83
1984	58.98	160.98
1985	54.48	156.55
1986	75.93	204.87
1987	64.34	147.14
1988	51.91	204.53
1989	71.68	268.78
1990	33.31	148.37
1991	35.62	100.44
1992	59.10	151.85
1993	52.29	124.06
1994	93.23	123.40
1995	75.03	141.60
1996	55.58	126.24

1 - Excludes catch and effort for Solway Region

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Table 3.3.5.4 Fisheries in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations) (p = 0.1 taken as significance level)

Section/ Data type	Test No.	Fisheries	Life stage	Period (years)	'p' value	Tren d
Section 3.3.5						
CPUE	**1.**	Scottish net fisheries. Catch/trap month		25	<0.001	**Dn**
	2.	UK (England & Wales) Net and fixed engines catches		9	0.3	NT
	3.	Rod catch/season, Finland (Teno, Naatamo) and France			0.002	**Up**
	4.	Rod catch/day Finland (Teno, Naatamo) and UK(N Ireland) (Bush)			0.22	NT
Section 3.3.9						
Expoloitation rates	**5.**	Burrishoole + Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	1 SW	10	>0.1	Nt
	6.	Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	1 SW	5	>0.1	Nt
	7.	Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	2 SW	10	>0.1	Nt
	8.	Burrishoole + Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	2 SW	5	>0.1	Nt
	9.	Ponoy rods, Tuloma + Kola rods and nets (Russia)	All ages	10 5	0.019 >0.1	**Dn** Nt

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

Country	Catches of Salmon						
	Year/ Season	Wild	Farmed		Total Farmed	Ranched	Total
Norway	1989	707	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	654	FW	13			
			SEA	170	183	2	839
	1996	557	FW	19			
			SEA	203	222	8	787
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
	1992/1993	16.1			5.9	0	22
	1993/1994	5.8			1.2	0	7
	1994/1995	4.8			1.2	0	6
	1995/1996	0.8			0.2	0	1
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
	1993	70			<1	0	70
	1994	49			<1	0	49
	1995	48			<1	0	48
	1996	44			<1	0	44
France	1991	13			0	0	13
	1992	20			0	0	20
	1993	16			0	0	16
	1994	18			0	0	18
	1995	9			0	0	9
	1996	14			0	0	14
Iceland[4]	1991	130			3	+	133
	1992	175			+	+	175
	1993	160			-	+	160
	1994	140			-	+	140
	1995	150			-	+	150
	1996	122			-	+	122
Ireland[5]	1991	400			1.7	2.3	404
	1992	621			2.3	6.7	630
	1993	532			1.1	8.1	541
	1994	789			2.6	12.5	804
	1995	774			0.7	14.8	790
	1996	667			1.8	15.9	685
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
	1996	131			0	0	131
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
	1996	10			1	22[1]	33
UK (E&W)	1991	200			0	0	200
	1992	186			0	0	186
	1993	274			0	0	274
	1994	319			0	0	319
	1995	307			0	0	307
	1996	194			0	0	194
UK (N.Ire)	1991	54			<1	-	55
	1992	85.3			1.1	2.6	89
	1993	80.5			0.2	2.3	83
	1994	90.1			0.5	0.4	91
	1995	80.6			1.5	0.9	83
	1996[2]	74.7			n/a	2.3	77
UK (Scot)[3]	1991	448			14	0	462
	1992	569			31	0	600
	1993	515			31	0	546
	1994	644			5	0	694
	1995	586			2	0	588
	1996[2]	380			1	0	380

[1] Fish released for mitigation purposes and not expected to contribute to spawning.
[2] Provisional figures.
[3] Data from 1994 onwards is figure reported in national catch statistics; previous years' data calculated from sampling programmes.
[4] "+" indicates a small but unquantified catch.
[5] Smolts released for enhancement of stocks or rod fisheries are included in wild.

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Table 3.3.7.2 Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989-1996. n=number of salmon examined.

	Coast				Fjords			
Year	n	No.localities	%	Range	n	No.localities	%	Range
1989	1217	7	45	7 - 66	803	4	14	8 - 29
1990	2481	9	48	16 - 64	940	5	15	6 - 36
1991*	1245	6	49	29 - 63	336	3	10	6 - 16
1992	1162	7	44	4 - 72	307	1	21	-
1993	1477	7	47	1 - 60	520	4	20	7 - 47
1994	1087	7	34	2 - 62	615	4	19	2 - 42
1995	976	7	42	2 - 57	745	4	17	2 - 47
1996*	1183	6	54	35 - 68	678	4	16	3 - 22

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

Table 3.3.7.3 Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June-18 August) and brood stock catches (19 August–31 December) in Norway in 1989–1996. (n=number of salmon examined; R= number of rivers sampled).

	1 June–18 August				19 August–31 December			
Year	n	R	%	Range	n	R	%	Range
1989	5970	39	7	0 - 26	1892	19	35	2 - 77
1990	5380	39	7	0 - 55	2071	23	34	2 - 82
1991	4563	31	5	0 - 23	1738	25	24	0 - 82
1992	4259	32	5	0 - 24	1489	22	26	0 - 71
1993	3952	27	4	0 - 22	1207	19	20	0 - 64
1994	3239	18	4	0 - 19	1664	18	23	0 - 75
1995*	3553	27	4	0 - 20	1061	18	26	0 - 71
1996*	2650	28	7	0 - 54	1443	23	31	0 - 82

* In 1995 and 1996 the results are presented for the two periods separated at 31 August.

Table 3.3.7.4 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	1996
Total run						
(excl. ranched)	2344	2570	3253	2064	1527	1099
No. escapees	3	24	18	54	6	2
% in sample	0.13	0.93	0.55	2.62	0.39	0.18

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

	Ireland[1]						UK (Northern Ireland)[1]				UK (Scotland)[2]	
	Burrishoole	Corrib		Dee	Itchen	Test	River Bush				North Esk	
	net	net	net	rod	rod	rod	net	net	net	net	In-river netting	
Year	HR	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	-	45	29	89	60	92	83	25	26
1990	52	31	45	-	51	36	61	38	63	70	37	37
1991	65	19	19	6	45	26	65	43	57	46	10	15
1992	71	24	28	16	27	25	56	33	74	75	28	27
1993	71	31	82	13	42	28	41	12	67	71	25	18
1994	73	50	0	17	50	32	-	40	71	64	19	18
1995	84	50	18	9	27	28	67	42	69	-	14	12
1996[3]	81	52	75	-	56	23	-	-	81	77	19	10
Mean												
1986-95	74	37	30	12	41	30	64	39	74	69	26	26
1990 - 94	73	35	29	12	38	28	57	34	68	64	19	18

[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.
'-' = no data

Continued...........

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

	Iceland[1]	Norway[2]							Sweden[3]		Russia[1,6]		
	Ellidaar	Drammen			Imsa				Lagan		Ponoy	Kola	Tuloma
	rod	rod	net		net		net		net		rods	rods and nets	
Year	W	W/HR	HR[4]		W		HR[4]		HR [4]		W	W+HR	W
	1SW		1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	all sea ages		
1985	40	33	57	-	73	94	81	100	81	-	47	90	47
1986	34	50	81	50	79	82	78	90	93	82	50	77	50
1987	54	44	64	52	56	95	83	95	78	55	48	91	49
1988	45	53	70	47	51	80	78	91	73	91	77	87	51
1989	41	35	40	59	65	74	44	65	76	86	78	84	50
1990	41	33	23	40	42	42	47	68	80	82	50	80	50
1991	37	28	54	59	37	72	50	66	91	92	20	58	48
1992	48	46	-	51	61	76	74	91	73	98	11	77	45
1993	41	45	20	-	53	80	85	89	89	82	10	79	39
1994	49	42	42	34	58	80	70	94	70	100	0 [8]	73	42
1995	43	53	32	40	-	86	57	88	58	70	3 [8]	77	49
1996[5]	56	47	10	37	66	-	80	87	62	78	>3 [8]	66	43
Mean													
1986-95	43	43	47	48	56	77	67	84	78	84	43	78	47
1991- 95	44	43	37	46	52	79	67	86	76	88	14	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 and in 1994-96 on mark-recovery estimates.
[4]HR in R. Drammen, R. Imsa and R. Lagan are pooled groups of 1+ and 2+ smolts.
[5]Provisional figures.
[6]Net only.
[8] Commercial fisheries on the Ponoy were closed in 1993 and catch-and-release rod fishing was introduced.
W = Wild
HR = Hatchery reared.
'-' = no data

Reporting rates for external tags:

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

Table 3.4.1.1 Conservation reference levels, estimated numbers of spawners and egg deposition and fraction of reference levels attained in rivers in the NEAC area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
FRANCE		**River Scorff**				
Egg deposition requirement:			**0.95**			
Observed:						
1994	624		1.61			1.69
1995	908	50	1.62			1.71
1996	654	102	1.38			1.45
		River Nivelle				
Egg deposition requirement:			**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
1996	171	43	0.671			3.05
IRELAND		**River Burrishoole**				
Spawner/egg deposition requirement:						
	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	500		1.05	0.81		0.81
1996	405		0.85	0.66		0.66

Table 3.4.1.1 cont'd Conservation reference levels, estimated numbers of spawners and egg deposition and fraction of reference levels attained in rivers in the NEAC area.

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
UK(ENG. & WALES)	**River Dee**					
Egg deposition requirement:			**15.30**			
Observed:						
1992	2461	1147	11.24			0.73
1993	6425	1509	23.89			1.56
1994	3206	885	11.80			0.77
1995	3442	1087	13.69			0.89
1996			12.81			0.84
UK(N.IRELAND)	**River Bush**					
Egg deposition requirement:			**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
1996			1.32			0.57
UK(SCOTLAND	**North Esk**					
Spawner/egg deposition requirement:						
	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
1996	5576	2364	24.64	2.39	1.43	1.93

Table 3.4.1.1 cont'd Conservation reference levels, estimated numbers of spawners and egg deposition and fraction of reference levels attained in rivers in the NEAC area.

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
<u>RUSSIA</u>		<u>River Tuloma</u>				
Female spawner and egg deposition targets:						
	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
1996	201	918	11.53	0.24	0.26	0.27

Table 3.4.1.2 Status of stocks in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations) (p = 0.1 taken as significance level)

Type of data	Test No.	Rivers (Countries)	Life stage	Period (years)	'p' value	Trend
Section 3.4.1 Egg deposition	6.	Bush (UK NI), North Esk (UK Scot), Nivelle (Fra), Burrishoole (Ire), Tuloma (Rus)	Eggs	10	>0.1	Nt
	7.	Bush (UK NI), North Esk (UK Scot), Nivelle (Fra), Burrishoole (Ire), Tuloma (Rus)	Eggs	5	0.02	**Dn**
Section 3.4.2 Smolt counts	8.	Oir (Fra), Imsa + Orkla + Halselva (Nor), Burrishoole (Irl), Bush (UK NI),North Esk + Girnock (UK Scot),	Smolts	10	>0.1	Nt
	9.	Oir (Fra), Imsa + Orkla (Nor), Burrishoole (Irl), Bush (UK(NI)),North Esk , Girnock + Baddoch (UK Scot), Hogvadsan (Swe),Ellidaar (Ice), Ylapulmankijoki +Tsarsjoki (Fin)	Smolts	5	>0.1	Nt
Section 3.4.3 Adult counts	10.	Burrishoole (Irl), Usk + Test + Kent + Frome + Itchen (UK E&W), North Esk, Girnock + Baddoch (UK Scot), Bush, Mourne (UK NI), Imsa + Halselva (Nor),Ellidaar (Ice), Hogvadsan (Swe), Oir + Nivelle + Bresle (Fra)	Adults	10	>0.1	Nt
	11.	Burrishoole (Irl), Usk + Test + Kent + Leven + Itchen (UK E&W), North Esk, Girnock + Baddoch + West Water (UK Scot), Bush, Mourne (UK NI), Imsa + Halselva (Nor),Ellidaar (Ice), Hogvadsan (Swe), Oir, Nivelle (Fra)	Adults	5	>0.1	Nt
	12.	Tuloma + Ponoy + Kola + Zap Litca + Yokanga + Varsuga (Russia)	Adults	30	0.006	**Up**
	13.	Tuloma + Ponoy + Kola + Zap Litca + Yokanga + Varsuga (Russia)	Adults	20	0	**Up**
	14.	Tuloma + Ponoy + Kola + Zap Litca + Yokanga + Varsuga (Russia)	Adults	10	0.067	**Dn**
	15.	Tuloma + Ponoy + Kola + Zap Litca + Yokanga + Varsuga + Keret (Russia)	Adults	5	>0.1	Nt
Section 3.4.4 Wild smolt survival	16.	Corrib (Irl), Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot), Elidaar (Ice)	1SW return to homewaters	10	0.049	**Dn**
	17.	Corrib (Irl), Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot), Elidaar (Ice)	1SW return to homewaters	5	>0.1	Nt
	18.	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	10	0.008	**Dn**
	19.	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	5	>0.1	Nt
Section 3.4.4 Hatchery smolt survival	20.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	10	0.01	**Dn**
	21.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	5	>0.1	Nt
	22.	Kollafjordur (Ice), , Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	10	>0.1	Nt
	23.	Kollafjordur (Ice), Imsa + Drammen (Nor), Lagan (Swe)	2SW return to	5	>0.1	Nt

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

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

Year	Finland							Norway			Sweden
	River Teno	River[1] Inarijoki	River[1] Utsjoki	River[2] Ylapulmankijoki	River[2] Tsarsjoki	River[2] Karigasjoki	River[2] Kuoppilajoki	River Halselva	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 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			788	1,194	-	882
1990	35.3	51.1	101.5	3,058	2,615	2,576		812	1,822	323,000	1,042
1991	40.7	53.2	32.3	2,447	1,828	1,349	739	1,377	1,995	243,000	1,235
1992	25.8[5]	48.2	51.2	3,538	4,219	435	257	865	1,500	262,534	1,247
1993	34.0	41.5	66.7	2,825	3,078	189[5]	70	613	398	297,264	1,305
1994	50.8	60.9	96.9	1,268	2,794	706	142	494	-	165,875	993
1995	45.7	40.5	63.5	-	-	-	-	497	338	174,677	1,525
1996	32.3	27.1	48.7	-	-	-	-	558	682	162,522	795
Mean 91–95	39.4	48.9	62.1	-	-	-	-	769	1,058	228,670	1,261

[1] Major tributary of River Teno
[2] Tributary of River Teno. Smolt traps out of commission since 1995.
[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 3.4.2.1 (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]	1,312	1,245	5,376	18,442	11.3				-	2,091	
1987	-		11,039[9]	363	-	3,817	21,994	10.3				199,000	1,132	
1988	23,000		9,946[9]	419	-	6,554	22,783	8.9				-	2,595	
1989	22,500	14,642	6,658[9]	830	-	6,563	17,644	16.2				141,000	1,360	
1990	24,000	11,115	2,505[9]	808	-	5,968	17,133	5.6	2.42	10.86	19.21	175,000	2,042	1,907
1991	22,000	9,300	5,287[9]	202	-	3,804	18,218	12.5	4.87	12.04	6.4	236,000	1,503	2,582
1992	27,700	19,100	3,452	672	1,160	6,926	10,021	13.0	1.08	6.74	5.62	-	2,572	2,029
1993	18,000	-[11]	2,640	226	1,700	5,429	11,583[10]	7.8	3.13	6.93	7.37	-	2,147	-
1994	14,500	-[11]	8,092[9]	539		5,971	14,145	11.5	3.63	15.42	5.32	148,000	1,223	1,280
1995	18,000	6,750	2,841	733	2,400	5,998	5,718	8.5	0.51	3.56	4.33	138,000	2,056	1,789
1996			5,068	1,003	1,300	5,854	1,244	9.9	2.19	-	10.74	162,000	1,636	1,627
Mean 91–95	20,040	11,717	4,462	474	1,753	5,626	11,937	10.7	2.6	8.9	5.8	174,000	1,900	1,920

[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.
[9] Influenced by enhancement (fry releases).
[10] Minimum estimate due to severe flooding.
[11] Smolt counts too small for estimate.

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

	Iceland	Norway	Norway	Sweden	Russia	Russia	Russia	Russia	Russia	Russia	Russia
Year	River Ellidaar	River Halselva	River Imsa	River Högvads ån	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	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	52	9	1475	5470	137419	3427	21212	6300	3468	1498
1988	4435	77	44	1283	8069	72528	3294	20620	5203	2270	575
1989	4329	64	83	480	8413	65524	3531	19214	10929	2850	2613
1990	3383	68	67	879	11594	56000	2520	37712	13383	3376	1194
1991	3020	89	43	534	7174	63000	690	21000	8500	1704	2081
1992	2917	35	70	345	5476	61300	536	26600	14670	5208	2755
1993	3363	18	39	603	4520	68300	687	26800	11400	2600	2267
1994	2298	29	-	640	3320	77800	753	20500	9730	2500	2100
1995	2509	9	-	156	4737	42290	1066	23000	6051	1153	1916
1996	2170	25	2	249	4430	67900	391	22400	7700	2700	2330
Mean 91–95	2821	36	51	456	5045	62538	746	23580	10070	2633	2224

Continued....

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

Year	Ireland Burrishoole Total trap	UK (E&W) Usk Counter	UK (E&W) Frome Counter	UK (E&W) Test Counter + catch	UK (E&W) Itchen Counter + catch	UK (E&W) Kent Counter	UK (E&W) Leven Counter	UK (NI) Bush Total trap	UK (NI) Faughan Counter	UK (NI) Mourne Counter	UK (Scotl.) N. Esk Counter	UK (Scotl.) West Water Counter	UK (Scotl.) Girnock Total trap	UK (Scotl.) Baddoch Total trap	France Nivelle Trap est.	France Oir Trap est.	France Bresle 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	7446	4093	1507	1336			2832	3228	7572	11243		187	150	130	235	89
1989	662	1719	3186	1730	791	1137		1029	8287	9497	11026		108	191	263	235	214
1990	231	2532	1880	790	367	2216		1850	6458	11541	4762		58	144	291	121	126
1991	547	2746	805	538	152	1736	667	2341	4301	7987	9127	2962	97	118	184	46	211
1992	360	3108	900	614	357	1816	394	2546	7375	7420	10795	2809	73	88	234	45	243
1993	528	5197	1182	1249	852	1526	469	3235	8655	17855	10887	2699	42	63	472	161	74
1994	516	9120	1078	775	374	2072	562	2010	7439	19908	11341	2976	81	149	317	-	77
1995	561	6189	1016	647	880	2762	329	1521	5838	7547	9864	2391	124	46	195	128	85
1996	405	6926	1353	623	437	3246	387	1087	1329[2]	5435	7993	2656	68	85	214	165	40
Mean 91–95	502	5272	996	764	523	1982	484	2331	6722	12143	10403	2767	83	92	280	95	138

[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) count for 1996 not believed to be accurate.

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

Smolt	Iceland[1]			Ireland		UK (N.Ireland)[8]	Norway[2]		UK (Scotland)[2]			France		
migration	Ellidaar	R.Vesturdalsa[4]		River Corrib	River Corrib	R. Bush	R. Imsa		North Esk			Oir[5]	Nivelle[6]	Bresle
year	1SW	1SW	2SW	1SW	2SW	1SW[3]	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20													
1980				9.4	1.6									
1981				11.8	3.8		17.3	4	13.7	6.9	0.3			
1982				15.6	2.7		5.3	1.2	12.6	5.4	0.2			
1983		2		10.6	1.2		13.5	1.3	-	-	-	3.2		8.5
1984				19.8	1.7		12.1	1.8	10	4.1	0.1	7.7		16.3
1985	9.4			15.4	1.4		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				12.0	1.0	35.1	17.3	5.6	13.9	3.4	0.1	9.3	2.6	-
1988	12.7			12.4	0.5	36.2	13.3	1.1	-	-	-	2.3	2.4	-
1989	8.1	1.1	2	5.3	1.0	25.0	8.7	2.2	7.8	4.9	0.1	2.4	3.5	-
1990	5.4	1	1	4.4	0.6	34.7	3.0	1.3	7.3	3.1	0.2	6.1	1.8	-
1991	8.8	4.2	0.6	5.6	0.1	27.8	8.7	1.2	11.2	4.5	-	13.2	9.2	-
1992	9.6	2.4	0.8	5.9	-	29.0	6.7	0.9	-	-	-	4.4[7]	8.9	6.9[7]
1993	9.8	-	-	9.0	0.2	-	15.6		-	-	-	8.3[7]	8.3[7]	10.3[7]
1994	9.0	-	-	7.8	0.1	27.1	-	-	17.2	2.2	-	3.7	7.1[7]	7.5[7]
1995	9.4	1.6		6.7		n/a	1.8	-	11.3				1.8	
Mean 1991-95	9.3	2.1	1.1	7.0	0.2	29.1	7.2	1.3	11.0	3.7	0.2	7.1	7.1	8.2

[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.
[7] Incomplete returns.
[8] Assumes 30% exploitation in trap fishery.

Table 3.4.4.2 Estimated survival of wild smolts (%) into freshwater for various monitored rivers in the NE Atlantic area.

Smolt year	Iceland[1]			Ireland		Ireland	UK(N.Ireland)		Norway[2]		UK (Scotland)[1]			France		
	River Ellidaar	River Vesturdalsa[5]		River Corrib[8]		River Burrishoole	River Bush		River Imsa		North Esk[4]			Oir[3]	Nivelle[6]	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	1.8	5.4	9.5	0.9	2.1	0.3	4.2	2.0	0.2	-	-	-
1982	-	-	-	5.7	1.6	5.8	7.8	0.8	0.7	0.1	4.9	2.2	0.2	-	-	-
1983	-	2.0	-	3.2	0.7	3.4	1.9[3]	1.7	2.4	0.1	-	-	-	3.2	-	5.5
1984	-	-	-	4.5	0.7	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	0.8	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	0.4	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	0.1	10.1	3.9	0.8	4.5	0.6	-	-	-	2.3	2.2	-
1989	8.1	1.1	2.0	2.5	0.4	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	2.5	0.1	9.5	12.0	2.2	3.4	0.2	5.2	2.3	0.2	13.2	9.2	-
1992	9.6	2.4	0.8	2.7	-	7.6	16.8	2.0	3.1	0.2	-	-	-	4.4	8.3	5.8
1993	9.8	-	-	1.9	0.2	9.5	15.1	2.0	7.0	-	-	-	-	8.3	7.2	6.3
1994	9.0	-	-	1.8	0.1	9.4	8.9	0.7	-	-	4.9	1.9	-	3.7	1.8[7]	4.3[7]
1995	9.4	1.6	-	1.9	-	6.8	n/a	-	0.6	-	5.1	-	-	-	-	-

[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.
[8] Assumes 30% exploitation in trap fishery.

Table 3.4.4.3 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.

Smolt year	Iceland[1] Kollafjordur		Ireland[1] R. Burris-hoole[3]	N. Ireland[1] R. Bush (1SW)		Norway[2] R. Imsa		Norway[2] R. Drammen		Sweden[2] R. Lagan	
	1SW	2SW	1SW	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	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	5.1	0.7	7.5	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	0.9
1994	3.34	0.1	11.5	1.6	-	6.2	0.6	1.2	0.9	4.0	1.2
1995	3.8		16.8	3.1	24	0.4	-	0.5	-	2.7	-

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

Table 3.4.4.4 Estimated survival of hatchery smolts (%) to adult return to freshwater, for various monitored rivers and experimental facilities in the NE Atlantic area.

	Iceland[1]		Ireland[1]	N. Ireland[1]		Norway[2]				Sweden[4]	
Smolt year	Kollafjordur		R.Burri-shoole[3]	R. Bush (1SW)		R. Imsa		R. Drammen		R. Lagan	
	1SW	2SW	1SW	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	0.5	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	1.4	2.2	0.8	0.1	-	-	-	-
1992	5.1	0.7	2.2	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	0.6
1994	3.34	0.1	1.8	0.5	-	2.6	0.1	0.8	0.6	3.0	0.6
1995	3.8	-	3.1	0.57	0.55	0.1	-	0.4	-	1.4	-

[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 fishery in 1994 and 1995 : 49% and 27%.

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

		1991/92	1992/93	1993/94	1994/95	1995/96
Expected No. fish **landed** if fishery operated =		87,484	87,484	87,484	87,484	87,484
Discard rate =		8.8%	9.4%	14.4%	15.1%	11.9%
Discard mortality =		80.0%	80.0%	80.0%	80.0%	80.0%
Expected No. fish **killed** if fishery operated =		94,237	94,745	99,258	99,932	96,960
No. fish killed in research fishery =		9,350	9,099	3,035	4,187	300
Total number of fish saved per year =		84,887	85,646	96,223	95,745	96,660
Proportion of farmed fish in catch =		37.0%	27.0%	17.0%	19.0%	19.0%
Number farm escapees saved =		31,408	23,125	16,358	18,191	18,365
Number of wild fish saved =		53,479	62,522	79,865	77,553	78,295
Sea age composition of wild fish:	1SW	4.0%	12.0%	16.0%	10.6%	10.7%
	2SW	83.0%	61.0%	64.0%	80.8%	72.2%
	2SW+	13.0%	27.0%	20.0%	8.6%	17.2%

		1992	1993	1994	1995	1996
Additional salmon expected to have returned:	**1SW**	**1,618**	**5,852**	**9,967**	**6,412**	**6,504**
	MSW	**40,327**	**55,466**	**64,207**	**67,936**	**71,389**
Estimated MSW returns to **all European** homewaters:	Mean est.	1,284,725	1,225,466	1,240,996	1,198,615	1,036,234
% MSW returns derived from suspension of commerial fishing at Faroes: (Assuming all from Europe)		3%	5%	5%	6%	7%
Estimated MSW returns to **Northern European** homewaters:	Mean est.	600,124	605,786	528,930	510,744	538,816
% MSW returns derived from suspension of commerial fishing at Faroes: (Assuming 65% from N. Europe)		4%	6%	8%	9%	9%

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Table 3.5.2 Results of Non-parametric Ratio analysis to examine changes in homewater catches between 1987-91 and 1992-96.

Type of data	Area considered	Periods compared	p value	Effect
1SW catches in Northern Europe	Finland, Sweden, Norway	1987-91 vs 1992-96	0.013	**Lower catch**
	Norway only	1987-91 vs 1992-96	0.004	**Lower catch**
1SW catches in Southern Europe	Ireland (total catch), UK(Scot), UK (E&W), France	1987-91 vs 1992-96	0.02	**Lower catch**
MSW catches in Northern Europe	Finland, Sweden, Norway	1987-91 vs 1992-96	0.304	Not sig.
	Norway only	1987-91 vs 1992-96	0.279	Not sig.
MSW catches in Southern Europe	UK (Scot), UK (E&W), France	1987-91 vs 1992-96	0.05	**Lower catch**
Russian adult counts All ages	R. Varzuga, Ponoy, Kola, Yokanga, Zap Litca, Tuloma	1987-91 vs 1992-96	0.162	Not sig.

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Table 3.6.1 Area-by-area breakdown of the number of Atlantic salmon rivers, the number of rivers that presently have biological reference points (BRP), and the number of rivers which will probably have BRPs established in the next five years. (ND in the Table indicates we could not obtain the information.)

Area	No. Rivers	No. with BRP	No. to have BRP in next 5 yrs
Russia	~178 [a]	1	3
Finland	2 [b]	0	1 [c]
Norway	669 [d]	1 [e]	1
Sweden	~10 [f]	0	1
Iceland	~100	0	2
UK(Scotland)	~400	1	1
UK(N Ireland)	~11 [g]	1	11
Ireland	133	1	133
UK(England/Wales)	76	76 [h]	76
France	43	37	43
Spain	18	ND	ND
Totals	**~1640**	**42**	**272**

a. Rivers with main stem channels > 5 km
b. Both rivers are shared with Norway.
c. Reference points for a tributary within one of the 2 systems will be established.
d. Includes 41 rivers where populations are extinct, 54 rivers with threatened populations, 147 rivers with vulnerable populations, 242 rivers with small (< 100 adults returning) populations, 98 rivers with healthy, large populations, 9 *Gyrodactylus* impacted rivers, 68 rivers where populations are present but nothing is known of their status, and 10 which may have transient populations.
e. Values are preliminary
f. Includes 1 river whose population is maintained exclusively by stocking reared fish, and 8-10 wild rivers along Sweden's west coast, some of which are enhanced. Rivers draining to the Baltic are excluded.
g. This includes 3 major catchments which are jointly managed by UK(N Ireland) and Ireland, 4 major Glen rivers, the Bush where reference points have been established, and a number of other significant salmon rivers. We have not counted as separate rivers all of the tributaries within major catchments which will be managed with their own reference points. However, this tributary approach is a major thrust of the management effort.
h. Preliminary reference levels have been established and will be reviewed and updated in the next 4 yrs.

Table 3.6.2 **Details of preliminary salmon spawner escapement requirements for rivers in UK(England and Wales) established by the Environment Agency (Environment Agency, 1996).**

	Area	target	target /el (eggs (millions))				Vals calcd for 1SW&MSW				1995		diff	failure
River	Ha	eggs	eggs	% 1SW	1SW	MSW	Fec.	Females	No.	No.	Total	total	vs.	in last
	(GIS)	$100m^{-2}$	million				(mean)	(mean %)	1SW	MSW	spawn's	eggs	ref.pt.	3 yrs
Coquet	144.0	324	4.67	72.8	3.4	1.3	5723	54	1467	248	1715	3.90	0.8	N
Tyne	294.3	418	12.30	27.2	3.3	9.0	6966	61	1446	1748	3194			
Wear	141.2	364	5.14	57.2	2.9	2.2	6210	56	1270	429	1700			
Tees	318.9	302	9.63	27.2	2.6	7.0	6940	62	1132	1369	2501			
Esk-Yorks	27.4	468	1.28	61.2	0.8	0.5	6087	59	339	97	436			
Thames	1286.4	269	34.60	42.6	14.7	19.9	6730	54	6369	3878	10246			
Test	80.0	425	3.40	52.6	1.8	1.6	4673	58	772	315	1087	0.90	2.5	Y
Itchen	35.2	184	0.65	64.7	0.4	0.2	5949	56	181	45	226			
Avon-Hants	360.0	237	12:46	67.3	5.7	2.8	5966	52	2481	545	3025	2.80	5.7	Y
Stour	234.0	218	5.10	36.5	1.9	3.2	6616	64	804	632	1437			
Piddle	25.4	194	0.49	36.5	0.2	0.3	6616	64	78	61	139			
Frome	64.9	257	1.67	56.3	0.9	0.7	6174	58	405	142	548	7.90	-6.2	N
Axe	56.8	247	1.40	100.0	1.4	0.0	4812	53	606	0	606			
Exe	206.6	343	7.09	100.0	7.1	0.0	4812	45	3062	0	3062			
Teign	69.8	383	2.67	77.1	2.1	0.6	5566	55	890	119	1010			
Dart	68.3	401	2.74	77.8	2.1	0.6	5524	57	921	119	1039			
Avon-Bristol	17.8	294	0.52	78.8	0.4	0.1	5438	62	178	22	200			
Erme	10.3	300	0.31	100.0	0.3	0.0	4812	63	134	0	134			
Yealm	8.4	297	0.25	69.3	0.2	0.1	5659	66	75	15	90			
Plym	17.2	436	0.75	38.4	0.3	0.5	6542	65	125	90	215			
Tavy	22.6	312	0.70	81.5	0.6	0.1	5396	57	248	25	274			
Tamar	197.0	293	18:31:49	86.1	5.0	0.8	5322	49	2147	157	2304			
Lynher	17.1	378	0.65	92.4	0.6	0.0	5049	58	259	10	268			
Looe	13.3	207	0.28	63.9	0.2	0.1	5292	67	76	19	95			
Fowey	34.2	430	1.47	79.5	1.2	0.3	5445	59	505	59	564			
Camel	3.7	338	0.12	60.4	0.1	0.0	6003	60	32	10	42			
Taw	175.2	323	5.66	76.8	4.3	1.3	5630	52	1878	256	2134			
Torridge	155.3	291	4.52	67.1	3.0	1.5	5905	55	1310	290	1600			
Lyn	27.0	556	1.50	100.0	1.5	0.0	4812	60	647	0	647			
Severn	898.1	190	17.06	26.0	4.4	12.6	8875	50	1917	2465	4382			
Wye	1402.0	245	8:22	17.0	5.8	28.5	6681	64	2523	5566	8089	19.20	15.1	Y
Usk	241.6	423.00	10.22	79.2	8.1	2.1	5575	50	3497	415	3912			
Taff	75.9	436	3.31	91.4	3.0	0.3	5117	51	1306	56	1362			
Ogmore	34.5	253	0.87	94.5	0.8	0.0	4994	54	357	9	366			
Afan	16.9	450	0.76	100.0	0.8	0.0	4812	61	329	0	329			
Neath	37.1	419	1.55	92.2	1.4	0.1	5069	55	619	24	642			
Tawe	45.1	379	1.71	81.1	1.4	0.3	5413	57	599	63	662			
Loughor	35.1	289	1.02	100.0	1.0	0.0	4812	56	439	0	439			
Gwendraeth	26.98	214	0.58	100.0	0.6	0.0	4812	57	249	0	249			
Tywi	283.3	377	10.68	65.5	7.0	3.7	5985	53	3023	719	3742			
Taf	87.6	276	2.42	74.3	1.8	0.6	5168	58	776	121	898			
Cleddau-E	58.55	296	1.73	69.8	1.2	0.5	5737	59	523	102	625			
Cleddau-W	63.37	213	1.35	100.0	1.3	0.0	4812	55	583	0	583			
Nevern	37.4	344	1.28	75.6	1.0	0.3	5528	62	420	61	481			
Teifi	296.0	413	5:23:43	61.9	7.6	4.7	6076	55	3269	909	4179	9.70	2.5	N
Aeron	34.6	417	1.44	87.7	1.3	0.2	5195	58	547	35	582			
Ystwyth	46.1	397	1.83	94.0	1.7	0.1	5004	56	744	21	765			
Rheidol	5.0	426	0.21	89.2	0.2	0.0	5155	57	83	5	87			
Dyfi	204.5	419	8.57	82.3	7.1	1.5	5414	53	3046	296	3342			
Dysinni	44.8	287	1.29	95.0	1.2	0.1	4964	60	528	13	541			
Mawddach	56.6	312	1.77	76.3	1.3	0.4	5095	58	582	82	664	1.30	0.5	N
Artro	8.8	423	0.37	100.0	0.4	0.0	4812	62	161	0	161			
Dwyryd	24.6	520	1.28	86.3	1.1	0.2	5209	63	477	34	511			
Glaslyn	29.6	337	1.00	82.9	0.8	0.2	5327	60	358	33	391			
Dwyfawr	24.6	390	0.96	83.1	0.8	0.2	5313	61	345	32	377			
Llyfni	10.3	469	0.48	90.7	0.4	0.0	5071	65	188	9	197			
Gwyrfai	10.6	372	0.39	30.1	0.1	0.3	6715	67	51	54	105			
Seiont	16.6	380	0.63	72.3	0.5	0.2	5602	64	197	34	231			
Ogwen	20.5	465	0.95	89.1	0.9	0.1	5131	62	367	20	388			
Conwy	141.5	452	6.40	77.5	5.0	1.4	5549	55	2142	281	2423			
Clwyd	140.8	417	5.87	89.8	5.3	0.6	5165	52	2278	117	2395			
Dee	620.0	248	9:01	64.8	10.0	5.4	5384	56	4305	1057	5361	14.60	0.8	Y
Ribble	157.9	413	6.52	73.2	4.8	1.7	5631	52	2062	341	2403			
Wyre	46.4	264	1.22	97.9	1.2	0.0	4883	54	518	5	523			
Lune	423.0	327	13.83	75.4	10.4	3.4	5596	52	4506	664	5170	10.20	3.6	N
Kent	42.2	399	1.69	80.9	1.4	0.3	4541	58	589	63	652			
Leven	45.8	249	1.14	88.7	1.0	0.1	5181	56	437	25	463	0.90	0.2	Y
Crake	16.3	243	0.40	88.7	0.4	0.0	5181	56	152	9	161	0.40	0.0	Y
Duddon	11.1	402	0.45	95.5	0.4	0.0	4946	62	184	4	188			
Esk	13.8	401	0.55	56.2	0.3	0.2	6222	56	134	47	182			
Irt	19.8	317	0.63	94.5	0.6	0.0	4961	66	256	7	263			
Ehen	32.3	335	1.08	95.7	1.0	0.0	4946	59	447	9	456			
Derwent	135.4	369	5.00	61.4	3.1	1.9	6063	56	1325	376	1702			
Ellen	16.8	322	0.54	100.0	0.5	0.0	4812	60	233	0	233			
Eden	436.9	464	20.27	76.3	15.5	4.8	6601	48	6683	938	7621			
Esk-Border	143.51	440	6.3	66.1	4.2	2.14	5764	65	1803	418	2221			
Total									85995	26239	112234			

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Table 3.6.3. Biological Reference Points ir. ance. MBAL (Spawning Target), Total Allowable C h and % of the TAC caught in 1996

river	production area	MBAL eggs (1)	MBAL spawners	possible harvest (2)	provisionnal TAC (3)	provisionnal TAC	final TAC (4)	number of catches declared		estimated catches	number of eggs taken	% of TAC taken
	100m2	million	No fish	million eggs	million eggs	No fish	million eggs	1SW	MSW	1SW+MSW	million eggs	
Bresle		not available								5		
Arques		not available								5		
Sienne	1372	0.65		0.45	0.16	67	0.24	3	10	13	0.06	25
See	1121	0.53		0.36	1.09	248	1.63	45	135	212	1.01	62
Selune	1113	0.53		0.36	0.39	106	0.58	86	48	159	0.52	90
Couesnon	974	0.46		0.32	0.11	46	0.17	0	2	2	0.01	6
Leff	505	0.24		0.16	0.18	42	0.27	4	5	12	0.05	19
Trieux	1559	0.74		0.51	0.55	174	0.82	53	45	101	0.36	44
Jaudy	1033	0.49		0.34	0.36	96	0.54	1	1	2	0.00	0
Leguer	1924	0.91		0.63	0.67	183	1.01	55	46	110	0.40	40
Yar	281	0.13		0.09		26						
Douron	452	0.21		0.15	0.26	67	0.39	45	36	90	0.31	79
Dourduff	322	0.15		0.10	0.11	30	0.17	1	0	1	0.00	0
Jarlot	396	0.19		0.13		37						
Queffleuth	404	0.19		0.13		38						
Penze	581	0.28		0.19	0.31	67	0.46	16	20	45	0.16	35
Fleche	352	0.17		0.11		33						
Aber-Wrac'h	404	0.19		0.13	0.14	38	0.21	1	0	4	0.00	0
Aber Ildut	430	0.20		0.14		40						
Aber Benoit	415	0.20		0.13		29						
Elorn	1139	0.54		0.37	0.81	184	1.22	122	87	230	0.79	65
Mignonne	385	0.18		0.13	0.13	36	0.20	3	11	16	0.08	40
Camfrout	237	0.11		0.08	0.08	18	0.12	3	5	10	0.04	33
Faou	177	0.08		0.06	0.06	16	0.09	1	1	3	0.01	11
Aulne	7157	3.40		2.33	2.51	700	3.76	485	179	720	2.02	54
Goyen	489	0.23		0.16	0.18	55	0.27	19	34	75	0.29	107
Odet-Steir-Jet	2142	1.02		0.70	1.39	334	2.08	54	78	160	0.58	28
Aven	749	0.36		0.24	0.44	105	0.66	59	20	83	0.22	33
Belon	255	0.12		0.08		24						
Isole		not available				not available				9		
Elle	3420	1.62		1.11	1.20	282	1.80	63	96	142	0.70	39
Laita		not available				not available				21		
Scorff	2000	0.95		0.65	0.87	269	1.30	56	21	96	0.31	24
Blavet	3508	1.67		1.14	1.23	402	1.84	106	64	195	0.66	36
Kergroix	362	0.17		0.12	0.09	24	0.14	0	5	8	0.05	36
Loire	48500	23.04	3600 (5)	0.00		fishing closed						
Dordogne		not available		0.00		fishing closed						
Garonne		not available		0.00		fishing closed						
Adour	30600	14.54	3200 (5)	?		not applied in 1996				1476		
Nivelle	461	0.22	76 (5)	0.15		not applied in 1996				6		
Rhine	11300	5.37	1483 (5)	0.00		fishing closed						

Number of salmon rivers: 43
Number of BRP available: 37 86%

(1) Prod area x 4.75 eggs/m2
(2) Prod. area x 3.25 eggs/m2 (8 eggs/m2 (average max. prod.) - 4.75eggs/m2)
(4) TAC x 1.5 after July 1, the year's situation being considered good enough, except for chronically over-exploited stocks where provisionnal TAC and final TAC are identical
(5) provisional figures

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Table 3.7.2.1 Estimated pre-fishery abundance of maturing and non-maturing 1SW recruits in the NEAC Area (1970-96) with 95%iles of @Risk simulations .

Year	Total NEAC Area						Southern European Area						Northern European Area					
	Maturing 1SW			Non-maturing 1SW			Maturing 1SW			Non-maturing 1SW			Maturing 1SW			Non-maturing 1SW		
	'-5%	Mean	'+95%	'-5%	Mean	'+95%	'-5%	Mean	'+95%	'-5%	Mean	'+95%	'-5%	Mean	'+95%	'-5%	Mean	'+95%
1971				2,063,879	2,313,961	2,593,711				1,438,480	1,634,821	1,874,733				590,656	665,897	754,995
1971	3,690,930	4,230,384	4,897,917	2,326,509	2,624,629	2,978,700	2,920,924	3,458,488	4,141,074	1,547,669	1,785,492	2,074,059	654,440	788,728	938,395	726,577	824,340	939,932
1972	3,963,670	4,518,144	5,208,072	2,601,689	2,924,126	3,305,908	3,003,073	3,549,364	4,215,026	1,656,456	1,912,254	2,224,190	811,683	984,356	1,174,938	885,714	996,257	1,125,062
1973	4,385,547	5,009,943	5,798,376	2,230,929	2,501,604	2,822,877	3,258,210	3,871,693	4,633,043	1,378,697	1,591,553	1,852,481	964,184	1,155,804	1,365,127	793,266	896,892	1,017,642
1974	4,409,045	5,036,018	5,814,116	2,471,953	2,764,074	3,101,475	3,365,077	3,971,516	4,740,573	1,556,777	1,787,016	2,068,679	901,410	1,081,939	1,278,475	861,094	962,944	1,080,200
1975	4,215,415	4,769,221	5,442,241	1,744,727	1,954,145	2,182,262	3,177,628	3,718,088	4,357,745	915,389	1,074,372	1,268,581	893,025	1,063,681	1,252,837	763,236	862,891	979,790
1976	3,251,497	3,686,372	4,204,359	1,841,600	2,093,703	2,378,965	2,303,564	2,704,322	3,195,793	1,099,742	1,303,814	1,554,837	820,867	992,846	1,179,239	671,836	767,135	875,925
1977	3,186,447	3,635,759	4,183,862	1,605,876	1,861,139	2,162,589	2,281,014	2,706,813	3,234,038	1,045,552	1,273,330	1,554,941	773,183	940,490	1,130,286	494,801	563,059	639,660
1978	2,939,883	3,374,136	3,909,567	1,803,953	2,051,760	2,319,745	2,240,006	2,659,711	3,196,959	1,011,751	1,198,050	1,427,514	611,392	727,022	858,121	718,398	832,328	967,861
1979	3,036,858	3,464,557	4,001,817	2,073,081	2,347,860	2,660,462	1,973,685	2,353,850	2,842,067	1,080,566	1,283,146	1,531,385	923,671	1,121,332	1,340,434	923,884	1,040,353	1,175,328
1980	2,606,262	3,018,452	3,466,218	2,304,201	2,649,959	3,071,845	1,621,984	1,932,189	2,299,289	1,281,778	1,572,744	1,947,448	861,900	1,061,119	1,280,035	942,875	1,061,390	1,201,149
1981	2,405,950	2,854,831	3,382,213	1,709,787	1,964,343	2,267,071	1,651,338	2,061,645	2,562,305	839,544	1,044,786	1,310,623	635,303	769,703	921,765	811,528	907,920	1,023,355
1982	2,814,609	3,398,073	4,067,448	1,796,319	2,081,274	2,441,049	2,222,183	2,750,433	3,437,968	915,630	1,162,721	1,477,574	509,751	609,877	722,320	806,113	903,550	1,018,049
1983	3,819,631	4,437,827	5,143,028	1,506,743	1,747,869	2,023,372	2,843,056	3,392,350	4,074,763	705,630	891,128	1,126,879	830,485	999,499	1,189,854	745,487	845,117	960,458
1984	2,927,753	3,462,053	4,109,022	1,681,113	1,924,736	2,193,143	1,927,925	2,388,042	3,014,857	890,947	1,084,543	1,331,152	847,194	1,031,766	1,229,340	741,766	833,375	942,692
1985	3,347,703	3,828,824	4,355,011	1,988,164	2,336,349	2,788,310	2,259,000	2,676,742	3,202,884	1,041,401	1,347,127	1,786,549	930,226	1,115,309	1,328,980	857,549	965,844	1,091,521
1986	3,529,037	4,084,294	4,727,385	1,543,619	1,794,909	2,125,097	2,547,313	3,024,846	3,668,540	823,242	1,038,319	1,346,529	854,074	1,023,600	1,207,254	654,881	739,924	842,134
1987	2,882,823	3,341,984	3,901,008	1,532,146	1,798,500	2,145,305	1,876,762	2,267,137	2,775,553	964,992	1,209,143	1,545,103	886,588	1,033,576	1,208,974	503,244	570,938	648,835
1988	3,481,575	3,997,958	4,589,579	1,190,560	1,407,105	1,689,698	2,602,760	3,075,066	3,636,090	665,197	854,934	1,115,412	756,803	894,352	1,053,746	471,621	544,603	627,866
1989	2,947,505	3,554,946	4,346,306	1,118,535	1,322,509	1,571,811	1,923,717	2,417,022	3,144,807	551,750	724,314	950,329	928,835	1,131,279	1,391,150	512,154	593,059	687,084
1990	2,158,091	2,502,832	2,885,911	1,073,170	1,301,318	1,610,474	1,253,846	1,511,413	1,870,625	485,485	659,318	945,684	810,458	988,020	1,208,258	536,804	627,633	736,816
1991	1,782,717	2,108,060	2,469,559	1,196,041	1,478,528	1,882,214	1,001,218	1,223,640	1,547,948	580,481	796,541	1,165,784	722,413	885,318	1,109,972	561,516	666,536	786,544
1992	2,233,315	2,610,966	3,096,785	1,156,037	1,405,196	1,741,933	1,397,401	1,713,802	2,176,962	523,072	724,487	1,031,711	743,647	888,936	1,082,999	574,119	665,752	770,862
1993	2,047,603	2,392,516	2,805,973	1,151,575	1,425,562	1,821,025	1,330,158	1,608,211	2,009,408	599,247	830,090	1,205,236	655,119	774,256	918,930	494,992	585,584	690,547
1994	2,215,307	2,586,289	3,029,179	1,118,935	1,374,506	1,748,946	1,506,813	1,803,249	2,235,892	582,642	793,357	1,135,232	641,836	768,649	916,547	471,137	566,201	667,884
1995	1,992,606	2,314,378	2,768,201	971,513	1,176,762	1,458,530	1,290,196	1,569,681	1,965,059	425,641	574,029	819,744	617,454	738,174	865,585	492,545	596,638	705,500
1996	2,009,592	2,259,977	2,572,178	-	-	-	1,386,935	1,591,237	1,863,774	-	-	-	562,333	658,881	769,419	-	-	-

Table 3.7.3.1 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		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
1995/96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996/97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean 1986/87 to 95/96	<1	<1	<1	12.4	0	4.9	0	11.9	0.9	0.9	0	1.0	8.7	<1	0.0
Mean 1991/92to 95/96	0	<1	0	2.3	0	2.0	1.0	1.8	<1	<1	0	0.2	5.2	0	<1

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: 0.5
Sweden: 0.65
Elsewhere: 0.5

Table 3.7.4.1 Estimated relationship between catch at Faroes and the level of exploitation on 2SW salmon from the N Esk and Imsa.

Faroes catch (t)	Estimated level of exploitation N Esk Wild %	R.Imsa Wild & Hatchery %
50	0	4
100	0	6
150	1	9
200	1	12
250	2	14
300	2	17
350	3	20
400	3	22
450	4	25
500	4	28
550	5	31
600	5	33

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Table 3.8.1.1 Postsmolts and 1SW salmon caught in surface trawls in Norwegian and Scottish cruises in the northern North Sea and the Norwegian Sea with adjacent areas. Cruise marked with * carried out by SOAEFD (Marine Lab.) Aberdeen, all others by IMR, Bergen, Norway.

Year	Time of sampling (date to date)	Total No. of hauls	No. postsmolts caught	No. 1SW salmon	% hauls containing salmon	Area
1991	23 July / 27August	75	34	2	24	Norwegian Sea, N-East
1993	25 July / 15August	61	13	1	3	Norwegian Sea, S-E
1995 a	30May / 1 July	47	46	2	19	SW Ireland, NW Hebrides
1995 b	7 July / 1 August	60	62	4	32	Norwegian Sea , E
1995 c	30 July / 14 August	50	2	0	4	Norwegian Sea , N
1996a*	3 june / 13 June*	13*	167*	0*	38.5*	Shetland- Faroes*
1996 b	5-15 June and 3-7 July	73	66	1	19	Norwegian Sea, S-SW Scotland -Faroes
1996 c	23 June / 2 July	8	0	0	0	North Sea
1996 d	9 July / 4 August	31	2	0	9	Greenland Sea-Norwegian Sea, N
1996 e	19 July / 15 August	89	12	1	8	Norwegian Sea, E-NE
Total number 1991- 96		507	404	11		

Table 4.1.1.1. Licensed effort, quota, harvests and percent of total harvest comprised of large salmon in the Labrador and Québec commercial fisheries, 1990 to 1996.

	1990	1991	1992	1993	1994	1995	1996
Labrador							
Licensed effort	570	570	495	288	218	218	215
Quota (t)	340	295	273	178	92	73.5	55
Harvest (t)	202	120	204	112	93	55	48
Harvest (number)	60,514	40,233	56,590	34,170	24,017	19,156	15,116
% Large (by number)	45%	33%	57%	50%	64%	59%	48%
Québec (Q7 to Q9)							
Licensed effort	165	152	147	94	90	90	87
Quota (number)	29,605	28,359	23,400	15,325	15,175	15,175	12,068
Harvest (number)	19,292	19,265	19,363	14,657	13,800	13,653	11,718
Harvest (t)	63	63	63	46	43	42	32
% Large (by number)	82%	83%	80%	75%	72%	71%	61%
Québec (Q11)							
Harvest (number)	225	389	337	212	485	300	268
Harvest (t)	1	2	2	1	3	2	1

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

	% of provincial harvest			% of eastern Canada	Number of fish
	Native peoples	Recreational	Commercial		
Small salmon					
Newfoundland / Labrador	0.0[1]	83.5	16.5	54.7	47,657
Québec	0.9	60.8	38.3	13.6	11,833
New Brunswick	14.4	85.6	0.0	27.5	23,922
P.E.I.	3.8	96.2	0.0	0.5	446
Nova Scotia	10.6	89.4	0.0	3.8	3,283
Large salmon					
Newfoundland / Labrador	0.0[1]	6.3	93.7	25.8	7,756
Québec	22.6	42.6	34.8	71.2	21,405
New Brunswick	100.0	0.0	0.0	2.2	661
P.E.I.	0.0	0.0	0.0	0.0	0
Nova Scotia	100.0	0.0	0.0	0.8	244

[1] Native peoples in Conne River Newfoundland (SFA 11) did not fish in 1996 because of low returns.

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

Magaguadavic River (SFA 23, Canada)						
Year	1SW	Prop. Aqua'	MSW	Prop. Aqua'	Total	Prop. 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	540	0.90	198	0.85	738	0.89
1996	195	0.89	68	0.29	263	0.74

Three rivers of eastern Maine						
	St. Croix		Dennys		Narraguagus	
Year	Total run	Prop. Aqua'	Total run	Prop. Aqua'	Total run	Prop. Aqua'
1994	181	0.54	47	0.89	52	0.02
1995[1]	60	0.22	9	0.56	56	0.00
1996	152	0.13	31	0.68	64	0.13

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

Table 4.2.1.1. Comparison of returns of small and large salmon to monitored rivers of eastern Canada in 1996 relative to returns in 1995 and to returns in 1985 to 1995.

	Number of rivers in each category			
		Returns in 1996 relative to returns in 1995		
Size group	Total	<90%	90% to 110%	> 110%
Bay of Fundy and Atlantic coast of Nova Scotia (SFA 19 to 23)				
Small	10	3	1	6
Large	10	3	2	5
Southern Gulf of St. Lawrence and Québec (SFA 15 to 18, Q1 to Q11)				
Small	22	4	2	16
Large	22	8	2	12
Insular Newfoundland (SFA 3 to 14)				
Small	15	2	5	8
Large	15	3	2	10

		Rank of 1996 within the 1985 to 1996 period		
Size group	Number of rivers	Lowest	Median	Highest
Bay of Fundy and Atlantic coast of Nova Scotia (SFA 19 to 23)				
Small	3	9	9	8
Large	3	12	11	10
Southern Gulf of St. Lawrence and Québec (SFA 15 to 18 and Q1 to Q10)				
Small	16	12	8	1
Large	16	8	11	1
Insular Newfoundland (SFA 3 to 14)				
Small	7	8	1	1
Large	7	2	1	1

Table 4.2.2.1 Estimated numbers of 1SW returns in North America by geographic regions, 1971-96.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	32966	115382	112266	224994	9381	15993	33118	57918	11515	19525	32	199278	433844	316561
1972	24675	86362	108509	217092	7592	13322	42202	73599	9522	16915	18	192518	407309	299913
1973	5399	18897	143729	287832	10066	17719	43681	76661	14766	24823	23	217664	425954	321809
1974	27034	94619	84667	169103	10730	17939	65673	113924	26723	44336	55	214883	439975	327429
1975	53660	187809	111847	223890	11155	19307	58613	101791	25940	36316	84	261298	569197	415247
1976	37540	131391	114787	229853	12238	21323	90307	155434	36931	55937	186	291989	594124	443056
1977	33409	116931	109649	219106	11064	19434	31322	55905	30860	48387	75	216380	459838	338109
1978	16155	56542	97070	194133	10196	18131	26008	45347	12457	16587	155	162041	330895	246468
1979	21943	76800	106791	213327	12395	23165	50872	91758	30875	49052	250	223126	454352	338739
1980	49670	173845	120355	240449	17529	31828	45715	81291	49925	73560	818	284012	601790	442901
1981	55046	192662	156541	312697	23581	44516	70214	126193	37371	62083	1130	343883	739282	541583
1982	38136	133474	139951	279115	13783	25320	79858	141657	23839	38208	334	295901	618108	457004
1983	23732	83061	109378	218548	10859	19217	25335	43737	15553	23775	295	185152	388633	286893
1984	12283	42991	129235	257256	8655	16007	37694	63546	27954	47493	598	216419	427892	322155
1985	22732	79563	120816	240985	11301	20085	61244	109879	29410	51983	392	245896	502887	374392
1986	34270	119945	124547	248688	18093	31957	114665	203466	30935	54678	758	323268	659492	491380
1987	42938	150283	125116	249856	19713	35917	86457	154660	31746	55564	1128	307098	647408	477253
1988	39892	139623	132059	263363	24409	43511	123433	221220	32992	56935	992	353778	725643	539711
1989	27113	94896	59793	119261	16152	29341	72906	128831	34957	59662	1258	212179	433250	322714
1990	15853	55485	98830	197276	22318	40891	83498	155978	33939	60828	687	255125	511146	383135
1991	12849	44970	64016	127698	17328	31033	59574	111005	19759	31555	310	173835	346571	260203
1992	17993	62094	116116	231954	22164	40264	146364	229318	22832	37340	1194	326663	602164	464413
1993	25186	80938	131045	261721	21715	39446	89814	144378	15699	27747	466	283926	554695	419311
1994	18159	56888	95487	190655	20805	37384	55623	116881	7584	11785	436	198095	414029	306062
1995	25802	78675	111889	223758	13521	22844	26010	96239	12556	20539	213	189991	442267	316129
1996	57281	169077	141196	287528	20799	36956	49955	97137	17776	29387	657	287664	620741	454203

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

Table 4.2.2.2 Estimated numbers of 2SW returns in North America by geographic regions, 1971-96.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	4312	29279	2385	9104	27320	38152	29510	46780	11187	16410	687	75400	140412	107906
1972	3706	25168	2494	9129	26919	42102	35670	59880	14028	19731	1449	84267	157459	120863
1973	5183	35196	2995	11808	31915	48623	34945	59487	10359	14793	1448	86844	171355	129099
1974	5003	34148	1968	6702	43041	63894	49112	83344	21902	29071	1412	122437	218571	170504
1975	4772	32392	2382	8002	36994	55069	31193	51829	23944	31496	2348	101632	181136	141384
1976	5519	37401	2327	7663	38806	57755	29289	51381	21768	29837	1343	99052	185380	142216
1977	4867	33051	1880	6309	43150	69334	58862	100690	28606	39215	2032	139397	250632	195015
1978	3864	26147	2005	6419	35311	56379	30511	51395	16946	22561	4235	92872	167135	130004
1979	2231	15058	1103	3691	20330	30422	8694	14279	8962	12968	1928	43248	78346	60797
1980	5190	35259	2447	7794	47910	75464	43447	73764	31897	44823	5826	136717	242930	189823
1981	4734	32051	2317	7475	35565	54467	17779	29506	19030	28169	5635	85060	157302	121181
1982	3491	23662	2975	9228	35341	56528	31702	51026	17516	24182	6144	97169	170770	133969
1983	2538	17181	2511	7915	30358	44963	29079	46788	14310	20753	2101	80898	139700	110299
1984	1806	12252	2273	7117	26684	41035	20512	34059	17938	27899	3186	72399	125547	98973
1985	1448	9779	961	3319	30944	47583	23223	43271	22841	38784	5363	84781	148099	116440
1986	2470	16720	1592	5402	37726	57536	36504	70257	18102	33101	5963	102358	188979	145668
1987	3289	22341	1338	4629	36315	53453	22977	47135	11529	20679	2861	78309	151098	114704
1988	2068	14037	1553	5346	39149	61020	26267	49634	10370	19830	3008	82415	152874	117645
1989	2018	13653	704	2452	33519	52128	17478	34859	11939	21818	3137	68796	128047	98421
1990	1148	7790	1341	4562	33188	53090	25446	52880	10248	18871	4859	76230	142052	109141
1991	548	3740	1057	3577	32277	50952	21162	43711	10613	17884	2594	68252	122458	95355
1992	2515	15548	3024	10354	32492	52532	29609	59997	9777	16456	2540	79958	157427	118692
1993	3858	18234	1487	5217	26081	41225	26006	51067	7279	12622	2237	66949	130602	98776
1994	5653	24396	1889	6255	27384	44187	22334	56496	4600	7720	1309	63169	140363	101766
1995	11535	41606	2296	7462	22243	34706	24461	62503	4959	8722	1752	67246	156752	111999
1996	9152	32905	2523	8671	22824	37041	20613	42497	7107	12623	2316	64534	136052	100293

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

Table 4.2.3.1. Run reconstruction data inputs used to estimate pre-fishery abundance of maturing (MN1) and non-maturing (NN1) 1SW salmon of North American origin. (terms defined in table 4.2.3.2)

1SW	SFA {1-7, 14b}		SFA {8-14a}		SFA {1-7, 14b}
Fishery	H_s	H_l	H_s	H_l	H_l
Year (i)	(i)	(i)	(i)	(i+1)	(i+1)
1971	158,896	199,176	70,936	42,861	144,496
1972	143,232	144,496	111,141	43,627	227,779
1973	188,725	227,779	176,907	85,714	196,726
1974	192,195	196,726	153,278	72,814	215,025
1975	302,348	215,025	91,935	95,714	210,858
1976	221,766	210,858	118,779	63,449	231,393
1977	220,093	231,393	57,472	37,653	155,546
1978	102,403	155,546	38,180	29,122	82,174
1979	186,558	82,174	62,622	54,307	211,896
1980	290,127	211,896	94,291	38,663	211,006
1981	288,902	211,006	60,668	35,055	129,319
1982	222,894	129,319	77,017	28,215	108,430
1983	166,033	108,430	55,683	15,135	87,742
1984	123,774	87,742	52,813	24,383	70,970
1985	178,719	70,970	79,275	22,036	107,561
1986	222,671	107,561	91,912	19,241	146,242
1987	281,762	146,242	82,401	14,763	86,047
1988	198,484	86,047	74,620	15,577	85,319
1989	172,861	85,319	60,884	11,639	59,334
1990	104,788	59,334	46,053	10,259	39,257
1991	89,099	39,257	42,721	0	32,341
1992	24,249	32,341	0	0	17,096
1993	17,074	17,096	0	0	15,377
1994	8,640	15,377	0	0	11,176
1995	7,980	11,176	0	0	7,267
1996	7,849	7,267	0		

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

Variable	Definition
i	Year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.01/month)
t1	Time between the mid-point of the Canadian fishery and return to river = 2 months
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp(-M t1)}
H_s(i)	Number of "Small" salmon caught in Canada in year i; fish <2.7 kg
H_l(i)	Number of "Large" salmon caught in Canada in year i; fish >2.7 kg
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 fishery on 2SW salmon in Canada
MR1(i)	Return estimates of maturing 1SW salmon in Atlantic Canada in year i
NN1(i)	Pre-fishery abundance of non-maturing 1SW + maturing 2SW salmon in year i
NR(i)	Return estimates of non-maturing 1SW + maturing 2SW salmon in year i
NR2(i+1)	Return estimates of maturing 2SW salmon in Canada
NC1(i)	Harvest of non-maturing 1SW salmon in Nfld + Labrador in year i
NC2(i+1)	Harvest of maturing 2SW salmon in Canada
NG(i)	Catch of 1SW salmon in Greenland
S2	Survival of 2SW salmon between Greenland and homewater fisheries

Table 4.2.3.3. Run reconstruction data inputs and estimated pre-fishery abundance
for non-maturing 1SW salmon (potential 2SW salmon) of North American origin. (terms defined in table 4.2.3.2)

1SW	NG1	NC1		NC2		NR2		NN1		
Fishery		min	max	min	max	min	max	min	max	mid-point
Year (i)	(i)	(i)	(i)	(i+1)	(i+1)	(i+1)	(i+1)	(i)	(i)	(i)
1971	287,672	17,881	43,730	144,008	172,907	84,267	157,459	558,772	698,262	628,517
1972	200,784	15,768	37,316	203,072	248,628	86,844	171,355	537,924	704,156	621,040
1973	241,493	21,150	51,412	223,422	262,767	122,437	218,571	646,237	827,293	736,765
1974	220,584	21,187	50,243	223,332	266,337	101,632	181,136	602,040	767,372	684,706
1975	278,839	32,385	73,371	243,315	285,486	99,052	185,380	690,698	874,657	782,677
1976	155,896	24,285	57,005	225,424	271,703	139,397	250,632	584,919	792,954	688,937
1977	189,709	24,323	57,902	146,535	177,644	92,872	167,135	479,650	630,508	555,079
1978	118,853	11,796	29,813	86,644	103,079	43,248	78,346	274,681	350,041	312,361
1979	200,061	19,478	42,242	202,634	245,013	136,717	242,930	596,098	784,262	690,180
1980	187,999	31,132	70,739	186,367	228,568	85,060	157,302	520,049	686,938	603,493
1981	227,727	31,000	70,441	125,578	151,442	97,169	170,770	505,980	656,164	581,072
1982	194,715	23,583	52,338	104,116	125,802	80,898	139,700	423,668	542,030	482,849
1983	33,240	17,688	39,712	76,554	94,103	72,399	125,547	216,351	317,097	266,724
1984	38,916	13,255	30,019	74,062	88,256	84,781	148,099	228,661	331,793	280,227
1985	139,233	18,582	40,002	97,329	118,841	102,358	188,979	379,639	521,528	450,583
1986	171,745	23,343	50,988	121,610	150,859	78,309	151,098	416,903	558,125	487,514
1987	173,687	29,639	65,127	74,996	92,205	82,415	152,874	378,207	511,367	444,787
1988	116,767	20,709	44,860	75,300	92,364	68,796	128,047	297,491	406,641	352,066
1989	60,693	18,139	39,691	53,173	65,040	76,230	142,052	222,691	330,833	276,762
1990	73,109	11,072	24,518	37,739	45,590	68,252	122,458	202,077	284,709	243,393
1991	110,680	9,302	20,175	22,639	29,107	79,958	157,427	234,257	338,756	286,507
1992	41,855	2,748	6,790	11,967	15,386	66,949	130,602	132,563	211,438	172,001
1993	0	1,878	4,441	10,764	13,839	63,169	140,363	84,288	176,420	130,354
1994	0	1,018	2,651	7,823	10,058	67,246	156,752	84,729	188,746	136,738
1995	20,828	910	2,267	5,087	6,540	64,534	136,052	99,398	182,194	140,796
1996	12,357	858	2,006							

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

1SW	MC1		MR1		MN1		
Fishery Year (i)	min (i)	max (i)	min (i)	max (i)	min (i)	max (i)	mid-point (i)
1971	213,987	267,720	199,278	433,844	415,268	705,924	560,596
1972	237,286	279,064	192,518	407,309	431,739	690,466	561,102
1973	346,109	408,260	217,664	425,954	565,961	838,495	702,228
1974	322,772	379,370	214,883	439,975	539,814	823,767	681,791
1975	351,015	422,105	261,298	569,197	614,940	997,022	805,981
1976	313,060	375,300	291,989	594,124	607,984	975,395	791,689
1977	252,058	318,032	216,380	459,838	470,612	782,491	626,552
1978	132,546	172,340	162,041	330,895	296,216	506,560	401,388
1979	218,442	252,711	223,126	454,352	443,811	711,629	577,720
1980	343,344	412,617	284,012	601,790	630,211	1,020,455	825,333
1981	308,670	377,651	343,883	739,282	656,009	1,124,364	890,187
1982	265,678	312,538	295,901	618,108	564,552	936,858	750,705
1983	197,184	234,389	185,152	388,633	384,197	626,928	505,562
1984	158,852	187,900	216,419	427,892	377,445	620,092	498,769
1985	227,928	259,284	245,896	502,887	476,295	767,226	621,760
1986	278,654	321,357	323,268	659,492	605,171	987,478	796,324
1987	319,510	375,472	307,098	647,408	629,695	1,029,387	829,541
1988	240,291	276,488	353,778	725,643	597,625	1,009,425	803,525
1989	205,998	239,495	212,179	433,250	420,310	677,099	548,704
1990	134,630	156,382	255,125	511,146	392,319	672,665	532,492
1991	117,141	133,509	173,835	346,571	292,723	483,564	388,143
1992	21,986	30,556	326,663	602,164	351,932	638,772	495,352
1993	15,027	19,983	283,926	554,695	301,807	580,253	441,030
1994	8,142	11,928	198,095	414,029	208,228	430,118	319,173
1995	7,278	10,200	189,991	442,267	199,179	456,912	328,045
1996	6,861	9,026	287,664	620,741	297,416	636,006	466,711

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Table 4.2.4.1 Estimated numbers of 2SW spawners in North America by geographic regions, 1971-96.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	4012	28882	1810	8230	3888	11665	4330	8185	4496	9032	550	19086	66543	42814
1972	3435	24812	1985	8358	6243	18729	17832	32941	7459	12699	1159	38112	98697	68405
1973	4565	34376	2275	10720	6711	20132	20535	38068	3949	7844	1188	39222	112327	75774
1974	4490	33475	1534	6043	8151	24453	31736	57859	9526	15979	1214	56651	139022	97836
1975	4564	32119	1959	7355	7087	21261	18500	33167	11861	18830	2034	46004	114766	80385
1976	4984	36701	2003	7160	7428	22284	14849	29639	11045	18337	1189	41499	115310	78404
1977	4042	31969	1134	5131	10995	32985	32576	60108	13578	23119	1594	63919	154906	109412
1978	3361	25490	1564	5728	8805	26415	11565	22725	6517	11428	3518	35331	95304	65318
1979	1823	14528	992	3506	3980	11940	3603	6768	4683	8234	1581	16662	46557	31609
1980	4633	34525	1894	6928	11396	34188	20000	37543	14270	25628	4600	56794	143412	100103
1981	4403	31615	1935	6874	7629	22887	4701	9924	5870	13353	4614	29151	89267	59209
1982	3080	23127	2635	8691	8867	26601	11093	20213	5656	11335	4994	36326	94961	65643
1983	2267	16824	2167	7364	5694	17082	7485	14186	1505	6529	1790	20908	63774	42341
1984	1478	11822	2082	6829	5814	17442	15362	27129	14245	23650	2646	41627	89517	65572
1985	1258	9530	949	3300	6741	20223	21276	39730	18185	33580	4830	53238	111193	82216
1986	2177	16334	1560	5354	7964	23892	33264	64333	15435	30120	5480	65881	145513	105697
1987	2895	21821	1322	4605	6633	19899	20174	42349	10235	19233	2632	43891	110538	77215
1988	1625	13452	1529	5310	8967	26901	23505	44553	9074	18381	2809	47508	111406	79457
1989	1727	13270	697	2441	7615	22845	14912	30402	11689	21539	2809	39449	93305	66377
1990	923	7493	1321	4532	8330	24990	23027	49443	9688	18245	4298	47586	109001	78293
1991	491	3665	1044	3557	7737	23211	19752	41239	9356	16479	2409	40789	90560	65675
1992	2012	14889	2968	10270	8452	25356	27940	53062	8725	15280	2403	52414	121085	86749
1993	3624	17922	1437	5139	6281	18842	25457	45598	6599	11862	2104	45247	101019	73133
1994	5339	23981	1825	6156	7077	21232	20540	53562	4321	7408	1308	40263	113392	76828
1995	11173	41127	2223	7350	5114	15343	22816	60074	4837	8586	1752	47719	133907	90813
1996	8832	32480	2455	8565	6012	18036	18642	39333	6724	12195	2316	44669	112401	78535

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

Table 4.2.4.2 Estimated numbers of 1SW spawners in North America by geographic regions, 1971-96.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	29032	111448	85600	198328	2882	8646	19874	35490	4800	12810	30	142218	366752	254485
1972	21728	83415	84107	192690	2535	7605	24319	43231	2992	10385	17	135697	337343	236520
1973	0	11405	108247	252350	3391	10173	28104	50910	8658	18715	15	148415	343567	245991
1974	24533	92118	58182	142618	3107	9321	48343	84560	16209	33822	43	150418	362482	256450
1975	49688	183837	78457	190500	3582	10746	42668	74845	18232	28608	70	192697	488606	340652
1976	31814	125665	80324	195390	4006	12018	56019	99606	24589	43595	158	196910	476431	336671
1977	28815	112337	75297	184754	3705	11115	14045	27442	16704	34231	58	138624	369937	254281
1978	13464	53851	68451	165514	3533	10599	13768	25422	5678	9808	132	105026	265326	185176
1979	17825	72682	75622	182158	4896	14688	29764	56140	18577	36754	247	146930	362669	254799
1980	45870	170045	84506	204600	6425	19275	26449	49946	28878	52513	741	192869	497120	344994
1981	49855	187471	109871	266027	9553	28659	39397	75549	18236	42948	1033	227946	601688	414817
1982	34032	129370	98080	237244	5209	15627	52004	95578	12179	26548	298	201801	504666	353234
1983	19360	78689	76958	186128	3713	11139	13610	24536	7747	15969	263	121650	316724	219187
1984	9348	40056	89904	217925	3329	9987	17988	33398	17964	37503	552	139085	339421	239253
1985	19631	76462	84264	204433	3910	11730	39504	73496	18158	40731	368	165835	407220	286528
1986	30806	116481	87051	211192	6153	18459	82069	149044	21204	44947	679	227962	540803	384382
1987	37572	144917	100634	225374	7292	21876	59224	109466	21589	45407	1094	227404	548133	387769
1988	34369	134100	92218	223522	8514	25542	85500	158268	23288	47231	936	244826	589599	417213
1989	22429	90212	41331	100799	5928	17784	44677	81355	23873	48578	1115	139354	339843	239599
1990	12544	52176	68863	167309	8377	25131	55989	110334	22753	49642	630	169156	405223	287189
1991	10526	42647	43487	107169	6122	18366	44203	85587	13814	25610	250	118401	279630	199016
1992	15229	59331	92434	208272	8135	24405	118548	187604	15125	29633	1138	250609	510383	380496
1993	22499	78251	104712	235387	7969	23907	70849	115851	11957	24005	448	218435	477849	348142
1994	15228	53958	65691	160859	7416	22248	32638	89852	6699	10900	429	128102	338246	233174
1995	22924	75797	81877	193746	4043	12129	15403	60741	10519	18502	213	134978	361128	248053
1996	53888	165684	102904	249237	7191	21573	24133	68141	14468	26079	657	203242	531371	367306

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

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

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

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

	North America		Prefishery	Recruits/	Labrador (L)		Newfoundland (N)		Quebec (Q)		Gulf of St. Lawrence (G)		Scotia-Fundy (S)		USA (US)	
	Total 2SW	Lagged 2SW	abundance	2SW lagged												
Year	spawners	spawners	recruits	spawner	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged
71	42814		628517		16447		5020		7777		6257		6764		550	
72	68405		621040		14124		5171		12486		25386		10079		1159	
73	75774		736765		19470		6497		13421		29302		5896		1188	
74	97836		684706		18982		3788		16302		44797		12752		1214	
75	80385		782677		18341		4657		14174		25833		15345		2034	
76	78404		688937		20842		4582		14856		22244		14691		1189	
77	109412		555079		18006		3132		21990		46342		18348		1594	
78	65318	80161	312361	3.90	14425	14759	3646	5901	17610	12591	17145	35356	8973	10034	3518	1520
79	31609	89605	690180	7.70	8175	17486	2249	4752	7960	14660	5185	36805	6459	14270	1581	1631
80	100103	79603	603493	7.58	19579	18903	4411	4441	22792	14934	28771	24960	19949	14937	4600	1429
81	59209	89540	581072	6.49	18009	18795	4404	4517	15258	15124	7312	31939	9612	16888	4614	2277
82	65643	90973	482849	5.31	13104	19695	5663	3679	17734	18282	15653	34028	8496	12699	4994	2590
83	42341	64266	266724	4.15	9546	18710	4765	3457	11388	18429	10835	13238	4017	7514	1790	2918
84	65572	65815	280227	4.26	6650	15422	4456	2822	11628	13790	21245	14919	18947	14569	2646	4293
85	82216	69507	450583	6.48	5394	11576	2124	3682	13482	16276	30503	19549	25882	13668	4830	4756
86	105697	61364	487514	7.94	9255	15361	3457	4377	15928	17624	48799	11256	22777	8998	5480	3748
87	77215	61475	444787	7.24	12358	17772	2963	5171	13266	16781	31261	13495	14734	5813	2632	2443
88	79457	65559	352066	5.37	7538	14762	3420	5029	17934	14266	34029	15119	13728	13002	2809	3380
89	66377	80110	276762	3.45	7498	10875	1569	4506	15230	12227	22657	24628	16614	23026	2809	4849
90	78293	89445	243393	2.72	4208	7799	2926	3032	16660	12779	36235	37517	13966	23978	4298	4340
91	65675	85997	286507	3.33	2078	6285	2300	3043	15474	14418	30496	41293	12917	17965	2409	2993
92	86880	75566	172001	2.28	8451	8072	6619	3110	16904	14545	40501	32876	12002	14173	2403	2791
93	73484	77894	130354	1.67	10773	10649	3288	3197	12561	15787	35527	29427	9231	15464	2104	3370
94	77028	74522	136738	1.83	14660	9247	3990	2275	14154	16168	37051	28393	5865	15007	1308	3433
95	91074	75573	140796	1.86	26150	7453	4786	2480	10229	16129	41445	33560	6712	13350	1752	2602
96	78952	73270			20656	5299	5510	2652	12024	16009	28987	34647	9459	12373	2316	2291
97		74942				3511		4946		16073		38235		10342		1835
98		70305				6285		4358		14598		36282		7225		1557
99		74476				9930		3894		13584		38759		6391		1919

Spawners lagged by:

Labrador = 0.077 x i-5 spawners + 0.524 x i-6 + 0.341 x i-7 + 0.040 x i-8
Newfoundland = 0.041 x i-4 spawners + 0.598 x i-5 + 0.324 x i-6 + 0.038 x i-7
Quebec = 0.058 X i-4 spawners + 0.464 x i-5 + 0.378 x i-6 + 0.089 x i-7
Gulf = 0.398 x i-4 spawners + 0.573 x i-5 + 0.029 x i-6
Scotia-Fundy = 0.600 x i-4 spawners + 0.394 x i-5 + 0.006 x i-6
USA = 0.377 x i-3 spawners + 0.520 x i-4 + 0.103 x i-5.

Table 4.3.1 Index ratio for small and large salmon returns, by river, for premoratorium (1984–1991) and moratorium (1992–1996) periods. Corresponding commercial exploitation rates were derived from respective index ratio data.

			Small salmon			Large salmon		
			Index Ratio			Index Ratio		
Area	River		Premoratorium	Moratorium	Premoratorium Exploitation Rate (%)	Premoratorium	Moratorium	Premoratorium Exploitation Rate (%)
Northeast	Exploits River	(SFA 4)	0.804	1.522	47.2	0.730	3.092	76.4
	Gander River	(SFA 4)						
		Salmon Brook	0.755	1.070	29.4	0.179	1.006	82.2
		Main River	0.403	1.184	66.0	0.130	0.474	72.6
	Middle Brook	(SFA 5)	0.720	1.276	43.6	0.519	2.552	79.7
	Terra Nova River	(SFA 5)	0.840	1.384	39.3	0.473	1.542	69.3
South	Northeast Placentia River	(SFA 10)	0.544	0.942	42.3	0.430	1.642	73.8
West east	Humber River	(SFA 13)	0.515	1.166	55.8	0.215	0.636	66.2
	Lomond River	(SFA 14 A)	0.816	1.502	45.7	0.314	0.882	64.4
	Torrent River	(SFA 14 A)	0.843	1.932	56.4	0.545	2.178	75.0
	Western Arm Brook	(SFA 14 A)	0.704	1.846	61.9	0.080	3.252	97.5
	Average Commercial Exploitation rate (all indices combined)				48.8			75.7

Table 4.3.2 Recreational and commercial landings, zones Q7 and Q8, Québec.

Year	Recreational			Commercial		
	1SW	MSW	TOTAL	1SW	MSW	TOTAL
Premoratorium						
1984	758	1 968	2 726	270	7 718	7 988
1985	780	2 897	3 677	304	11 004	11 308
1986	1 749	2 967	4 716	673	9 482	10 155
1987	1 710	2 652	4 362	379	10 317	10 696
1988	2 090	3 415	5 505	547	8 305	8 852
1989	1 806	2 769	4 575	359	9 540	9 899
1990	2 481	4 594	7 075	447	8 293	8 740
1991	1 396	4 071	5 467	130	7 288	7 418
84-91 means	1 596	3 167	4 763	389	8 993	9 382
Moratorium						
1993	1 103	3 136	4 239			
1994	1 446	2 740	4 186			
1995	739	2 149	2 888		Closed	
1996	1 337	2 599	3 936			
93-96 means	1 156	2 656	3 812			

Table 4.3.3 Effect of quota reduction and delays in opening date in 1996 on the commercial landings in Q9, Québec.

Year	Commercial			% quota reached	Proportion of MSW
	1SW	MSW	TOTAL		
1984	524	3502	4026		0.87
1985	1789	3830	5619		0.68
1986	3034	8613	11647		0.74
1987	2613	10216	12829		0.80
1988	4213	9798	14011		0.70
1989	2256	8370	10626		0.79
1990	2978	7574	10552		0.72
1991	3152	8695	11847		0.73
1992	3718	10700	14418	95	0.74
1993	3627	10880	14507	96	0.75
1994	3861	9939	13800	91	0.72
1995	3915	9738	13653	90	0.71
1992-95	3780	10314	14095	93	0.73
1996	4532	7186	11718		0.61

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

Country	Stock Area	Management zone		2SW spawner requirement
Canada	Labrador	SFA 1		8,000
		SFA 2		25,300
		SFA 14B		1,400
		Subtotal	34,700	
	Newfoundland	SFA 3		240
		SFA 4		488
		SFA 5		233
		SFA 6 to 8		13
		SFA 9 to 12		212
		SFA 13		2,544
		SFA 14A		292
		Subtotal	4,022	
	Gulf of St. Lawrence	SFA 15		5,656
		SFA 16		21,050
		SFA 17		537
		SFA 18		3,233
		Subtotal	30,476	
	Québec	Q1		5,002
		Q2		3,116
		Q3		3,596
		Q5		1,326
		Q6		1,966
		Q7		6,461
		Q8		20,026
		Q9		7,794
		Q10		3,963
		Q11		7,500
		Subtotal	60,750	
	Scotia-Fundy	SFA 19		3,130
		SFA 20		1,676
		SFA 21		4,792
		SFA 22		211
		SFA 23		11,539
		Subtotal	21,348	
Canada Total			151,296	
USA	Connecticut (CT)			9,727
	Merrimack (NH)			2,599
	Penobscot (ME)			6,838
	Other Maine rivers (ME)			9,668
	Pawcatuck (RI)			367
USA Total			29,199	
North American Total			180,495	

Table 4.5.1 Fishing mortalities of 2SW salmon equivalents by North American fisheries, 1972-97.
Only mid-points of the estimated values have been used.

Year	CANADA										USA	Total	
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i								
	NF-LAB Comm 1SW (Yr i-1)	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i)	NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	Yr i		Terminal Fisheries as a % of Total
1972	27874	12	156881	184755	314	640	22024	22389	6801	236924	290	237214	22
1973	24016	8	223603	247619	719	904	26848	17914	6680	300684	260	300944	18
1974	32828	9	240676	273504	593	547	37165	21431	12734	345974	198	346172	21
1975	32316	10	242398	274714	241	535	31857	15678	12375	335399	314	335713	18
1976	47846	13	261770	309616	618	414	33424	18091	11111	373274	154	373428	17
1977	36777	10	246090	282867	953	962	34252	33434	15562	368032	438	368470	23
1978	37200	14	160477	197677	580	566	28235	23807	10781	261646	717	262363	25
1979	18825	13	93917	112742	469	148	17416	6301	4506	141582	347	141929	21
1980	27923	8	221597	249520	646	709	38895	29834	18411	338015	1226	339241	26
1981	46088	15	205403	251492	384	491	29758	16330	13988	312442	1021	313463	20
1982	45894	18	137132	183026	473	438	28201	25711	12353	250202	1150	251352	27
1983	34348	16	113815	148163	313	448	26273	27098	13515	215810	311	216121	31
1984	25969	18	84480	110448	379	239	22231	6040	3971	143309	540	143849	23
1985	19578	15	80351	99929	219	16	25782	2744	4930	133621	533	134154	26
1986	26504	15	107009	133514	340	40	31703	4581	2824	173002	483	173485	23
1987	33629	16	134879	168508	457	21	31618	3795	1370	205768	229	205997	18
1988	42874	26	82769	125642	514	30	32150	3922	1373	163631	199	163830	23
1989	29664	20	82998	112662	337	9	27594	3512	265	144379	328	144707	22
1990	26164	23	58518	84682	261	25	26479	2928	593	114968	561	115529	27
1991	16101	19	41250	57352	66	17	26141	1941	1331	86847	185	87032	34
1992	13336	19	25615	38952	581	70	25608	4302	1114	70627	137	70764	45
1993	4315	10	13541	17856	273	64	21092	3009	720	43015	133	43148	59
1994	2859	7	12179	15038	365	82	21632	2364	295	39775	1	39776	62
1995	1660	5	8852	10511	420	93	18246	2038	129	31437	0	31437	67
1996	1437	5	5756	7193	372	87	17908	2567	406	28533	0	28533	75
1997	1295	-	-	-	-	-	-	-	-		-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.904837

NF-Lab comm as 2SW = NC2 (mid-pt) * 0.99005

Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)

a - starting in 1993, includes estimated mortality of 10% on hook and released fish

Table 4.5.2 History of fishing-related mortalities of North American salmon as 2SW equivalents, 1972-96.

Year	Canadian total	USA total	North America Grand Total	% USA of Total North American	Greenland total	NW Atlantic Total	Harvest in homewaters as %of total NW Atlantic
1972	236924	290	237214	0.12	260296	497510	48
1973	300684	260	300944	0.09	181677	482621	62
1974	345974	198	346172	0.06	218512	564684	61
1975	335399	314	335713	0.09	199593	535305	63
1976	373274	154	373428	0.04	252304	625731	60
1977	368032	438	368470	0.12	141060	509530	72
1978	261646	717	262363	0.27	171656	434019	60
1979	141582	347	141929	0.24	107543	249472	57
1980	338015	1226	339241	0.36	181023	520263	65
1981	312442	1021	313463	0.33	170108	483572	65
1982	250202	1150	251352	0.46	206056	457407	55
1983	215810	311	216121	0.14	176185	392306	55
1984	143309	540	143849	0.38	30077	173926	83
1985	133621	533	134154	0.40	35213	169366	79
1986	173002	483	173485	0.28	125983	299468	58
1987	205768	229	205997	0.11	155401	361398	57
1988	163631	199	163830	0.12	157158	320988	51
1989	144379	328	144707	0.23	105655	250362	58
1990	114968	561	115529	0.49	54917	170446	68
1991	86847	185	87032	0.21	66152	153184	57
1992	70627	137	70764	0.19	100147	170912	41
1993	43015	133	43148	0.31	37872	81020	53
1994	39775	1	39776	0.00	0	39776	100
1995	31437	0	31437	0.00	0	31437	100
1996	28533	0	28533	0.00	18846	47379	60

Greenland harvest of 2SW equivalents = NG1 * 0.904837

Table 4.6.1. Juvenile Atlantic salmon stocking program by life stage in the USA (1975 - 1996).

Year	Life Stage					
	Fry	% Change From Previous Year	Parr	% Change From Previous Year	Smolt	% Change From Previous Year
1975	67900		33400		241900	
1976	89600	32	205500	515	346600	43
1977	121500	36	16100	-92	504200	45
1978	156000	28	163400	915	456400	-9
1979	225500	45	179600	10	574000	26
1980	412000	83	12500	-93	813300	42
1981	427000	4	419500	3256	469100	-42
1982	695000	63	597500	42	725700	55
1983	254000	-63	513000	-14	743100	2
1984	1285000	406	544200	6	1174700	58
1985	1051000	-18	466400	-14	1165900	-1
1986	1270000	21	676700	45	1173000	1
1987	3307000	160	1241500	83	1066800	-9
1988	3994000	21	1251000	1	1430200	34
1989	3177000	-20	1622000	30	895600	-37
1990	3291000	4	1187200	-27	1277600	43
1991	4399000	34	1117800	-6	1314400	3
1992	4960000	13	1070800	-4	1309500	0
1993	7823000	58	899100	-16	1099700	-16
1994	11461000	47	373300	-58	1113600	1
1995	11439300	0	511900	37	665000	-40
1996	11030000	-4	597500	17	657100	-1

Table 5.1.1.1 Nominal catches of salmon, West Greenland 1960-96 (metric tons round fresh weight).

Year	Norway	Faroes	Sweden	Denmark	Greenland[4]	Total	Quota
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1539	1539	-
1965	-[1]	36	-	-	825	861	-
1966	32	87	-	-	1251	1370	-
1967	78	155	-	85	1283	1601	-
1968	138	134	4	272	579	1127	-
1969	250	215	30	355	1360	2210	-
1970	270	259	8	358	1244	2146[3]	-
1971	340	255	-	645	1449	2689	-
1972	158	144	-	401	1410	2113	1100
1973	200	171	-	385	1585	2341	1100
1974	140	110	-	505	1162	1917	1191
1975	217	260	-	382	1171	2030	1191
1976	-	-	-	-	1175	1175	1191
1977	-	-	-	-	1420	1420	1191
1978	-	-	-	-	984	984	1191
1979	-	-	-	-	1395	1395	1191
1980	-	-	-	-	1194	1194	1191
1981	-	-	-	-	1264	1264	1265[5]
1982	-	-	-	-	1077	1077	1253[5]
1983	-	-	-	-	310	310	1191
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	-[6]
1989	-	-	-	-	337	337	-[6]
1990	-	-	-	-	274	274	-[6]
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237	237	-
1993	-	-	-	-	0[2]	0[2]	-
1994	-	-	-	-	0[2]	0[2]	-
1995	-	-	-	-	83	83	77
1996	-	-	-	-	92	92	-

[1] Figures not available, but catch is known to be less than 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 Greenland vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non Greenland catches 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 (840 t) by more than 10%. Quota adjusted to 900 t in 1989 and 924 t 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 5.1.1.2 Distribution of nominal catches (metric tons), Greenland vessels.

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

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

Table 5.1.2.1 Percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82) and from commercial samples (1978-92 and 1995-96).

Source	Year	Sample size Length	Scales	Continent of origin (%) NA	(95%CI)[1]	E	(95%CI)
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(75,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3488	3488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977[2]	606	606	38	(41,34)	62	(66,59)
	1978[3]	49	49	55	(69,41)	45	(59,31)
	1979	328	328	47	(52,41)	53	(59,48)
	1980	617	617	58	(62,54)	42	(46,38)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1653	1653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4570	1930	59	(61,58)	41	(42,39)
	1982	1949	414	62	(64,60)	38	(40,36)
	1983	4896	1815	40	(41,38)	60	(62,59)
	1984	7282	2720	50	(53,47)	50	(53,47)
	1985	13272	2917	50	(53,46)	50	(54,47)
	1986	20394	3509	57	(66,48)	43	(52,34)
	1987	13425	2960	59	(63,54)	41	(46,37)
	1988	11047	2562	43	(49,38)	57	(62,51)
	1989	9366	2227	56	(60,52)	44	(48,40)
	1990	4897	1208	75	(79,70)	25	(30,21)
	1991	5005	1347	65	(69,61)	35	(39,31)
	1992	6348	1648	54	(57,50)	46	(50,43)
	1995	2045	2045	65	(69,61)	35	(39,31)
	1996	3341	1297	42	(45,38)	58	(62,55)

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

[2]During Fishery.

[3]Research samples after fishery closed.

Table 5.1.2.2 The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-92 and 1995-96.

	Proportion weighted by catch in number		Numbers of Salmon caught	
Year	NA	E	NA	E
1982	57	43	192200	143800
1983	40	60	39500	60500
1984	54	46	48800	41200
1985	47	53	143500	161500
1986	59	41	188300	131900
1987	59	41	171900	126400
1988	43	57	125500	168800
1989	55	45	65000	52700
1990	74	26	62400	21700
1991	63	37	111700	65400
1992	45	55	46900	38500
1995	65	35	20700	11200
1996	40	60	12900	19100

Table 5.1.3.1 Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-92 and 1995-96. Fork length (cm); whole weight (kg). NA = North America; E = Europe.

	Whole weight (kg)									Fork length (cm)					
	Sea age & origin									Sea age & origin					
	1SW		2SW		PS		All sea ages		TOTAL	1SW		2SW		PS	
Year	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.1	3.8	5.5	5.8	-	5.1	3.3	3.9	3.6	65.0	68.7	77.0	80.3	-	75.3
1970	2.9	3.5	5.7	5.5	4.9	3.8	3.1	3.5	3.3	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.7	3.4	4.3	-	-	-	2.7	3.4	3.1	62.8	67.7	72.0	-	-	-
1972	3.0	3.5	5.9	6.1	2.7	4.0	3.3	3.6	3.4	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.3	4.5	9.5	10.0	-	-	3.8	4.7	4.2	64.5	70.4	88.0	96.0	61.5	-
1974	3.1	3.8	7.1	8.1	3.4	-	3.2	3.9	3.6	64.1	68.1	82.8	87.4	66.0	-
1975	2.6	3.4	6.1	6.2	2.6	4.8	2.7	3.5	3.1	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.6	3.2	6.2	7.2	3.6	3.6	2.8	3.2	3.0	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	3.0	3.5	7.0	7.9	2.5	6.6	3.0	3.5	3.4	63.7	67.3	83.6	-	60.8	85.0
1979	3.0	3.5	7.1	7.6	3.9	6.3	3.1	3.6	3.3	63.4	66.7	81.6	85.3	61.9	82.0
1980	3.0	3.3	6.8	6.7	3.6	3.9	3.1	3.4	3.2	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.8	3.5	6.9	7.4	4.1	3.7	2.9	3.6	3.2	62.3	66.7	82.8	84.5	72.5	-
1982	2.8	3.2	5.6	5.6	4.0	5.7	2.9	3.4	3.1	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.5	3.0	5.8	5.9	3.4	3.6	3.0	3.1	3.1	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.6	2.8	5.8	5.8	3.6	5.8	3.2	3.0	3.1	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.5	2.9	5.4	5.5	5.2	5.0	2.7	3.0	2.9	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.8	3.1	6.4	6.1	3.3	4.4	2.9	3.2	3.0	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.0	3.2	6.4	6.0	4.7	4.7	3.1	3.3	3.2	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.8	3.4	6.8	6.8	4.8	4.6	2.9	3.4	3.2	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.6	2.9	5.9	5.8	4.2	5.8	2.8	3.0	2.9	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.5	2.6	6.5	5.8	3.9	5.1	2.7	2.7	2.7	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.4	2.5	5.8	6.2	5.2	5.1	2.6	2.8	2.7	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.5	2.7	6.5	6.0	4.1	5.3	2.9	2.7	2.8	62.3	63.2	83.4	81.1	77.4	82.7
1995	2.4	2.6	6.5	5.3	3.8	4.0	2.7	2.6	2.5	61.2	62.6	82.1	78.5	71.5	72.8
1996	2.7	2.8	6.6	6.2	5.2	4.9	2.9	2.8	2.9	63.0	63.4	81.3	81.6	78.2	77.0

Table 5.1.3.2 River age distribution (%) for all North American and European origin salmon caught at West Greenland, 1968-92 and 1995-96.

	River age							
Year	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	.32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0.0
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0.0
1992	6.7	36.7	34.1	19.1	3.2	0.3	0.0	0.0
1995	5.3	29.1	35.2	20.2	8.4	1.9	0.0	0.0
1996	7.4	23.8	35.2	21.9	10.7	0.9	0.2	0.0
Mean	4.4	36.5	35.7	16.1	6.1	1.1	0.1	0.0
European								
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0
1988	18.4	61.6	17.3	2.3	0.5	0.0	0.0	0.0
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0
1990	15.9	56.3	23.0	4.4	0.2	0.2	0.0	0.0
1991	20.9	47.4	26.3	4.2	1.2	0.0	0.0	0.0
1992	11.8	38.2	42.8	6.5	0.6	0.0	0.0	0.0
1995	14.7	54.9	27.5	3.0	0.0	0.0	0.0	0.0
1996	7.6	49.2	31.5	10.2	1.3	0.2	0.0	0.0
Mean	19.7	59.8	17.3	2.9	0.4	0.0	0.0	0.0

Table 5.1.3.3 Sea-age composition (%) of samples from commercial catches at West Greenland, 1985–92 and 1995–96.

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
1996	92.1	5.4	2.5	97.1	1.7	1.2

Table 5.1.3.4 Distribution (percent of landings) by sizes of salmon captured at West Greenland, NAFO SA1 for the years 1987-92 and 1995-96.

Size category	Year							
kg	1987	1988	1989	1990	1991	1992	1995	1996
1.1 - 3.3	63.8	56.1	77.5	72.9	82.9	55.3	84.5	66.7
3.3 - 5.6	32.1	41.3	18.4	23.5	14.4	41.7	12.4	28.8
> 5.6	4.0	2.6	4.1	3.6	2.7	3.0	3.1	4.5

Table 5.2.1.1 Pre-Fishery abundance estimates, thermal habitat index based on sea surface temperature, lagged spawner index for North America excluding Gulf and US spawners (SNLQ), results of a jackknife cross-validation of the forecast model, and deterministic forecasts.

Year	Pre-Fishery Abundance Low	Pre-Fishery Abundance High	Pre-Fishery Abundance Mid	Thermal Habitat February	Lagged Spawners Low	Lagged Spawners High	Lagged Spawners Mid	Jackknife Cross-Validation Prediction	Jackknife Cross-Validation Residuals
71	558,772	698,262	628,517	2011					
72	537,924	704,156	621,040	1990					
73	646,237	827,293	736,765	1708					
74	602,040	767,372	684,706	1862					
75	690,698	874,657	782,677	1827					
76	584,919	792,954	688,937	1676					
77	479,650	630,508	555,079	1915					
78	274,681	350,041	312,361	1951	19,324	67,245	43,284	556,082	-243,721
79	596,098	784,262	690,180	2058	24,185	78,152	51,168	560,567	129,613
80	520,049	686,938	603,493	1823	25,137	81,292	53,215	521,599	81,894
81	505,980	656,164	581,072	1912	26,636	84,012	55,324	599,494	-18,423
82	423,668	542,030	482,849	1703	24,677	84,034	54,355	508,217	-25,369
83	216,351	317,097	266,724	1416	20,418	75,803	48,110	314,214	-47,491
84	228,661	331,793	280,227	1257	22,101	71,105	46,603	219,432	60,794
85	379,639	521,528	450,583	1410	21,556	68,848	45,202	228,759	221,824
86	416,903	558,125	487,514	1688	20,120	72,600	46,360	379,914	107,599
87	378,207	511,367	444,787	1627	18,192	72,880	45,536	347,813	96,973
88	297,491	406,641	352,066	1698	22,144	71,975	47,060	404,858	-52,793
89	222,691	330,833	276,762	1642	27,305	73,961	50,633	457,587	-180,825
90	202,077	284,709	243,393	1503	26,081	69,096	47,588	342,416	-99,023
91	234,257	338,756	286,507	1357	22,353	61,068	41,710	188,733	97,773
92	132,563	211,438	172,001	1381	20,122	59,676	39,899	186,907	-14,907
93	84,288	176,420	130,354	1252	22,458	67,737	45,098	220,243	-89,889
94	84,729	188,746	136,738	1329	21,659	63,735	42,697	210,480	-73,743
95	99,398	182,194	140,796	1310	20,355	58,468	39,412	153,268	-12,473
96				1470	19,373	53,292	36,333	*169,723* 1	
97				1594	18,514	51,232	34,873	*196,654* 1	

1. Deterministic forecast values.

Table 5.2.2.1 Estimate of pre-fishery abundance in 1997 forecasted by H2-SNLQ regression model of probability levels between 25 and 75%

Cumulative Density Function %	Forecast
25	108,459
30	128,023
35	146,444
40	163,645
45	180,377
50	196,858
55	213,264
60	230,097
65	247,268
70	265,337
75	285,157

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Table 5.2.3.1 Quota options (mt) for 1997 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 (F*NA*)										
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	6	13	19	26	32	39	45	52	58	65
60	0	16	31	47	63	78	94	110	125	141	157
65	0	25	50	75	100	125	151	176	201	226	251
70	0	35	70	105	140	175	210	245	280	315	350
75	0	46	92	138	183	229	275	321	367	413	458

Sp. res =	201,483
Prop NA =	0.5568
WT1SWNA =	2.647
WT1SWE =	2.75
ACF =	1.133

Table 5.2.4.1 2SW spawner requirement (male and female), proportion female and range of proportion female for six stock areas of North America.

Stock Area	2SW Requirement	Proportion of North America	Proportion Female		
			Point	Minimum	Maximum
Labrador	34,700	0.19	0.75	0.65	0.85
Newfoundland	4,022	0.02	0.75	0.65	0.85
Gulf	30,476	0.17	0.85	0.75	0.95
Québec	60,750	0.34	0.70	0.60	0.80
Scotia-Fundy	21,348	0.12	0.85	0.75	0.95
U.S.A.	29,199	0.16	0.50	0.45	0.55
Total North America	180,495		0.72		

Table 6.2.1 Frequency of occurrence of escaped farmed salmon among Scottish fisheries for wild salmon (1981–1996).

Year	Net											Rod
	East Riggs %	Redpoint %	Achiltibuie %	Culkein Clachtol %	Strathy %	Bonar B. %	Spey %	Dee %	N. Esk %	Tay %	Tweed %	N. Esk %
1981	[a]0				[a]0	[a]0	[a,b]0		[a,b]0			
1982	[a]0				[a]0.3	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1983	[a]0				[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1984	[a]0				[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1985	[a]0			[a]0	[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0
1986				[a]0.6	[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0
1987	[a]0			[a]1.3	[a]0	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1988				[a]1.5	[a]0.6	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1989				[a]6.6	[a]6.1	[a]0.7	[a,b]0.08		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1990		[a,b,c]22		[a]4.7	[a]3.8	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0.13	[a,b]0
1991		[a,b,c]19.8		[a]8.6	[a]7.3	[a]0.4	[a,b]0.14		[a,b]0.13	[a,b]0	[a,b]0	[a,b]0
1992		[a,b,c]18.5		[a]3.5	[a]2.3	[a]0.5	[a,b]0		[a,b]0	[a,b]0.13	[a]0	[a,b]0.16
1993		[a,b,c]37.5		[a,b]14.4	[a,b]15.2	[a,b]0.7			[a,b]0	[a,b]0	[a,b]0	[a,b]0.15
1994				[a,b]7.7	[a,b]7.1	[a,b]0.6			[a,b]0	[a,b]0.18	[a,b]0.4	[a,b]0.3
1995		[a,b]14.5	[a,b]4.2		[a,b]4.1				[a,b]0	[a,b]0	[a,b]0	[a,b]0
1996		[a,b]4.84	[a,b]6.9		[a,b]3.4				[a,b]0	[a,b]0	[a,b]0	[a,b]0

Detected by [a]morphological characters, [b]scales growth patterns or [c]carotenoid pigment analysis.

Table 6.2.2 Geographical distribution by frequency (%) of escaped farmed fish located among commercial catch samples for UK (Northern Ireland) and Ireland inshore catches (1991–1996).

	Frequency (%)					
Location	1991	1992	1993	1994	1995	1996
Northern Ireland (UK)	-	3.72	0.26	1.18	4.03	-
Donegal	0.00	0.02	0.09	0.14	0.02	0.34
Mayo	1.16	1.69	0.27	0.10	0.14	0.25
Galway	0.39	0.10	0.06	0.08	0.03	0.00
S. West	0.00	0.01	1.05	1.08	0.19	0.42
S. and East	-	-	-	-	-	0.00

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960-96

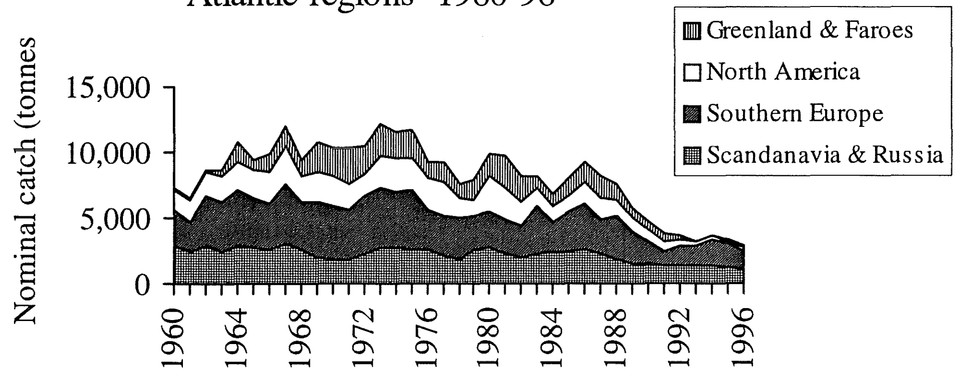


Figure 2.2.1.1 Production of farmed salmon (tonnes round fresh weight) in the North Atlantic, 1980-1996 (legend stacked relative to 1996 tonnages)

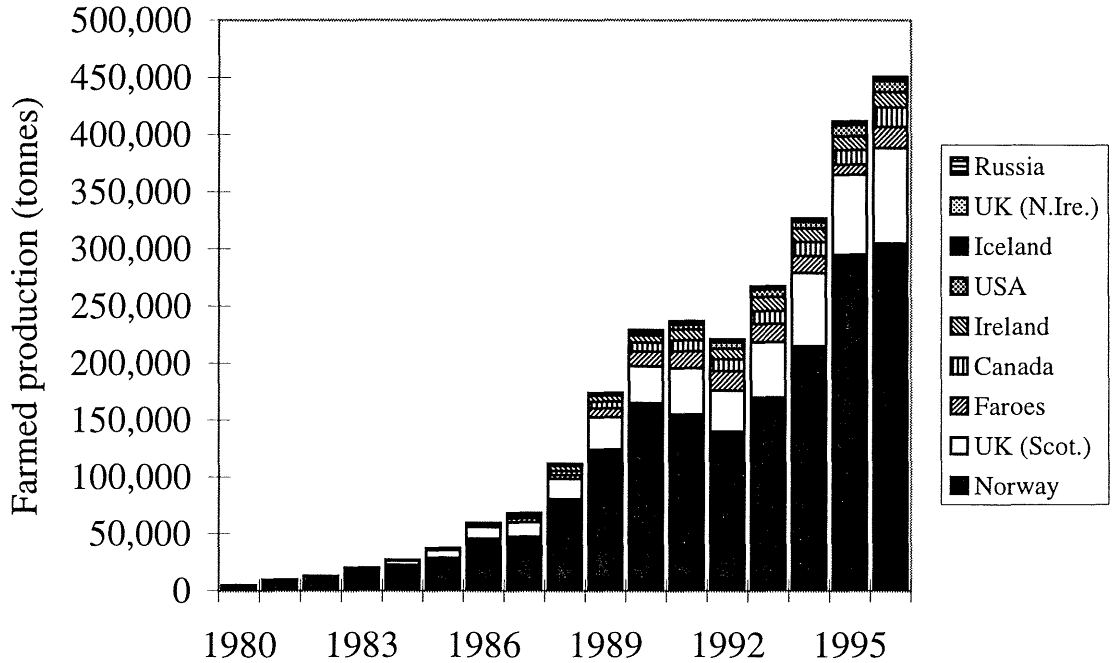


Figure 2.2.2.1. Production of ranched salmon (tonnes round fresh weight) as harvested at ranching facilities in the North Atlantic, 1980-1996 (legend stacked relative to 1996 tonnages).

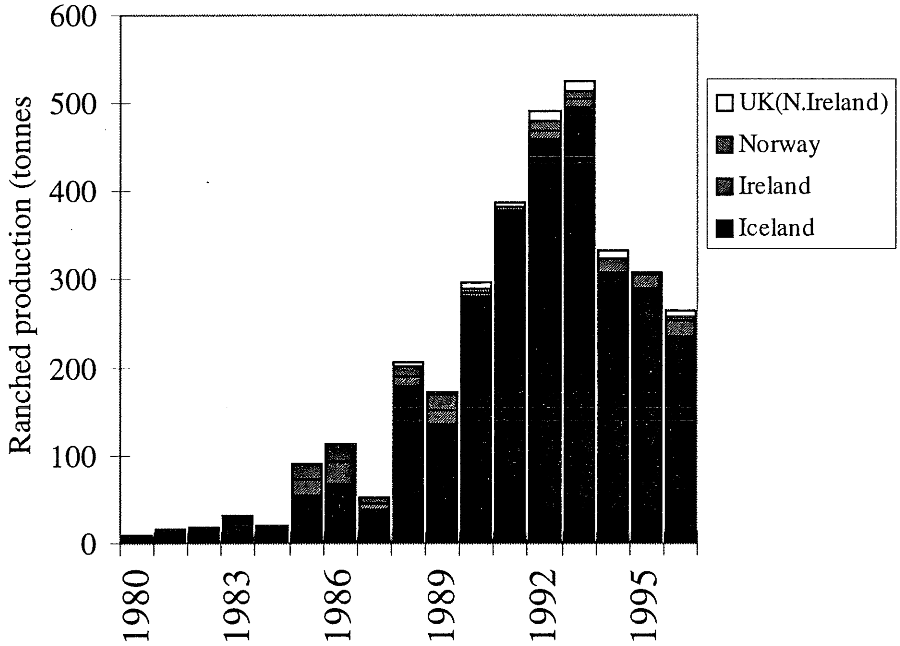


Figure 2.5.1. Map of northeast Atlantic area with rivers Figgjo and North Esk marked and general area of post-smolt habitat marked with hatching.

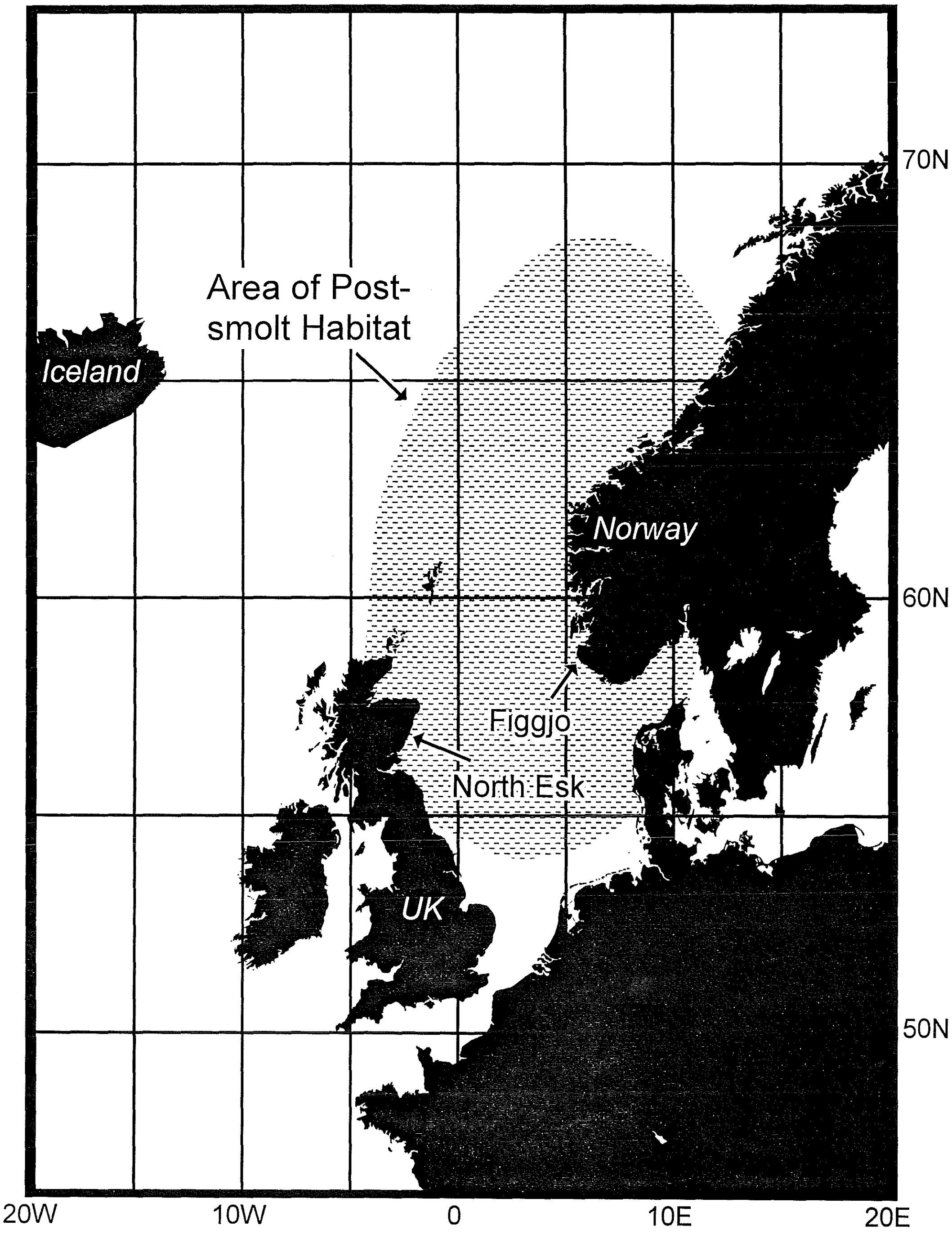


Figure 2.5.2. Tag recovery rate for 1SW salmon to the rivers Figgjo and North Esk versus year (A); tag recovery rate for 1SW salmon to the river Figgjo versus recovery rate for the North Esk (B); tag recovery rate for 2SW salmon to the rivers Figgjo and North Esk versus year (C); tag recovery rate for 2SW salmon to the river Figgjo versus recovery rate for the North Esk (D).

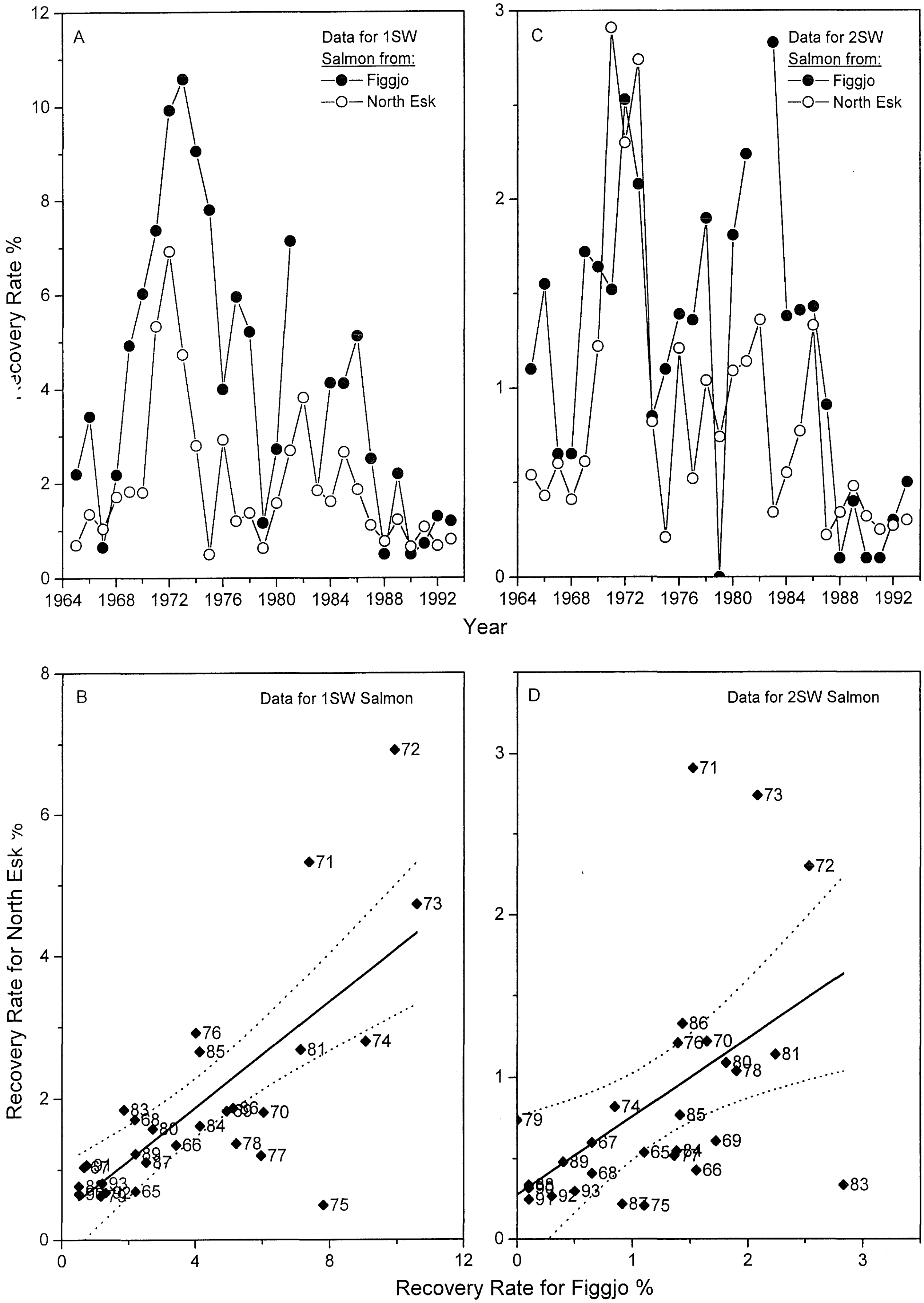


Figure 2.5.3. Correlation between thermal habitat and recovery rate of 1SW salmon versus the center longitude used to calculate the thermal habitat time series. Data for the Figgjo stock and thermal habitat ranges of 5-7°C (A); 6-8°C (B); 7-9°C (C); 8-10°C (D). Data for the North Esk stock and thermal habitat ranges of 5-7°C (E); 6-8°C (F); 7-9°C (G); 8-10°C (H).

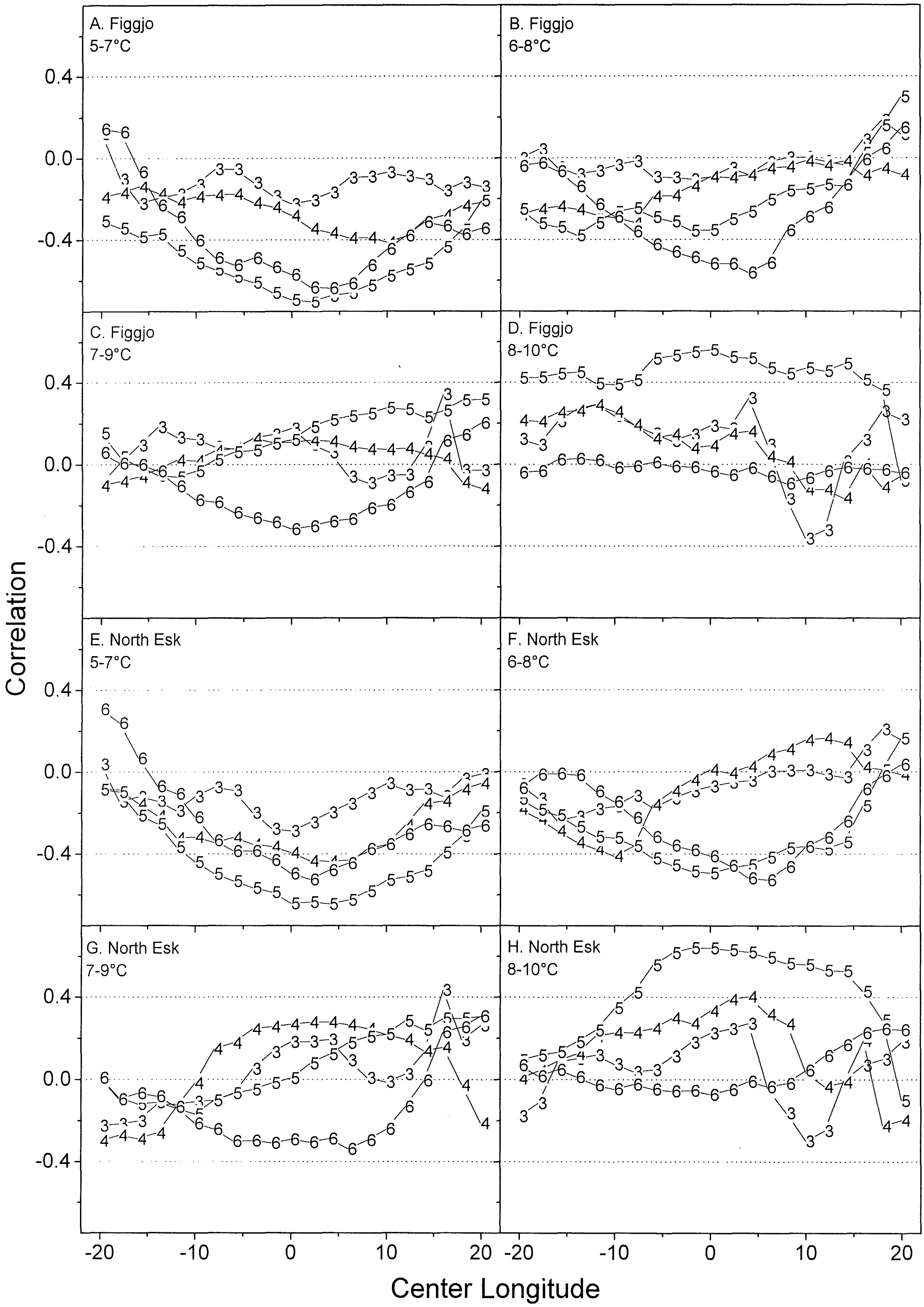
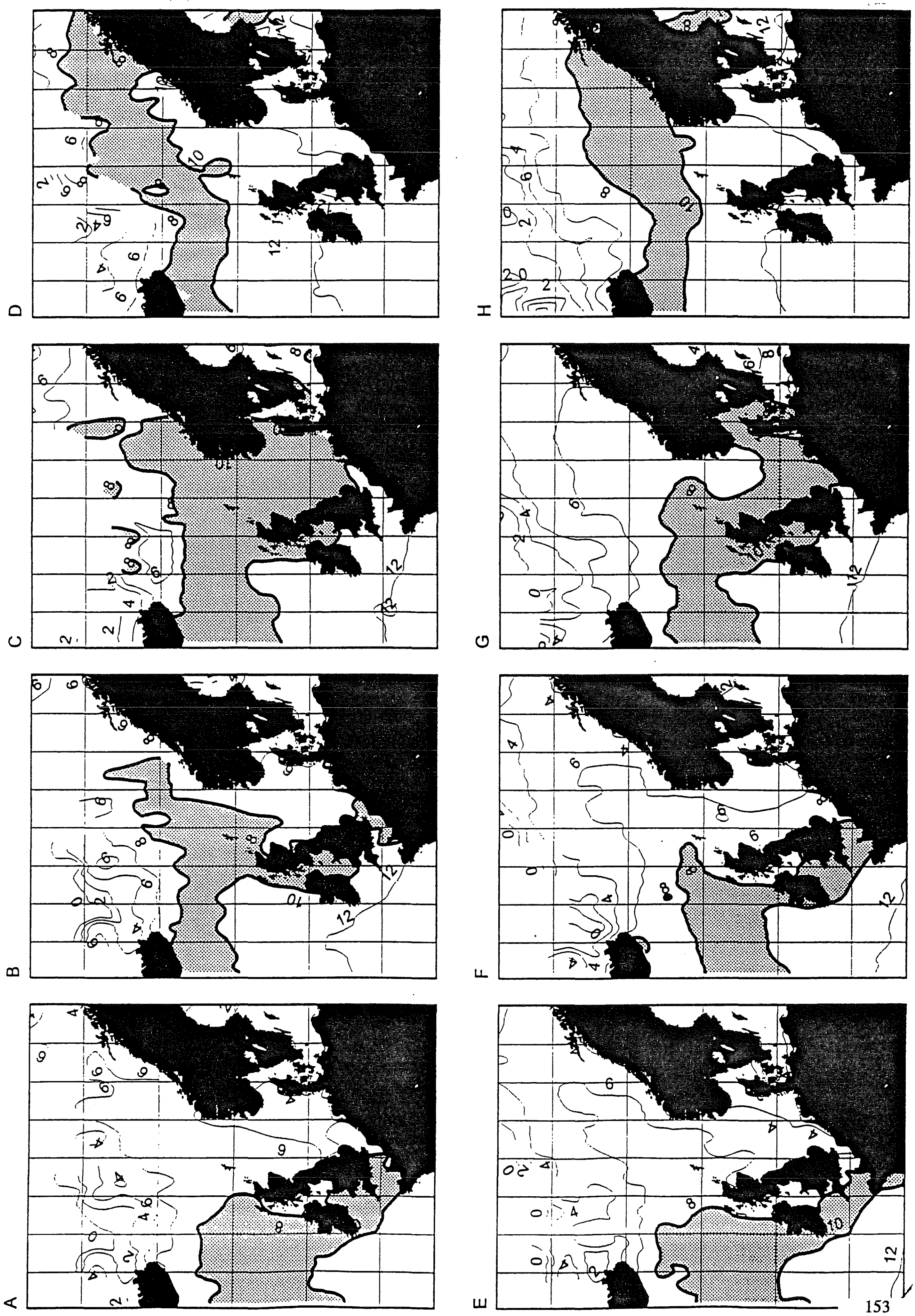


Figure 2.5.4. Sea surface temperature maps of the Northeast Atlantic area with 2°C isotherms and the SST area of 8-10°C marked with hatching for the period 1971-74, months March (A); April (B); May (C); June (D). Data for period 1985-88 , months March (E); April (F); May (G); June (H).



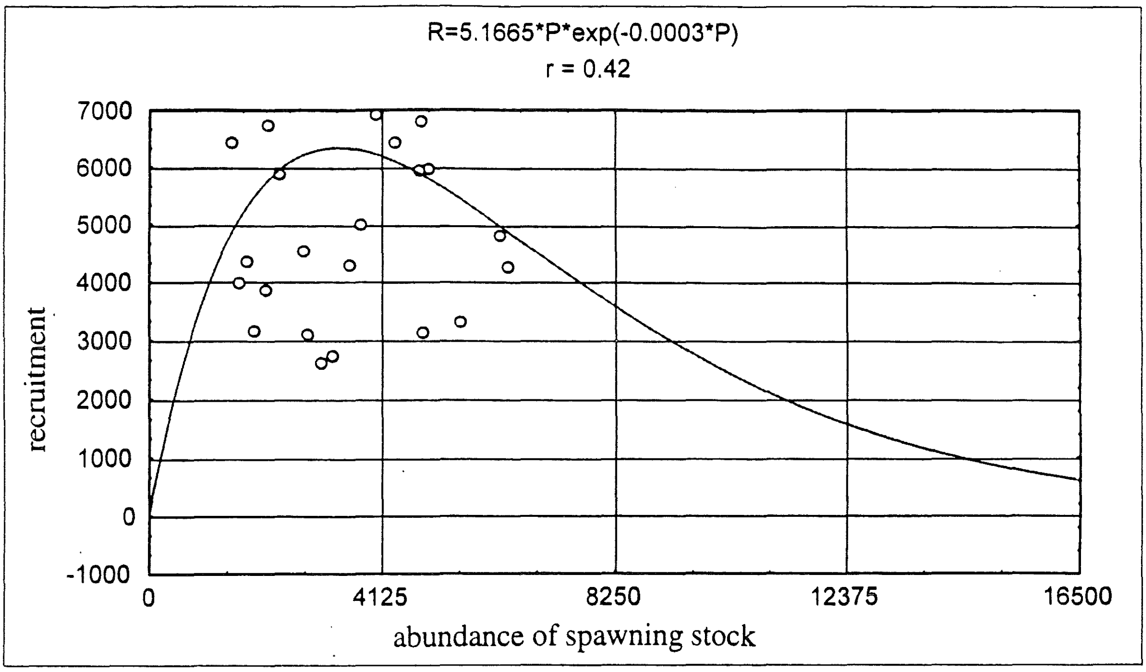


Figure 2.5.5 Stock/recruit plot (spawner to spawner) for the Tuloma River, Russia, with a fitted Ricker equation.

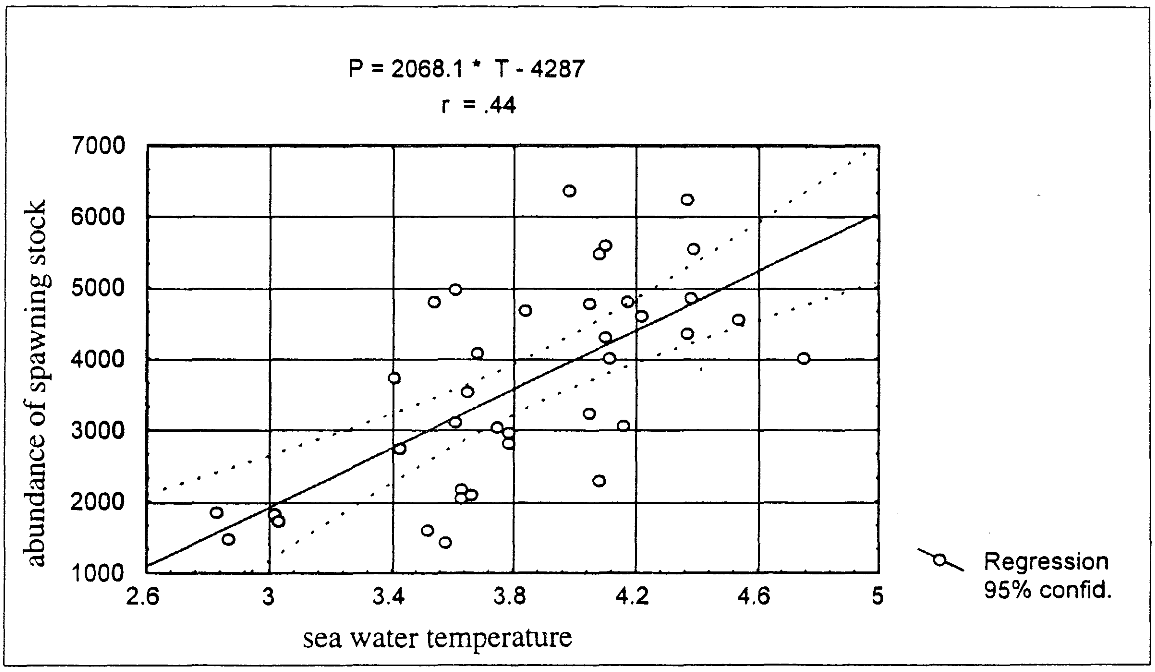


Figure 2.5.6 Plot of average sea temperature during the time at sea versus number of spawners returning to the Tuloma River.

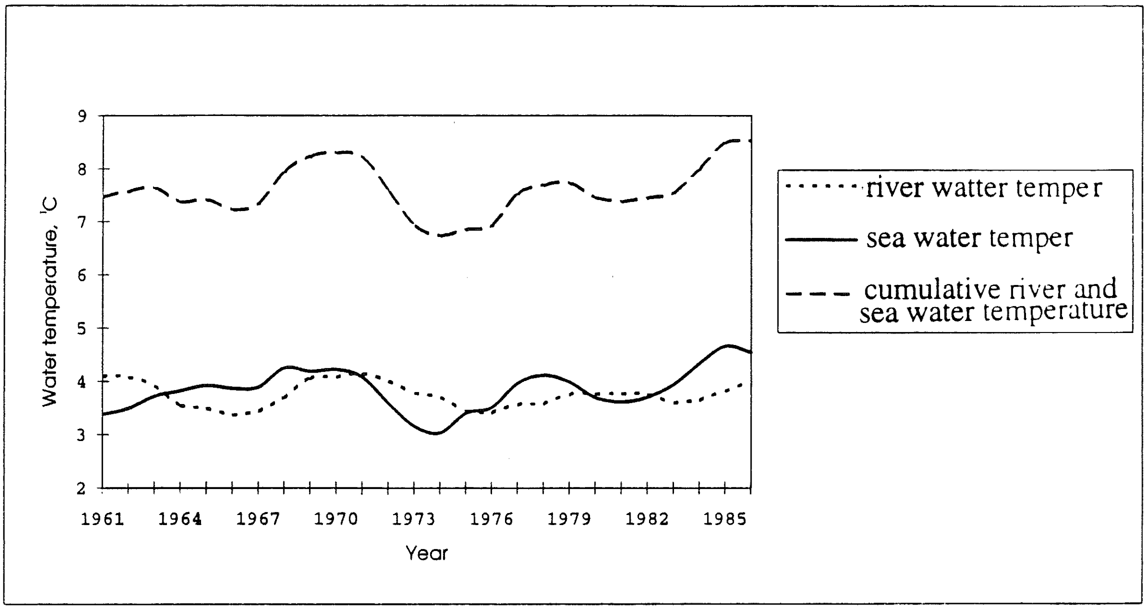


Figure 2.5.7 Average mean yearly water temperatures during the river and sea stages of the Atlantic salmon year classes considered in this analysis. Cumulative temperatures are the sum of the river and sea temperatures.

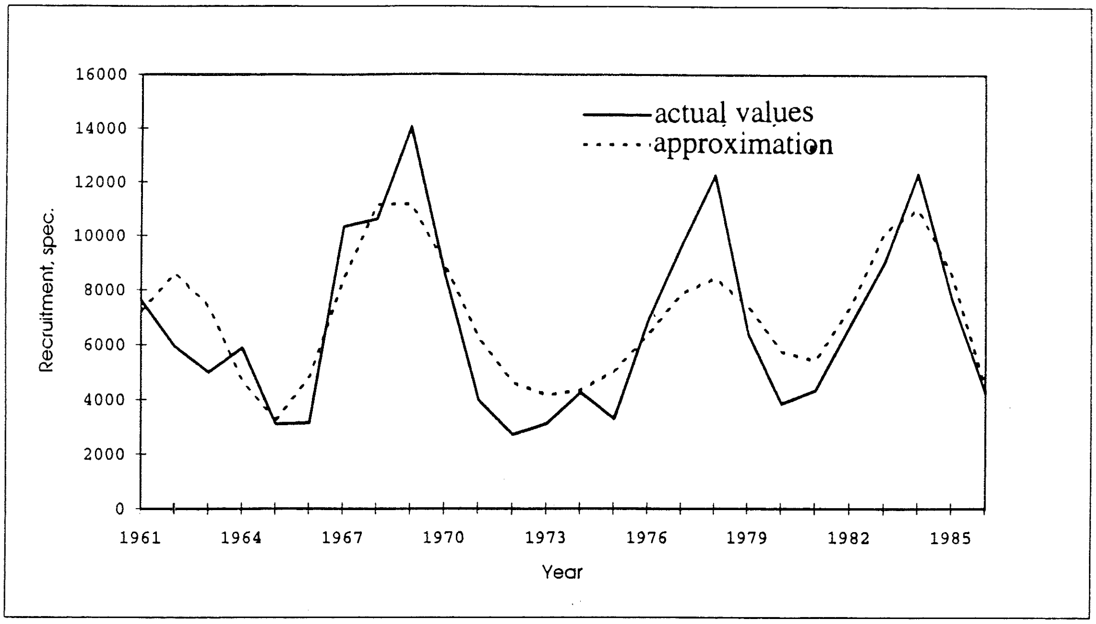


Figure 2.5.8 Recruitment of Atlantic salmon to the Tuloma River plotted with predicted values resulting from a model fitting 4 harmonics with periods: $T_1 = 13.1$; $T_2 = 7.4$; $T_3 = 5.5$; $T_4 = 2.8$;

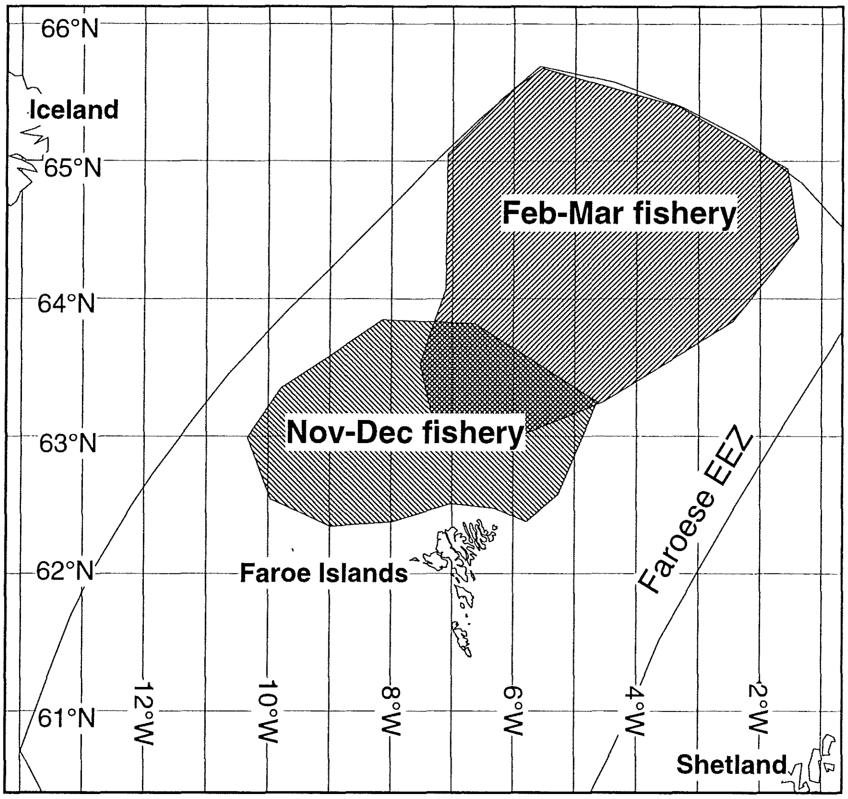


Figure 3.2.2.1. Areas fished during the tagging experiment at Faroes (1992/1993 – 1994/1995). The autumn fishery (Nov-Dec) is located closer to the isles and more westerly than the winter fishery (Feb-Mar) located further to the north-east.

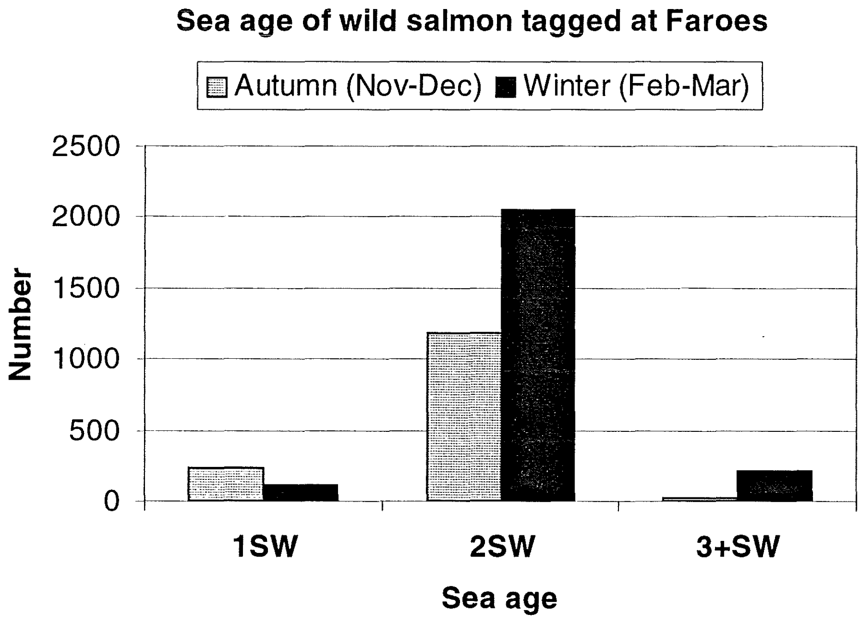


Figure 3.2.2.2. Sea age distribution of wild Atlantic salmon by half season. The autumn is defined as Nov-Dec and winter as Feb-Mar.

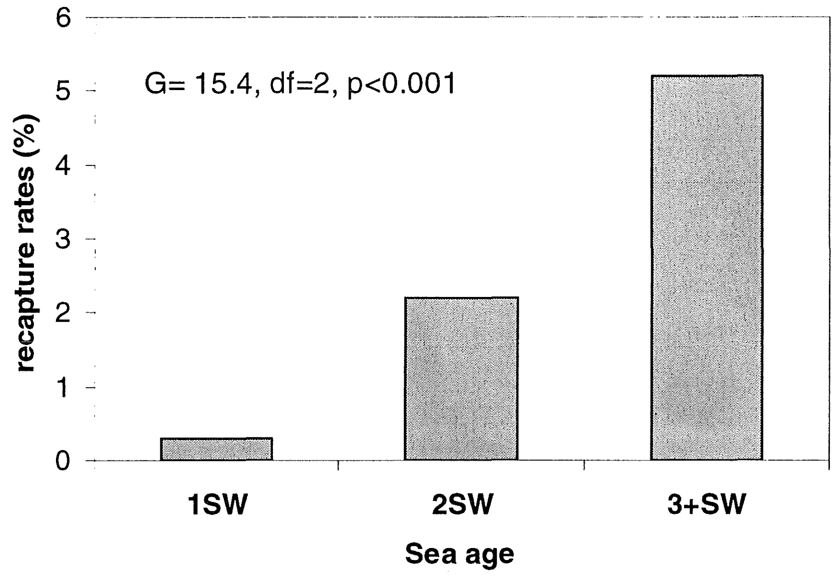


Figure 3.2.2.3. Recapture rates by sea age of wild Atlantic salmon tagged north of the Faroes.

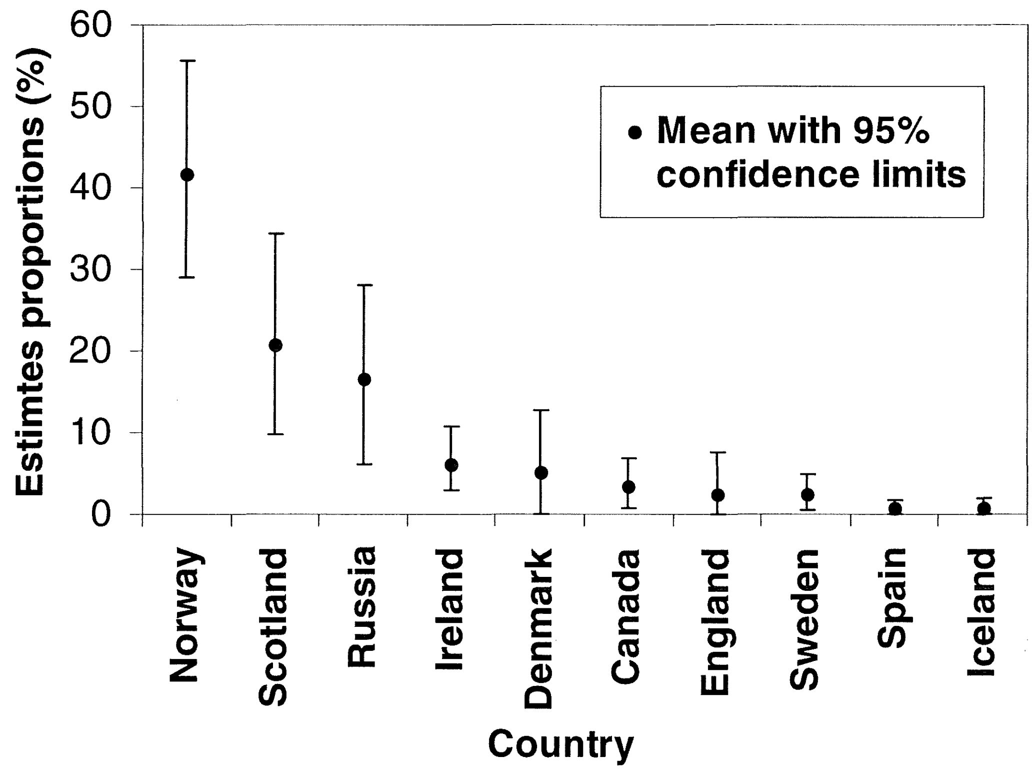


Figure 3.2.2.4. Estimated proportions (%) of wild salmon tagged at Faroes returning to different countries in the Northeast Atlantic. Confidence limits (95%) are indicated around the mean proportions.

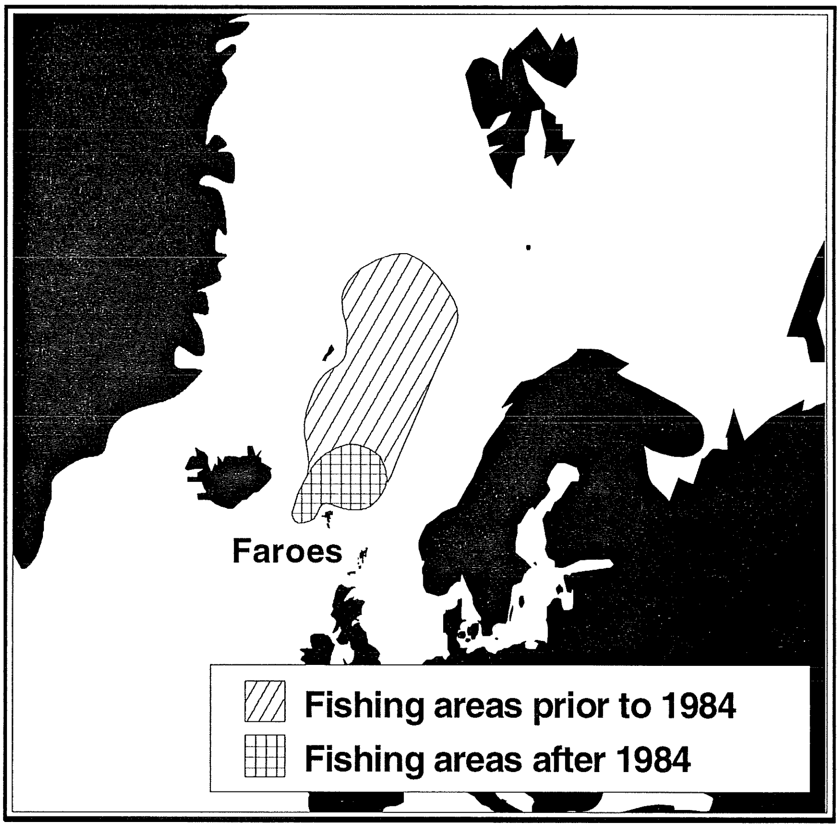


Figure 3.2.3.1. Map of the Northeast Atlantic showing the approximate areas of distribution of salmon and Faroese fishing areas before 1984 and after when area restrictions were in force.

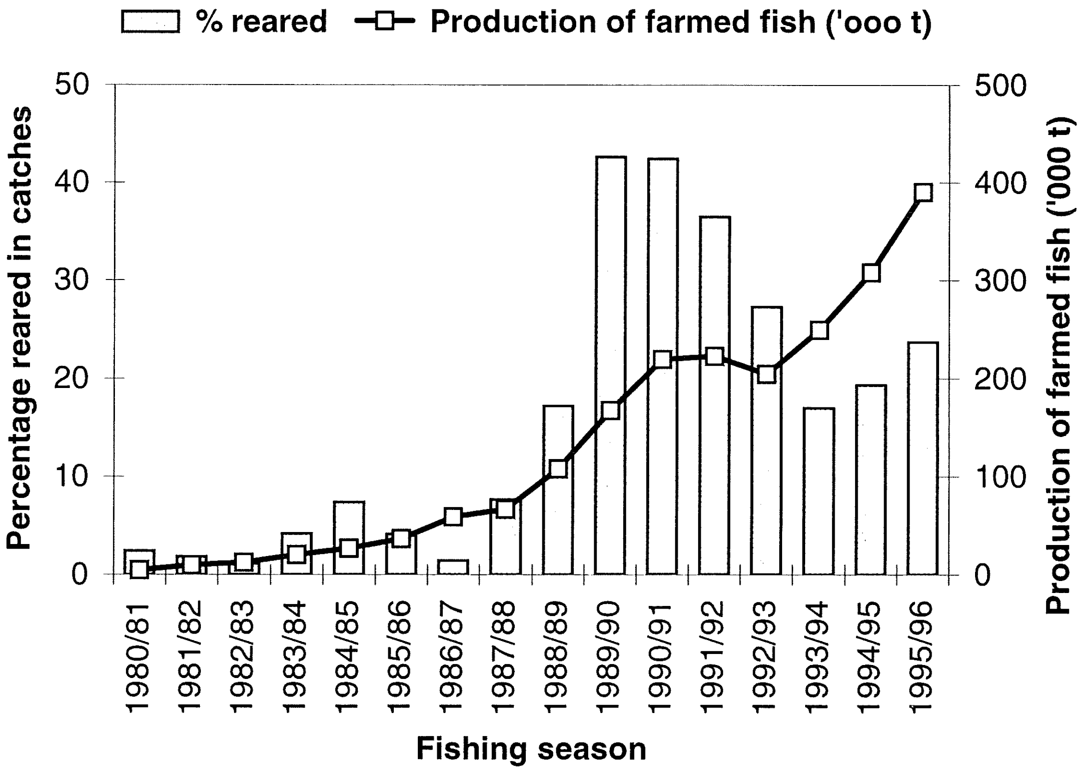


Figure 3.2.3.2. Distribution of farmed salmon in samples collected in Faroese waters from the 1980/81 fishing season, and total production of farmed salmon in the Northeast Atlantic.

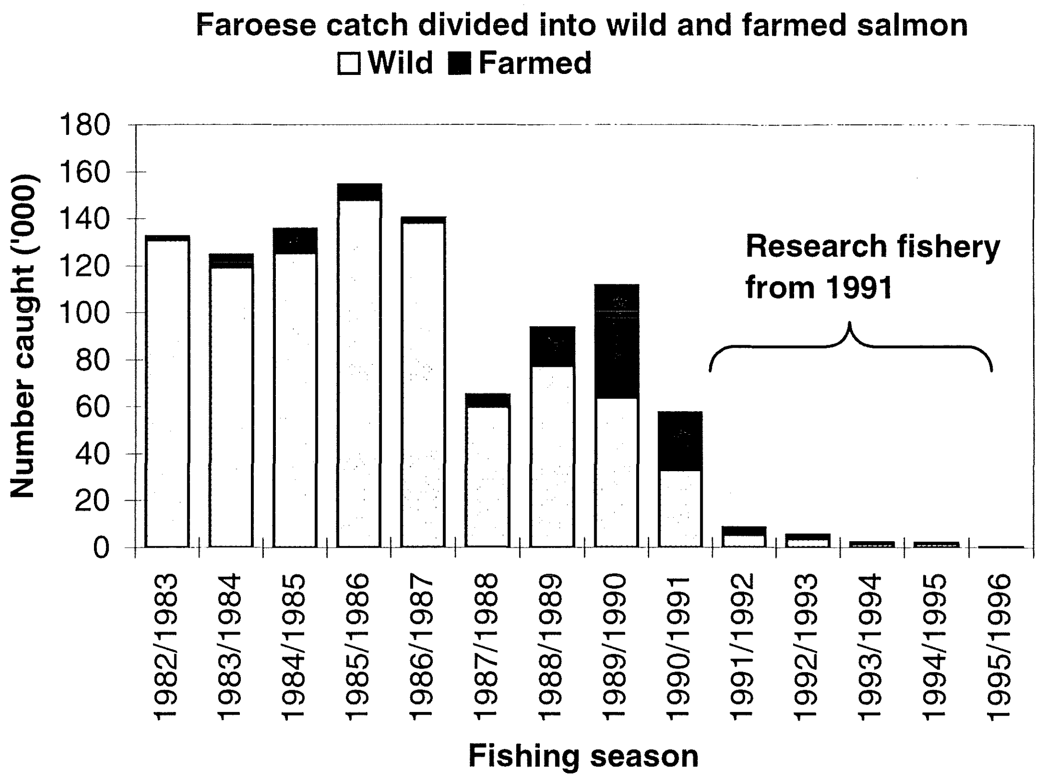


Figure 3.2.3.3. Estimated catches of wild and farmed Atlantic salmon in Faroese waters from the 1980/81 fishing season.

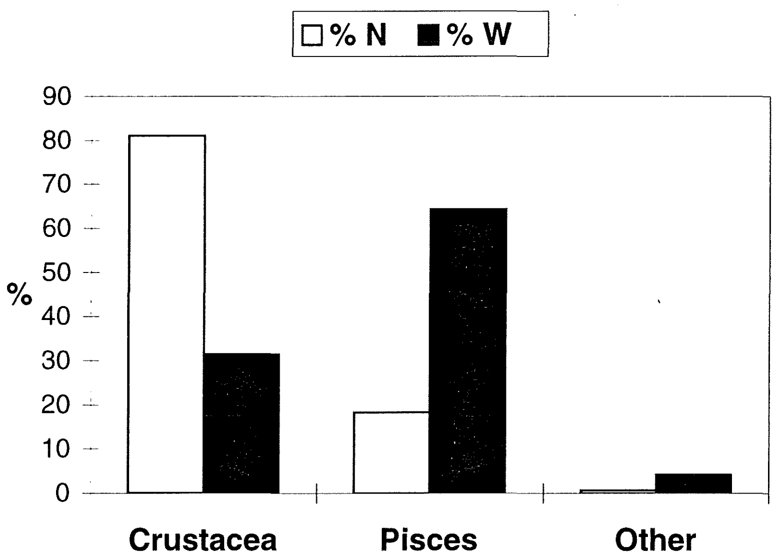


Figure 3.2.4.1. Percentage distribution of stomach content in number (%N) and weight (%W) of the major prey-groups for all three fishing seasons combined (1992/93 - 1994/95). (source: Jacobsen and Hansen (1996)).

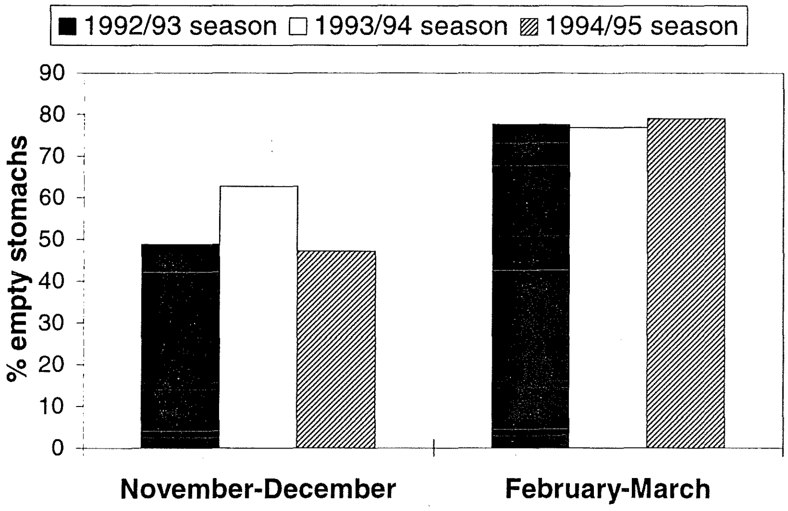


Figure 3.2.4.2. Percentage of salmon stomachs containing food in Nov-Dec and Feb-Mar in three consecutive fishing seasons 1992/93, 1993/94 and 1994/95 from the area north of the Faroes. (source: Jacobsen and Hansen (1996)).

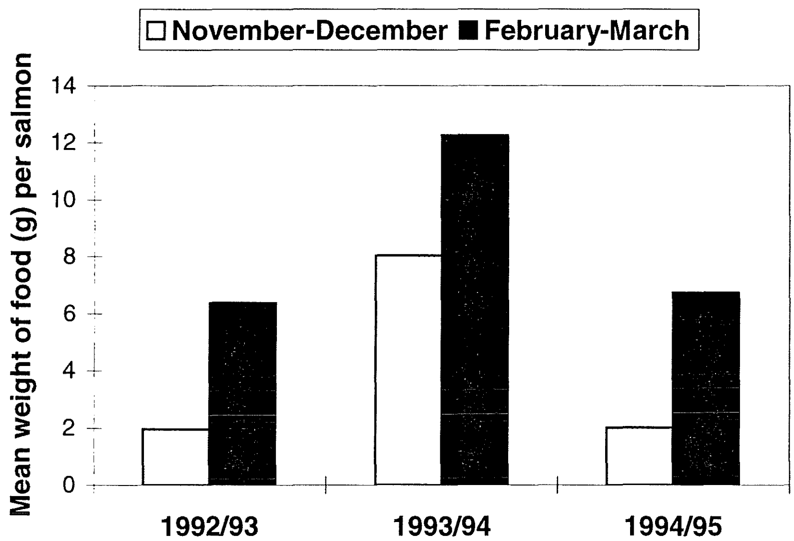


Figure 3.2.4.3. Mean weight of food content (g) per salmon in Nov-Dec and in Feb-Mar during three consecutive fishing seasons 1992/93, 1993/94 and 1994/95. (source: Jacobsen and Hansen (1996)).

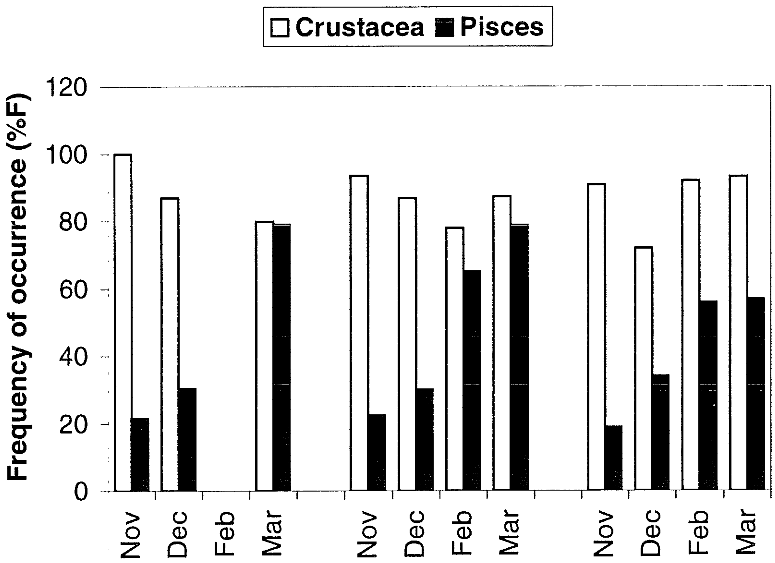


Figure 3.2.4.4. Percentage frequency of occurrence (%F) of prey of crustaceans vs. fish by month in salmon stomachs in three consecutive fishing seasons 1992/93, 1993/94 and 1994/95 from the area north of the Faroes. (source: Jacobsen and Hansen (1996)).

Figure 3.3.4.1. Nominal catches of salmon in the NEAC countries in 1996 relative to previous indices.

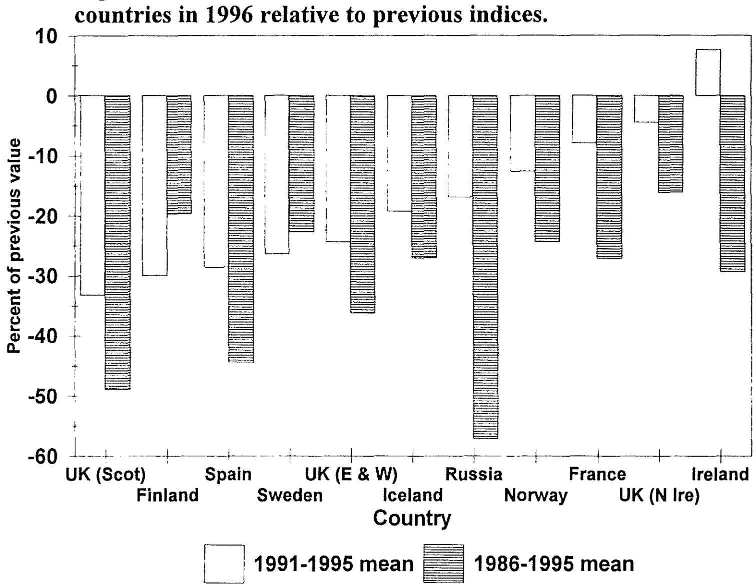


Figure 3.3.6.1. The proportion of 1SW salmon in NEAC catches in 1996 relative to previous indices.

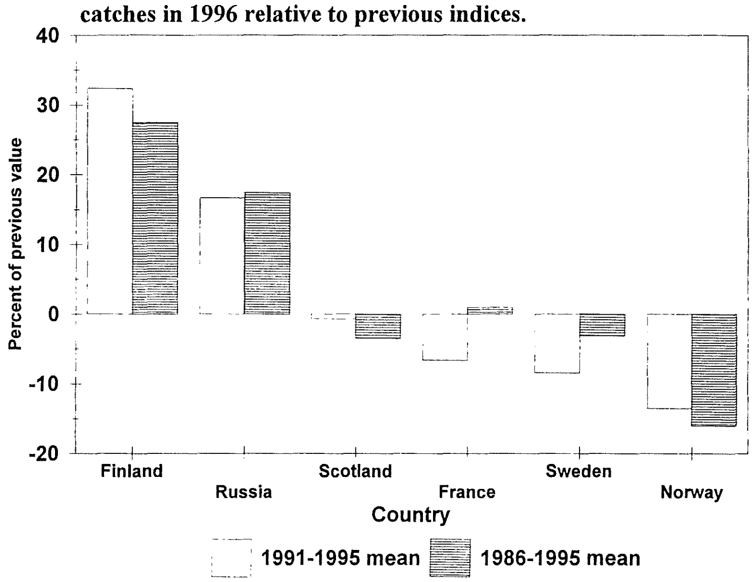
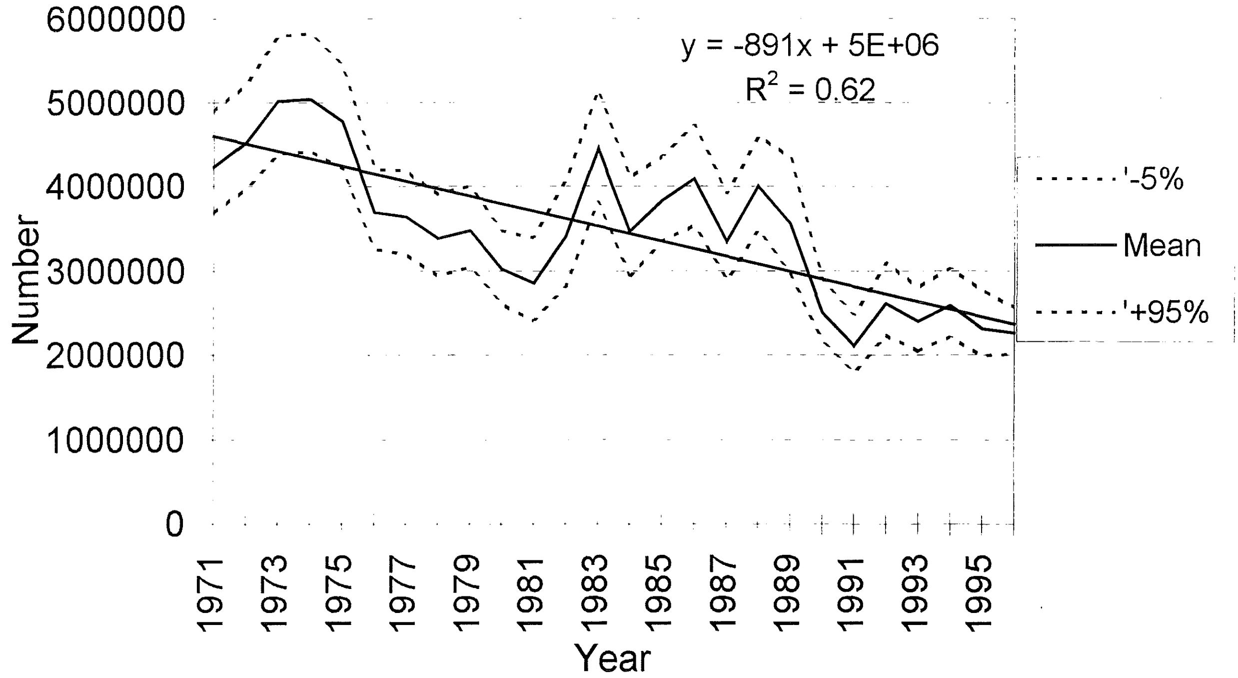


Figure 3.7.2.1 Estimation of pre-fishery abundance of salmon stocks in the NEAC Area by @Risk simulation:

a) total maturing 1SW recruits



b) total non-maturing 1SW recruits

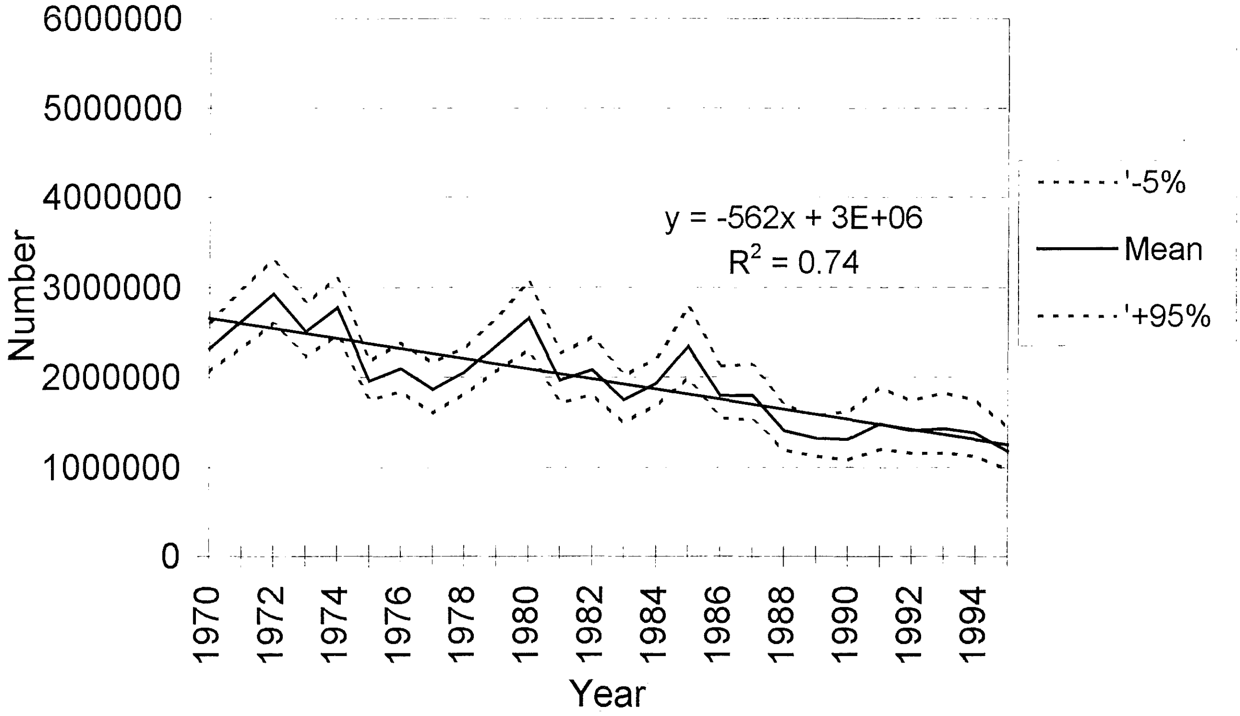
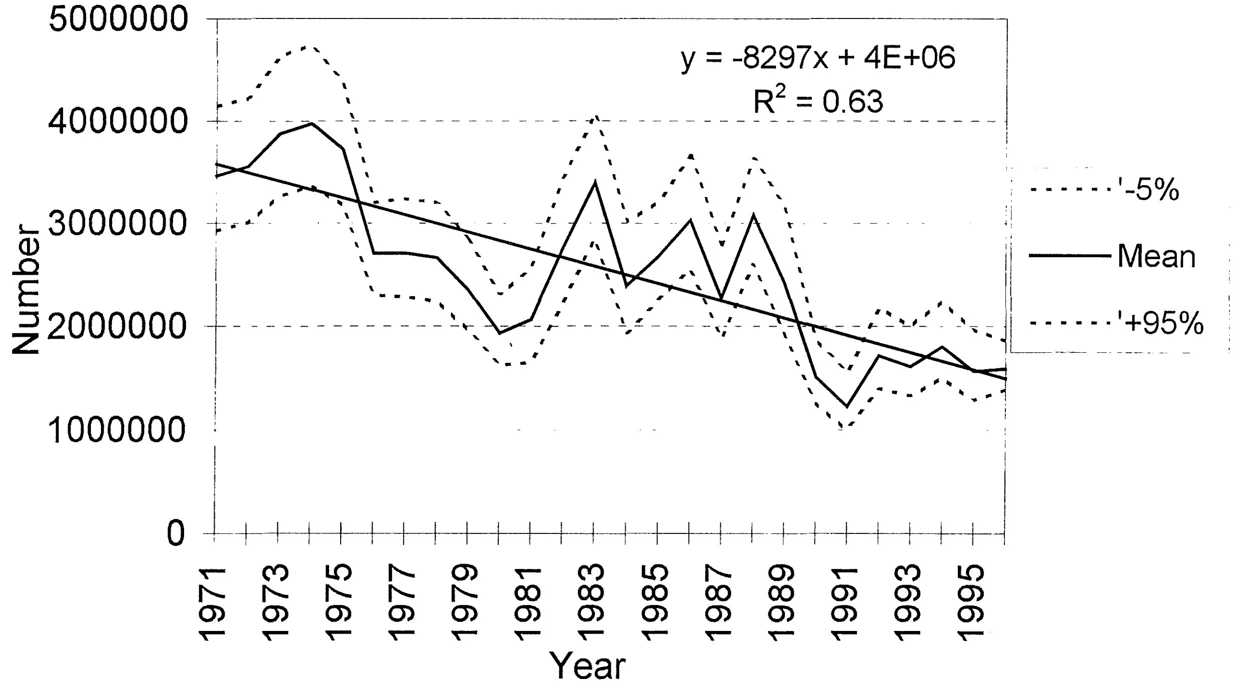


Figure 3.7.2.2 Estimation of pre-fishery abundance of Southern European salmon stocks by @Risk simulation:

a) maturing 1SW recruits (Southern)



b) non-maturing 1SW recruits (Southern)

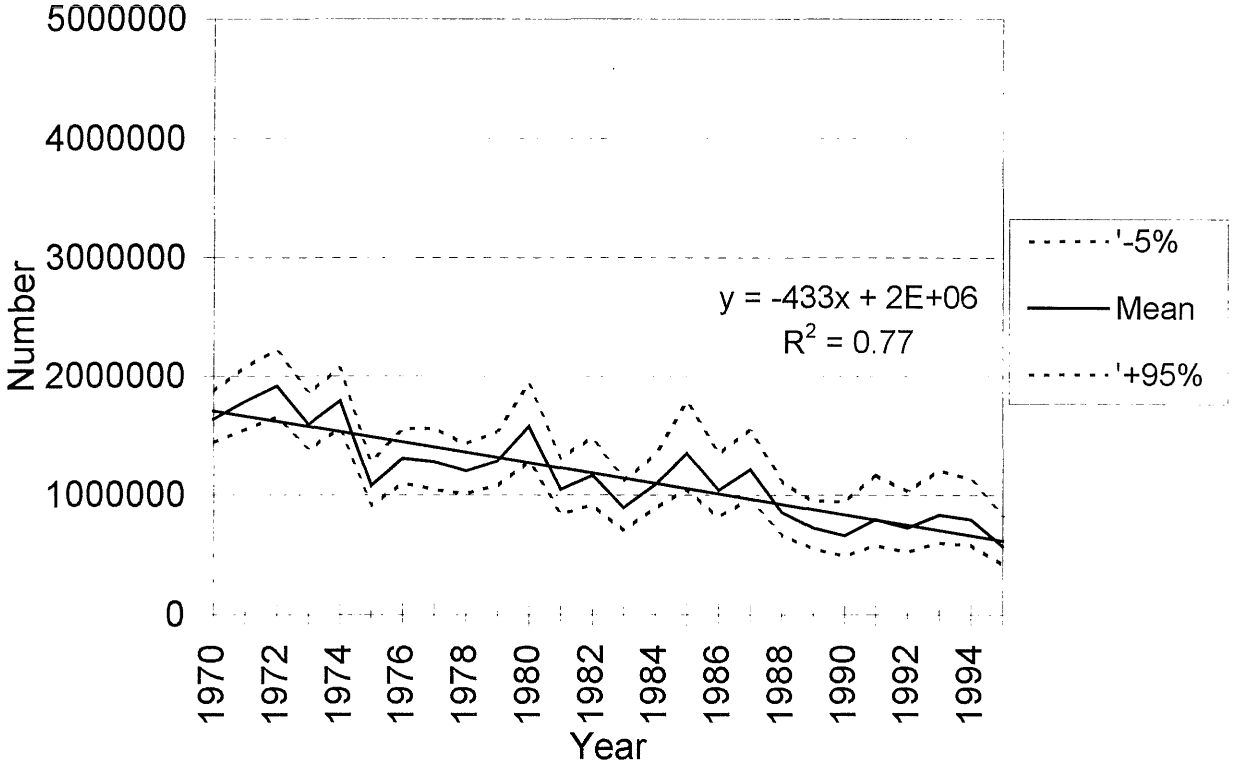
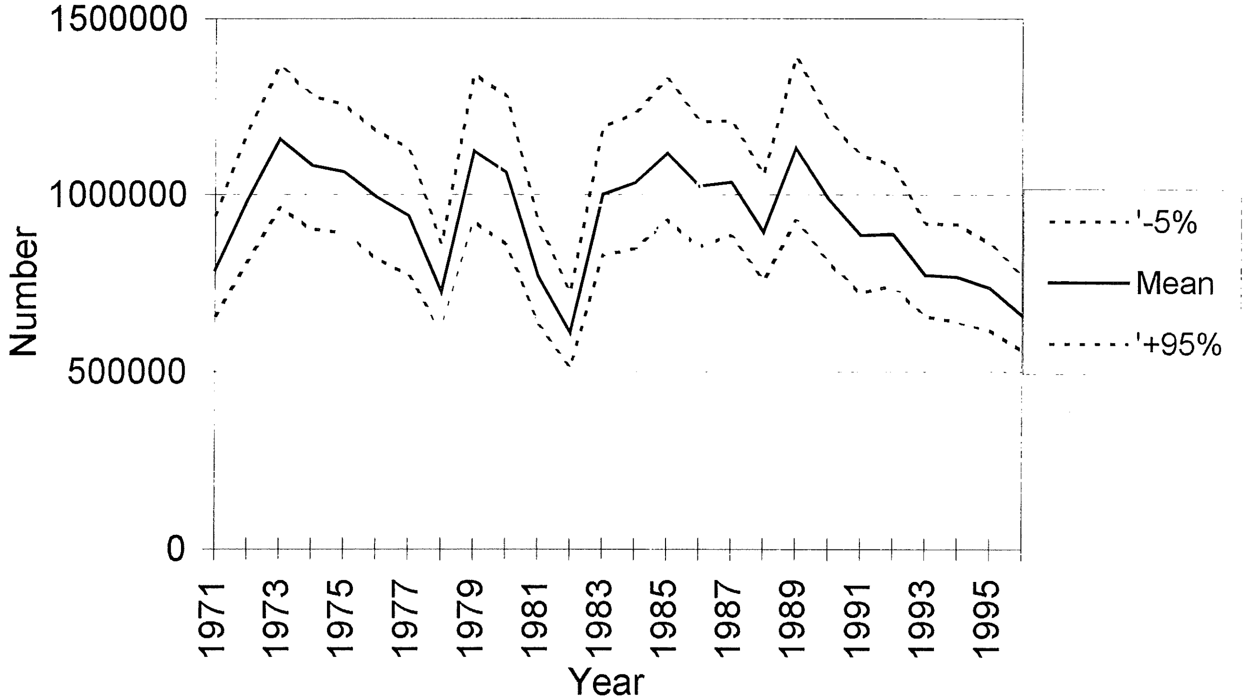


Figure 3.7.2.3 Estimation of pre-fishery abundance of Northern European salmon stocks by @Risk simulation:

a) maturing 1SW recruits (Northern)



b) non-maturing 1SW recruits (Northern)

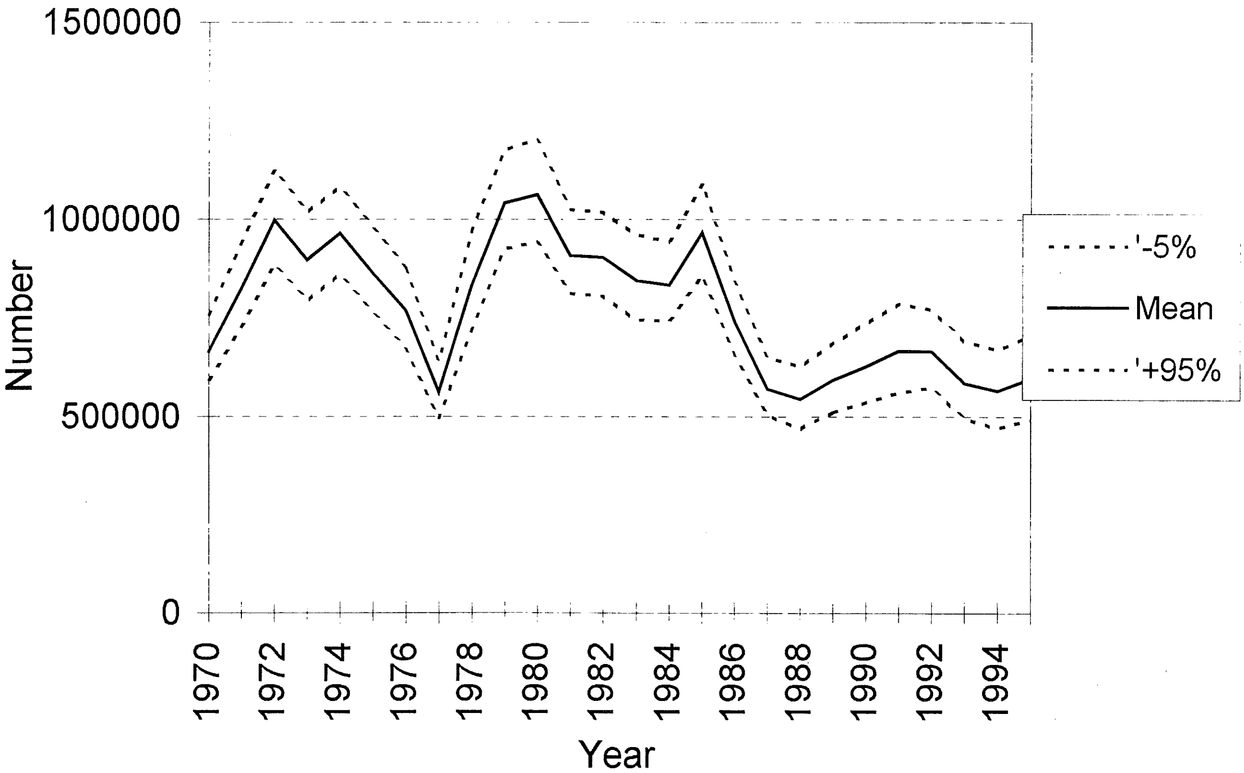
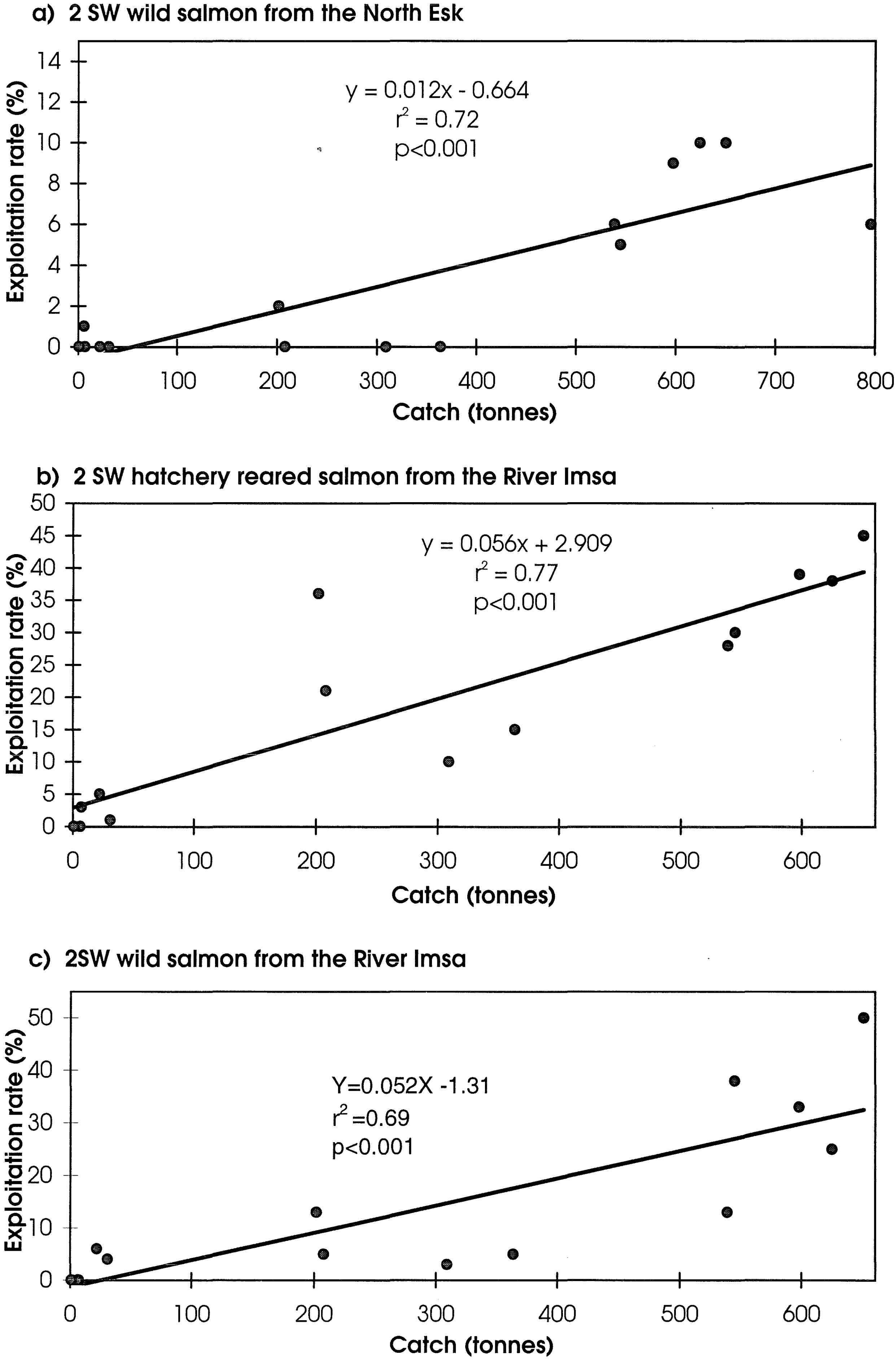


Figure 3.7.3.1 Exploitation rate on various monitored stocks in the NEAC Area against catch in the Faroes fishery



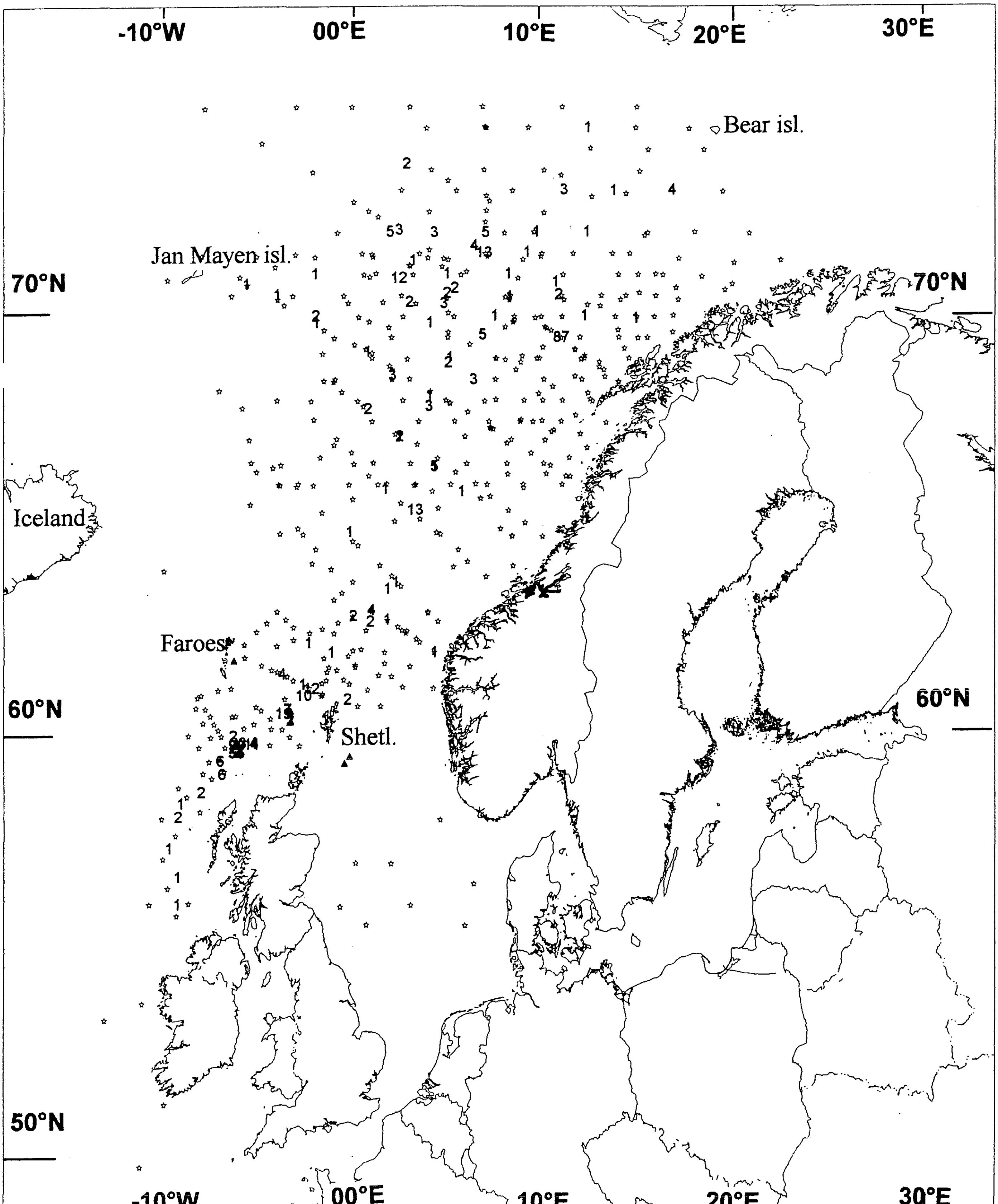


Fig.3.8.1.1. Locations of IMR and Scottish surface trawl-hauls 1991 -96. Stars indicate IMR hauls with no salmon. Triangles indicate Scottish hauls with no salmon. Numbers indicate number of salmon captured in a haul. Geographic position in the middle of the number. Darker stars indicate multiple hauls in overlapping positions.See also table 3.8.1.1.

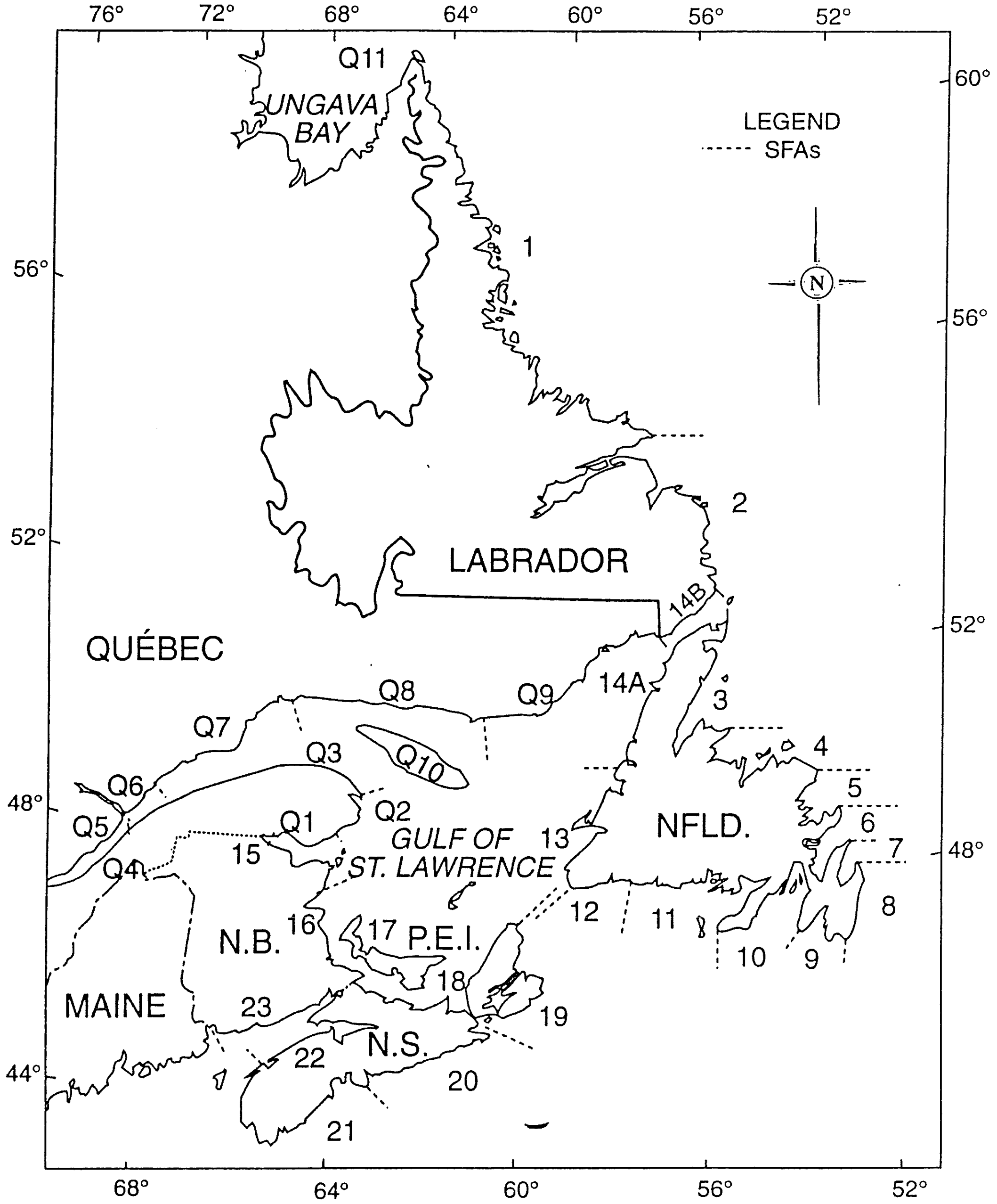


Figure 4.1.1.1 Map of Salmon Fishing Areas (SFAs) in Canada.

Figure 4.1.1.2. Summary of recreational fisheries management in eastern Canada in 1996.

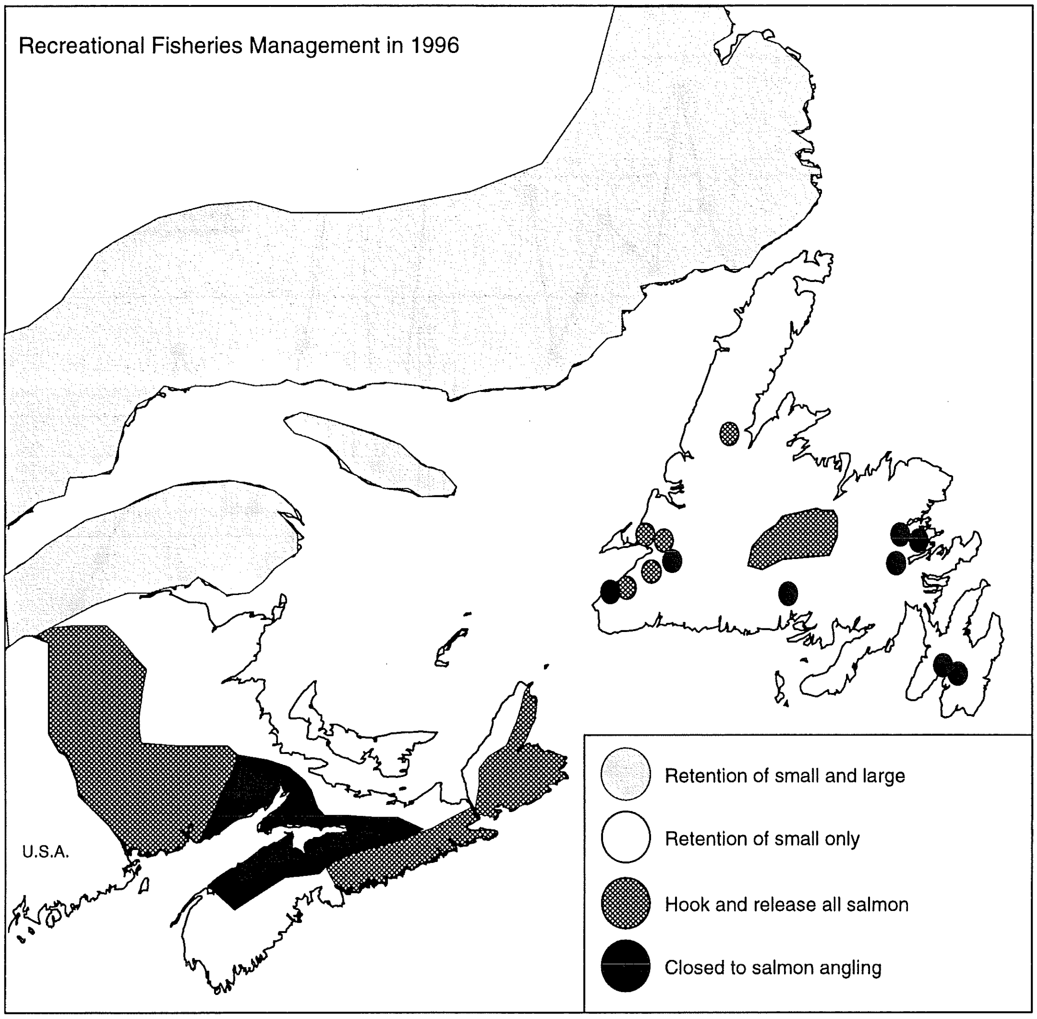


Figure 4.1.2.1. Harvest (t) of small salmon, large salmon, and total in Canada, 1960 to 1996.

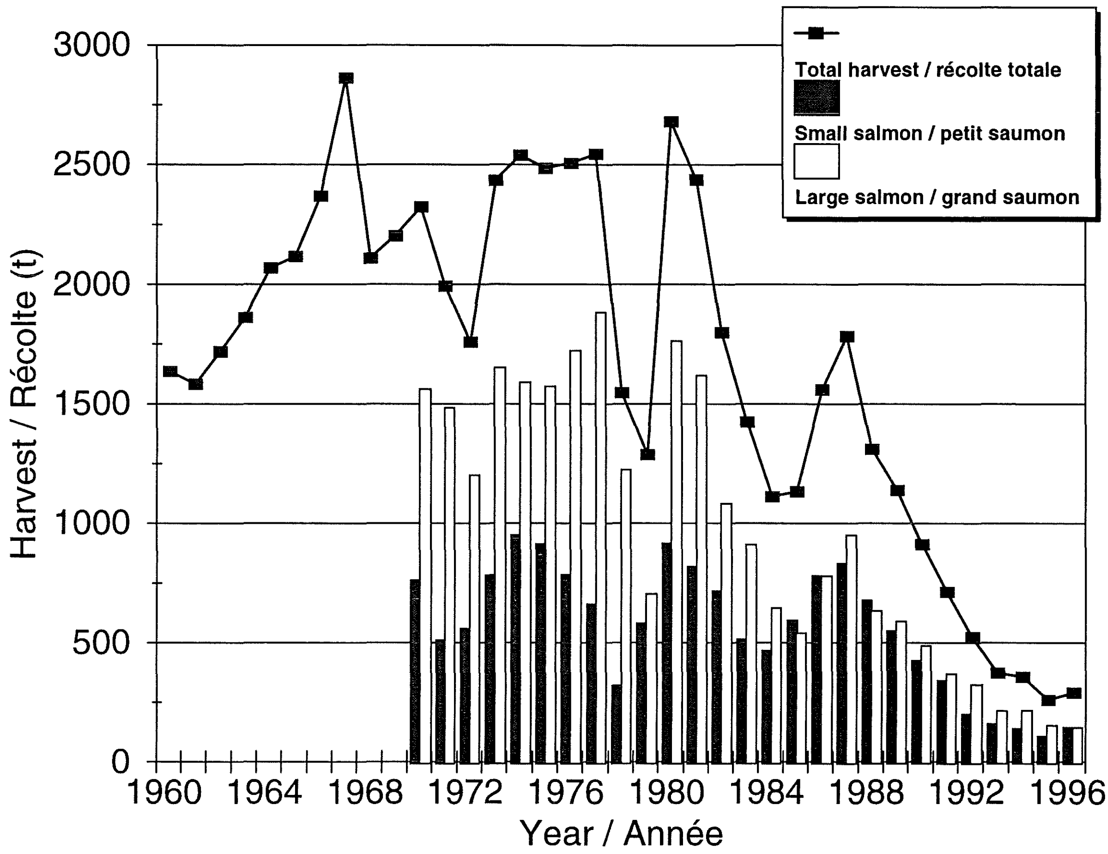


Figure 4.1.2.2. Harvest (number) of small salmon and large salmon and total in the recreational fisheries in Canada, 1974 to 1996.

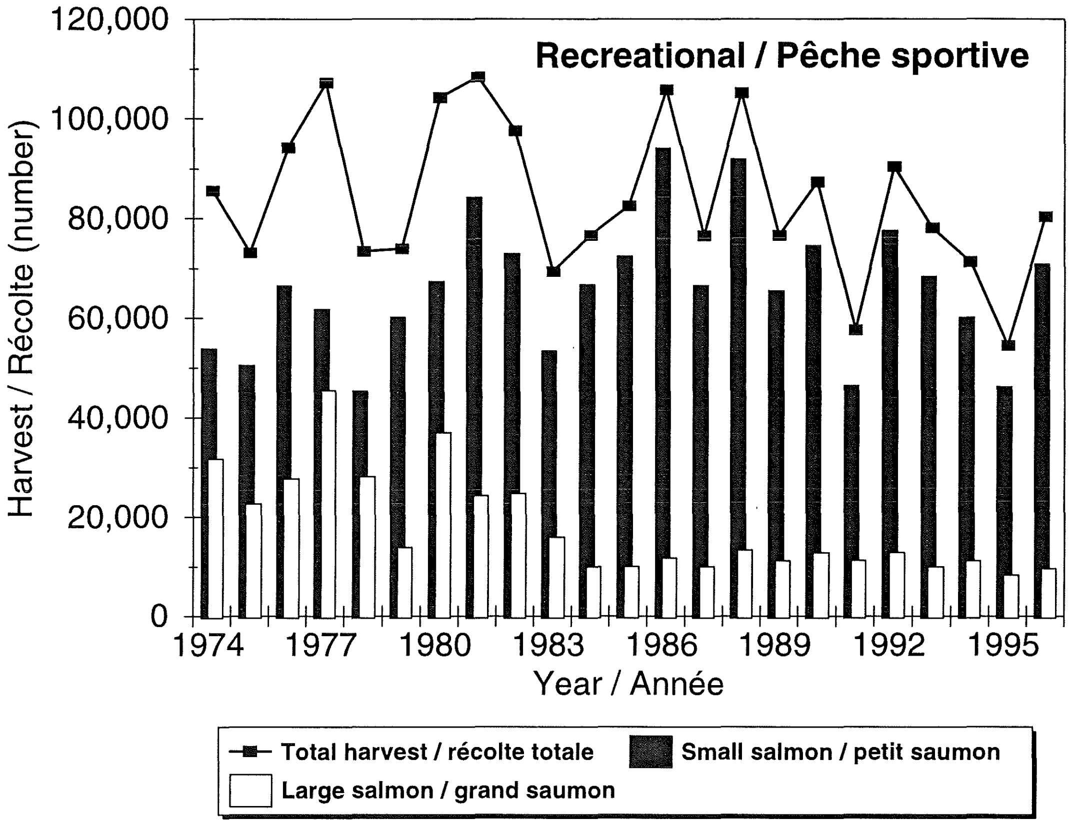
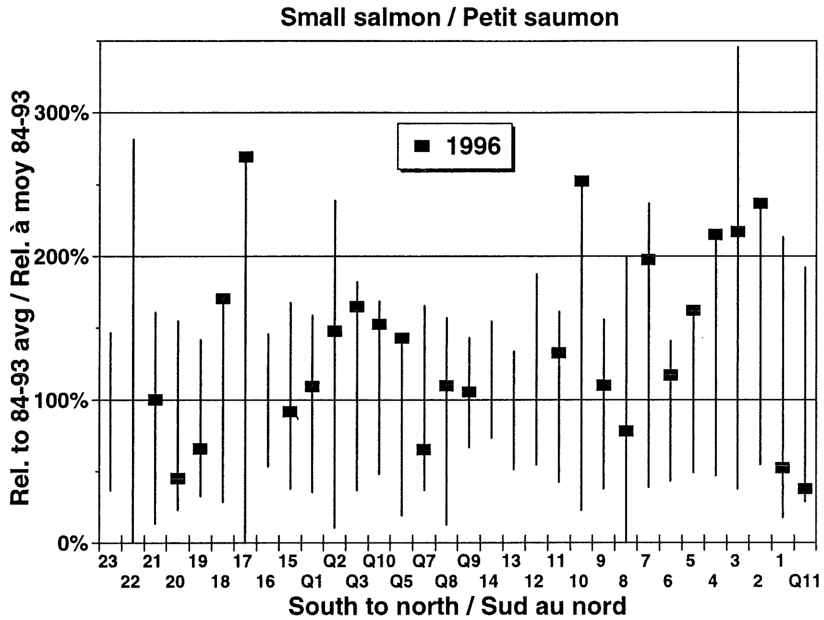


Figure 4.1.2.3. Angling catches of small and large salmon by management area in 1996 (black square) expressed as a percentage of the average catches for the period 1984 to 1993. The vertical lines represent the minimum to maximum range. No estimates of catch were available for SFA 12, 13, 14, 16 and 23 in 1996.



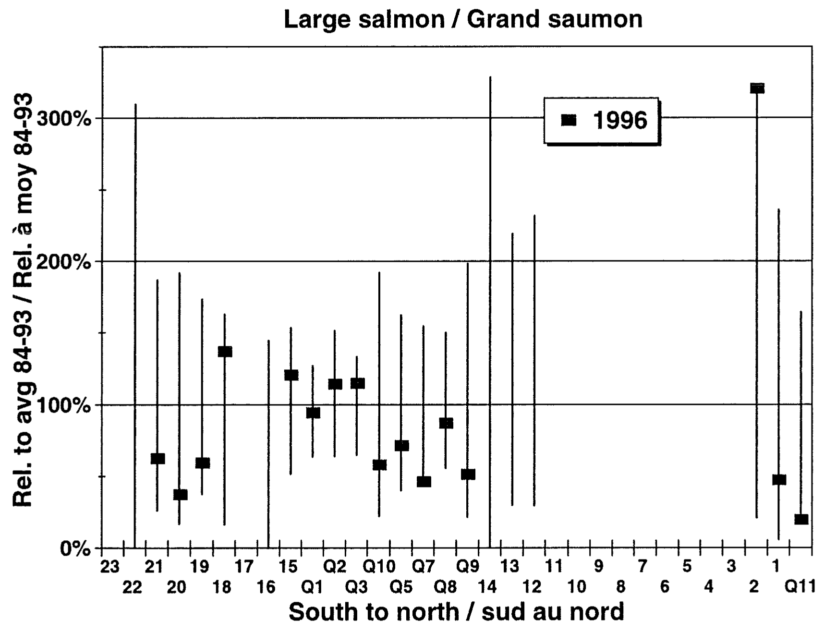


Figure 4.1.2.4. Harvest (t) of small salmon and large salmon and total in the commercial fisheries of Canada, 1974 to 1996.

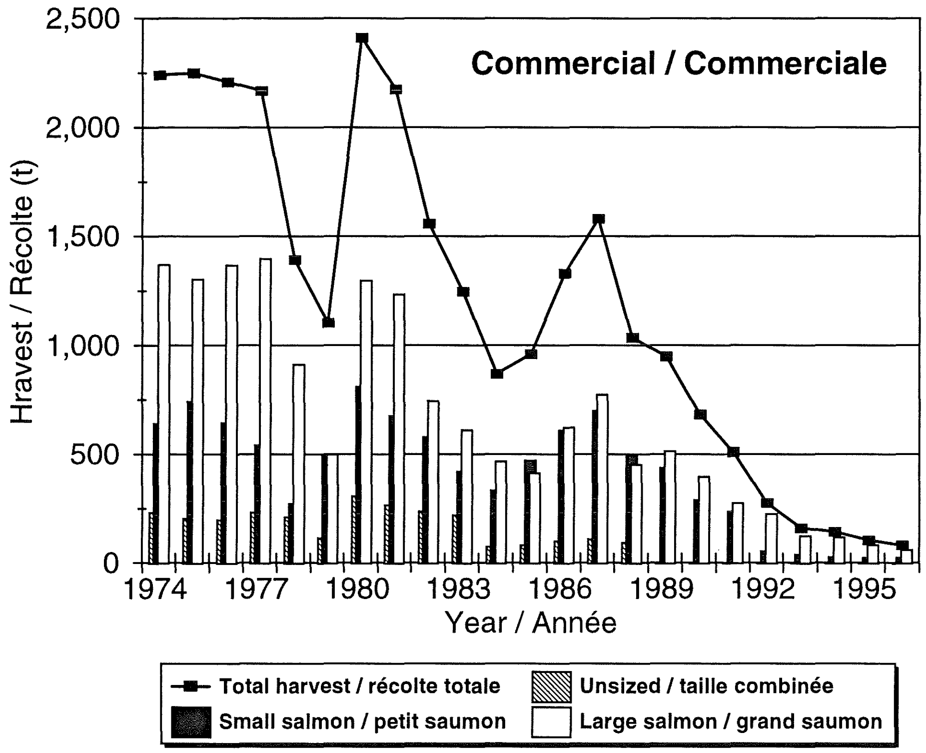


Figure 4.1.3.1. Origin (wild, hatchery, aquaculture) of Atlantic salmon returning to monitored rivers of eastern Canada in 1996. Only rivers in which more than one origin type were observed are indicated.

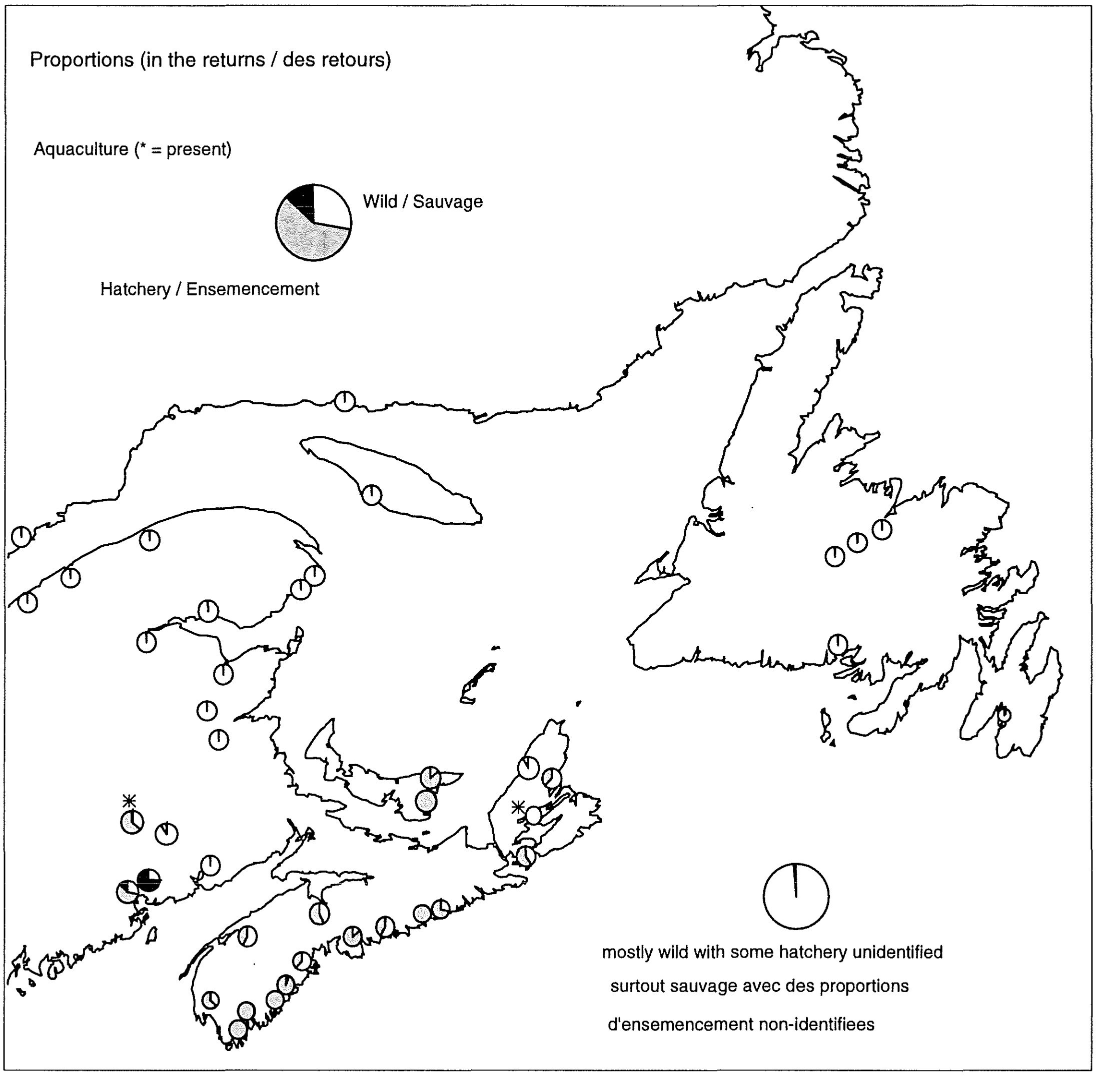


Figure 4.2.1.1. In-river returns of small salmon and large salmon for 26 monitored rivers in four geographic areas of eastern Canada from 1985 to 1996. The in-river returns do not account for removals in marine fisheries. N = number of rivers.

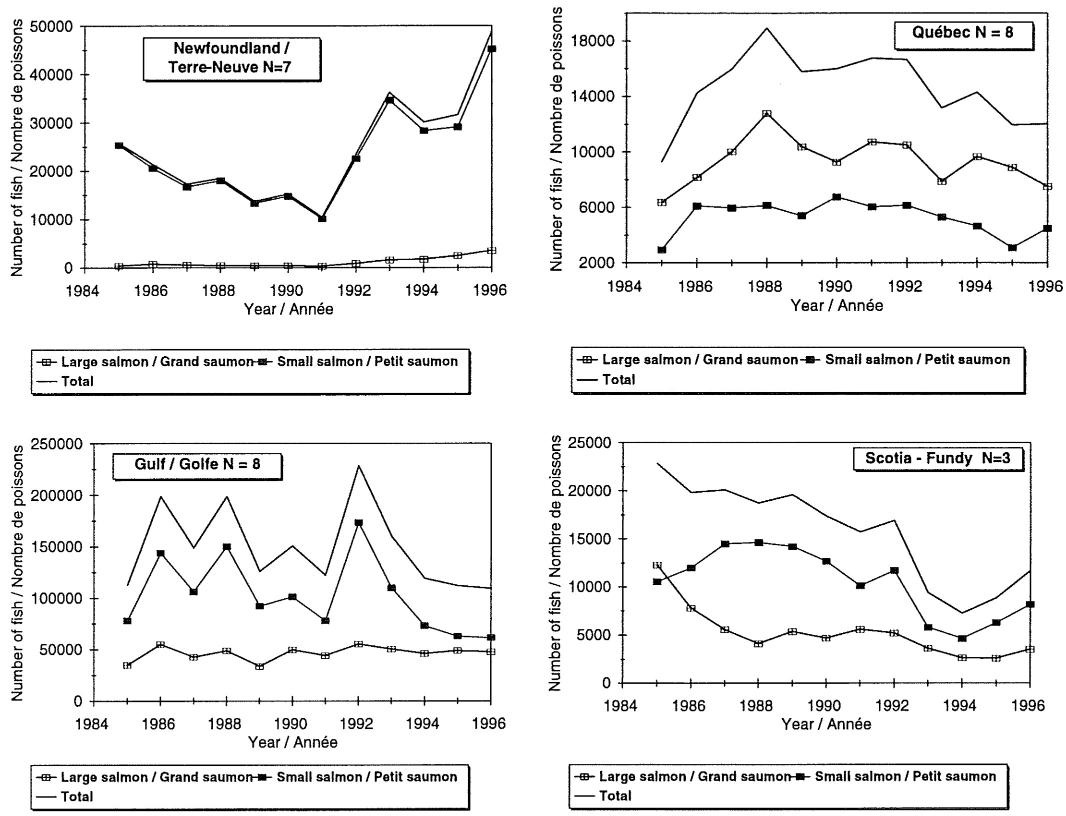
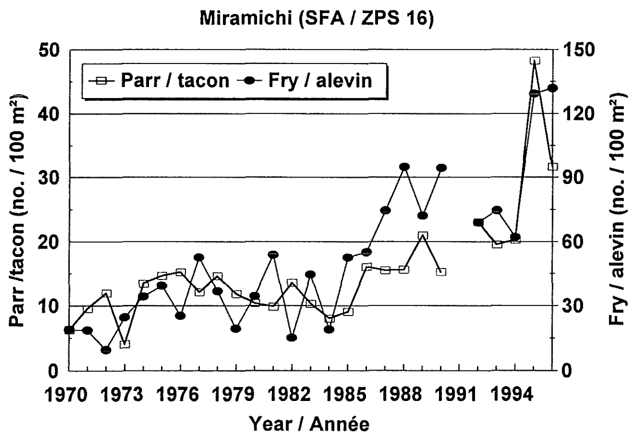
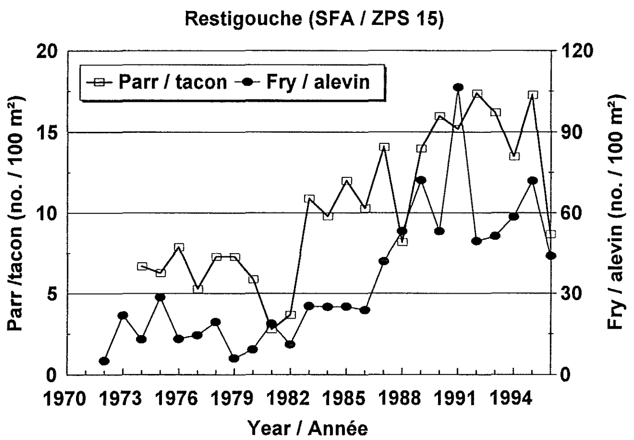


Figure 4.2.1.2. Mean juvenile Atlantic salmon densities in the Miramichi River (SFA 16), Restigouche River (SFA 15) and the Stewiacke River (SFA 22), Canada based on sampling at standard index sites in each river.





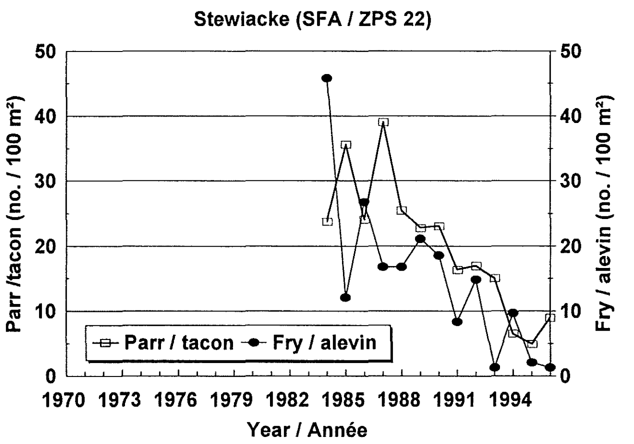


Figure 4.2.1.3. Documented returns of Atlantic salmon to thirteen rivers in NEW ENGLAND, USA.

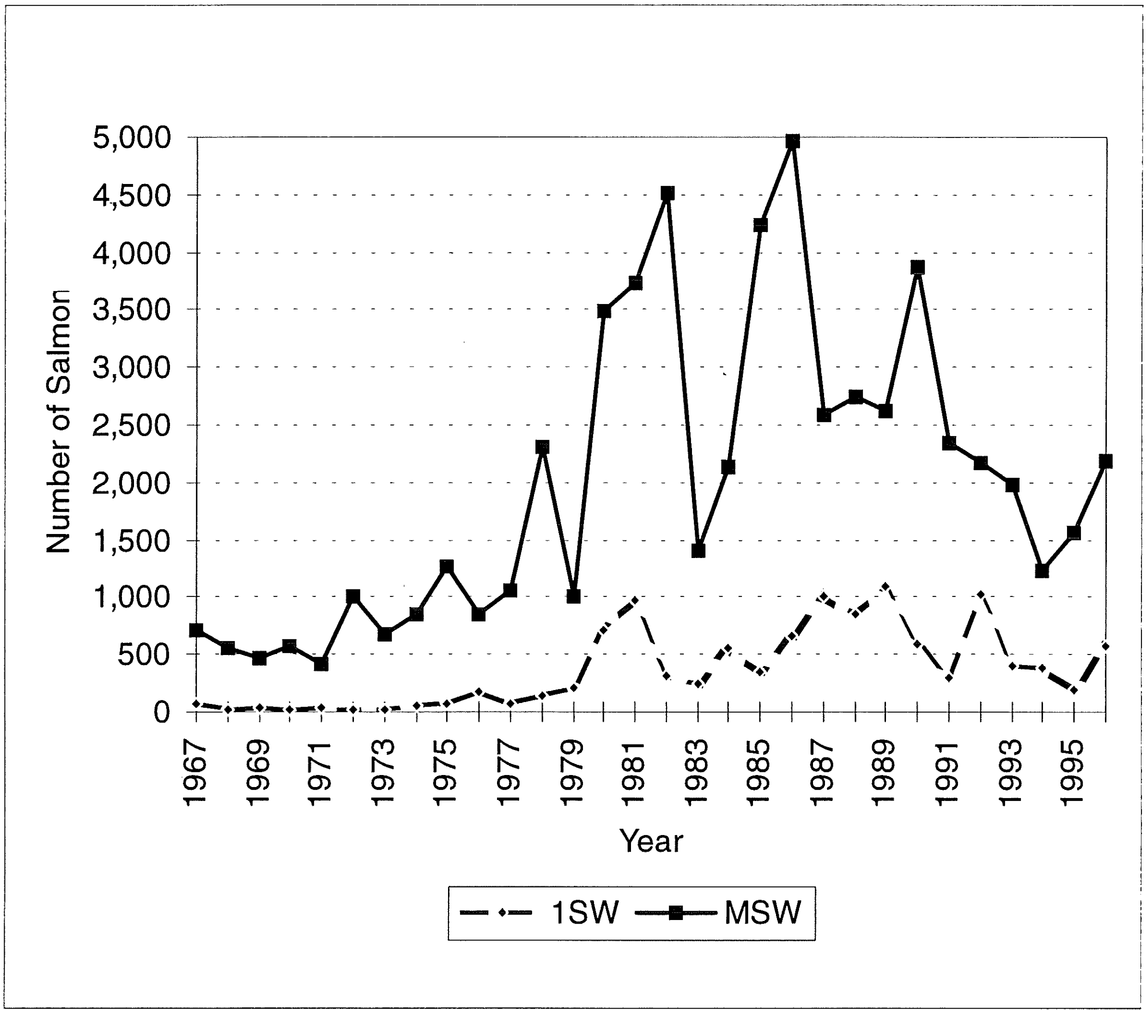


Figure 4.2.2.1 Comparison of estimated mid-points of 1SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 1SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 1SW spawners (squares).

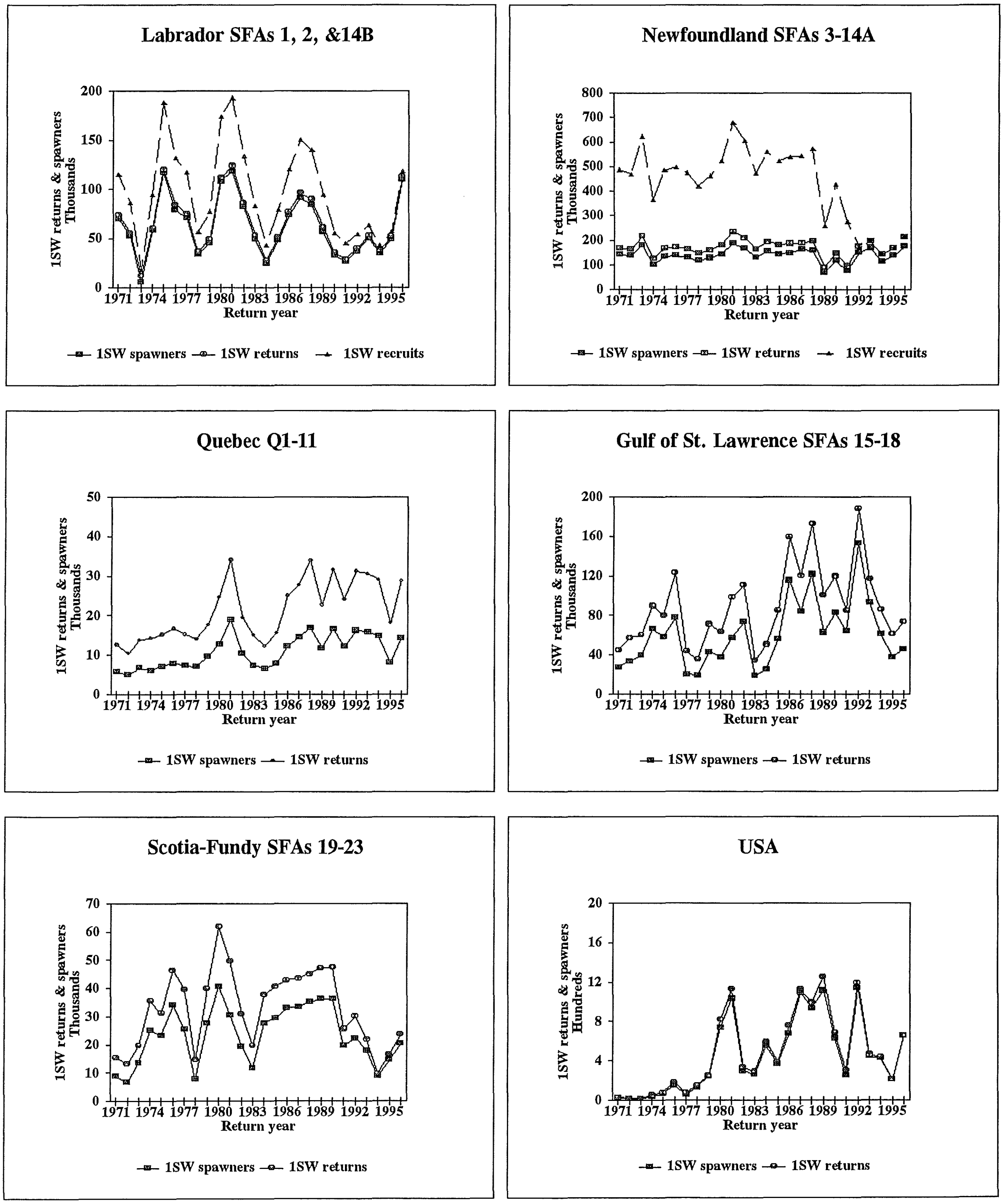


Figure 4.2.2.2 Comparison of estimated mid-points of 2SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 2SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 2SW spawners (squares) and 2SW spawning targets (triangles) for 1971-96 return years.

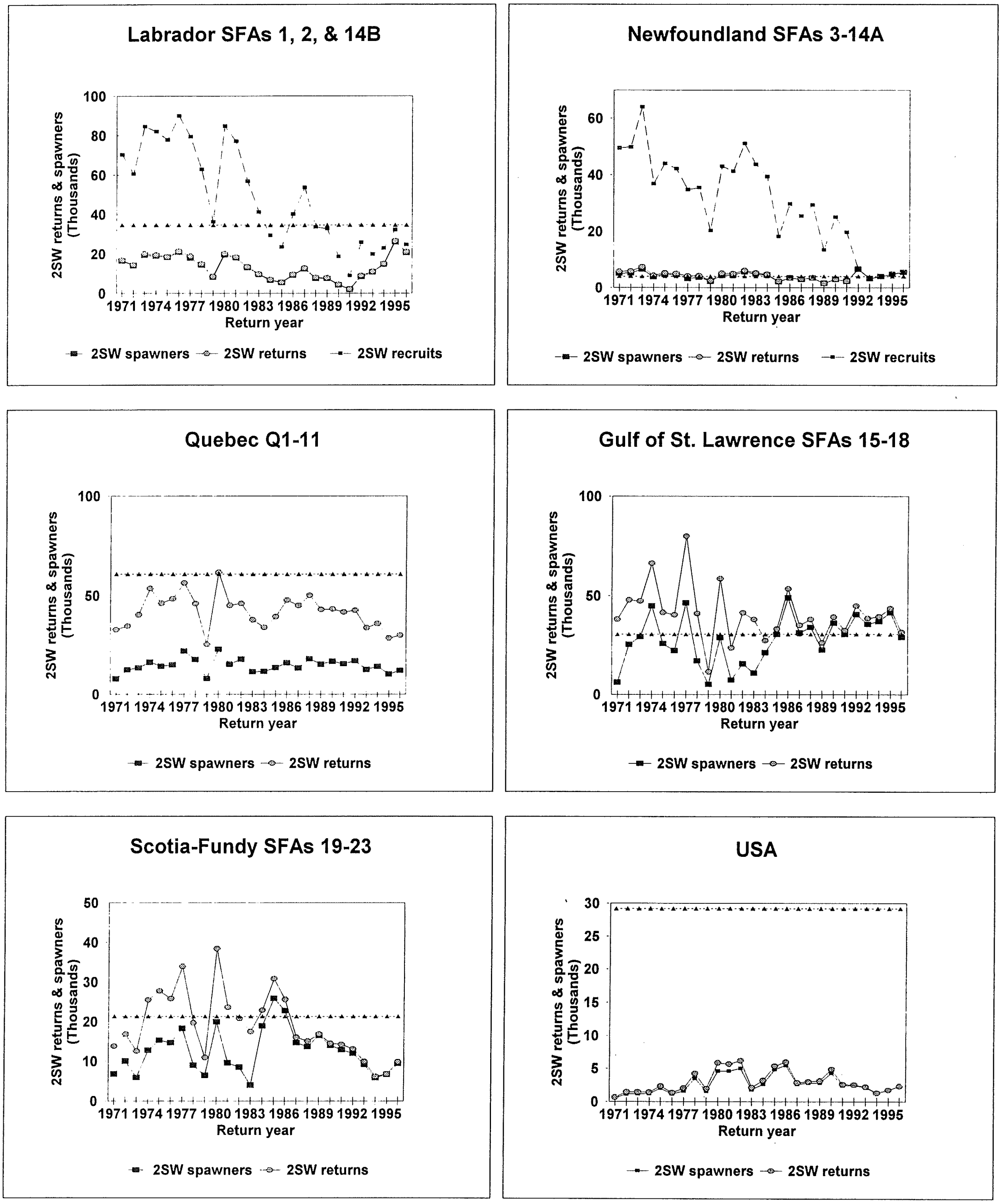


Figure 4.2.3.1. Pre-fishery abundance estimate of maturing and non-maturing salmon in North America (A), and proportion of smolt class maturing after 1SW (B).

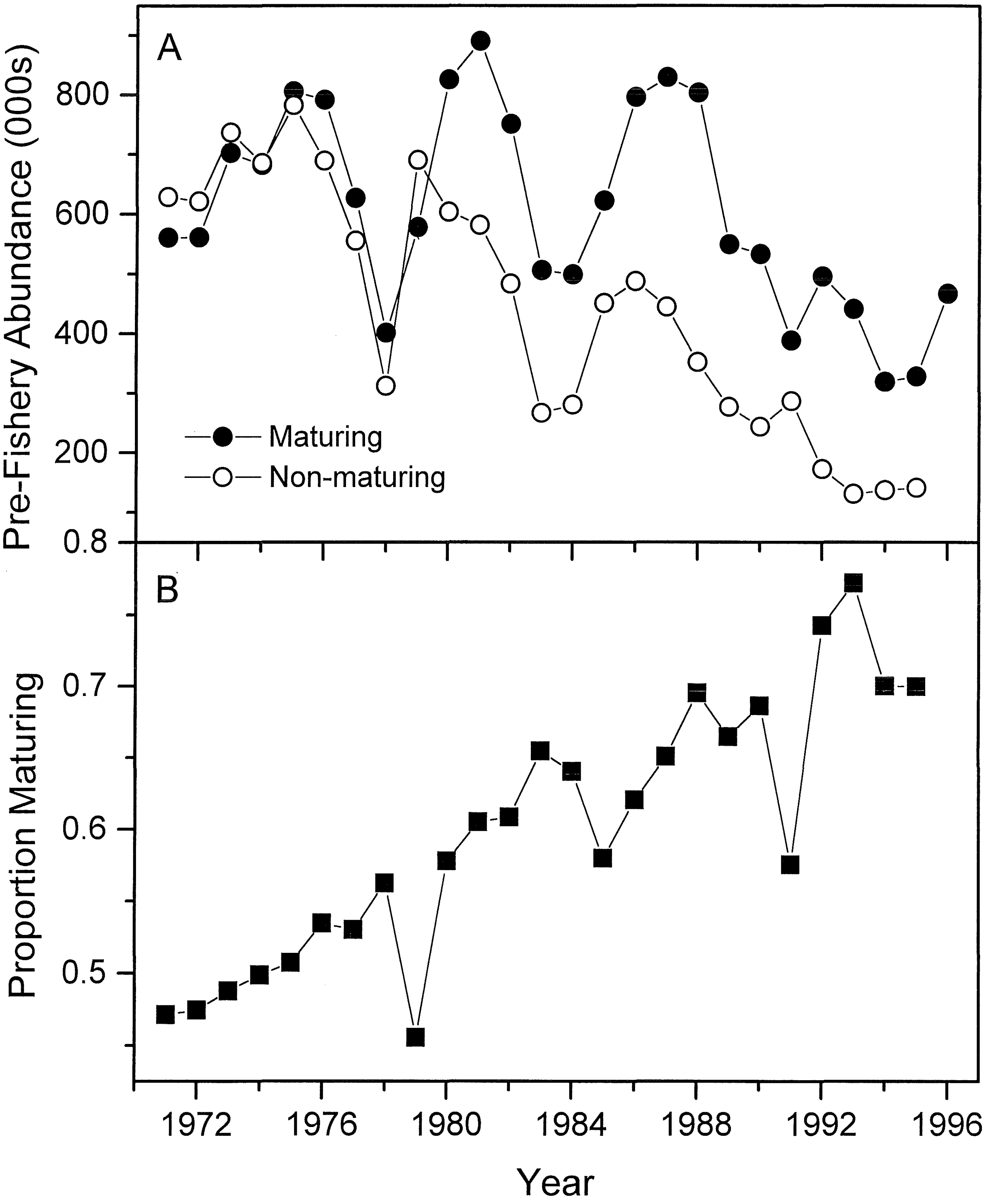


Figure 4.2.3.2. Total 1SW recruits (non-maturing and maturing) originating in North America.

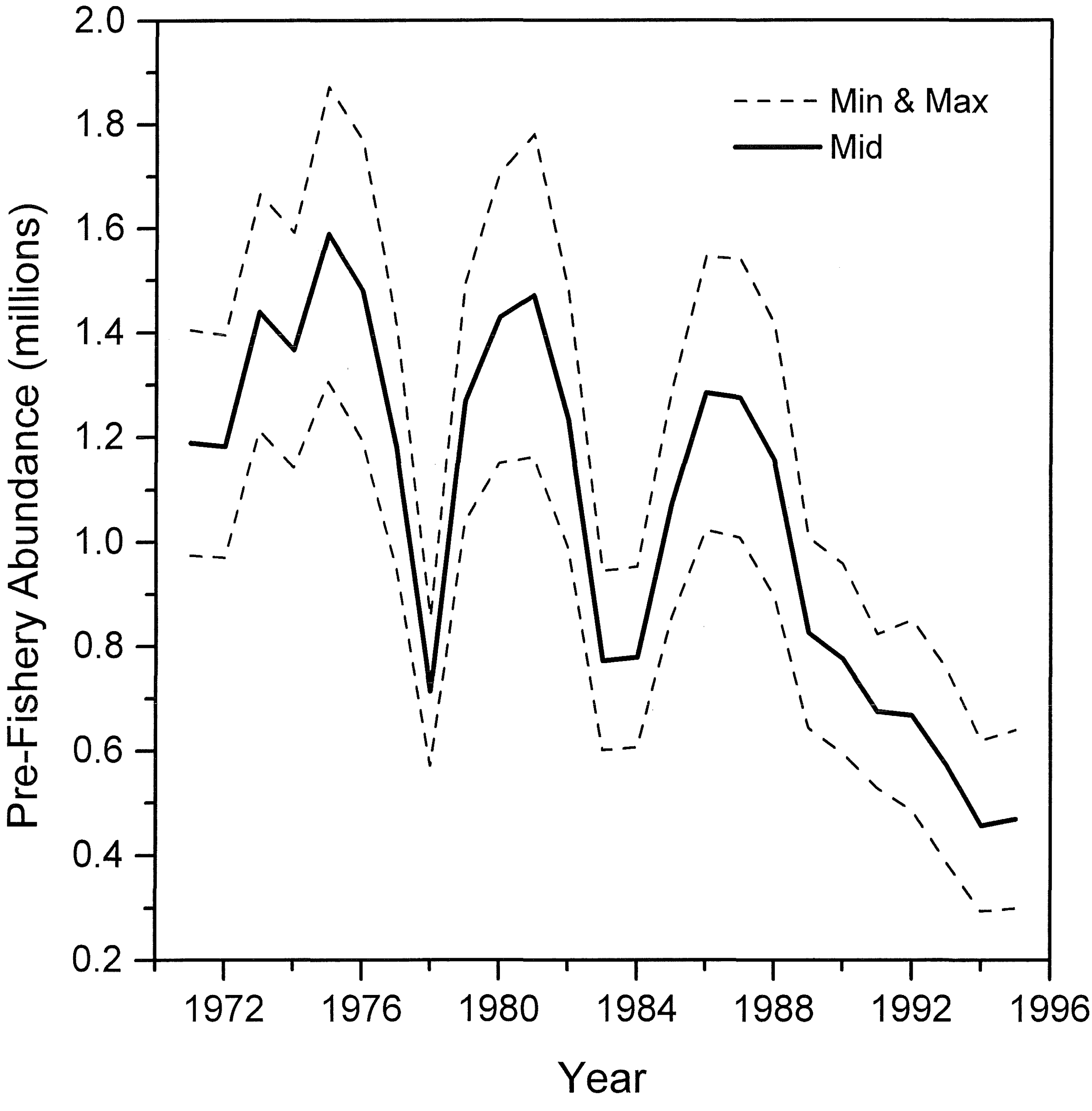


Figure 4.2.4.1. Egg depositions in 1996 relative to conservation requirements in 85 assessed rivers of eastern Canada. The black slice represents the proportion of the conservation requirement achieved in 1996. A solid black circle indicates that the egg deposition requirement was attained or exceeded.

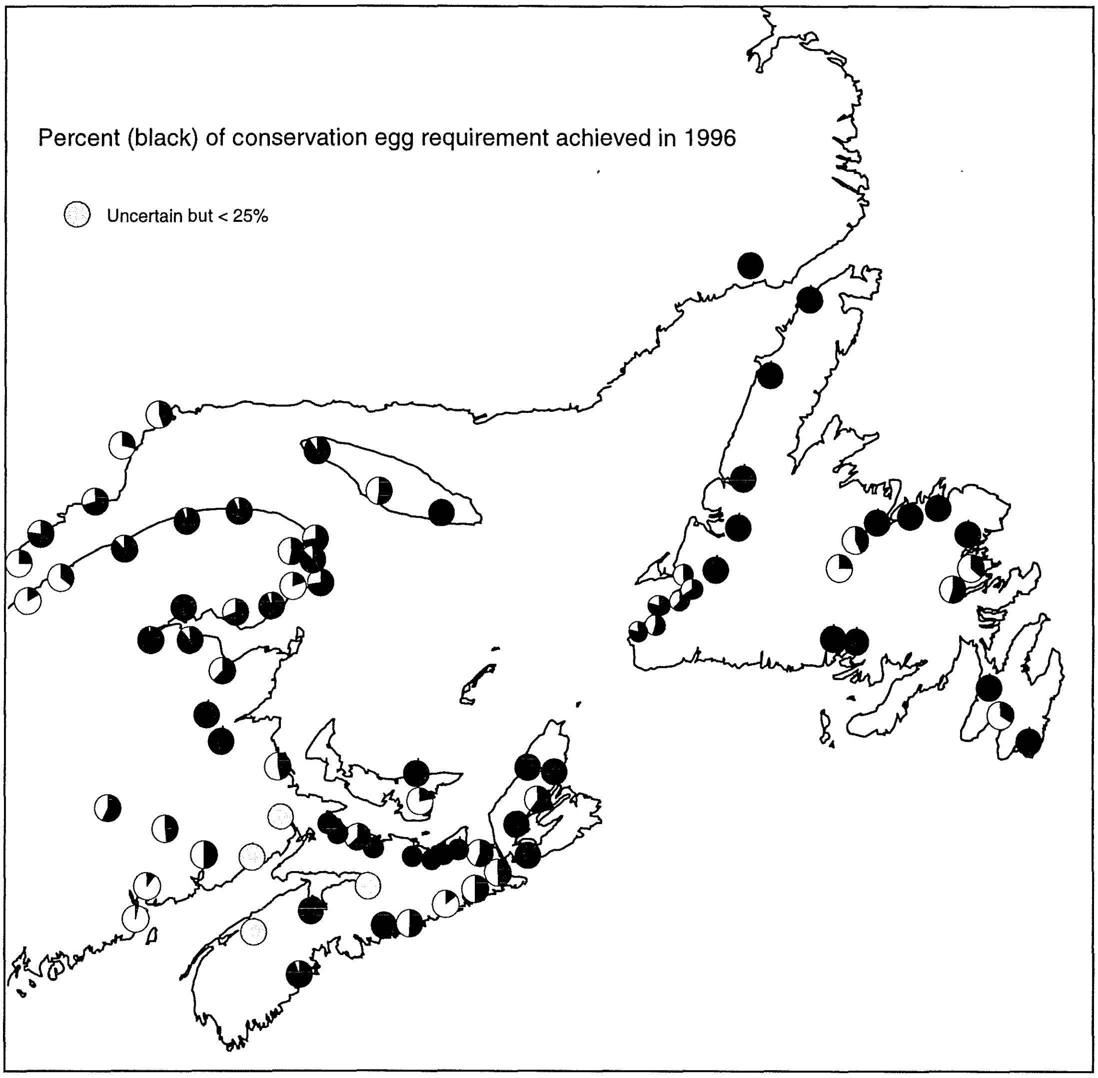


Figure 4.2.4.2. Proportion of the conservation requirements met in monitored rivers in four geographic area of eastern Canada, 1984 to 1996. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion and the number above the vertical line is the number of rivers included in the annual summary. The horizontal line defines the location of 100% of conservation requirements.

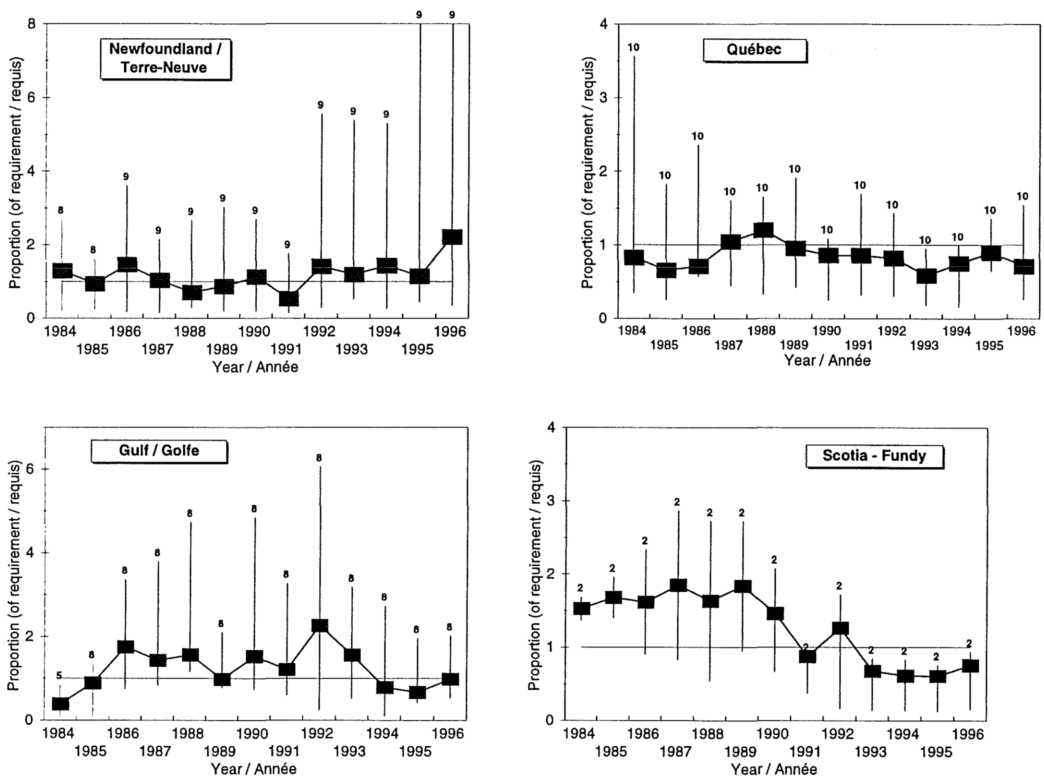
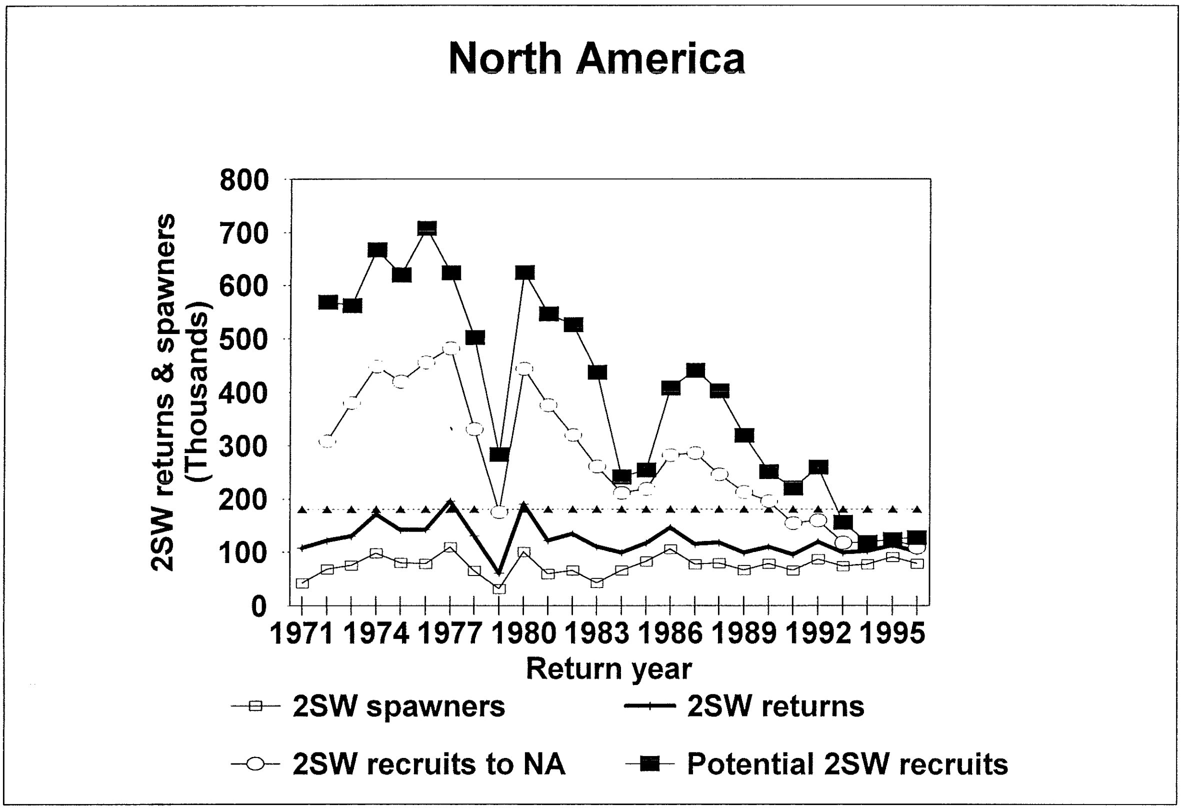


Figure 4.2.4.3 Top panel: comparison of estimated of potential 2SW production prior to all fisheries, 2SW recruits available to North America and 2SW returns and spawners for 1971-96.
Triangles indicate the 2SW spawner threshold.
Bottom panel: comparison of potential maturing 1SW recruits and returns and 1SW spawners for 1971-96 return years.



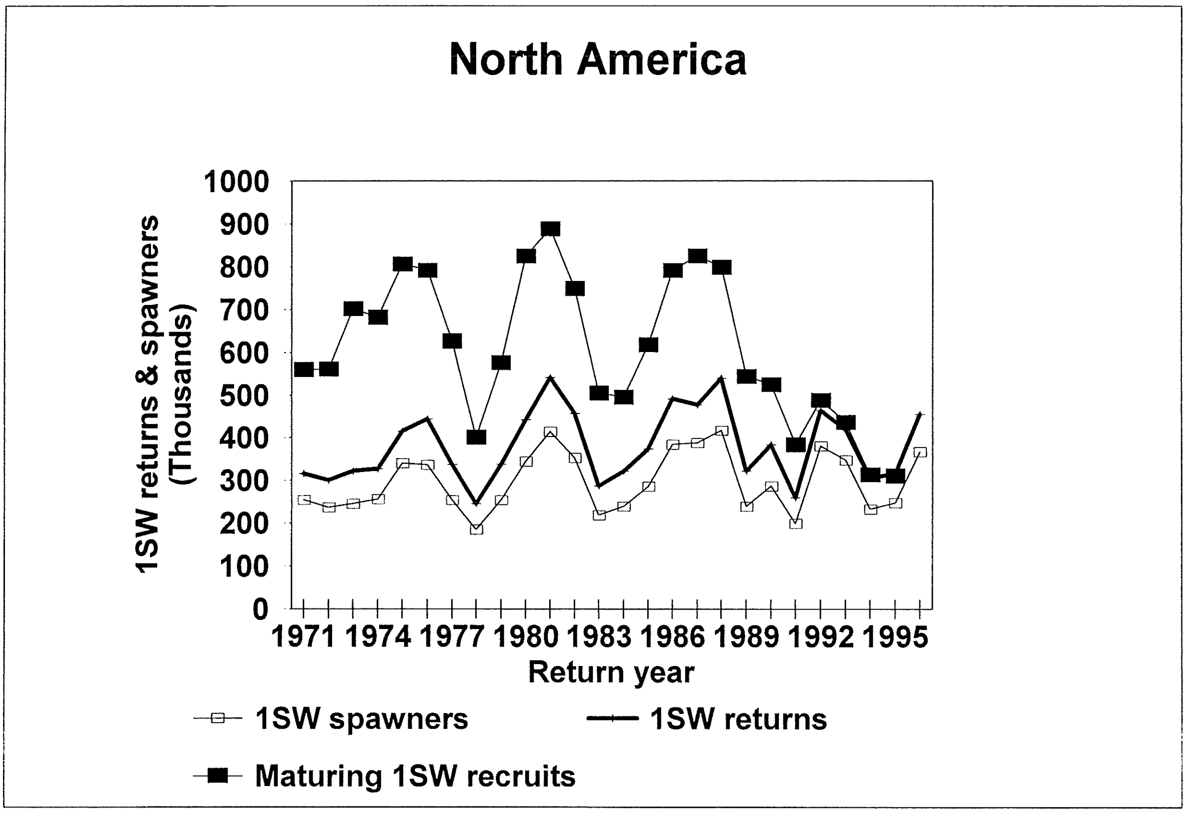


Figure 4.2.4.4. Lagged spawner contributions to prefishery abundance in the given year for six geographic areas of North America. The horizontal line represents the spawning requirement (in terms of 2SW fish) in each geographic area.

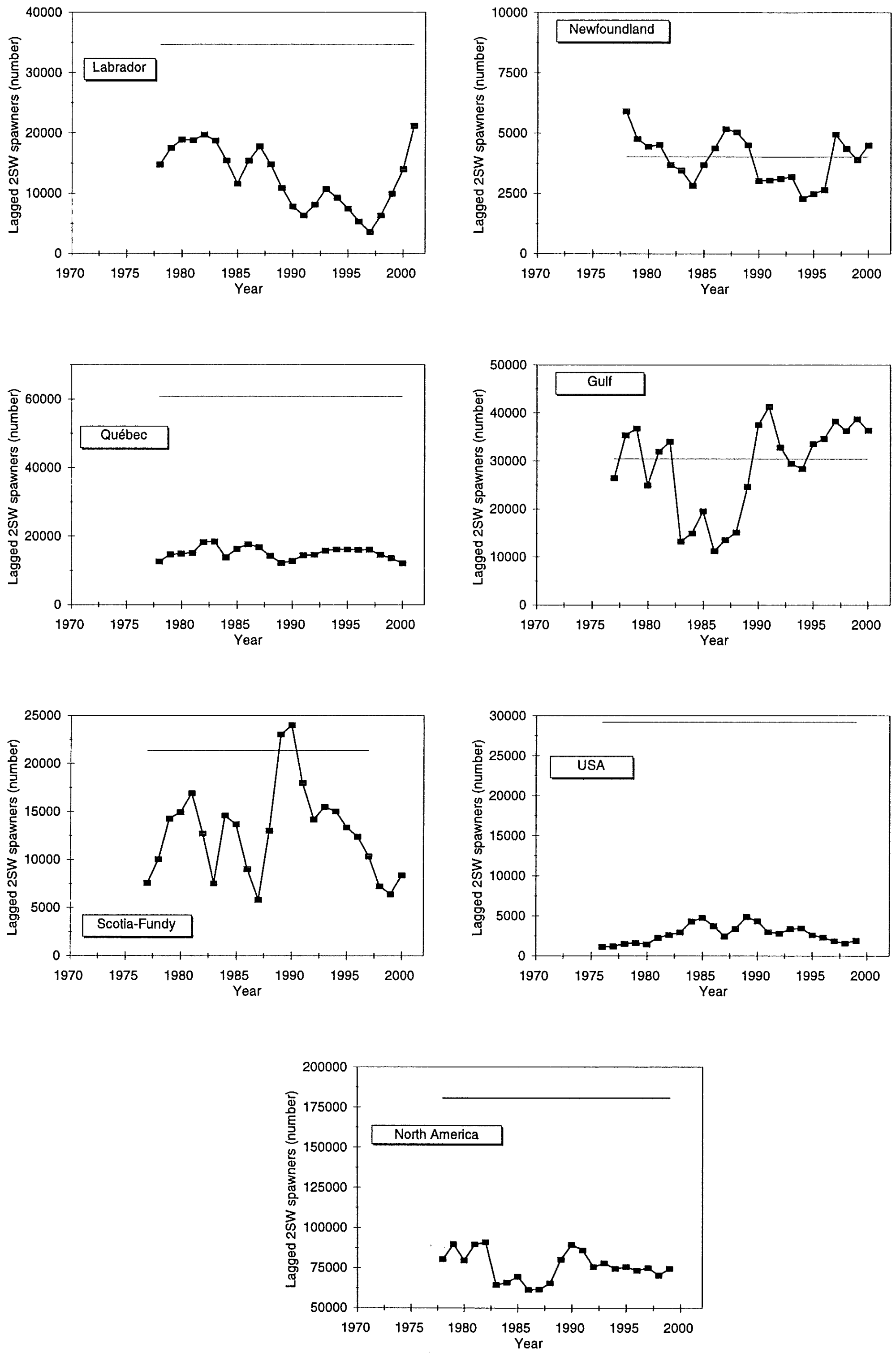


Figure 4.2.4.5. Proportion of lagged spawners in the six geographic areas of North America relative to the total lagged spawner escapement contributing to the year of prefishery abundance. The horizontal line represents the theoretical spawner proportions for each area based on the 2SW spawner requirement for North America. Lower figure shows collective changes in relative proportions of lagged spawners.

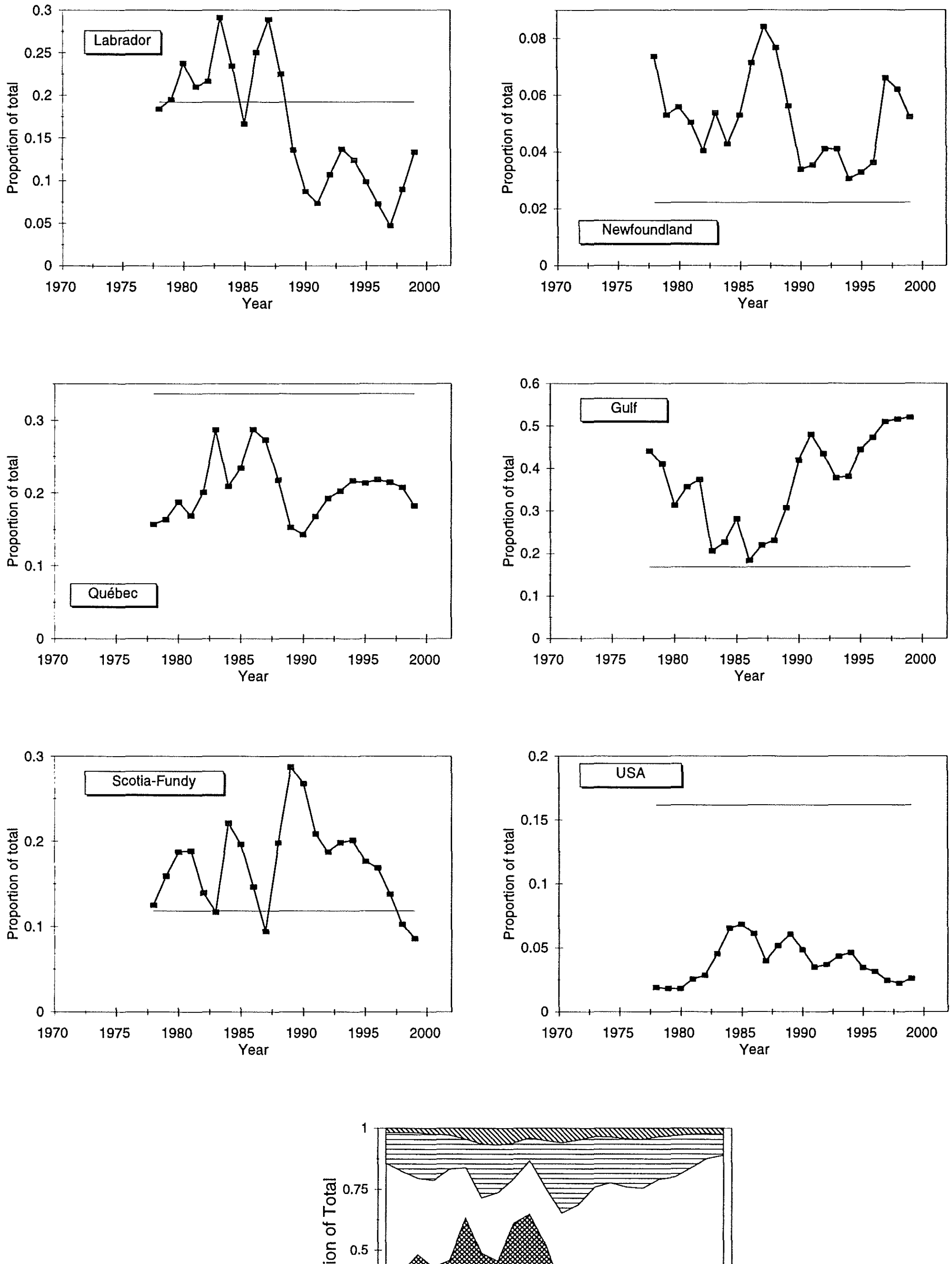
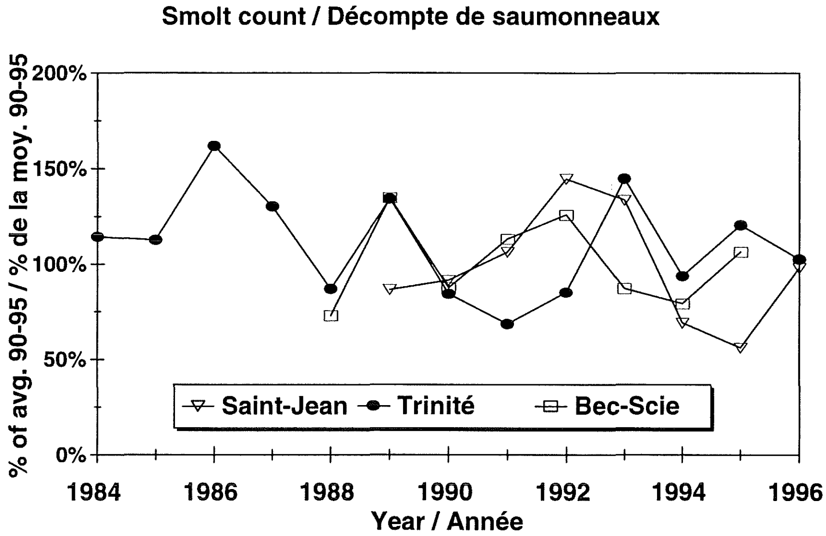


Figure 4.2.5.1. Variability in the smolt output from seven rivers of eastern Canada in 1984 to 1996 relative to the average smolt output (by individual river) for the 1990 to 1995 period. Québec rivers are in the upper panel. Newfoundland rivers are in the lower panel.



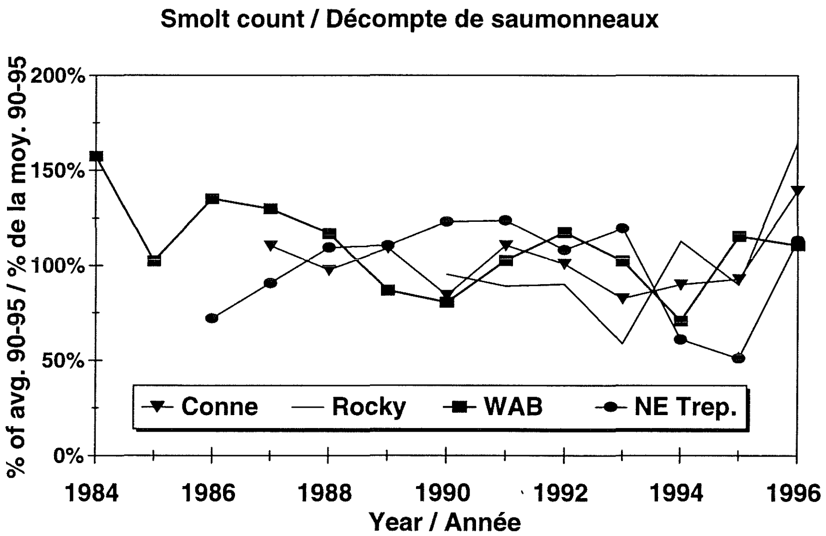


Figure 4.2.5.2. Trends in survival rates of hatchery (Saint John, LaHave, Liscomb, and aux Rochers rivers) and wild smolts (all other rivers) to 1SW, 2SW and for the entire cohort returns in-river to eastern Canada. Year refers to the year of smolt migration.

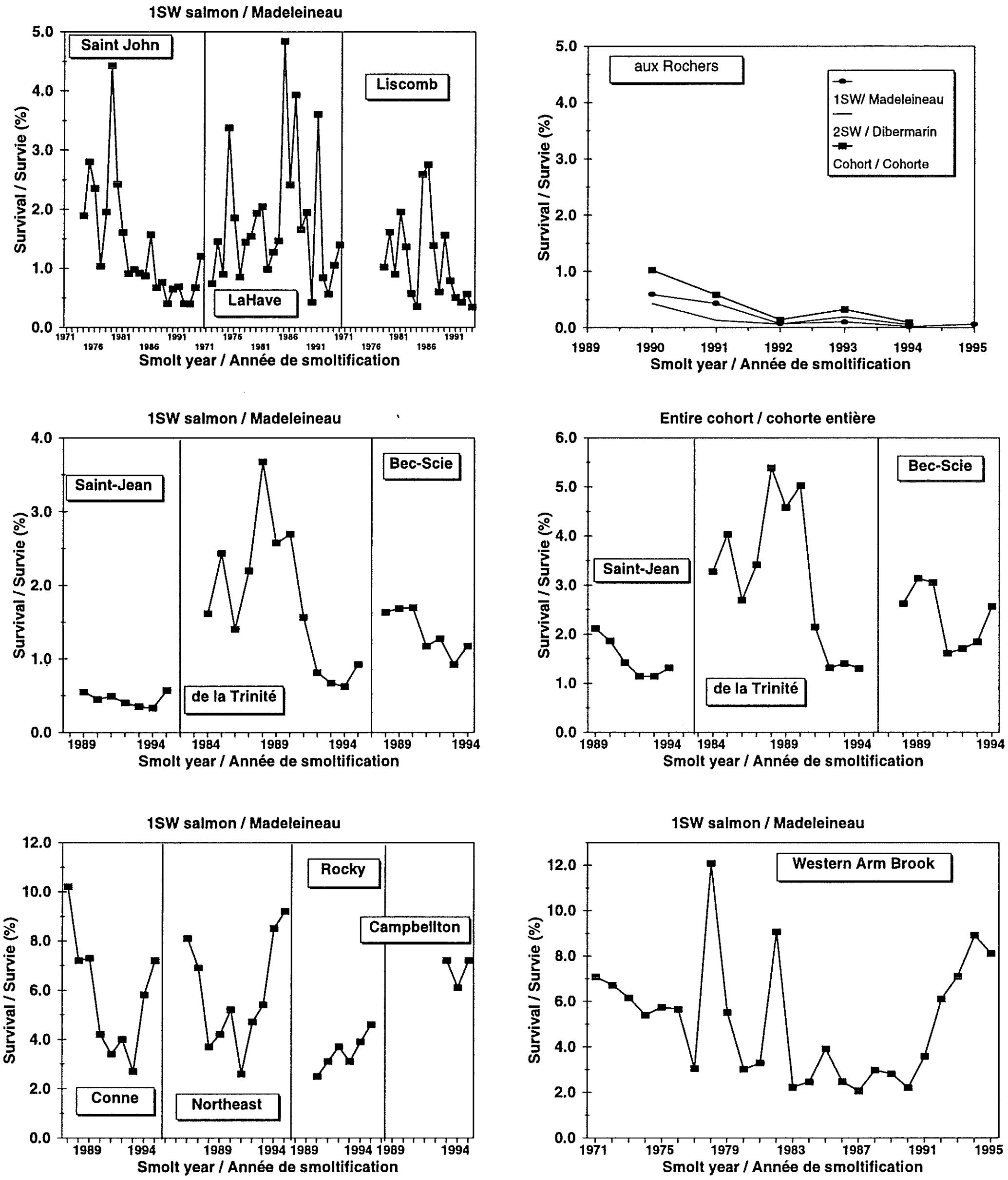


Figure 4.2.5.3. Marine survival of hatchery-reared Atlantic salmon smolts released into the Penobscot River, Maine, USA.

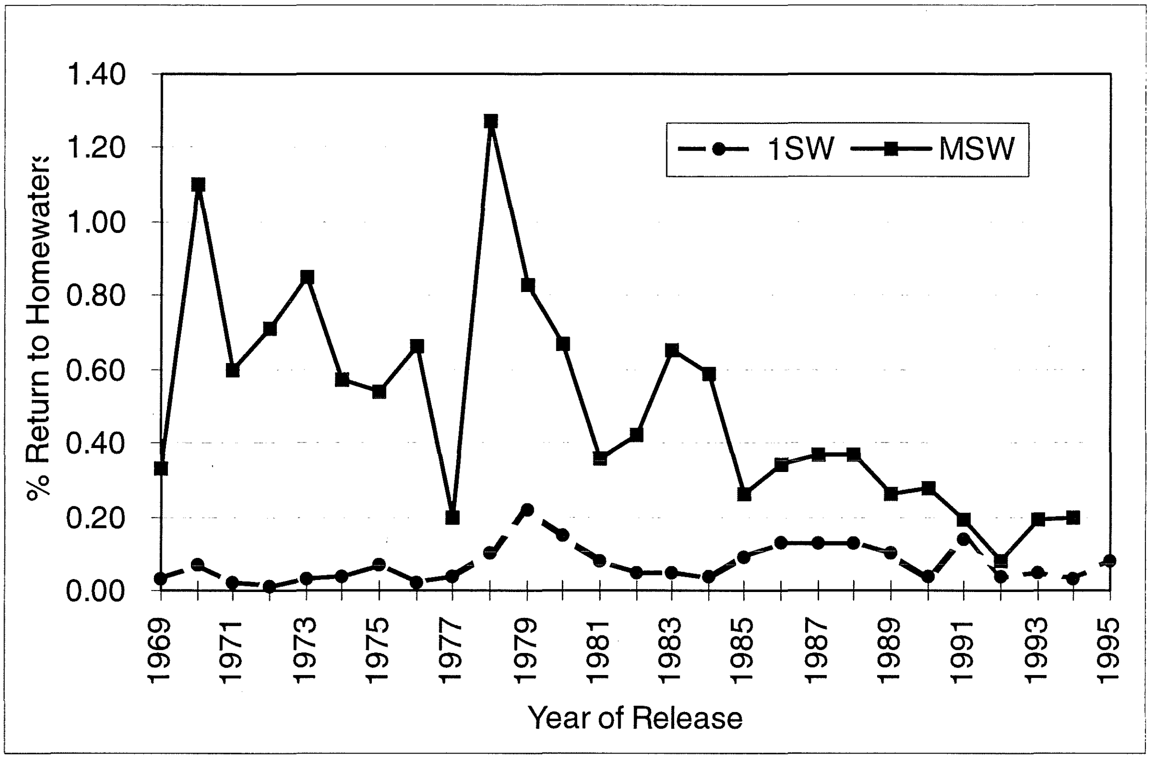
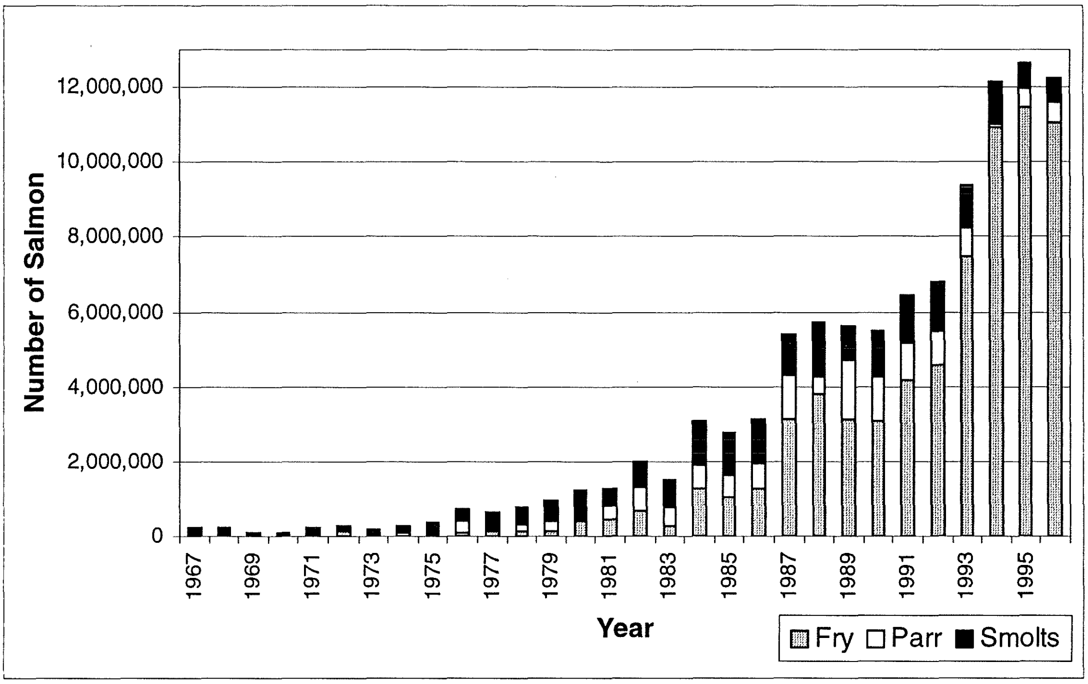


Figure 4.6.1. Number of Atlantic salmon by life stage stocked into USA rivers, 1967 to 1996.



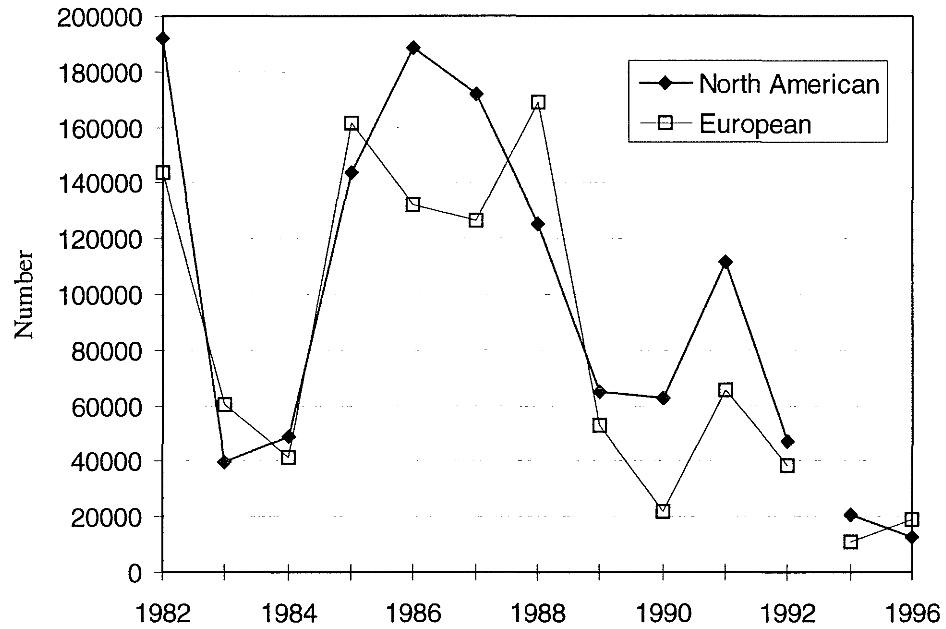


Figure 5.1.2.1 Numbers of European and North American Atlantic salmon caught at West Greenland 1982-92 and 1995-96.

Figure 5.2.1.1 Thermal habitat index for February and lagged spawners (SNLQ).

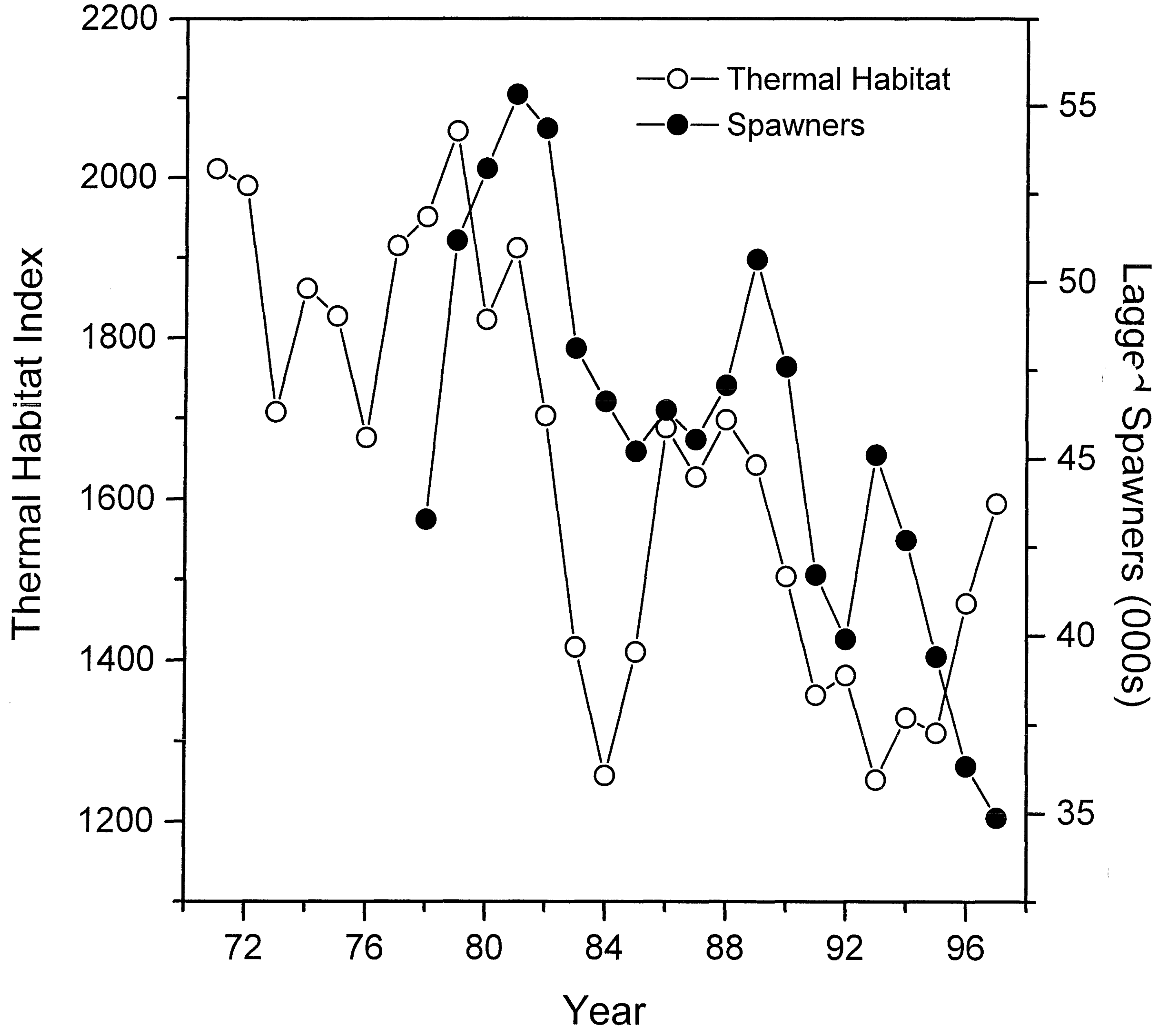


Figure 5.2.2.1. Observed estimates, jackknifed historical predictions, and deterministic forecasts (A) of pre-fishery abundance. Residual pattern from jackknifed predictions (B).

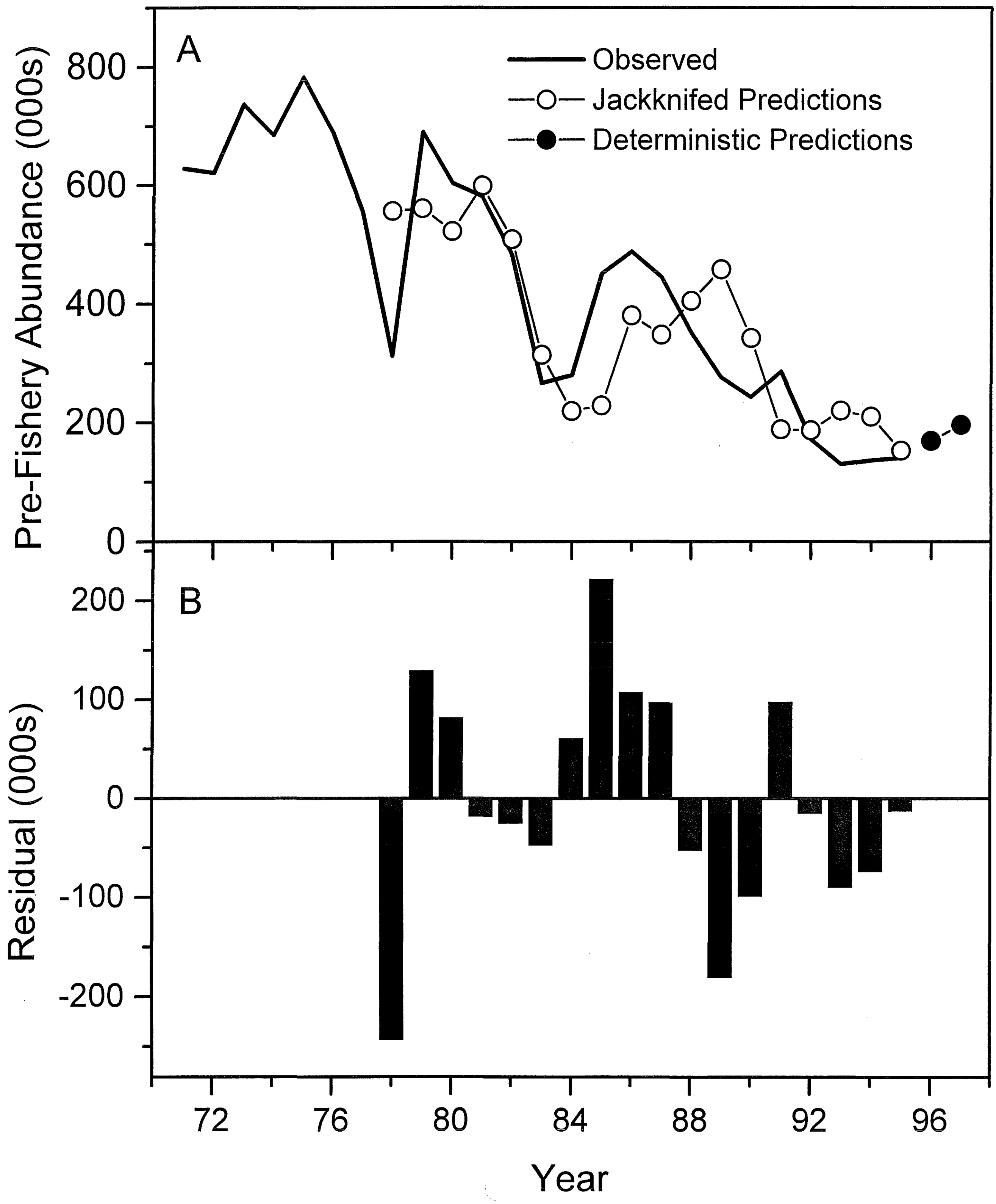


Figure 5.2.2.2. Jackknifed predicted versus observed (A) and residuals versus observed (B) estimated pre-fishery abundance.

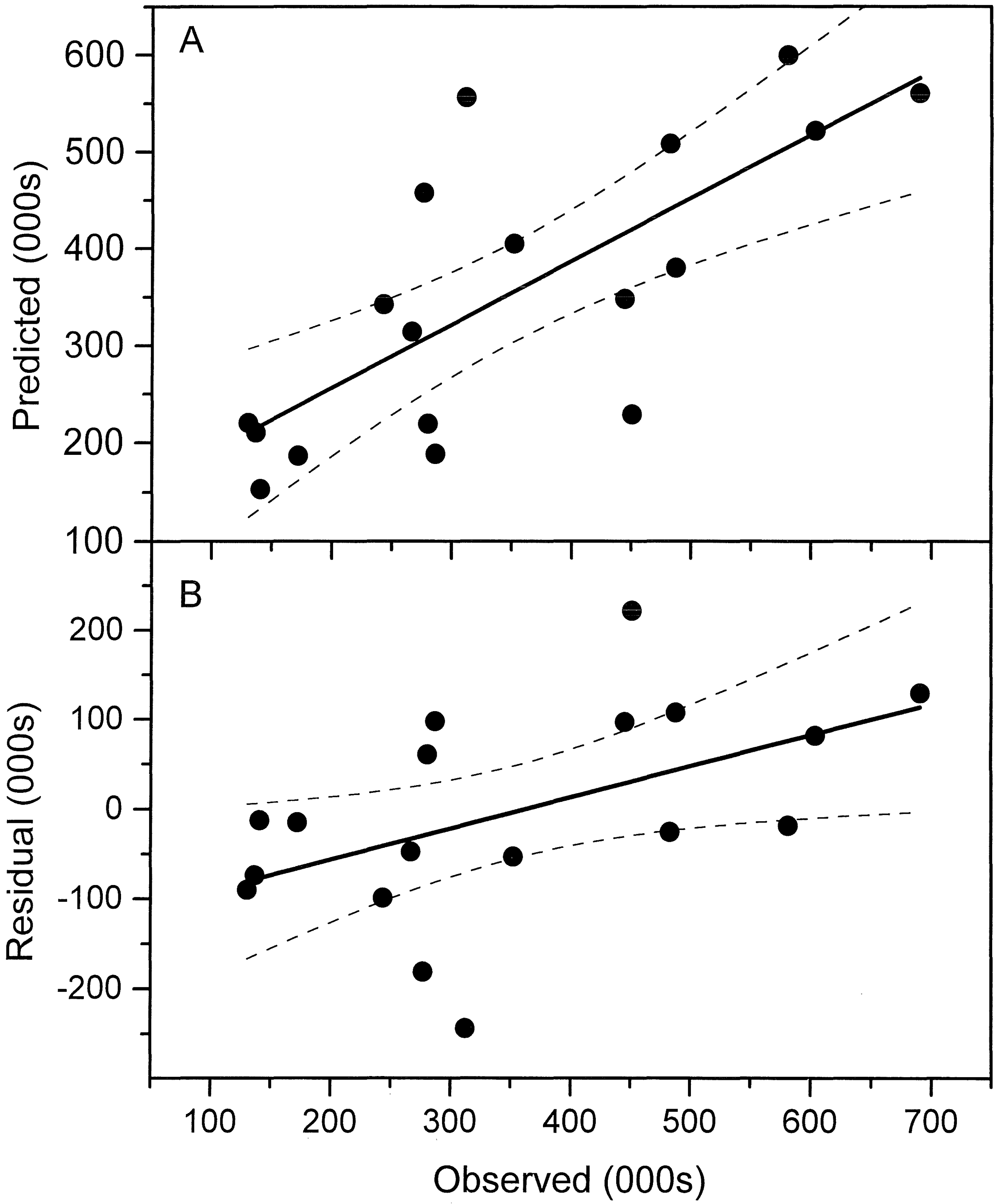


Figure 5.2.2.3. Observed estimates and jackknifed predictions of pre-fishery abundance based on neural network model (A). Residual patterns for jackknifed model predictions based on neural network model (B).

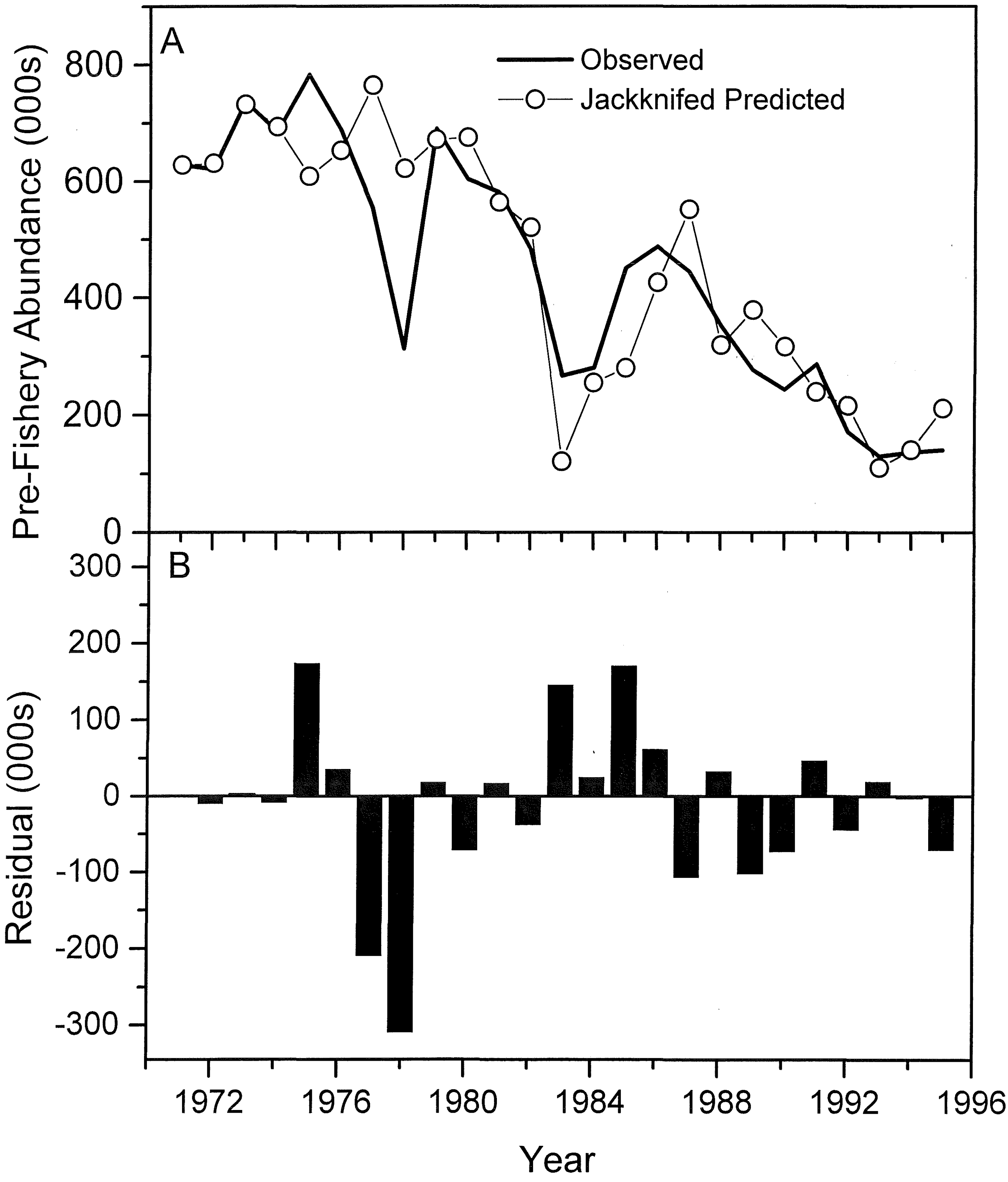


Figure 5.2.2.4. Scattergram between observed estimates and jackknifed predicted values (A) and observed value and jackknifed residuals (B) of pre-fishery abundance based on neural network model.

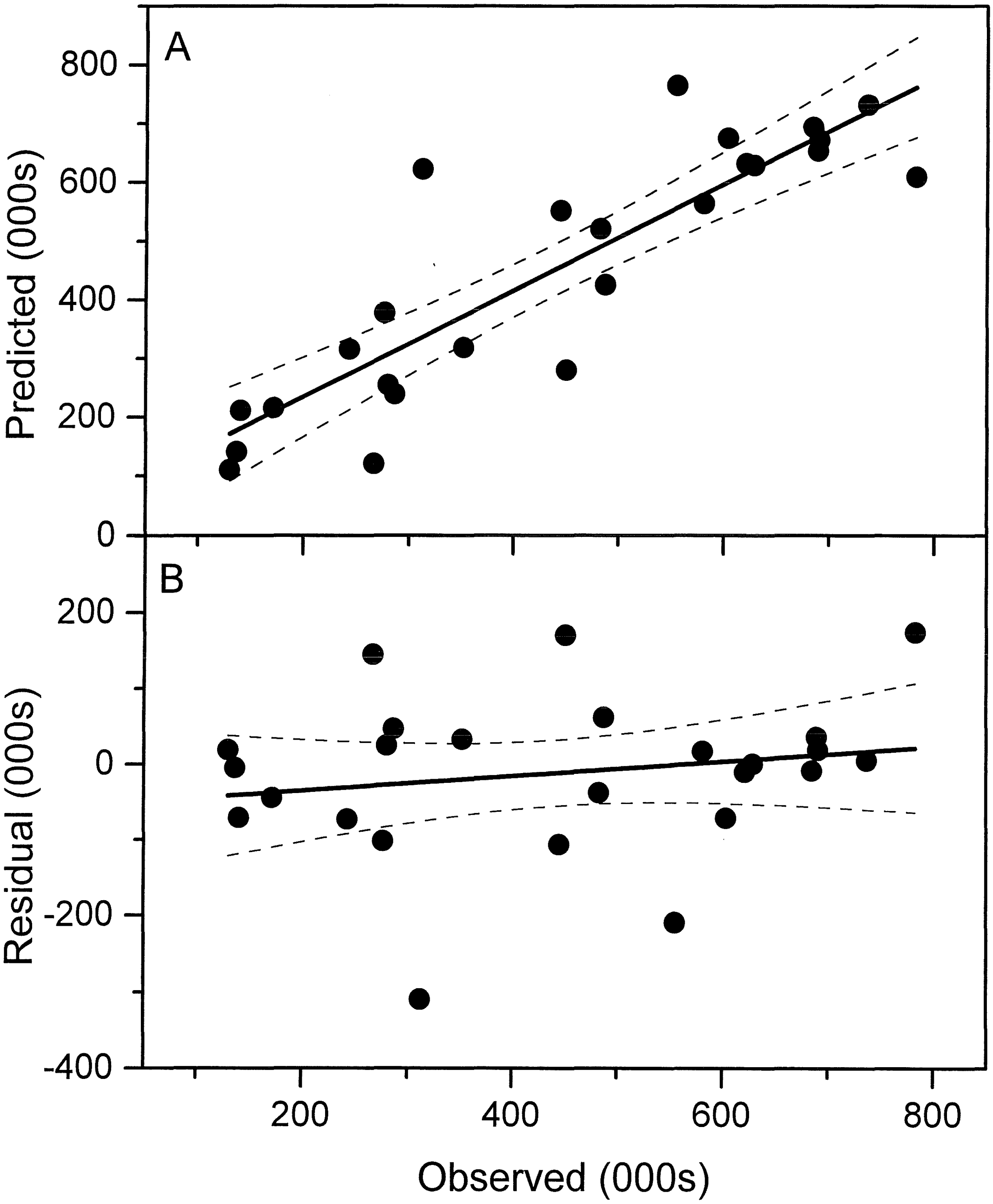


Figure 5.2.4.1. Theoretical risk analysis plots showing the risk-prone and risk-averse zones relative to the uncertainty of the stock assessment.

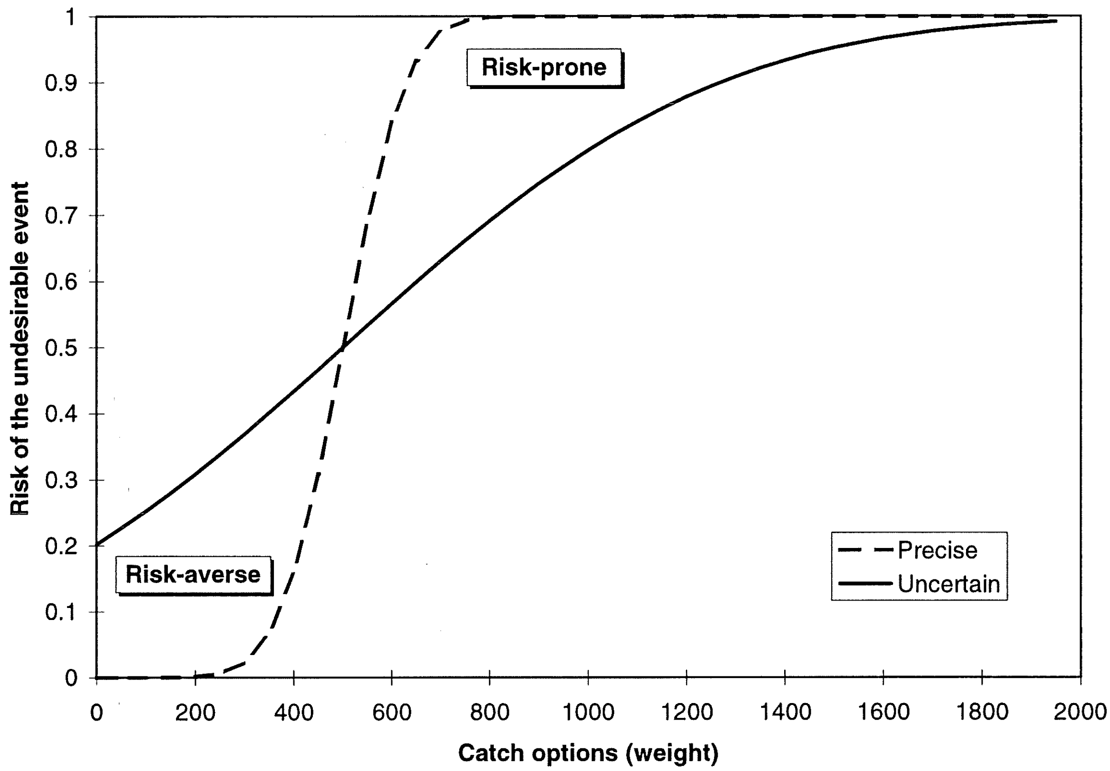


Figure 5.2.4.2. Probability of meeting or exceeding 2SW spawner requirements in six stock areas of North America relative to total escapements of 2SW salmon and assuming equal production rates in each area.

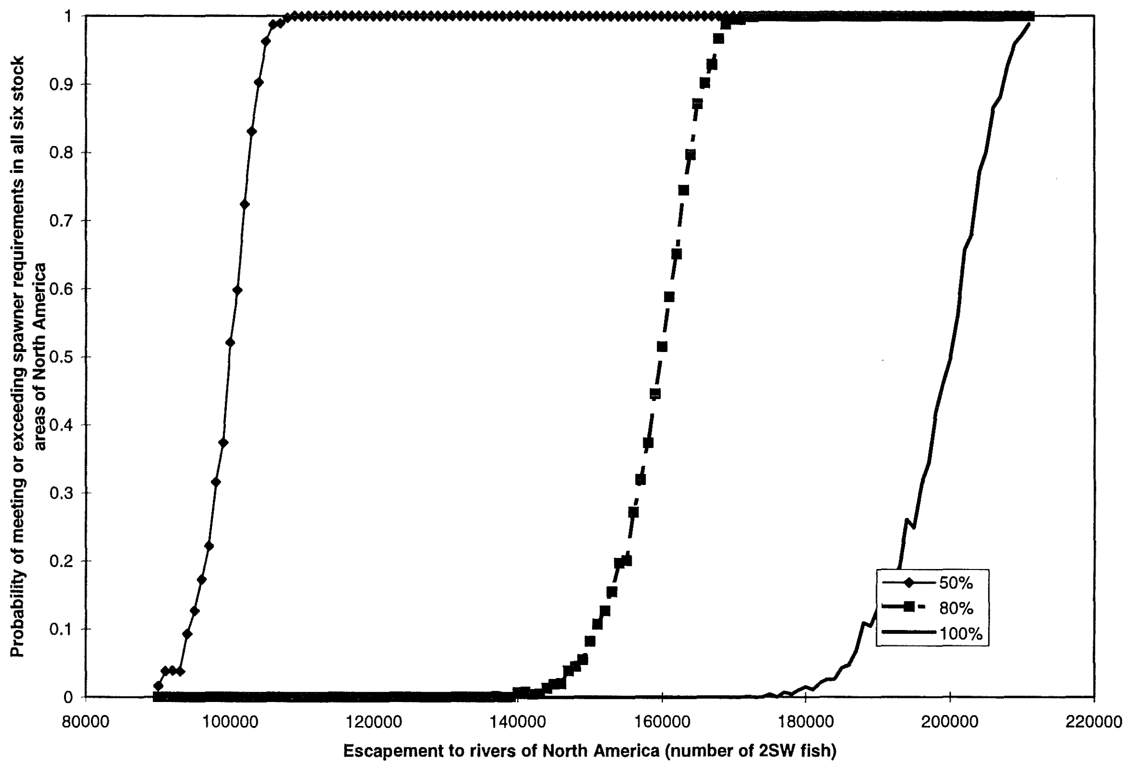


Figure 5.2.4.3. Distributions and probabilities of prefishery abundance forecasts (upper panel), number of North American origin salmon captured in a 500 t fishery at West Greenland (middle panel) and the post-fishery returns to North America (bottom panel), 1976 and 1996.

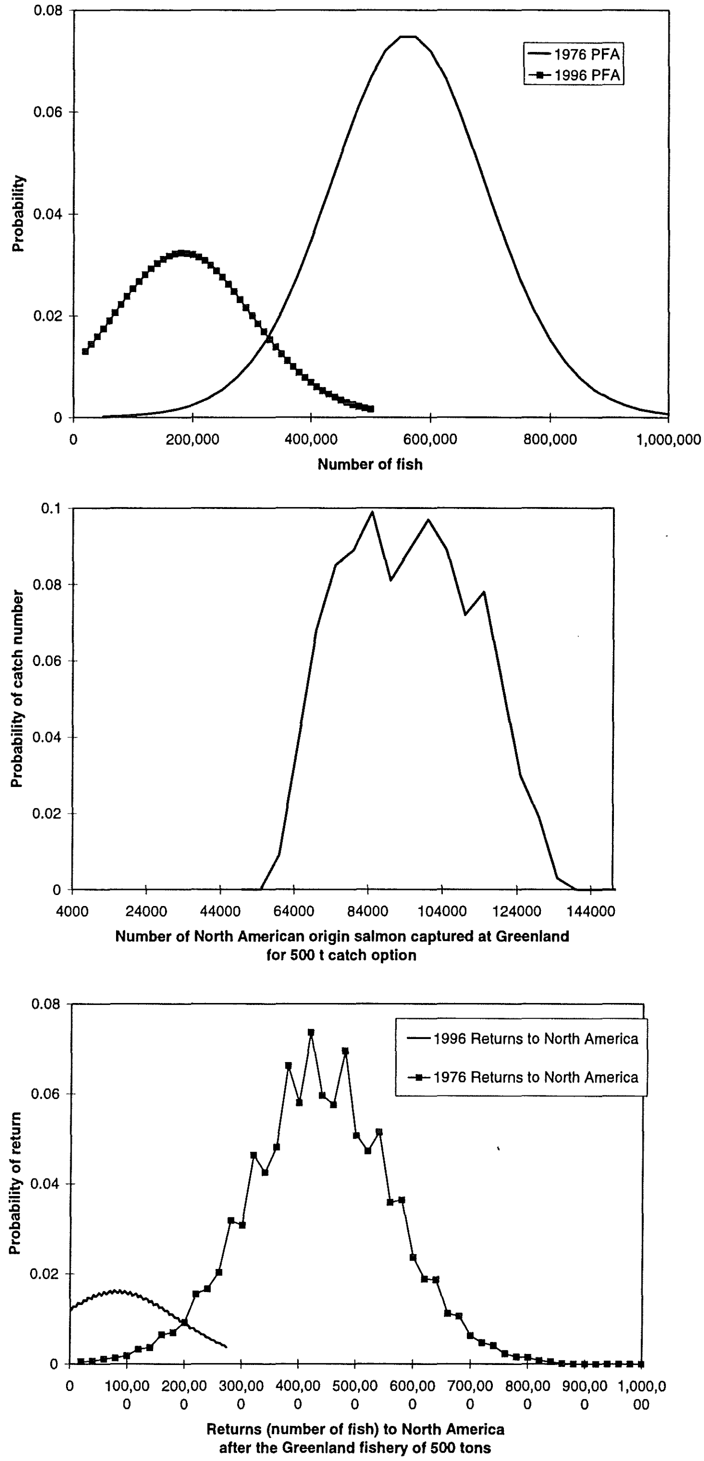


Figure 5.2.4.4. Risk plots for the 1976 and 1996 catch options for the West Greenland fishery. The risk plots consider only the risk of the Greenland fishery assuming that after Greenland, all fish return to the rivers of North America to spawn.

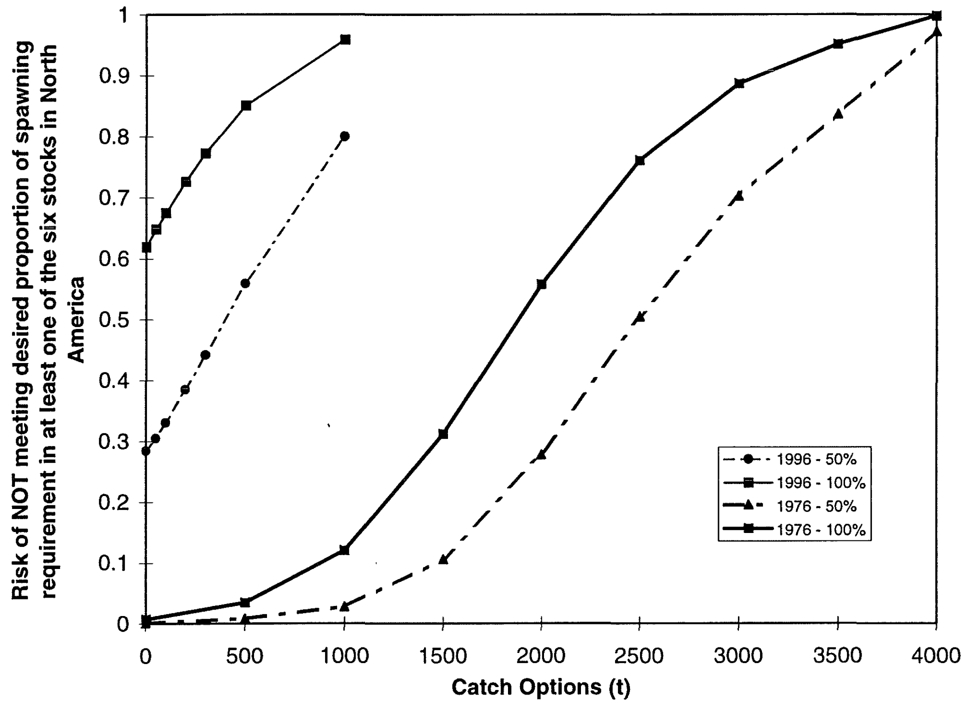
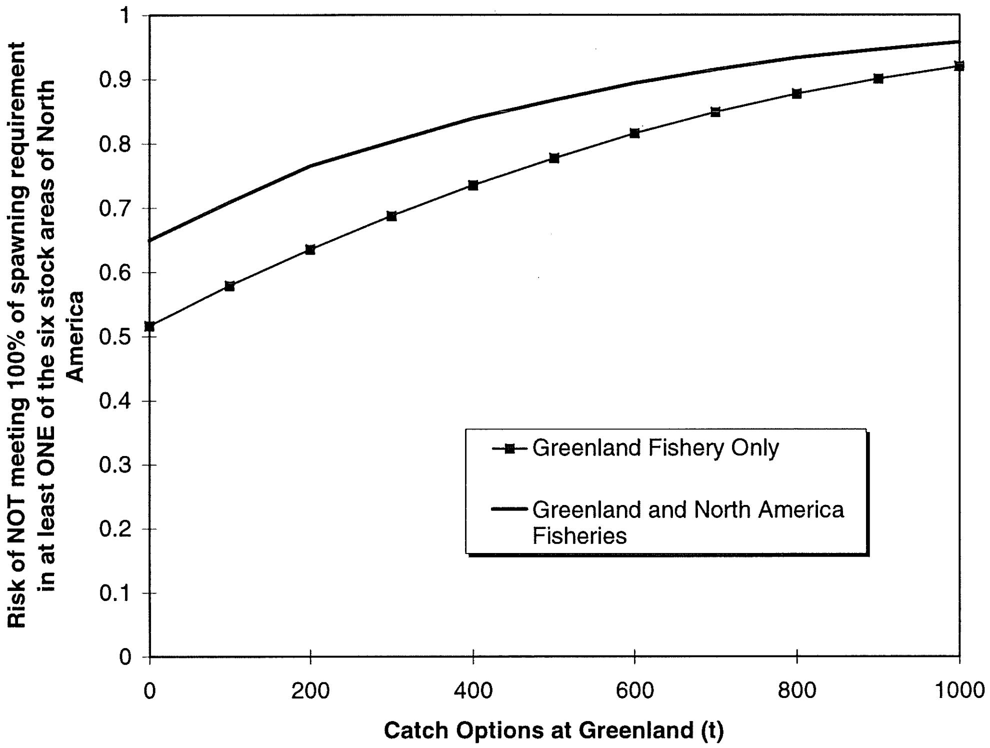
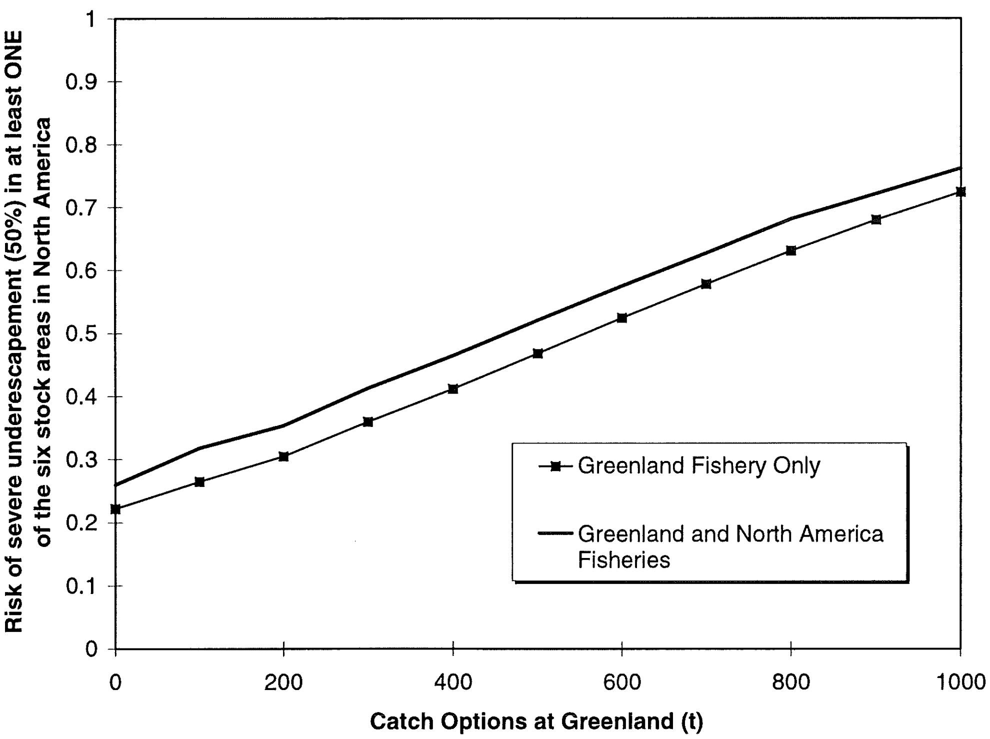


Figure 5.2.4.5. Risk analysis for catch options on the prefishery 1SW non-maturing component in 1997. Risk is expressed relative to catch options at Greenland for 1997 and cumulatively with the exploitation rates of 0.15 to 0.28 on 2SW salmon returning to North America in 1998. Exploitation rates in North America are based on the 1996 values (Section 4.1.4). The upper panel describes the risk of not meeting the spawning requirement in at least one of the six stock areas in North America. The lower panel describes the risk of a severe underescapement (50% of spawner requirement) in at least one of the six stock areas.





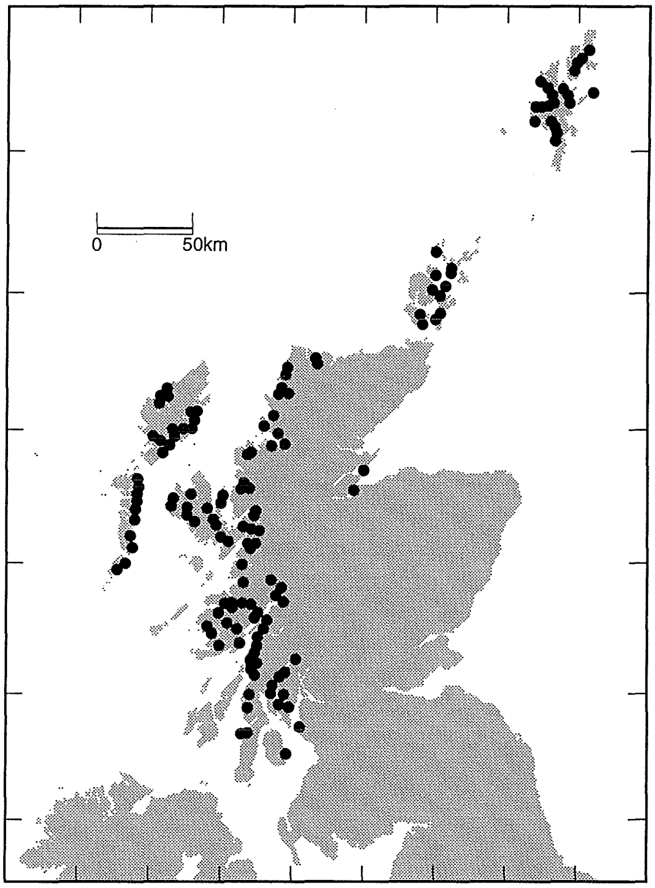


Figure 6.2.1 Location of fish farming operations in Scotland.

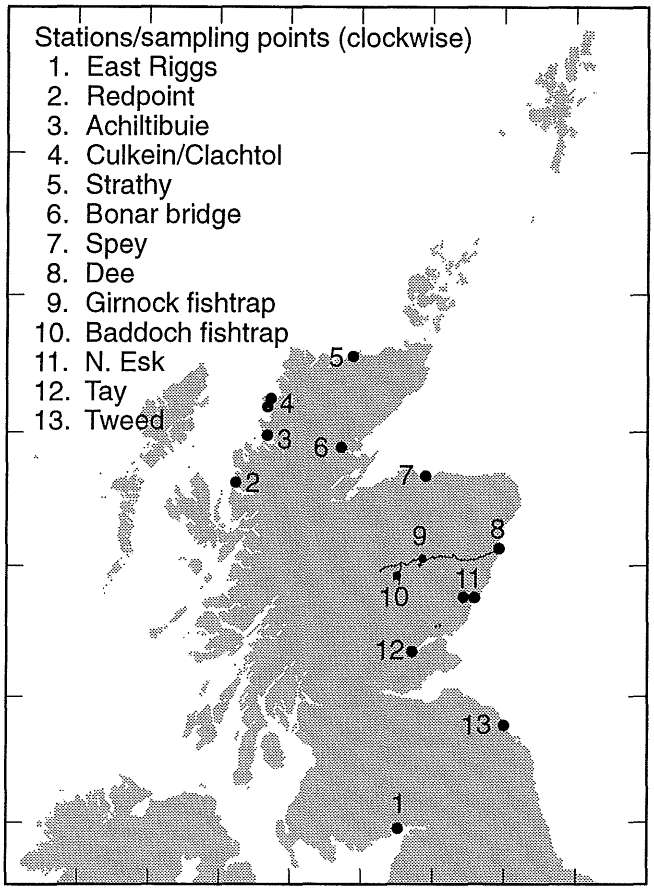


Figure 6.2.2 Location of Fisheries and traps sampled for fish farmed salmon.

APPENDIX 1

Minutes of Joint Session of the North Atlantic Salmon Working Group and the Baltic Salmon and Sea Trout Assessment Working Group

At its 1996 Statutory Meeting, ICES resolved (C.Res. 1996/2:14:13) that a half day joint session be held between the North Atlantic Salmon Working Group and the Baltic Salmon and Sea Trout Assessment Working Group to:

- discuss current progress with the implementation of spawning targets with reference to the conclusions of the Workshop on Spawning Targets held in France in 1996 **(a)**.

- define the term 'wild salmon' **(b)**.

Also, a formal request was made by the International Baltic Sea Fisheries Commission to the ICES to consider guidelines for establishing 'potential salmon rivers'. This was referred to the Baltic Salmon and Sea Trout Assessment Working Group for their consideration, with the suggestion that they discuss this with the North Atlantic Salmon Working Group at the joint session.

a) Current progress with the implementation of spawning targets with reference to the conclusions of the Workshop on Spawning Targets for the Assessment and Management of Atlantic Salmon Stocks (Pont-Scorff, France, June 24 to 28, 1996)

A summary of this Workshop was presented. Four main themes of interest were identified at the Workshop on Spawning Targets held in France and reviewed at the joint session:

- stock and recruitment analysis for deriving spawning targets with special reference to precision of estimates and methodological pitfalls,
- transfer and validation of spawning targets between river systems,
- use of time series data such as catches, juvenile densities and other indirect indices of stock and recruitment for defining spawning targets and evaluating the status of stocks, and
- managing the resource on the basis of spawning targets and incorporating uncertainty (concepts of risk analysis).

The intention of the workshop was to provide a teaching/exchange forum, to discuss objectives and distribute techniques currently available for the derivation and use of escapement reference points. The workshop was not intended to recommend procedures which individuals should follow or to recommend data to be collected. It was not intended to define specific reference points for particular rivers.

It was agreed at the workshop that the word "target" was an unfortunate choice as it implied that once the target was reached any extra fish were surplus. A more appropriate term suggested was "reference point" which would include the spawning target which was only one of several possible reference points. Clear definitions were required for other reference points (optima, thresholds, observation, MBAL and others).

A threshold level of escapement (synonymously referred to as conservation reference points) were defined based on the principles of genetic diversity and stock integrity. These levels should ensure the fitness of stocks (ability to sustain itself, rebuild, and not be threatened by insufficient escapement); no exploitation should occur below these reference points. It was also concluded that the definition of optimum spawning reference points requires clarification of the decision rules for resource use and that fixed exploitation rate management is the best policy for maximising benefit (yield) from the resource.

It was established that the derivation of reference points goes beyond fitting classical Stock - Recruitment curves and the examination of the goodness of fit. Currently available analysis tools incorporate the uncertainty around the average relationship and most of these methods can be applied using standard spreadsheet software. Generally, methods for assessing uncertainty are likely to be too optimistic and observation error (errors in estimation of spawning stock) result in underestimation of the policy parameters and overestimation of precision. This uncertainty should be acknowledged when advising managers on policy planning in the following manner:

- advice should be elaborated under a risk analysis framework
- and expressed in terms of probabilities of achieving a pre-defined goal or of probabilities of an undesired event.

The approach should take into account:

- knowledge on the nature of the S/R relationships,
- strategy of exploitation (e.g. catch levels),
- uncertainty about the S/R relationship, and
- uncertainty in implementation of the exploitation strategy.

The incorporation of risk analysis is the major area for improving the quality of the advice to managers by a scientific organisation such as ICES.

A further area examined in some detail by the Workshop was the transport of Stock - Recruitment relationship and derived reference points. Two extreme approaches are:

1. no extrapolation across rivers because every system is unique.
2. generalisation over very broad areas because all systems should behave roughly the same.

Neither of these are satisfactory. In the first instance transport is necessary as collection of stock and recruitment data is justifiable if the results can be generalised across a group of rivers and secondly there is no readily useable "recipe" to assess and ensure the validity of transport across rivers. Scientists must have at their disposal data sets to test and develop new tools. Good Stock-Recruitment series (long duration and with appropriate contrast) are not common and they should be shared within the scientific community for maximum benefit.

Progress was made at the Workshop in the derivation of reference points and transportability. This issue is considered to be of extreme importance considering that in most countries there were no short-term possibilities for developing individual Stock - Recruitment relationships for all rivers (there are over 500 rivers in Canada and 600 in Norway). A Canadian life history model (ASRAM) was developed to examine management strategies for stocks threatened by acidification in rivers of varying productivity. Definition of spawning requirements for several rivers in Brittany (France) based on a donor stream were established and the Environment Agency (Wales) has been exploring habitat based approaches to define spawning targets for rivers in England and Wales.

Further progress is more dependent on good data than on the development of tools to process data. Special attention must be devoted to:

- the precision of the stock and recruitment estimates, and
- experimental designs (i.e. direct manipulation of stock abundance to observe the response of the recruitment) to maximise learning from the data gathered.

The Working Groups acknowledged the advances which the Workshop had made to the understanding and clarification of many of the issues relating to spawning targets.

In discussion a number of valuable points were raised.

MBAL should not be seen as a target. For example, in the UK (England/Wales) MBAL has been set at the Maximum Gain. However, the assessment of compliance is based on an analysis of spawner escapement over a number of years. In Canada MBAL was seen as a point below which fishing should not take place.

While it was acknowledged that new information can be used to refine the reference points, caution was also expressed that substantially altering these reference points or changing too often may make the advice appear inconsistent or unstable. It was also noted that improvements to some Stock-Recruitment relationship can be made by incorporating extra parameters (relationships between river length and age composition , gradient classified approaches, altitude and productivity). The Baltic Group indicated that much of their work in future will be based on theoretical approaches and methodologies adapted to the Baltic from other areas. They were seeking to establish new monitored rivers to help with the establishment and management of wild stocks by the year 2010.

A number of recommendations were made by the participants of the joint session:

1. Data series which were being used to provide reference points should be continued.

2. Risk analyses and similar approaches to quantify uncertainty should be used on existing Stock - Recruitment relationships.

3. The development of new data series and Stock - Recruitment relationships should be encouraged.

4. A list of rivers where sufficient information is available to establish reference points should be collated. Contact individuals should be identified who are involved in the collection of data or involved in the development of methods/models forwarding the progress of transporting reference points for Atlantic salmon stocks should also be compiled to encourage the dissemination of data, information and methodologies. A preliminary list is provided in Appendix 8 which will be expanded in due course.

b) Define the term wild salmon

In 1995, ACFM requested that both groups provide definitions of "Wild salmon". Different definitions were produced.

i. The North Atlantic Working Group defined Atlantic salmon "types" as follows:

Native salmon are wild salmon which are members of a population with no known effects from intentional or accidental releases.

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.

Naturalised salmon are fish that have spent their entire life cycle in the wild and originate from parents, one or both of 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.

These definitions recognise a "continuum" of salmon, based upon the degree to which each fish and its parental generation have been continuously subjected to natural selection. Natural selection acts over time upon individuals within populations, which then evolve to match their members biological characteristics to their environment. The presence of well adapted individuals confers characteristics like resistance, resilience, and the ability to sustain itself upon populations. Native salmon are the most valuable from biological perspective. They are self sustaining, and any losses are irreversible. Wild and naturalised salmon have the potential to develop self-sustaining populations.

ii. The definition provided by the Baltic Salmon Working Group was:

A **wild salmon** is the result of natural spawning and has spent its entire life cycle in nature.

Underlying the Baltic group's definition was a concern about conserving wild stocks. The group emphasised that " A wild population was not simply a collection of wild salmon because the definition of wild lacks the genetic and adaptive contexts that are major biological characteristics of locally adapted spawning populations". These "genetic and adaptive contexts" are the end product of natural selection acting on individuals, and ultimately permit populations to be self sustaining. Under the Baltic Group's definition, "Native", "Wild" and "Naturalised" salmon could all be termed "wild".

ANACAT met in September 1996 and concluded that the North Atlantic Group's definition of wild salmon was more acceptable than that of the Baltic group because it considered the need for salmon to be subjected to natural selection for at least one generation before they were called "wild". During the joint meeting of the two groups in April 1997, members of the North Atlantic Working Group reiterated their need to maintain the present definitions. The recognition of the continuum of salmon types is very important, for theoretical and practical (management) reasons. However, both the North Atlantic Working group and ANACAT recognised that since there is no easy way to determine if salmon's parents were wild, for certain management purposes the Baltic definition might have to be used.

During the Joint Meeting of the Working Groups, the WGBAST agreed to adopt the definitions proposed by the WGNAS. They also agreed that the goal of present wild salmon management practices is to maintain self sustaining populations, and to strive for the fish in them to have characteristics as similar to "Native" salmon as possible. As an expedient, especially for management purposes, biologists are forced to define a variety of salmon types as "wild". Both Working Groups agreed that the term is best used to describe populations which are (or are progressing towards becoming) self-sustaining. In a management context, all categories of "wild salmon" require a precautionary approach with appropriate measures as necessary being taken to protect them.

APPENDIX 2

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP ON NORTH ATLANTIC SALMON, 1997.

Doc. No. 1	Chaput, G. [editor]. Extract from: Proceedings of a workshop to review conservation principles for Atlantic salmon in Eastern Canada. Can.Manus.Rep.Fish.Aquat.Sci. (In prep)
Doc. No. 2	Prévost, É. and G. Chaput. Lessons and guidelines from the international workshop on spawning targets for the assessment and management of Atlantic salmon stocks (Pont Scorff, France, June 24 to 28, 1996).
Doc. No. 3	Chaput, G., F. Caron, T.L. Marshall, D. Meerburg, and D. Reddin. Report on the status of Atlantic salmon stocks in eastern Canada in 1996.
Doc. No. 4	Chaput, G. and É. Prévost Catch advice for Greenland based on the risk of not meeting North American spawner requirements.
Doc. No. 5	Baum, E. and L.W. Stolte. 1996 USA Atlantic salmon fisheries and stock status.
Doc. No. 6	Ó. Maoiléidigh, N. J. Browne, A. Cullen, T. McDermott, N. Bond, D. McLaughlin, and G. Rogan. National report for Ireland - the 1996 salmon season.
Doc. No. 7	Næsje, T.F. and L. Saksgård. Yearly catches of Atlantic salmon in River Alta, North Norway.
Doc. No. 8	Lund, R.A., L.P. Hansen. Farmed salmon in Norwegian home waters.
Doc. No. 9	Lund, R.A., L.P. Hansen, and J.A. Jacobsen. Smolt age and sea age of Atlantic salmon sampled in the research fishery at Faroes in the 1991/1992 to 1994/1995 fishing seasons.
Doc. No. 10	Aas, O. Estimation of non-registered catches of Atlantic salmon in Norway.
Doc. No. 11	Hansen, L.P. Atlantic salmon; national report for Norway 1996.
Doc. No. 12	Jacobsen, J.A. The salmon research fishery at Faroes in the 1995/1996 season.
Doc. No. 13	Withdrawn.
Doc. No. 14	Holm, M., J.C. Holst, and L.P. Hansen. Salmon surveys in the Norwegian Sea 1996. Methods, distribution of catches and provisional data of fish caught.
Doc. No. 15	Hansen, L.P., J.A. Jacobsen, and R.A. Lund. The incidence of escaped farmed Atlantic salmon, *Salmo salar* L., in the Faroese fishery and estimated catches of wild salmon.
Doc. No. 16	Jacobsen, J.A., L.P. Hansen, and E.C.E. Potter. Origin of wild and farmed Atlantic salmon, *Salmo salar* L., tagged and released north of the Faroe Islands.
Doc. No. 17	Insulander, C. An attempt to estimate spawning stock targets in the River Hogvadsan.
Doc. No. 18	Gudbergsson, G. National report for Iceland - the 1996 salmon season.
Doc. No. 19	Zubchenko, A.V., A.A. Loenko, N.G. Popov, V.P. Antonova, and V.A. Valetov. Atlantic salmon in Russian rivers. Fisheries and status of stocks in 1996.
Doc. No. 20	Tretjak, V.L., G.B. Rudneva, and A.V. Zubchenko. Assessment of optimal spawning stock and factors affecting the abundance of Atlantic salmon in the Tuloma River.
Doc. No. 21	MacLean, J.C. National report for UK (Scotland).

Doc. No. 22 Hay, D.W. The status of salmon populations in the Girnock and Baddoch burns, tributaries of the Aberdeenshire Dee, Scotland.

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APPENDIX 3

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APPENDIX 4

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APPENDIX 5

Appendix 5(i). Estimated numbers of 2SW salmon recruits, returns and spawners for Labrador salmon stocks including west Greenland. 1996 catches are preliminary.

	Commercial catches of large salmon			Labrador Origin Large returns before commercial fishery						Labrador 2SW Recruits prior to commercial fishery						Labrador 2SW Recruits,NF & Greenland		Labrador salmon			Labrador 2SW to rivers		Labrador 2SW spawners	
																SFAs 1,2 &14B		Labrador at Greenland	Total+NF+WG		SFAs 1,2 &14B		SFAs 1,2 &14B Angling catch subtracted	
Year	SFA 1	SFA 2	SFA 14B	SFA 1		SFA 2		SFA 14B		SFA 1		SFA 2		SFA 14B										
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
*1969	18929	48822	10300	12620	16826	32548	55797	6867	11772	8834	15144	19529	44637	4120	9418	32483	69198	34280	80636	133032	3248	20760	2890	20287
*1970	17633	45479	9595	11755	20152	30319	51976	6397	10966	8229	18137	18191	41581	3838	8773	30258	68490	56379	99561	154121	3026	20547	2676	20085
*1971	25127	64806	13673	16751	28716	43204	74064	9115	15626	11726	25845	25922	59251	5469	12501	43117	97596	24299	85831	163577	4312	29279	4012	28882
*1972	21599	55708	11753	14399	24685	37138	63666	7835	13432	10080	22216	22283	50933	4701	10746	37064	83895	59202	112096	178927	3706	25168	3435	24812
*1973	30204	77902	16436	20136	34519	51935	89031	10957	18784	14095	31067	31161	71225	6574	15027	51830	117319	22348	96314	189771	5183	35196	4565	34376
1974	13866	93036	15863	9244	15847	62024	106327	10575	18129	6471	14262	37214	85061	6345	14503	50030	113827	38035	109433	200476	5003	34148	4490	33475
1975	28601	71168	14752	19067	32687	47445	81335	9835	16859	13347	29418	28467	65068	5901	13488	47715	107974	40919	109012	195006	4772	32392	4564	32119
1976	38555	77796	15189	25703	44063	51864	88910	10126	17359	17992	39657	31118	71128	6076	13887	55186	124671	67730	146485	245646	5519	37401	4984	36701
1977	28158	70158	18664	18772	32181	46772	80181	12443	21330	13140	28963	28063	64144	7466	17064	48669	110171	28482	97937	185706	4867	33051	4042	31969
1978	30824	48934	11715	20549	35227	32623	55925	7810	13389	14385	31705	19574	44740	4686	10711	38644	87155	32668	87816	157045	3864	26147	3361	25490
1979	21291	27073	3874	14194	24333	18049	30941	2583	4427	9936	21899	10829	24752	1550	3542	22315	50194	18636	50481	90267	2231	15058	1823	14528
1980	28750	87067	9138	19167	32857	58045	99505	6092	10443	13417	29571	34827	79604	3655	8355	51899	117530	21426	95490	189152	5190	35259	4633	34525
1981	36147	68581	7606	24098	41311	45721	78378	5071	8693	16869	37180	27432	62703	3042	6954	47343	106836	32768	100331	185233	4734	32051	4403	31615
1982	24192	53085	5966	16128	27648	35390	60669	3977	6818	11290	24883	21234	48535	2386	5455	34910	78873	43678	93497	156236	3491	23662	3080	23127
1983	19403	33320	7489	12935	22175	22213	38080	4993	8559	9055	19957	13328	30464	2996	6847	25378	57268	30804	67021	112531	2538	17181	2267	16824
1984	11726	25258	6218	7817	13401	16839	28866	4145	7106	5472	12061	10103	23093	2487	5685	18063	40839	4026	29802	62306	1806	12252	1478	11822
1985	13252	16789	3954	8835	15145	11193	19187	2636	4519	6184	13631	6716	15350	1582	3615	14481	32596	3977	24644	50494	1448	9779	1258	9530
1986	19152	34071	5342	12768	21888	22714	38938	3561	6105	8938	19699	13628	31151	2137	4884	24703	55734	17738	52991	97275	2470	16720	2177	16334
1987	18257	49799	11114	12171	20865	33199	56913	7409	12702	8520	18779	19920	45531	4446	10161	32885	74471	29695	76625	135970	3289	22341	2895	21821
1988	12621	32386	4591	8414	14424	21591	37013	3061	5247	5890	12982	12954	29610	1836	4197	20681	46789	27842	57355	94614	2068	14037	1625	13452
1989	16261	26836	4646	10841	18584	17891	30670	3097	5310	7588	16726	10734	24536	1858	4248	20181	45509	26728	55528	91673	2018	13653	1727	13270
1990	7313	17316	2858	4875	8358	11544	19790	1905	3266	3413	7522	6926	15832	1143	2613	11482	25967	9771	26158	46828	1148	7790	923	7493
1991	1369	7679	4417	913	1565	5119	8776	2945	5048	639	1408	3072	7021	1767	4038	5477	12467	7779	15596	25571	548	3740	491	3665
1992	9981	19608	2752	7219	13760	14182	27032	1990	3794	5053	12384	8509	21626	1194	3035	14756	37045	13713	28469	50758	2515	15548	2012	14889
1993	3825	9651	3620	3682	8021	9290	20238	3485	7591	2577	7219	5574	16190	2091	6073	10242	29482	6592	16834	36074	3858	18234	3624	17922
1994	3464	11056	857	4124	9453	13162	30170	1020	2339	2887	8507	7897	24136	612	1871	11396	34514	0	11396	34514	5653	24396	5339	23981
1995	2150	8714	312	4873	11490	19752	46570	707	1667	3411	10341	11851	37256	424	1334	15687	48931	0	15687	48931	11535	41606	11173	41127
1996	1370	5479	418	3610	8672	14437	34680	1101	2646	2527	7804	8662	27744	661	2117	11850	37665	4432	16282	42098	9152	32905	8832	32480

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),.29-.50(94), .15-.26(95), .13-.23(96)

EST 2SW RETURNS - (EST LARGE RETURNS*PROP 2SW), PROP 2SW SFA 1=.7-.9,SFAs 2&14B=.6-.8

WG - are North American 1SW salmon of river age 4 and older of which 70% are Labrador origin

EST RET TO FRESHWATER - (EST 2SW RET-2SW CATCHES)

EST 2SW SPAWNERS = EST 2SW RETURNS TO FRESHWATER - 2SW ANGLING CATCHES

*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

Appendix 5(ii). Estimated numbers of 1SW salmon recruits, returns and spawners for Labrador. 1996 catches are preliminary.

	Commercial catches of small salmon			Labrador origin small recruits before commercial fishery in Labrador						Labrador grilse recruits prior to commercial fishery						Grilse Recruits		Grilse to rivers		Labrador grilse spawners Angling catch subtracted	
				SFA 1		SFA 2		SFA 14B		SFA 1		SFA 2		SFA 14B		SFA 1,2&14B+Nfld		SFA 1,2&14B		SFA 1,2&14B	
Year	SFA 1	SFA 2	SFA 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	48912	122280	18587	65053	15476	61942
*1970	14666	29441	8605	17600	39110	35329	78509	10326	22947	14080	35199	28263	70658	8261	20652	66584	166459	25302	88556	21289	84543
*1971	19109	38359	11212	22931	50958	46031	102291	13454	29898	18345	45862	36825	92062	10763	26908	86754	216884	32966	115382	29032	111448
*1972	14303	28711	8392	17164	38141	34454	76563	10070	22378	13731	34327	27563	68907	8056	20140	64934	162335	24675	86362	21728	83415
*1973	3130	6282	1836	3756	8346	7539	16753	2203	4896	3004	7511	6031	15077	1763	4407	14208	35520	5399	18897	0	11405
1974	9848	37145	9328	11818	26261	44574	99053	11194	24875	9454	23635	35659	89148	8955	22387	71142	177856	27034	94619	24533	92118
1975	34937	57560	19294	41924	93165	69072	153493	23153	51451	33540	83849	55258	138144	18522	46306	141210	353024	53660	187809	49688	183837
1976	17589	47468	13152	21107	46904	56962	126581	15782	35072	16885	42214	45569	113923	12626	31565	98790	246976	37540	131391	31814	125665
1977	17796	40539	11267	21355	47456	48647	108104	13520	30045	17084	42710	38917	97294	10816	27041	87918	219796	33409	116931	28815	112337
1978	17095	12535	4026	20514	45587	15042	33427	4831	10736	16411	41028	12034	30084	3865	9662	42513	106282	16155	56542	13464	53851
1979	9712	28808	7194	11654	25899	34570	76821	8633	19184	9324	23309	27656	69139	6906	17266	57744	144360	21943	76800	17825	72682
1980	22501	72485	8493	27001	60003	86982	193293	10192	22648	21601	54002	69586	173964	8153	20383	130710	326776	49670	173845	45870	170045
1981	21596	86426	6658	25915	57589	103711	230469	7990	17755	20732	51830	82969	207422	6392	15979	144859	362147	55046	192662	49855	187471
1982	18478	53592	7379	22174	49275	64310	142912	8855	19677	17739	44347	51448	128621	7084	17710	100357	250892	38136	133474	34032	129370
1983	15964	30185	3292	19157	42571	36222	80493	3950	8779	15325	38314	28978	72444	3160	7901	62452	156129	23732	83061	19360	78689
1984	11474	11695	2421	13769	30597	14034	31187	2905	6456	11015	27538	11227	28068	2324	5810	32324	80811	12283	42991	9348	40056
1985	15400	24499	7460	18480	41067	29399	65331	8952	19893	14784	36960	23519	58798	7162	17904	59822	149555	22732	79563	19631	76462
1986	17779	45321	8296	21335	47411	54385	120856	9955	22123	17068	42670	43508	108770	7964	19910	90184	225461	34270	119945	30806	116481
1987	13714	64351	11389	16457	36571	77221	171603	13667	30371	13165	32914	61777	154442	10933	27334	112995	282486	42938	150283	37572	144917
1988	19641	56381	7087	23569	52376	67657	150349	8504	18899	18855	47138	54126	135314	6804	17009	104980	262449	39892	139623	34369	134100
1989	13233	34200	9053	15880	35288	41040	91200	10864	24141	12704	31759	32832	82080	8691	21727	71351	178377	27113	94896	22429	90212
1990	8736	20699	3592	10483	23296	24839	55197	4310	9579	8387	20966	19871	49678	3448	8621	41718	104296	15853	55485	12544	52176
1991	1410	20055	5303	1692	3760	24066	53480	6364	14141	1354	3384	19253	48132	5091	12727	33812	84531	12849	44970	10526	42647
1992	9588	13336	1325	14646	34950	20371	48613	2024	4830	11716	31455	16296	43751	1619	4347	29632	79554	17993	62094	15229	59331
1993	3893	12037	1144	9514	23619	29417	73030	2796	6941	7611	21257	23534	65727	2237	6247	33382	93231	25186	80938	22499	78251
1994	3303	4535	802	10659	26807	14635	36805	2588	6509	8527	24126	11708	33125	2071	5858	22306	63109	18159	56888	15228	53958
1995	3202	4561	217	14863	37638	21170	53612	1007	2551	11890	33874	16936	48251	806	2296	29632	84420	25802	78675	22924	75797
1996	1676	5308	865	16295	41455	51606	131291	8410	21395	13036	37310	41285	118162	6728	19256	61049	174728	57281	169077	53888	165684

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),.10-.19(94),.07-.13(95),.03-.06(96)

EST GRILSE RETURNS CORRECTED FOR NON-MATURING 1SW - (SMALL RET*PROP GRILSE), PROP GRILSE SFAs1,2&14B=0.8-0.9

EST RET TO FRESHWATER - (EST GRILSE RET-GRILSE CATCHES)

EST GRILSE SPAWNERS = EST GRILSE RETURNS TO FRESHWATER - GRILSE ANGLING CATCHES

*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

Furthermore small catches in 1973 were adjusted by ratio of large:small in 1972&74 (SFA 1-1.4591, SFA 2-2.2225, SFA 14B-1.5506).

Appendix 5(iii). Atlantic salmon returns to freshwater, total recruits prior to the commercial fishery and spawners summed for Salmon Fishing Area 3-14A, insular Newfoundland, 1969-1996.
Ret. = retained fish; Rel. = released fish.

	Small catch	Small returns to river		Small recruits		Small spawners		Large returns to river		Large recruits		Large catch	Large spawners		2SW returns to river		2SW spawners		2SW recruits	
Year	Retained	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Min	Max	Min	Max	Min	Max	Min	Max
1969	34944	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	36552	120816	240985	241633	803283	84264	204433	3612	7680	12041	76800	0	3581	7649	961	3319	949	3300	3205	33186
1986	37496	124547	248688	249094	828961	87051	211192	6850	14103	22832	141030	0	6770	14023	1592	5402	1560	5354	5308	54020
1987	24482	125116	249856	250232	832852	100634	225374	6357	13068	21190	130684	0	6316	13027	1338	4629	1322	4605	4461	46293
1988	39841	132059	263363	264119	877877	92218	223522	6369	13330	21231	133299	0	6309	13270	1553	5346	1529	5310	5177	53459
1989	18462	59793	119261	119587	397537	41331	100799	3260	6752	10865	67518	0	3241	6733	704	2452	697	2441	2347	24517
1990	29967	98830	197276	197659	657588	68863	167309	5751	11868	19170	118675	0	5701	11817	1341	4562	1321	4532	4470	45620
1991	20529	64016	127698	128032	425661	43487	107169	4449	9173	14831	91734	0	4416	9140	1057	3577	1044	3557	3524	35771
1992	23118	116116	231954	116116	231954	92434	208272	15797	31897	15797	31897	0	15656	31756	3024	10354	2968	10270	3024	10354
1993	24693	131045	261721	131045	261721	104712	235387	7955	16227	7955	16227	0	7791	16063	1487	5217	1437	5139	1487	5217
1994	28959	95487	190655	95487	190655	65691	160859	7915	16099	7915	16099	0	7709	15894	1889	6255	1825	6156	1889	6255
1995	29055	111889	223758	111889	223758	81877	193746	8972	18182	8972	18182	0	8753	17963	2296	7462	2223	7350	2296	7462
1996	36707	141196	287528	141196	287528	102904	249237	11035	22857	11035	22857	0	10817	22638	2523	8671	2455	8565	2523	8671

SRR (Small returns to river) are the sum of Bay St. George small returns (Reddin & Mullins 1996) plus Humber R small returns (Mullins & Reddin 1996) plus small returns in SFAs 3-12 & 14A.
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+(SR*0.1))
SR = salmon catch released
RL (RATIO large:small) are from counting facilities in SFAs 3-11, 13 & 14A, angling catches in SFA 12.
LRR (Large returns to river) = SRR * RL
LR (Large recruits) = LRR*(1-Exploitation rate large (ERL)), where ERL=0.7-0.9, 1969-91; & ERL=0, 1992-95.
LS (Large spawners) = LRR-large catch retained (LC)-(0.1*large catch released)
2SW-RR (2SW returns to river)= LRR*proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-S (2SW spawners) = LS * proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-R (2SW recruits) = LR * proportion 2SW of 0.4-0.6 for SFAs 12-14A& 0.1-0.2 for SFAs 3-11.

Appendix 5(iva). Total catch of salmon in Quebec by recreational, commercial and First peoples fisheries, 1969-96.

	Recreational				Commercial				First peoples			
Year	1SW	2SW	3SW+repeat	TOTAL	1SW	2SW	3SW+repeat	TOTAL	1SW	2SW	3SW+repeat	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	2 484	11 627	794	9 137	3 916	13 847	508	3 197	1 519	5 224
1985	3 910	6 741	2 879	13 530	2 093	11 633	4 986	18 712	424	2 672	1 137	4 233
1986	6 153	7 964	3 416	17 533	3 707	14 622	6 267	24 596	523	3 294	1 411	5 228
1987	7 292	6 633	2 844	16 769	2 992	15 922	6 824	25 737	517	3 256	1 396	5 169
1988	8 514	8 967	3 829	21 310	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	12 723	5 453	20 790	347	2 188	903	3 438
1990	8,377	8 330	3 561	20 268	3 425	11,264	4 828	19,517	321	2 021	1 129	3 471
1991	6,122	7 737	3 315	17 174	3 282	11,460	4 912	19,654	340	2 142	1 530	4 012
1992	8,135	8 452	3 598	20 185	3 849	11,096	4 755	19,700	215	1 357	2 805	4 377
1993	7,969	6 281	3 235	17 485	3 627	7,957	3 410	14,994	357	2 981	1 277	4 615
1994	7,416	7 077	3 646	18 139	3 870	7,291	3 125	14,285	357	3 291	1 410	5 058
1995	4,043	5 114	2 635	11 792	3 915	7,027	3 011	13,953	284	2 754	1 180	4 218
1996	7,191	6 012	3 097	16 300	4 532	5,218	2 236	11,986	110	3 389	1 453	4 952
Mean	5,334	7,233	3,938	16,505	2,849	13,139	6,563	22,551	390	2572	2246	5208

Zone Q11

	Commercial				First peoples			
Year	1SW	2SW	3SW+repeat	TOTAL	1SW	2SW	3SW+repeat	TOTAL
1 969	789	1 654	102	2 544	118	247	15	380
1 970	788	1 652	102	2 542	173	363	22	558
1 971	787	1 651	102	2 540	228	478	29	736
1 972	787	1 650	102	2 538	283	594	37	914
1 973	786	1 648	101	2 536	339	710	44	1 092
1 974	786	1 647	101	2 534	394	826	51	1 270
1 975	785	1 646	101	2 532	449	941	58	1 448
1 976	785	1 645	101	2 531	504	1 057	65	1 626
1 977	722	1 515	93	2 330	620	1 300	80	2 000
1 978	773	1 620	100	2 493	620	1 300	80	2 000
1 979	618	1 297	80	1 995	983	2 061	127	3 171
1 980	1 280	2 684	165	4 129	1 651	3 462	213	5 326
1 981	1 255	2 632	162	4 049	1 691	3 546	218	5 455
1 982	463	970	60	1 492	723	1 515	93	2 331
1 983	619	1 299	80	1 998	809	1 697	104	2 611

TOTAL included 3SW and repeat spawner

Recreational

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

First people harvest before 1984

average values,1984-1993

First people harvest before 1972:

conducted with commercial permits , (data included in commercial harvest) except for Q11

Appendix 5(ivb) Total return estimation of salmon in Québec, 1969-1996.

	Low estimation				High estimation			
Year	1SW	2SW	3SW+repeat	TOTAL	1SW	2SW	3SW+repea	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	26 684	11 591	46 930	16 007	41 035	17 747	74 788
1985	11 301	30 944	13 231	55 476	20 085	47 583	20 339	88 008
1986	18 093	37 726	16 174	71 994	31 957	57 536	24 670	114 163
1987	19 713	36 315	15 567	71 595	35 917	53 453	22 915	112 285
1988	24 409	39 149	16 748	80 306	43 511	61 020	26 091	130 621
1989	16 152	33 519	14 326	63 997	29 341	52 128	22 297	103 767
1990	22 318	33 188	14 506	70 012	40 891	53 090	23 056	117 037
1991	17 328	32 277	14 535	64 140	31 033	50 952	22 629	104 614
1992	22 164	32 492	16 430	71 086	40 264	52 532	25 300	118 096
1993	21 715	26 081	12 347	60 143	39 446	41 225	20 006	100 677
1994	20 805	27 384	13 054	61 243	37 384	44 187	21 572	103 144
1995	13 521	22 243	10 485	46 249	22 844	34 706	16 778	74 328
1996	20 799	22 824	10 901	54 524	36 956	37 041	18 113	92 109
Mean	15 193	33 618	18 597	67 408	27 148	51 525	28 384	107 057

Low estimation

landings (recreational+comm.+First people) + spawner (= 1 * recreational) + unreported (= .15* total landing

High estimation

landings (recreational+comm.+First people) + spawner (= 3 * recreational) + unreported (= .30* total landing

Appendix 5(v). 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
1996	7046	14593	2940	8295	7779	15723	5902	12275	0.65	5056	10220	3836	7979

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 were subtracted from the total for the watershed.
The returns and spawners estimates thus derived for the SFA 15 portion of the Restigouche were then multiplied by the minumum (1.117) and maximum (1.465) ratios of angling catch in SFA15:SFA 15 portion of Restigouche catch to obtain estimates for SFA 15.

Appendix 5(vi a). Returns and escapements of large salmon to SFA 16

	2SW returns to SFA 16		Returns to the Miramichi River						Returns of large	
			Large	0.8	1.33	Prop. 2SW	2SW Returns to Miramichi			
Year	Min.	Max.	returns	Min.	Max.		Min	Max	Min	Max
1971	19697	32746	24407	19526	32461	0.918	17924	29799	21457	35672
1972	24645	40972	29049	23239	38635	0.965	22427	37284	25538	42456
1973	22896	38065	27192	21754	36165	0.958	20835	34639	23905	39742
1974	33999	56523	42592	34074	56647	0.908	30939	51436	37444	62250
1975	21990	36558	28817	23054	38327	0.868	20011	33267	25334	42117
1976	17118	28459	22801	18241	30325	0.854	15578	25898	20045	33325
1977	43160	71753	51842	41474	68950	0.947	39275	65296	45575	75769
1978	18539	30822	24493	19594	32576	0.861	16871	28048	21532	35797
1979	5484	9117	9054	7243	12042	0.689	4991	8297	7960	13233
1980	30332	50426	36318	29054	48303	0.95	27602	45888	31928	53080
1981	9489	15775	16182	12946	21522	0.667	8635	14355	14226	23651
1982	21875	36368	30758	24606	40908	0.809	19907	33095	27040	44954
1983	19762	32854	27924	22339	37139	0.805	17983	29897	24549	40812
1984	12562	20884	15137	12110	20132	0.944	11431	19005	13307	22123
1985	15861	26369	20738	16590	27582	0.87	14434	23996	18231	30309
1986	23460	39003	31285	25028	41609	0.853	21349	35493	27503	45724
1987	13590	22594	19421	15537	25830	0.796	12367	20561	17073	28385
1988	15599	25933	21745	17396	28921	0.816	14195	23599	19116	31781
1989	9880	16426	17211	13769	22891	0.653	8991	14948	15131	25155
1990	15474	25725	28574	22859	38003	0.616	14081	23410	25120	41762
1991	15929	26482	29949	23959	39832	0.605	14495	24098	26329	43772
1992	19191	31905	37000	29600	49210	0.590	17464	29034	32527	54077
1993	21662	36012	35200	28160	46816	0.7	19712	32771	30945	51446
1994	14582	37515	27450	18278	47023	0.726	13270	34139	20086	51674
1995	18879	48135	32627	19747	50348	0.87	17180	43803	21700	55327
1996	13034	24328	24812	17443	32557	0.68	11861	22139	19168	35777

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.
For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.
For 1994 to 1996, min and max are 5th and 95th percentiles from the assessment.
Prop. 2SW are from scale ageing. For 1996, 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

Same procedure for escapements as used to calculate returns.

	Escapement of 2SW to		Escapements to the Miramichi River						Escapement of	
				0.8	1.33	Prop.	Escapement of 2SW			
Year	Min	Max	**Large**	**Min.**	**Max.**	**2SW**	Min	Max	Min	Max
1971	3508	5832	4347	3478	5782	0.918	3192	5307	3822	6353
1972	14992	24924	17671	14137	23502	0.965	13643	22681	15535	25827
1973	17134	28486	20349	16279	27064	0.958	15592	25922	17889	29741
1974	27495	45711	34445	27556	45812	0.908	25021	41597	30281	50343
1975	16366	27209	21448	17158	28526	0.868	14893	24760	18855	31347
1976	10760	17889	14332	11466	19062	0.854	9792	16279	12600	20947
1977	27404	45560	32917	26334	43780	0.947	24938	41459	28938	48109
1978	8197	13627	10829	8663	14403	0.861	7459	12401	9520	15827
1979	2751	4573	4541	3633	6040	0.689	2503	4161	3992	6637
1980	15762	26204	18873	15098	25101	0.95	14343	23846	16592	27584
1981	2702	4492	4608	3686	6129	0.667	2459	4088	4051	6735
1982	9429	15676	13258	10606	17633	0.809	8581	14265	11655	19377
1983	5986	9951	8458	6766	11249	0.805	5447	9056	7436	12362
1984	12189	20264	14687	11750	19534	0.944	11092	18440	12912	21466
1985	15390	25586	20122	16098	26762	0.87	14005	23283	17690	29409
1986	22659	37670	30216	24173	40187	0.853	20619	34280	26564	44162
1987	12635	21006	18056	14445	24014	0.796	11498	19116	15873	26390
1988	15050	25021	20980	16784	27903	0.816	13696	22769	18444	30663
1989	8921	14831	15540	12432	20668	0.653	8118	13496	13662	22712
1990	14940	24838	27588	22070	36692	0.616	13595	22602	24253	40321
1991	15472	25721	29089	23271	38688	0.605	14079	23406	25573	42515
1992	18984	27603	35927	29281	42573	0.590	17275	25118	32176	46784
1993	21755	31632	34702	28282	41122	0.7	19797	28785	31079	45189
1994	14207	37140	27147	17808	46553	0.726	12929	33797	19569	51157
1995	18345	47600	32093	19188	49789	0.87	16694	43316	21086	54713
1996	12510	23804	23478	16741	31855	0.68	11384	21661	18397	35005

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Appendix 5 (vib). Returns and escapements of small salmon to SFA 16, 1971-96.

	1SW returns to SFA 16		Returns to the Miramichi River			Prop.	1SW Returns to Miramichi	
				0.8	1.33	1SW	0.97	1.00
Year	Min.	Max.	Small	Min.	Max.		Min	Max
1971	30420	52137	35673	28538	47445		27682	47445
1972	39461	67633	46275	37020	61546		35909	61546
1973	37986	65104	44545	35636	59245		34567	59245
1974	62607	107303	73418	58734	97646		56972	97646
1975	55345	94857	64902	51922	86320		50364	86320
1976	78095	133848	91580	73264	121801		71066	121801
1977	23658	40547	27743	22194	36898		21529	36898
1978	20711	35496	24287	19430	32302		18847	32302
1979	43460	74487	50965	40772	67783		39549	67783
1980	35464	60782	41588	33270	55312		32272	55312
1981	55661	95399	65273	52218	86813		50652	86813
1982	68543	117477	80379	64303	106904		62374	106904
1983	21476	36807	25184	20147	33495		19543	33495
1984	25333	43418	29707	23766	39510		23053	39510
1985	51847	88862	60800	48640	80864		47181	80864
1986	100240	171802	117549	94039	156340		91218	156340
1987	72327	123962	84816	67853	112805		65817	112805
1988	103966	178189	121919	97535	162152		94609	162152
1989	64153	109953	75231	60185	100057		58379	100057
1990	71160	121962	83448	66758	110986		64756	110986
1991	51906	88962	60869	48695	80956		47234	80956
1992	132610	198777	152647	124407	180887		120675	180887
1993	80271	120323	92400	75306	109494		73047	109494
1994	44288	92257	56929	41549	83954		40303	83954
1995	20998	85127	54145	19699	77466		19108	77466
1996	40133	73318	44377	37651	66719		36521	66719

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.
For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.
For 1994 to 1996, min and max are 5th and 95th percentiles from the assessment.
Prop. 1SW are from scale ageing. Proportions vary from 0.97 to 1.00. Ref. Moore et al. 1995.

Miramichi makes up 91% of total rearing area of SFA 16.
Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 1SW returns to Miramichi / 0.91

Same procedure for escapements as used to calculate returns.

	Escapement of 1SW to SFA 1		Escapements to the Miramichi River					
							Escapement of 1SW	
				0.8	1.33	Prop.	Min	Max
Year	Min	Max	**Small**	**Min.**	**Max.**	**1SW**	0.97	1
1971	18714	32075	21946	17557	29188		17030	29188
1972	23139	39659	27135	21708	36090		21057	36090
1973	26169	44852	30688	24550	40815		23814	40815
1974	47060	80656	55186	44149	73397		42824	73397
1975	41332	70839	48469	38775	64464		37612	64464
1976	53194	91171	62380	49904	82965		48407	82965
1977	11296	19361	13247	10598	17619		10280	17619
1978	12239	20977	14353	11482	19089		11138	19089
1979	26306	45086	30848	24678	41028		23938	41028
1980	22934	39307	26894	21515	35769		20870	35769
1981	34049	58358	39929	31943	53106		30985	53106
1982	47754	81846	56000	44800	74480		43456	74480
1983	12662	21702	14849	11879	19749		11523	19749
1984	16142	27665	18929	15143	25176		14689	25176
1985	35658	61114	41815	33452	55614		32448	55614
1986	76234	130659	89398	71518	118899		69373	118899
1987	53533	91751	62777	50222	83493		48715	83493
1988	76984	131945	90278	72222	120070		70056	120070
1989	41260	70717	48385	38708	64352		37547	64352
1990	50759	86997	59524	47619	79167		46191	79167
1991	41161	70547	48269	38615	64198		37457	64198
1992	112317	168359	129288	105370	153206		102209	153206
1993	66385	99509	76416	62279	90553		60411	90553
1994	27829	75289	42479	26108	68513		25325	68513
1995	13079	53561	34084	12270	48740		11902	48740
1996	19278	51818	24812	18086	47154		17543	47154

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Appendix 5 (vii). Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1970-1996. PEI commerci landings are also given.

	Small recruits		Small spawner		Large recruits		Large spawners		2SW recruits		2SW spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	4	8	2	6	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	13	23	7	17	2	4	1	3	2	4	1	3
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	2	4	1	3	4	8	2	6	4	8	2	6
1980	11	19	6	14	2	4	1	3	2	4	1	3
1981	235	415	127	307	36	64	32	60	36	64	32	60
1982	159	281	86	208	14	26	6	18	14	26	6	18
1983	15	27	8	20	15	27	13	25	15	27	13	25
1984	15	27	8	20	12	22	12	22	12	22	12	22
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	1049	1899	580	1430	85	153	84	152	85	153	84	152
1996	1225	2720	779	2274	167	371	167	371	167	371	167	371
70-86 X	63	111	34	82	6	10	5	9	6	10	5	9
87-96 X	1122	2044	619	1541	122	224	122	224	122	224	122	224

Notes

Number of small retained salmon in 1993 was not recorded. The number given is the mean for 1986-1992

For 1970-1980, percent small is calculated from numbers of small and large salmon in the retained catch in each year. For 1981-1995, 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 as 0.34, 0.347, and 0.2 of estimated returns in 1994, 1995, and 1996, respectively. For other years the mean of these values is used. The min and max max numbers of small recruits are calculated using exploitation + or - 0.1; e.g. 0.34 + or - 0.1 gives 0.24 and 0.44.

Small spawners = number of small recruits - number of small retained

Large recruits = (number of small recruits/(0.01*percent small))-number of small recruits

Large spawners = number of large recruits - number of large retained

It is asssumed that large salmon and 2SW salmon are equivalent

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 5 (viiia). Total 2SW returns and spawners to SFA 18, 1970-1996.

	LARGE RETURNS						*Commercial catches*			*TOTAL 2SW*		*SPAWNERS*				*TOTAL*	
	Margaree		*SFA 18*		*2SW RETURNS*			*2SW ctch*		*RETURNS*		*Margaree*		*SFA 18*		*SPAWNERS*	
	Large salmon		1.381	2.151	0.77	0.87	Zone 6	0.77	0.87	(inc comm.)				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	1,750	3,815	2,417	8,205	1,861	7,138		0	0	1,861	7,138	1,693	3,758	2,339	8,082	1,801	7,031
1996	2,214	4,050	3,058	8,710	2,355	7,578		0	0	2,355	7,578	2,001	3,837	2,764	8,252	2,128	7,179

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 1984-1996 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; 1984-1996 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 5(viii b). Total 1SW returns and spawners to SFA 18, 1970-1996.

	RETURNS				SPAWNERS			
	Margaree		SFA 18		Margaree		SFA 18	
	0.37	0.21	1.214	2.198			1.214	2.198
Year	Min	Max	Min	Max	Min	Max	Min	Max
1970	230	395	279	869	145	310	176	682
1971	57	98	69	215	36	77	43	169
1972	114	195	138	429	72	153	87	337
1973	449	772	545	1,697	283	606	343	1,332
1974	162	279	197	613	102	219	124	482
1975	97	167	118	368	61	131	74	289
1976	259	447	315	981	163	351	198	770
1977	186	321	226	705	117	252	143	554
1978	68	116	82	256	43	91	52	201
1979	1,614	2,777	1,959	6,104	1,017	2,180	1,234	4,791
1980	451	777	548	1,707	284	610	345	1,340
1981	2,430	4,181	2,950	9,191	1,531	3,282	1,859	7,215
1982	1,868	3,214	2,267	7,065	1,177	2,523	1,429	5,546
1983	184	316	223	695	116	248	141	546
1984	400	688	486	1,512	158	446	192	980
1985	634	1,167	770	2,565	125	658	152	1,446
1986	838	1,420	1,017	3,121	56	638	68	1,402
1987	1,143	1,865	1,388	4,100	166	888	202	1,952
1988	1,674	2,911	2,032	6,399	795	2,032	965	4,467
1989	591	977	718	2,148	30	416	36	914
1990	940	5,077	1,141	11,160	291	4,428	353	9,733
1991	794	3,891	964	8,553	42	3,139	51	6,900
1992	1,258	2,419	1,527	5,317	701	1,862	851	4,093
1993	1,489	3,851	1,808	8,465	906	3,268	1,100	7,184
1994	573	1,101	696	2,420	259	787	314	1,730
1995	538	1,083	653	2,381	329	874	399	1,921
1996	1277	2960	1,550	6,507	935	2,618	1,135	5,755

Recreational ctch

Year	SFA 18	Marg-aree	Ratio
1984	298	242	1.23
1985	618	509	1.21
1986	1180	782	1.51
1987	1289	977	1.32
1988	1349	879	1.53
1989	928	561	1.65
1990	1206	649	1.86
1991	1262	752	1.68
1992	1242	678	1.83
1993	1218	777	1.57
1994	659	429	1.54
1995	710	323	2.20
1996	1998	1165	1.72
		Min	1.214
		Max	2.198

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, 1984-1996, based on annual assessments in CAFSAC and DFO Atl. Fish. Res. Docs, eg., Claytor et al. MS 1995.
Spawners for 1970-1983 equal returns minus removals; 1984-1996 from various Margaree CAFSAC and Atl. Res. Doc. series, eg., Claytor et al. MS 1995.

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Appendix 5 (ix). Total 1SW returns and spawners, SFAs 19, 20, 21 and 23, 1970-1996.

	RETURNS						TOTAL RETURNS			SPAWNERS					TOTAL SPAWNERS	
	River returns SFA 19-21		Comm-ercial	SFA 23			SFAs 19,20,21,23		angled	Spawners 19-21		SFA 23 H+W rtns		Harvest	19,20,21,23	
Year	MIN	MAX	19-21	Wild MIN	Wild MAX	Hatch	MIN	MAX	19-21	MIN	MAX	MIN	MAX		MIN	MAX
1970	8,236	16,868	3,189	5,206	7,421	100	16,731	27,578	3,609	4,627	13,259	5,306	7,521	1,420	8,513	19,360
1971	6,345	13,062	1,922	2,883	4,176	365	11,515	19,525	2,761	3,584	10,301	3,248	4,541	2,032	4,800	12,810
1972	6,636	13,354	1,055	1,546	2,221	285	9,522	16,915	2,917	3,719	10,437	1,831	2,506	2,558	2,992	10,385
1973	8,225	16,744	1,067	3,509	5,047	1,965	14,766	24,823	3,604	4,621	13,140	5,474	7,012	1,437	8,658	18,715
1974	14,478	29,385	2,050	6,204	8,910	3,991	26,723	44,336	6,340	8,138	23,045	10,195	12,901	2,124	16,209	33,822
1975	5,096	10,393	2,822	11,648	16,727	6,374	25,940	36,316	2,227	2,869	8,166	18,022	23,101	2,659	18,232	28,608
1976	12,421	25,398	1,675	13,761	19,790	9,074	36,931	55,937	5,404	7,017	19,994	22,835	28,864	5,263	24,589	43,595
1977	13,349	27,943	3,773	6,746	9,679	6,992	30,860	48,387	5,841	7,508	22,102	13,738	16,671	4,542	16,704	34,231
1978	2,535	5,241	3,651	3,227	4,651	3,044	12,457	16,587	1,113	1,422	4,128	6,271	7,695	2,015	5,678	9,808
1979	12,365	25,381	3,154	11,529	16,690	3,827	30,875	49,052	5,428	6,937	19,953	15,356	20,517	3,716	18,577	36,754
1980	16,534	33,825	8,252	14,346	20,690	10,793	49,925	73,560	7,253	9,281	26,572	25,139	31,483	5,542	28,878	52,513
1981	18,594	38,329	1,951	11,199	16,176	5,627	37,371	62,083	8,163	10,431	30,166	16,826	21,803	9,021	18,236	42,948
1982	10,008	20,552	2,020	8,773	12,598	3,038	23,839	38,208	4,361	5,647	16,191	11,811	15,636	5,279	12,179	26,548
1983	4,662	9,562	1,621	7,706	11,028	1,564	15,553	23,775	2,047	2,615	7,515	9,270	12,592	4,138	7,747	15,969
1984	12,398	25,815	0	14,105	20,227	1,451	27,954	47,493	4,724	7,674	21,091	15,556	21,678	5,266	17,964	37,503
1985	16,354	34,055	0	11,038	15,910	2,018	29,410	51,983	6,360	9,994	27,695	13,056	17,928	4,892	18,158	40,731
1986	16,661	34,495	0	13,412	19,321	862	30,935	54,678	6,182	10,479	28,313	14,274	20,183	3,549	21,204	44,947
1987	18,388	37,902	0	10,030	14,334	3,328	31,746	55,564	7,056	11,332	30,846	13,358	17,662	3,101	21,589	45,407
1988	16,611	33,851	0	15,131	21,834	1,250	32,992	56,935	6,384	10,227	27,467	16,381	23,084	3,320	23,288	47,231
1989	17,378	35,141	0	16,240	23,182	1,339	34,957	59,662	6,629	10,749	28,512	17,579	24,521	4,455	23,873	48,578
1990	20,119	41,652	0	12,287	17,643	1,533	33,939	60,828	7,391	12,728	34,261	13,820	19,176	3,795	22,753	49,642
1991	6,718	13,870	0	10,602	15,246	2,439	19,759	31,555	2,399	4,319	11,471	13,041	17,685	3,546	13,814	25,610
1992	9,269	18,936	0	11,340	16,181	2,223	22,832	37,340	3,629	5,640	15,307	13,563	18,404	4,078	15,125	29,633
1993	9,104	18,711	0	5,439	7,880	1,156	15,699	27,747	3,327	5,777	15,384	6,595	9,036	415	11,957	24,005
1994	2,446	4,973	0	3,880	5,554	1,258	7,584	11,785	493	1,953	4,480	5,138	6,812	392	6,699	10,900
1995	5,974	12,364	0	3,675	5,268	2,907	12,556	20,539	1,885	4,089	10,479	6,582	8,175	152	10,519	18,502
1996	10,132	20,750	0	2,250	3,243	5,394	17,776	29,387	2,184	7,948	18,566	7,644	8,637	1,124	14,468	26,079

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. MS 1985).

SFA 22: Inner Fundy stocks and inner-Fundy SFA 23 (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 MS 1992 (commercial harvest, bi-catch 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.

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Appendix 5 (x a). Total 2SW returns to SFAs 19, 20, 21 and 23, 1970-1996.

	SFA 19		*SFA 20*		*SFA 21*		Total	*SFA 23*				*TOTAL*	
								Wild	Wild	Htch	Htch	*SFAs 19,20,21,23*	
	MIN	MAX	MIN	MAX	MIN	MAX	Comm-	MIN	MAX	MIN	MAX		
	2SW=0.7-0.9		2SW=0.6-0.9		2SW=0.5-0.9		ercial	2SW= 0.85-0.95		2SW= 0.85-0.95			
Year	Exp. rate=0.2-0.45		Exp. rate=0.2-0.45		Exp. rate=0.2-0.45		19-21	p. abv= 0.4-0.6				MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	2,644	8,540	12,674	0	0	13,609	20,915
1971	600	1,266	344	802	481	1,199	2,607	7,089	10,463	66	73	11,187	16,410
1972	735	1,614	421	1,002	454	1,198	4,549	7,362	10,809	507	559	14,028	19,731
1973	726	1,571	665	1,532	546	1,437	4,217	3,773	5,559	432	477	10,359	14,793
1974	1,035	2,225	691	1,588	548	1,397	8,873	8,766	12,790	1,989	2,198	21,902	29,071
1975	376	824	149	343	882	2,321	9,430	11,217	16,490	1,890	2,088	23,944	31,496
1976	791	1,672	346	822	441	1,146	5,916	12,304	18,106	1,970	2,175	21,768	29,837
1977	999	2,152	660	1,509	873	2,354	9,205	14,539	21,420	2,330	2,575	28,606	39,215
1978	810	1,739	429	995	655	1,706	6,827	6,059	8,903	2,166	2,391	16,946	22,561
1979	532	1,169	431	978	508	1,288	2,326	4,149	6,084	1,016	1,123	8,962	12,968
1980	1,408	3,051	746	1,714	1,483	3,989	9,204	16,500	24,041	2,556	2,824	31,897	44,823
1981	886	1,856	926	2,133	1,754	4,475	4,438	8,696	12,690	2,330	2,577	19,030	28,169
1982	917	1,990	316	746	682	1,756	5,819	8,266	12,198	1,516	1,673	17,516	24,182
1983	477	1,030	641	1,475	552	1,434	2,978	8,718	12,793	944	1,043	14,310	20,753
1984	828	1,768	638	1,500	766	2,004	0	14,753	21,573	953	1,054	17,938	27,899
1985	1,495	3,132	2,703	6,355	2,102	5,469	0	15,793	23,002	748	826	22,841	38,784
1986	3,500	7,541	2,561	5,987	2,150	5,312	0	9,210	13,507	681	754	18,102	33,101
1987	2,427	5,237	1,066	2,527	1,114	2,872	0	6,512	9,590	410	453	11,529	20,679
1988	2,635	5,724	1,914	4,464	1,105	2,945	0	3,936	5,836	780	861	10,370	19,830
1989	2,236	4,810	1,512	3,485	1,631	4,086	0	6,159	8,994	401	443	11,939	21,818
1990	2,406	5,178	1,085	2,515	1,271	3,260	0	4,994	7,375	492	543	10,248	18,871
1991	1,890	4,050	965	2,200	421	1,071	0	6,739	9,902	598	661	10,613	17,884
1992	1,788	3,923	631	1,488	480	1,236	0	6,213	9,074	665	735	9,777	16,456
1993	876	1,897	1,006	2,321	564	1,498	0	4,470	6,504	363	402	7,279	12,622
1994	833	1,845	242	561	305	773	0	2,790	4,066	430	475	4,600	7,720
1995	759	1,582	666	1,565	518	1,339	0	2,504	3,670	512	566	4,959	8,722
1996	1,315	2,807	613	1,440	863	2,300	0	3,460	5,129	856	947	7,107	12,623

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. MS 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 MS 1992 (commercial harvest, bi-catch etc., incl. in estimated returns) + est. 0.85-0.95 * MSW hatchery returns to Mactaquac; 2SW production in remainder of SFA ignored.

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Appendix 5(x b). Total 2SW spawners in SFAs 19, 20, 21 and 23, 1970-1996.

	RETURNS						***REMOVALS***		***SPAWNERS***		***SFA 23***				***TOTAL SPAWNERS***	
	SFA 19		***SFA 20***		***SFA 21***		angled (19-21)		SFAs (19-21)		***RETURNS***		***REMOVALS***			
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	941	1,375	1,485	4,222	8,540	12,674	7,004	7,828	3,021	9,068
1971	600	1,266	344	802	481	1,199	541	812	884	2,455	7,155	10,536	3,543	3,960	4,496	9,032
1972	735	1,614	421	1,002	454	1,198	623	922	987	2,892	7,869	11,368	1,397	1,562	7,459	12,699
1973	726	1,571	665	1,532	546	1,437	740	1,108	1,197	3,432	4,205	6,036	1,454	1,625	3,949	7,844
1974	1,035	2,225	691	1,588	548	1,397	871	1,277	1,404	3,933	10,755	14,988	2,632	2,942	9,526	15,979
1975	376	824	149	343	882	2,321	534	867	874	2,621	13,107	18,578	2,120	2,369	11,861	18,830
1976	791	1,672	346	822	441	1,146	603	887	975	2,754	14,274	20,281	4,203	4,698	11,045	18,337
1977	999	2,152	660	1,509	873	2,354	967	1,463	1,565	4,552	16,869	23,995	4,856	5,427	13,578	23,119
1978	810	1,739	429	995	655	1,706	723	1,088	1,171	3,352	8,225	11,294	2,879	3,218	6,517	11,428
1979	532	1,169	431	978	508	1,288	560	851	911	2,585	5,165	7,207	1,393	1,557	4,683	8,234
1980	1,408	3,051	746	1,714	1,483	3,989	1,390	2,131	2,247	6,623	19,056	26,865	7,033	7,860	14,270	25,628
1981	886	1,856	926	2,133	1,754	4,475	1,338	2,125	2,228	6,339	11,026	15,267	7,384	8,253	5,870	13,353
1982	917	1,990	316	746	682	1,756	734	1,096	1,181	3,396	9,782	13,871	5,307	5,932	5,656	11,335
1983	477	1,030	641	1,475	552	1,434	633	971	1,037	2,968	9,662	13,836	9,194	10,275	1,505	6,529
1984	828	1,768	638	1,500	766	2,004	267	419	1,965	4,853	15,706	22,627	3,426	3,829	14,245	23,650
1985	1,495	3,132	2,703	6,355	2,102	5,469			6,300	14,956	16,541	23,828	4,656	5,204	18,185	33,580
1986	3,500	7,541	2,561	5,987	2,150	5,312			8,211	18,840	9,891	14,261	2,667	2,981	15,435	30,120
1987	2,427	5,237	1,066	2,527	1,114	2,872			4,607	10,636	6,922	10,043	1,294	1,446	10,235	19,233
1988	2,635	5,724	1,914	4,464	1,105	2,945			5,654	13,133	4,716	6,697	1,296	1,449	9,074	18,381
1989	2,236	4,810	1,512	3,485	1,631	4,086			5,379	12,381	6,560	9,437	250	279	11,689	21,539
1990	2,406	5,178	1,085	2,515	1,271	3,260			4,762	10,953	5,486	7,918	560	626	9,688	18,245
1991	1,890	4,050	965	2,200	421	1,071			3,276	7,321	7,337	10,563	1,257	1,405	9,356	16,479
1992	1,788	3,923	631	1,488	480	1,236			2,899	6,647	6,878	9,809	1,052	1,176	8,725	15,280
1993	876	1,897	1,006	2,321	564	1,498			2,446	5,716	4,833	6,906	680	760	6,599	11,862
1994	833	1,845	242	561	305	773			1,380	3,179	3,220	4,541	279	312	4,321	7,408
1995	759	1,582	666	1,565	518	1,339			1,943	4,486	3,016	4,236	122	136	4,837	8,586
1996	1315	2807	613	1440	863	2300			2,791	6,547	4,316	6,076	383	428	6,724	12,195

Returns from App.13a, returns minus removals equals spawners.

APPENDIX 6

SAS program to calculate Atlantic salmon pre-fishery abundance with an estimate of precision based on empirically derived distributions of observed patterns of pre-fishery abundance.

```
FILENAME CATCH DDE 'EXCEL | YR78_97 ! R3C1:R23C19';

OPTIONS NOCENTER LINESIZE = 120;

*... DATA FOR CATCH ADVICE FOR 1997 FROM RISKVAR.XLS ;

DATA CATCH;
   INFILE CATCH;
   INPUT YEAR NG1 NC1_L NC1_H NC2_L NC2_H NR2_L NR2_H NN1_L NN1_H NN1_M H2
GUS_L GUS_H GUS_M H123 GNF_L GNF_H GNF_M;

PROC PRINT;

PROC REG;
  MODEL NN1_M = H2 GUS_M/P R;

DATA D2;  SET CATCH;
    SEED = 0;

DO SIM = 1 TO 1000;
 RAN_C1  = NC1_L + ((NC1_H - NC1_L) * RANUNI(SEED));
 RAN_C2  = NC2_L + ((NC2_H - NC2_L) * RANUNI(SEED));
 RAN_R2  = NR2_L + ((NR2_H - NR2_L) * RANUNI(SEED));
 RAN_PFA = (((RAN_R2/.99005) + RAN_C2)/.90483) + RAN_C1 + NG1;
 RAN_SP  = GUS_L + ((GUS_H - GUS_L) * RANUNI(SEED));
OUTPUT;

END;

PROC SORT; BY SIM;

PROC REG NOPRINT;
 BY SIM;
 ID YEAR;
 MODEL RAN_PFA = H2 GUS_M/ P R;
 OUTPUT OUT=PREDIC P=PRAN_PFA STDI=STDI_PFA;

DATA UNIV;
  SET PREDIC;
  IF YEAR=1997;
  DO I=1 TO 1000;
    NEW_PFA=PRAN_PFA+((STDI_PFA)*RANNOR(0));
    OUTPUT;
  END;

RUN;

PROC UNIVARIATE  DATA = UNIV;
    VAR NEW_PFA;
    OUTPUT OUT=D4 PCTLNAME=
   MEAN=M STD=S
   PCTLPRE=PFA
       PCTLPTS=5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95;

PROC PRINT;

RUN;
```

APPENDIX 7

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.

APPENDIX 8

Preliminary list of rivers and contact individuals collecting data and/or developing models and methods of relevance to the development of reference points for Atlantic salmon.

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
Canada	LaHave	Egg, juvenile, adult, modelling	Peter Amiro	Dept. of Fisheries and Oceans, Box 550, Halifax, NS CANADA B3J 2S7	1-902-426-8104	1-902-426-6814	amirop@ gfc.dfo.ca
Canada	Rivière St-Jean	Egg, smolt, adult	François Caron	Service de la Faune Aquatique 150, est, Boul. René-Lévesque Québec, QC CANADA G1R 4Y1	1-418-643-5442	1-418-646-6863	carfr01@ msmail.mef. gov.qc.ca
Canada	Rivière de la Trinité	Egg, smolt, adult	François Caron	ibid	ibid	ibid	ibid
Canada	Rivière Bec-Scie	Egg, smolt, adult	François Caron	ibid	ibid	ibid	ibid
Canada	Miramichi River	Egg, juvenile, adult	Gérald Chaput	Dept. of Fisheries and Oceans P.O. Box 5030, Moncton, NB CANADA E1C 9B6	1-506-851-2022	1-506-851-2147	ChaputG@ gfc.dfo.ca
Canada	Catamaran Brook	Egg, juvenile, smolt, adult	Rick Cunjak	Dept. of Fisheries and Oceans P.O. Box 5030, Moncton, NB CANADA E1C 9B6	1-506-851-2002	1-506-851-2147	CunjakR@ gfc.dfo.ca
Canada	Conne River	Egg, smolt, adult	Brian Dempson	Dept. of Fisheries and Oceans Box 5667, St. John's, NF CANADA B3J 2S7	1-709-772-4475	1-709-772-3578	Dempson@ nflorc.nwafc. nf.ca
Canada	Saint John	Adult	Larry Marshall	Dept. of Fisheries and Oceans, Box 550, Halifax, NS, CANADA B3J 2S7	1-902-426-3605	1-902-426-6841	larry.marshall @maritimes. dfo.ca
Canada	Western Arm Brook	Egg, smolt, adult	Conrad Mullins	Dept. of Fisheries and Oceans Box 2009, Corner Brook NF, CANADA A2H 4B4	1-709- 637-4352	1-709- 637-4445	Mullins@ nflorc.nwafc. nf.ca

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
Canada	Northeast Brook	Egg, smolt, adult	Mike O'Connell	Dept. of Fisheries and Oceans Box 5667, St. John's, NF CANADA B3J 2S7	1-709-772-2866	1-709-772-3578	Oconnell@ nflorc.nwafc. nf.ca
Finland	Tornionjoki	Egg, juvenile, smolt, adult	Atso Romakkamemi	Finnish Game and Fisheries Research Institute, Bothnian Bay Fisheries Res. St., Jenssitie 2 FIN-95200 Simo FINLAND	+358 16266694	+358 16266784	atso.romakka memi@rktl.fi
Finland/ Norway	Teno	Juvenile, adult	Eero Niemelä	Finnish Game and Fisheries Research Institute River Tenojoki Fisheries Research Station 99980 Utsjoki FINLAND	358 16 677 117 (9-228811)	358 16 677 117	eero.niemela@ rktl.fi
France	Nivelle	Egg, juveniles, adults	Jacques Dumas	INRA Station Hydrobiologique 64310 Saint-Pée-sur-Nivelle FRANCE	33-59-51-59-51	33-59-54-51-52	
France	Oir	Egg, juveniles, smolts, adults	Alix Nihouarn	Conseil Supérieur de la Pêche 84 rue de Rennes 35510 Cesson Sévigne FRANCE	33-99-83-96-82	33-99-83-45-80	
France	Bresle	Egg, smolts, adults	Gilles Euzenat	Conseil Supérieur de la Pêche Station salmonicole Rue des Fontaines 76260-Eu FRANCE	33-35-66-33-60	33-35-50-06-40	
France	Scorff	Egg, juveniles, smolts, adults, modelling	Etienne Prévost	INRA 65 rue de Saint-Brieuc 35042 Rennes cedex FRANCE	33 99-28-52-48	33 99-28-54-40	Prevost@ roazhon.inra.fr

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
Iceland	Ellidaar	Egg, juvenile, smolt, adult	Thorolfur Antonsson, Gudni Gudbergsson	Institute of Freshwater Fisheries, Vagnhöfda 7 112 Reykjavik ICELAND	354 567 6400	354 567 6420	ggis@itn.is
Iceland	Vesturdolsa	Egg, juvenile, smolt, adult	Thorolfur Antonsson	Institute of Freshwater Fisheries, Vagnhöfda 7 112 Reykjavik ICELAND	354 567 6400	354 567 6420	
Iceland	Nupsa	Juvenile, adult	Tumi Tomasson	Institute of Freshwater Fisheries, Vagnhöfda 7 112 Reykjavik ICELAND	354 567 6400	354 567 6420	
Iceland	Blanda	Juvenile, adult	Sigurdur Gudjonsson	Institute of Freshwater Fisheries, Vagnhöfda 7 112 Reykjavik ICELAND	354 567 6400	354 567 6420	
Ireland	All rivers	Adult	N. Ó Maoiléidigh	Marine Institute Fisheries Research Centre Abbotstown Dublin 15 IRELAND	353 1 81210111	353 1 8205078	omaoile@ frc.ie
Ireland	Burrishole	Egg, smolt, adult	Phil McGinnity	Salmon Research Agency of Ireland Furnace, Newport Co. Mayo IRELAND	353 98 41 107	353 98 41 107	
Ireland	Northern Region rivers	Juvenile	P. Boylan	Northern Regional Fisheries Board Station Road Ballyshannon, Co. Donnegal IRELAND	353 72 51435	353 72 52053	

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
Norway	Imsa	Smolt, adult	Lars P. Hansen	Norwegian Institute for Nature Research Tungasletta 2 N-7005 Trondheim NORWAY	+47 73580657	+47 73915433	lars.petter. hansen@nina. nina.no
Russia	Tuloma, Kola, Ponoy	Juvenile, smolt, adult	Alexander Zubchenko	Polar Institute of Marine Fisheries and Oceanography 6 Knipovitch Street 183767 Murmansk RUSSIA	7-51 295 10 518	7-51 295 10 423	
Russia	Ponoy	Juvenile, adult	Fred Whoriskey	Atlantic Salmon Federation Box 429, St. Andrews NB E0G 2X0 CANADA	1-506 529 1039	1-506 529-4071	fwlp@ nbnet.nb.ca
UK (Northern Ireland)	River Bush	Egg, juvenile, smolt, adult	Walter Crozier	Agricultural and Environmental Sciences Research Division River Bush Salmon Station 21 Church Street, Bushmills, Co. Antrim N. IRELAND, UK	44 126 5731435	44 126 5732130	
UK (Scotland)	North Esk	Egg, juvenile, smolt, adult	Julian MacLean	FRS, Freshwater Fisheries Lab 16 River St., Montrose, Angus DD10 0BU, Scotland, UK	44 1674 677070	44 1674 672604	j.c.maclean@ marlab.ac.uk
UK (Scotland)	Girnock, Baddoch (R. Dee)	Egg, juvenile, smolt, adult	Alan F. Youngson	FRS Marine Laboratory P.O. Box 101, Victoria Road Aberdeen, AB11 9DB Scotland, UK	44 1224 876544	44 1224 295511	youngsonaf@ marlab.ac.uk
UK (Scotland)	Girnock Baddoch (R. Dee)	Egg, juvenile, smolt, adult	David W. Hay	FRS Marine Laboratory Freshwater Fisheries Lab Faskally, Pitlochry Perthshire, PH16 5LB Scotland, UK	44 1796 472060	44 1796 473523	hayd@ffl. marlab.ac.uk

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
UK (Scotland)	Shelligan (R. Tay)	Egg, juvenile	Ross Gardiner	FRS Marine Laboratory Freshwater Fisheries Lab Faskally, Pitlochry Perthshire, PH16 5LB Scotland, UK	44 1796 472060	44 1796 473523	gardinerr@ffl. marlab.ac.uk
UK (England and Wales)	Dee (Wales)	Egg smolt, adult	Nigel Milner	Environment Agency Welsh Region Bryn Menai Holyhead Road Bangor Gwynedd LL55 1HR, UK	+44 1286 672247	+44 1286 670561	nigel.milner@ environmentag ency.gov.uk
UK (England and Wales)	Test	Smolts, adults, exploitation, survival	Lawrence Talks	EA-Southern Region (Hants) Sarum Court Sarum Road Winchester Hants SO22 5DP	+44 1962 713267	+44 1962 841573	
UK (England and Wales)	Lune, Leven and Caldew	Smolts, adults, exploitation, survival	Dr Miran Aprahamian	EA-North West Region Richard Fairclough House Knutsford Road Warrington WA4 1HG GTN 4329 2713	+44 1925 53999	+44 1925 415961	
USA	Narraguagus	Juvenile, smolts, adults	Ken Beland	ME Atlantic Salmon Authority 650 State Street Bangor, ME 04401-5654, USA	1-207 941-4449	1-207 941-4443	Ken.Beland@ State.me.us
USA	Dennys, Machias, E.Machias, Pleasant, Ducktrap, Sheepscot	Juvenile, adult	Gregg Horton	ME Atlantic Salmon Authority 650 State Street Bangor, ME 04401-5654, USA	1-207 941-4449	1-207 941-4443	Gregg.Horton @State.me.us
USA	Penobscot	Adult	Ed Baum	ME Atlantic Salmon Authority 650 State Street Bangor, ME 04401-5654, USA	1-207 941-4449	1-207 941-4443	Ed.Baum@ State.me.us

Country	River	Type of data	Contact	Address	Telephone	FAX	E-mail
USA	Merrimack	Adult	Larry Stolte	US Fish and Wildlife Service 151 Broad St. Nashua, NH 03063, USA	1-603-598-4393	1-603 595-3478	Smolte@ aol.com
USA	Connecticut	Adult	Janice Rowan		1-413-548-9138		RSFFA.CR@ mail.fws.gov