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REPORT OF THE NORTH ATLANTIC SALMON WORKING GROUP

Copenhagen, 5- 12 March 1993

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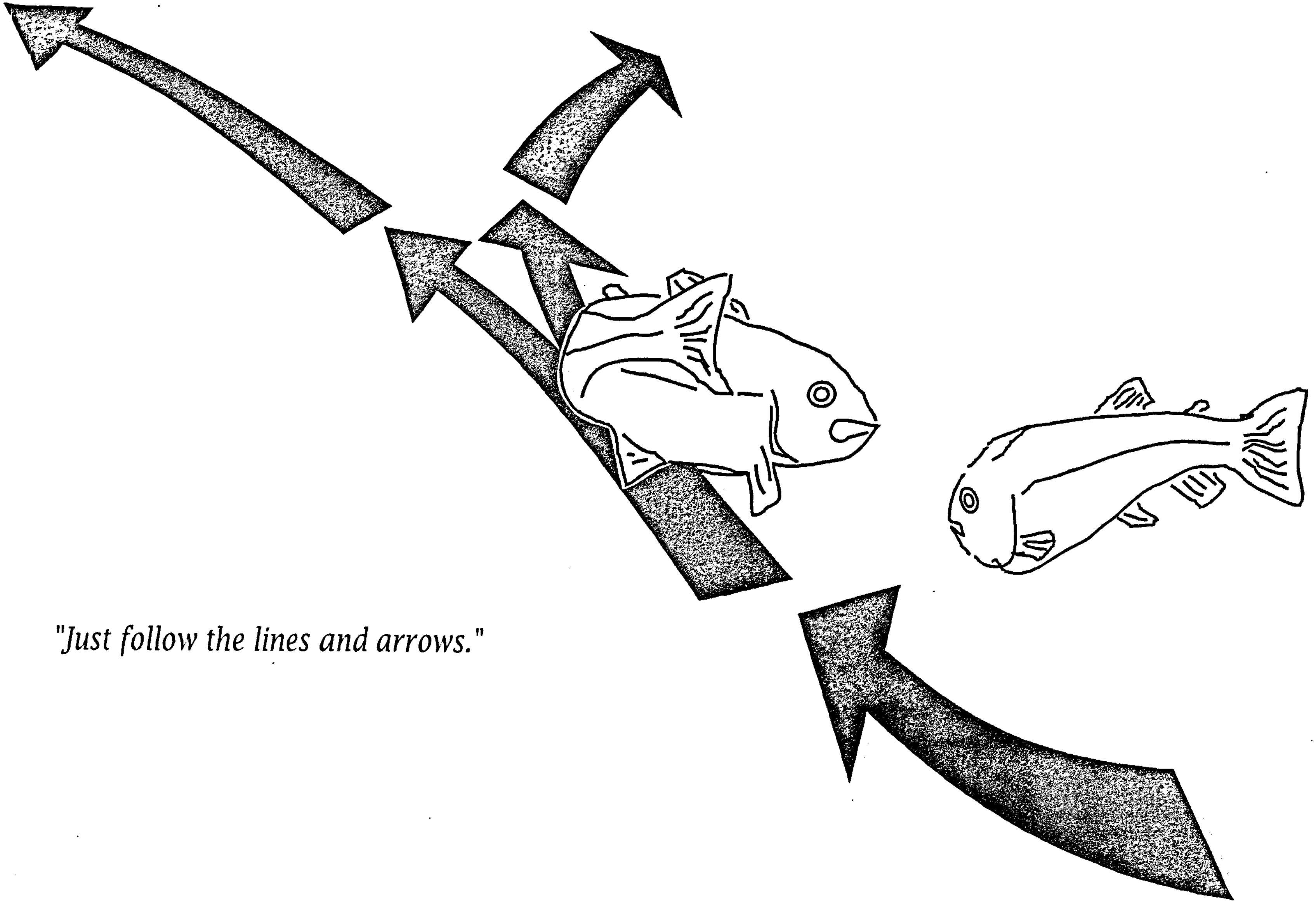
Atlantic Salmon Migration



"Just follow the lines and arrows."

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1 INTRODUCTION

1.1 Main Tasks

At its 1992 Statutory Meeting, ICES resolved (C.Res. 1992/2:8:5) that the Working Group on North Atlantic Salmon (Chairman: Dr. K. Friedland) should meet at ICES Headquarters from 5-12 March 1993 to consider questions which include those posed to ICES by NASCO (Appendix 1).

Two Study Groups met prior to the Working Group and submitted reports: The Study Group on North-East Atlantic Salmon Fisheries (C.M.1993/Assess:13, and the Study Group on the North American Salmon Fisheries (C.M.1993/Assess:9).

The Working Group considered a further 21 papers submitted by participants (Appendix 2). References cited in the report are given in Appendix 3.

1.2 Participants

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Meerburg, D.J.	Canada
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Sharov, A.	Russia
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2 CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches of Salmon

Total nominal catches of salmon reported by country in all fisheries for 1960-1992 are given in Table 2.1.1, and nominal catches in homewater fisheries for 1960-1992 are given in Table 2.1.2.

Catch statistics in the North Atlantic area also include fish farm escapees and in the North-East area ranched fish. The updated total catch for 1991 of 4,124 t is 813 t less than the total catch in 1990 of 4,937 t. Total landings for 1991 were the lowest recorded and show decreases for several countries. Figures for 1992 (3,996 t) are provisional, but it appears likely that the final data will still show a decrease from 1991. This is the fifth year in which the total catch has decreased from the previous year. The decline in the catch of wild stocks may be greater than suggested by the catch statistics because of the inclusion in the statistics of increasing catches of fish farm escapees and ranched fish.

The lack of information on fishing effort presents major difficulties in interpreting the catch data of any one year and also in comparing catches of different years. Management plans in several countries are designed to decrease catches. The trends in catch data are discussed in Section 3.

2.2 Catches in Numbers by Sea Age and Weight

Reported nominal salmon catches for several countries by sea age and weight are summarised in Table 2.2.1. As in Tables 2.1.1 and 2.1.2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1992 are provisional. Different countries use different methods to partition their catches by sea age class. These methods are described in the footnotes to Table 2.2.1. A number of countries split catches on the basis of the results from scale reading a sample of the catch. Several others use a weight split, so that fish classed as MSW salmon are those weighing about 3 kg or more, the exact level varying between countries, during that part of the year when both 1SW and MSW salmon are present in catches. In many of these countries, this split is felt to be reasonably accurate. However, the results of analyses of catch sampling programmes in Scotland have shown that the use of a weight split in categorising fish there can lead to substantial mis-reporting errors with often large numbers of 1SW salmon being included in the MSW catch record. Moreover, the error increases throughout the season as larger 1SW salmon enter the fishery in the late summer and can vary greatly between years. Those years when large catches of 1SW salmon were recorded were characterised by the presence of large proportions of 1SW salmon exceeding the split weight in the catches, these fish being included as MSW salmon in the nominal catch figures.

2.3 Unreported Catches

2.3.1 Unreported catches within commission areas

Unreported catches by year and commission area, as estimated by the Working Group, are presented in Table 2.3.1 except for the West Greenland Commission Area for which estimates are unavailable. The total unreported catch in 1992 was estimated to be 1,962 t; a decrease of

17% from the 1987-1991 mean of 2,377 t (Table 2.3.1). Unreported catch estimated for the North-East Commission area was 1,825 t in 1992; a decrease of 18% from the five-year mean for 1987-1991. Unreported catch estimated for the North American Commission was 137 t in 1992; a decrease of 15% from the 1987-1991 mean of 161 t. The Working Group emphasized that these are very imprecise figures and that the differences should not be considered to be significant. In addition, it was noted that several countries estimate unreported catches as a proportion of total or regional declared catches; as a result, there is a tendency for the total unreported catch to alter in line with the nominal catch.

Methods of estimating unreported catches have been reported previously by the Working Group (Anon. 1989a). A radio-tracking study carried out in the Teno River, Finland and Norway, in 1992 indicated that out of a sample of 66 radio-tagged fish entering the river, none was caught illegally before spawning time.

The estimates of un-reported catches in previous Working Group Reports were provisional and have been revised in Table 2.3.1. Consequently, it is impossible to derive estimates for the West Greenland Commission by subtraction of values reported in this report from those previously reported values. However, total non-catch fishing mortalities, which include unreported catches, have been estimated for the West Greenland Commission area (range of values 0.1 to 0.3).

2.3.2 Unreported catches in international waters

Sightings by Icelandic and Norwegian vessels fishing for salmon in international waters to the north of the Faroes EEZ were reported to NASCO. NASCO informed the Working Group that 2 sightings were reported in the 1991/1992 season, both in May 1992. The catch in this area during the season is therefore estimated to have been similar to 1990/1991, i.e. between 25 and 100 t. Considering the area of these sightings, it is expected that most salmon caught would be of European origin.

3 STATUS OF STOCKS OCCURRING IN THE COMMISSION AREAS

3.1 Organisation of Stock Status Information

The Working Group examined data that had been presented at previous Working Group meetings, together with data tabled at the 1993 meetings of the Study Group on North American Fisheries and the Study Group on North-East Atlantic Salmon Fisheries. The Working Group attempted to analyse and present data on stock status in a more comprehensive fashion, especially in providing statistical analysis of trends where they occur. The Working Group also considered the types of data required to describe the status of stocks in the North-East Atlantic with respect to escapement against spawning targets.

3.2 Eastern North Atlantic

3.2.1 Measures of abundance

Catches

Total nominal landings of salmon in the North-East Atlantic in 1992 (Table 2.1.1) increased relative to the 1991 value, although they remained lower than the 5 and 10 year averages. The overall catch figures are not particularly informative, as various regulatory measures have reduced catch in some countries (for example Norway), while in Iceland catches are influenced by ranching efforts. Presence of fish farm escapees in commercial catches is significant in at least one country (Norway); thus catch statistics overestimate wild abundance. Furthermore, catch statistics may not reflect the true abundance of wild stocks, given the range of factors that affect catches, such as effort variations, fishing conditions and variable run timing in relation to fishing seasons.

Freshwater production

Counts or estimates of wild smolt production are available from 11 stocks in the North-East Atlantic, and indices of juvenile salmon abundance from the R. Bush (UK, N Ireland) and estimates of total 0+ population in the R. Nivelle [France] (Table 3.2.1.1). Although these examples may not be representative of wider groups of stocks, they may indicate trends in freshwater productivity. Smolt numbers in the R. Burrishoole (Ireland) recovered in 1992, with the count being close to the previous 12 year average. In most rivers the 1992 counts fell within the range observed in the last 10 years, except in the R. Bush (UK, N Ireland) and the R. Bresle (France). Whether the low smolt count on the R. Bush in 1992 is attributable to density-dependent mortality at high ova depositions or recent environmental degradation cannot be determined.

Despite concerns in several countries that reduced adult runs in 1990 and 1991 may have resulted in inadequate spawning populations, there is no widespread evidence that juvenile production in 1992 has been affected. It must be noted, however, that effects on juvenile production consequent on poor adult runs in 1990 and 1991 will not be fully felt until 1993 and 1994 and even later in rivers with older smolt ages. A route regression analysis of time series trends (Appendix 7) indicated an overall significant positive trend ($P < 0.05$) in juvenile production in the rivers Nivelle (France), Burrishoole (Ireland), Imsa (Norway), Bush (UK, N Ireland) and Girnock Burn (UK, Scotland) during the period 1985-1992 (Figure 3.2.1.1).

3.2.2 Escapement

Adult counts (or estimates) for 20 wild stocks are presented in Tables 3.2.2.1 and 3.2.2.2, including new data for the R. Bresle (France) and additional historical time series for the Rivers Kola and Zap. Litca (Russia). Although year to year variations in adult numbers counted in monitored rivers are evident, runs were generally higher in 1992 compared to either or both of the previous two years. In about two thirds of rivers monitored 1992 adult runs were comparable to or greater than average runs for the whole time series. In the R. Imsa (Norway) an increase in the adult run in 1992 has been attributed to cessation of drift netting in coastal waters. In 3 Russian rivers (Kola, Yokanga and Zap. Litca), adult counts were above the range for the last 10 years. These high numbers could be partly explained by management measures taken in Norway, leading to reduced exploitation on Russian stocks, though natural factors governing the dynamics of these stocks must also be considered. For the R. Hogvadsan in Sweden, wild adult counts have not increased in the last 4 years despite earlier increases attributed to mitigation liming. Given that in some cases counts/estimates represent minimum figures for adult runs, the 1992 figures for the North-East Atlantic provide some evidence that conditions causing poor adult runs in 1990 and 1991 may have been transitory.

Route regression analysis of trends in adult escapement among a grouping of 4 Russian rivers (Tuloma, Ponoy, Kola and Zap. Litca) from 1964-1992 indicated a significant positive trend ($P<0.001$; Figure 3.2.2.1). A shorter time series of adult counts (1981-1992) examined among other NE Atlantic rivers (Burrishoole, Severn, Bush, N Esk, and Girnock Burn) displayed no significant overall trend ($P>0.4$).

3.2.3 Survival indices

Estimates of marine survival for wild smolts from 6 stocks returning to homewaters (i.e., before homewater exploitation) and for 9 stocks into freshwater are presented in Tables 3.2.3.1 and 3.2.3.2, respectively. Marine survival rates for hatchery smolts are given in Tables 3.2.3.3 and 3.2.3.4 for return to homewaters (6 stocks) and freshwater (5 stocks), respectively. 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.

Survival to 1SW coastal return of wild smolts from the 4 monitored stocks where estimates are available was higher in 1992 than the previous year, except for the R. Bush (UK, N Ireland), where a decrease relative to 1991 (but not 1990) was noted. The higher levels of coastal returns were also reflected in improved survival of 1SW wild smolts into freshwater (Table 3.2.3.2) in 8 rivers where data are available. For 3 of the 4 stocks for which data are available, survival to coast and to freshwater of 2SW fish was still relatively poor in 1992, suggesting that these fish were affected by the marine conditions that led to reduced runs in several countries of 1SW fish from the 1990 smolt migration year.

Route regression analysis of trends in survival of wild 1SW fish back to homewaters from the R. Bush (UK, N Ireland) and Imsa (Norway) stocks for 1986-1991 smolt release years indicated no significant trend in survival for these stocks. Although other data series were available, these were not used in the analysis because of incomplete time series. In contrast, wild 1SW survival to freshwater for the R. Burrishoole (Ireland), R. Bush (UK, N Ireland) and R. Imsa (Norway) showed a significant upward trend ($P<0.05$) for smolt releases 1981-1991 (Figure 3.2.3.1). This suggests that survival of wild 1SW fish to freshwater was positively influenced by reduced coastal exploitation during this period.

Survival indices for hatchery-reared smolts returning as 1SW fish to coastal waters in 1992 were more variable than for wild fish (Table 3.2.3.3), with 3 stocks having decreased coastal returns and 2 increased relative to 1991. Different trends were noted for separate smolt age groups from the R. Bush (UK, N Ireland). Similar variability was evident in 2SW coastal returns. With the exception of the Kollafjordur (Iceland), 1SW hatchery-reared returns to freshwater (Table 3.2.3.4) were generally lower in 1992 than in 1991, in contrast to the data on wild 1SW returns. Returns to freshwater of 2SW hatchery-reared fish in 1992 were poorer than in the previous year, in agreement with data from wild fish (Table 3.2.3.4).

Although there are some inconsistencies in trends from wild and hatchery smolts, compared to 1991, there is evidence among the monitored river data that while 2SW survival indices still reflect poor marine survival of the 1990 smolt year class in many areas, the 1991 year class has displayed improved marine survival, reflected in 1SW returns in 1992.

Hatchery 1SW returns to homewaters were examined for smolt release years 1984-1991 for R. Burrishoole (Ireland), R. Bush (UK, N Ireland), R. Imsa, R. Drammen (Norway) and R. Lagan (Sweden) strains. Using route regression analysis a significant downward trend in survival ($P<0.01$) was detected (Figure 3.2.3.2). However, an analysis of 1SW returns to freshwater carried out for the same time series (without the R. Lagan) indicated no significant trend ($P>0.4$).

3.2.4 Spawning Targets

Data on abundance and escapement by themselves, while useful in indicating possible trends in numbers of salmon through time, are of limited use in assessing stock status. This is especially true of catches in homewater fisheries where catch levels can be affected by effort variations and weather conditions during fishing seasons. Similarly, rod catches are susceptible to climatic-induced variation and hence are of limited use in describing stock status. Wild smolt counts or estimates are available for only a limited number of monitored rivers. However, as smolt counts are river-specific these cannot be routinely used to infer status of stocks outside the river in question.

The Working Group considered that status of stocks in the North-East Atlantic would best be appraised by considering adult escapement (in terms of ova depositions) evaluated against spawning targets, in a similar manner to that adopted for Canadian stocks (Anon., 1992a). Ideally, biologically based spawning targets would be set for each river system, such that the target for each would represent the number of ova required to optimise smolt and/or production from that system. This would not only provide a baseline against which annual ova depositions could be compared, but allows for the possibility that estuarine and in-river fisheries for single stocks could be managed to crop only adults in excess of the target spawning number. Targets should be set sufficiently high to allow compensation for density-independent variation.

Spawning targets can only be meaningfully set for each river system based on knowledge of spawners required for optimum productivity obtained from the stock-recruitment relationship and applied to survey data of the available areas of riverine and lacustrine habitat. However, with the exception of the R. Bush (UK, N Ireland), the R. North Esk and a tributary of the R. Dee (UK Scotland), the R. Imsa (Norway), the R. Burrishoole (Ireland) and several Russian rivers (Tuloma, Varzyga, Ponoy, Zap. Litca and Iokanga), data on stock/recruitment relationships are not widely available. Canadian spawning targets are based on different levels of freshwater productivity and cannot be used for North-East Atlantic rivers. Accordingly, there is a need to carry out further research to define stock/recruitment relationships in a range of North-East Atlantic rivers and to determine whether productivity levels so far observed can be applied to other river systems. It is noted that data required for assessing stock/recruitment relationships are currently being collected in several other monitored rivers, including the R. Hogvadsan (Sweden), R. Oir, R. Bresle and R. Nivelle (France), and the R. Orkla (Norway).

As an example of the first use of such data, preliminary modelling of the R. Bush stock/recruitment relationship suggests that the target ova deposition in the river lies in the region of 3.7-5.5 ova m^{-2} of useable salmonid habitat, corresponding to a whole river ova deposition of approximately 2.03 million. Natural ova deposition (derived from trap counts of potential spawning hen fish) has exceeded this target in 7 of the last 8 years.

Several significant factors need to be taken into account in setting and expressing individual river targets, such as variation in the sex ratio of spawners, changing fecundity through time and changing 1SW:MSW ratios, and the desired sea age composition for depositing ova. This technique of stock assessment allows appraisal of whether spawner target shortfalls are local in nature or more widespread, such that aggregated national targets are not being met.

In order to begin to assess stocks with respect to spawning targets the following data are needed:

Baseline data:

> As stock/recruitment data will not be available for each river for which targets are to be set, it will be necessary to apply deposition optima from a limited number of experimental rivers to other rivers, provided that equivalence of productivity and ecological characteristics can reasonably be assumed. Ranges of freshwater productivity are known for many more rivers than stock/recruitment relationships, enabling them to be placed into groups. It will also be necessary to measure or estimate the total area of useable salmonid habitat in each river, such that per metre optima can be extrapolated to whole river systems. Different per metre target values will need to be applied to lacustrine and riverine habitats. It is recommended that a standardised method of expressing targets should be adopted, such that these are comparable among rivers.
>
> One suggested approach would be to derive target ova depositions expressed as numbers of ova per square metre of usable habitat. These can be expressed either as total numbers of ova required by each river system, or more simply as the numbers of spawning fish (possibly for each sea age group).

Annual assessment data:

> Numbers of potential spawning adults will be required and can be estimated directly from traps or counting fences or indirectly from tag and recapture data. From these, estimates of ova deposition can be derived from fecundity measurements applied to the sex ratio, separately for each sea age group.
>
> In order to provide meaningful data, the number of rivers monitored would need to be increased. It

should, however, be noted that the parameters required for this type of assessment consist only of annual data on spawning escapement and biological composition of potential spawners. As significant factors affecting stocks at a national level (such as acidification or increased natural marine mortality) are likely to be felt among many rivers it would only be necessary to monitor relatively few rivers nationally to detect significant trends with respect to targets. It should be possible to set provisional targets for several river types based on currently available information, but it should be emphasised that resources should continue to be made available for refinement of target assessment methodology and more importantly for research into reasons why targets may not be met in many stocks.

The Working Group recommends that a workshop be held to consider available evidence that might be used to set targets and to identify what further data are necessary to implement assessment of stock status with respect to targets.

3.3 Western North Atlantic

Several short-term and a few long-term datasets for North American stocks were available to the Working Group. The most useful datasets now consist of estimates of returns and adult counts at fishways, and smolt survival rates for Canadian and USA rivers (Anon., 1993a). The moratorium on the commercial salmon fishery in insular Newfoundland and reductions of bag limits and imposition of quotas in many of the recreational fisheries have reduced the ability to infer stock status from most of the commercial and many of the recreational catch data series.

3.3.1 Measures of abundance

Counts of small and large salmon by Salmon Fishing Area (SFA) (Figure 3.3.1.1) obtained at fishways and counting fences in Canada since 1974 are provided in Tables 3.3.1.1 to 3.3.1.5. Counts of small salmon at 11 of 16 fishways or fences on systems in insular Newfoundland in 1992 were up from the 1987-1991 mean. In 14 of 16 cases, the large salmon count in Newfoundland was above the 1987-1991 mean, in some cases several times higher. In the Maritime Provinces, counts of small and large salmon were below the mean at 2 of 3 fishways (in SFA 20, 21, 23). Counts of small salmon in Quebec increased over the 1987-1991 mean at 3 of 4 fishways; counts of large salmon were above the mean at 2 and below the mean at 2 of 4 fishways.

Total catches in 1992 in Maine (USA) rivers with salmon runs that are primarily of wild origin were the lowest recorded in the available time series of data and 86% below the 1967-1986 average (Anon., 1993a). Similarly, the catch of 2SW salmon of wild origin has steadily declined since 1980 (Figure 3.3.1.2). These data suggest that low catches were due to low salmon abundance in recent years.

The status of stocks in Canada for 1992 may be summarized as follows for grouped management areas:

Labrador, East and South Coast Newfoundland (SFAs 1-11):

The total abundance, as inferred from catch statistics and monitoring facilities, of small and large salmon in SFAs 1 to 11 was below average. Spawning escapements in most rivers of SFAs 1 to 11 improved over 1991 in part because of reduced marine exploitation. However, it is evident that counts of small salmon similar to or greater than those observed in 1992 have occurred in recent years. With respect to large salmon, counts increased in 11 of 14 monitoring facilities, the exceptions being only on the south coast of Newfoundland.

West Coast Newfoundland, Gulf New Brunswick and Gulf Nova Scotia (SFAs 12-18):

Returns to the counting facilities at Torrent River and Western Arm Brook and the returns to the Humber River indicate that the abundance in rivers in SFAs 12-14 was up from 1991 and from the 1987-1991 mean. Returns of small salmon in 1992 were the highest in the Miramichi River (SFA 16) since 1971. Returns of large salmon were also up from the previous 5-year mean. In SFA 18, returns of both small and large salmon were similar to the 1987-1991 mean. Target egg requirements were approximated or exceeded in all monitored rivers in these SFAs in 1992.

Atlantic Nova Scotia, Bay of Fundy Nova Scotia, and New Brunswick (SFAs 19-23):

Counting facility and river spawner counts indicated that returns of wild large salmon were as low as those of 1991, and as low or lower than the 1987-1991 mean. Small salmon counts approximated the 1987-1991 means, except on the Liscomb River where they were lower. All rivers within the lower Bay of Fundy remained closed to fishing because inseason monitoring of returns and juvenile densities within these rivers remained low compared to previous years.

Gaspé, PQ (Q1-Q4):

Counting facility, river spawner counts and catch statistics show that 1992 small and large salmon returns were above those of 1991 and the 1987-1991 mean.

North Shore, PQ (Q5-Q9):

Counting facility and catch statistics show that 1992 small and large salmon returns were below average in the western part of this area and above average in the eastern part.

Anticosti and Ungava PQ (Q10-Q11):

Catch statistics and spawner counts for area Q10 and catch statistics for area Q11 reveal that both small and large salmon returns were lower than in 1991 and the 1987-1991 mean.

Trends in counts of small salmon at fishways and fences and an estimate or run-size for 21 rivers in Canada for the period 1974-1992 are shown in Figure 3.3.1.3. These data suggest that while the abundance of small salmon was generally increasing during the period 1974-1985, that trend was reversed during the period 1985-1991. In 1992 the abundance of small salmon in some areas of insular Newfoundland increased in apparent response to the closure of the Newfoundland fishery. Trends in large salmon abundance (Figure 3.3.1.4), the important contributor to egg deposition in most mainland rivers, generally show a downward trend, with the exception of the East and West Coasts of Newfoundland in 1992.

The Working Group used a nonparametric randomization test (Appendix 8) to test for significant differences in 1992 returns of small and large salmon to the 21 rivers of Canada shown in Figures 3.3.1.3 and 3.3.1.4. Rivers were grouped by geographical area and a comparison of 1992 returns to the previous 5-year mean resulted in the following:

Area	N	Counts of Small Salmon		Counts of Large Salmon	
		Ratio	Probability	Ratio	Probability
East Coast, NFLD	4	2.16	.003	5.90	.001
West Coast, NFLD	3	1.72	.057	4.94	.007
South Coast, NFLD	4	0.89	.499	0.74	.589
Gulf Region/Mainland	3	1.72	.057	1.24	.120
Maritimes	3	0.83	.828	0.94	.583
Quebec	4	1.03	.469	0.92	.659

Significant increases in the small and large salmon returns to the East and West Coast rivers of Newfoundland and small salmon returns to the Gulf region rivers were demonstrated.

In Section 5.3, the abundance of 2SW spawners of North American origin stocks that contribute to the West Greenland fishery is estimated for the years 1974-1991 (Figures 3.4.4.2 and 5.4.1.6). The abundance of 1SW fish at West Greenland destined to be 2SW in North American rivers peaked in 1975 and has been steadily declining ever since.

3.3.2 Escapement

Assessments are available for 16 Atlantic salmon stocks in Canada. Spawning requirements are determined using the following standards: 2.4 eggs/m^2 of fluvial habitat and, for insular Newfoundland, 368 eggs/hectare of lacustrine habitat. Annual estimates of run size and spawning escapements relative to a target spawning requirement are provided for the Restigouche (SFA 15), Miramichi (SFA 16) and Saint John (SFA 23), Margaree (SFA 18), LaHave (SFA 21), Conne River (SFA 11), and rivière de la Trinité (Q7), Grand (SFA 19), Liscomb (SFA 20), Gander (SFA 4), Terra Nova (SFA 5), Middle Brook (SFA 5), Rocky (SFA 9), Biscay Bay (SFA 9), Northeast (SFA 10) and Humber (SFA 13) rivers (Table 3.3.1.5).

Estimates of egg depositions in 1992 may have approximated (rivière de la Trinité and Restigouche) or exceeded (Miramichi, Margaree, Northeast, Humber, Gander, Middle and Biscay Bay) target egg requirements in nine rivers. The percent change in total egg depositions for monitored rivers in Canada during 1992 is compared to the 1987-1991 average in Figure 3.3.2.1. Egg depositions were as much as 300 % above average in 10 rivers, while 60-75% decreases were noted in 2 rivers. The noticeable increases in egg depositions in some areas are probably the result of reductions in marine exploitation in Canada during 1992.

In Section 5.3, the abundance of North American salmon that contribute to the West Greenland fishery is estimated for the period 1974-1991 (Table 5.3.1.1). The difference between estimates of total 2SW returns in rivers (R2) and the catch of 2SW salmon in rivers provides an estimate of the spawning escapement of 2SW salmon. The estimated number of 2SW spawners to North American Rivers has shown a downward trend since 1980 (Figure 5.4.1.6).

3.3.3 Survival indices

Estimates of survival of wild smolts to 1SW returns for 5 rivers and hatchery smolts to 1SW returns for 3 rivers in Canada are shown in Figure 3.3.3.1. Survival of hatchery smolts released in the Penobscot River (USA) to 1SW and MSW returns to homewaters is also shown. While large annual variations in survival between years is common, many stocks continue to exhibit trends of reduced marine survival over time. While poor smolt survival years are not uniformly exhibited by all stocks, it is evident that smolt survival for many stocks is lower than in previous years.

3.3.4 Spawning targets

Spawning targets for 2SW salmon in North America are generally based upon availability of suitable juvenile rearing habitat. The number of eggs (2.4 /m^2) required to saturate the fluvial habitat to ensure optimal smolt production or adult returns is based upon the work of Elson (1975). For lacustrine habitat in insular Newfoundland an egg deposition target of 368 eggs per hectare has been adopted. Derivation of the optimal spawning numbers of 2SW salmon is problematic because it requires some estimate of the desired sea-age composition of spawners. The desired level may be based upon historical observations of the populations, particularly during periods prior to the initiation of mixed-stock fisheries. The sea-age composition of such stocks reflects some balance of evolutionary selective factors, particularly mortality rates in the freshwater and marine environments. Beyond those considerations, 2SW salmon returns may reflect the intention to preserve or restore historical fishing opportunities within rivers. The Working Group suggested that analyses of life history strategies may be a useful starting point to define more objective measures, but the development of such models was beyond the scope of this meeting.

Composite estimates for 2SW spawning targets were developed for salmon rivers in the USA, and Canadian SFAs 1 to 23 and Quebec Zones Q1 to Q11. For USA rivers, 2SW targets were based upon the number of accessible juvenile salmon habitat units, a 50-50 sex ratio, a fecundity of 7,200 eggs/female, and the assumption that all eggs are provided by maiden 2SW salmon. Summary estimates, references, and assumptions made in the estimation procedures, by geographical region in North America, are provided in Table 3.3.4.1. The overall target number of 2SW spawners in North America is 196,306. Most (84%) of the North American target number of spawners is required for rivers in Canada.

This target of about 200,000 2SW spawners has almost certainly not been achieved in the 19 year time period when one considers the mid-point of the estimates even though production of these stocks is estimated to have been as high as 650,000-850,000 over the same time period (Figure 5.4.1.1). A significant portion of this spawning deficit has been in US rivers which are under restoration. Canadian 2SW spawning requirements of about 165,000 fish have not been met when one considers either the minimum or midpoint of the spawner estimates although the maximum estimates exceeded the spawning target in 6 of the 19 years (Table 5.4.1.1).

3.4 Causes of Apparent Reduced Survival of Salmon

3.4.1 Recent survival observations

The Working Group considered recent information from various countries on the survival of salmon returning to freshwater from the sea. In particular, sea survival has declined for 1SW salmon of the 1989 and 1990 smolt classes from stocks over a wide range on both sides of the Atlantic. This decline in sea survival was observed in stocks in Scotland, Iceland, Canada and the US. In addition, stocks in Norway and Canada have shown low survival rates from the 1991 smolt class while some improvement was noted in Scotland with the biggest improvement in survival of the 1991 smolt class shown in Iceland. It can be concluded that for the majority of countries there has been a trend towards reduced marine survival in the late 1980s and early 1990s.

3.4.2 Methods of assessing mortality

Atlantic salmon population dynamics are frequently investigated in two distinct phases: freshwater and marine. Variation in freshwater survival rates is generally well documented and thought to be a major factor regulating abundance in many river systems (Thorne and Ames, 1987; Hvidsten and Hansen, 1988). Atlantic salmon marine life history and, in particular, mortality during the marine phase has not been investigated nearly as thoroughly. It is,, however, thought that salmon survival is highly dependent on the productivity of the marine environment and the availability of suitable prey during their marine life. Salmon, similarly to other marine fish species, are intricately woven into the ecological system of the ocean.

Increased understanding of marine ecology has highlighted the role of ocean life in Atlantic salmon population dynamics (Reddin, 1988; Dempson, 1992, Reddin and Friedland, 1993, Friedland and Reddin, 1993). Many of these new insights were the result of analyses of tag return data and smolt to adult survival rates. Although the fishing mortality has been reduced on North American stocks over the past decade, for some stocks overall marine mortality has continued to remain relatively high. Given the magnitude of marine mortality and its variability, it is of great importance to evaluate its impact on the salmon stocks.

Changes in survival can be observed by direct and indirect methods. The most direct methods are those which estimate marine survival of wild or hatchery released smolts by enumerating smolts and adult returns in subsequent years. In some cases, survival rates can be estimated from freshwater catches and escapement. If rivers over a wide geographic area are fluctuating in a similar way then one can exclude differences in freshwater survival. There is considerable information showing that survival and marine growth are interrelated. Decreased size of returning 1SW or 2SW salmon as well as changes in the ratio of these year classes or sex ratios within each year class can be used as corroborative evidence of changes in marine survival. In order to determine the underlying causes for fluctuations in marine mortality it can also be very useful to relate salmon abundance to changes in oceanographic conditions in defined geographic areas or to relate it to overall ocean productivity.

Sources of marine mortality can for the sake of clarity be partitioned into two groups, i.e. estuarine/coastal effects and oceanic effects. Estuarine/coastal effects act upon the survival of discrete stocks or stock complexes. Oceanic effects, on the other hand, could impact on Atlantic salmon over broad geographic areas.

3.4.3 Estuarine and coastal effects

Estuarine/coastal mortalities are a result of factors that influence smolt survival upon passage into estuarine and nearshore marine ecosystems. Atlantic salmon smolts face a physiologically stressful osmotic challenge, when entering the marine environment. This stress can be compounded by unfavourable local temperature regimes (Lega *et al.*, 1992) as well as unfavourable feeding conditions. Variation in nearshore temperatures can affect the timing of spring productivity blooms and if such blooms are not synchronous with smolt migration, decreased survival would be expected. Blooms of zooplankton have actually been used as an indicator for release timing in pink salmon ranching operations in the Pacific.

Piscivorous fish, birds, and mammals in areas surrounding river mouths can adversely affect smolts and returning adults (Hvidsten and Lund, 1986; Larsson, 1985). With increased ecological awareness and changing wildlife management practices, populations of piscine, avian and mammalian predators have increased in recent years. Increases in such predatory and competing populations could affect certain Atlantic salmon stocks. In these cases the size and general condition of smolts upon seawater entry is of special importance. It is in the transition from freshwater to marine ecosystems in the nearshore areas that the interdependency of both habitats is most evident.

3.4.4 Oceanic effects

Because it is difficult to measure mortality in estuarine/coastal areas separately from mortality in oceanic areas it is very difficult to quantify their effects on salmon populations. Furthermore, these effects would in many cases be interrelated in local geographic areas. In principle, oceanic effects are those that affect Atlantic salmon over a wide geographic range or in more confined areas, where mixed stocks of salmon are feeding. Oceanic effects are difficult to study as the time and cause of mortality is very obscure. Correlation of salmon survival, abundance and growth with oceanographic and hydrographic factors, as well as with pelagic prey and predator abundance, for example, falls in this category.

Marine survival:

Evidence of oceanic effects on survival can be obtained from observed coherence in survival among stocks. Researchers computed North American return rates, expressed as the number of 1SW or 2SW returns per smolt for five stocks of salmon: Connecticut, Penobscot, and Union rivers (USA) and Saint John River and Western Arm Brook (Canada) (Friedland and Reddin, 1993). The decline in return rates and Z-transformed rates showed that survival of the 1977 smolt class was very poor followed by good survival of the 1978 smolt class (Figure 3.4.4.1). When compared statistically, the correlations among all five rivers were significant at $p<0.05$. The common pattern of return rates suggests that factors controlling survival act nearly equally on all of these stocks and thus variability in survival between stocks is low. Coherence in the estimated survival rates of stocks spanning a wide geographical range suggests that a dominant cause of mortality acts on the stocks when they are coincident in place and time. Consequently, fall and winter become likely periods, since stocks are mixed by this time.

The coherence in marine survival rates observed in monitored stocks is further supported by the trends in abundance for the North American stock complex. The time series of pre-fishery abundance of 1SW non-maturing salmon for North American stocks, quantity N1 used in the run reconstruction modelling, is provided in Figure 3.4.4.2. Many features in this time series reflect the likely impact of changes in survival rate observed for the individual stocks that were monitored over the same time period. For example, poor survival of the 1977 smolt class followed by good survival of the 1978 smolt would have resulted in low abundance for fish in fishery year 1978 and high abundance the following year. This is exactly what is observed in the abundance time series. In addition, both the survival rate and abundance time series show decreasing trends through the 1980s and early 1990s.

Smolt condition factor:

The interplay between marine and riverine environments is exemplified in recent investigations of two Newfoundland rivers, the Conne River (1987-1992) and Northeast Brook (Trepassey) (1986-1992). Sea survival is measured for stocks from both rivers by counting smolts and adult returns. The stocks in these rivers differ greatly in smolt production capacity. Conne River (SFA 11) produces roughly 60,000 to 80,000 smolts while Northeast Brook (Trepassey, SFA 9) produces approximately 1,500 smolts. Despite production differences, both systems have shown similar trends in sea survival rates in recent years (Figure 3.4.4.3). Researchers enumerated outmigrant smolts and adults returning one year later as grilse to determine marine survival. Smolt condition was modeled to examine the relationship between fish weight and fork length, week of entry, and year (Patterson, 1992). A condition index was derived from model coefficients that correspond to the log of the geometric mean:

$$(1)\ \mathrm{Log}(W_i) = a[0] + a\,[w] + b\cdot\mathrm{Log}(L_i) + c\,[y] + e_i$$

This index avoids some of the bias and statistical problems associated with traditional condition indices (Cone, 1989; Patterson, 1992).

In both river systems, marine survival was variable and decreased over time (Figure 3.4.4.3). The lowest survival was observed in the 1992 returns. Adverse environmental conditions in the spring and early summer of 1991 in the Newfoundland area were among the most severe on record (Narayanan *et al.*, 1993). It is probable that smolt survival was related to these harsh environmental conditions.

The linear model (Equation 1) explained 93% and 95% of the variation in weight of Northeast Brook and Conne River smolts respectively. Both year and week factors were significant with condition decreasing over time (week). River age was not a significant factor. Although the time series is limited, a possible association between smolt condition and subsequent marine survival was shown (Figure 3.4.4.4). That is, higher overall sea survival coincided with years of higher smolt condition. In the Conne River, smolt condition was also positively associated with condition of returning 1SW fish.

The investigations on salmon stocks in Conne and Northeast rivers highlight two important points regarding Atlantic salmon survival. First, the salmon stocks in two distinct river systems seem to be affected similarly by marine events resulting in low survival. Secondly, the relationship between smolt condition and marine survival suggests that growth and survival in riverine and marine environments is linked. As such, an holistic approach is needed to assess correctly underlying causes for observed trends in overall Atlantic salmon survival.

Ocean climate:

Climatic and oceanographic factors seemed to exert great influence on the variability in abundance of stocks of Atlantic salmon on the north coast of Iceland. Coherence in marine survival rates of stocks from a relatively narrow geographic area could be related to factors operating during early or late marine life. Scarnecchia *et al.* (1989b) analyzed the yield of Atlantic salmon from 59 Icelandic rivers with respect to stream flow as well as sea and air temperature in an attempt to identify causes of variation in yield. A group of 24 northern and northeastern rivers, which flowed into seas with wide annual variation in climatic and oceanic conditions (as indicated by coastal sea and air temperatures) exhibited significantly greater variation in yield of both 1SW and 2SW salmon than 31 rivers on Iceland's west coast.

A previous study demonstrated a great coherence in yield of salmon stocks on the north coast of Iceland (Scarnecchia, 1984), where stocks tend to fluctuate together as if controlled by a common external marine factor. Several periods of low abundance have been identified in that area, usually related to adverse marine conditions. Such periods of low abundance occurred in northern Iceland in 1965-1969, 1980-1982, 1984 and 1989-1091 (Gudbergsson and Arnason, 1992). Icelandic oceanographers have linked such periods to the dominance of the East Greenland current, as opposed to the Gulf stream, in northern Icelandic waters (Malmberg and Kristmannsson, 1992).

Marine growth:

Observations in Iceland have indicated a direct relationship between the abundance of salmon and the abundance of prey species, such as capelin (Malmberg, 1992; Antonsson *et al.*, 1992). It seems likely that such factors could also be related to growth of salmon.

There is an indication that reduction in marine growth can be used as supportive evidence of reduction in survival. Friedland and Reddin (1993) assessed seasonal marine growth by examining intercirculi spacings of first year oceanic zones of 2SW Atlantic salmon scales from the Penobscot River (1975-1990). Analyses of intercirculi spacings indicative of three descriptive indices of annual marine growth: 1) marine entry zone, 2) summer growth zone, and 3) first sea-winter zone, were measured with an image processing system (Figure 3.4.4.5). The return rate was significantly correlated to only the winter growth index, suggesting that annual recruitment is determined during the winter of the first year at sea. Comparisons were also made to multi-variate combinations of the growth indices. The variable combination of marine entry and first sea-winter zones was found to have a significant multiple R of 0.745. Reddin and Shearer (1987) and Ritter (1989) similarly deemed the winter period critical to Atlantic salmon survival. The index also suggests a positive relationship between survival and winter growth. That is, in years of good growth, a greater proportion of the stock survived and vice versa. Thus, environmental conditions during the winter appear to affect the growth and ultimately survival of Atlantic salmon.

The Working Group has also noted that the size of 1SW salmon in the West Greenland fishery has been progressively decreasing from the early sixties to the present (Figures 3.4.4.6 and 3.4.4.7). This can probably be considered corroborative evidence of reduced marine survival of those fish. Comparison of stock abundance and mean length (Figures 3.4.4.8 and 3.4.4.9) at West Greenland indicates a significant relationship between the two for European stocks ($R^2=0.59$, $P<0.0001$) which indicates that the size of fish may be related to survival and abundance.

The Working Group considered information from Icelandic ranching operations regarding reduced survival and growth of 1SW salmon in corresponding years (Isaksson, 1991). Survivals of 1988-1990 smolt classes released from Kollafjördur ranching station were very low and the average weight of returning 1SW fish dropped from a normal average of 2.6 kilograms to 2.2. kilograms. Similar results were also obtained from the 1983 smolt releases. Changes from the normal ratio of 0.5 to 0.8 male grilse and a delay in maturation provided evidence suggesting that conditions in the marine environment can influence salmon life history.

Marine habitat:

Two recent investigations have concluded that the area of winter marine habitat has been declining in recent years in areas of the Atlantic Ocean that would influence production of North American and European salmon.

Friedland and Reddin (1993) computed a time series of quarterly sea surface temperature (SST) anomaly indices for two regions of the western and eastern north Atlantic Ocean. The indices were derived from surface marine observations scaled to 5° latitude by 5° longitude squares. Anomalies were deviations in measured sea surface temperatures from the 1949-1972 means. Atlantic salmon habitat was controlled by two factors: temperature preference and migration.

The area of nursery habitat for North American stocks varied considerably by both season and year (200,000 to 1.5 million km^2) from 1946 to 1988 (Figure 3.4.4.10). The marine habitat of European stocks similarly varied from 1.8 to 2.8 million km^2. Spring and summer marine habitat indices suggested an increase in summer habitat for North American salmon. Winter habitat of North American stocks decreased in size during the mid 1950s and then increased to over 1 million km^2 during the late 1960s and early 1970s. Since that time winter habitat has progressively declined for both North American and European stocks.

Reddin and Friedland (1993) found a similar trend. Their indices were based on the same temperature constraints but utilized more refined temperature data and a different time frame (1970-1992). Their analysis indicated a similar trend of decreasing habitat indices over the past twenty winters. Thus, the area of winter habitat for Atlantic salmon in their first winter at sea appears to be decreasing.

To assess the potential effects of decreasing winter habitat, Friedland and Reddin (1993) compared a time series of catch and first principal component scores of habitat seasonally for North American and European stocks (Figure 3.4.4.11). Principal component scores for the winter indices were significantly correlated with a catch series that included the Greenland catch of North American origin salmon. The correlation between catch and the winter principal component was improved when the North American catch included the estimated catch in homewaters as opposed to the Greenland landings. The first principal component score for the spring European habitat indices were compared to the portion of European catch that extended back in time to 1946. These data represented approximately 60% of the total for the whole stock complex.

Figure 3.4.4.12A demonstrates that patterns of catches for Ireland, Norway, Sweden, Scotland, and Greenland are similar to total catches for Europe between 1960 and 1990. In earlier years, when total catch data were not available, this subset of catches can be assumed to represent the total. Thus the pattern evident in the subset of data can be used as a surrogate for the pattern in total catch and can be compared with available habitat indices for the period (Figure 3.4.4.12B). The results indicate that marine mortality is similar among stocks and thus its cause must operate over a wide area that includes all stocks in the sea or it must occur when they are together.

In summary, the available evidence suggests that the size and numbers of returning adult salmon are influenced by smolt condition factor, growth during the marine phase and factors affecting the marine environment and the available habitat. The distribution and migration of salmon at sea is influenced by sea temperature as was noted in previous Working Group Reports in some years for salmon in the Greenland area (Anon., 1985b). The strong correlations between marine survival and the above factors do not necessarily imply cause and effect.

3.5 Summary Stock Status

3.5.1 North-East Atlantic Commission

Short term:

Overall comparison of stock abundance indices for 1992 indicates some improvement relative to the previous 2 years. There is no evidence of a reduction in juvenile production among monitored rivers and adult escapement appears to have been generally higher in 1992. It must be noted, however, that effects on juvenile production of poor 1SW adult runs in 1990 and 1991 will not be fully felt until 1993 and 1994 and even later in rivers with older smolt ages.

Examination of fishery-independent indices of abundance (marine survival to coastal waters) indicated improved 1SW survival from the 1991 wild smolt year class for most monitored stocks. This was reflected in improved return rates to freshwater. Survival of 1SW hatchery-reared fish to coastal waters was more variable than for wild fish in 1992, having increased for some strains and decreased for others relative to 1991 survivals. 1SW hatchery return rates to freshwater were lower in 1992 than in 1991.

In general 2SW survival rates were poor for wild and hatchery-reared fish returning in 1992, indicating that they were probably affected by conditions which caused poor 1SW survival of the 1990 smolt year class in many areas.

A problem affecting ability to assess the status of wild stocks is the continuing significant presence of farmed fish in catches of several countries.

Long term:

The route regression analyses carried out by the Working Group suggested positive trends in freshwater productivity over an 8 year period, though stocks known to be affected by acidification and other specific factors were not tested. Adult escapement held up well over a 10 year period in many rivers, reflecting generally decreased homewater exploitation.

Fishery-independent indices of survival of wild smolts indicated no trend in survival to coastal waters over a 5 year period; however, survival to rivers increased over an 11 year period in response to decreasing coastal exploitation.

Data examined by the Working Group at this and previous meetings suggest that abundance and catches were much higher in the northeast Atlantic during the early 1970s and that they have declined ever since. Given the natural tendency for Atlantic salmon to fluctuate in natural cycles with respect to abundance and sea age composition, it is likely that high natural abundance in the 1970s led to increased exploitation (including establishment of high seas fisheries). High exploitation, once established, coincided with and probably contributed to, a decline in abundance for many stocks. In response to perceived and actual abundance fishing effort has declined in most fisheries, with management measures contributing to reductions in catch. At the end at the 1980s poor natural marine survival in many areas compounded the low stock situation. However, improved natural survival combined with low exploitation rates may contribute to a recovery in stock status.

3.5.2 West Greenland Commission

Although not measured precisely, it is believed that the most abundant European stocks in West Greenland originate from the UK and Ireland. It appears that the abundance of some of these stocks has declined in recent years. Similar declines in abundance have been noted in many North American stocks that contribute to the West Greenland fishery. The decline in catch and fishery-independent measures of abundance in North America, and the decline in catch beyond the expectation that would have resulted from effort reduction in Europe, suggest that the abundance of fish available to the West Greenland fishery remains low.

3.5.3 North American Commission

The status of the North American stock complex was evaluated with data on spawning escapement, adult returns, and recreational catch. The moratorium on commercial fishing on the island of Newfoundland had the expected effect of improving the runs and escapement of both small and large salmon in that region. However, these counts were exceeded in pre-moratorium years suggesting that abundance of these stocks is still low. Gulf and Quebec region stocks displayed a mixture of stock status with most rivers showing improvement and others suggesting low abundance relative to the previous year. The largest river of the region, the Miramichi, is meeting or exceeding its escapement target. The stocks in the Scotia-Fundy Region continue to show low abundance. USA salmon production remains hatchery dependent. Abundance in USA stocks has not increased in spite of increased stocking, suggesting that survival is poor. The mixture of stock conditions does not give a clear depiction of the stock complexes' ability to sustain harvests. It is necessary to consider the total abundance of the North American stock complex and trends in this abundance to determine the likelihood of recruitment over-fishing.

4 FISHERIES RELEVANT TO THE NORTH-EAST ATLANTIC COMMISSION

4.1 Description of the Fisheries at Faroes

4.1.1 Gear and effort

Gear in use in the Faroes fishery did not change in 1992. The fishing effort was greatly reduced in the 1991/1992 season due to the buy-out of the Faroes quota by various interested parties for the years 1991-1993. Only one research vessel operated during the fishing season, under the direction of the Faroes Fisheries Laboratory. A total of 52 sets was fished by this vessel during 6 trips in the 1991/1992 season.

4.1.2 Catches and discards

No commercial fishery took place in 1991/1992. The research fishery followed the same pattern as in previous seasons, beginning close to the islands and moving in a north-easterly direction out to the fishery limit during the season. The total catch in the 1991/1992 season was 31 t and the preliminary catch for the calendar year 1992 was 23 t (Table 4.1.2.1). The catch in number by month is given in Table 4.1.2.2. As in the last two seasons, it was impossible to fish in January due to bad weather. In 1991/1992 no fishing took place outside the Faroes EEZ (Figure 4.1.2.1)

A total of 8,464 fish was caught of which 782 were less than the permitted 60 cm total length. The discard rate from the catch ranged from 2.5 to 15.7%, and the overall estimate was 8.8% (Table 4.1.2.3). This value is within the range observed since the 1992/1983 season. As noted in the two preceding seasons (Anon., 1992c) the proportion of discards tended to decline as the season progressed.

4.1.3 Catch per unit effort

The catch in number per 1000 hooks (CPUE) (divided by 10) by statistical rectangle for the whole season is shown in Figure 4.1.2.1. As in the last few seasons the CPUE in the first part of the season was very high and, as in 1988/1989, it remained high during February and March and dropped off in April (Table 4.1.3.1); no fishery took place outside the Faroes EEZ (Table 4.1.3.2).

It should be noted that the overall CPUE of 79 salmon per 1000 hooks for the 1991/1992 season is the highest on record since the 1981/1982 season (Table 4.1.3.1). One reason for this might be the fact that the research vessel M/S "Polarlaks" has been one of the best vessels in the salmon fishery in previous seasons. However, as only one vessel was operating it would not have had the benefit of receiving information from vessels fishing in other areas to enable it to find the best fishing locations. In this case several vessels spread over the area would have a higher chance of spotting areas with good catches than just one vessel. If on the other hand the reduced exploitation in the fishery resulted in increased concentrations of salmon within the Faroes EEZ compared with previous years, more salmon would be available to the single vessel, thereby increasing its catch and the CPUE. A third and possibly the most likely explanation could be the high number of reared salmon observed in the Faroes area in the 1991/1992 season. As much as 37% of the salmon caught were estimated to be of reared origin (Jacobsen *et al.*, 1992), and samples from the 1990/1991 and 1989/1990 season also indicate similar numbers of reared fish in the Faroes area. The presence of high numbers of reared salmon in the Faroes catch could mask a decline in the wild stock in the area.

4.1.4 Biological composition of the catch

Production of farmed salmon in the North-East Atlantic is discussed in Section 7. When assessing salmon fisheries and wild salmon stocks, it is important to estimate the farmed and ranched component. If a high proportion of such fish are present, but not accounted for, the catches of wild salmon will be overestimated and the size and status of the wild stocks may be masked. There is direct evidence that salmon that have escaped from Norwegian farms are caught in the long-line salmon fishery north of the Faroes (Hansen *et al.*, 1987), and recent observations have shown that escaped reared fish are numerous in catches in these areas (Jacobsen *et al.*, 1992). As a part of the sampling programme of Atlantic salmon in the long-line fishery at Faroes, fish were examined in order to estimate the occurrence of reared salmon in the fishery. Identification was carried out by scale analysis (Lund *et al.*, 1989; Lund and Hansen, 1991). In 31 fish (5% of the total number examined) it was not possible to judge if the fish were reared or wild; in the analysis these fish were taken to be wild.

In all samples reared salmon were observed in relatively high frequencies (Table 4.1.4.1). Both in February and December 1990 more than 40 percent of the fish examined were of reared origin. During the 1991/1992 fishing season, when sampling occurred over a large part of the fishing season, the average proportion of reared salmon was 37%. During 1991/1992, the proportion of reared fish was significantly lower in March and April (25-28%) than earlier in the season (36-48%)(X^2-test, $P<0.01$). The methodology used to discriminate between wild and reared fish tends to underestimate the proportion of reared fish, in particular those which escaped at the freshwater stage, or at an early marine stage (Lund *et al.*, 1989, Lund and Hansen, 1991). Thus, potential error in classification is directed towards reared fish being classified as wild rather than vice versa. It is thought that these fish are farm escapes rather than fish which have been deliberately released as smolts because tagging programmes have shown that the latter contribute relatively little to the fishery.

The high frequency of escapees from fish farms at Faroes is in the same order of magnitude as in Norwegian homewater fisheries. In 1989, 1990 and 1991 the average proportions of farmed salmon in fisheries on the outer Norwegian coast were estimated to be 45, 48 and 49% respectively, whereas in fjord fisheries the corresponding proportions were 14, 15 and 10% (Lund, *et al.*, 1992). The reason for this difference is that a large proportion of escaped farmed salmon enters fjords and rivers after the fishing season has closed. In a single salmon fishery in western Scotland, Webb and Youngson (1992) estimated that 22% of the catch were of reared origin. Because this value was based on morphological data alone, it cannot be compared directly with the values obtained in Norway.

Research carried out in Norway indicates that in most cases adults of escaped farmed fish return to the area from which they escaped (Hansen and Jonsson, 1991). The high proportion of farmed salmon in the Norwegian home water fisheries, 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. It is also reasonable to assume that farmed fish escaping from cages in Scotland, Faroes and Ireland also contribute to the Faroese fishery.

Biological characteristics of wild salmon obtained from scale samples were compared with those of reared fish. Age was determined by scale analysis in accordance with conventional rules described in Anon. (1984b) and smolt lengths were estimated by linear back-calculation. In reared fish, age and smolt length calculation may frequently be complicated by a diffuse transition between the freshwater and sea zones of the scale confusing the position of the last winter-band in freshwater (Lund and Hansen, 1991). When this occurred, the estimation was based on the minimum value. Back-calculation of smolt size was carried out with some of the scales taken from wild fish (the samples from 1990 and a sub-sample from February 1992).

In samples from all three seasons the wild fish were significantly larger than the reared fish (Mann-Whitney U-test, $p<0.01$). There also appear to be significant differences in size within all sea-age groups compared (1-3) (Mann-Whitney U-test, $p<0.01$) (Figure 4.1.4.1). Reared 1SW fish were significantly larger than wild 1SW fish, whereas among the 2SW and 3SW groups, the wild fish were larger. However, although the sea-age of ranched fish is usually determined correctly, misinterpretation of sea-age may be common in salmon reared in sea pens (Lund and Hansen, 1991). This may explain the extensive size overlap between the sea-age groups in reared fish. It is possible that the sea-age composition of the reared fish is actually similar to the wild fish but that their growth is different.

Among the reared fish, 12 out of 239 individuals (5.0%) were less than 57 cm in fork length, and thus discarded, whereas among the wild fish 13 out of 351 fish (3.7%) were discarded. This difference is not significant ($p>0.05$). The size distribution of wild and reared fish in samples taken in 1991/1992 are shown in Table 4.1.4.2.

Sea age distribution: The sea-age of the reared and wild fish interpreted from scale reading also differed significantly (Figure 4.1.4.2) (Mann-Whitney U-test, $P<0.001$). However, in both categories the majority of the fish were 2SW salmon, accounting for 85% of the wild fish and 70% of reared fish. 1SW fish, on the other hand, appeared from the scale reading to be more numerous among the reared fish (25%). Thus, the estimated average sea-age of reared fish was lower (1.8 years) than for the wild fish (2.1 years). However, this difference may reflect errors in the reading of the reared fish scales.

The sea-age composition of the total catch has been estimated on the proportion of the catch thought to be of wild origin. The division of the catch into wild and reared components was based on the four samples of scales examined (Table 4.1.4.1). The sea-age composition of the wild component was based on the age composition of the wild components of each sample and is shown in Table 4.1.4.3. In comparison to previous seasons (Table 4.1.4.4) there was an increase in the proportion of 3SW fish in the catch and a consequent decrease in the proportion of 2SW fish. However, it was noted that no correction had been made with the previous years' data to account for reared fish; this may have resulted in a significant error in estimating the age composition of the catch using either scale readings or a length split.

Weight distribution: The weight composition of the catch is only available for wild and reared fish combined (Table 4.1.4.5). This confirms the increase in the proportion of large fish (>5 kg.) relative to the previous seasons.

Smolt age distribution: In the pooled samples, the smolt age (estimated from scale reading) of the reared fish was significantly higher than for the wild fish (Figure 4.1.4.3) (Mann-Whitney U-test, $P<0.001$). The mean smolt age of the wild fish was 2.6 years (range 1-5 yrs), while it was 3.3 years for the reared fish (range 1-7 yrs). However, in commercial rearing of Atlantic salmon, smolts are exclusively 1 or 2 years old. The high smolt age readings from the scales are consistent with previous evaluations of scale interpretation of reared fish, which exhibit false winter-bands (Lund and Hansen, 1991). This error in the smolt age reading of farm escapees will bias the estimates of smolt age composition of the total catch if it is not accounted for. Table 4.1.4.6 gives estimates for wild fish alone in 1991/1992. These data give a similar smolt age composition to the catch of previous seasons; however, no account has been taken of the possible presence of farmed fish in samples in previous years, which will have resulted in some smolt ages being overestimated.

Smolt size: The range of variation in the back-calculated smolt lengths was far greater in reared fish (9-41 cm) than in the wild fish (8-19 cm) (Figure 4.1.4.4), and the average smolt length was significantly higher in reared fish (21.9 cm) than in wild fish (12.8 cm) (Mann Whitney U-test, $p<0.001$). The production of large smolts is often a production goal in commercial rearing.

4.1.5 Origin of the catch

All adipose fin-clipped fish caught were scanned for microtags (Table 4.1.5.1). Tags were recovered principally from Irish salmon originating from Shannon River hatchery releases. As the overall release of this particular group was large (320,000) and tags of Irish origin are recovered regularly from the Faroes fishery, this number of tags is not unexpected. Individual tags were also recovered from 3 rivers in UK (England and Wales) and 2 rivers in Scotland. One French origin tag was recovered; this is the first French microtag recovery although Carlin tags have been recovered in the past. The number of external tags recovered from Norway and Sweden was also lower than in previous years.

Table 4.1.5.2 gives the estimated numbers of external tags and microtags recovered in the Faroes fishery per 1000 smolts of each year class released. These data have to be interpreted with great care as many of the tagged smolts are of reared origin and may not be representative of larger groups of stocks and survival rates for fish handled and tagged in different ways will differ.

The data confirm previous observations on the relative catch rates at which stocks from different countries were represented in the fishery. All sets of data indicate a decline in the catch rate reflecting the drop in catch at Faroes in 1991/1992.

4.1.6 Exploitation rates

The exploitation rates in the Faroese fishery on several stocks from Norway, Sweden and UK (Scotland) are summarized in Table 4.1.6.1.

The exploitation of hatchery stocks from the Drammen (Norway) and Lagan (Sweden) have shown similar changes with levels being quite low in the 1986/1987 and 1987/1988 seasons and higher in 1989/1990 and 1990/1991. Also the exploitation on the Imsa stocks (wild and hatchery) increased in 1989/1990 and 1990/1991 compared to the preceding years. The exploitation rates on wild fish from the North Esk have been lower in the last five years than previously.

Exploitation rates in 1991/1992, after the cessation of the commercial fishery, were below 5% for all stocks. This was considerably lower than the average for the preceding five year period. The exploitation on the Norwegian Drammen and Imsa hatchery 2SW fish decreased from an average of 21 and 23% to 2 and 1% respectively.

4.2 Description of Homewaters Fisheries

4.2.1 Long-term changes in effort

In order to provide a picture of management measures taken to control effort in homewater fisheries, the Study Group compiled lists of the numbers of gear units used or licensed each year (over the past 10-25 years) by country and gear type (Table 4.2.1.1 and Figure 4.2.1.1). It must be emphasized that these data cannot be used to estimate CPUE and may not be comparable between countries (for example a drift net unit in Norway will be less than 100 m while in other countries it may be several hundred metres long).

The data available from France, Norway, UK (England and Wales), UK (N. Ireland), and UK (Scotland) all indicate a decrease in the numbers of gear units used. In Norway the decrease has been particularly marked with the closure of the drift net fishery in 1989. In Ireland, effort in commercial fisheries appears to have decreased while rod licences increased.

4.2.2 Gear and effort

There were no reported changes in the fishing methods and gear used in 1992 for any countries. However, new regulations were introduced in some countries and a new national rod licensing scheme was introduced in UK (England and Wales). Generally, effort reflected the perceived low abundance of salmon.

Ireland: No changes were reported in gear usage in general, but extensions to the fishing season were granted for draft net fisheries on 8 rivers (7 extended for 5 days and 1 extended for 2 days) and for rod fisheries in 5 rivers (extended by two weeks each). A by-law introduced in 1990 restricting the areas and seasons for commercial drift netting in the Western Region was maintained for 1992. This by-law was principally aimed at protecting sea trout but also allowed more salmon into rivers.

Norway: All salmon fishing was prohibited in the R. Vosso and some minor limitations were introduced to the marine fishery in the Sognefjord and Österöy areas.

Russia: The number of fishing days was decreased in commercial fisheries in many rivers so as to increase the availability of fish to the recreational fishery.

Sweden: New regulations introduced in 1992 for all Swedish west coast fisheries for salmonids standardised the coastal closed season of 16 September to 28 February. As before, there are zones around river mouths where fishing is prohibited or restricted. Bag nets remain the primary fishing gear although set gill nets may be used between 20 June and 20 July. The closed season for the rod and line fishery was also standardised from 1 or 15 October to 28 February. In Svinesund, the boundary area with Norway, new regulations set the closed season at 16 August to 9 May. During the open season in Svinesund bag nets and set gill nets may not be operated from 6 pm Friday to 6 am Monday.

UK (N. Ireland): The number of fishing licences issued in 1992 (232) was slightly lower than the 1991 figure (239), although overall effort was higher than in the previous year. In the Foyle fishery area, the season started one week earlier than usual and finished one month earlier than usual. The management policy of variable early closure in response to counter-based measures of escapement has been suspended. In future, the commercial netting season will stop on the last day of July. The angling season in the River Bush has been extended by 2 weeks to 15 October.

UK (England and Wales): A new national rod licence was introduced enabling all anglers to fish for migratory salmonids subject to local access regulations. Netting restrictions on the River Camel (southwest region) ceased following a 3-year rehabilitation scheme. Also in the region 2 seine net licences were not renewed for Rivers Taw, Torridge and Tavy. Anglers had mandatory bag limits on the Taw and Torridge. In the southern region, a net fishery on the River Itchen was operated exclusively by the NRA to provide fish for tracking purposes.

UK (Scotland): Regulations were introduced in three districts (Tay, Ugie and Girvan) prohibiting the use of prawns and shrimps as bait. The rod fishing season in the Findhorn Salmon Fishery District was reduced by 6 days. Lawful salmon netting methods were defined.

4.2.3 Catches and catch per unit effort

Revised estimates of total nominal catches by country for the 1991 fishery, and provisional estimates for the 1992 fishery, were available (Table 2.1.1). It should be noted that catches of ranched fish and fish farm escapees are included in these figures (see Section 4.2.4). The figure given in 1992 for UK (Scotland) is incomplete, and the data for Norway, UK (N. Ireland), UK (England and Wales) and Iceland are provisional. CPUE data were only available for UK (England and Wales) (Table 4.2.3.1) and Finland (Table 4.2.3.2).

The total catch figure for homewater fisheries in the North-East Atlantic available to the Working Group for the 1992 fishery was 3,249 t, 15% up on the 1991 figure but considerably lower than the previous 5 and 10 year averages (Table 2.1.1). All countries, with the exception of UK (England), Norway and Russia, had greater catches than in 1991. The 1992 catches for Finland, Iceland, UK (N. Ireland) and Sweden were also greater than both the previous 5 and 10 year averages. Specific information was provided as follows:

Finland: The 1992 catch and CPUE (Table 4.2.3.2) were the highest since the mid-1970s. This is believed to be partly attributable to the coastal netting restrictions introduced in Norway and to high flows which prevented Norwegian salmon weir fishing in the lower part of the Teno River.

France: The catch was 54% up on the 1991 figure although close to the 5 but below the 10-year averages. 50% of the catch was taken in the south west of France which had a good year. This pattern may be explained by a combination of dry weather and reduced fishing effort which occurred in all regions with the exception of the south west.

Iceland: The total catch increased by 17% from the previous year. The average increase in the sports catch, primarily in the grilse component, was about 30%, but on the north-east coast where catches had been depressed, it was about 100%, mostly in the 1SW component.

Ireland: Catches in 1992 were much improved over 1991 which had the lowest salmon catch recorded in the period 1960 to 1991. However, the 1992 catch was 28% less than the previous 5 year average. It was generally perceived that good numbers of salmon were present in the fisheries but continuing naval protection may have reduced the overall number of fish being landed particularly in the northern region.

Norway: The total catch was the lowest recorded for more than 30 years, probably reflecting the effects of the regulations introduced in Norway in 1989 and a reduced abundance of fish.

Russia: The total catch was the lowest recorded since 1922 reflecting a perceived low abundance and the effects of limiting the commercial catch to promote the development of the sport fishery.

Sweden: The catch in 1992 increased for the third year in succession and was the second highest on record. Dry weather conditions resulted in an increased coastal catch but a decreased river catch.

UK (England and Wales): Following a succession of unusually dry years (1989-1991), most parts of England and Wales experienced much wetter weather in 1992. Although conditions for fish movements were greatly improved the effects on catches were variable with those in parts of the south west showing a very marked increase, while those in the north were generally reduced. CPUE has, however, continued to decline in most areas.

4.2.4 Composition of the catch

The national salmon catches for several North-East Atlantic countries are summarized in Table 2.2.1. The age classes are separated both by scale analysis and by separating weight distributions in the catches. Specific information on age composition was summarized for the following countries.

France: The overall proportion of grilse (48% in numbers) in the catch was close to the mean of the last 5 years.

Iceland: There was an increase in the grilse component compared to 1991, especially in north-eastern Iceland. The average size of grilse was higher than in the previous year and the sex ratio in grilse was fairly even.

Norway: Catches in Norway were the lowest on record and slightly lower than for the previous three years. There was a slight reduction in the grilse component.

Russia: As in the 1989-1991 period grilse dominated the catches (72.5%). The decrease in MSW salmon was primarily due to the depressed state of stocks with high proportions of MSW fish.

UK (Scotland): The proportion of the reported catch classified as 1SW fish was greater than in 1990 and 1991, but similar to that observed in the 1985-1989 5-year period

4.2.5 Origin of the catch

Table 4.2.5.1 indicates the origin of the catch in each country based on recoveries of tags over a number of years. The table has been updated for 1992 to include any previously unreported occurrences of non-national-origin tags in homewater catches and any new records in 1992. Double crosses indicate the principal component of the catch and single crosses represent other stocks contributing regularly to the tag recoveries. Rare recoveries of one country's tags in another country's catches are indicated by dashes and are assumed to indicate very minor contributions to the catches. It must be noted that the table may reflect the relative size of the national catches and does not imply the proportion of the stock from a given country which is taken in another country's catches. In some cases, although the majority of the catch in a given country may originate from that country, the contributions from rivers in adjacent countries may be substantial. Therefore, countries with small stocks are not likely to contribute a significant proportion of the catch to fisheries which take large numbers of fish from other larger stocks. However, the actual numbers of the smaller stock which are taken in the fishery may be high relative to the total size of this small stock.

There is an obvious area of exchange between most adjacent fisheries with the possible exception of the Russian fishery and the French fishery which are at the outer limits of the range of the north-east Atlantic salmon stocks. The Working Group noted that this type of analysis gave very little information on how national stocks are exploited by different countries including the country of origin. A similar table incorporating weights of stock contributing to each national catch would provide a better assessment of the mixed homewater fisheries and this should be incorporated as part of the overall assessment of salmon stocks in the north-east Atlantic. It was felt that sufficient information was available to make, at the very least, an estimate of the contributions of non-national-origin stocks to national catches in the same way that the Faroese mixed stock fishery was currently being assessed. The Working Group recommended that an attempt be made to produce such a table in 1994.

Table 4.2.5.2 shows the estimated contributions of ranched and farmed fish to national catches in recent years. In this context ranching is defined as the release into the wild of reared smolts with the intention of attempting to harvest all of the returning adults. Releases of reared fish to enhance wild stocks or compensate for lost wild production are, therefore, included in wild production. However, it is acknowledged that some fish released for enhancement may not contribute to spawning for various reasons; in this respect they are similar to ranched fish.

Ranching is carried out on a large scale by Iceland. Ranched fish comprised 76% of the total catch in 1991 and 70% in 1992. In addition 14 t in 1991 and 24 t in 1992 of the Swedish catch were made up of fish which had been released but were not expected to contribute to wild spawning populations. Small-scale ranching for research purposes is carried out from the R. Bush, UK (N. Ireland) and at several sites in Norway. Ranching to enhance the rod fishery is carried out from the R. Burrishoole, Ireland. In this case only limited numbers of ranched fish have been allowed upstream to supplement wild spawning stocks.

Farmed fish make a significant contribution to the catches of Norway, Faroes and UK (Scotland). The proportion of farmed fish in Norwegian catches have remained relatively stable in the period 1989-1992 (Table 4.2.5.2). The proportion of farmed fish in freshwater catches is much lower than in catches at sea because farmed fish enter freshwater later than wild fish.

In UK (Scotland), sampling in 1990 indicated that most of the reared fish caught in fisheries had escaped or been lost from sea cages. In 1991 and 1992, however, sampling on the west coast revealed that most of the farm origin fish were derived from losses or releases of smolts or parr. On the east coast, where the incidence of farm escapees was low, most of the farm origin fish were adult escapees.

While farmed fish are present in most fisheries except Russia and France the exact contribution is not known. Levels of between 7 and 20% farmed fish have been reported from some catches in regional fisheries (coastal and estuarine) in Ireland. In most other countries, farmed fish are thought to form only a very minor (or negligible) part of the catch.

The Working Group recommends that countries should attempt to estimate the numbers and stages of fish farm escapees in each year.

4.2.6 Exploitation rates in Homewater fisheries

The exploitation rates in homewaters for a number of other stocks from Norway, Sweden, Russia and the UK are summarised in Tables 4.2.6.1 and 4.2.6.2.

A comparison of exploitation patterns for different stocks does not show any obvious similarities, except that hatchery stocks are often more heavily exploited than wild stocks. This is the case even when wild and reared fish originate from the same stock, as is the case for the River Bush and River Imsa stocks.

The levels of exploitation in 1992 seemed to be about average in most cases, except for the Russian River Ponoy where the exploitation was reduced. Exploitation rates on the three Russian rivers shown in Table 4.2.6.2 are adjusted by altering the proportion of days on which fish caught in traps on the rivers are released or killed. In 1991 and 1992 it was decided to reduce the exploitation rate in R. Ponoy in order to increase spawning stocks and make more fish available for the developing recreational fishery.

An illegal fishery of considerable magnitude occurs in many of the Russian rivers. The illegal fishery was estimated to catch 15% of the spawning stock in River Varzuga, 25% in River Pechora and 26% in River Umba. There is no clear sign that the illegal fishery is changing in size from year to year.

4.2.7 Management measures in Norway

Full details of the management measures introduced in Norway in 1989 are given in Anon. (1990a), Appendices 2 and 3.

The impact of the measures on catches in Norwegian homewaters between 1989 and 1992 is shown in Table 4.2.7.1 and Figure 4.2.7.1. In the period 1982-1988 the nominal catch of salmon fluctuated between 1,076 and 1,623 t (mean 1,449 t). It decreased to 850 to 930 t (mean 891 t) between 1989 and 1992 probably as a result of the new management measures. In 1989 and 1992 the marine catches of salmon averaged 474 t, which is much lower than for 1982-1988, when catches varied between 841 and 1,324 t (mean 1,146 t). The catch in the marine salmon fisheries, excluding drift netting, was close to the average for this period (Rcrit = 1.03, p = 0.4, see Appendix 8).

It is likely that the ban on drift netting in 1989 has resulted in a larger number of salmon being available to other marine homewater fisheries. The additional regulations in these fisheries has probably resulted in a substantial increase in freshwater escapement suggested by increased catches in freshwater despite the fact that freshwater fisheries also have been regulated by extending the annual closed time and that fishing for salmon has been totally banned in several rivers. Between 1989 and 1992 the freshwater catch accounted for 45% and 50% of the total nominal catch, annually, compared to between 18 and 27% over the years 1982-1988. The catch in freshwater increased significantly (Randomisation test, Rcrit = 1.346, $p < 0.05$) in 1989-1992 compared to 1985-1990. Increased freshwater escapement is also suggested by the significant reduction in homewater exploitation rates on most components of the River Imsa stock during 1989-1992 (Randomisation test, Rcrit = 0.737, $p < 0.001$). This was not as evident for the River Drammen stock, because drift net exploitation on this stock has always been low, but the decrease was still significant (Rcrit = 0.755, $p < 0.05$).

The frequency of net-marked salmon entering a river will also give information about changes in netting effort on the migration route. The proportion of net-marked salmon has been recorded in several Norwegian rivers since 1978. In most of these rivers, sampling took place from 1978 to 1986 and was then re-established in 1990, 1991 and 1992. Table 4.2.7.2 shows unweighed means of the proportion of net-marked salmon in angling catches from 12 rivers in the period before the extensive homewater regulations were introduced, and the unweighed means of the proportion of net-marked salmon recorded in 1990-1992 in the same rivers. In all except one river the proportion of net-marked salmon recorded in 1990-1992 was much lower than unweighed means during the period 1978-1988. The reduced proportion of net-marked fish may be accounted for by the management measures introduced in the Norwegian homewater fishery in 1989.

The salmon fishery on the Norwegian coast intercepts stocks from Sweden, Finland and Russia on their way back to their home rivers. Exploitation in Norway on 1SW fish tagged as smolts in the River Lagan, Sweden in 1989, 1990, 1991 and 1992 was lower (average 1%) than in 1985-1988 (average 7%) (Table 4.2.7.3). Table 4.2.7.4 shows numbers of external tags recovered in Norway of salmon tagged as smolts in Sweden since 1975. The number of tags recovered in Norway per 1000 smolts released was very high at the end of the 1970s and beginning of the 1980s. It declined through the 1980s, and from 1989 to 1992 it was extremely low and much lower than all other years. The unweighed mean in the catch years 1977-1988 was 10.9 tags recovered per 1000 smolts released, whereas the corresponding average for 1989-1992 was 0.5. It is concluded that the regulations introduced in the Norwegian homewater fishery in 1989 benefited Swedish west coast stocks. A randomisation test on the exploitation rates and tag return rates in Norwegian fisheries showed a significant decline (Rcrit = 1.519, $p<0.001$).

It is also expected that the management measures in the Norwegian fisheries might have benefited Finnish and Russian stocks. Table 4.2.3.2 shows the catch (kg) per angler.season and catch (kg) per angler.day in the Tana River, Finland. These data show a significant increase in the period 1989-1992 compared to 1985-1988 (Randomisation test, Rcrit = 1.332, $p<0.024$).

The escapement into 3 Russian rivers (Kola, Ponoy and Zap.Litca) also increased in 1989-1992 compared to 1985-1988 (Randomisation test, Rcrit = 1.519, $p<0.001$).

The Norwegian management measures have, therefore, been shown to have been related to:

1) a significant decrease in the homewater exploitation rates in some Norwegian index river stocks;

2) a significant increase in freshwater catches in Norway;

3) a significant increase in CPUE in Finland;

4) a significant decrease in interception of Swedish tagged fish;

5) a significant increase in escapement into 3 Russian rivers.

4.3 By-catch and Mortality of Salmon in Non-Salmon Directed Fisheries

The landing of salmon caught in fisheries targeting other species is illegal in most countries in the North-East Commission area except France, where it is authorized, 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 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 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 the information available to determine whether such catches are regular occurrences.

4.4 Indicators of Trends in Abundance of Salmon in the North-East Atlantic

Several biological and physical indicators can potentially be used to predict the abundance of salmon stocks in subsequent years. Most common are population estimates conducted at various points in the salmon's lifecycle, both in fresh and salt water.

4.4.1 Freshwater assessments

Biological indices used in freshwater include catches, run or escapement counts (spawning targets), estimates of egg, fry or parr abundance as well as smolt counts. These methods tend to be less costly than marine assessments and have thus been used to some extent in all countries bordering the north Atlantic. These methods give good estimates of the utilization of the rearing capacity in individual rivers and smolt counts can in some cases be a good indicator of grilse and salmon abundance in subsequent years.

In general, one can say that the precision with which these methods predict future salmon abundance decreases as one goes forward in the life cycle due to the additive mortalities encountered in freshwater from egg to smolt as well as those in the marine environment.

Counts of runs and escapement are undertaken in many countries. These methods give very accurate information about the status of the stock in question and can, in some cases, be used to calculate egg deposition. The method has been used successfully to estimate spawning targets in Canada. Counters and their operation, however, are expensive and are usually only applied to a limited number of rivers.

Estimation of egg deposition by sampling river beds or counting redds does not seem to be a practical method to predict future abundance of Atlantic salmon, although it is used extensively in Pacific salmon.

Electrofishing surveys of fry and parr give good indications of the utilization of the rearing capacity of individual rivers. In some cases they can be useful as predictors for future abundance of salmon. These methods are, however, mostly usable for relatively small rivers, which can be easily electrofished.

In the River Bush (UK, Northern Ireland) fry estimates (0+) have been found to be fairly representative of 1- and 2-year smolt production as observed in the downstream smolt traps. A method to estimate smolt production from habitat assessments and juvenile surveys has also been developed and successfully tested in France. In Iceland, where juveniles spend 2-5 years in freshwater, electrofishing surveys have only given moderate success in predicting future salmon abundance. It seems likely, therefore, that the longer the stocks stay in freshwater as juveniles, the less applicable this technique will be, considering the variable mortality in fresh and salt water depending on climatic and oceanographic factors. It was also noted that variable precocious maturity in parr would reduce the applicability of these methods.

Smolt counts are by far the best method to predict future abundance of salmon. Traps are operated on index rivers in several countries. These traps are, however, expensive to construct and operate. Information from these has, however, sometimes been used as an index for larger areas, especially with respect to marine survival.

4.4.2 Marine assessments

Methods used to predict salmon abundance through assessments during the marine phase include test fishing at various stages, acoustic surveys and prediction of non-maturing 1SW salmon from returning 1SW salmon in home waters. In some cases, oceanographic and meteorological factors, as well as the abundance of prey and possibly predatory species could be used to improve the predictive ability of the model. It has been noted that good salmon years in certain parts of Iceland seem to coincide with high catches in the capelin fishery.

It seems likely that a large fraction of the marine mortality of salmon takes place fairly soon after migration into seawater. Early feeding in the sea might be an important factor in survival as well as the impact of various predators. Sampling of post-smolts and their predators during this early marine period might, in time, give some useful indices for a prediction model. Sampling of post-smolts, however, has turned out to be a very difficult task all around the Atlantic.

Sampling the abundance of prey species might also be a useful index to use in a prediction model. Such survival indices have been developed in the Pacific and zooplankton indices are used to determine proper release time for pink and chum salmon in Alaskan ranching operations.

Test fishing on the feeding grounds might in theory provide a meaningful indicator of abundance of fish. If some of the fish are carrying tags, it might give an indication of relative stock abundance. The benefits of these approaches, however, are dependent on the value of the information in relation to the cost of running such a project; test fisheries tend to be very costly.

When considering test fisheries it is important to consider that salmon from Europe are distributed over the entire north Atlantic from West Greenland to the Norwegian Sea with variable contributions from the countries of origin. Oceanic conditions might be highly variable from one area to another making sampling in one area a poor indicator of overall marine survival and subsequent homewater catches. Test fishing at key locations during the spawning migration might in some countries yield useful advance information on the run size. However, in many cases, this technique would not be very cost effective.

4.4.3 Acoustic assessments

Acoustic methods have been used to estimate the abundance of pelagic fish for decades. Some difficulties have been encountered in estimating salmon abundance with these methods as the salmon feed close to the surface and do not aggregate in dense schools. Improved technology might, however, provide a solution to this problem in future years. A new 95 KHz sector-scanning sonar modified for fisheries research will be tested as an aid in assessing abundance and distribution of pelagic species (including salmon) within the framework of the "Ecology of the Nordic Seas" programme that will be implemented in Norway in 1994.

4.4.4 Forecasts of salmon abundance from 1SW returns

The abundance of 1SW fish can potentially be used as a rough predictor of the abundance of 2SW salmon in the following year. The method was first used in the Pacific to predict sockeye salmon abundance from the returns of jacks (1SW males) the previous year. Run reconstruction models have in the past indicated that age of maturity is one of the more stable biological parameters in salmon.

The method has been tried in Iceland, Canada and Scotland. In northern Iceland the catches of 2SW salmon in freshwater were highly correlated with the catches of grilse in the previous year (Scarnecchia *et al.*, 1989a). In the study a strong relationship ($p<0.01$) was found between grilse abundance and subsequent 2SW returns in 18 out of 22 rivers in northern Iceland, whereas a similar relationship only existed for 12 out of 21 rivers in western Iceland. In Iceland, the technique has proved to be most useful on the north coast, where environmental conditions favour late maturation and where there is also greatest fluctuation in salmon abundance due to changing environmental conditions. The technique has not proved to be successful in Scotland, however.

4.4.5 Future prediction models

It seems likely that future predictive models will have to combine data from various sources. It can be concluded that the most efficient methods are based on the counting of smolts followed by counting of upstream migrating salmon, which could be used to estimate egg deposition. In the absence of such information electrofishing surveys might yield useful information. Knowledge of various biological and physical parameters related to sea conditions, both in the inshore and oceanic areas, would probably increase the prediction value of such models.

Marine assessments of salmon are costly and seem unlikely to be viable for prediction of salmon abundance in most fisheries or homewaters.

Assessment of 2SW salmon from the abundance of 1SW fish in homewaters seems to be a promising method in some areas with relatively large quantities of 2SW salmon.

Development of prediction models is not only important for salmon managers around the north Atlantic but is also considered a top priority research project for the salmon ranching industry, which needs to know in advance with some certainty about the tonnage to be marketed during a particular salmon season. In this case, however, the numbers of smolts released are usually known and the success of the operation is more dependent on smolt quality, release techniques and conditions in the sea.

4.5 Effects of the NASCO Tag Return Incentive Scheme

Most of the North-East Atlantic countries provided data to NASCO for the Tag Return Incentive Scheme (UK (England and Wales), Scotland, Ireland, Norway, Sweden, Russia and Finland). However, Northern Ireland do not use any external tags and in UK (England and Wales) and Ireland they are only used on kelts and as external indicators of the presence of transmitter tags. Iceland does not participate in the scheme and Norway only provides data on Norwegian tags caught outside their homewaters. No information was available for France.

No quantitative analyses of the effects of the scheme have been carried out. The main reasons are the small numbers of external tags used and insufficient awareness of fishermen about the NASCO lottery in most participating countries. At the moment there is no good evidence for positive effects of the scheme on the rates of tag returns. The only positive effect of the scheme was reported from Finland, where tag reporting rates (estimated by observers) are thought to have increased, but there are no quantitative estimates. Iceland has no interest in this programme as its stocks are not exploited by other countries. Norway, on the other hand, conducts many tagging experiments, but does not participate in the incentive scheme in order to avoid interference with ongoing assessments of recent homewater measures. In Scotland it was thought that the scheme had no effect on catch return rates; in the principal fisheries taking tagged fish, reporting rates are thought to be close to 100% already. In most other fisheries the numbers of tag recoveries are too small to detect a change.

4.6 Effects of the Cessation of Fishing Activity at Faroes

The mean catch in the Faroes fishery in the three fishing seasons 1988/1989 to 1990/1991 was 87,454 salmon (292 t) per season. The catch in the 1991/1992 research fishery, after the buy-out of the quota, was 8,464 fish (31 t). Thus, the catch at Faroes was reduced by 78,990 fish (261 t) compared to the previous three seasons.

Data presented to the Working Group (Jacobsen *et al.*, 1992) suggest that about 37% of the fish taken at Faroes in the 1991/1992 seasons may have been of farmed origin, and the proportion may have been similar in preceding years. Thus the extra number of wild fish not caught as a result of the cessation of fishing may be about 50,000 fish (164 t), the remaining ~29,000 fish (97 t) being fish farm escapees.

The Working Group has previously provided a model to assess the effects of the catch at Faroes on stocks returning to homewaters (Anon., 1984a). It was estimated at that time that 78% of fish in the Faroes area will mature in the same year and 97% of these will survive to reach home waters if they are not caught. Using these data, the estimated increase in wild fish returning to home waters is about 37,800 salmon. Some additional fish saved from the fishery in 1991/1992 would be expected to return to home waters in 1993.

The Working Group was unable to model reliably the fate of the farmed salmon from the Faroes fishery, but it is believed that these will also return to homewaters. Assuming that the farmed fish behave in the same way as the wild fish, the predicted increase in the numbers of fish returning to homewaters in 1992 would be approximately:

Wild 1SW	3,400
Wild 2SW	34,400
Farmed	22,000

[Aging of the farmed component is thought to be unreliable and all age groups are therefore grouped].

These fish will probably have contributed to homewater fisheries in most salmon producing countries in the north-east Atlantic. However, it is unlikely that it will be possible to demonstrate a significant change in catches after a single year. The majority (perhaps 60-80%) of the wild fish caught at Faroes are thought to originate from Scandinavian, Finnish and Russian stocks (Anon., 1991c, 1992c, and Section 4.1.5) and thus the greatest impact should be seen in the fisheries of these countries. The total homewater catch in these countries in 1992 was 326,603 of which 17% (56,000) were estimated to be farm escapees (Table 4.2.5.2) and, of the wild fish, 173,000 were estimated to be 1SW and 147,000 MSW salmon. Assuming that the mean exploitation rate in homewater fisheries is 40-70% the additional catch should have been 800-1,900 1SW wild fish, 8,200-19,000 MSW wild fish and 5,300-12,300 farm escapees.

These increased catches would, therefore, have represented the following proportions of the recorded catches:

Wild 1SW	~ 1%
Wild 2SW	6 - 13%
Farmed	10 - 22%

Such small increases will have been within the annual variation of catches in these countries and will not represent a statistically significant increase. (It is not possible to provide reliable standard deviations on catches in these countries in recent years because of changes in fishery regulations, the contribution of farmed fish and the lack of appropriate catch data.) Catches for Ireland, Scotland (large salmon), Russia (2SW salmon) and Norway (MSW salmon) in 1992 were compared with those in 1987-1991 using the Randomisation test; the change was not significant (Rcrit = 0.736, p = 0.257).

Exploitation rates on stocks from UK and Ireland have been very low at Faroes in most years. The buy-out of the quota must be expected to have resulted in additional fish returning to these countries, but the predicted improvements in catches will be very small. In view of the variability of homewater catches it is not expected that they will be statistically significant even after many years.

If we assume that monitored stocks have been relatively stable over the past four years, the cessation of fishing should have reduced exploitation at Faroes to about 10% of levels in the previous three seasons. For stocks in UK and Ireland the numbers of tag recoveries in the last four seasons have been too low for such a reduction to be statistically significant. However, exploitation rates on Imsa and Drammen stocks in 1991/1992 were 0-4% and 2% in comparison to rates between the 1988/1989 to 1990/1991 seasons of 0-37% and 13-45%. Exploitation on 2SW fish from R. Imsa, R. Drammen and R. Lagan decreased from a mean of 17% in the 1988/1989 to 1990/1991 seasons to 3% in 1991/1992. The reductions were significant when tested by the Randomisation method (Rcrit = 0.129, p <0.001).

4.7 Sensitivity Analysis

The Study Group on North-East Atlantic Salmon Fisheries was asked to make a sensitivity analysis of the national run reconstruction model. This analysis confirmed that the national run reconstruction model is very insensitive to variations in M (natural mortality after first sea winter) and t (time between fisheries). The model is dependent upon reliable tag recovery data. If tag recoveries in any fishery are small (<10) then the reliability of the recapture estimates and consequent estimates of exploitation rates will have large confidence limits (≥ ± 60%). Similar errors will be introduced into the estimates of catches of national stocks.

If the reason for the number of tag recoveries being small is that the catch scanning rate is low, then the errors may be significantly reduced by increasing the proportion of the catch examined for tags. Where external tags are used efforts should be made to maximise reporting rates. If the number of tag recoveries is small because the exploitation rate is low, it may not matter that the resulting estimate of exploitation rate is imprecise. Where the exploitation rate is higher the number of tags recovered may be greater and this will give a more a precise estimate of exploitation rate.

Parts of the model can be sensitive to the correction factors (x + y) used to adjust levels of exploitation in homewater fisheries on the monitored and national stocks. However, this is only a critical problem (for factor "x" only) when the exploitation rate on the tagged stock in the other homewater interception fishery is very high (>50%).

Despite these potential sources of error the Working Group noted that no alternative approach was currently available for estimating the contribution of national stocks in the North-East Atlantic to fisheries outside home waters.

5 FISHERIES RELEVANT TO THE WEST GREENLAND COMMISSION

5.1 Description of the Fishery at West Greenland, 1992

In 1992, the fishery at West Greenland (NAFO Sub-area 1) was opened on 1 August and ended in November, although the official closing date was 31 December. The total nominal catch was 237 t (Tables 5.1.1 and 5.1.2) which is 235 t less than in 1991, when the total landings were 472 t (revised from last years figure of 438 t).

No TAC was set for 1992, but the decision was to observe the landings after the first fourteen days of the fishery, and in the event of these being high compared to previous years, a TAC would be implemented. Because of small landings a TAC was never put into force.

The geographical distribution of the fishery in 1992 (Table 5.1.2) was more southerly than in previous years. Landings in the two more southerly NAFO Divisions 1E and 1F accounted for 86% of the total landings in Subarea 1. The landings in NAFO Divisions 1A and 1B were again low, whereas landings in NAFO Divisions 1E and 1F were high, with highest figures in Division 1F.

The salmon fishery in Greenland is a small boat fishery and is executed in inshore and coastal areas. Approximately 80% of the total landings were taken by boats smaller than 30 feet. The landings during the first fourteen days is given for 1980 to 1992 (see text table in the next column).

It should be noted that the provisional data for 1992 include 62 t in Division 1E that could not be allocated to standard week. Regardless of the proportion of that catch taken during the first fourteen days of the fishery, the 1992 value would remain one of the lowest in the time series.

The nominal landings during the first fourteen days, 1980-1992 (in tonnes).

Year	First seven days	First fourteen days	Dates
1980	260	711	1- 14 Aug
1981	465	735	15 - 28 Aug
1982	470	766	25 Aug - 7 Sep
1983	105	192	10 - 23 Aug
1984	17	58	10- 23 Aug
1985	204	361	1 - 14 Aug
1986	509	848	15 - 28 Aug
1987	439	737	25 Aug - 7 Sep
1988	219	337	25 Aug - 7 Sep
1989	131	219	18 - 31 Aug
1990	12	38	1 - 14 Aug
1991	115	208	5 - 18 Aug
1992	36	60	1 - 14 Aug

5.1.1 Composition and origin of the catch, 1992

Estimation of Continental Proportions in the West Greenland Catch

The Working Group examined the composition and origin of salmon caught at West Greenland based on discriminant analysis of scale samples from NAFO Divisions 1C, 1E, and 1F. The duration of the scanning period was extended in 1992 in an effort to cover a larger proportion of the catch in accordance with the sampling design proposed in Anon. (1992a). Scanning was targeted at ports where catches were highest.

The database used to develop the discriminant function consisted of 788 North American and 788 European known-origin salmon collected at West Greenland from 1980 to 1991. Due to the high within scale variation, three discriminant functions were used - one for salmon with river age 1, one for salmon with river age 2, and one for salmon with river age 3 and older.

Scale samples, which were independent of the discriminant analysis database and weighted to 1991 river-age distributions at West Greenland, were used to test the discriminant functions. The results indicated an overall misclassification rate of 19.5% and error rates of ± 3.3%, based on prior probabilities of 0.5. This database and the discriminant function were accepted by the Working Group for examination of the 1992 West Greenland fishery. The accuracy of the discriminant analysis was also tested against known origin samples collected at West Greenland in 1992. These samples were identified to continent of origin based on the presence of a coded wire microtag. The results indicated an overall misclassification of 27% and an error rate of 18.9%. The problem of lack of scale material from European sources was felt to be a major limitation to the development of the database and the Working Group again recommended that each country should provide as many homewater scale sets of the same year class as samples taken in Greenland.

Stratified length and weight sampling was carried out on commercial salmon catches in NAFO Div. 1C (2,717 from 8 Aug to 2 Sept), Div. 1E (2,005 from 9 to 31 Aug) and Div. 1F (1,527 from 16 to 23 Aug). In total, 6,249 salmon were examined and 1,612 scale samples analyzed. The results of classifying salmon in samples from commercial catches in 1992 gave a North American proportion of 54% (95% CL = 57,50), and a European proportion of 46% (95% CL = 50,43) (Table 5.1.1.1). This is the lowest number of fish recorded for North America since in the period 1982 to 1992. The number of European fish is the third lowest in the same time period. In 1992, 63% of the catch was taken at the same time as the samples, compared to 52% in 1991, 26% in 1990, 73% in 1989, 62% in 1988 and 85% in 1987. Of the total catch, 7.3% was sampled for determination of continental proportions compared to 3.1% in 1991, 5.8% in 1990, 8.0% in 1989, 3.8% in 1988 and 4.5% in 1987.

An alternative estimate of the overall proportion of North American and European origin salmon for the years 1982 to 1992 was derived by weighting Division samples by catch in numbers. Pooled samples from other Divisions were applied to Divisions with no samples. In 1992, a percentage of 45% North American origin corresponds to a catch of 108 t or 38,500 salmon and 129 t or 46,900 salmon from Europe. These results are shown below for weight and, in Table 5.1.1.2, for number of salmon caught by continent of origin.

Year	Weighted by catch in numbers					
	North America		Europe		% of all samples combined	
	%	Wt(t)	%	Wt(t)	NA	EU
1982	57	-	43	-	62	38
1983	40	-	60	-	40	60
1984	54	-	46	-	50	50
1985	47	-	53	-	50	50
1986	59	537	41	423	57	43
1987	59	556	41	411	59	41
1988	42	349	58	544	43	57
1989	55	179	45	158	56	44
1990	78	213	22	62	75	25
1991	63	290	37	183	65	35
1992	45	108	55	129	54	46

Trend analyses of the samples taken from NAFO divisions by date show no significant trends. Analyses of the proportions by continental origin, however, indicate a significantly lower proportion of North American salmon in Division 1E (39.5% NA) and 1F (43.3% NA) than in Division 1C (70%) at the 5% level of significance. There was no significant difference between Divisions 1E and 1F.

NAFO Div.	Nominal catch (t)	% N. American origin	% European origin
1A	0.1	*	*
1B	3.7	*	*
1C	22.4	70	30
1D	5.3	*	*
1E	73.5	40	60
1F	130.0	43	57

*not sampled

Tag Recovery

Information on country of origin can be derived from recoveries of tags (both Carlin and coded-wire) at Greenland in 1992. Salmon landings at Greenland were again scanned in 1992 for adipose finclips and coded-wire tags (CWTs) using procedures similar to those in previous years.

In 1992, a total of 7,883 salmon (9.2% of the West Greenland catch) was examined for adipose finclips and CWTs by Canadian, USA, Irish and Danish scientists. In the sample, 3.04% had adipose finclips, and CWTs were recovered from 33.8% of the finclipped fish (Table 5.1.1.3). Thus, the overall proportion of the catch sample that had CWTs was 1.03% compared to 0.50% in 1991, 0.84% in 1990, 0.64% in 1989, 0.50% in 1988, and 0.58% in 1987. The number of fish scanned in 1992 was slightly higher than in either 1991 or 1990, but remained at a much lower level than the years 1985-1989. In contrast to 1991, however, the proportions of fish landed with adipose fin clips and microtags was relatively high, with the proportion containing microtags being the highest on record since scanning commenced. The proportion of adipose finclipped fish containing microtags was also the highest on record.

The proportions of fish having adipose fin clips and CWTs sampled at each port differed significantly from a uniform distribution (Chi Sq = 23.4 and 7.3 respectively). In most previous years the proportion of fish having fin clips and microtags has decreased from north to south throughout the fishery. In two years, 1988 and 1991, fin clipped and microtagged fish have been evenly distributed. This pattern particularly held true for North American-origin tagged salmon; whereas European salmon appeared to be generally more evenly distributed throughout the NAFO Divisions. In 1992, proportions of finclipped and microtagged fish were highest in the north (NAFO Division 1C) and lowest in the middle of the three regions in which scanning occurred (NAFO Division 1E) (Table 5.1.1.4).

The total number of CWT tags recovered in the Greenland catch was 81. The number per country of origin was as follows: 36 (44.4%) USA, 20 (24.7%) Ireland, 15 (18.5%) Canada, 5 (6.2%) Iceland, 4 (4.9%) England and Wales, 1 (1.2%) Scotland (Table 5.1.1.5). All of these tags came from 1SW salmon, most having been released as hatchery-reared smolts in 1991; although 7 (5 from Canada, 1 from Scotland and 1 from England and Wales) were tagged as wild smolts in 1991 and 2 (both from England and Wales) originated from tagged parr released in 1990.

The proportions of tags of US origin was much higher in the northern part of the fishery area (NAFO Division 1C) than elsewhere while tags of Irish origin occurred in progressively higher proportion moving from north to south. Tags of Canadian origin were higher in NAFO Divisions 1C and 1F than in 1E while recoveries of tags from other European countries were too low to identify patterns of distribution in the fishery.

The contribution by various countries to the 1992 West Greenland harvest cannot be determined at this time due to differential survival of stocks tagged, as well as the proportion of coded-wire-tagged fish relative to total smolt production in each country.

The updated time series of Carlin tag returns for the USA origin 1SW salmon in West Greenland is shown in Table 5.1.4.2. In all, 5 tags were recovered in the Greenland catch to date with 3 of these occurring in NAFO Division 1E. The number of tags recovered from the Greenland fishery of unknown age salmon has increased in recent years. Assuming that most of these recoveries are from 1SW salmon, the recoveries are concentrated in recent fisheries and do not reflect the general pattern of tag recoveries observed for tags of known age salmon.

Proportional Harvest Estimates

The Working Group considered an estimate of the number of Maine origin salmon harvested at West Greenland in 1992 using the proportional harvest method (Anon., 1989a). In this method, the number of 1SW North American salmon of river age 1 in the West Greenland fishery are apportioned by the relative production of sea age 1 smolts by Maine and Canadian hatcheries the year before. The contribution to the Greenland harvest of other US origin (i.e., Merrimack, Connecticut) smolts is considered low. The proportional harvest method was used to provide a current year estimate of the harvest.

Input data for the method are shown in Tables 5.1.1.6 and 5.1.1.7. There were minor scaling changes applied to the North American percentage used in the historical time series of input data since the last assessment. Based on this method, the estimate of Maine origin salmon harvested at West Greenland in 1992 was 1,950 (Table 5.1.1.8). This is the lowest number recorded in the time series. Previously (Anon., 1992a), the range of values for this estimate was 2,350 to 33,351. The corrected range of numbers of Maine origin salmon in the West Greenland catch is now 1,950 to 30,492.

The standard deviations of these estimates (a more appropriate precision estimator than previously used in the model) are also shown. With the exception of 1976, the S.D. ranged from 26.5% to 51.1 % of the mean (average 38.4%). The parameters for the Harvest Model remain as reported in Anon. (1992a).

Fish Farm Escapees

The incidence of reared Atlantic salmon in the catches at West Greenland was examined from scales taken from salmon sampled in the 1991 fishery. The criteria used to identify reared salmon were similar to those used to distinguish farmed origin salmon in the Faroes fishery (Lund *et al.*, 1989; Lund and Hansen, 1991) and are based on the analysis of scales of Norwegian salmon of known origin. Reared salmon were observed in very low frequency (1.1%) and these were determined to be of farmed origin. An additional 2.6% of the number of fish examined could not be accurately classified although they showed similar scale characteristics to fish which had been released as smolts from hatcheries.

5.1.2 Stock identification considerations

The approach to identify continental origin which has been adopted since 1986 is based on a genotypic/phenotypic method. Unfortunately, due to the low number of European salmon in the database of tissue samples collected at West Greenland, it has been impossible to develop a new database on an annual basis. Due to concerns that annual variability in scale characters might increase the level of misclassifications, scales were collected from homewaters in 1990 from the same smolt class as at Greenland in 1989 and a new database was established. Scale samples were received from 5 European countries, Canada and the USA. The scale samples in the new database were interpreted using an image processing system. As the original database had been interpreted manually, comparisons were made with both manually and computer interpreted data sets from 1987 which were chosen randomly from the overall database. The two sets of results were compared by pairwise T-test and it was established that there were no significant differences between the results generated by the two methods.

Subsequently, the 1990 homewater database was compared to unknown scales in the 1989 scale samples from West Greenland by the original discriminant function. Misclassification and error rates were estimated for data from the same smolt class as in Greenland in 1989. Significant differences were noted between the data collected at Greenland and homewaters which may be due to the inclusion of new rivers samples which were not in the original database. It was also noted that some scale characters from samples from northern Norway and Finland showed more affinity to scales from North American than to other European scales. Differences were also noted between scales collected from the same rivers in 1985 and 1990. The Working Group felt that the addition of the circuli spacing variables from the digitised scales should add much to the discriminating power of the technique.

Neural Networks

The Working Group previously reported (Anon., 1992a) that neural networks seem to provide a better discrimination of European and North American stocks on the basis of length and scale characteristics than discriminant analysis. However, uncertainty was expressed about some aspects of the operation of neural networks. In particular, the following potential difficulties were raised:

a) the system of grouping data employed in the previous study might affect the classification process.

b) the misclassification rates and the error rates for the trained network may vary significantly depending upon when the network is considered to be adequately trained.

c) the misclassification and error rate might be affected by the sequence in which the training records were presented.

Further investigation of this technique has shown that good discrimination of stocks can be achieved with some neural networks without grouping the data; this, therefore, overcomes the first difficulty.

The investigation also showed that when a network was trained several times on the same dataset, the neural weightings may vary very considerably between runs. However, the variation in misclassification rate (13%) was very small between runs. The error rate was more variable, although it could be stabilised by training the network for longer periods.

The Working Group felt that this approach was useful and that this technique and other discriminatory techniques should be used to examine the groups of fish that are misclassified and whether they represent particular stocks or national groups.

Otolith Morphology

The usefulness of otolith shape to discriminate the origin of salmon caught in mixed stock fisheries was described to the Working Group. The method utilises Fourier descriptors of otolith shape for stock identification. These models were tested for:

1) North American and European continent of origin.
2) United States and Canada country of origin.
3) Ireland and United Kingdom country of origin

The discriminant function developed to identify continent of origin classified otoliths more efficiently than the function used to identify country of origin.

The method may be useful for establishing training sets for other discriminant analyses rather than as a standard sampling element. This is due mainly to the ease of scale sampling compared to otolith sampling. However, it is apparent that these new techniques involving the use of digitising and computer-based technologies should be developed further.

Genetic Algorithm

An alternative approach based on Artificial Intelligence procedures is to use Genetic Algorithms. These begin by formulating a set of rules based on the data presented to assess the predictive capabilities of these data. Data from fish of known origin were used to develop rules for distinguishing between North American and European salmon based on scale measurements (circuli counts). The variables used were scale parameters (CSIW and CS1S, i.e., circuli counts for winter and summer bands).

The original data were split into a training set and a test set. An initial rule might be that CS1W was equal to -20. Therefore, this would be evaluated as 'true' if CS1W was equal to -20 and false if it was greater. This rule has no predictive power as CS1W values must be positive. The rule would not, therefore, survive past the first generation but may adapt or mutate to become CS1W $\geq$ 6. Rules can also combine with other rules, e.g., CS1W >20 & LENGTH <66, implying that a fish can be identified as North American if it is less than 66 cm and the scale has more than 20 circuli. Each rule is tested against training data and, if it has better predictive power than previous rules, it will be retained. If it has only moderate predictive ability, it may be randomly mutated or combined with another rule.

The results obtained were not quite as good as those obtained by discriminant analyses or neural networks. The Genetic Algorithm has an advantage over neural networks in that it is easier to understand the basis on which the discrimination is being made. This may help in understanding the dataset that is being investigated and also aid in interpretation of stock differentiation. Development of these and other methods of stock discrimination are important to the development of accurate identifiers of stock composition for mixed stock fisheries.

5.1.3 Biological characteristics of the harvest, 1992

Biological characteristics (length, weight, and age) were recorded from samples of commercial catches from NAFO Divisions 1C, 1E and 1F in 1992 using the results of discriminant analysis to divide samples into North American and European components. A summary of these data is provided in Table 5.1.3.1. and Figures 3.4.4.6 and 3.4.4.7.

Analysis of Variance of mean fork lengths and mean whole weights of salmon separately by sea age, origin and NAFO division showed that virgin 1SW salmon of North American origin were significantly shorter and lighter than European origin salmon. The analysis also showed that there was a significant difference between Division 1E and Divisions 1C and 1F for fork length and between Divisions 1D and 1C, and Division 1E for mean whole weight when a division comparison was done. The 2SW virgin salmon of European origin were shown to be significantly lighter and shorter than North American origin salmon whereas this difference was only noted in weight when analyzed in 1991.

The division comparison showed that for mean fork length, Division 1C was significantly longer than Division 1E. For mean weight, in this analysis, Division 1C was significantly heavier than Divisions 1E and 1F.

Examination of Figures 3.4.4.6 and 3.4.4.7 shows a downward trend in mean length and weight for 1SW salmon of European and North American origin salmon in the West Greenland fishery. The reduction in the average weight is particularly evident for 1SW salmon of European origin. A number of hypotheses to explain this trend were considered by the Working Group including: shift in stock composition, gear changes, sampling dates, fishery opening dates. While these factors may explain some outlying points, the Working Group concluded that none of these factors explain the overall trend. It is probable that the trend reflects a real change in fish size. It was noted that the drop in average weight should be reflected in the weights of 2SW salmon returning to homewaters particularly in Europe in recent years and the Working group recommended that datasets be examined for any change in the average weights of returning salmon.

The sea age composition in 1992 (Tables 5.1.3.2 and 5.1.3.3) of 94.4% 1SW and 0.2% previous spawners was lower than 1990 and 1991 values. More MSW (5.5%) were recorded in 1992 than in the previous 6 year period.

The North American 1SW component was the lowest recorded in the period 1985 to 1992. On the other hand, the European 1SW component increased in 1992. Conversely, the North American 2SW component increased to the highest value recorded in this period while the European component decreased.

Figures 5.1.3.1 and 5.1.3.2 summarise some of the information in Table 5.1.3.4.

River age composition of European origin fish has shifted dramatically in recent years. River age 2 European fish typically composed 50-60% of the sample during the historical time series, whereas in 1992 the value is less than 40%. Simultaneously, the proportion of river age 3-8 European salmon has increased to 50%. Trends in age composition of North American origin salmon are not as evident.

5.1.4 Historical data on tag returns and harvest estimates

There are three main methods for estimating the harvest of USA-origin salmon in the fishery at West Greenland (Anon., 1989a). One of these methods, the proportional harvest model (updated in Section 5.1.1) provides estimates for the current fishery year. Two other approaches, the Carlin tag harvest model and the CWT harvest model, rely on the fraction of tags in the homewater run in the following year.

Carlin tag method

The parameters in the Carlin tag harvest model for 1SW salmon remain as reported in the previous assessment (Anon., 1992a). The 2SW harvest estimates were not updated this year as there were no 2SW tags (Maine-origin) returned from the fishery in 1992. All 1SW returns in year i are raised to harvest estimates with the ratio of tagged to untagged 2SW returns in homewaters in year i + 1 (RATIO). RATIO values are shown in Table 5.1.4.1. For 1992, the estimates of tags and run size were 28 tags and 1,888 fish, respectively. The relatively low numbers of tags in the run resulted in the 4th lowest RATIO parameter used in the harvest model time series (RATIO for 1992 = 0.0150). This means that each tag reported accounts for a large number of fish. Only harvest for an assumed passage efficiency of 85% is presented.

Over the time period there has been a considerable number (96) of tags returned for which the year of capture is unknown. These tags were presumably caught mostly as 1SW fish in the year following release. These tags were not developed into estimates of harvest, however, as they are assumed to form part of the pool of "unreported" tags for previous years and are already accounted for in the harvest estimate by the reporting rate factor.

The updated time series of tag returns from Maine-origin 1SW salmon in West Greenland can be found in Table 5.1.4.2. Tag returns (to date) for the 1992 fishery total 5 tags with the largest recovery occurring in NAFO Division 1E. The estimated harvest of 1SW salmon in West Greenland is summarized by year for 85% passage efficiency and is primarily distributed in NAFO Divisions 1C to 1E. This estimate of 1,871 fish in 1991 is about 23% higher than the estimate of harvest for 1990 (which was the highest recorded) and about 5% higher than the previous 10-year mean of 1,775 fish (Table 5.1.4.3).

CWT Method

In 1991, CWTs from USA-origin salmon, including fish from the Connecticut, Merrimack and the Penobscot Rivers, were recorded in West Greenland. Using the methodology in Anon. (1988a), the Working Group estimated harvests based on the CWT sampling programs at both West Greenland and in homewaters. Ratios of CWT-tagged to untagged 2SW salmon (RATIO) returning to the Connecticut, Merrimack and Maine Rivers in 1992 were 0.646, 0.367 and 0.318, respectively (Table 5.1.4.4).

As not all weeks or areas of the fishery were sampled, assumptions concerning the numbers of tags caught in those weeks and areas were again necessary (Anon., 1989a). In 1991, the Working Group recommended that the various stratification procedures of the CWT sampling be investigated (Anon., 1991a) and in 1992 (Anon., 1992a), three stratification strategies were considered, each producing different levels of harvest for the three stock groups (Maine, Connecticut, and Merrimack). In 1993, two post-stratification strategies were explored by stock:

1. stratification by area with no stratification over time.
2. stratification by area with stratification by standard week generally limited to a division between early and late segments of the fishery.

Deficiencies in the 1991 sampling program were readily apparent from the harvest estimates for all stocks. Use of either stratification scheme reveals under-sampling in NAFO Divisions E and F. Under scheme 1, only 1.3% of the catch was scanned in the southern strata whereas only 0.8% of the catch was scanned in the early season within Divisions E and F. Scheme 1 was selected as the best stratification strategy for all stocks because of these sampling problems and the lower estimated variance of this method.

Harvest estimates for the 1SW component of the three stocks for 1991 at West Greenland were 82 for Connecticut, 384 for Merrimack and 1,707 for Maine. Past estimates of harvest and the coefficient of variation are given in Table 5.1.4.5. Estimates for 1990 were revised in comparison to Anon. (1992a) as new data became available on the Greenland total harvest for that year. Estimates for all three stocks in 1991 were lower than those of 1990. The Maine estimate was the lowest in the five year time series. The various estimates of harvest are shown graphically in Figures 5.1.4.1.

The Working Group noted the continued divergence of Carlin and CWT estimates of US-origin 1SW fish harvested in West Greenland from the number estimated by the proportional harvest method and recommended that the causality of these differences be investigated.

5.2 Description of Homewater Fisheries

Tagging experiments have demonstrated that almost all countries listed in the national catch tables (Table 2.1.1) contribute salmon to the West Greenland fishery. However, stocks from these countries contribute to the fishery to differing extents, both because the proportion of MSW salmon in the stocks varies and because of differences in their migratory behaviour at sea.

For European salmon stocks, the relative contributions have not been estimated precisely, although MSW stocks from the UK, Ireland, and France are thought to contribute to the fishery at a higher rate than Scandinavian stocks. Additional information on fisheries in the north-east Atlantic is contained in Section 4.

For North American salmon stocks, most of the salmon that contribute to the West Greenland fishery are produced in rivers of eastern Canada, with the balance originating from a few rivers in the northeastern US. Additional information on the fisheries in the north-west Atlantic is provided in Section 6.

5.3 Stock Abundance and Exploitation at West Greenland

The Working Group first applied a continental run reconstruction model in Anon. (1991a). This model was improved in 1992 (Anon., 1992a,b) to provide estimates of stock abundance and exploitation rates at West Greenland for the period 1983 to 1990. One of the concerns of the Working Group was the difficulty in estimating numbers of returning 2SW salmon (R2) to North America. These concerns were addressed by the

North American Salmon Study Group (Anon., 1993a) and data were assembled for 1974 to 1992. Estimation procedures for R2 varied by Salmon Fishing Area (SFA) in Atlantic Canada and fishing zone in Quebec; details of the estimation are described in Anon. (1993a).

The data necessary for the run-reconstruction model can also be used to estimate pre-fishery abundance of the non-maturing 1SW cohort (N1) (i.e., the cohort destined to return as 2SW maiden spawners) for North American stocks. A summary of the model parameters and basic equations are provided in Table 5.3.1. It is important to distinguish the differences between the estimates of pre-fishery abundance and the outputs of the continental run-reconstruction model. The pre-fishery abundance estimator reconstructs the population by summing 2SW returns, and catches from fisheries on non-maturing 1SW salmon in Canada and Greenland, and 2SW salmon in Canada. This value represents the extant population and does not account for the fractions of the population present in a given fishery. In contrast, the continental run reconstruction model provides a range of feasible exploitation rates and fractions of the population present in Canada and Greenland. In turn, these exploitation rates provide an estimate of the total population abundance at West Greenland prior to the fishery. Of course, the population at West Greenland consists of both North American and European stocks. By assuming that the proportions observed in the catch are representative of the population, the size of the respective continental populations at Greenland can be estimated.

The data used to estimate prefishery abundance and to derive exploitation rates provide the basis for examining a broad array of questions on population status. Care was taken to document the derivation of these data in Appendix 4 of Anon., 1993b and Appendix 6 of this report.

5.3.1 Continental run reconstruction model

The continental run reconstruction model is based on the simple premise that the range of feasible exploitation rates and population parameters must be internally consistent with observed catches and returns to rivers. A graphical approach is used to examine the set of nonlinear equations for the model parameters (see Anon., 1992a).

Data from Table 5.3.1.1 were input to the topdown constraints model to provide estimates of exploitation rates in West Greenland, population abundance at Greenland, and the estimated fraction of the nonmaturing 1SW stock available to Canada (Table 5.3.1.2). Table 5.3.1.1(a) summarises the total catches in Greenland, region-specific catches of small and large salmon in Canada, and minimum and maximum estimates of the numbers of returning 2SW salmon to North America. These data are used to compute catch estimates by sea age (Table 5.3.1.1b) using the equations and parameters presented in Section 5.3.1 of Anon. (1992a). Estimates of pre-fishery abundance will be addressed in Section 5.4.1.

All runs of the model assumed that the fraction of the stock unavailable to any fishery was 30% (i.e., FU=0.3). In 1992 two values of FU (the fraction unaccounted for), 0.05 and 0.3, were used; however, the lower value was considered unrealistically small.

Exploitation rates at West Greenland have been variable, showing marked dips in 1983-84 and 1989 and peaks in 1981-82, 1987 and 1991 but no overall trend (Figure 5.3.1.1). The estimates of the exploitation rate at West Greenland are sensitive to the value of FU used; if a higher value of FU is chosen then a smaller proportion of the stock will be estimated to be available to the West Greenland fishery and the estimate of exploitation rate will be increased.

The estimated stock abundance of all origins at West Greenland has declined fairly steadily from about 1 to 1.5 million at the start of the period to only 200,000-400,000 at the end (Figure 5.3.1.2). The abundance of European and North American stocks have changed very much in line with each other, although European stocks were more abundant at the beginning of the period but less abundant at the end (Figure 5.3.1.3).

The average maximum and minimum exploitation rates for these stocks in Canada were 52% and 72%, and rates appear to have remained fairly stable after an initial decline in the 1970s (Figure 5.3.1.4). It should be noted that these exploitation rates refer to fisheries on maturing and non-maturing 1SW salmon in SFAs 3-7 in Newfoundland. Exploitation rates on the maturing and nonmaturing components of the 1SW cohort are assumed to be similar due to their comparable sizes and mixing within the fisheries.

The estimated proportion of non-maturing 1SW salmon returning from Canada for the years 1974-91 varied from a minimum of 1-4% to a maximum of 7-30% (Table 5.3.1.2) and appears to have increased slightly over the period (Figure 5.3.1.5).

5.3.2 Exploitation of Maine-origin (USA) salmon

Extant exploitation rates

A model to calculate extant exploitation rates of 1SW and 2SW Maine origin salmon was presented in Anon (1990a). The calculations were updated by including 1991 catch data for Greenland and Newfoundland and homewater returns for 1992 (Tables 5.3.2.1 to 5.3.2.3). The extant exploitation rates for 1SW Maine origin salmon in 1991 were higher than at any time for the period 1967-91, although similar levels had been recorded in 1971, 1975 and 1976. The extant exploitation rate for 2SW fish was estimated to be over 90% for all combinations of parameters; it was also one of the highest levels recorded since 1967, although it had been exceeded in 1969, 1978 and 1982.

Fishery area exploitation of 1SW Maine origin salmon at Newfoundland and West Greenland

Fisheries for non-maturing 1SW salmon of North American origin occur simultaneously in West Greenland and Canada. Estimates of exploitation rates in these fisheries depend on what proportion of the extant stock is thought to be vulnerable to each fishery. Estimates of exploitation rates are presented in Table 5.3.2.4; these are based on the assumption that the population of 1SW Maine origin salmon is available to only the Newfoundland and West Greenland fisheries (i.e., FU=0.). A monthly natural mortality rate of 0.01 was used in all cases. The same assumed levels of reporting were used as in 1992 (Anon., 1992a). Levels of P (the proportion of the stock migrating from Canada) of 0.1, 0.5 and 0.9 were evaluated.

The values for 1991 show that exploitation rates in both Canada and Greenland were among the highest estimated for any year since 1967. The exploitation in Canada was at about the same level between 1975 and 1983 but higher than between 1984 and 1990. The exploitation rate at Greenland has not been as high as the 1991 level since 1974.

The exploitation rates for the Maine stock at West Greenland and in Canada are plotted with the results of the Constraints model in Figure 5.3.2.1. For the Constraints model the mid-point between the minimum and maximum estimates is used. For the estimates on the Maine stock the results for P=0.1 are used, as this is the closest to the values of P derived from the Constraints model. The similarity between the estimates by the two independent methods is good, particularly since 1982. The results suggest that exploitation rates derived for Maine stocks do not deviate markedly from the overall magnitude and temporal pattern of exploitation rates for the aggregate North American stock complex.

5.3.3 Numerical contributions of salmon stocks to the fishery and exploitation of individual stocks

The Working Group has previously noted the incidence of various stocks in the West Greenland fishery. Quantification of the contributions of specific stocks has been possible only for a few populations that have had significant tagging programs. For example, harvest estimates based on Carlin tags are presented in Sec. 5.1.3 for Maine rivers and have been presented previously for the Saint John River, New Brunswick (Anon., 1990b). Contributions of various European stocks to West Greenland in 1989 were derived using a run reconstruction model (Anon., 1992a). Genetic techniques are able to discriminate the stocks of North America and Europe, as well as to distinguish variation among individual fish. However, the identification of individual stocks has proven elusive, owing to the apparent variation among individuals within known stocks. Hence, decomposition of the entire catch at Greenland into specific stocks is likely to remain infeasible for the foreseeable future.

Nonetheless, the implications of mixed stock Atlantic salmon fisheries for lower productivity stocks (see Anon., 1992a) remain an important motivation in the search to distinguish stocks. A coarser degree of discrimination among stock complexes would partially satisfy the need to manage on a stock specific basis. Previously the Working Group (Anon., 1992a) recommended that run reconstruction models be applied to groups of stocks, particularly "northern" and "southern" stocks in North America.

The variation in smolt ages along latitudinal gradients has long been recognized in Atlantic salmon populations (Lear and Misra, 1978). Various management plans have also noted the higher smolt ages in northern regions and Anon. (1991a) demonstrated the relationship between the catch of river age 3+ salmon at Greenland and Labrador catches.

The Working Group considered the application of a maximum likelihood approach to estimate the relative contribution of northern and southern North American stock complexes to West Greenland. The approach utilizes composite information on the river age distribution of northern and southern stocks to estimate the contribution of each complex to the mixed stock fishery. The mixed stock fishery comprises proportions contributed by both stock complexes. Maximum likelihood estimation (MLE) allows estimation of the relative contributions to the fishery. The basic approach is shown conceptually in Figure 5.3.3.1.

The first application of MLE of discrete characters to distinguish fish stocks was done by Milner *et al.* (1981) and has been subsequently improved by Millar (1987, 1990) and Fournier *et al.* (1984). For the two stock problem the MLE is straightforward.

Consider two stocks consisting of A age classes with river age distributions (X_{N1}, X_{N2}, X_{N3}, ... ,X_{NA}) where X_{Ni} is the proportion of river age i in the northern stock. The similar distribution for the southern stock is (X_{S1},...X_{SA}). Let the contribution of the northern stock be P_N and the southern stock P_S where $P_N + P_S = 1$. If (Y_1, Y_2, ... Y_A) represents the river age frequency distribution in the mixture fishery then the relative proportions of northern and southern stocks can be estimated using the expectation maximization algorithm (see Millar, 1987) as:

$$P_N^{new} = 1/N \sum_{i}^{A} Y_i \, P_N^{old} \, X_{Ni}/(P_N^{old} \, X_{Ni} + P_S^{old} \, X_{Si})$$

Summary data for best available estimates of river age distributions by region are presented in Table 5.3.3.1. The geographic distribution of stock can be observed in Figure 3.3.1.1. The Division of stock between northern and southern complexes was determined by SFAs that had 50% or more smolts of river age 4 or greater, except in SFA4. Region-specific river age frequency estimates were weighted by their estimated production to derive a composite distribution (Anon., 1986c). To test the approach, the river age distribution of the North American component at Greenland was examined (i.e., Y_i) (Table 5.3.3.2).

The results suggest that the proportion of northern stock complexes at Greenland has declined greatly since 1974 (Figure 5.3.3.2). Analysis of the overall catches (Figure 5.3.3.3) of the stock complexes reveals that both groups have declined in abundance.

The Working Group considered the maximum likelihood approach to discrimination of the "northern" and "southern" stock complexes promising. If the approach can be successfully applied to pertinent North American fisheries, the continental run reconstruction model could be extended to address stock complexes. This might identify causes of the more rapid decline in northern salmon stocks. Before such a modelling exercise can be attempted several factors need to be considered: 1) actual sample sizes for the mixed stock fisheries are required to estimate the variance; 2) alternative weighting of the region-specific smolt age distributions should be investigated; 3) alternative groupings of SFAs into northern and southern stock complexes should be considered; 4) temporal variability in smolt age distributions could be important if the changes are large; and 5) differential exploitation of river age groups should be considered. The last point relates to the assumption in the model of equal contributions by various smolt ages within a stock complex. The Working Group recommends that these matters be investigated.

5.3.4 Relative importance of regulatory measures in the fishery and homewaters

Since the early 1970s both Canada and Greenland have imposed a variety of management measures designed to reduce fishing mortality on stocks. Greenland excluded foreign vessels in 1976 and reduced its quota in 1984 from 1,190 t to 870 t. In 1984, Canada introduced a series of sweeping reductions in fishing effort including license buy-out programs, season and regional closures, and quota restrictions. These efforts culminated in 1992 with the moratorium on commercial fisheries in insular Newfoundland, a license buy-back programme, and the imposition of quotas on recreational fisheries. In spite of these changes, population abundance of the MSW component of the stock has continued to decline (Table 5.3.1.1).

In the absence of information on stock status, one might conclude that the management measures have had no effect on the stock. Estimates of pre-fishery abundance, and numerous other indicators of stock status reveal that the restrictive management measures in Canada and, to a lesser extent, Greenland have coincided with a period of increasing marine mortality. Under these circumstances it is necessary to postulate what would have happened without such regulations.

The run-reconstruction model provides a context to address this issue. The pre-fishery abundance estimate is defined as

(1) $N1(i)=(R2(i+1)/S1+C2(i+1))/S2+C1(i)+G1(i)$

where the variables are defined in Table 5.3.1. Given a derived estimate of pre-fishery abundance, it is possible to rearrange Equation (1) in terms of R2(i+1) for postulated catches in the fisheries. Thus

(2) $R2^{*}(i+1)= [(N1(i)-G1(i)-C1(i))\ S1-C2(i)]\ S2$

The Working Group considered the following three scenarios to project the effects of regulations on returning 2SW salmon:

1. What if the quota at West Greenland had remained at 1,190 t?
2. What if Canada had not restricted fishing effort in the Newfoundland-Labrador commercial fishery?
3. What would be the combined effects of 1) and 2)?

Scenario 1. Effects of 1,190 t Greenland Quota

The Working Group projected what the catch of North American salmon might have been at Greenland in year i by dividing the quota of 1,190 t by the mean weight of salmon caught in year i and multiplying the result by the observed proportion of salmon of North American origin. In years in which the quota was not attained, it was assumed that sufficient numbers of salmon were not available to the fishery. Therefore, the 1,190 t would not have had any effect.

The projected value of the Greenland catch ($G1^{*}(i)$) was computed as

$$(3)\quad G1^{*}(i) = \begin{cases} P_{na}(i)\ Q\ /W(i), & \text{if } G1(i) < Q(i) \\ G1(i), & \text{if quota in year i not attained} \end{cases}$$

where the quota in year i is denoted as Q(i). The projected effects on 2SW returns is then

$$(4)\quad R2^{*}(i+1) = [(N1(i)-G1(i)-C1(i))\ S1-C2(i)]\ S2$$

Projected effects of a 1,190 t Greenland quota are shown in Figure 5.3.4.1. As the quota was limiting on catches only in 1985-1988, the projected consequences suggest that about 50,000 North American salmon were saved per year between 1985-1988. Similar numbers of European origin salmon would also have been saved, but their subsequent fate can not be evaluated.

Scenario 2. Effects of effort reductions of the Newfoundland-Labrador Commercial Fishery in Canada

Using the data in Table 5.3.1.1, the overall exploitation rate on North American 2SW salmon in the Newfoundland-Labrador commercial fishery can be estimated as:

$$(5)\quad U2(i+1) = C2(i+1)\ /\ [(N1(i)-G1(i)-C1(i))S1]$$

where the denominator represents the abundance immediately prior to the 2SW fishery. Estimates of U2 in Figure 5.3.4.2 reveal a progressive decline in the exploitation rate from over 0.5 in the 1975 return year (i.e., the 1974 Greenland fishery year) to less than 0.2 in the 1992 return year. The Working Group asked what would have happened to 2SW returns if exploitation had been equal to the average of the 1975-1978 period ($U2^{*}=0.44$). The numbers of 2SW returns can be written as:

$$(6)\quad R2^{**}(i+1) = (N1(i)-G1(i)-C1(i))\ S1(1-U2^{*})\ S2$$

Results of this scenario (Figure 5.3.4.3) show that the effort reductions have saved about 50,000 salmon destined to be have been 2SW returns per year since 1985 and almost 60,000 salmon in 1992. Conversely, without effort restrictions, actual 2SW returns would have been reduced by 50,000 salmon per year.

Scenario 3. Cumulative Effect of Quotas and Effort Reduction

The cumulative projection scenarios 1 and 2 can obtained by substituting $G1^{*}(i)$, from Equation (1) into Equation (6) as follows:

$$(7)\quad R2^{***}(i+1) = (N1(i)-G1^{*}(i)-C1(i))\ S1(1-U2^{*})\ S2$$

The penalty for a high quota and high effort (Figure 5.3.4.4) suggests that an additional 70,000 2SW salmon (an increase of about 20,000) salmon would have been harvested in 1985-1988. The effects of both scenarios are not additive because the exploitation rate $U2^{*}$ is removing a fixed fraction of a smaller number returning from Greenland.

Overall, the scenarios suggest that substantial savings of 2SW returns to home river areas of North Americas have occurred as a result of regulatory measures in the Newfoundland-Labrador commercial fishery. Additional benefits to spawning populations would also have resulted from the prohibition on retention of large salmon in most Canadian angling fisheries, season and daily baglimit reductions for angling in Quebec, Labrador and Maine, closures of the Caspé, N.B., N.S. and PEI commercial fisheries and reduction in the commercial fisheries of Quebec. The benefits of the reduced quota are intermittent and related to the availability of salmon at Greenland. Substantial reductions in harvest occurred in Greenland between 1972-1976 as a result of quota regulations; this time period, however, cannot be assessed using this methodology. In years when the stocks are low, a fixed quota will result in increased exploitation.

5.3.5 Relationship between the abundance of grilse and multi-sea-winter salmon in the returns to homewaters and its effects on the management of the fisheries

The Working Group was unsure of the intent of this question; thus, three different responses were considered. One response dealt with the utility of estimates of the population size of grilse returns to homewaters in predicting or forecasting the population size of 2SW salmon returning the following year. The second response considered the effects of changing the grilse:multi-sea-winter salmon ratio in the spawning population on production of MSW salmon. The third response considers how fisheries in homewaters can be manipulated to account for differences in relative abundances of grilse and multi-sea-winter salmon.

Application of Grilse returns to forecast 2SW salmon returns

A review of techniques to forecast returns of 2SW salmon were reviewed at the Workshop on Salmon Assessment Methodology held in 1992 (Anon., 1992d). Linear regression techniques for predicting 2SW catches from 1SW catches in the previous year have been tested for the rivers Tay and North Esk, in Scotland. When temporal trends in the 1SW and 2SW catch data were removed no correlations between the 1SW catches and 2SW catches of salmon derived from the same smolt year could be demonstrated. However, linear regressions are used to forecast returns of MSW salmon (log) from 1SW returns of the same smolt-class on the LaHave and the Liscomb rivers, Nova Scotia. Linear regression models were significant ($p<0.01$) for 30 of 43 rivers examined in Iceland (Anon.,1992d from Scarnecchia *et al.*, 1989a). Multiple regressions using 1SW salmon yield and sea temperatures in year i as X variables explained significant additional variation in only a few rivers. A multiple linear regression has been adopted on the Saint John River, New Brunswick to forecast MSW returns (log) in year i+1 from 1SW returns (log) and their mean fork length in year i. The coefficient for mean length is negative and is interpreted as an index of an earlier maturation of some salmon due to growing conditions at sea. Nonparametric approaches (probability distribution functions) for forecasting MSW salmon from 1SW returns are being used for the Miramichi River. However, for the Saint John River salmon stock nonparametric techniques were considered to be no more useful than parametric techniques. During some years predictions of MSW salmon from returns of 1SW salmon of the salmon smolt-class were not possible due to major changes in 1SW:MSW ratios (Anon., 1991a).

Effects of changing the grilse:multi-sea-winter salmon ratio in the spawning population on production of MSW salmon.

Results of studies reported by Naevdal (1983), Gjerde (1984) and Ritter *et al.* (1986) implicate genetic influence on sea-age at maturity. Progeny of grilse produce proportionately more salmon that mature as grilse than progeny from 2SW salmon (Piggins, 1974; and Ritter *et al.*, 1986). However, there is also evidence that environmental conditions can influence the sea-age at which salmon will first mature. Saunders *et al.* (1983) demonstrated an influence of low winter temperatures (1-2°) in postponing maturation of salmon held in sea-cages. Information provided in Scarnecchia *et al.* (1989b) and additional information provided to the Working Group (Section 3.4.4) for Icelandic rivers also demonstrated that climatic and oceanographic factors influenced the age at first maturity. The river environmental conditions also influence the age at first maturity (Scarnecchia, 1989b; Jonsson *et al.*, 1991). Hatchery rearing of salmon also affects the age-at-maturity which lends further evidence of the influence of the early rearing environment on first maturity. Selective fishing has an influence on the age of maturity of spawners which may have long-term genetic effects (Schaffer, 1974; Riddell, 1986). The Working Group was not aware of any studies that demonstrated that the increase in the number of grilse spawners in a river has resulted in a genetic shift to earlier maturation, or grilsification of the stock. However, concern was expressed that this may occur.

Manipulation of Fisheries to account for differential abundance

The Working Group noted that situations may arise where the abundance of multi-sea-winter salmon stocks may be low while the grilse stocks may be high, compared to the average (or vice-versa). In these situations, fishery managers may consider options to adjust the harvest pressure on the sea-age category needing additional protection. Where these two sea-age categories are mixed in a fishery, options may include a change in mesh size for gill nets, or in the case of non-lethal fisheries (i.e. trap-nets and angling), regulations to prohibit retention of the sea-age category needing protection. When the grilse and MSW stocks are not mixed temporally, fisheries can be regulated by opening and closing seasons of the fisheries to reduce exploitation of the sea-age needing protection. Examples of these possibilities were noted in Canada's management actions since 1984 to reduce exploitation on MSW salmon stocks.

5.4 Advice on Catch Levels at West Greenland

The Working Group was asked to propose and evaluate methods to estimate possible catch levels based upon maintaining adequate spawning biomass. The problems of estimating the total allowable catch (TAC) for salmon have been examined by the Working Group (Anon., 1982, 1984, 1986, 1988a). 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 application of TACs to mixed stock fisheries are still relevant. In principle, reductions in catches in mixed stock fisheries provided via an annually adjusted TAC would reduce mortality on the population as a whole. However, benefits that might accrue to particular stocks would be difficult to demonstrate, in the same way that detriments to individual stocks are difficult to identify.

The Working Group considered how the predictive measures of abundance outlined in Section 5.3 could be implemented to give annual catch advice. The aim of advice would be to limit catch to a level that would facilitate achieving overall spawning escapement equivalent to the sum of spawning targets in individual North American and European rivers (when the latter have been defined). To achieve the desired level of exploitation for a given level of predicted abundance either a TAC could be fixed or some form of effort limitation introduced.

Although a TAC would limit total catch, it would concentrate the fishing mortality on the stocks in the fishing area up to the time when the various boat quotas are filled. If different stocks enter and leave the fishery area at different times, this could increase the risk of certain stocks being more heavily exploited than others.

Effort limitation would, in theory, provide a greater range of options for management, such as season length restrictions, regulating number of boats or licences or close periods in the fishery. However, it was felt that the diversity of boat types and sizes and their large numbers would make effort limitation difficult in practice, particularly because no reliable data exist on the relationship between effort and exploitation in the fishery.

The advice for any given year is dependent on obtaining a reliable predictor of the abundance of non-maturing 1SW abundance for North American stocks prior to the start of the fishery in Greenland.

Prediction of this pre-fishery abundance of 1SW salmon destined to return as 2SW salmon is difficult. Clearly, such predictions could have wide prediction intervals and it would be important to proceed cautiously by using the lower range of predicted abundance levels for management decisions. Further analysis of the error structure of the N1 abundance estimates might provide a means of imputing error bounds on the projections. In turn, these error bounds could be incorporated into the catch advice and expressed in terms of the likelihood of achieving spawning targets. Some portions of the stock will receive excess numbers of spawners while others will be underseeded. However, the above approach could provide improved safeguards, particularly if applied to smaller geographical groupings of stocks (stock complexes) as suggested by the Working Group in 1988 (Anon., 1988a).

5.4.1 Estimating the pre-fishery abundance of non-maturing 1SW salmon prior to the fishery

The method described in Anon. (1992a) was used to estimate the pre-fishery abundance of non-maturing 1SW salmon of North American origin prior to the 1993 fishery at West Greenland. The Working group used this time series as the basis for forecasting the pre-fishery abundance relevant to 1SW fisheries in Canada and Greenland in 1993 and the 2SW salmon fishery in Canada in 1994. Two main methods were examined, the first utilising a univariate time series model and the second being a regression model based on environmental information.

The first method, involving examination of a univariate time series, was a Holt exponential smoothing model with linear trend and no seasonality (Holt, 1957). The time series was too short to consider a Box-Jenkins model. The final model had an R-square value of 0.521, Bayes Information Criterion (BIC) of 154,000 and a forecast error of 139,100 (Koehler and Murphree, 1986). Figure 5.4.1.1 shows the observed pre-fishery abundance of North American 1SW salmon at Greenland and the predicted values with 25% and 75% confidence limits derived using this method. This method provided estimates of pre-fishery abundance of approximately 280,000 fish in 1992 and approximately 260,000 in 1993 (Figure 5.4.1.2). In order to show a range of estimates of pre-fishery abundance in 1993, forecasts were made of low, mid and high estimates.

The second method examined involved the use of a regression analysis to predict the pre-fishery abundance of non-maturing 1SW fish prior to the start of the fishery using information on catch rates and sea surface temperature (SST) obtained from research vessels fishing in the Labrador Sea from 1965 to 1991 (Reddin and Shearer, 1987), in the Irminger Sea in the 1970s (Møller Jensen and Lear, 1980), and in the Grand Bank area in 1979 and 1980 (Reddin, 1985). These data were used to estimate the area of winter habitat available to salmon in the north-west Atlantic. Most of the fishing consisted of repetitive surface sets at single stations using drift gill nets about 3 m in depth. Catch rates (CPUE) were expressed as numbers of salmon caught divided by the product of net length in nautical miles and the length of time the nets were in the water:

CPUE = number of salmon caught/(length of nets*hours fished)

The relationship between (CPUE) and SST was examined by ANOVA to test the hypothesis of no effect of SST on catch rate.

A plot (Figure 5.4.1.3) of mean values for SSTs grouped by rounding to the nearest °C showed that catch rates were significantly related to SST ($F=3.34$, $P=0.0006$). This result indicates a curvilinear relationship for salmon and SST. Furthermore, salmon are found at sea in water with SSTs between 3 and 13°C and the peak in abundance occurs between 7 and 8.5°C.

The significant relationship for SSTs and salmon catch rates suggested that salmon modify their movements at sea depending on SST. This relationship also suggested that habitat area in the north-west Atlantic should be weighted to catch rate and SSTs. Also, Saunders (1986) has reviewed the thermal biology of Atlantic salmon in the sea phase and stated that for adult salmon in the sea, there is a preference for areas with SSTs between 4° and 12° C, with an optimal range of 4° to 8° C.

The area used to determine available salmon habitat encompasses the north-west 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 (Figure 5.4.1.4). The total area is 5.36 x 10^6 km^2 and includes all the known locations at sea for salmon of North American origin. The area of overwintering habitat (January-April) for salmon in the study area was determined from Comprehensive Ocean-Atmospheric Data Set (COADS). This information, issued by the National Centre for Atmospheric Research at Boulder, Colorado, USA consisted of two datasets. The first is "in situ" SST data extending up to 61° N from 1970-1981. It was derived from sea surface temperatures recorded by ships of opportunity, land observations, and sea ice limits. The second dataset is "blended" data extending from 1982-1993 (up to January 1993). These data were derived from a blend of "in situ" and satellite data. The combined dataset consists of monthly mean SSTs for 2° squares over the northwest Atlantic up to 61° N. The area of overwintering habitat was determined for the months of January to April when the available area was at a minimum. The area of each two degree square was calculated at its mid-point by multiplying its length by its width. The length (L) was determined for every two degrees of latitude by the formula:

L (length) at x° N = cosine x° * 111.1 km

where x is mid-latitude of a 2° square.

The overall area was then summed from the areas of the individual 2° squares as described in Friedland and Reddin (1993). A relative index of the area suitable for salmon was developed by weighting the area at each temperature group by the catch rate for the same temperature group from the research vessels. A number of relationships of habitat and pre-fishery abundance estimates was tried but those with March values of habitat proved the best. Figure 5.4.1.5a shows the predicted values for pre-fishery abundance by this method and the observed abundance for 1974-1991. The predicted values appear to fit observed data quite well except during the period of low abundance in the late 1970s. Abundance was positively correlated with the weighted areas of habitat in March (Figure 5.4.1.5b).

In an attempt to investigate whether the use of spawning stock information would provide predictions which fitted the pre-fishery abundance estimates better, estimates of 2SW spawners in North America for the years 1974-1992 were developed from the estimates of 2SW returns (R2) to North America (Table 5.3.1.1) by subtracting harvests of 2SW salmon which occurred in or near the rivers in the various commercial, recreational and native food fisheries (see Appendix 6). For Newfoundland and Labrador, only in-river harvests in recreational fisheries were subtracted as catches of 2SW salmon are accounted for in the estimates of catches of 2SW salmon in Canada (C2). Details of the calculations for the Scotia-Fundy, Gulf and Newfoundland Regions of Canada and for the USA are shown in Appendices 6.1, 6.2, 6.3, and 6.4 respectively. Estimates of 2SW spawners ranged from a low of 34,000 to a high of 218,000 over the period 1974-1992; the average for this period has been between 66,000-148,000 and there has been a general decrease over time in the estimates (Table 5.4.1.1 and Figure 5.4.1.6).

As has been previously shown, there are relationships between the pre-fishery abundance (N1) and environmental variables reflecting winter habitat in the North Atlantic. Abundance of the N1 (recruitment) would also be expected to vary as a result of variability in spawning levels (stock). Stock-recruitment relationships were examined by fitting Ricker functions of the form R=a*S*exp(-bS) to estimates of stock (the spawner estimates above) and recruitment (the N1 lagged by 5, 6, or 7 years). While there appeared to be a general tendency for recruitment to increase with increasing stock levels, no significant relationships were found. This could be related to the wide variability in the productivity and smolt ages of the numerous stocks contributing to these estimates and the uncertainty inherent in the estimates of spawning stock. Walters and Ludwig (1981) have demonstrated that relatively small measurement errors (σ_v = 0.2) can transform a true linear stock-recruitment curve into one which appears to show very little relationship between spawning stock size and recruitment. Thus, spawning information was not included in the regression using environmental variables.

The pre-fishery abundance for 1992 was estimated by the regression method to be about 300,000 fish, compared with 275,000 fish predicted by the univariate time series analysis method (Figure 5.4.1.2). No prediction could be made for the 1993 pre-fishery abundance as 1993 March SST data will not become available until May 1993.

The Working Group felt that in the absence of March 1993 SST data, any advice given from this meeting should be based on the univariate analysis method. Nevertheless, it was felt that the prediction based on environmental data was likely to be more soundly based in biology, incorporating as it does data describing the state of the ocean at a time when fish are known to be there. Therefore, it was decided that the Working Group Chairman will communicate the 1993 forecast based on March environmental data to ACFM prior to its meeting in May (pending the availability of data) and recommend that this be examined prior to the formulation of a decision on catch advice (R-square, BIC and forecast error will also be reported).

The Working Group noted the annual fluctuations in the estimates of abundance of salmon at West Greenland (Table 5.3.1.2) and examined the levels of these values relative to the mean between years.

Year i	Year i + 1	
	Low	High
Low	9	1
High	2	5

This indicated that most years when abundance was estimated to be low were followed by years when abundance was again low and most years when abundance was high were followed by years when abundance was again high. In 1990 and 1991, the values were the lowest in the time series of pre-fisheries abundance. Thus, some sort of qualitative assessment of the likely level of pre-fishery abundance of 1SW fish at Greenland for a current year could be obtained from knowledge of the preceding year's abundance estimate. Thus, the Working Group recommends that until March environmental data are available, the forecast used in the provision of catch advice will be approximately 260,000 salmon (50% estimate Table 5.4.1.2).

5.4.2 Development of models to set catch quotas in relation to stock abundance

The Working Group adapted the advice given in Anon, (1992a) on setting catch advice at West Greenland. In the absence of March 1993 SST data, the Working Group employed the univariate time series analysis prediction of pre-fishery abundance of 1SW salmon prior to the start of the 1993 West Greenland fishery.

To achieve the spawning management goal, a pool of fish must be set aside prior to fishery allocation in order to meet spawning targets and allowing for natural mortality in the intervening months between the fishery and spawning migration. The Working Group identified 193,306 fish as the spawning target. Thus, 219,132 pre-fishery abundance fish must be reserved (196,306/exp*(-.01*11)).

When the management decision of selection of the pre-fishery abundance level upon which to base allocation is made, this abundance minus the spawning reserve is the pool of fish available for allocation (Table 5.4.1.2). Subsequent to this, when the Greenland allocation is agreed, the quota can be computed. First, the number of European 1SW salmon to contribute to the quota is estimated:

$$E1SW=\frac{NA1SW}{PropNA}-NA1SW$$

Where:

NA1SW = the Greenland allocation of pre-fishery North American 1SW salmon

and

PropnNA = the proportion of the total number of 1SW fish at West Greenland which is of North American origin.

The quota is then computed by:

$$Quota = (NA1SW*WT1SWNA+E1SW*WT1SWE)*ACF$$

Where:

E1SW = the Greenland allocation of pre-fishery European 1SW salmon

WT1SWNA = mean weight of North American 1SW salmon at Greenland

WT1SWE = mean weight of European 1SW salmon at Greenland

and

ACF = age correction factor multiplier to account for multi-sea-winter salmon in the catch.

The data necessary to perform the quota calculations are based on the following forecasts:

Parameter	Value	25-75% confidence limits
PropnNA	0.540	0.477 - 0.603
WT1SWNA	2.525	2.406 - 2.643
WT1SWE	2.660	2.510 - 2.810
ACF	1.121	1.070 - 1.172

These forecasts were performed with exponential smoothing techniques. The fishery allocation to North America can be harvested in 1SW fisheries in 1993 or in 2SW fisheries in 1994. It must be remembered that natural mortality will reduce the numbers of fish reserved for 2SW fisheries, thus the allocation must account for this.

This procedure can be expressed graphically. Allocation of pre-fishery abundance salmon can be determined in respect to the advice on pre-fishery abundance forecasts by selecting a forecast value from the probability density function (PDF) of pre-fishery abundance (Figure 5.4.2.1). Translating vertically from this estimate level and observing where the line intersects the allocation curve pairs for various allocation schemes, the allocation can be read on the Y-axis. This figure uses the univariate forecast to develop the PDF. A worked example based on the mean estimate (50th percentile) is illustrated below:

	Allocation to Greenland (%)					
	0	20	40	60	80	100
	Allocation in number of fish					
Greenland	0	7,739	15,478	23,218	30,957	38,696
North America	38,696	30,957	23,218	15,478	7,739	0

By using the PDF of the pre-fishery abundance, the probability that the true stock abundance is greater or lower than the reference point can be estimated. The probability level associated with the reference point provides a measure of the probability of reaching escapement targets given alternative allocations among fisheries. The probability levels associated with the reference point can be classified into broad categories termed "chance neutral", "chance averse", and "chance high". The mean estimate of the forecast represents a reference point at which there is a 50% chance that the true abundance is lower than required to achieve the spawning target given no overfishing of the actual allocation. This level is termed the "chance neutral" forecast. Likewise, the forecast value at the 25th percentile, or the value with a 25% chance that the abundance is lower, is the "chance averse" forecast. The forecast value at 75th percentile, or the value with a 75% chance that the abundance is lower, is the "chance high" forecast.

5.4.3 Assessment of risk of not achieving management objective of adequate spawning biomass

In order to assess the risk of not achieving the management objective of adequate spawning, the Working Group reviewed the PDF of pre-fishery abundance (Figure 5.4.2.1). It can be seen that if a conservative approach to protecting returns to homewaters were to be adopted for 1993, no catches of potential 2SW salmon could be permitted in either Greenland or Canada. Even if the "chance neutral" scenario were to be adopted, the catch allowances would be small and would result in either very low allowable catches in Greenland or Canada or no allocation to one or other of the countries and a small permitted catch in the other. Adoption of a high risk approach, i.e., assume the 75th percentile of the forecast of 350,000 fish would probably mean that the numbers of 2SW salmon returning to North American homewaters in the year following the fishery would be insufficient to meet target spawning requirements.

The Working Group recommends using as the basis for catch advice a pre-fishery abundance estimate below the 50th percentile.

It must also be noted that basing catch advice on estimated stock abundance of Canadian non-maturing 1SW fish may carry with it additional risks of over-exploiting particular stocks or stock complexes that are more vulnerable than the average, for example because they have lower productivity. This will have the effect of increasing the risks for certain stocks at all levels of catch, while decreasing the risks for others. In the long term catch advice for the mixed stock fisheries should be based upon the stock complexes that are most vulnerable.

5.5 By-catch and Mortality of Salmon in Non-Directed Fisheries

The only other fisheries likely to catch salmon in West Greenland are those where gill nets are set for arctic charr. However, these nets are set in the fjords at a time of year when salmon are either not present or in very low abundance. It is thought that by-catches of salmon are of negligible proportions.

5.6 Effects of the NASCO Tag Return Incentive Scheme on the Assessment of Fisheries

At the 1988 Annual Meeting of the North Atlantic Salmon Conservation Organization the Council resolved to establish a lottery for tag returns in each of the Commission areas. The objectives of the lottery were to encourage the reporting of tag recoveries and to improve the quality of recapture information. Tag recoveries in distant-water fisheries are used to describe the distribution of various stocks and, more importantly, to estimate the number of salmon harvested in the fishery. Such estimates of harvest are inversely proportional to the value of reporting rate employed in the model. Previous analyses (Anon., 1992d) have demonstrated that harvest estimates are highly sensitive to reporting rate.

The Working Group considered a direct estimator of reporting rate in the West Greenland fishery, based on comparison of Carlin and coded-wire tag recoveries in West Greenland for the period 1987 to 1991 (Table 5.6.1). An error analysis approach was developed to estimate the variance of the reporting rate estimate. Details on the estimation methodology are provided below.

Define the following variables:

H_E = Harvest estimate based on recovery of external (E) Carlin tags

H_I = Harvest estimate based on recovery of internal (I) coded wire tags

R = total number of fish returning to Maine rivers $R = N_E + N_I + N_U$

N_E = Number of Externally tagged salmon returning to Maine rivers

N_I = Number of Internally tagged salmon returning to Maine rivers

N_U = Number of Untagged salmon returning to Maine rivers

P_I = N_I/R = Internally tagged proportion of the run

P_E = N_E/R = Externally tagged proportion of the run

T_E = Total number of Carlin tags voluntarily reported by fishermen

T_I = Estimated number of coded-wire tags taken in fishery

r = Reporting rate for external tags

Summary data for the pre-lottery and lottery periods are summarized in Table 5.6.1. Harvest estimates in the fishery include both tagged and untagged groups of fish. The harvest methodology used by the Working Group (Anon. 1992d) raises the number of tags recovered in the fishery by the ratio of the total run to the corresponding tagged group of fish. Hence

(8) $H_E = (T_E/r)\ (R/N_E)$, and

(9) $H_I = (T_I)\ (R/N_I)$

Equation 9 is an unbiased estimator of the harvest because of the optimal sampling properties of the CWT sampling programme in Greenland. If Equations 8 and 9 are valid measures of harvest then $H_E = H_I$ and, therefore,

(10) $r = (T_E P_I)/(T_I P_E)$

Assuming that T_E and T_I are independent, and recognizing the covariance between P_E and P_I, the variance of r can be approximated as

(11) $V(r) \approx V(T_E)\ (P_I/(T_I P_E))^2 + V(P_I)\ (T_E/(T_I P_E))^2 + V(T_I)((-T_E\ P_I)/(T_I^2\ P_E))^2 + V(P_E)\ ((-T_E\ P_I)/(T_I\ P_E^2))^2 + 2\ Cov(P_I,\ P_E)\ (T_E/(T_I P_E))\ (T_E\ P_I)/(T_I\ P_E^2)$

The variance of T_I is estimated directly from the sampling programme at Greenland. The numbers of internal N_I and external tags N_E enumerated in the returns R are assumed to be multinomially distributed with parameters R, P_I, and P_E. Under the multinomial model, the variance and covariance terms in Equation 11 are given by

(12) $V(P_E) = V(N_E/R) = R^{-2}\ V(N_E) = R^{-2}\ (R(N_E/R)(1-N_E/R))$

(13) $V(P_I) = V(N_I/R) = R^{-2}\ V(N_I) = R^{-2}\ (R(N_I/R)(1-N_I/R))$

(14) $Cov(P_E,\ P_I) = -\ (N_E\ N_I)\ R^{-3}$

Finally, the number of external tags recovered can be viewed as the outcome of a Poisson process in which the probability of encountering a tagged fish is very low. If this assumption is appropriate then the variance of T_E is equal to T_E. i.e.,

(15) $V(T_E) = T_E$

The confidence interval for the proportion r is computed using the logistic transformation as recommended in Burnham *et al.* (1987). The upper and lower limits for r, r_U and r_L, respectively, were computed as

(16) $r_L = r/(r + (1-r)C)$

(17) $r_U = r/(r + (1-r)/C)$

where

(18) $C = \exp\ ((z_{\alpha/2}\ SE(r))/(r\ (1-r)))$

Direct comparison of harvest estimates from Carlin and CWT recoveries suggests a substantial increase in reporting rate during the NASCO lottery period (Table 5.6.2). Reporting rates in Greenland appear to have increased appreciably in 1989 to levels 2 to 3 times higher than evident in 1987 and 1988. The low numbers of Carlin-tagged 2SW salmon returning to Maine rivers and the low numbers recovered in Greenland result in high variability in the reporting rate estimate (Figure 5.6.1). The asymmetry of the confidence intervals (25-75%) follows from the logit transformation.

The Working Group noted that the validity of the reporting rate estimator (Equation 10) depends on the assumption that the migratory behaviour of tagged (CWT and Carlin) and untagged cohorts is similar. Differential migratory patterns among these groups would invalidate the use of the raising factor in Equations 8 and 9. Previous analyses of distributional differences among experimental batches of Carlin-tagged smolts revealed no apparent differences (Anon., 1989a). The relative homogeneity of smolt release times and smolt quality for Maine rivers do not suggest that major differences are likely.

These data suggest that the NASCO lottery scheme increased the Carlin tag reporting rates in the West Greenland fishery. The resulting estimate had wide confidence intervals; thus, the rate could not be shown to be statistically significant. The Working Group expressed concern about potential trends in reporting rates once the lottery stops, as fishermen may be less amenable to reporting tags than pre-lottery.

6 FISHERIES RELEVANT TO THE NORTH AMERICAN COMMISSION

6.1 Description of Fisheries in Canada

The following were new management measures for commercial fisheries in 1992:

1) A 5-year moratorium was implemented for the commercial fishery in insular Newfoundland. Fishing was permitted in Labrador (Salmon Fishing Areas (SFA) 1, 2 and 14B (Figure 3.3.1.1). Quotas in SFAs 2 and 14B were reduced from those of 1991 by 20 t in SFA 2 and 2 t in SFA 14B. Quotas for the Newfoundland and Labrador commercial fishery for 1992 and previous years are given in Table 6.1.1. SFA 1 had an allowance of 80 t, the same as 1990 and 1991; an allowance is an estimate of expected catch and not a limitation on allowable harvest. Monitoring of the quotas was conducted by Fisheries Officers who were in contact with buyers and fishermen on a weekly or daily basis.

   A voluntary commercial salmon license buy-back program was also implemented for fishermen in SFAs 2-14. Fishermen were allowed to apply for the buy-back until 31 December 1992.

2) In Quebec commercial fishing quotas were reduced in area Q 7 (Figure 3.3.1.1) by 52% (from 1809 to 875 fish) from 1991, commensurate with a reduction in a number of licences under a buy-back program. In Q 8 and Q 9, the quotas were reduced by 26% and 9%, respectively.

The following were new management measures for recreational fisheries in 1992:

1) The seasonal bag limit for the recreational fishery of Newfoundland-Labrador, Nova Scotia, and New Brunswick was reduced from 10 to 8 fish (SFAs 1-16, and 18-23). In Prince Edward Island (SFA 17), the seasonal and daily limits were reduced from 10 and 2 to 7 and 1, respectively. Most rivers of the inner Bay of Fundy (SFA 22 and parts of SFA 23) were not opened to recreational fishing for conservation reasons. As in previous years, large salmon could be retained as part of seasonal and daily limits only in Labrador (SFAs 1, 2, and 14B) and in Quebec.

2) Quotas for each SFA were introduced for the first time to the recreational fisheries of Newfoundland and Labrador. All rivers of each SFA were closed to retention of salmon after the quota in each SFA was reached. Some rivers of SFAs 11, 13 and 14 were managed by individual river quotas. The quotas by SFA were as shown in the text table in the next column.

3) There were minor changes in angling seasons relative to previous years.

A more detailed description of other aspects of the commercial fisheries was provided in Anon. (1985a).

SFA	Number of fish
1	442
2	2,160
3	1,300
4	4,800
5	2,000
6	200
7	40
8	0
9	600
10	200
11	1,700
12	600
13	5,000
14A	3,900
14B	1,100
Total	24,042

The total salmon landings for Canada in 1992 were 470 t (Table 2.1.2); these are the lowest recorded landings during the period 1960-92. The landings of small salmon (179 t) in 1992 were 48% below the 1991 landings (341 t) and 32% below the previous 5-year mean (565 t). The landings (291 t) of large salmon in 1992 were 21% below the landings of large salmon in 1991 (370 t) and 48% below the previous 5-year mean (606 t). Of the total Canadian landings by weight, 35% were in Quebec, 46% in Newfoundland and Labrador and 19% in the Maritime Provinces. The recreational fisheries harvested 42%, commercial fisheries 51% and the native food fisheries 7% of the total landings by weight (Table 6.1.2).

The decline in total commercial landings from 1,596 t in 1987 to 242 t in 1992 was influenced by the closure of the fisheries in SFAs 3-14A. Catches increased in SFAs 1 and 2 from 1991; but were lower than catches in 1987-1990 (Table 6.1.1). There was no commercial catch applied to the quota in area Q 11 in 1992. Landings in Newfoundland and Labrador of 168 t were the lowest recorded for the period 1910-1970 (May and Lear, 1971) and 1971-1992 (Table 6.1.3). Landings in 1991 and 1990 were the second and third lowest, respectively. In Newfoundland and Labrador, the number of licensed commercial fishermen decreased from 3,130 in 1991 to 406 primarily due to the licence retirement program. A detailed description of the commercial, recreational, and native fisheries, in 1992, is provided in Anon. (1993a).

The landings in the commercial (in weight), and angling fisheries (in numbers) in 1992 by SFA and comparisons to the mean landings 1987-1991 are provided in Tables 6.1.4, and 6.1.5, respectively. Historical commercial and recreational landings are presented in Figure 6.1.1.

The commercial landings of small and large salmon, by weight, declined from the mean landings in 1987-1991 throughout Labrador SFAs 1, 2 and 14B (Table 6.1.4.). Landings in SFAs 1 and 2 in 1992 were below the allowance but the quota was caught in SFA 14B (Table 6.1.1). However, low abundance of salmon also appears to be a contributing factor, particularly in SFAs 1, 2 and 14B. Severe ice conditions along the northern Labrador coast may also have been a contributing factor.

The landings of small and large salmon in Q7 and Q8, Quebec, decreased from the mean landings 1987-1991, but increased in Q9 (Table 6.1.4). The catch declines in Q7 and Q8 may be related to the reductions in quotas and removal of fishing licences.

The recreational landings of large salmon in SFA 1, 2 and 14B were substantially above the 1987-1991 mean (Table 6.1.5). The recreational landings of large salmon declined below the 1987-1991 mean landings in Q7 and Q9 through Q11; whereas, increases were noted in all other areas (Table 6.1.5). The landings of small salmon were below the 1987-1991 mean landings in SFAs 1-2, 4-7, 9-14, 19-21, Q7 and Q10-Q11 (Table 6.1.5). Increases in recreational landings of small salmon occurred in SFAs 3, 15-16, 18, 23, Q1-6, and Q8-9.

Recreational catches of salmon in Newfoundland and Labrador were above the quotas in all SFAs except 2, 5 and 14B. Quotas were exceeded in SFAs by between 2 to 34% (Table 6.1.6.)

6.1.1 Composition and origin of the catch

During 1992, salmon of Canadian and USA origin were captured in the fisheries of Newfoundland and Labrador as evidenced by recaptures of tagged 1SW salmon from both countries. Salmon with coded wire tags (CWT) were recovered during sampling at five commercial fishing ports in SFAs 1, 2 and 14B. Samplers scanned over 12,000 fish (about 26% of the total catch in Labrador) for the presence of adipose fin clips and CWTs. Of this sample, 51 fish had adipose fin clips and 19 fish had CWTs (Table 6.1.1.1). Overall, the frequency of tagged salmon in scanned samples was 0.2% in 1992 compared to 0.7% in 1991.

Eighteen of the 19 CWTs recovered were from USA rivers; one was from Canada. All USA origin tags came from 1991 releases in the Penobscot, Connecticut and Merrimack rivers. The Canadian origin tag was from a 1991 release in the Saint John River. The lower recovery of Connecticut River origin tags in 1992 than in 1991, may in part reflect lower tag releases in the Connecticut River. The differences in numbers of recoveries among river systems do not necessarily imply differential exploitation because of the differences in relative numbers of tags at large, and the location and time of sampling.

Eleven Carlin tags from Maine-origin salmon were reported from Canada during 1992. Five of these tags were returned with information on date of recovery; of these five tags one was recovered from the 1991 fishery and four were from the 1992 fishery. The other six could not be assigned to a specific year. Two tags were reported from SFAs where salmon fishing is prohibited by the moratorium. These tags, recovered in SFAs 3 and 6, were reported as taken by non-salmon gear and by recreational gear, respectively. Estimates of harvest of USA-origin salmon captured in the 1992 fisheries will not be available until after the 1993 returns to homewaters.

6.1.2 Historical data on tag returns and harvest estimates.

Carlin-based estimates for Canada

The Working Group updated the time series of tag returns and harvest estimates of Maine-origin 1SW and 2SW salmon in Newfoundland and Labrador. Tag returns for Maine-origin 1SW salmon can be found in Table 6.1.2.1. There were seven tags returned in 1992 from fisheries prior to 1992, but only one of these tags could be assigned to the fishery in a specific year due to incomplete recovery information.

Neither the structure of the harvest model nor its parameter values were changed from the previous assessment in Anon. (1992a). Updated values and the new data for the 1991 run size used to calculate the RATIO parameter can be found in Anon. (1993a). Estimates for tags and total run size of 2SW salmon to Maine rivers, using a fishway efficiency of 85%, are presented in Table 5.1.4.1. For 1992, the estimates of tags and run size were 28 tags and 1,888 fish, respectively. The relatively low number of tags in the run resulted in the RATIO parameter being the third lowest in the harvest model time series (RATIO for 1992 = 0.0150).

Estimated harvests of 1SW salmon in Newfoundland and Labrador are summarised by year for 85% fish passage efficiency in Table 6.1.2.2. The total harvest of 1,425 Maine-origin salmon in the 1991 fishery occurred primarily in SFA 3. The 1991 harvest estimate is higher than the 1990 estimate, and is the second highest harvest since 1986. Updated values for 1SW:2SW ratios and ratios of harvest to run size of 2SW salmon are presented in Table 6.1.2.3. The grilse to salmon ratio in homewater returns for the 1990 smolt class is 0.159; this ends the trend of relatively high grilse returns that began in 1986.

Detailed summaries of the tag returns and harvests for 1SW and 2SW salmon in mainland Canada (Anon., 1990b) are not presented in this assessment since there were no new tag returns for these areas and age groups.

CWT-based estimates for locations sampled

The Working Group considered, for areas where catches were sampled, harvest estimates of Maine-, Merrimack-, and Connecticut-origin stocks in Newfoundland and Labrador derived from CWT-tagged salmon. In addition, Maine-origin salmon were also tagged with Carlin tags. Estimates based on Carlin tags for the 1991 fishery were calculated identically to the methods used in other reports of Carlin-derived harvest estimates (Anon., 1987; Anon., 1990a). CWT harvest estimates were computed identically to the methods used in Anon. (1990a). To compute the harvest with CWT data, the following tag raising factors were used:

Stock	Tags	Run	Raising factor
Maine rivers	601	1,888	3.139
Merrimack	61	166	2.721
Connecticut	310	480	1.548

The estimated number of tags for sample strata in the fishery was first raised for non-catch fishing mortality (Anon., 1989b) and then raised to total harvests for the strata. Comparative harvest estimates of Maine-origin salmon based on CWT and Carlin tag recoveries were calculated for the Statistical Sections and Salmon Fishing Areas sampled. The CWT-based estimates ranged from 0 fish in some areas to a total of 417 salmon in SFA 3 (Table 6.1.2.4). Coefficients of variation for SFA estimates were 7 and 4% suggesting these estimates have high precision. The ratio of harvest estimation methods (Carlin/CWT) was consistently less than 1.0 for the Statistical Sections and SFAs where harvests occurred. Previous comparisons of Carlin and coded wire tag harvest estimates generally indicated coded wire tag estimates were greater than Carlin estimates (Anon. 1990a, 1991a, 1992a). This reversal would be consistent with the effect of Carlin tag reporting rates that are higher than the levels assumed in the Carlin harvest model. The Working Group also stressed that although the precision of the CWT estimate is high (i.e., low CV), the precision of the Carlin estimate is probably very low, thus it is unlikely that the means of the two harvest estimates are significantly different.

Estimates of harvest of Connecticut- and Merrimack-origin salmon are provided in Table 6.1.2.4. A total of 593 Connecticut-origin and 140 Merrimack-origin salmon were harvested in SFAs 3 and 4 during the period of the commercial fishery sampled in 1991.

As previously noted in Anon. (1989b), potential sources of bias in the harvest model include the scanning samples of landings that have not been sorted by size category and incompatibilities between the scanning samples and catch statistics. These potential sources of bias are more problematic for the community level harvest estimates than the pooled estimates for Statistical Sections or SFAs. The bias affecting the estimates for Statistical Sections or SFAs are related to the representativeness of the sampling sites.

6.2 Description of Fisheries in the United States of America

The Maine rivers provide the only legal sport fishery for Atlantic salmon in the USA. The sport catch (number of fish killed) of Atlantic salmon in 1992 was as follows:

River	Number of Atlantic salmon				Total for 1992	Total for 1991
	1SW	2SW	3SW	PS		
St. Croix	1	(grilse only)			1	2
Dennys	1	4	0	0	5	7
East Machias	0	6	0	0	6	5
Machias	0	3	0	0	3	2
Pleasant	(catch and release only)				0	0
Narraguagus	2	15	0	0	17	22
Union	0	0	0	0	0	0
Penobscot	48	105	0	0	153	192
Ducktrap	0	0	0	0	0	0
Sheepscot	2	4	1	0	7	4
Kennebec	0	0	0	0	0	4
Saco	0	0	0	0	0	0
Other (Marine)	0	1	0	0	1	0
Total	54	138	1	0	193	238
(1991 Total)	(48)	(185)	(1)	(4)	(238)	

Recreational catches of Atlantic salmon were about 19% lower in 1992 than in 1991. The decreased catch was attributed to smaller runs of salmon, a reduction in the season catch limit per angler, and a 17% reduction in license sales. The estimated number of salmon caught and released in Maine rivers exceeded the number caught and killed by a margin of 2:1. This was attributed to the reduction in 1992 of the season limit from 5 to 1 fish per angler.

The average exploitation rate (6.8%) on combined age classes in the Penobscot River for 1992 was lower than for 1991 (11.5%). Estimates are based upon the fish passage efficiency (0.85) and reporting rate (0.80) used by the Working Group in previous years. Exploitation rates for hatchery and wild salmon in the Penobscot River were:

	Hatchery	Wild
1SW	0.16	0.30
2SW	0.08	0.17

These data contrast with previous observations, where exploitation rates on wild salmon were higher due to earlier run timing. The reasons for the change in 1992 were attributed to the new management measure enacted (reduction of season limit from 5 to 1) and a conscious effort by Penobscot River anglers to reduce the harvest of salmon caught early in the season.

6.3 Description of Fisheries in France (Islands of St. Pierre and Miquelon)

The catch of salmon for the islands of St. Pierre and Miquelon in 1992 was 1.3 t (Table 2.1.1). The most recent information on fishing effort is for 1989 when there were 13 professional and 37 recreational fishermen fishing for salmon. Tag returns from previous years indicate that salmon of Canadian and USA-origin have been caught in the fisheries of St. Pierre and Miquelon.

On 10 June 1992, an international Court of Arbitration in New York announced a boundary decision between Canada and France for the St. Pierre-Miquelon area. The new French zone is shown in Figure 6.3.1. The area is a key-hole shape with a 10.5 nautical mile (the width of the southern exposure of the islands) corridor projecting due south for 200 miles.

6.4 Evaluate the Effects of Quota Management Measures and Closures Taken in 1991 and 1992 in Newfoundland-Labrador Commercial Fisheries.

6.4.1 Effects on Canadian stocks and fisheries

The Newfoundland and Labrador commercial Atlantic salmon fishery was under quota management in 1990 and 1991. The quotas in 1991 were set by SFA (Table 6.1.1 and Anon., 1992a). The fishing season began on 5 June and closed in each SFA when the quota was reached or on 15 October. In 1991, quotas were attained in eight SFAs (3, 5, 6, 7, 8, 9, 10, 11, and 13) with corresponding closing dates ranging from 29 June to 23 September. A preliminary evaluation of the effects of the quota management measures for 1990 and 1991 was reported in Anon. (1992a).

1991 Quota Management Measures

The quantities of large and small salmon affected by the early closure of the fisheries in 1991, owing to quota management measures, were evaluated by applying the closure date in each SFA in 1991 to the temporal distribution of the landings in each SFA and year, for 1984-1989. This allows for an estimation of the amount of landings which would not have been caught had similar closing dates been in effect (1984-1989). Minimum, maximum, and mean percentages of the landings were calculated and applied in a similar manner to the landings in each SFA for 1991.

The estimated total mean weight of small and large salmon that were not caught in 1991 due to early closure of the fisheries is summarized in Table 6.4.1.1. With respect to small salmon, this estimate was 21 t (about 12,600 fish) while for large salmon it was 9 t (2,500 fish).

Minimum and maximum effects of the quota were estimated by examining the temporal distribution of the total landings, 1984-1989, for SFAs closed in 1991 and selecting the year of lowest (1989) and highest (1985) landings that would not have been caught and applying the percent of these landings to the total harvest in 1991. Results are:

The estimated average numbers of small (12,600) and large (2,500) salmon not caught in 1991 are about 70% less than the estimated numbers not caught in 1990 (Anon., 1992a). The quota had the greatest effect in reducing numbers of small salmon caught in SFAs 10, 11 and 13, while the largest reduction in number of large salmon caught occurred in SFA 11 (Table 6.4.1.1).

1992 Commercial Salmon Fishery Moratorium

In 1992, a five-year moratorium was placed on the commercial Atlantic salmon fishery in insular Newfoundland while in Labrador, 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 and Labrador. It is noted that in July a two year moratorium was also placed on the Northern Cod Fishery affecting SFAs 1-9. This measure should have eliminated by-catch in cod fishing gear in these SFAs. Recreational fishery quotas were also introduced in each SFA for the first time. After the quota was reached in each SFA, hook-and-release fishing only was permitted.

The exploitation of salmon in the commercial fisheries in Newfoundland, prior to 1992, has been estimated on several occasions and is shown below:

Stock	Exploitation rate		Years of study	Reference
	1SW	MSW		
L. Codroy	0.48	0.75	1954-1963	Murray (1968)
Sandhill	0.38	0.90	1968-1972	Pratt *et al.* (1974)
Western Arm	0.65	-	1978	Chadwick *et al.* (1985)
Exploits	0.60	-	1989	Anon. (1990a)
Conne	0.03	-	1989	Anon. (1990a)

The low exploitation on the Conne River stock is related to the early run timing of this stock compared to other Newfoundland stocks (Anon., 1990a). Thus, in 1992, with the commercial fisheries closed, the escapements of grilse to rivers in insular Newfoundland should increase by 61% to 186% and MSW salmon by 300% to 900% above the escapement that would have occurred if there was a fishery.

The only data available to evaluate the effects of the closure of the commercial fisheries were recreational catch statistics and the counts of salmon on several river systems. In a previous meeting the Working Group (Anon., 1990a) pointed out that exploitation rates in the recreational fisheries were significantly different among years and river systems. Thus, the interpretation of any comparisons of the angling catches in 1992 with those of previous years must be done with caution.

The catches in the recreational fisheries, in each SFA in 1992, were compared to catches in 1991, and the 1984-89 mean cumulative catches up to the date corresponding to the date the quota was reached in each SFA. Counts of salmon at fishways or counting fences in 1992 were compared with numbers of salmon counted in 1991 and the mean of numbers counted in 1984-1989. Ratios of returns of small:large salmon enumerated at fish counting facilities in 1992 were also compared with the ratios obtained in 1984-1989.

Recreational catch

The total recreational catch of small salmon (23,127) retained up to the date quotas were reached in each of the SFAs 3-14A in 1992 increased by 113% over 1991. On an individual SFA basis, the catch in 1992 relative to the catch at a similar date in 1991, increased for all SFAs except for SFA 14B. The overall increase in catch of small salmon, for all of insular Newfoundland, was 113% which suggests that the total abundance of small salmon was similar in 1992 to that in 1991 (Tables 6.4.1.2 and 6.4.1.3). Only SFAs 3,5, and 12-14A had higher catches of small salmon in 1992 than the mean catches in 1984-1989. The total catch of small salmon for insular Newfoundland was only 0.3% higher than the catch in 1984-1989. The variation in changes in catches from 1992 to 1991 and 1984-1989 among SFAs may be related to: 1) different commercial exploitation rates among stocks in previous years; 2) the fact that changes in abundance of salmon have varied among SFAs; and 3) the fact that exploitation rates in the recreational fisheries have varied among rivers and years. The recreational quotas in 1992 had the effect of eliminating angling catches in the latter part of the season and dramatically reducing angling effort during the hook-and-release component of the fishery.

In southern Labrador (SFAs 2 and 14B), where large salmon could be retained, the early closure appeared to have resulted in a disproportionate harvesting of small and large salmon relative to previous years. The earlier entry of large salmon into Labrador rivers resulted in the exploitation of these fish over much of the run, whereas only a portion of the small salmon run was exploited.

Fish counting facilities

Counts of small and large salmon were available from monitored rivers in SFAs 4, 5, 9, 10, 11, and 14A, insular Newfoundland, while an index trap-net fishery occurred at Humber River, SFA 13. Counts of small salmon increased (12-376%) over 1991 at all except two counting facilities which showed a decrease (-51% -5%) (Table 3.3.1.1 and Table 3.3.1.3). In comparison to the 1984-1989 means, the numbers of small salmon counted in 1992 increased along the northeast and east coasts (SFAs 4-5), generally decreased along the south coast (SFAs 9 and 11) with Northeast River (SFA 10) the exception, and again increased in west coast Newfoundland (SFA 14A) (Figure 6.4.1.1, Table 3.3.1.1 and Table 3.3.1.3).

Except for Northeast Brook, Trepassey, counts of large salmon increased over 1991. In comparison to the 1984-1989 mean, increases occurred for all rivers except Biscay Bay River and Northeast Brook, Trepassey (SFA 9), and Conne River (SFA 11) (Figure 6.4.1.1, Tables 3.3.1.2 and 3.3.1.3). These rivers are located along the south coast of insular Newfoundland.

The closure of the commercial fisheries should have produced a noticeable decrease in the small:large salmon ratio in the rivers. Figure 6.4.1.2 summarises the ratio of small:large salmon at various counting facilities for the period 1984-89 in comparison with the ratios observed in 1992. For most rivers, there were substantial declines in the ratio, implying proportionately greater returns of large to small salmon in 1992 compared with 1984-1989. Rivers in SFAs 9 and 11 showed little or no change in these ratios, whereas rivers in SFAs 4, 5, 10 and 14A (not illustrated) did appear to benefit by the moratorium.

There were reports that there was an increase in the mean size of grilse in the rivers in Newfoundland, although no data were presented to the Working Group. This observation would be consistent with expectations since the commercial fishery selected for larger grilse.

6.4.2 Effects on USA stocks

The Working Group evaluated the effects of the 1991 quota regime on USA stocks harvested in the Newfoundland-Labrador fishery by determining the percentage of Maine-origin salmon that would not have been caught in previous fisheries had the closing dates observed in 1991 been in force (Table 6.4.2.1). The small numbers of salmon harvested and the variability in the percentage of harvest forgone makes it difficult to evaluate the closure. The mean percentage of 1SW Maine-origin salmon which would not have been caught in SFAs affected by the quota during the period 1984-1989, if the 1991 closure date were in force, is 16%.

The effects of the 1992 moratorium can be estimated directly. In SFAs 1-14a, affected by the moratorium, nearly 100% (i.e. some by-catch in other gears will still occur) of the harvest would be expected to be forgone. The average harvest in these SFAs during the period 1984-1989 was 763 salmon out of an average total harvest of 1,144 fish per year. Thus, within this base period, 67% of the harvest of Maine-origin salmon would have been forgone. The 1990 and 1991 years were not included in the base years because of the apparently more southerly distribution of the Maine-origin salmon in 1990 and 1991 (Table 6.1.2.1). The Working Group considered the harvest levels observed for Merrimack and Connecticut river origin salmon in areas sampled during recent fisheries (Section 6.1.2). Given the observed presence of Merrimack and Connecticut-origin salmon in Labrador (Section 6.1.1), the Working Group agreed that similar percentages of harvests as with Maine-origin stocks may have been forgone for these stocks as well.

6.5 By-catch and Mortality of Salmon in Non-directed Fisheries

By-catch of Atlantic salmon in non-salmon fisheries was examined by searching tagging, sea sampling, commercial catch, and research vessel databases.

USA

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 coastal by-catch of Maine stocks was estimated to average 10 salmon yearly and there were no reports of by-catch since 1988 (Table 5.3.2.1).

By-catch of Merrimack- and Connecticut-origin Atlantic salmon can not be estimated directly because of the lack of tag data. It is assumed that commercial and recreational fisheries for other species, close to and in these rivers, result in by-catch.

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 indicates that the catch of salmon in the offshore fisheries is negligible. Two percent of the tag returns in the Scotia Fundy region from 1966-1991 were returned from non-salmon gear; primarily, mackerel, herring, shad, cod, gaspereau, and bass. There is evidence that by-catch could occur in sea-run brook trout fisheries in Q9 and SFAs 1 and 2.

By-catch of juvenile and adult salmon also occurs in gaspereau and eel fishing gear in the Gulf Region and eel fisheries in SFA 3-14. The trap-nets and fyke nets used in these fisheries are of such a small mesh size that mortalities from meshing are considered to be minimal; but mortality of juvenile salmon are reported to be high in some rivers in SFAs 3-14.

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. Data were not available to estimate actual tonnage losses in by-catch fisheries. In the North American Commission area, landing of salmon by-catch is not permitted. Thus estimates of by-catch loss are partially addressed in the estimates of unreported catches, when these arise from illegal landings in non-salmon gear.

6.6 Effects of the NASCO Tag Return Incentive Scheme

6.6.1 Angler reporting rate in the Gulf Region, Canada

Data on tag recoveries were available for adult salmon in the Miramichi River for 1971-1975 and 1985-1991, and the Margaree River for 1987-1992. The analysis of the tag returns is given in Anon., 1993a. The effects of the lottery were not detectable in any of the datasets examined. While it was noted that there was a slight increase in recovery rates in the Miramichi River, these were not statistically significant. Thus, there was insignificant evidence to reject the null hypothesis that the lottery had no effect on tag recoveries. The Working Group noted that the sample sizes employed in both rivers would be able to detect only large increases in reporting rates of about 50% as statistically significant.

6.6.2 Reporting rates for Maine tags

Carlin-tagged Atlantic salmon have been released in Maine rivers since 1966 and recovered in the fisheries of Canada and Greenland, and within the rivers at traps and by anglers. Tag recoveries in distant fisheries were considered in relation to estimated counts of tag returns to Maine rivers. The results of the analysis suggest that the magnitude of the reporting rate change was less then the inherent variability in the historical relationship between fishery and homewaters.

7 PRODUCTION OF FARM SALMON

The production of farm salmon by several countries in 1992, as reported to the Working Group was 220,862 t (Table 7.1). This was some 15,849 t less than the confirmed total for 1991 (236,711 t) and reversed the trend which has been evident since records began in 1980 (Figure 7.1). Production decreased in Norway, UK (Scotland) and the Faroe Islands but increased in Canada, UK (Northern Ireland) and USA. Despite the reduction in 1992, farmed salmon production was 55 times the nominal catch of wild salmon in the North Atlantic area.

8 COMPILATION OF TAG RELEASES AND FIN-CLIP DATA FOR 1992

Data were provided by Working Group members on the prescribed form and have been compiled as a separate report (Anon., 1993 c). In excess of 1.84 million microtags (CWTs) and 0.33 million external tags were applied to Atlantic salmon released in 1992 (Table 8.1). In addition 2.32 million salmon were fin-clipped, 2.23 million with adipose finclip only. Thus more than 4.49 million marked fish were released.

9 RESEARCH

9.1 Progress on Data Requirements and Research Needs

The Working Group reviewed the requirements for future meetings (Section 11.3) and research programmes (Section 11.4) in Anon. (1992a).

1. Nominal catches by country (Table 2.1.1, Anon., 1992a) do not in themselves provide insight into their potential to contain intercepted salmon of another country. It was agreed that nominal catch of salmon reported by country would be more meaningful if the existing time series and future reporting could be separated into coastal and estuarine/freshwater components.

   No progress.

2. The Working Group developed and applied a continental run reconstruction model to estimate abundance of North American salmon at West Greenland. Abundance estimates for North American stocks were then used to define a range of estimates of pre-fishery abundance and exploitation rates. The interactive effects between abundance and exploitation rates at West Greenland were then modelled in relation to achievement of North American spawning targets. The Working Group recommended that: i) with the potential of the approach to interpret historical patterns of abundance and exploitation rates, the total return and catch data be assembled for fishery years prior to 1983, ii) further analyses be carried out to examine the different contributions of stocks from different areas to the West Greenland fishery, iii) future refinement of this approach should include assessment of the relative risks associated with errors in the prediction of pre-fishery abundance and application of the model to groups of stocks (e.g., river age 4 and older, and river age 3 and younger).

   Tasks largely completed; analyses now adopted as part of entire assessment.

3. The Working Group also examined information from Canada and West Greenland which may provide an estimate of pre-fishery and in-season abundance at West Greenland. The Working Group recommended that: i) 1SW data from fisheries, river counts and traps in Europe be examined for pre-season predictors, and, ii) all available daily catch data (by small and large boats) from the West Greenland fishery be examined with more rigorous statistical procedures, e.g. probability distribution functions for an in-season predictor.

   Minor progress made.

4. The identification of North American and European fish in West Greenland in 1991 was again hindered by the lack of a suitable test sample of fish of known origin and the high misclassification rates associated with the historical database used to form the discriminant function. As in earlier years, scale samples should be collected from 2SW salmon in

home-waters in 1992 and forwarded to D. Reddin, Canada.

Samples forwarded but analyses not complete.

5. The Working Group noted the importance of continuing the scientific research and monitoring in the Faroes fishery area and expressed an interest in seeing the results from the current research programme.

The Working Group welcomes the progress of the research programme at Faroes.

Results examined and again requested for the coming year.

9.2 Progress on Recommendations from 1992

1. If there is a requirement by ICES for the Study Group on North American Salmon Fisheries to meet in 1993, the Working Group encouraged national agencies to: consider the adoption of graphic methods to depict measures of central tendency, trends etc.; investigate stock-recruit relationships for naturally spawning fish in the Penobscot and Saint John rivers and examine forecast models for MSW salmon in an attempt to explain observed recent decreases in the numbers of MSW salmon and increases in the numbers of 1SW salmon returning to some Canadian rivers.

Considerable progress although new efforts are suggested for investigations of 1SW:MSW ratios.

The Study Group on the Norwegian Sea and Faroes Salmon Fishery should be renamed the Study Group on North East Atlantic Salmon Fisheries, thereby recognizing the discontinuation of commercial salmon fishing by Faroese boat owners within the Faroes EEZ through the 1993/94 season and the continuing need to collate information on homewater fisheries. The new Study Group should meet at ICES headquarters for 4 days immediately prior to the meeting of the Working Group on North Atlantic Salmon to compile relevant data including that from 1989 and 1990 smolt releases for the run reconstruction model.

Completed.

2. The Working Group concluded that the neural network analysis may offer an alternative to the discriminant analysis of separating stocks of North American and European salmon at West Greenland. The Working Group recommends that the neural network methodology undergo further testing using simulation data sets run parallel with discriminant function analysis. Specifically, the neural network should be evaluated with respect to its: i) sensitivity of classification success with respect to the order of input observations, ii) sensitivity of classification success to category boundaries applied to the input parameters, iii) ability to discriminate simulated samples drawn from underlying distributions with known parameters, iv) relationship to traditional statistical methods, particularly log linear models for categorical data.

Considerable progress, but analytical techniques are still evolving. Investigations should continue in parallel with other techniques to discriminate between stocks.

3. A considerable number of USA tags have recently been returned from West Greenland without year-of-capture data. Virtually all tags could be safely assigned a year of capture on the basis of smolt-release information. The Working Group suggested an investigation of the assumptions used to set non-reporting rates that would be violated if these tags were now used in the Carlin tag method of estimating Maine origin salmon at West Greenland.

Completed.

4. The Working Group noted that increasingly larger proportions of the landings at West Greenland are taken by boats smaller than 30 feet. The Working Group recommended that changes in fleet characteristics be considered as a means of adjusting non-catch fishing mortality for use in the proportional harvest model.

Some effort data provided but largely inadequate for analyses.

5. The Working Group endorsed a recommendation for a Working Group member, L.W. Stolte (not in attendance), to develop and implement a video/slide exchange program between interested parties in Atlantic salmon producing countries. The exchange could focus on techniques and installations for salmon culture, fish passage, harvest, juvenile stocking, etc. The content could be reviewed in the context of a scientific critique. Working Group participants volunteering to be the contact person(s) for their country are asterisked in Appendix 5 (Anon., 1992a).

Initial exchanges in the formative stages.

6. The Working Group noted recent declines in marine survival of Atlantic salmon. No data were formally tabled at the Working Group that related survival and causality, although it was apparent that several inves-

tigations were on-going. The Working Group encouraged these investigations, especially those that examined causality of survival patterns of stock complexes at large in the North Atlantic. Investigations should include the use of historical data to determine trends in stock status, comparability of trends between stocks of different river systems that can be ascribed similar migration patterns, and the examination of biological/environmental factors that could explain variation in abundance.

Considerable progress made. (See Section 3.4.)

7. The Working Group made considerable progress in efforts to analyze and present time series of data so as to identify trends descriptive of the status of stocks. Additional datasets were made available which had not previously been utilized. Much data remains to be examined. In addition to techniques used to examine/depict trend analysis in this report, the Working Group recommended consideration of the Lowess technique and the diagnostics of "route regression" to assist in the identification, grouping and testing of similarities/differences of trends in time-series data.

   Additional progress made using these and a non-parametric ratio test. (See Section 3.)

8. The Working Group examined the adequacy of the sampling programme at West Greenland and recommended that sampling be maintained within the 3 NAFO Divisions and that the duration of sampling within one or two of these locations be extended by one or two weeks.

   Low catches in 1992 dictated modification of the sampling programme to insure that sampling effort was not wasted in low catch areas.

9.3 Requirements for Future Meetings

1. The Working Group reviewed progress made to date on requirements stated previously (Anon. 1992a) and research needs and noted that 1SW data from fisheries, river counts and traps in Europe (and North America, along with environmental variables) be examined for pre-season predictors of stock abundance in West Greenland.

2. With respect to the country of origin of salmon in North-East Atlantic sea fisheries, the Working Group recommended that available information be used to estimate and tabulate the contribution of non-national origin stocks to national catches in the same way that the Faroese mixed stock fishery was currently being assessed.

3. The Working Group noted the significant contribution of ranched and farm fish to various fisheries and recommended the documentation of the numbers and stages of salmon escaping from fish farms or being released for purposes of sea-ranching.

4. The Working Group noted the variation between exploitation rates at West Greenland derived from the continental run reconstruction model and those based on Carlin tags. The Working Group recommended that the values derived from Carlin tags be re-investigated.

5. The Working Group noted the continued divergence of Carlin and CWT estimates of USA-origin 1SW fish harvested in West Greenland from the estimated numbers provided by the proportional harvest method and recommended that the causality of these differences be investigated.

9.4 Research Programmes

1. The identification of North American and European fish in West Greenland in 1993 was again hindered by the lack of a suitable test sample of fish of known origin and the high misclassification rates associated with the historical database used to form the discriminant function. In addition, recent scale collections from homewaters also had a high misclassification rate. The collection of otoliths and tissues for biochemical methods of establishing/verifying a test database are encouraged. As in earlier years, scale samples should be collected from 2SW salmon in homewaters in 1992 and forwarded to D. Reddin, Canada.

2. The Working Group noted the importance of continuing the scientific research and monitoring in the Faroes fishery area and expressed interest in annually reviewing the results from the research programme.

9.5 Potential Terms of Reference of Future Meetings

The Working Group reviewed the remit (Appendix 1), requirements for future meetings (Sec. 9.3) and recommendations (Sec. 10) as background to the concerns of managers and the scientific community. The Working Group noted that recent remits had benefited from the input of the NASCO Scientific Advisory Committee and that their input would be likely to increase given that a technique is now largely in place to provide catch advice for the West Greenland Commission Area and that most formerly significant sea fisheries of the North American and North-East Atlantic Commission areas were presently closed or restricted. The Working Group recognized that managers would be likely to continue to be interested in the description of events, catch, etc. in the remaining fisheries as well as descriptions of the stock status - the latter now having the potential to be addressed in more detail with respect to conservation.

The Working Group could now perhaps focus on questions based on investigations relevant to methodologies, causal mechanisms of stock dynamics, conservation, and man-induced threats to wild salmon stocks (e.g., transfers of parasites/diseases, ranching of salmon, acidification of rivers etc.). Examples of generic questions for which answers might be developed in the 1990s include:

1. Advise on target and critical spawning levels for Atlantic salmon stocks of the North Atlantic.
2. Evaluate biological and environmental variables which provide interpretation of trends of salmon abundance in the North Atlantic.
3. Evaluate recent changes in the abundance of wild, farm and ranched salmon at large and, where possible, indicate the impacts that these fish may have on the abundance of wild stocks.
4. Document grilsification, describe potential mechanisms and assess the impact that grilsification may have on stock abundance and future spawning requirements.

The Working Group noted that some of these questions could benefit from a syntheses of approaches and examination of available databases within topic-specific workshops.

9.6 Future Meeting

The Working Group recommended the acceptance by the Council of an invitation from Iceland to host the 1994 meeting. Regardless of the meeting site, the Working Group recommended that for the most thorough preparation of working materials, the date of the meeting be delayed until early-April.

The Working Group also noted that because techniques to provide catch advice for the sea fisheries in the Commission areas were now reasonably in hand, and because few sea fisheries remained for which advice might be offered, as the study groups on North American Salmon Fisheries and North East Atlantic Salmon Fisheries recommended (Appendix 4), future remits that focused on conservation and dynamics of wild and escaped (ranched) salmon stocks could be more profitably dealt with in plenary sessions of the Working Group. The Working Group recommended that if one or both Study Groups were not required to meet, the duration of the Working Group meeting be extended by 2 days to allow sub-groups to collate the usual catch records and assessment data.

10 RECOMMENDATIONS

1. The Working Group endorsed the recommendations of the Study Group on North American Salmon Fisheries and the Study Group on North East Atlantic Salmon Fisheries (Appendix 4).

   Additionally, the Working Group recommended the carry over of elements of recommendations from Anon. (1992a) specifically:

   i) collect samples to establish the reliability of the rDNA technique to identify salmon collected at Greenland as North American or European,

   ii) further test new analyses including new versions of neural networks, genetic algorithms, Fourier transformations of otolith outline shape etc., to discriminate between stocks of North American and European stocks at West Greenland,

   iii) investigate stock-recruit relationships for naturally spawning fish and forecast models for MSW salmon in an attempt to explain observed recent decreases in the numbers of MSW salmon and increases in the numbers of 1SW salmon returning to some Canadian (and European) rivers and

   iv) investigate the causality of survival patterns of stock complexes at large in the North Atlantic.

2. The Working Group was aware of several investigations to further assess the impact of ranched/escaped fish on wild stocks. The Working Group recommended that the Study Group on Genetic Risks to Atlantic Salmon stocks convene in 1994 to update techniques to identify the impact of ranched fish on wild stocks and assess recent laboratory-based and behavioural research.

3. The Working Group noted that the mean size of European fish in the West Greenland fishery was positively correlated with estimates of pre-fishery abundance. The Working Group recommended that the length distribution of 2SW salmon returning to homewaters in the following year be compared with the lengths of the same cohort for possible insight to global growth patterns (and implicitly, survival) for the North Atlantic. Additional insights may also be gained from analyses of lengths (and possibly sex ratios) of 1SW returns from the same smolt class, particularly in those stocks in which the proportion of 1SW fish has increased in recent years

4. The Working Group had previously encouraged the examination of forecast models for MSW salmon in an attempt to explain recent reductions in the num-

bers of MSW salmon and in some North American stocks, an increase in the numbers of 1SW returns. A review of Scottish catch data indicated that 'grilsification' may also have occurred in the north-east Atlantic. The Working Group recommended that, in addition to the analyses of lengths in home-waters, salmon:grilse ratios be examined with a view to explaining possible causality under scenarios of annually variable marine survival among non-maturing 1SW cohorts.

5. The Working Group encouraged the continued investigation of techniques to discriminate between stocks in the West Greenland Commission Area. The techniques all provide varying levels of error rates and the Working Group recommended that the techniques should be used to examine the groups of fish that are misclassified and whether they represent particular stocks or national groups.

6. With respect to the use of Fourier analyses of otolith shapes to distinguish between stocks, the Working Group recommended the collection of otoliths from fish in West Greenland and from mature 1SW salmon in homewaters (from stocks in which fish of the same smolt class can be assumed to have frequented West Greenland waters) as mature 1SW fish may provide a basis for discriminating continental origins.

7. The Working Group considered a maximum likelihood approach to discrimination of the northern and southern North American stock complexes and recommended that this matter be investigated further. In addition, consideration should be given to extending the continental run reconstruction model to address stock complexes and the cause of the more rapid decline in the northern North American stock complex. Factors to be considered before the undertaking of such an analysis are listed in Section 5.3.3.

8. The Working Group noted the considerable strides made in the identification of conservation targets for salmon stocks of the North Atlantic. The Working Group recommended that a workshop be convened to consider available stock and recruit data, methodologies and, where possible, their standardization, for the development of target egg and adult spawner requirements.

Table 2.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1992 (1992 provisional figures).

Year	Canada (5)	Den.	Faroes	Finland	France	East Grld.	West Grld.	Iceland	Ireland (1, 3)	Norway (4)	Russia	St. P & M.	Sweden (WC)	UK E&W	UK Scotland	UK N.I.(1,2)	USA	Others (6)	Total
1960	1636	-	-	-	-	-	60	100	743	1659	1100	-	40	283	1443	139	1	-	7204
1961	1583	-	-	-	-	-	127	127	707	1533	790	-	27	232	1185	132	1	-	6444
1962	1719	-	-	-	-	-	244	125	1459	1935	710	-	45	318	1738	356	1	-	8650
1963	1861	-	-	-	-	-	466	145	1458	1786	480	-	23	325	1725	306	1	-	8576
1964	2069	-	-	-	-	-	1539	135	1617	2147	590	-	36	307	1907	377	1	-	10725
1965	2116	-	-	-	-	-	861	133	1457	2000	590	-	40	320	1593	281	1	-	9392
1966	2369	-	-	-	-	-	1370	106	1238	1791	570	-	36	387	1595	287	1	-	9750
1967	2863	-	-	-	-	-	1601	146	1463	1980	883	-	25	420	2117	449	1	-	11948
1968	2111	-	5	-	-	-	1127	162	1413	1514	827	-	20	282	1578	312	1	403	9755
1969	2202	-	7	-	-	-	2210	133	1730	1383	360	-	22	377	1955	267	1	893	11540
1970	2323	-	12	-	-	-	2146	195	1787	1171	448	-	20	527	1392	297	1	922	11241
1971	1992	-	-	-	-	-	2689	204	1639	1207	417	-	18	426	1421	234	1	471	10719
1972	1759	-	9	32	34	-	2113	250	1804	1568	462	-	18	442	1727	210	1	486	10915
1973	2434	-	28	50	12	-	2341	256	1930	1726	772	-	23	450	2006	182	2.7	533	12746
1974	2539	-	20	76	13	-	1917	225	2128	1633	709	-	32	383	1708	184	0.9	373	11941
1975	2485	-	28	76	25	-	2030	266	2216	1537	811	-	26	447	1621	164	1.7	475	12209
1976	2506	-	40	66	9	<1	1175	225	1561	1530	772	2.5	20	208	1019	113	0.8	289	9536
1977	2545	-	40	59	19	6	1420	230	1372	1488	497	-	10	345	1160	110	2.4	192	9495
1978	1545	-	37	37	20	8	984	291	1230	1050	476	-	10	349	1323	148	4.1	138	7650
1979	1287	-	119	26	10	<1	1395	225	1097	1831	455	-	12	261	1076	99	2.5	193	8089
1980	2680	-	536	34	30	<1	1194	249	947	1830	664	-	17	360	1134	122	5.5	277	10080
1981	2437	-	1025	44	20	<1	1264	163	685	1656	463	-	26	493	1233	101	6	313	9929
1982	1798	-	865	54	20	<1	1077	147	993	1348	354	-	25	286	1092	132	6.4	437	8634
1983	1424	-	678	57	16	<1	310	198	1656	1550	507	3	28	429	1221	187	1.3	466	8731
1984	1112	-	628	44	25	<1	297	159	829	1623	593	3	40	345	1013	78	2.2	101	6892
1985	1133	-	566	49	22	7	864	217	1595	1561	659	3	45	361	913	98	2.1	-	8095
1986	1559	-	530	38	28	19	960	310	1730	1598	608	2.5	54	430	1271	109	1.9	-	9248
1987	1784	-	576	49	27	<1	966	222	1239	1385	564	2	47	302	922	56	1.2	-	8142
1988	1311	-	243	34	32	4	893	396	1874	1076	419	2	40	395	882	114	0.9	-	7716
1989	1139	-	364	52	14	<1	337	278	1079	905	359	2	29	296	895	142	1.7	-	5893
1990	911	13	315	59	15	<1	274	426	586	930	315	2	33	338	624	94	2.4	-	4937
1991	711	3.3	95	69	13	4	472	505	404	876	215	1	38	200	462	55	0.8	-	4124
1992	470	10	23	78	20	5	237	590	630	850	161	1.3	49	195	525	151	0.7		3996
5YM	1171	-	319	53	20	2	588	365	1036	1034	374	2	37	306	757	92	1	-	6162
10YM	1288	-	486	51	21	4	645	286	1199	1285	459	2	38	338	930	107	2	-	7241

5YM - 1987-1991 Mean

10YM - 1982-1991 Mean

1. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
2. Not including angling catch (mainly 1SW).
3. Includes only those catches sold through dealers
4. Before 1966, sea trout and sea charr included (5% of total).
5. Includes estimates of some local sales, and, prior to 1984, by-catch.
6. Includes catches in Norwegian Sea by vessels from Denmark, Sewden, Germany, Norway and Finland

Table 2.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1992 (1992 provisional figures).

S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). T = S + G.

	Canada (5)			Finland			France	Iceland	Ireland (1, 3)			Norway (4)			Russia	Sweden (W.C.	UK E.&W.	UK N.I. (1, 2)	UK Scotland			USA	Total (6)
Year	Lg	Sm	T	S	G	T	T	T	S	G	T	S	G	T	T	T	T	T	Lg	Sm	T	T	T
1960	-	-	1636	-	-	-	-	100	-	-	743	-	-	1659	1100	40	283	139	971	472	1443	1	7144
1961	-	-	1583	-	-	-	-	127	-	-	707	-	-	1533	790	27	232	132	811	374	1185	1	6317
1962	-	-	1719	-	-	-	-	125	-	-	1459	-	-	1935	710	45	318	356	1014	724	1738	1	8406
1963	-	-	1861	-	-	-	-	145	-	-	1458	-	-	1786	480	23	325	306	1308	417	1725	1	8110
1964	-	-	2069	-	-	-	-	135	-	-	1617	-	-	2147	590	36	307	377	1210	697	1907	1	9186
1965	-	-	2116	-	-	-	-	133	-	-	1457	-	-	2000	590	40	320	281	1043	550	1593	1	8531
1966	-	-	2369	-	-	-	-	106	-	-	1238	-	-	1791	570	36	387	287	1049	546	1595	1	8380
1967	-	-	2863	-	-	-	-	146	-	-	1463	-	-	1980	883	25	420	449	1233	884	2117	1	10347
1968	-	-	2111	-	-	-	-	162	-	-	1413	-	-	1514	827	20	282	312	1021	557	1578	1	8220
1969	-	-	2202	-	-	-	-	133	-	-	1730	801	582	1383	360	22	377	267	997	958	1955	1	8430
1970	1562	761	2323	-	-	-	-	195	-	-	1787	815	356	1171	448	20	527	297	775	617	1392	1	8161
1971	1482	510	1992	-	-	-	-	204	-	-	1639	771	436	1207	417	18	426	234	719	702	1421	1	7559
1972	1201	558	1759	-	-	32	34	250	200	1604	1804	1064	514	1578	462	18	442	210	1013	714	1727	1	8317
1973	1651	783	2434	-	-	50	12	256	244	1686	1930	1220	506	1726	772	23	450	182	1158	848	2006	2.7	9844
1974	1589	950	2539	-	-	76	13	225	170	1958	2128	1149	484	1633	709	32	383	184	912	716	1628	0.9	9551
1975	1573	912	2485	-	-	76	25	266	274	1942	2216	1038	499	1537	811	26	447	164	1007	614	1621	1.7	9676
1976	1721	785	2506	-	-	66	9	225	109	1452	1561	1063	467	1530	772	20	208	113	522	497	1019	0.8	8030
1977	1883	662	2545	-	-	59	19	230	145	1227	1372	1018	470	1488	497	10	345	110	639	521	1160	2.4	7837
1978	1225	320	1545	-	-	37	20	291	147	1082	1229	668	382	1050	476	10	349	148	781	542	1323	4.1	6482
1979	705	582	1287	-	-	26	10	225	105	922	1027	1150	681	1831	455	12	261	99	598	478	1076	2.5	6312
1980	1763	917	2680	-	-	34	30	249	202	745	947	1352	478	1830	664	17	360	122	851	283	1134	5.5	8073
1981	1619	818	2437	-	-	44	20	163	164	521	685	1189	467	1656	463	26	493	101	834	389	1223	6	7317
1982	1082	716	1798	-	-	54	20	147	63	930	993	985	363	1348	364	25	286	132	596	496	1092	6.4	6265
1983	911	513	1424	-	-	57	16	198	150	1506	1656	957	593	1550	507	28	429	187	672	549	1221	1.3	7274
1984	645	467	1112	-	-	44	25	159	101	728	829	995	628	1623	593	40	345	78	504	509	1013	2.2	5863
1985	540	593	1133	-	-	49	22	217	100	1495	1595	923	638	1561	659	45	361	98	514	399	913	2.1	6655
1986	779	780	1559	28	10	38	28	310	136	1594	1730	1042	556	1598	608	54	430	109	745	526	1271	1.9	7737
1987	951	833	1784	35	14	49	27	222	127	1112	1239	894	491	1385	564	47	302	56	503	419	922	1.2	6598
1988	633	677	1310	26	8	34	32	396	141	1733	1874	656	420	1076	419	40	395	114	501	381	882	0.9	6573
1989	590	549	1139	17	35	52	14	278	132	947	975	469	436	905	359	29	296	142	464	431	895	1.7	5086
1990	486	425	911	24	35	59	15	426	-	-	586	545	385	930	315	33	338	94	423	201	624	2.4	4333
1991	370	341	711	-	-	69	13	505	-	-	404	535	342	876	215	38	200	55	177	285	462	0.8	3549
1992	291	179	470	-	-	78	20	590	-	-	630	549	301	850	161	49	195	151	214	311	525	0.7	3720

5YM	606	565	1171	-	-	53	20	365	-	-	1016	620	415	1034	374	37	306	92	414	343	757	1	5228
10YM	699	589	1288	-	-	51	21	286	-	-	1188	800	485	1285	460	38	338	107	510	420	930	2	5993

S=salmon (2SW or MSW fish). G=grilse (1SW fish). T=S+G. Sm=small. Lg=large.

5YM - 1987-1991 Mean

10YM - 1982-1991 Mean

1. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
2. Not including angling catch (mainly 1SW).
3. Inludes only catches sold through dealers.
4. Before 1966, sea trout and sea charr included (5% of total).
5. Includes estimates of some local sales and by-catch, some fish in "Sm" column are non-maturing.
6. 0.08 t reported by Portugal not included in 1987

Table 2.2.1 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1992 are provisional. Some countries divide 1SW from MSW salmon based on weight.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW!		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,731
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,311
	1989	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	233,690	425	-	-	-	-	-	-	-	-	106,379	486	-	-	340,069	911
	1991	189,324	341	-	-	-	-	-	-	-	-	82,532	370	-	-	271,856	711
	1992	103,594	179	-	-	-	-	-	-	-	-	59,814	291	-	-	163,408	470
Faroe Islands	1982/1983	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/1984	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/1985	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/1986	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/1987	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/1988	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/1989	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/1990	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/1991	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/1992	16	-	7,611	-	837										8,464	31
Finland	1990	13,460	24	-	-	-	-	-	-	-	-	5,420	35	-	-	18,700	59
	1991																69
	1992																78
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
Iceland	1982	23,026	58	-	-	-	-	-	-	-	-	18,119	89	-	-	41,145	147
	1983	33,769	85	-	-	-	-	-	-	-	-	24,454	113	-	-	58,223	198
	1984	18,901	47	-	-	-	-	-	-	-	-	22,188	112	-	-	41,089	159
	1985	50,000	125	-	-	-	-	-	-	-	-	16,300	94	-	-	66,300	217
	1986	67,300	174	-	-	-	-	-	-	-	-	22,300	136	-	-	89,600	310
	1987	42,550	114	-	-	-	-	-	-	-	-	18,840	108	-	-	61,390	222
	1988	112,000	288	-	-	-	-	-	-	-	-	19,000	108	-	-	133,500	396
	1989	70,817	158	-	-	-	-	-	-	-	-	20,037	115	-	-	90,854	278
	1990	98,241	-	-	-	-	-	-	-	-	-	34,267	-	-	-	132,508	426
	1991	144,639	-	-	-	-	-	-	-	-	-	30,510	-	-	-	175,149	505
	1992	149,783	-	-	-	-	-	-	-	-	-	34,683	-	-	-	184,466	590

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW!		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330,558	1,079
	1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	194,785	586
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,600	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,153	630
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	150,580	301	-	-	-	-	-	-	-	-	94,624	549	-	-	245,204	850
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	34,015	-	8,370	-	3,517	-	169	-	-	-	-	-	821	-	46,892	161
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
UK (England & Wales)	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296
	1990	53,143	-	-	-	-	-	-	-	-	-	33,533	-	-	-	86,676	338
	1991	34,596	-	-	-	-	-	-	-	-	-	17,053	-	-	-	51,649	199
	1992		-	-	-	-	-	-	-	-	-		-	-	-		

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW!		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
UK (Scotland)	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	81,094	201	-	-	-	-	-	-	-	-	87,924	423	-	-	169,018	624
	1991	73,608	177	-	-	-	-	-	-	-	-	65,193	285	-	-	138,801	462
	1992	92,028	214	-	-	-	-	-	-	-	-	70,205	311	-	-	162,233	525
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
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

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

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

Scale reading: Faroe Islands, France, Russia, UK (England and Wales), USA and West Greenland.

Weight (split weight): Canada (2.7 kg), Finland (3 kg), Iceland (various spOlits used at different times and places), Norway (3 kg), UK (Scotland) (3 kg in some places and 3.7 kg in others). All countries except Scotland report no problems with using weight to catergorise catches into sea age classes. In Scotland, misclassification may be very high in some years.

In Ireland, catches are not divided into sea age classes.

Table 2.3.1 Guess-estimates of unreported catches in tonnes within national EEZs in the North-East and North American Commissions of NASCO. Unreported catches for West Greenland Commission are unavailable.

Year	Unreported catches		
	North-East	North American	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
Mean (1987-1991)	2,216	161	2,377

Table 3.2.1.1 Wild Smolt Counts and Estimates on various Index Streams in the NE Atlantic Area including juvenile index counts in the River Bush and River Nivelle catchments.

Year of count	France			Iceland		Ireland	Norway		Sweden	UK (N. Ireland)	UK (Scotland)		UK (N. Ireland)
	R. Nivelle	R. Oir	Bresle	R. Ellidaar	R. Vesturdalsa	R. Burrishoole	R. Imsa	R. Orkla	R. Högvadsån	R. Bush	R. N.Esk	Girnock Burn	R. Bush
	Juv.survey[4]	Estimate	Estimate	Estimate	Estimate	Total trap	Total count	Estimate	Partial count[1]	Total trap	Estimate	Total trap	Juvenile surveys[2]
1959									4,057				
1960									1,962				
1961									7,899				
1962									2,795				
1963									5,700				
1964									9,771		275,000		
1965									2,610		183,000		
1966									367		172,000		
1967									627		98,000	2,057	
1968									1,564		227,000	1,440	
1969									4,742		-	2,610	
1970									242		-	2,412	
1971									-		167,000	2,461	
1972									-		260,000	2,830	
1973									1,184		165,000	1,812	
1974									184	43,958	106,000	2,842	
1975									363	33,365	173,000	2,444	
1976									247	21,021	93,000	2,762	
1977									-	19,693		3,679	
1978									38	27,104		3,149	
1979									103	24,733		2,724	
1980						11,208			1,064	20,139	132,000	3,074	
1981						9,434	3,214		500	14,509	195,000	1,640	-
1982			1,860			10,381	736		1,566	10,694	160,000	1,626	-
1983			1,880			9,383	1,287	121,000	2,982	26,804	-	1,747	32.6
1984			1,250			7,270	936	183,000	4,961	30,009[3]	220,000	3,247	19.5
1985	850		2,550	29,000		6,268	892	173,000	4,989	30,518[3]	130,000	2,716	7.6
1986	6,500[5]	1,325	1,245	-		5,376	477	227,000	2,076	18,442	-	2,091	11.3
1987	11,800[5]	379	-	-		3,817	480	238,000	3,173	21,994	199,000	1,132	10.3
1988	9,950[5]	454	-	23,000		6,554	1,700	152,000	2,571	22,783	-	2,595	8.9
1989	6,658	858	-	22,500	14,642	6,563	1,194	-	882	17,644	141,000	1,360	16.2
1990	2,505[5]	817	-	24,000	11,115	5,968	1,822	323,000	1,042	17,133	175,000	2,042	5.6
1991	5,287	210	-	22,000	9,300	3,804	1,995	243,000	1,235	18,281	236,000	1,503	12.5
1992	3,452	678	690	-	-	6,926	1,500	262,534	1,247	10,006	-	2,572	13.0
Mean	5,875	674	1,579	26,167	12,879	7,169	1,339	213,645	2,383	23,264	175,600	2,320	13.8

[1] The smolt trap catch a part of the smolt run.

[2] Juvenile surveys represent index of fry (o+) abundance (number per 5 minutes electrofishing) at 137 sites, based on natural spawning in the previous year.

[3] These smolt counts show effects of enhancement.

[4] Estimate of the 0+ parr population size in autumn.

[5] Influenced by enhancement (fry releases).

Table 3.2.2.1 Wild adult counts to various rivers in the NE Atlantic area

	Scandinavia and Russia									
	Iceland	Norway	Sweden	Russia	Russia	Russia	Russia	Russia	Russia	Russia
Year	River Ellidaar	River Imsa	River Hōgvadsån	River Tuloma	River Varzuga	River Keret	River Ponoy	River Kola	River Yokanga	R. Zap. Litca
	Estimate	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap
1952				4800						
1953				2950						
1954			364	4010						
1955			210	4600				4855		
1956			144	4800				2176		
1957			126	4300				2949		
1958			632	6228				1771		1051
1959			197	6125				2790		1642
1960			209	10360				5030		2915
1961			229	11050				5121		2091
1962			385	10920				5776		2196
1963			217	7880				3656		1983
1964			390	4400			23666	3268		1664
1965			442	5600			12998	3676		1506
1966			375	3648			10333	3218		787
1967			90	9011			11527	7170		1486
1968			172	6277			18352	5008		1971
1969			321	4538			9267	6525		2341
1970			610	6175			9822	5416		2048
1971			173	3284			8523	4784		1502
1972			281	6554			10975	8695		1316
1973			100	9726			20553	9780		1319
1974			270	12784			24652	15419		2605
1975			138	11074			41666	12793		2456
1976			65	8060			44283	9360		1325
1977			49	2878			37159	7180		1595
1978			23	3742			24045	5525		766
1979			15	2887			17920	6281		700
1980			260	4087			15069	7265		548
1981			512	3467			11670	7131		477
1982		66	572	4252			9585	5898		889
1983		14	447	9102			15594	10643		1254
1984		32	629	10971			26330	10970		1859
1985		31	768	8067			38787	6163		1563
1986	2726	22	1632	7275	71562	2798	32266	6508	3212	1815
1987		9	1475	5470	137419	1986	21212	6300	3468	1498
1988		44	1283	8069	72528	2898	20620	5203	2270	575
1989	2921	83	480	8413	65524	2986	19214	10929	2850	2613
1990	1822	67	879	11594	56000	2520	37712	13383	3376	1194
1991	1881	43	534	7174	63000	690	21000	8500	1704	2081
1992	2917	70	345	5476	61300	-	26600	14670	5531	2755
Mean	2338	41	405	6665	77672	2313	21467	8471	2813	1629

Table 3.2.2.2 Wild adult counts to various rivers in the NE Atlantic area.

	Ireland, UK and France									
	Ireland	UK (E&W)	UK (E&W)	UK (E&W)	UK (NI)	UK (Scotl.)	UK (Scotl.)	France	France	France
Year	R.Burrishoole	R. Severn	R. Dee	R. Usk	R. Bush	R.N. Esk	Girnock (Dee)	R. Nivelle	R. Oir	R. Bresle
	Total trap	Counter	Counter	Counter	Total trap	Counter	Total trap	Trap estimate	Trap estimate	Trap estimate
1966							269			
1967							214			
1968							196			
1969							49			
1970							90			
1971							125			
1972							137			
1973					2614		225			
1974					3483		184			
1975					3366		121			
1976			1585		3124		164			
1977			4945		1775		115			
1978			4448		1621		38			
1979			2056		1820		82			
1980	832	3416	1802		2863		203			
1981	348	3884	4417		1539	9025	67			
1982	510	1875	848		1571	8121	73			
1983	602	1232	2942		1030	8972	63			
1984	319	1711	2960		672[1]	7007	106	180	274	98
1985	567	3257	5719		2443	9912	67	115	295	148
1986	495	2129	23[1]		2930	6987	156	329	193	211
1987	468	1206	4391		2530	7014	293	218	131	183
1988	458	1958	6243	7446	2832	11243	187	161	230	89
1989	662	5207	3488	1719	1029	11026	108	264	235	204
1990	231	1006	3952	2532	1850	4762	58	291	84	126
1991	547	1006	190[1]	1911	2341	9127	97	184	46	211
1992	360	1388	-	3084	2546	10795	73	233	52	243
Mean	503	2324	3126	3402	2181	8472	134	219	171	168

[1] Minimum count.

In both the UK(E&W) Severn and UK(E&W) Dee, the counters are some distance upstream so that the counts do not represent total counts for these systems. 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.

Table 3.2.3.1 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]			UK (N.Ireland)	Norway[2]		UK (Scotland)[2]			France
migration	Ellidar	R.Vesturdalsa[4]		R. Bush	R. Imsa		North Esk			Bresle
year	1SW	1SW	2SW	1SW[3]	1SW	2SW	1SW	2SW	3SW	All ages
1975	20.0									
....										
1981					17.3	4.0	13.7	6.9	0.3	
1982					5.3	1.2	12.6	4.5	0.2	
1983		2.0			13.5	1.3	-	-	-	8.5
1984					12.1	1.8	23.0	5.4	0.1	16.3
1985	9.4				10.2	2.1	26.1	6.4	0.2	12.2
1986				31.3	3.8	4.2	-	-	-	19.4
1987				35.1	17.3	5.6	13.9	3.4	0.1	-
1988	12.7			36.2	13.3	1.1	-	-	-	-
1989	8.1	1.1	2.0	25.0	8.7	2.2	7.8	4.9	0.1	-
1990	5.4	1.0	1.0	34.7	3.0	1.3	7.3	4.2	-	-
1991	8.8	4.2	-	27.4	8.5	-	11.1	-	-	-

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Microtags, corrected for tagging mortality.
[4] Assumes 50% exploitation in rod fishery.

Table 3.2.3.2 Estimated survival of wild smolts (%) into freshwater for various monitored rivers in the NE Atlantic area.

Smolt	Iceland[1]			Ireland	UK (N.Ireland)		Norway[2]		UK (Scotland)[1]			France		
migration	R.Ellidar	R.Vesturdalsa[5]		R.Burrishoole	R. Bush		R. Imsa		North Esk[4]			Oir[3]	Nivelle[6]	Bresle
year	1SW	1SW	2SW	1SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20.8													
1979	-			7.3										
1980	-			3.1										
1981	-			5.4	9.5	0.9	2.1	0.3	4.2	2.0	0.2			
1982	-			5.8	7.8	0.8	0.7	0.1	4.9	2.2	0.2			
1983	-	2.0		3.4	1.9[3]	1.7	2.4	0.1	-	-	-	3.7		5.5
1984	-	-		7.8	6.4	1.4	3.2	0.3	3.9	2.1	0.1	6.4		11.7
1985	9.4	-		7.9	7.9	1.9	2.1	0.1	5.9	2.9	0.2	7.4		9.6
1986	-	-		8.7	9.7	1.9	1.7	0.8	-	-	-	3.4	15.7	14.4
1987	-	-		12.0	12.0	0.4	8.3	1.5	6.7	2.1	0.1	7.6	2.7	-
1988	12.7	-		10.1	3.9	0.8	4.5	0.6	-	-	-	2.3	2.2	-
1989	8.1	1.1	2.0	3.5	9.3	1.4	4.9	0.6	3.5	2.7	0.1	2.0	3.5	-
1990	5.4	1.0	1.0	9.2	11.8	1.7	1.7	0.3	4.2	2.1	-	3.9[7]	1.7[7]	-
1991	8.8	4.2	-	9.5	12.0	-	3.4	-	5.2	-	-	10.6[7]	5.6[7]	-

[1] Microtags.

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

[3] Minimum estimate.

[4] Before in-river netting.

[5] Assumes 50% exploitation in rod fishery.

[6] Survival of 0+ parr to adults.

[7] Incomplete returns.

Table 3.2.3.3 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 migration year	Iceland[1]		Ireland[1]	N. Ireland[1]		Norway[2]				Sweden[2]	
	Kollafjordur		R.Burrishoole[3]	R. Bush		R Imsa		R Drammen		R. Lagan	
	1SW	2SW	1SW	1SW 1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981	5.6	3.1	7.6	-	-	10.1	1.3	-	-	-	-
1982	8.7	1.6	8.7	-	-	4.2	0.6	-	-	-	-
1983	1.2	0.9	3.4	1.9	8.1	1.6	0.1	-	-	-	-
1984	4.5	0.5	20.3	13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	7.3	0.7	18.7	15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	no release		9.1	2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	8.9	0.7	12.6	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	5.3	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	-	7.6	5.4	8.7	3.2	-	0.1	-	3.4	-

[1] Microtagged.

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

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

Table 3.2.3.4 Estimated survival (%) of hatchery smolts to adult return to freshwater, for various monitored rivers and experimental facilities in the NE Atlantic area.

Smolt migration year	Iceland[1]		Ireland[1]	N. Ireland[1]		Norway[2]			
	Kollafjordur		R.Burrishoole[3]	R. Bush		R Imsa		R Drammen	
	1SW	2SW	1SW	1SW 1+ smolts	2+ smolts	1SW	2SW	1SW	2SW
1981	5.6	3.1	1.3	-	-	2.0	0.1		
1982	8.7	1.6	1.6	-	-	0.2	0.03		
1983	1.2	0.9	0.5	0.1	0.4	0.1	0.0		
1984	4.5	0.5	3.0	0.9		0.6	0.03	2.5	1.2
1985	7.3	0.7	3.7	2.8	4.3	1.3	0.13	0.6	0.9
1986	no release		1.7	0.1	2.1	1.1	0.07	2.2	1.1
1987	8.9	0.7	3.5	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	-	2.5	1.4	2.2	0.8	-	0.1	

[1] Microtagged.

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

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

Table 3.3.1.1 Counts of small salmon from fishways and counting fences in insular Newfoundland 1974-1992 by Salmon Fishing Areas (SFA); also shown is the mean 1987-1991.

Year	Fishways									Counting fences				
	SFA 4			SFA 5			SFA 9	SFA 10	SFA 11	SFA 4	SFA 9			SFA 11
	1A	1B	2	3	4	5	6	7	8	9	10	11	12	13
1974	2538		857	770a		162		223						
1975	9218	5531		1119a		778		186a						
1976	3991	2935				335		294						
1977	6148	4300				371								
1978	3790	2704	755	1403	810	436		390						
1979	6715	3925	404a	1350a	569	455		454						
1980		4597	997	1712	843	420		433						
1981	8114a	4264	2459	2414	1115	619		334a						
1982	7605a	2796	1425	1281	963	625		86a					133	
1983		2952a	978	1195	1210	853		233			2330		272	
1984	17219	6300a	1081	1379	1233	904		419			2430	89	359	
1985	16652	5985	1663	904	1557	960		384			1377a	124	170	
1986	9697	3072	1064	1036	1051	726		725	211		2516	158	296	7515
1987	9014	2327	493a	914	974	570	80	325a	155a		1302a	91	368	9687
1988	8974	3433	1562	772	1737	795	313	543	149		1695	97	205a	7118
1989	7192	1694	596	496	1138	668	168	706	175	7743	889a	62	441	4469
1990	6629	1057	328a	745	1149	410a	401	551	208	7520	1657	71	307a	4321
1991	5245	1060	245	562	873	311a	211	353	46a	6445	394	99	218	2086
1992	12538	3520	1168	1182	1443	886	237	921	101	17296a	1298a	49	249	1973
1987-91 Mean	7411	1914	811	698	1174	678	235	538	177	7236	1249	84	342	5536

1 Exploits River
  a) Bishop's Falls
  b) Gt. Rattling Brook
2 Gander River (Salmon Brook)
3 Middle Brook

4 L. Terra Nova River
5 U. Terra Nova River
6 Rocky River
7 Northeast River (Placentia)
8 Grand Bank Brook

9 Gander River
10 Biscay Bay River
11 Northeast Brook (Trepassey)
12 Colinet River
13 Conne River

a Partical counts: not included in means

Table 3.3.1.2 Counts of large salmon from fishways and counting fences in insular Newfoundland 1974-1992 by Salmon Fishing Areas (SFA); also shown is the mean 1987-1991.

Year	Fishways									Counting fences				
	SFA 4			SFA 5			SFA 9	SFA 10	SFA 11	SFA 4	SFA 9			SFA 11
	1A	1B	2	3	4	5	6	7	8	9	10	11	12	13
1974	411		9	77a		121		9						
1975	1439	505		9a		52		36a						
1976	460	117				37		56						
1977	581	271				262								
1978	303	81	52	16	20	89		32						
1979	277	124	6a	54a	170	30		37						
1980		426	15	91	39	17		34						
1981	1695a	514	33	39	90	28		62a						
1982	181a	122	18	20	19	8		36a					116	
1983		302	12	75	57	76		22			88		43	
1984	529	111a	38	57	107	98		44			83	33	97	
1985	183	38	26	27	112	60		0			21a	41	42	
1986	355	174	12	15	140	58		39	4		101	30	31	397
1987	310	41	9a	19	56	38	1	16a	2a		106a	30	55	498
1988	147	10	24	14	206	45	6	11	2		61	19	16a	418
1989	89	14	24	19	142	51	9	15	7	473	104a	18	81	319
1990	122	15	7a	13	144	34a	17	25	15	508	71	9	50a	361
1991	99	40	2	14	114	26a	16	8	7a	670	35	13	18	87
1992	314	242	101	43	270	224	46	46	35	3850a	49a	10	78	154
1987-91 Mean	153	24	17	16	132	45	10	15	8	550	56	18	51	337

1 Exploits River
a) Bishop's Falls
b) Gt. Rattling Brook
2 Gander River (Salmon Brook)
3 Middle Brook

4 L. Terra Nova River
5 U. Terra Nova River
6 Rocky River
7 Northeast River (Placentia)
8 Grand Bank Brook

9 Gander River
10 Biscay Bay River
11 Northeast Brook (Trepassey)
12 Colinet River
13 Conne River

a Partical counts: not included in means

Table 3.3.1.3 Counts of wild Atlantic salmon at fences (Western Arm Brook) and fishway traps in Salmon Fishing Areas (SFA) 14, 20, 21, and 23. Numbers in parentheses indicate number of salmon returning to Western Arm Brook before removals for Torrent River transfer.

Year	SFA 14				SFA 20		SFA 21		SFA 23	
	Western Arm Brook		Torrent		Liscomb		La Have		Saint John	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1974	299(399)	4	38	3			29	2	3,389	4,775
1975	393(631)	1	191	25			38	5	5,725	6,200
1976	420(520)	0	341	47			178	23	6,797	5,511
1977	341	3	789	33			292	25	3,504	7,247
1978	285	1	971	21			275	67	1,584	3,034
1979	1,578	0	1,984	39	60	0	856	67	6,234	1,993
1980	430	3	792	63	111	0	1,637	288	7,555	8,157
1981	447	1	2,101	97	76	6	1,866	366	4,571	2,441
1982	387	3	2,112	523	252	10	799	256	3,932	2,262
1983	1,141	4	2,007	442	520	15	1,129	213	3,623	1,712
1984	117	0	1,805	606	48	48	384	384	7,353	7,011
1985	162	1	1,553	507	87	87	638	638	5,331	6,391
1986	252	0	2,815	736	117	117	584	584	6,347	3,656
1987	378	1	2,505	1,614	88	88	532	532	5,097	3,088
1988	102	1	2,065	477	76	76	380	380	8,062	1,930
1989	414	1	1,339	532	75	75	511	511	8,417	3,854
1990	124	0	2,296	955	44	44	596	596	6,486	3,163
1991	233	1	1,415	586	38	38	236	236	5,415	3,639
1992	480	8	2,347	145	27	27	215	215	5,729	3,522
Mean 1987-91	328	1	1,932	833	64	64	451	451	6,695	3,135

Table 3.3.1.4 Counts of Atlantic salmon at fishways 1975-1992 in areas Q3 and Q7, Quebec.

Year	Q7		Q3					
	de la Trinité		Matane		Madeleine		Mitis	
	Small	Large	Small	Large	Small	Large	Small	Large
1975			943	1487			66	159
1976			1067	1393	115	155	90	165
1977			1189	1078	77	70	83	170
1978			807	2571	56	374	77	133
1979			1540	725	93	57	281	141
1980	1144	156	1466	2102	81	79	193	387
1981	1892	367			313	146	270	151
1982	2173	828			259	317	114	563
1983	891	461			96	167	46	157
1984	1663	421	876	931	74	392	239	236
1985	1008	519	762	1003	156	301	181	378
1986	1364	546	2364	1397	359	439	636	451
1987	1115	514	1018	2290	406	951	225	557
1988	1324	760	692	2086	499	781	477	314
1989	1744	441	1208	923	482	926	338	428
1990	1637	460	1270	1520	452	932	528	282
1991	1306	496	1586	1354	461	671	329	327
1992	449	539	1877	1456	509	700	697	439
Mean 1987-91	1425	534	1157	1635	460	852	379	381

Table 3.3.1.5 Estimated numbers of returning and spawning Atlantic salmon, egg depositions, ratios of large salmon spawners to returns and fraction of target egg deposition attained in 16 rivers in Atlantic Canada. Empty cells mean no prediction available. Bold numbers are target spawners and eggs.

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
<u>Restigouche River</u> - SFA 15								
TARGET				**2.6**	**12.2**	**71.4**		
1982	8.0	11.2		2.0	1.8	10.9	0.16	0.15
1983	3.4	10.2	13.5	0.6	1.4	8.7	0.14	0.12
1984	10.9	7.8	11.3	1.3	3.1	18.6	0.40	0.26
1985	7.0	10.0	12.2	2.5	6.3	37.4	0.63	0.52
1986	10.7	14.1	14.8	3.8	8.8	52.6	0.63	0.74
1987	10.0	10.2	21.9	3.5	5.9	35.0	0.58	0.49
1988	13.5	12.7	12.9	4.7	8.2	49.3	0.65	0.69
1989	6.7	10.6		2.3	6.2	37.1	0.58	0.52
1990[2]	10.2-17.1	10.5-16.4		4.3-10.1	6.3-11.3	37.9-68.0	0.65[5]	0.53-0.95
1991[2]	5.9-9.8	8.6-13.6		2.5-5.9	5.1-9.3	30.4-55.5	0.64[5]	0.43-0.78
1992[2]	11.1-18.5	11.8-18.7		4.8-11.1	7.4-13.2	44.3-79.3	0.67[5]	0.62-1.11
<u>Miramichi River[1]</u> - SFA 16								
TARGET				**22.6**	**23.6**	**132.0**		
1982	80.4	30.8		56.0	13.3	109.8	0.40	0.83
1983	25.2	27.9	43.0	14.8	8.5	48.1	0.27	0.36
1984	29.7	15.1	10.2	18.9	14.7	77.0	0.91	0.58
1985	60.8	20.7	18.4	41.8	20.1	130.0	0.92	0.98
1986	117.5	31.3	28.4	89.4	30.2	226.4	0.93	1.72
1987	84.8	19.4	54.2	62.8	18.1	175.9	0.88	1.42
1988	121.9	21.7	36.4	90.3	21.0	189.3	0.92	1.50
1989	75.2	17.2	-	48.4	15.5	124.1	0.84	0.97
1990	83.4	28.6	-	59.7	27.6	191.2	0.93	1.51
1991	60.9	29.9	26.0	48.3	29.1	200.6	0.94	1.58
1992	152.7	31.8	29.0	126.6	31.1	265.3	0.98	2.01
<u>Saint John River above Mactaquac Dam[1]</u> - SFA 23								
TARGET				**3.2**	**4.4**	**29.5**		
1982	8.2	7.3		4.9	2.3	18.9	0.31	0.64
1983	6.1	6.9		3.7	1.3	9.6	0.19	0.33
1984	9.8	10.9	6.2	6.9	6.1	40.2	0.56	1.36
1985	8.5	11.3	9.3	5.3	6.3	41.2	0.56	1.40
1986	8.8	6.9	8.8	5.9	3.5	26.5	0.51	0.90
1987	9.2	4.8	11.0	7.0	2.8	24.3	0.58	0.82
1988	10.2	3.5	8.0	7.8	1.7	16.0	0.49	0.54
1989	10.9	4.5	7.1	7.5	3.5	28.5	0.78	0.97
1990	8.8	4.1	7.1	6.1	3.2	27.1	0.78	0.92
1991	8.8	5.2	4.7	5.7	3.5	26.9	0.67	0.91
1992	8.9	4.9	5.1	5.1	3.3	24.7	0.67	0.84

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Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
LaHave River above Morgan Falls[12] - SFA 21								
TARGET[7]				—	—	—		
1983	1.1	0.2		1.1	0.2	2.0	1.00	
1984	2.0	0.4	0.2[3]	2.0	0.3	3.1	0.75	
1985	1.3	0.6	0.3[3]	1.3	0.4	3.4	0.67	
1986	1.6	0.6	0.4[3]	1.6	0.4	4.1	0.67	
1987	2.5	0.5	0.4[3]	2.5	0.4	4.9	0.80	
1988	2.5	0.4	0.7[3]	2.4	0.3	4.4	0.75	
1989	2.1	0.5		2.1	0.4	4.3	0.80	
1990	1.9	0.6		1.9	0.3	3.3	0.75	
1991	0.5	0.2		0.4	0.2	1.4	0.73	
1992	1.9	0.2		1.8	0.2	3.4	0.67	
Margaree River[1] - SFA 18								
TARGET				**0.6**	**1.0**	**6.7**		
1983	0.2	0.5		0.1	0.3	1.8	0.60	0.27
1984	0.4	0.4		0.2	0.3	2.0	0.75	0.30
1985	0.6	0.8		0.4	0.8	5.3	1.00	0.79
1986	0.8	2.0		0.5	2.0	12.9	1.00	1.93
1987	1.5	4.0		1.1	4.0	25.9	1.00	3.87
1988	2.2	1.7		1.6	1.7	11.1	1.00	1.65
1989	0.8	2.3		0.6	2.3	16.9	1.00	2.17
1990	1.0	11.1		0.7	11.1	71.7	1.00	10.7
1991	1.9	3.5		1.5	3.5	21.9	1.00	3.3
1992	1.0	3.9		0.3	3.9	25.4	1.00	3.8
Conne River - SFA 11[11]								
TARGET				**4.0**	-	**7.8**		
1986	8.3	0.4		5.4	0.4	11.3	0.65[4]	1.45
1987	10.2	0.5		7.8	0.5	16.7	0.77[4]	2.14
1988	7.6	0.4	7.9-8.8	5.6	0.4	12.4	0.74[4]	1.59
1989	5.0	0.3	6.2-6.8	3.6	0.3	8.0	0.72[4]	1.03
1990	5.4	0.4	6.8-7.9	3.8	0.4	8.7	0.70[4]	1.12
1991	2.4	0.1	4.5-5.3	2.1	0.1	4.0	0.88[4]	0.51
1992	2.5	0.2	3.5-7.2	1.8	0.2	4.0	0.71[4]	0.51
Rivière de la Trinité - Q7								
TARGET				**1.0**	**0.5**	**2.7**		
1982	2.4	0.3		1.6	0.2	1.2	0.66	0.45
1983	0.9	0.5		0.7	0.5	2.3	1.00	0.85
1984	1.8	0.5		1.4	0.4	2.2	0.80	0.82
1985	1.1	0.6		0.9	0.4	2.1	0.67	0.78
1986	1.6	0.6		1.1	0.4	2.3	0.67	0.86
1987	1.3	0.6		0.8	0.4	2.5	0.67	0.91
1988	1.6	0.8		1.0	0.7	4.1	0.88	1.52
1989	1.9	0.5		1.3	0.3	2.2	0.60	0.80
1990	1.9	0.5		1.2	0.4	2.5	0.80	0.91
1991	1.3	0.5		1.0	0.4	2.3	0.77	0.85
1992	0.6	0.6		0.4	0.5	2.6	0.74	0.95

Cont'd

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Humber River - SFA 13								
TARGET				**18**	**6**	**27.7**		
1987	12.3	0.9		9.2	0.9	16.1	1.00	0.58
1988	16.2	1.1		12.1	1.1	12.4	1.00	0.77
1989	4.9	0.3		3.7	0.3	2.9	1.00	0.23
1990	12.2	0.9		9.2	0.9	16.0	1.00	0.58
1991	5.7	0.4		4.3	0.4	7.5	1.00	0.27
1992	22.3	3.7		17.9	3.7	44.0	1.00	1.59
Gander River - SFA 4								
TARGET				**22**	**-**	**46.2**		
1989	7.7	0.45		6.6	0.45	16.3	1.00	0.35
1990	7.7	0.51		6.6	0.51	16.5	1.00	0.36
1991	6.7	0.67		5.6	0.67	15.1	1.00	0.33
1992	18.3	4.15		17.0	4.15	51.2	1.00	1.11
Rocky River - SFA 9								
TARGET				**0.9**	**-**	**3.4**		
1987	0.08			0.2[9]		0.8		0.23
1988	0.3			0.3		1.2		0.36
1989	0.2			0.2		0.7		0.20
1990	0.4			0.4		1.6		0.47
1991	0.2			0.2		0.9		0.26
1992	0.3			0.3		1.1		0.32
Terra Nova River - SFA 5								
TARGET[6]				**7.1**	**-**	**14.3**		
1986	1.5	0.14		1.0	0.14	2.7	1.00	0.19
1987	1.4	0.06		0.9	0.06	2.2	1.00	0.15
1988	2.1	0.21		1.7	0.21	4.3	1.00	0.30
1989	1.4	0.14		1.1	0.14	2.9	1.00	0.20
1990	1.5	0.14		1.1	0.14	2.9	1.00	0.20
1991	1.1	0.11		0.8	0.11	2.2	1.00	0.16
1992	1.8	0.27		1.4	0.27	4.2	1.00	0.29
Middle Brook - SFA 5								
TARGET				**1.01**	**-**	**2.34**		
1986	1.0	0.015		0.76	0.015	2.10	1.00	0.90
1987	1.1	0.019		0.87	0.019	2.11	1.00	0.90
1988	1.3	0.014		0.63	0.014	1.54	1.00	0.66
1989	0.6	0.019		0.46	0.019	1.18	1.00	0.50
1990	1.1	0.013		0.72	0.013	1.74	1.00	0.74
1991	0.8	0.014		0.49	0.014	1.20	1.00	0.51
1992	1.6	0.043		1.14	0.043	3.34	1.00	1.42

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Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Biscay Bay River - SFA 9								
TARGET				**1.11**	**-**	**2.95**		
1986	2.7	0.10		2.18	0.10	6.14	1.00	2.08
1987	1.4	0.11		1.17	0.11	3.52	1.00	1.19
1988	1.8	0.06		1.33	0.06	3.74	1.00	1.26
1989	1.0	0.10		0.81	0.10	2.56	1.00	0.87
1990	1.7	0.07		1.32	0.07	3.78	1.00	1.28
1991	0.4	0.04		0.40	0.04	1.16	1.00	0.39
1992	1.3	0.05		1.25	0.05	3.47	1.00	1.18
Grand River[10] (above fishway) - SFA 19								
TARGET[8]				**0.54**	**-**	**1.1**		
1988	0.70	-		0.74	-	-		1.36
1989	0.60	-		0.45	-	-		0.83
1990	0.62	-		0.44	-	-		0.83
1991	0.44	-		0.35	-	-		0.64
1992	0.19	-		0.14	-	-		0.26
Liscomb River[1] - SFA 19								
TARGET[7]				**-**	**-**	**-**		
1985	0.76	0.136		0.68	0.136	1.58	1.00	
1986	1.74	0.225		1.50	0.225	3.20	1.00	
1987	2.43	0.142		2.14	0.142	3.89	1.00	
1988	1.05	0.120		0.91	0.120	1.88	1.00	
1989	0.88	0.146		0.82	0.146	1.84	1.00	
1990	1.57	0.066		1.39	0.066	2.43	1.00	
1991	0.83	0.060		0.76	0.060	1.42	1.00	
1992	0.29	0.039		0.27	0.039	0.57	1.00	
Northeast River (Placentia Bay) - SFA 10								
TARGET				**0.22**	**-**	**0.72**		
1986	0.88	0.039		0.65	0.039	2.49	1.00	3.46
1987	0.35	0.016		0.32	0.016	1.09	1.00	1.52
1988	0.64	0.011		0.45	0.011	1.50	1.00	2.09
1989	0.81	0.015		0.60	0.015	2.00	1.00	2.77
1990	0.70	0.025		0.53	0.025	1.81	1.00	2.51
1991	0.37	0.008		0.35	0.008	1.16	1.00	1.61
1992	0.96	0.046		0.92	0.046	3.16	1.00	4.39

[1] Hatchery and wild origin.

[2] Range of estimates provided for Restigouche Rivers in 1990 to 1992.

[3] Prediction does not adjust for increased counts resulting from release of MSW fish from angling.

[4] Small salmon spawners/small salmon returns.

[5] Mean value.

[6] Target for the entire river system (including areas under enhancement).

[7] No targets determined for acid-stressed rivers.

[8] Target for complete river.

[9] Incl. a transfer of 124 female spawners to this river.

[10] All size groups combined.

[11] Prediction is for small salmon return.

[12] Does not include hatchery fish.

Table 3.3.4.1 Summary of spawning target estimates for North America by geographical region.

Region[1]	Target	Minimum Value	Maximum Value	Documentation
SFA 1	7300	5600	9000	Estimates for SFA 1 and 2 are imputed from the minimum and maximum values of total catches (recreational + commercial + native) in Labrador and part of the catch in Greenland for the period 1974-1978. Min. value = {[Min. catch of Salmon in Labrador (1974-1978) in SFAI]. + [Average catch of North American origin 1SW salmon with river age >3 caught at Greenland (1974-1978), discounted for 10 months of natural mortality (10%), = 47,700]. * [Assumed fraction of Labrador origin salmon (>3), = 0.70]. * [Average fractioin of SFA1 + SFA2 Labrador catch taken in SFA1, = 0.27]}. * [Average fraction of 2SW salmon in spawning run = 0.30]. = {[9,517] + [47,700] * [0.70] [0.27]} * [0.3]. Max. value = {[Max. catch of salmon in Labrador (1974-1978) in SFA1]. + (other terms listed for min. value)} = {[20,976] + [47,700] * [0.70] [0.27]} [0.3]. Mean value = [Min + Max]/2. Values rounded to nearest 100.
SFA 2	20300	15,200	25,300	Minimum and maximum values for SFA2 are computed as in SFA1 except that average fraction of SFA1 + SFA2 Labrador catch taken in SFA2 is 0.73. Min. value = {[29,295] + [47,700] * [0.70] * [0.73]} *[0.3]. Max. value = {[60,102] + [47,700] * [0.70] * [0.73]} * [0.3]. Values rounded to nearest 100.
SFA 3	200			Updated from Anon., 1978 to include production in lacustrine habitat and newly colonized areas.
SFA 4	2000			See SFA 3
SFA 5	800			See SFA 3
SFA 6	50			See SFA 3

Continued...

Table 3.3.4.1 Continued

Region[1]	Target	Minimum Value	Maximum Value	Documentation
SFA 7	40			See SFA 3
SFA 8	13			See SFA 3
SFA 9	400			See SFA 3
SFA 10	400			See SFA 3
SFA 11	800			See SFA 3
SFA 12	100			See SFA 3
SFA 13	5300			See SFA 3
SFA 14	800			See SFA 3
SFA 15[3]	13736	12629	14153	Target for large salmon is 15600 per CAFSAC advisory document 91/16. Target value is sum of 3 rivers in SFA 15: Restigouche, Eel, Nepisiquit. Min value is Restigouche target/max proportion of Restigouche in SFA 15 = 12200/0.966. Max value is Restigouche target /min proportion of Restigouche in SFA 15 = 12200/0.862.
SFA 16[3]	27800	24651	29500	CAFSAC Adv. Doc. 91/16. Tabled spawning targets for 4 rivers in SFA 16 (Miramichi, Tabusintac, Richibucto, Buctouche. Maximum value = Miramichi target/0.8 where 0.8 represents proportion of SFA 16 watershed in Miramichi drainage.
SFA 17[3]	1100			CAFSAC Adv. Doc. 91/16; CAFSAC Subcomm. Rep. 91/13. Tabled target for Morell River + broodstock requirement for other rivers.
SFA 18[3]	3500	1571	2114	CAFSAC Adv. Doc. 91/16; CAFSAC Res. Doc. 92/26. Tabled targets for Margaree, East R. , West R., South R., Afton/Pomquet. Max value = Target for Margaree/ min prop. for Margaree to SFA 18 = 1036/0.49
SFA 19[3]	1863	1300	1490	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 20[3,4]	3200	2240	2560	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 21[3,4]	2735	1910	2190	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 22[3]	2600	130	260	An update from Anon, 1978 where NewMin = Min* 0.05, NewMax=Max*0.10 [No significant contribution to distant water fisheries]
SFA 23[3]	11100	9440	10550	Marshall and Penney, 1983 and Anon. 1978 where NewMin=Min*0.85; NewMax = Max*0.95 .
Q 1[2]	4844			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)

Continued...

Table 3.3.4.1 Continued

Region[1]	Target	Minimum Value	Maximum Value	*Documentation*
Q 2[2]	2945			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 3[2]	3432			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 5[2]	1521			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 6[2]	2085			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 7[2]	7142			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 8[2]	18420			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 9[2]	7357			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 10[2]	3520			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 11[2]	7500			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Canadian Total	165203			
USA Rivers				
Connecticut	8152			See Table 6.1.2.3 (Anon., 1993a)
Merrimack	3074			See Table 6.1.2.3 (Anon., 1993a)
Penobscot	6840			See Table 6.1.2.3 (Anon., 1993a)
Other Maine	13037			Kennebec River has been excluded because its habitat is not accessible. Estimates include areas accessible via trap and truck operations.
USA Total	31103			
Grand Total	196306			

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

[2] Point Estimate of 2SW spawners

[3] For SFAs 15-23 targets are for MSW salmon. All eggs are to come from 2SW salmon; the previous spawners provide a buffer. Minimum and maximum values refer to 2SW targets which were derived by removing previous spawners and 3+ SW returns.

[4] Targets under review due to acidification.

Table 4.1.2.1 Nominal landings of Atlantic salmon by Faroes vessels in years 1982-1991 and the seasons 1981/1982 - 1991/1992.

Year	Catch (t)	Season	Catch (t)
1982	606	1981/1982	796
1983	678	1982/1983	625
1984	628	1983/1984	651
1985	566	1984/1985	598
1986	530	1985/1986	545
1987	576	1986/1987	539
1988	243	1987/1988	208
1989	364	1988/1989	309
1990	315	1989/1990	364
1991[1]	95	1990/1991[1]	202
1992[2]	23	1991/1992[3]	31

[1] Partly from research fishery.
[2] Research fishery, preliminary figures.
[3] Research fishery.

Table 4.1.2.2 Catch in number of salmon by month in the Faroes fishery for the seasons 1983/1984 to 1991/1992.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
				Commercial fishery					
1983/1984	8,680	24,882	12,504	26,396	32,712	12,486	6,849	-	124,508
1984/1985	5,884	20,419	14,493	24,380	26,035	25,471	19,095	-	135,776
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	-	111,425
1990/1991	6,921	28,972	3,720	7,996	6,275	3,557	-	-	57,442
				Research fishery					
1991/1992	-	3,842	-	931	3,039	652	-	-	8,464

Table 4.1.2.3 Estimation of discard rates in the Faroes fishery 1982/1983 to 1991/1992 (total catch, wild and reared fish combined).

Season	No. of samples	Number sampled	No<60 total	Discard rate %	Range %		
			Commercial fishery				
1982/1983	7	6,820	472	6.9	0	-	10.4
1983/1984	5	4,467	176	3.9		-	
1984/1985	12	9,546	1,289	13.5	3	-	32
1985/1986	7	14,654	286	1.8	0.6	-	13.8
1986/1987	13	39,758	2,849	7.2	0	-	71.3
1987/1988	2	1,499	235	15.6		-	
1988/1989	9	17,235	1,804	10.7	0.4	-	31.9
1989/1990	5	16,375	1,533	9.4	3.6	-	18.5
1990/1991	3	4,615	681	14.8	9.9	-	17.5
			Research fishery				
1991/1992[1]	6	8,927	782	8.8	2.5	-	5.7

[1]Total catch sampled.

Table 4.1.3.1 Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery south of 65°30'N in the seasons 1981/1982 - 1991/1992.

Season	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Season
				Commercial fishery					
1981/1982	-	38	41	49	58	51	34	-	46
1982/1983	19	120	-	61	50	39	36	40	48
1983/1984	85	80	86	58	45	28	26	-	51
1984/1985	38	38	32	32	37	39	40	-	36
1985/1986	64	52	68	54	48	78	61	-	56
1986/1987	31	43	34	44	70	111	102	-	64
1987/1988	56	51	-	47	34	25	22	-	43
1988/1989	63	80	48	68	61	76	-	-	71
1989/1990	81	86	38	56	87	77	-	-	76
1990/1991	81	97	-	35	39	51	-	-	67
				Research fishery					
1991/1992[1]	-	93	-	72	77	50	-	-	79

Table 4.1.3.2 Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery south of 65°30'N in the seasons 1981/1982 - 1991/1992.

Season	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Season
				Commercial fishery					
1981/1982	-	-	72	69	73	64	65	-	69
1982/1983	-	-	-	-	68	41	-	54[1]	60
1983/1984	102[1]	-	-	-	34[1]	-	-	-	70
1984/1985	-	-	-	46	31	37	43	-	37
1985/1986	-	-	-	-	38[1]	82	84	-	80
1986/1987	-	-	67[1]	64	77	-	94	-	77
1987/1988	48	68	73	71[1]	31[1]	32[1]	-	-	65
1988/1989	-	-	-	-	71[1]	-	-	-	71
1989/1990	-	-	-	-	-	103	-	-	103
1990/1991	-	-	-	-	-	-	-	-	-
				Research fishery					
1991/1992[1]	-	-	-	-	-	-	-	-	-

[1] Data from less than 6 sets.

Table 4.1.4.1 Proportion of reared fish in samples from the Faroese salmon fisheries.

Season	Time	N	%
1989/1990	February 1990	73	44
1990/1991	December 1990	99	42
1991/1992	December 1991	119	36
	February 1992	158	48
	March 1992	79	25
	April 1992	98	28

Table 4.1.4.2 Length distribution from scale samples 1991/1992 season, 5 cm groups, excluding fish that cannot be classified.

Length	Dec 1991		Feb 1992		Mar 1992		Apr 1992		Season 1991/1992		
	Wild	Reared	Wild	Reared	Wild	Reared	Wild	Reared	Wild	Reared	Both
40	0	0	0	0	0	0	0	0	0	0	0
45	4	0	0	0	0	0	0	0	4	0	4
50	3	2	2	0	0	0	1	0	6	2	8
55	0	1	0	2	0	1	1	1	1	5	6
60	2	3	0	5	0	3	0	0	2	11	13
65	8	5	2	11	1	2	2	2	13	20	33
70	27	15	16	23	10	1	7	11	60	50	110
75	20	11	29	18	22	8	25	6	96	43	139
80	4	3	10	10	13	4	17	6	44	23	67
85	1	2	8	2	2	0	4	0	15	4	19
90	1	1	5	4	3	1	4	1	13	7	20
95	0	0	3	2	5	0	4	0	12	2	14
100	1	0	1	0	1	0	0	0	3	0	3
105	0	0	1	0	1	0	1	0	3	0	3
Sum	71	43	77	77	58	20	66	27	272	167	439

Table 4.1.4.3 Catch in number by sea-age class by month in the Faroes salmon fishery in 1991/1992 (wild fish only).

Month	Sea age						Total
	1	%	2	%	3+	%	
Nov	-	0	-	0	-	0	-
Dec	242	9.9	2,100	85.9	103	4.2	2,445
Jan	-	0	-	0	-	0	-
Feb	6	1.3	381	78.7	97	20	484
Mar	0	0	1,800	79.0	479	21	2,279
Apr	0	0	405	86.4	64	13.6	469
Total	248	4.4	4,686	82.6	743	13.1	5,675

Table 4.1.4.4 Catch in number by sea-age class by fishing seasons in the Faroes salmon fishery since 1983/1984.

Season	Sea age								Total
	1	%	2	%	3	%	4	%	
				Commercial fishery					
1983/1984	5,142	3	136,418	86	16,401	10	59	+	157,961
1984/1985	381	+	138,375	92	11,358	8	0	0	150,114
1985/1986	2,021	1	169,462	96	5,671	3	87	+	177,241
1986/1987	71	+	124,628	95	6,621	5	75	+	131,395
1987/1988	5,833	9	55,728	86	3,450	5	0	0	65,011
1988/1989	1,351	1	86,417	92	5,728	6	0	0	93,496
1989/1990	1,560	1	103,407	93	6,463	6	0	0	111,430
1990/1991	631	1	52,420	91	4,390	8	0	0	57,442
				Research fishery					
1991/1992[1]	248	4	4,686	83	743	13	+	+	5,675
Total	17,238	2	874,604	92	60,881	6	221	+	952,454

[1] Wild fish only.

Table 4.1.4.5 Percentage distribution by weight category (kg) of salmon landed at Faroes in the 1991/1992 season.

Fishing season	Weight category (kg)						
	<2.5	2.5-3	3-4	4-5	5-7	7-9	>9
				Commercial fishery			
1983/1984	9.7	20.1	41.5	14.2	4.7	6.2	3.6
1984/1985	13.3	21.4	42.3	11.7	3.6	4.9	2.8
1985/1986	9.6	18.3	46.4	16.4	5.3	2.8	1.2
1986/1987	24.4	26.5	30.9	9.1	4.1	3.5	1.5
1987/1988	35.8	26.6	24.3	5.6	4.6	2.3	0.8
1988/1989	26.4	26.2	33.9	7.9	3.2	2	0.4
1989/1990	24.4	23.8	37.8	8.9	3.2	1.5	0.4
1990/1991	13.2	20.1	38.8	13.0	7.6	4.8	3.0
				Research fishery			
1991/1992	13.0	14.1	31.1	11.0	10.0	13.1	7.7

Table 4.1.4.6 Smolt age composition in samples taken in the Faroes fishery from 1984/1985 to 1991/1992.

Season	1	2	3	4	5	6	Unknown	Total
				Commercial fishery				
1984/1985	1.5	37.9	46.9	12.3	1.5	0.1	0	2,194
1985/1986	0.8	20.4	52.7	24.4	1.7	0	0	951
1986/1987	0.2	16.2	48.5	31.8	3.1	0.2	0	575
1987/1988	1.2	35.9	49.5	13.2	0.4	0	0	680
1988/1989	3.5	47.0	40.5	7.0	0.3	0	1.8	798
1989/1990	3.9	52.2	35.5	6.7	1.1	0	0.6	358
1990/1991	-	-		No scale samples		-	-	-
				Research fishery				
1991/1992[1]	2.6	38.7	43.5	5.2	0.4	0	9.5	271

[1] Wild fish only.

Table 4.1.5.1 Estimated numbers of discards, 1SW and 2SW microtagged salmon caught in the Faroese fishery from smolt releases between 1984 and 1991 (year of fishery for 2SW is n+1).

					Number in catch			
Year of migration yr(n)	Country of origin	Number released	Discards yr(n)	1SW yr(n)	All 1SW yr(n)	2SW Yr(n+1)	Total	Rec./rel x 1000
1984	Faroe Islands	19,620	-	-	-	9	9	0.46
	Ireland	260,816	246	-	246	15	261	1.00
	N. Iceland	72,352	33	-	33	-	33	0.45
	UK (Engl. + Wales)	39,780	-	-	-	3	3	0.08
	UK (Scotland)	30,040	49	-	49	-	49	1.64
1985	Faroe Islands	30,079	-	-	-	87	87	2.89
	Ireland	220,000	86	-	86	3	89	0.40
	UK (Engl. + Wales)	53,347	-	-	-	15	15	0.28
	UK (Scotland)	13,497	-	-	-	3	3	0.22
1986	Faroe Islands	43,000	-	-	-	54	54	1.26
	Ireland	143,866	30	-	30	41	41	0.29
	UK (Engl. + Wales)	177,071	4	-	4	12	12	0.07
	UK (N. Ireland)	26,320	15	-	15	15	15	0.58
	UK (Scotland)	16,217	8	-	8	8	8	0.47
1987	Ireland	162,189	154	3	157	161	161	0.99
	N. Iceland	27,978	-	3	3	30	30	1.06
	UK (Engl. + Wales)	195,373	51	-	51	75	75	0.38
	UK (N. Ireland)	20,145	-	-	-	2	2	0.09
	UK (Scotland)	20,876	-	-	-	4	4	0.17
	USA	640,400	-	-	-	2	2	0.00
1988	Canada	13,322	6	-	-	-	6	0.45
	Faroe Islands	43,481	12	-	12	69	81	1.87
	Ireland	165,841	104	-	104	7	111	0.67
	UK (Engl. + Wales)	189,913	12	2	14	12	26	0.13
	UK (Scotland)	31,331	12	-	12	-	12	0.39
1989	Faroe Islands	26,943	-	-	-	8	8	0.28
	Ireland	185,439	105	-	105	-	105	0.57
	N. Iceland	85,452	-	-	-	4	45	0.04
	UK (Engl. + Wales)	256,342	23	2	25	15	40	0.16
	UK (Scotland)	30,288	-	-	-	4	4	0.13
1990	Faroe Islands	11,820	-	-	-	3	3	0.25
	Ireland	153,821	44	-	44	1	45	0.29
	UK (Engl. + Wales)	250,024	15	-	15	-	15	0.06
	UK (N. Ireland)	29,875	15	-	15	-	15	0.49
	UK (Scotland)	41,390	15	-	15	2	17	0.40
1991	Faroe Islands	NA	1	-	1	NA	1	-
	Ireland	471,152	19	-	19	NA	19	0.04
	UK (Engl. + Wales)	231,205	3	-	3	NA	3	0.01
	France	21,376	1	-	1	NA	1	0.05

NA = not available.

Table 4.1.5.2 Comparison of the estimated number of tag recaptures (CWT and External tags) in the Faroes fishery per 1,000 released for all ages (external tag reporting rate = 0.75).

Year	Country of Origin								
	Faroes^1	N. Iceland^1	Ireland^1	UK (Engl. + Wales)^1	UK (Scotland)^1	UK (Scotland) N. Esk^2	UK (N.Ireland)^1	Sweden^2	Norway^2
1975								0.23	
1976								0.54	
1977								2.62	
1978								6.02	
1979								3.58	
1980						1.16		8.03	3.10
1981						2.83		16.10	9.39
1982						3.38		13.19	8.38
1983						0.92		10.21	4.04
1984	0.46	0.45	1	0.08	1.64	0.61		4.26	5.36
1985	2.89		0.4	0.28	0.22	0.86		10.68	3.97
1986	1.26		0.29	0.07	0.47	0	0.58	7.30	1.13
1987		1.06	0.99	0.38	0.17	0	0.09	9.55	2.16
1988	1.87		0.67	0.13	0.39	0.69		1.45	2.26
1989	0.28	0.04	0.57	0.16	0.13	0.81		4.10	2.49
1990	0.25		0.29	0.06	0.4	0.08	0.49	0.45	0.34^3
1991			0.04	0.01		0.15		1.12	

^{1}microtags; ^{2}external tags; ^{3}preliminary data only.

Table 4.1.6.1 Estimated exploitation rates of 1SW and 2SW salmon in the Faroes fishery. All estimates are based on recoveries of external tags.

Season	Exploitation Rates %										
	Norway						Scotland			Sweden	
	R. Drammen		River Imsa				North Esk			R. Lagan	
	Hatchery		Wild		Hatchery		Wild			Hatchery	
	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	1SW	2SW
1981/1982			0^1	-	1^1	-	0^1	6	0^1		
1982/1983			0^1	25	2	38	1^1	10	6^1		
1983/1984			0^1	50^1	1^1	45	0^1	10	18^1		
1984/1985	5	-	0^1	33^1	2	39	0^1	9^1	16^1	0^1	
1985/1986	0^1	30	0^1	38	0^1	30	$<1^1$	5^1	0^1	3^1	22^1
1986/1987	0^1	3^1	0^1	13^1	1^1	28	0^1	6^1	0^1	2^1	0^1
1987/1988	0^1	6^1	0^1	5^1	1^1	21	0^1	0^1	0^1	0^1	9^1
1988/1989	0^1	36	0^1	3^1	0^1	10^1	4^1	0^1	0^1	0^1	13^1
1989/1990	0^1	45	0^1	5^1	0^1	15	2^1	0^1	0^1	1^1	21^1
1990/1991	1^1	13	0^1	13^1	0^1	36	$<1^1$	2^1	0^1	1^1	18^1
1991/1992^2	-	2^1	0^1	4^1	0^1	1^1	-	0^1	0^1	1^1	3^1
Mean for 1986/87 to 1990/91	0	21	0	8	0	23	1	2	0	1	12

^{1}Estimate based on less tthan 10 tag returns.
^{2}Provisional exploitation rate estimates.

Reporting rates for external tags: Faroes = 0.75; W. Greenland = 0.75; N. Esk = 1.00; Montrose Bay = 1.00;
Norway = 0.50; Sweden = 0.65; Elsewhere = 0.50

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

Year	UK (England and Wales)				UK (Scotland)		UK (N. Ireland)				Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Fixed engine[1]	Net and cable	Driftnet	Draftnet	Bagnets and boxes	Rod licences	Bagnet	Bendnet	Liftnet	Driftnet (No. Nets)
1966											7,101		55	
1967											7,106	2,827	48	11,498
1968											6,588	2,613	36	9,149
1969											6,012	2,756	32	8,956
1970											5,476	2,548	32	7,932
1971											4,608	2,421	26	8,976
1972											4,215	2,367	24	13,448
1973											4,047	2,996	32	18,616
1974											3,382	3,342	29	14,078
1975											3,150	3,549	25	15,968
1976											2,569	3,890	22	17,794
1977											2,680	4,047	26	30,201
1978											1,980	3,976	12	23,301
1979											1,835	5,001	17	23,989
1980											2,118	4,922	20	25,652
1981											2,060	5,546	19	24,081
1982					8,389	647	123	221	18	14,784	1,843	5,217	27	22,520
1983	232	209	333	149	10,610	668	120	207	17	14,145	1,735	5,428	21	21,813
1984	226	223	354	149	7,716	638	121	192	19	13,529	1,697	5,386	35	21,210
1985	223	230	375	144	5,779	529	122	168	19	14,962	1,726	5,848	34	20,329
1986	220	221	368	139	4,789	597	121	148	18	15,332	1,630	5,979	14	17,945
1987	213	206	352	143	6,297	579	120	119	18	-	1,422	6,060	13	17,234
1988	210	212	284	145	2,118	395	115	113	18	-	1,322	5,702	11	15,532
1989	201	199	282	150	1,843	356	117	108	19	-	1,888	4,100	16	-
1990	200	204	292	144	2,234	340	114	106	17	-	2,375	3,890	7	-
1991	199	187	264	142	1,836	295	-	-	18	-	2,343	3,628	8	-
1992							121	91	19	-				

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

Continued...

Table 4.2.1.1 Continued

Year	Ireland				Finland				France		
					The Teno River			The Näätanu River			
	Driftnets No.	Draftnets	Other commercial nets	Rod and line	Recreational fishery		Commercial fishery	Recreational fishery	Rod and line licences	Commercial nets in freshwater[3]	Licences in estuary[3,4]
					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							
[illegible]75	1,046	672	212	13,142							
1976	1,047	677	225	14,139							
1977	997	650	211	11,721							
1978	1,007	608	209	13,327							
1979	924	587	240	12,726							
1980	959	601	195	15,864							
1981	878	601	195	15,519	16,859	5,742	677	467			
1982	830	560	1972	15,697	19,690	7,002	693	484	4,145	55	82
1983	801	526	190	16,737	20,363	7,053	740	587	3,856	49	82
1984	819	515	194	14,878	21,149	7,665	737	677	3,911	42	82
1985	827	526	190	15,929	21,742	7,575	740	866	4,443	40	82
1986	768	507	183	17,977	21,482	7,404	702	691	5,919[1]	58[1]	86
1987[1]	-	-	-	-	22,487	7,759	754	689	5,804[2]	87[2]	80
1988	836	-	-	-	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	-	24,118	8,681	742	696	3,826	83	78
1990	756	-	-	-	19,596	7,677	728	614	2,977	71	76
1991	707	496	-	-	22,922	8,286	734	718	2,760	78	71
[illegible]92	694	-	-	-	26,748	9,058	749	875	2,155		56

[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).

Table 4.2.3.1 CPUE data for net and fixed engine salmon fisheries by National River Authority Region in UK (England and Wales), 1988-1992.

Data expressed as catch per licence-day.

NRA Region	1988	1989	1990	1991	1992
Northumbria	6.85	5.38	6.64	3.98	3.51
Yorkshire	2.24	2.16	2.94	1.28	0.80
Southern	10.15	16.8	8.56	6.40	NA
Welsh	-	0.90	0.78	0.62	NA
North West	-	0.82	0.63	0.51	0.35

Table 4.2.3.2 CPUE for rod fisheries on the Tana River, Finland (1983-1992).

Year	Catch (kg) per angler season		Catch (kg) per angler day	
1983	3.4		1.2	
1984	2.2		0.8	
1985	2.7	x = 2.43	0.9	x = 0.85
1986	2.1		0.7	
1987	2.3		0.8	
1988	1.9		0.7	
1989	2.2	x = 3.23	0.8	x = 1.15
1990	2.8		1.1	
1991	3.4		1.2	
1992	4.5		1.5	

Table 4.2.5.1 Origin of catches of salmon in homewater fisheries based on tag recoveries.

++ = Principal component of catch
\+ = Consistant recoveries
\- = Rare tag recovery

Origin of stock	Catch by Country									
	Rus	Fin	Nor	Swe	Fr	UK E & W	UK Scot	UK N.Ire	Ire	Ice
Russia	++	-	+							
Finland	-	++	+							
Norway		+	++	+		-	-		-	
Sweden			+	++						
France					++	-	-	-	-	
UK (E & W)			-	-		++	+	+	+	
UK (Scot)						+	++	+	+	
UK (N.Ire)						-	+	++	+	
Ireland			-	-		-	+	+	++	
Iceland			-				-			++

Table 4.2.5.2 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						
	Wild		Farmed		Total Farmed	Ranched	Total
Norway	1989	710	FW	29			
			SEA	166	195		905
	1990	716	FW	29			
			SEA	185	214		930
	1991	688	FW	20			
			SEA	169	189		877
	1992[2]	651	FW	26			
			SEA	173	199		850
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
France	1991	13			0	0	13
	1992	20			0	0	20
Iceland	1991	130			3	375	505
	1992	175.5			+	412	590
Ireland	1991	<402.6			+	1.4	404
	1992	<628			+	2	630
Russia	1991	215			0	0	215
	1992	161			0	0	161
Sweden	1991	23			1	14[1]	38
	1992	24			1	24[1]	49
UK (E & W)	1991	200			0	0	200
	1992	195			0	0	195
UK (N.Ire)	1991	54			<1	0	55
	1992	147.3			1.1	2.6	151
UK (Scot)	1991	448			14	0	462
	1992	502			23	0	525

[1] Fish released for mitigation purposes and not expected to contribute to spawning.

[2] Provisional figures.

Table 4.2.6.1 Estimated exploitation rates (in %) of salmon in homewater fisheries in Ireland and UK.

Year	Ireland[1]	UK (England + Wales)[2]			UK (N. Ireland)[1]				UK (Scotland)[2]	
	Burrishoole	Itchen		Test	River Bush				North Esk	
	HR	W		W	W	W/HR	HR1+	HR2+	W	W
	Total	net	rod	rod	Net	Net	Net	Net	In-river netting	
	1SW	(all ages)			1SW	2SW	1SW	1SW	1SW	2SW
1985	82						93	-	23	35
1986	85						82	75	40	29
1987	75				69	46	94	77	29	37
1988	76			39	65	36	72	57	35	37
1989	82	9	45	29	89	60	92	83	25	26
1990	54	20	51	36	61	38	63	70	37	37
1991	65	30	45	26	65	43	57	46	10	15
1992[3]	68	9	27	25	56	32	74	75	28	27
Average	73	17	42	31	68	43	78	69	28	30

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

[2] Estimate based on counter and catch figures.

[3] Provisional figures.

HR = Hatchery reared.

W = Wild.

Table 4.2.6.2 Estimated total exploitation rates (in %) of salmon in homewater fisheries in Iceland, Norway and Sweden and Russia.

Year	Iceland[1]	Norway[2]						Sweden[3]		Russia[1]		
	R. Ellidaar	R. Drammen		R. Imsa				R. Lagan[3]		R. Ponoy	R. Kola	R. Tuloma
	W	HR[4]		W		HR[4]		HR2+		W	W+HR	W
	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	all sea ages		
1985		57	-	73	94	81	100	81		47	90	47
1986	34	81	50	79	82	78	90	93	82	50	77	50
1987		64	52	56	95	83	95	78	55	48	91	49
1988		70	47	51	80	78	91	73	91	77	87	51
1989	41	40	59	65	74	44	65	76	86	78	84	50
1990	44	23	40	42	42	47	68	80	82	50	80	50
1991	37	54	59	37	72	50	66	91	92	20	58	48
1992[5]	48	-	51	57	76	67	91	73	100	11	77	45
Average	41	56	51	58	77	66	83	81	84	48	81	49

[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 on assumed 50% exploitation in the river brood stock fishery.
[4] HR in R. Drammen and R. Ims are pooled groups of 1+ and 2+ smolts.
[5] Provisional figures.
W = Wild.
HR = Hatchery reared.

Reporting rates for external tags:

Faroes	0.75
W. Greenland	0.75
N. Esk	1.00
Montrose Bay	1.00
Norway	0.50
Sweden	0.65
Elsewhere	0.50

Table 4.2.7.1 Nominal catches in Norwegian homewaters 1982-1991 (t round weight) broken down to drift net fishery, marine fishery excluding drift nets (other nets) and freshwater fishery and the proportion of the total catch taken in freshwater.

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]
Drift nets	590	826	866	667	795	552	527	0	0	0	0
Other nets	469	418	458	572	497	461	314	488	514	470	427
Freshwater	289	306	299	322	306	372	235	417	416	407	423
Proportion in freshwater	0.21	0.20	0.18	0.21	0.19	0.27	0.22	0.46	0.45	0.46	0.50
Total	1,348	1,550	1,623	1,561	1,598	1,385	1,076	905	930	877	850

[1] Provisional data

Table 4.2.7.2 Frequency of net marks on Atlantic salmon in 12 Norwegian rivers sampled during 1978-1988 and in 1990-1992 (unweighted mean).

River %	1978-1988				1990-1992			
	Number of sampling years	Total number of fish examined	Net marks %	Range %	Number of sampling years	Number of fish examined	Net marks %	Range %
R. Repparfjord	7	4,812	29	18-45	2	281	35	29-40
R. Malselv	9	2,590	44	12-75	3	822	27	19-32
R. Vefsna	8	2,220	33	16-58	1	102	12	-
R. Namsen	9	4,036	25	12-36	3	609	8	4-14
R. Stjordal	4	889	43	32-63	3	411	17	6-25
R. Orkla	2	132	71	66-76	1	73	19	-
R. Orsta	7	2,094	73	48-90	2	138	20	17-23
R. Gaular	5	1,522	37	23-56	3	367	20	16-27
R. Etne	7	3,883	36	27-52	1	61	8	-
R. Suldal	7	1,025	18	8-43	3	886	2	1-4
R. Imsa	11	2,886	16	6-47	3	1,598	5	4-6
R. Figgjo	4	950	24	12-38	3	529	11	7-17

Table 4.2.7.3 Exploitation (% of extant stock) in Norwegian fisheries of 1SW salmon from the River Lagan (Sweden). Reporting rates as in Table 4.2.6.2

Year of fishery	1SW
1985	5
1986	6
1987	5
1988	11
1989	0
1990	3
1991	1
1992	0

Table 4.2.7.4 Numbers of external tags recovered in Norway from salmon tagged as smolts in Sweden (1977-1992).

Catch Year N	No. released in year N-1	Number of recaptures				No. rec. per 1000 released in year N-1	
		1SW	2SW	3SW	Total		
1977	4,974	54	5	.	59	11.9	
1978	4,571	57	10	.	67	14.6	
1979	9,968	209	18	.	227	22.8	
1980	5,219	48	14	1	63	12.1	
1981	996	16	3	3	22	22.1	x = 10.9
1982	6,546	56	1	1	58	8.9	
1983	8,894	125	10	.	135	15.2	
1984	10,713	26	4	1	31	2.9	
1985	5,724	16	7	2	25	4.4	
1986	5,981	16	4	2	22	3.7	
1987	2,373	16	3	.	19	8.0	
1988	5,864	23	.	2	25	4.3	
1989	8,279	3	1	.	4	0.5	
1990	9,749	4	1	.	5	0.5	
1991	8,841	2	.	.	2	0.2	x = 0.5
1992	5,959	3	.	1	4	0.7	

Table 5.1.1 Nominal catches at West Greenland, 1960-1992 (in tonnes, round fish weight).

Year	Norway	Faroes	Sweden	Denmark	Greenland[5]	Total	Quota
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1,539	1,539	-
1965	-[1]	36	-	-	825	861	-
1966	32	87	-	-	1,251	1,370	-
1967	78	155	-	85	1,283	1,601	-
1968	138	134	4	272	579	1,127	-
1969	250	215	30	355	1,360	2,210	-
1970	270	259	8	358	1,244	2,146[3]	-
1971	340	255	-	645	1,449	2,689	-
1972	158	144	-	401	1,410	2,113	-
1973	200	171	-	385	1,585	2,341	-
1974	140	110	-	505	1,162	1,917	-
1975	217	260	-	382	1,171	2,030	-
1976	-	-	-	-	1,175	1,175	1,190
1977	-	-	-	-	1,420	1,420	1,190
1978	-	-	-	-	984	984	1,190
1979	-	-	-	-	1,395	1,395	1,190
1980	-	-	-	-	1,194	1,194	1,190
1981	-	-	-	-	1,264	1,264	1,265[5]
1982	-	-	-	-	1,077	1,077	1,253[5]
1983	-	-	-	-	310	310	1,190
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	-
1989	-	-	-	-	337	337	900
1990	-	-	-	-	274	274	924
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237[2]	237[2]	-

[1] Figures not available, but catch is known to be less than the Faroese catch.
[2] Provisional.
[3] Including 7 t caught on longline by one of two Greenland vessels in the Labrador Sea early in 1970.
[4] For Greenlandic vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non-Greenlandic catches from 1969-1984 were taken with drift nets.
[5] Quota corresponding to specific opening dates of the fishery.

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 5.1.2 Distribution of nominal catches (tonnes) taken by Greenland vessels in 1977-1992 by NAFO divisions according to place where landed.

Div.	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]
1A	201	81	120	52	105	111	14	33	85	46	48	24	9	4	12	+
1B	393	349	343	275	403	330	77	116	124	73	114	100	28	20	36	4
1C	336	245	524	404	348	239	93	64	198	128	229	213	81	132	120	23
1D	207	186	213	231	203	136	41	4	207	203	205	191	73	54	38	5
1E	237	113	164	158	153	167	55	43	147	233	261	198	75	16	108	75
1F	46	10	31	74	32	76	30	32	103	277	109	167	71	48	158	130
1NK	-	-	-	-	20	18	-	5	-	-	-	-	-	-	-	-
Total	1,420	984	1,395	1,194	1,264	1,077	310	297	864	960	966	893	337	274	472	237
East Greenl.	6	8	+	+	+	+	+	+	7	19	+	4	-	-	4	5
Total	1,426	992	1,395	1,194	1,264	1,077	310	297	871	979	966	897	337	274	476	242

[1] Provisional figures.
+ Small catch <0.5 t.
- No catch.

Table 5.1.1.1 Percentage (by number) of North American an European salmon in research vessel catches at West Greenland (1969-1982) and from commercial samples (1978-1992).

Soource	Year	Sample size		Continent of origin (%)			
		Length	Scales	NA	(95% CI)[1]	g	(95% CI)
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(74,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3,488	3,488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977	-	-	-	(-)	-	(-)
	1978[2]	606	606	39	(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)
	1981	-	-	-	(-)	-	(-)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1,653	1,653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4,570	1,930	59	(61,58)	41	(42,39)
	1982	1,949	414	62	(64,60)	38	(40,36)
	1983	4,896	1,815	40	(41,38)	60	(62,59)
	1984	7,282	2,720	50	(53,47)	50	(53,47)
	1985	13,272	2,917	50	(53,46)	50	(54,47)
	1986	20,394	3,509	57	(66,48)	43	(52,34)
	1987	13,425	2,960	59	(63,54)	41	(46,37)
	1988	11,047	2,562	43	(49,38)	57	(62,51)
	1989	9,366	2,227	56	(60,52)	44	(48,40)
	1990	4,897	1,208	75	(79,70)	25	(30,21)
	1991	5,011	1,347	65	(69,61)	35	(39,31)
	1992	6,249	1,612	54	(57,50)	46	(50,43)

[1] CI - Confidence Intercal calculated by method of Pella and Robertson (1989) for 1984-1986 and by binomial distribution for the others.

[2] During fishery.

[3] Research samples after fishery closed.

Table 5.1.1.2 The numbers of North American and European Atlantic salmon caught at West Greenland from 1982 to 1992. Numbers are rounded to the nearest hundred fish.

Year	Numbers of salmon caught	
	NA	E
1982	192,200	143,800
1983	39,500	60,500
1984	48,800	42,200
1985	143,500	161,500
1986	188,300	131,900
1987	171,900	126,400
1988	125,500	168,800
1989	65,000	52,700
1990	75,000	26,300
1991	111,700	65,400
1992	38,500	46,900

Table 5.1.1.3. The number and percentage of fin-clipped and microtagged Atlantic salmon observed during the sampling programme at West Greenland in 1992.

SAMPLING SITE (sampling period)	NAFO DIV.	NO. SALMON EXAMINED				NO. AFC's OBSERVED				% AFC'S	NO.CWT's RECOVERED				% CWT's	% AFC's with CWT's	No. untagged AFC Fish	% untagged
		Weight category				Weight category					Weight category							
		<3 Kg	3-5 Kg	>5 Kg	Total	<3 Kg	3-5 Kg	>5 Kg	Total		<3 Kg	3-5 Kg	>5 Kg	Total				
MANIITSOQ (Aug 7-Sep 3)	1C	2593	133	69	2795	111	8	0	119	4.26	34	4	0	38	1.36	31.9	81	2.90
PAAMIUT (Aug 8-Sep 4)	1E	2596	277	54	2927	54	6	0	60	2.05	18	1	0	19	0.65	31.7	41	1.40
NARSSAQ	1F	1657	107	14	1778	43	4	0	47)	2.82	14	2	0	16)	1.11	39.3	37	1.71
Not sorted (13-25 Aug)					383	12	2	0	14)		6	2	0	8)				
TOTAL		6846	517	137	7500	220	20	0	240	3.04	72	9	0	81	1.03	33.8	159	2.02
TOTAL (incl. unsorted)					7883													
% (incl. unsorted)		86.85	6.56	1.74		91.7	8.33	0			88.9	11.1	0					

KEY: AFC = Adipose fin clip.
CWT = Coded wire microtag.

Table 5.1.1.4 Distributions of recaptures and recovery rates (per 1000 fish examined) of microtagged salmon from Europe and N. America caught in the West Greenland fishery, 1986-92.

YEAR	No. scanned by NAFO Division						TOTAL SCANNED
	1A	1B	1C	1D	1E	1F	
1986	-	7308	-	10120	7361	5571	30360
1987	-	6073	-	9263	6139	3572	25047
1988	522	7140	-	9884	2523	2258	22327
1989	-	3654	-	7591	4343	-	15588
1990	-	-	1156	3827	1427	-	6410
1991	-	-	3871	2324	1162	-	7357
1992	-	-	2795	-	2927	2161	7883

N. AMERICAN RECOVERIES.

YEAR	No. recoveries by NAFO Division						TOTAL RECOVERIES
	1A	1B	1C	1D	1E	1F	
1986	-	10	-	11	4	1	26
1987	-	33	-	43	11	16	103
1988	2	25	-	40	12	2	81
1989	-	31	-	34	7	-	72
1990	-	-	16	29	1	-	46
1991	-	-	14	9	5	-	28
1992	-	-	31	-	6	14	51

YEAR	Recovery rate (per 1000 fish)						TOTAL RECOV. RATE
	1A	1B	1C	1D	1E	1F	
1986	-	1.4	-	1.1	0.5	0.2	0.9
1987	-	5.4	-	4.6	1.8	4.5	4.1
1988	3.8	3.5	-	4.0	4.8	0.9	3.6
1989	-	8.5	-	4.5	1.6	-	4.6
1990	-	-	13.8	7.6	0.7	-	7.2
1991	-	-	3.6	3.9	4.3	-	3.8
1992	-	-	11.1	-	2.0	6.5	6.5

EUROPEAN RECOVERIES.

YEAR	No. recoveries by NAFO Division						TOTAL RECOVERIES
	1A	1B	1C	1D	1E	1F	
1986	-	15	-	21	4	4	44
1987	-	13	-	18	7	5	43
1988	1	10	-	11	6	1	29
1989	-	10	-	10	7	-	27
1990	-	-	1	3	4	-	8
1991	-	-	4	3	2	-	9
1992	-	-	7	-	13	10	30

YEAR	Recovery rate (per 1000 fish)						TOTAL RECOV. RATE
	1A	1B	1C	1D	1E	1F	
1986	-	2.1	-	2.1	0.5	0.7	1.4
1987	-	2.1	-	1.9	1.1	1.4	1.7
1988	1.9	1.4	-	1.1	2.4	0.4	1.3
1989	-	2.7	-	1.3	1.6	-	1.7
1990	-	-	0.9	0.8	2.8	-	1.2
1991	-	-	1.0	1.3	1.7	-	1.2
1992	-	-	2.5	-	4.4	4.6	3.8

NOTE: A dash represents no scanning undertaken.

Table 5.1.1.5 Distributions of recaptures at West Greenland in1992 of microtagged salmon from different release areas. Recovery rates per 1000 fish examined are also given for each NAFO Division.

COUNTRY	RELEASE SITE	RELEASE STAGE	TOT. NO. RECOVS.	RECOVS. BY NAFO DIV.		
				1C	1E	1F
USA	Connecticut R.	91 HS	3	2	0	1
	Penobscot R.	91 HS	27	18	4	5
	Merrimack R.	91 HS	6	4	1	1
	Total		36	24	5	7
	Recovery rate		4.6	8.6	1.7	3.2
CANADA	Nepisiguit R.	91 HS	4	2	1	1
	Renous R.	91 HS	3	2	0	1
	St. John R.	91 HS	3	1	0	2
	St. Jean R.	91 WS	2	1	0	1
	Jupiter R.	91 WS	1	0	0	1
	S.Sevogle R.	91 WS	1	0	0	1
	De La Trinite R.	91 WS	1	1	0	0
	Total		15	7	1	7
	Recovery rate		1.9	2.5	0.3	3.2
IRELAND	Castleconnell R.	91 HS	3	1	0	2
	Plassey	91 HS	4	2	2	0
	Limerick	91 HS	2	2	0	0
	R. Cong	91 HS	4	0	1	3
	R. Delphi	91 HS	3	0	3	0
	L. Furnace	91 HS	2	0	1	1
	Ennis	91 HS	2	0	1	1
	Total		20	5	8	7
	Recovery rate		2.5	1.8	2.8	3.2
ENGLAND & WALES	R. Wear	91 WS	1	0	1	0
	R. Tyne	90 HP	1	0	1	0
	R. Esk	90 HP	1	1	0	0
	R. Taff	91 HS	1	0	1	0
	Total		4	1	3	0
	Recovery rate		0.5	0.4	1.0	0
ICELAND	Dyrholaos	91 HS	1	1	0	0
	Kollafjordur	91 HS	2	0	1	1
	Hraunsfjordur	91 HS	2	0	1	1
	Total		5	1	2	2
	Recovery rate		0.6	0.4	0.7	0.9
SCOTLAND	R. Dee	91 WS	1	0	0	1
	Recovery rate		0.1	0	0	0.5

KEY:
91 HS = 1991 Hatchery smolt release.
91 WS = 1991 Wild smolt release.
90 HP = 1990 Hatchery parr release.

Table 5.1.1.6. Summary of input data for harvest calculations:
Releases by smolt age for Maine and Canada.

Release Year	Maine Rivers 1-yr (U1)	2-yr (U2)	Ratio Total:1-yr	Canada 1-yr (C1)	Smolt Multiplier f1*f2
1975	15758	153577	10.75	28700	3.809
1976	60229	242468	5.03	92636	1.980
1977	128885	245608	2.91	138000	1.403
1978	168033	135014	1.80	132900	1.007
1979	98693	272585	3.76	59800	2.343
1980	399903	282001	1.71	126300	1.296
1981	24695	232348	10.41	97800	2.098
1982	135007	259674	2.92	123700	1.526
1983	367605	170277	1.46	219200	0.917
1984	657722	137203	1.21	254800	0.871
1985	612548	108598	1.18	247400	0.839
1986	723400	55000	1.08	452800	0.662
1987	637536	82759	1.13	449300	0.663
1988	850900	87100	1.10	472500	0.709
1989	524300	80200	1.15	533954	0.571
1990	644100	33100	1.05	617353	0.537
1991	811100	29700	1.04	808843	0.519

Table 5.1.1.7. Summary of input data for harvest calculations: mean weights, landings, proportion North American stock, and the fraction of river age 1 harvest in Greenland.

Year (i)	Greenlan Catch (mt) Q	Mean Weight (kg) W	Std Dev Weight (kg) SD(W)	Prop. N. Amer. Origin Pna	Sample Size for Prop. n	Number of NA 1-yr in sample n1	Harvest Greenland (number) C	Estimated N. Am. To (number) Pna*C
1976	1175	3.04	0.98	0.43	275	2	386513	166201
1977	1420	3.21	0.96	0.40	577	12	442023	176809
1978	984	3.35	0.88	0.52	449	12	293731	152740
1979	1395	3.34	1.19	0.50	1358	57	417665	208832
1980	1194	3.22	0.88	0.48	1111	65	370807	177988
1981	1264	3.17	0.89	0.59	1109	39	398738	235256
1982	1077	3.11	0.96	0.62	446	6	346302	214707
1983	310	3.10	0.98	0.40	779	24	100000	40000
1984	297	3.11	1.14	0.50	1368	66	95498	47749
1985	864	2.87	0.86	0.50	1410	72	301045	150523
1986	960	3.03	0.85	0.57	1786	36	316832	180594
1987	966	3.16	0.74	0.59	1714	69	305696	180361
1988	893	3.18	0.77	0.43	1025	53	280818	120752
1989	337	2.87	0.89	0.56	1025	80	117422	65756
1990	274	2.69	0.83	0.75	1025	90	101859	76394
1991	474	2.65	0.92	0.65	771	40	178868	116264
1992	237	2.81	1.00	0.54	773	51	84342	45544

Table 5.1.1.8. Harvest estimates in numbers of Maine salmon in West Greenland using the proportional harvest model. Estimates include a non catch fishing mortality rate of 0.2.

Release Year	Total N. Amer 1-yr	Total Maine RA1+RA2	StdDev	Mean-1SD	Mean+1S	Coeff. of Variation 100 SD/M
1976	1209	5755	4496	1259	10251	78.1
1977	3554	8797	3785	5012	12582	43.0
1978	4082	7160	2838	4322	9998	39.6
1979	8765	11034	4249	6785	15283	38.5
1980	10413	30492	9385	21107	39877	30.8
1981	8273	13401	4379	9022	17780	32.7
1982	2888	7576	3871	3705	11447	51.1
1983	1232	2350	887	1463	3237	37.7
1984	2304	2640	1082	1558	3722	41.0
1985	7686	8370	2699	5671	11069	32.2
1986	3640	3816	1278	2538	5094	33.5
1987	7261	6006	1591	4415	7597	26.5
1988	6244	5173	1466	3707	6639	28.3
1989	5132	4547	1502	3045	6049	33.0
1990	6708	4790	1562	3228	6352	32.6
1991	6032	4048	1542	2506	5590	38.1
1992	3005	1950	744	1206	2694	38.2

Table 5.1.3.1 Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-1992.. Fork length (cm); whole weight (kg). NA = North American; E = European.

Year	Whole weight (kg)								Total	Fork length (cm)					
	Sea age									Sea age					
	1SW		2SW		PS		Total			1SW		2SW		PS	
	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.69	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.42	2.54	5.82	6.23	5.15	5.09	2.57	2.79	2.65	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.53	2.66	6.42	6.00	4.09	5.28	2.85	2.74	2.81	62.3	63.2	83.3	81.0	77.4	82.8

Table 5.1.3.2 Sea age composition (%) from research vessel and commercial catch samples of Atlantic salmon at West Greenland, 1969-1992.

Year	Type	1SW	MSW	PS
1969	Research	93.8	4.9	1.3
1970	Research	93.8	4.1	2.1
1971	Research	99.2	0.4	0.4
1972	Research	94.1	5.6	0.3
1973	Research	93.8	4.4	1.8
1974	Research	97.7	1.7	0.6
1975	Research	97.6	2.0	0.4
1976	Research	95.7	2.6	1.7
1977	No observations	-	-	-
1978	Research	96.9	1.1	1.1
1979	Commercial	96.6	2.1	1.3
	Research	96.7	1.8	1.5
1980	Commercial	97.5	2.2	0.3
	Research	98.4	1.1	0.5
1981	Commercial	97.0	2.5	0.6
1982	Commercial	93.6	6.0	0.5
	Research	95.3	2.4	2.2
1983	Commercial	90.5	8.1	1.4
1984	Commercial	87.6	11.6	0.7
1985	Commercial	93.8	5.9	0.3
1986	Commercial	96.2	3.0	0.8
1987	Commercial	97.0	2.0	1.0
1988	Commercial	97.4	1.7	0.9
1989	Commercial	93.8	4.6	1.6
1990	Commercial	95.9	3.2	0.9
1991	Commercial	94.7	4.9	0.3
1992	Commercial	94.4	5.5	0.2

Table 5.1.3.3 The sea age composition of samples from commercial catches at West Greenland, 1985-1992.

Year	Sea age composition (%)					
	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

Table 5.1.3.4 River age distribution (%) for all North American and European origin salmon sampled at West Greenland, 1968-1992.

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	6.6	36.6	34.4	19.2	3.0	0.3	0.0	0.0
Total	**4.3**	**37.4**	**35.7**	**15.7**	**5.8**	**1.0**	**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	11.7	38.8	42.5	6.5	0.5	0.0	0.0	0.0
Total	**20.4**	**60.5**	**16.2**	**2.5**	**0.4**	**0.0**	**0.0**	**0.0**

Table 5.1.4.1. Estimated Carlin tag recoveries and run size in Maine rivers. Ratio of tag to run size of 2SW salmon in homewaters. RATIO (year i) for use in estimation of distant water harvest (year i-1).

Year	Tags	Run	RATIO
1967	0	1019	0.0000
1968	168	729	0.2307
1969	7	690	0.0104
1970	13	856	0.0155
1971	68	687	0.0985
1972	318	1449	0.2197
1973	206	1448	0.1425
1974	215	1411	0.1520
1975	450	2345	0.1920
1976	184	1341	0.1374
1977	97	2025	0.0478
1978	97	4145	0.0233
1979	36	1878	0.0190
1980	0	5662	0.0000
1981	470	5122	0.0918
1982	284	6023	0.0472
1983	138	1930	0.0716
1984	61	3045	0.0202
1985	185	4855	0.0381
1986	309	5568	0.0555
1987	119	2397	0.0498
1988	319	2855	0.1118
1989	190	2946	0.0646
1990	172	4370	0.0393
1991	29	2057	0.0138
1992	28	1888	0.0150

Table 5.1.4.2. Carlin tag returns from 1SW salmon of Maine origin in West Greenland by year and NAFO division. (99 = NAFO division unknown)

YEAR	1A	1B	1C	1D	1E	1F	99	TOTAL
1967	1	10	10	8	3	2	3	37
1969	0	1	3	0	1	0	1	6
1970	10	14	6	7	12	2	7	58
1971	29	34	50	57	58	60	94	382
1972	5	4	35	6	15	5	12	82
1973	5	28	25	16	13	12	32	131
1974	8	75	95	79	32	20	48	357
1975	10	22	16	5	1	3	70	127
1976	13	11	9	3	0	0	3	39
1977	0	1	6	0	1	2	1	11
1978	0	5	2	0	0	0	2	9
1980	0	37	20	9	0	0	6	72
1981	0	17	5	0	0	0	18	40
1982	1	42	1	1	0	2	2	49
1983	0	1	6	0	0	0	0	7
1984	1	9	9	0	1	3	0	23
1985	4	25	7	8	0	5	9	58
1986	1	10	15	17	11	18	0	72
1987	2	30	52	43	29	10	0	166
1988	1	29	24	28	20	4	0	106
1989	4	14	44	22	14	8	0	106
1990	1	2	6	4	2	0	0	15
1991	0	1	15	1	2	1	0	20
1992	0	0	1	0	3	1	0	5
Unk	2	16	45	8	17	3	5	96
TOTAL	98	438	507	322	235	161	313	2074

Table 5.1.4.3. Estimated harvest of 1SW salmon of Maine origin in West Greenland by year and NAFO division. (99 = NAFO division unknown)

YEAR	1A	1B	1C	1D	1E	1F	99	TOTAL
1967	6	61	61	49	18	12	18	226
1969	0	91	273	0	91	0	91	545
1970	143	200	86	100	171	29	100	828
1971	186	218	320	365	371	384	602	2446
1972	49	39	345	59	148	49	118	809
1973	46	259	231	148	120	111	296	1212
1974	59	549	696	579	234	147	352	2615
1975	102	225	164	51	10	31	716	1299
1976	510	431	353	118	0	0	118	1529
1977	0	81	483	0	81	161	81	886
1978	0	592	237	0	0	0	237	1066
1980	0	1134	613	276	0	0	184	2207
1981	0	811	238	0	0	0	858	1908
1982	26	1100	26	26	0	52	52	1283
1983	0	70	418	0	0	0	0	488
1984	37	332	332	0	37	111	0	849
1985	101	633	177	203	0	127	228	1469
1986	28	283	424	480	311	509	0	2035
1987	25	377	654	541	365	126	0	2087
1988	22	632	523	610	436	87	0	2309
1989	143	501	1576	788	501	287	0	3797
1990	102	203	610	407	203	0	0	1525
1991	0	94	1403	94	187	94	0	1871
TOTAL	1585	8916	10244	4892	3285	2315	4051	35288

Table 5.1.4.4. The estimated number of CWTs and total number of fish in the 2SW run, and the RATIO used to raise tag recoveries to harvest estimates.

	Maine			Merrimack			Connecticut		
Year	CWT	Run	RATIO	CWT	Run	RATIO	CWT	Run	RATIO
1988	603	2855	0.211	13	54	0.241	93	94	0.989
1989	634	2946	0.215	3	79	0.038	58	106	0.547
1990	456	4370	0.104	110	219	0.502	226	262	0.863
1991	438	2057	0.213	69	329	0.210	153	202	0.757
1992	601	1888	0.318	61	166	0.367	310	480	0.646

Table 5.1.4.5. CWT harvest estimates for USA stocks. Harvest is in numbers and CV is coefficient of variation.

	MAINE		MERRIMACK		CONNECTICUT	
YEAR	HARVEST	CV	HARVEST	CV	HARVEST	CV
1987	5571	10	51	51	51	69
1988	3882	13			76	55
1989	2857	13	243	21	115	22
1990	2037	27	1072	39	297	39
1991	1707	28	384	60	82	42

Table 5.3.1 Definition of key variables used in continental run-reconstruction model for North America.

Variable	Definition
i	Year of the fishery on 1SW salmon in Greenland and Canada
i+1	Year of return to Canada for 2SW salmon
T2(i+1)	Total population size of 2SW salmon prior to fishery is home waters ion year i+1
Hc2(i+1)	Harvest of 2SW salmon in Canada in year i+1
Hc2(i)	Harvest of 2SW salmon in Canada in year i
Hg1(i)	Harvest of 2SW salmon in Greenland in year i
P	Fraction of extent population available to fishery in Canada
FU	Fraction of population not available to any fishery (e.g.,Labrador Sea or Irminger Sea)
1-P-FU	Fraction of extent population available to fishery in Greenland in year i
Ec(i)	Exploitation rate on 1SW salmon in Canada in year i
R2(i+1)	Total 2SW run to rivers in Canada in year i+1
R1(i)	Total 1SW run to rivers in Canada in year i
M	Natural mortality rate (.12/yr)
t1	Time between the midpoint of the Canadian fishery and return to river = 2 months
t2	Time between the midpoint of Greenland fishery and return to Canada = 10 months
S1	Survival of 2SW salmon between the homewater fishery and return to river {exp(-M tl)}
S2	Survival of 1SW salmon between the Greenland fishery and 2SW homewater fishery {exp(-M t2)}
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 02.
q	Fraction of 1SW salmon present in the Large size market category; range = 0.1 to 0.3

Table 5.3.1.1. Run reconstruction data inputs and estimated pre-fishery abundance.

a) Summary of catch and returns (numbers) by size class (Small, Large) for North America. Partitioning of catches by Salmon Fishing Area (SFA) is related to known migration patterns of 1SW salmon and to availability of grilse return estimates.

		NonMat 1SW Component		Mat 1SW Component		Grilse Returns		2SW Catches		Total 2SW Returns	
		{SFA 1-7, 14b}		{SFA 3-7,14a}		{SFA 3-7, 14a}		{SFA 1-7,14b}	{SFA 8-14a}	All North America	
Year (i)	Grid Catch (i)	H_Small (i)	H_Large (i)	H_Small (i)	H_Large (i)	Min (i)	Max (i)	H_Large (i+1)	H_Large (i+1)	Min (i+1)	Max (i+1)
1974	220584	192195	196726	145350	75500	35417	70833	215025	72814	140359	250015
1975	278839	302348	215025	201591	102975	42618	85237	210858	95714	149866	275879
1976	155896	221766	210858	160999	81405	51136	102272	231393	63449	186524	334585
1977	189709	220093	231393	159768	118236	64338	128675	155546	37653	130406	232706
1978	118853	102403	155546	77624	66104	50719	101438	82174	29122	65997	121538
1979	200061	186558	82174	160441	31538	55665	111330	211896	54307	188943	336505
1980	187999	290127	211896	200522	89972	56961	113922	211006	38663	132943	245885
1981	227727	288902	211006	190232	101407	81738	163477	129319	35055	130851	235015
1982	194715	222894	129319	161426	48010	63518	127035	108430	28215	104097	184851
1983	33240	166033	108430	132708	50363	54047	108093	87742	15135	87390	154251
1984	38916	123774	87742	104218	46638	58724	117448	70970	24383	101329	182619
1985	139233	178719	70970	140635	37798	67612	135223	107561	22036	132049	243616
1986	171745	222671	107561	164520	52625	61501	123002	146242	19241	111065	211008
1987	173687	281762	146242	217549	70785	63850	127700	86047	14763	108477	202402
1988	116767	198484	86047	138316	39785	70071	140142	85319	15577	94242	174791
1989	60693	172861	85319	128838	40279	28851	57702	59334	11639	97142	188173
1990	73109	104788	59334	80383	32597	46545	93090	39257	10259	78711	143510
1991	110680	89099	39257	69890	26465	33839	67678	26535	0	85657	154801
1992	43406	20165	26535	0	0	73693	147385	--	--	--	--
	[G1]							[H_L(1-7)]	[H_L(8-14)]	[R2_min]	[R2_max]

b) Summary of estimated catch and return data by sea age class for North America. See text and designated equations for details on computation.

Year	{SFA 1-7, 14a}		{SFA 3-7, 14a}		{SFA 3-7, 14a}		{SFA 1-13, 14a, 14b}		{all N. America}		Pre-fishery nonmaturing	
	1SW Non Maturing (i)		1SW Maturing (i)		Grilse Returns (i)		2SW Harvest (i+1)		2SW Returns (i+1)		1SW abundance (N. Amer	
(i)	min	max	min	max	min	max	min	max	min	max	min	max
1974	21187	50243	122320	151200	35417	70833	223332	266337	140359	250015	645270	844260
1975	32385	73371	169511	209235	42618	85237	243315	285486	149866	275879	747420	975679
1976	24285	57005	135312	166878	51136	102272	225424	271703	186524	334585	637526	886669
1977	24323	57902	137273	175715	64338	128675	146535	177644	130406	232706	521548	703704
1978	11796	29813	67388	87710	50719	101438	86644	103079	65997	121538	300076	398256
1979	19478	42242	130876	152912	55665	111330	202634	245013	188943	336505	654397	888718
1980	31132	70739	167615	204762	56961	113922	186367	228568	132943	245885	573500	785822
1981	31000	70441	160298	198589	81738	163477	125578	151442	130851	235015	543579	727880
1982	23583	52338	132982	158246	63518	127035	104116	125802	104097	184851	449565	592431
1983	17688	39712	110195	133035	54047	108093	76554	94103	87390	154251	233084	349139
1984	13255	30019	87105	106388	58724	117448	74062	88256	101329	182619	247134	370326
1985	18582	40002	115532	136777	67612	135223	97329	118841	132049	243616	412783	582518
1986	23343	50988	135826	162277	61501	123002	121610	150859	111065	211008	453468	625001
1987	29639	65127	179702	214906	63850	127700	74996	92205	108477	202402	407299	566654
1988	20709	44860	113836	135226	70071	140142	75300	92364	94242	174791	325895	458820
1989	18139	39691	106293	126830	28851	57702	53173	65040	97142	188173	246035	382318
1990	11072	24518	66914	81146	46545	93090	37739	45590	78711	143510	213753	308209
1991	9302	20175	58029	70047	33839	67678	18575	23882	85657	154801	236127	330050
1992	2282	5625	0	0	73693	147385	0	0	--	--		
	{Eq.7}	{Eq.6}	{Eq.23}	{Eq.22}			{Eq.16}	{Eq.17}				
	[C1_min]	[C1_max]			[R1_min]	[R1_max]	[C2_min]	[C2_max]	[R2_min]	[R2_max]	[N1_min]	[N1_max]

[N1_min] = ([R2_min] / S1 + [C2_min]) / S2 + [C1_min] + [G1]

[N1_max] = ([R2_max] / S1 + [C2_max]) / S2 + [C1_max] + [G1]

where $S1=\exp(-0.12*1/12)$ and $S2=\exp(-0.12*10/12)$

Table 5.3.1.2. Estimates of exploitation rates and population abundance for salmon at West Greenland derived from constrainst model.

		Exploitation				Proportion of stock in Canada		W.Grld catch	Prop N.Amer	Estimated range of abundance of salmon at West Greenland					
		Canada		Greenland						Total Population		N. American stocks		European stocks	
Year	Fu	Ec_min	Ec_max	Ec_min	Ec_max	P_min	P_max	HG1	f-na	Ng_min	Ng_max	Nna_min	Nna_max	Neu_min	Neu_max
1974	0.3	0.633	0.810	0.357	0.465	0.01	0.07	512986	0.43	1103196	1436936	474374	617882	628822	819053
1975	0.3	0.665	0.831	0.393	0.509	0.01	0.08	633725	0.44	1245039	1612532	547817	709514	697222	903018
1976	0.3	0.570	0.765	0.251	0.360	0.02	0.09	354309	0.44	984192	1411590	433044	621099	551147	790490
1977	0.3	0.516	0.732	0.379	0.541	0.02	0.18	441184	0.43	815497	1164074	350664	500552	464833	663522
1978	0.3	0.399	0.634	0.414	0.617	0.03	0.27	264118	0.45	428068	637966	192631	287085	235437	350881
1979	0.3	0.540	0.733	0.319	0.427	0.02	0.09	444580	0.45	1041171	1393668	468527	627150	572644	766517
1980	0.3	0.595	0.782	0.343	0.485	0.02	0.25	354715	0.53	731371	1034155	387627	548102	343744	486053
1981	0.3	0.495	0.708	0.442	0.641	0.03	0.11	474431	0.48	740142	1073373	355268	515219	384874	558154
1982	0.3	0.511	0.714	0.456	0.635	0.03	0.22	341605	0.57	537961	749134	306638	427006	231323	322128
1983	0.3	0.505	0.711	0.152	0.273	0.03	0.21	83100	0.4	304396	546711	121758	218684	182637	328026
1984	0.3	0.426	0.644	0.160	0.288	0.03	0.21	72067	0.54	250233	450419	135126	243226	115107	207193
1985	0.3	0.461	0.669	0.338	0.514	0.02	0.18	296240	0.47	576342	876450	270881	411931	305461	464518
1986	0.3	0.525	0.725	0.386	0.560	0.02	0.18	291093	0.59	519809	754127	306687	444935	213122	309192
1987	0.3	0.585	0.771	0.440	0.643	0.03	0.23	294385	0.59	457830	669057	270120	394744	187710	274313
1988	0.3	0.448	0.659	0.372	0.604	0.04	0.3	291918	0.4	483308	784726	193323	313890	289985	470835
1989	0.3	0.648	0.815	0.239	0.389	0.02	0.13	108380	0.56	278612	453473	156023	253945	122589	199528
1990	0.3	0.418	0.635	0.341	0.564	0.03	0.26	97479	0.75	172835	285862	129626	214397	43209	71466
1991	0.3	0.462	0.674	0.451	0.657	0.02	0.21	170277	0.65	259174	377554	168463	245410	90711	132144
Mean		0.522	0.723	0.346	0.510	0.024	0.182	307033	0.509	607176	872878	292700	421932	314477	450946

Table 5.3.2.1. Summary of input data for estimation of exploitation rates for Maine origin Atlantic salmon,

Year (i)	Run2 (i+1)	GH2 (i+1)	CH2 (i+1)	USAC (i+1)	NN2 (i+1)	GH1 (i)	CH1 (i)	RUN3 (i+2)	RUN1 (i)
1967	729	18	50	0	161	226	242	19	24
1968	690	135	274	0	274	0	411	18	36
1969	856	0	92	0	92	545	277	17	14
1970	687	100	135	14	14	828	398	49	44
1971	1449	77	12	7	52	2446	295	13	32
1972	1448	118	66	30	20	809	105	59	43
1973	1411	65	9	28	38	1212	220	28	99
1974	2345	73	65	30	7	2615	758	5	116
1975	1341	0	8	0	0	1299	1014	16	231
1976	2025	0	90	30	60	1529	2230	32	98
1977	4145	80	61	0	0	886	940	4	161
1978	1878	0	59	0	0	1066	309	10	847
1980	5122	61	135	0	0	2207	4631	36	1148
1981	6023	143	144	30	60	1908	1147	15	315
1982	1930	104	31	0	20	1283	1603	16	271
1983	3045	69	0	0	0	488	1700	8	388
1984	4855	0	95	0	0	849	1329	24	337
1985	5568	51	66	0	0	1469	2288	52	711
1986	2397	0	0	0	0	2035	552	7	950
1987	2855	38	49	13	0	2087	580	8	896
1988	2946	22	61	44	0	2309	393	21	1267
1989	4370	36	28	0	0	3797	1722	5	654
1990	2057	0	103	0	0	1525	780	6	301
1991	1888	0	0	0	0	1871	1425	6	1178

KEY Run2 = Estimated total run of 2SW salmon to Maine rivers
GH2= Harvest of 2SW salmon in Greenland
CH2= Harvest of 2SW salmon in Canada
USAC= Harvest of 2SW salmon in USA coastal waters
NN2 = Non- Newfoundland 2SW harvests
GH1= Harvest of 1SW salmon in Greenland
CH1= Harvest of 1SW salmon in Canada
RUN3 = Estimated total run of 3SW salmon to Maine Rivers
RUN1 = Estimated total run of 1SW salmon to Maine Rivers

Table 5.3.2.2. Estimated exploitation rate of 1SW salmon for the extant population of Maine origin stocks. Only columns with 0.00 unaccounted for are true extant" exploitation rates.

Natural Mortality	0.12	0.12	0.12	0.12	0.24	0.24	0.24	0.24
Fraction Unaccounted	0	0	0.1	0.1	0	0	0.1	0.1
Adjusted Carlin	1	2	1	2	1	2	1	2

1967	0.30	0.41	0.32	0.43	0.28	0.38	0.38	0.38
1968	0.21	0.26	0.23	0.28	0.19	0.24	0.24	0.24
1969	0.41	0.54	0.44	0.57	0.38	0.51	0.51	0.51
1970	0.52	0.63	0.55	0.66	0.49	0.60	0.60	0.60
1971	0.60	0.74	0.63	0.76	0.58	0.71	0.71	0.71
1972	0.32	0.45	0.34	0.48	0.29	0.42	0.42	0.42
1973	0.45	0.60	0.47	0.62	0.42	0.57	0.57	0.57
1974	0.54	0.69	0.57	0.71	0.52	0.67	0.67	0.67
1975	0.60	0.75	0.63	0.77	0.58	0.73	0.73	0.73
1976	0.60	0.74	0.63	0.76	0.57	0.71	0.71	0.71
1977	0.28	0.42	0.30	0.45	0.25	0.40	0.40	0.40
1978	0.39	0.55	0.41	0.58	0.36	0.52	0.52	0.52
1980	0.53	0.69	0.56	0.71	0.51	0.66	0.66	0.66
1981	0.30	0.45	0.32	0.47	0.28	0.42	0.42	0.42
1982	0.55	0.70	0.58	0.72	0.52	0.67	0.67	0.67
1983	0.39	0.55	0.41	0.58	0.36	0.52	0.52	0.52
1984	0.28	0.44	0.30	0.46	0.26	0.41	0.41	0.41
1985	0.37	0.53	0.39	0.56	0.34	0.51	0.51	0.51
1986	0.49	0.66	0.52	0.68	0.46	0.63	0.63	0.63
1987	0.45	0.61	0.47	0.63	0.42	0.58	0.58	0.58
1988	0.44	0.60	0.47	0.63	0.41	0.57	0.57	0.57
1989	0.53	0.69	0.55	0.71	0.50	0.66	0.66	0.66
1990	0.49	0.65	0.51	0.67	0.46	0.62	0.62	0.62
1991	0.61	0.76	0.63	0.78	0.58	0.74	0.74	0.74

Average: Last Ten Years	0.46	0.62	0.48	0.64	0.43	0.59	0.59	0.59
Average: Time Series	0.44	0.59	0.47	0.61	0.42	0.56	0.56	0.56

Table 5.3.2.3. Estimate exploitation rate of 2SW salmon for the extant population of Maine origin stocks. Only columns with 0.00 unaccounted for are true extant" exploitation rates.

Natural Mortality	0.12	0.12	0.12	0.12	0.24	0.24	0.24	0.24
Fraction Unaccounted	0	0	0.1	0.1	0	0	0.1	0.1
Adjusted Carlin	1	2	1	2	1	2	1	2

1968	0.76	0.87	0.78	0.88	0.74	0.85	0.76	0.86
1969	0.95	0.98	0.96	0.98	0.95	0.97	0.95	0.98
1970	0.83	0.91	0.85	0.92	0.82	0.90	0.83	0.91
1971	0.81	0.90	0.83	0.90	0.79	0.88	0.81	0.90
1972	0.86	0.92	0.87	0.93	0.84	0.92	0.86	0.92
1973	0.74	0.85	0.76	0.86	0.71	0.83	0.74	0.85
1974	0.70	0.83	0.73	0.84	0.68	0.81	0.70	0.83
1975	0.96	0.98	0.97	0.98	0.96	0.98	0.96	0.98
1976	0.31	0.47	0.33	0.50	0.29	0.45	0.31	0.47
1977	0.72	0.84	0.74	0.85	0.70	0.82	0.72	0.84
1978	0.97	0.99	0.98	0.99	0.97	0.98	0.97	0.99
1980	0.84	0.92	0.86	0.92	0.83	0.91	0.84	0.92
1981	0.83	0.91	0.84	0.92	0.81	0.90	0.83	0.91
1982	0.95	0.97	0.95	0.98	0.94	0.97	0.95	0.97
1983	0.89	0.94	0.90	0.94	0.87	0.93	0.88	0.94
1984	0.88	0.94	0.89	0.94	0.87	0.93	0.88	0.94
1985	0.78	0.88	0.80	0.89	0.76	0.87	0.78	0.88
1986	0.67	0.80	0.69	0.82	0.65	0.79	0.67	0.80
1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.90	0.95	0.91	0.95	0.89	0.94	0.90	0.95
1989	0.78	0.88	0.80	0.89	0.76	0.86	0.78	0.88
1990	0.92	0.96	0.93	0.96	0.91	0.96	0.92	0.96
1991	0.94	0.97	0.94	0.97	0.93	0.96	0.94	0.97

Average: Last Ten Years	0.77	0.83	0.78	0.83	0.76	0.82	0.77	0.83
Average: Time Series	0.78	0.85	0.80	0.86	0.77	0.84	0.78	0.85

Table 5.3.2.4. Estimates of exploitation rates for the reduced model in the fisheries of Newfoundland-Labrador and West Greenland for varying levels of P, the fraction of the stock migrating from Canada, (1-P, is fraction from Greenland) and for two levels of adjustment for reporting rate of Carlin tags. The fraction of the stock unaccounted for is assumed to be 0.0 for these estimates.

	Carlin Adjustment=1.0 Evaluation of P-fraction						Carlin Adjustment=2.0 Evaluation of P-fraction					
Year	Can.	Grld.	Can.	Grld.	Can.	Grld.	Can.	Grld.	Can.	Grld.	Can.	Grld.
(i)	0.1	0.9	0.5	0.5	0.9	0.1	0.1	0.9	0.5	0.5	0.9	0.1
1967	0.75	0.24	0.37	0.36	0.25	0.73	0.86	0.38	0.54	0.53	0.40	0.85
1968	0.84	0.00	0.52	0.00	0.37	0.00	0.91	0.00	0.68	0.00	0.54	0.00
1969	0.74	0.39	0.37	0.53	0.24	0.85	0.85	0.56	0.54	0.69	0.39	0.92
1970	0.84	0.54	0.51	0.68	0.37	0.91	0.91	0.71	0.68	0.81	0.54	0.96
1971	0.65	0.63	0.27	0.75	0.17	0.94	0.79	0.77	0.42	0.86	0.29	0.97
1972	0.40	0.36	0.12	0.50	0.07	0.83	0.57	0.53	0.21	0.67	0.13	0.91
1973	0.58	0.46	0.22	0.61	0.14	0.88	0.74	0.63	0.36	0.75	0.24	0.94
1974	0.74	0.53	0.37	0.67	0.24	0.91	0.85	0.69	0.54	0.80	0.39	0.95
1975	0.87	0.49	0.58	0.63	0.43	0.90	0.93	0.66	0.73	0.78	0.60	0.95
1976	0.91	0.43	0.67	0.57	0.52	0.87	0.95	0.60	0.80	0.73	0.69	0.93
1977	0.67	0.17	0.29	0.28	0.19	0.66	0.80	0.30	0.45	0.43	0.31	0.79
1978	0.60	0.36	0.23	0.50	0.14	0.84	0.75	0.53	0.37	0.67	0.25	0.91
1980	0.89	0.30	0.62	0.43	0.48	0.79	0.94	0.46	0.77	0.61	0.64	0.89
1981	0.63	0.24	0.26	0.36	0.16	0.74	0.77	0.39	0.41	0.53	0.28	0.85
1982	0.88	0.40	0.60	0.54	0.45	0.86	0.94	0.57	0.75	0.70	0.62	0.92
1983	0.83	0.14	0.50	0.22	0.36	0.59	0.91	0.24	0.67	0.36	0.53	0.74
1984	0.71	0.15	0.33	0.24	0.22	0.61	0.83	0.26	0.50	0.38	0.35	0.76
1985	0.79	0.21	0.43	0.32	0.29	0.70	0.88	0.34	0.60	0.49	0.45	0.82
1986	0.67	0.46	0.29	0.60	0.19	0.88	0.81	0.63	0.45	0.75	0.32	0.94
1987	0.65	0.42	0.27	0.57	0.17	0.87	0.79	0.59	0.42	0.72	0.29	0.93
1988	0.55	0.44	0.19	0.58	0.12	0.87	0.71	0.61	0.32	0.74	0.21	0.93
1989	0.78	0.46	0.42	0.61	0.28	0.89	0.88	0.63	0.59	0.76	0.44	0.94
1990	0.77	0.42	0.41	0.57	0.28	0.87	0.87	0.60	0.58	0.73	0.43	0.93
1991	0.87	0.50	0.58	0.64	0.43	0.90	0.93	0.66	0.73	0.78	0.60	0.95

AVG	0.73	0.36	0.39	0.49	0.27	0.79	0.84	0.51	0.55	0.64	0.41	0.86
AVG1	0.75	0.36	0.40	0.49	0.28	0.80	0.85	0.51	0.56	0.64	0.42	0.89

AVG is average for entire time series. AVG10 is average for last 10 years.

Table 5.3.3.1 Smolt Age Frequencies by Salmon Fishing Regions of Canada

Stock Area	Fishery Region	Smolt age								Potential Production
		1	2	3	4	5	6	7		
Northern Stocks	Q8		0.02	0.46	0.45	0.07				130
	SFA 1			0.09	0.52	0.36	0.04	0.00		61
	2			0.07	0.55	0.33	0.04			125
	3			0.18	0.77	0.05				2
	4		0.02	0.60	0.35	0.03	0.00			28
	Q9			0.43	0.53	0.04				57
	Q11			0.02	0.45	0.45	0.08			55
	Wtd Ave	0.00	0.01	0.26	0.49	0.22	0.03			458
Southern Stocks	SFA 5		0.02	0.53	0.40	0.05				11
	6			0.67	0.33	0.00				1
	7		0.09	0.78	0.07	0.06				1
	8		0.00	0.86	0.14	0.00				1
	9		0.05	0.73	0.22	0.01				5
	10		0.16	0.77	0.06	0.00				5
	11		0.03	0.73	0.23	0.01				11
	12		0.10	0.60	0.30					2
	13		0.05	0.60	0.30	0.05				58
	14			0.25	0.70	0.05				6
	15		0.20	0.75	0.05					126
	16		0.48	0.50	0.02					208
	17		0.70	0.30						1
	18		0.70	0.30						25
	19		0.70	0.30						5
	20		0.70	0.30						20
	21		0.70	0.30						16
	22		0.52	0.47	0.01					11
	23		0.52	0.47	0.01					40
	Q1		0.15	0.55	0.30					39
	Q2		0.14	0.42	0.40	0.03				23
	Q3		0.15	0.55	0.30					28
	Q4		0.00	0.00	0.00					0
	Q5		0.02	0.65	0.31	0.01				1
	Q6		0.10	0.80	0.10					15
	Q7		0.10	0.72	0.18	0.01				51
	Q10		0.08	0.63	0.27	0.02				25
	Penob	0.50	0.45	0.05						3
	other ME	0.05	0.75	0.20						3
	Merr	0.45	0.50	0.05						0.5
	Conn	0.95	0.05							1
	Wtd Ave	0.00	0.31	0.56	0.12	0.01	0.00			742.5

Table 5.3.3.2. Age Frequency of North American catch at West Greenland 1974-1992

	Smolt age						
Year	1	2	3	4	5	6	7
1974	1	36	37	12	12	3	0
1975	0	17	48	24	6	4	0
1976	1	43	31	15	11	0	0
1977							
1978	3	32	43	14	6	2	1
1979	4	40	41	11	3	1	0
1980	6	36	33	16	8	1	0
1981	4	32	38	19	7	2	0
1982	1	38	38	16	6	1	0
1983	3	47	33	13	4	1	0
1984	5	52	28	9	5	1	0
1985	5	41	36	12	5	1	0
1986	2	40	33	20	4	1	0
1987	4	41	32	17	6	0	0
1988	5	31	31	21	11	1	0
1989	8	39	30	16	6	1	0
1990	9	45	31	12	2	1	0
1991	5	34	44	13	4	1	0
1992	9	45	31	12	2	1	0

Table 5.4.1.1. Estimated Number of 2SW Spawners in North America.

	LABRADOR		NFLD		GULF		QUEBEC		SCOTIA-FUNDY		US	TOTAL	
YEAR	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX
1974	42794	98214	198	1246	32810	65904	8151	24453	7676	11843	1214	92842	202873
1975	40931	93114	201	1285	19313	43088	7087	21261	10018	14312	2034	79583	175093
1976	48147	109558	200	1308	15691	41304	7428	22284	8441	12242	1189	81096	187884
1977	40055	71711	210	1652	34235	72521	10995	32985	11045	16473	1594	98134	196936
1978	33148	75536	0	1557	12717	30291	8805	26415	6157	9490	3518	64345	146807
1979	20007	45761	216	1421	4096	13374	3980	11940	3937	6362	1581	33817	80438
1980	47351	108088	268	1845	21698	48929	11396	34188	12857	20032	4600	98170	217682
1981	43289	98393	374	2428	5294	20025	7629	22887	5548	10705	4614	66748	159052
1982	31373	71892	315	2069	11779	29930	8867	26601	4261	7481	4994	61589	142967
1983	21720	49525	245	1704	7903	22305	5694	17082	2716	5015	1790	40068	97421
1984	14967	34378	332	2008	16226	35134	5814	17442	10175	15462	2646	50159	107069
1985	12604	28633	358	2149	22345	49678	6741	20223	12591	25327	4830	59469	130840
1986	21905	49943	326	1959	35150	73865	7964	23892	12792	24791	5480	83616	179931
1987	27746	63453	351	2108	21330	52408	6633	19899	8477	15713	2632	67169	156213
1988	18220	41888	323	1941	24777	53800	8967	26901	7824	16025	2809	62919	143363
1989	17731	40572	156	934	15987	36695	7615	22845	9435	17845	2809	53733	121700
1990	9933	22865	235	1410	28759	69983	8330	24990	8589	16026	4298	60144	139572
1991	3652	8363	150	902	20952	50714	7737	23211	7693	13178	2409	42593	98777
1992	11060	25848	331	1988	26034	54098	8432	25296	7261	12174	2403	55521	121806
MEAN	26665	59881	252	1680	19847	45476	7803	23410	8289	14237	3023	65880	147707

ESTIMATES BASED ON:

LABRADOR: EST 2SW RETURNS - (ANGLED LARGE * PROP 2SW) WHERE PROP=.7-.9 FOR SFA1 & =.6-.8 FOR SFA 2

INS NFLD: EST 2SW RETURNS - (ANGLED LARGE* PROP 2SW) WHERE PROP=.O67; SPAWNERS =RETURNS FROM 84-92

GULF: EST NO. OF SPAWNERS IN SFA'S 12,13,14,15,16,17,18

QUEBEC: 1X OR 3X THE ESTIMATED ANGLING CATCH OF 2SW SALMON

SCOTIA-FUNDY: EST 2SW RETURNS - ANGLING CATCH OF 2SW WHERE 2SW PROP BASED ON SPECIFIC RANGE IN EACH SFA

US: ESTIMATED2SW RETURNS TO ALL US - ANGLED HARVEST OF 2SW SALMON IN MAINE

Table 5.4.1.2. Pre-fishery abundance of North American stocks forecast values at confidence limit (CL) levels from 10 to 90%.

Percent CL	Pre-Fishery Abundance Numbers
10	58725
15	96807
20	127073
25	153038
30	176356
35	197965
40	218468
45	238305
50	257828
55	277351
60	297188
65	317691
70	339299
75	362618
80	388583
85	418849
90	456931

Table 5.6.1 Summary of Carlin and coded-wire tags recovered in West Greenland, 1987-1991. Variables are defined in the text. Carlin tag estimates and total run size are adjusted for passage efficiency at the counting trap and angler reporting rates in Maine. Total returns of 2SW salmon to Maine represent adjusted totals summed over all salmon rivers in Maine (see Anon., 1992c).

Lottery?	Fishery Year	Tags in River		Total Run (R)
		Carlin(Ne)	CWT(Ni)	
no	1987	319	603	2,855
no	1988	190	634	2,946
yes	1989	172	456	4,370
yes	1990	29	438	2,057
yes	1991	28	601	1,888

Recoveries in Greenland				
Year	Carlin (Te)	CV(Te est)	CWT(Ti)	CV(Ti Est)
1987	166	1,176.64	7.76	10
1988	106	835.43	9.71	13
1989	106	298.12	9.71	13
1990	15	343.46	25.82	26
1991	20	503.27	22.36	28

Table 5.6.2 Logit transformed confidence intervals (interquartile range, 50% CI) for reporting rate estimates. Variables as defined in the text.

Logit Transformation: Confidence intervals Z(aplha=0.5) = 0.6745					
Year	V(r)	r	C	r_low	r_high
1987	0.0014	0.2667	1.1367	0.2424	0.2925
1988	0.0057	0.4234	1.2320	0.3734	0.4750
1989	0.0297	0.9426	8.5857	0.6569	0.9930
1990	0.0736	0.5223	1.8034	0.3775	0.6635
1991	0.1191	0.1700	3.6675	0.5064	0.9324

Table 6.1.1 Nominal catch in tonnes of Atlantic salmon of all ages for Salmon Fishing Areas of Newfoundland and Labrador and Quebec commercial fisheries in 1986-92. Numbers in parentheses are catch totals in numbers of fish. Catches for 1992 are preliminary.

Salmon fishing areas	1986	1987	1988	1989	1990		1991		1992	
					Catch	Quota	Catch	Quota	Catch	Quota
1	89	75	65	76	30	80a	7	80a	20	80a
2	308	407	292	213	149	200	79	200	132	180
3	192	369	192	151	136	155	110	120	-	-
4	200	180	104	133	93	100	56	78	-	-
5	61	60	39	37	24	25	18	25	-	-
6	54	48	25	27	17	20	22	20	-	-
7-11	167	137	82	108	82	82	81	82	-	-
13-14	159	212	174	122	87	95	81e	75	17f	13
Q7-Q9	85	97	89	79	64		73		73	
	(21,802)c	(23,525)c	(22,863)c	(20,525)c	(19,272)	(30,060)b	(19,264)	(28,384)b	(19,363)	(23,400)b
Q11	15d	11d	9d	1d	1	15	2	15	0	15
	(2,794)	(2,212)	(1,647)	(245)	(225)		(389)			
Total	1,329	1,596	1,071	947	683		529		242	

a Allowance.
b Quota was in numbers.
c Quotas for 1986 to 1989 were 33,125 per year.
d Quota was 15t each year.
e 17 tonnes of SFA 14 catch was monitored as part of SFA 2 quota.
f 4 tonnes of SFA 14 catch was monitored as part of SFA 2 quota.

Table 6.1.2 Preliminary 1992 catches by recreational (R), native (N), and commercial (C) fisheries in Canada by province (in kg round fresh weight).

	Small salmon		Large salmon		Total	Total
	(kg)	(%)	(kg)	(%)	(kg)	(%)
QUEBEC						
R	14,185	7.9	65,550	22.5	79,735	17.0
N	233	0.1	11,457	3.9	11,690	2.5
C	6,926	3.9	66,026	22.7	72,952	15.5
Total	21,344	11.9	143,033	49.2	164,377	35.0
NFLD						
R	42,799	23.9	3,300	1.1	46,099	9.8
N	672	0.4	14	0.0	686	0.1
C	38,920	21.8	129,354	44.5	168,274	35.8
Total	82,391	46.1	132,668	45.6	215,059	45.8
NB						
R	63,568	35.6	0	0.0	63,568	13.5
N	2,852	1.6	11,580	4.0	14,432	3.1
C	0	0.0	0	0.0	0	0.0
Total	66,420	37.2	11,580	4.0	78,000	16.6
NS						
R	8,257	4.6	0	0.0	8,257	1.8
N	310	0.2	3,436	1.2	3,746	0.8
C	0	0.0	0	0.0	0	0.0
Total	8,567	4.8	3,436	1.2	12,003	2.6
PEI						
R*	0	0.0	0	0.0	0	0.0
N	0	0.0	0	0.0	0	0.0
C	0	0.0	0	0.0	0	0.0
Total	0	0.0	0	0.0	0	0.0
TOTAL						
R	128,809	72.1	68,850	23.7	197,659	42.1
N	4,067	2.3	26,487	9.1	30,554	6.5
C	45,846	25.7	195,380	67.2	241,226	51.4
Total	178,772	100.0	290,717	100.0	469,439	100.0

*No catch statistics collected.

Table 6.1.3 Nominal catches (tonnes) in Newfoundland and Labrador commercial Atlantic salmon fishery, 1971-1992. Catches for 1992 are preliminary.

Year	Small	Large	Total[1]	Quota[2]
1971	-	-	1,577	-
1972	-	-	1,394	-
1973	-	-	2,011	-
1974	-	-	2,010	-
1975	750	1,294	2,043	-
1976	632	1,380	2,013	-
1977	533	1,404	1,938	-
1978	274	907	1,180	-
1979	494	495	987	-
1980	809	1,295	2,103	-
1981	676	1,233	1,910	-
1982	578	743	1,321	-
1983	417	611	1,028	-
1984	332	465	797	-
1985	470	411	881	-
1986	608	622	1,230	-
1987	705	780	1,485	-
1988	511	461	972	-
1989	431	436	867	-
1990	284	334	618	677
1991	244	210	454	600
1992	39	129	168	193

[1] Difference between total and sum of small and large are due to rounding.

[2] Excludes an allowance of 80 t for SFA 1.

Table 6.1.4 Preliminary landings, in tonnes, of Atlantic salmon harvested in the commercial fisheries in Atlantic Canada, 1992. Comparisons are made to the average landings, 1987-1991.

SFA	Small		Large		Total	
	Weight (t)	% change 1987-1991	Weight (t)	% Change 1987-1991	Weight (t)	% change 1987-1991
1	5	-61	16	-57	20	-60
2	32	-63	99	-30	132	-42
14B	3	-82	14	-50	17	-6
Q7	<1	-62	3	-68	3	-68
Q8	<1	-67	21	-38	21	-39
Q9	7	22	42	20	49	20
Q11	0	-100	0	-100	0	-100

Table 6.1.5 Preliminary landings, in numbers, of Atlantic salmon harvested in the recreational fisheries in Atlantic Canada, 1992. Comparisons are made to the average landings, 1987-1991.

SFA	Small		Large		Total	
	Numbers	% change 1987-1991	Numbers[3]	% change 1987-1991	Numbers	% change 1987-1991
1	164	-80	286	158	450	-51
2	1,718	-17	257	24	1,975	-13
3	1,562	28	0	-	1,562	28
4	5,290	-11	0	-	5,290	-11
5	1,941	-17	0	-	1,941	-17
6	230	-14	0	-	230	-14
7	40	-35	0	-	40	-35
8	closed					
9	690	-42	0	-	690	-42
10	245	-65	0	-	245	-65
11	2,273	-37	0	-	2,273	-37
12	639	-26	0	-	639	-26
13	5,439	-7	0	-	5,439	-7
14	5,634	-5	238	+79	5,872	-3
15	5,157	10	0	-	5,157	10
16	24,215	92	0	-	24,215	92
17[1]	-	-	0	0	-	-
18	1,249	3	0	-	1,249	3
19	475	-37	0	-	475	-37
20	930	-57	0	-	930	-57
21	2,310	-25	0	-	2,310	-25
22	18	NA	0	-	18	NA
23	3,452	15	0	-	3,452	15
Q1	1,620	37	3,114	-7	4,734	16
Q2	1,012	143	2,102	40	3,114	63
Q3	1,380	91	1,347	23	2,727	50
Q4[2]	0	-	0	-	0	-
Q5	88	69	98	113	186	90
Q6	385	16	628	37	1,013	28
Q7	520	-49	531	-3	1,051	-33
Q8	1,040	19	3,568	21	4,608	20
Q9	1,495	24	189	-56	1,684	3
Q10	351	-15	353	-32	704	-24
Q11	190	-81	116	-85	306	-83

[1] No catch statistics collected for 1991 or 1992.

[2] No rivers in this zone contain salmon.

[3] No retention allowed in SFA 3-7, 9-13,15,16,18-22.

NA season closed on almost all rivers in area in 1992.

Table 6.1.6 Annual quotas, catch and % change of the catch compared to quota for 1992, in number, for the recreational fishery in Newfoundland-Labrador by SFA; quotas and catch are for retained fish only, all sizes combined.

SFA	Quota	Catch	% change of catch from quota
1	442	450	2
2	2,160	1,975	-9
3	1,300	1,562	20
4	4,800	5,290	10
5	2,000	1,941	-3
6	200	230	15
7	40	40	0
8	closed		
9	600	690	15
10	200	245	23
11	1,700	2,273	34
12	600	639	7
13	5,000	5,439	9
14a	3,900	4,778	23
14b	1,100	1,094	-1
Total	24,042	26,646	11

Table 6.1.1.1. The number of salmon examined for CWTs, periods of sampling and origin of tags recovered in Canada, 1992.

Location	Sampling Period	Number Examined	Adipose Clipped	Percent Clipped	Origin		Total CWT	Percent CWT
					Canada	USA		
Cartwright	7/2-7/30	6119	2	0	0	1	1	0.0
Fox Harbour	7/1-7/22	2004	11	1	1	5	6	0.3
W. St. Modeste	6/29-7/14	311	7	2	0	1	1	0.3
Makkovik	7/24-8/17	1887	26	1	0	11	11	0.6
Rigolet	7/8-7/28	2023	5	0	0	0	0	0.0
Total		12344	51		1	18	19	
Average								0.2

Table 6.1.2.1. Carlin tag returns from 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area. (99=unknown area)

	SFA															
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	99	TOT
1967	3	1	7	14	5	0	4	0	1	1	2	0	0	0	2	40
1968	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3
1969	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	3
1970	5	2	13	5	1	1	0	1	0	1	0	0	0	0	0	29
1971	10	2	4	18	10	3	0	0	0	0	1	0	0	0	0	48
1972	6	1	0	0	4	0	0	0	0	0	0	1	0	0	0	12
1973	6	1	6	4	1	1	1	3	1	0	0	0	0	1	0	25
1974	0	5	19	38	13	10	5	3	3	3	0	1	0	3	0	103
1975	16	4	18	36	13	6	1	4	1	2	0	0	0	1	0	102
1976	18	6	26	14	5	5	0	0	0	3	2	0	0	1	0	80
1977	2	1	6	5	0	0	0	0	0	1	1	0	0	0	0	16
1978	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5
1980	55	24	112	72	22	6	0	3	2	3	12	0	0	3	1	315
1981	14	0	2	10	7	5	1	0	1	0	0	0	0	1	0	41
1982	14	7	20	21	7	6	1	0	0	1	4	0	2	2	0	85
1983	8	1	11	6	0	0	0	0	0	0	0	0	0	0	0	26
1984	12	4	7	7	4	2	1	0	0	1	1	0	0	0	0	39
1985	20	3	15	36	11	1	3	2	0	0	0	0	0	2	1	94
1986	3	5	6	2	1	0	0	1	0	0	0	0	0	3	0	21
1987	14	2	16	4	6	2	0	2	1	1	0	0	0	0	1	49
1988	8	2	5	0	1	0	1	0	0	1	1	0	0	1	0	20
1989	25	5	10	6	4	1	1	1	0	1	0	0	0	0	0	54
1990	0	2	2	2	0	0	0	0	0	0	2	0	0	0	0	8
1991	0	0	13	1	1	0	0	0	0	0	0	0	0	0	0	15
1992	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	4
Unk	4	0	2	4	0	0	1	1	0	0	1	0	0	1	0	14
TOT	247	79	324	308	117	50	20	22	10	19	27	2	2	19	5	1251

Table 6.1.2.2. Estimated harvest of 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area. (99=unknown area)

	SFA															
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	99	TOT
1967	14	5	43	87	31	0	25	0	6	6	12	0	0	0	12	242
1968	0	0	0	274	137	0	0	0	0	0	0	0	0	0	0	411
1969	0	0	185	0	0	0	0	92	0	0	0	0	0	0	0	277
1970	56	23	188	72	14	14	0	14	0	14	0	0	0	0	0	398
1971	51	10	26	117	65	20	0	0	0	0	7	0	0	0	0	295
1972	47	8	0	0	40	0	0	0	0	0	0	10	0	0	0	105
1973	44	7	56	38	9	9	9	28	9	0	0	0	0	9	0	220
1974	0	29	141	283	97	74	37	22	22	22	0	7	0	22	0	758
1975	129	32	187	374	135	62	10	42	10	21	0	0	0	10	0	1014
1976	418	139	777	418	149	149	0	0	0	90	60	0	0	30	0	2230
1977	95	48	368	307	0	0	0	0	0	61	61	0	0	0	0	940
1978	234	0	75	0	0	0	0	0	0	0	0	0	0	0	0	309
1980	666	291	1744	1121	343	93	0	47	31	47	187	0	0	47	16	4631
1981	330	0	61	303	212	151	30	0	30	0	0	0	0	30	0	1147
1982	217	109	399	419	140	120	20	0	0	20	80	0	40	40	0	1603
1983	441	55	779	425	0	0	0	0	0	0	0	0	0	0	0	1700
1984	350	117	262	262	150	75	37	0	0	37	37	0	0	0	0	1329
1985	400	60	386	926	283	26	77	51	0	0	0	0	0	51	26	2288
1986	67	112	172	57	29	0	0	29	0	0	0	0	0	86	0	552
1987	139	20	204	51	77	26	0	26	13	13	0	0	0	0	13	580
1988	138	34	111	0	22	0	22	0	0	22	22	0	0	22	0	393
1989	708	142	364	218	146	36	36	36	0	36	0	0	0	0	0	1722
1990	0	161	207	207	0	0	0	0	0	0	207	0	0	0	0	780
1991	0	0	1235	95	95	0	0	0	0	0	0	0	0	0	0	1425
TOT	4544	1400	7971	6055	2173	857	305	388	123	390	673	17	40	349	66	25351

Table 6.1.2.3. Estimated total run size of 1SW and 2SW salmon returning to Maine rivers and estimated harvests of 1SW salmon in Newfoundland and Labrador fisheries. All run size and harvest estimates are computed assuming 85 percent fish passage efficiency.

Year i	Run			Harvest i	Harvest /2SW Ru Ratio
	1SW i	2SW i+1	1/2SW Ratio		
1967	100	729	0.138	242	0.332
1968	24	690	0.035	411	0.595
1969	36	856	0.041	277	0.324
1970	14	687	0.021	398	0.579
1971	44	1449	0.030	295	0.204
1972	32	1448	0.022	105	0.072
1973	43	1411	0.030	220	0.156
1974	99	2345	0.042	758	0.323
1975	116	1341	0.086	1014	0.756
1976	231	2025	0.114	2230	1.101
1977	98	4145	0.024	940	0.227
1978	161	1878	0.086	309	0.165
1979	251	5662	0.044	NA	NA
1980	847	5122	0.165	4631	0.904
1981	1148	6023	0.191	1147	0.191
1982	315	1930	0.163	1603	0.831
1983	271	3045	0.089	1700	0.558
1984	388	4855	0.080	1329	0.274
1985	337	5568	0.061	2288	0.411
1986	711	2397	0.297	552	0.230
1987	950	2855	0.333	580	0.203
1988	896	2946	0.304	393	0.134
1989	1267	4370	0.290	1722	0.394
1990	654	2057	0.318	780	0.379
1991	301	1888	0.159	1425	0.755

NA=Not Available since no smolts were tagged in 1978.

Table 6.1.2.4. CWT and Carlin tag based harvest estimates for sampled areas in Canada, 1991.

STOCK			HARVEST		CWT	METHODS
Location (1)	CATCH	SCAN	CWT	CARLIN	CV	RATIO
MAINE RIVERS						
Statistical Sections						
SS 3	13640	8682	165.9	190.0	21	0.87
SS 3 + UNK	13640	8682	165.9	285.0	21	0.58
SS 4	18842	6207	236.0	380.1	6	0.62
SS 4 + UNK	18842	6207	236.0	475.1	6	0.50
SS 6	6212	1594	135.9	0.0	18	
SS 7	4134	1076	0.0	0.0		
SS 8	1447	421	0.0	0.0		
SS 8 + UNK	1447	421	0.0	95.0		
SS 9	2518	28	0.0	0.0		
SS 52	12048	1093	0.0	0.0		
Totals	58841	19101	537.7	570.1		0.94
Totals + UNK	58841	19101	537.7	855.1		0.63
MAINE RIVERS						
Salmon Fishing Areas						
SFA 3	38787	14889	417.6	855.1	7	0.49
SFA 3 + UNK	38787	14889	417.6	1045.2	7	0.40
SFA 4	16912	3117	94.6	0.0	4	
SFA 4 + UNK	16912	3117	94.6	95.0	4	1.00
Totals	55699	18006	512.2	855.1		0.60
Totals + UNK	55699	18006	512.2	1140.2		0.45
CONNECTICUT RIVER						
Salmon Fishing Areas						
SFA 3	38787	14889	382.3		4	
SFA 4	16912	3117	210.6		2	
Totals	55699	18006	592.9			
MERRIMACK RIVER						
Salmon Fishing Areas						
SFA 3	38787	14889	107.0		11	
SFA 4	16912	3117	33.3		4	
Totals	55699	18006	140.3			

(1) UNK indicates Carlin estimates include tags of unknown recovery date.

Table 6.4.1.1 Estimates of small and large salmon by weight (a) and by number (b) which were not harvested in 1991 due to the early closure of the commercial fisheries. Number in parenthesis is the percent of the harvest which would not have been caught, 1984-1989 if the season was closed on the same date as in 1991.

a) 1991

SFA	Harvest (t)	Predicted weight (t) not caught			
		Min	Max	Mean (%)	
		Small salmon			
3	52	<1	<1	<1	(<1)
5	12	<1	3	2	(11)
6	12	1	7	3	(20)
7	6	<1	<1	<1	(5)
8	3	<1	<1	<1	(6)
9	5	1	5	2	(32)
10	12	3	5	4	(24)
11	8	2	11	4	(36)
13	25	4	17	6	(21)
Total	135			21	
		Large salmon			
3	56	<1	3	<1	(1)
5	6	<1	<1	<1	(9)
6	6	<1	3	1	(15)
7	6	<1	1	<1	(7)
8	4	<1	<1	<1	(3)
9	1	<1	1	<1	(26)
10	6	<1	3	1	(14)
11	20	1	12	5	(19)
13	4	<1	2	≤1	(17)
Total	109			9	

b) 1991

SFA	Harvest (n)	Predicted number not caught			
		Min	Max	Mean (%)	
		Small salmon			
3	27,722	11	78	25	(<1)
5	6,781	400	1,513	837	(11)
6	6,926	643	3,783	1,749	(20)
7	3,187	71	266	172	(5)
8	1,904	94	194	122	(6)
9	3,080	504	3,202	1,524	(32)
10	6,533	1,515	2,921	2,071	(24)
11	4,158	1,057	5,750	2,276	(35)
13	15,688	2,274	9,960	3,895	(20)
Total	75,979			12,572	
		Large salmon			
3	13,696	43	772	189	(1)
5	2,066	124	320	205	(9)
6	1,726	130	927	316	(15)
7	1,534	40	301	109	(7)
8	959	8	64	25	(3)
9	176	6	227	61	(26)
10	1,859	134	775	300	(14)
11	4,616	279	2,669	1,098	(19)
13	871	77	321	168	(16)

Table 6.4.1.2. Cumulative catch, effort, and catch per unit effort (CPUE) to the date of closure of the recreational fishery for the retention of Atlantic salmon in each SFA, in 1992.

			Small salmon catch			Large salmon catch		
SFA	Quota	Date Caught	1992	1991	Mean 84-89*	1992	1991	Mean 84-89*
1	442	Aug. 28	164	79	858	286	8	153
2	2160	Aug. 8	1718	585	1690	257	27	159
14B	1100	Aug. 12	920	1026	1224	238	48	162
Labrador	3702		2802	1690	3772	781	83	474
3	1300	July 24	1562	704	787			
4	4800	July 24	5290	1932	5542			
5	2000	July 19	1941	461	1407			
6	200	Aug. 9	230	106	288			
7	40	Aug. 4	40	11	72			
8	Closed							
9	600	July 13	690	347	1194			
10	200	July 4	245	34	486			
11	1700	July 5	2273	692	3300			
12	600	July 6	639	157	612			
13	5000	Aug. 1	5439	3762	5230			
14A	3900	Aug. 12	4778	2647	4130			
Ins. NFLD	20340		23127	10853	23048			

			Effort (roddays)			CPUE		
SFA	Quota	Date Caught	1992	1991	Mean 84-89*	1992	1991	Mean 84-89*
1		Aug. 28	675	835	1094	0.67	0.10	0.92
2		Aug. 8	2636	1808	2008	0.75	0.34	0.92
14B		Aug. 12	4219	3508	4311	0.27	0.31	0.32
Labrador			7530	6151	7413	0.48	0.29	0.57
3		July 24	2884	2262	1499	0.54	0.31	0.53
4		July 24	15097	10316	17576	0.35	0.19	0.32
5		July 19	5830	2395	4801	0.33	0.19	0.29
6		Aug. 9	2028	1135	2180	0.11	0.09	0.13
7		Aug. 4	1070	325	885	0.04	0.03	0.08
8								
9		July 13	4956	4561	4976	0.14	0.08	0.24
10		July 4	1520	1091	1961	0.16	0.03	0.25
11		July 5	5857	3439	8106	0.39	0.20	0.41
12		July 6	1716	934	1592	0.37	0.17	0.38
13		Aug. 1	19010	15332	17991	0.29	0.25	0.29
14A		Aug. 12	15019	10820	13866	0.32	0.24	0.30
Ins. NFLD			74987	52610	75433	0.31	0.21	0.31

* 1987 Not included in SFAs 3-11

Table 6.4.1.3. Percentage change in cumulative recreational catch, effort, and catch per unit of effort (CPUE) to the date of closure of the recreational fishery for the retention of Atlantic salmon in each SFA in 1992, in relation to 1991 and the 1984-89 mean.

	Small Salmon Catch		Large salmon catch		Effort (roddays)		CPUE	
SFA	1991	Mean 84-89*	1991	Mean 84-89*	1991	Mean 84-89*	1991	Mean 84-89*
1	107.6%	-80.9%	3475.0%	86.9%	-19.2%	-38.3%	570.0%	-27.2%
2	193.7%	1.7%	851.9%	61.6%	45.8%	31.3%	120.6%	-18.5%
14B	-10.3%	-24.8%	395.8%	46.9%	20.3%	-2.1%	-12.9%	-15.6%
Labrador	65.8%	-25.7%	841.0%	64.8%	22.4%	1.6%	65.5%	-15.8%
3	121.9%	98.5%			27.5%	92.4%	74.2%	1.9%
4	173.8%	-4.5%			46.3%	-14.1%	84.2%	9.4%
5	321.0%	38.0%			143.4%	21.4%	73.7%	13.8%
6	117.0%	-20.1%			78.7%	-7.0%	22.2%	-15.4%
7	263.6%	-44.4%			229.2%	20.9%	33.3%	-50.0%
8								
9	98.8%	-42.2%			8.7%	-0.4%	75.0%	-41.7%
10	620.6%	-49.6%			39.3%	-22.5%	433.3%	-36.0%
11	228.5%	-31.1%			70.3%	-27.7%	95.0%	-4.9%
12	307.0%	4.4%			83.7%	7.8%	117.6%	-2.6%
13	44.6%	4.0%			24.0%	5.7%	16.0%	-0.0%
14A	80.5%	15.7%			38.8%	8.3%	33.3%	6.7%
Ins. NFLD	113.1%	0.3%			42.5%	-0.6%	47.6%	-0.0%

* 1987 Not included in SFAs 3-11.

Table 6.4.2.1 Estimates of numbers of 1SW salmon of Maine-origin which would not have been harvested in the Newfoundland and Labrador commercial fisheries, 1984-1989, if the fisheries were closed each year on the same day that the fisheries were closed in 1991. The number in parenthesis is the percentage of the total numbers of 1SW Maine-origin caught in SFA.

SFA	Date fishery closed in 1991	Year										
		1984		1985		1986	1987		1988	1989	Mean (%)	
3	23 Sep	37	(25)	77	(75)	0	0		0	0	19	(13)
5	25 Jul	37	(33)	51	(66)	0	0		0	0	15	(22)
6	21 Jul	5	(7)	26	(100)	0	0		0	0	5	(55)
7	27 Jul	0		0		0	0		0	0	0	
8	26 Jul	0		0		0	0		0	0	0	
9	13 Jul	0		0		0	0		0	0	0	
10	11 Jul	0		0		0	13	(100)	0	0	2	(12)
11	29 Jun	37	(100)	0		0	0		0	0	6	(100)
13	6 Jul	0		0		0	0		0	0	0	
Total		116	(29)	154	(60)	0	13	(4)	0	0	47	(15.5)
Standard deviation											69.27	(24.56)

Table 7.1 Production of farmed salmon in the North Atlantic area (in tonnes round fresh weight), 1980-1992.

Year	Scotland	Norway	Iceland	Canada	Northern Ireland	Faroe Islands	USA	Russia	Ireland	Total
1980	598	4,153		11					21	4,783
1981	1,13	8,22		21					35	9,611
1982	2,152	10,266		38		70			100	12,626
1983	2,536	17,000		69		110			257	19,972
1984	3,912	22,300		227		120			385	26,944
1985	6,921	28,655	91	359		470			700	37,196
1986	10,338	45,675	123	672		1,370			1,215	59,393
1987	12,721	47,417	490	1,334		3,530	365		2,232	68,089
1988	17,951	80,371	1,053	3,542		3,300	455		4,700	111,372
1989	28,553	124,000	1,480	5,865		8,000	905		5,063	173,871
1990	32,350	165,000	2,800	7,810	<100	13,000	2,086	5	5,983	229,034
1991	40,593	155,000	2,680	9,395	100	15,000	4,560	0	9,483	236,711
1992	36,101	140,000	2,100	10,380	200	17,000	5,850	0	9,231	220,862

Table 8.1 Number of microtags, external tags and finclips applied to Atlantic salmon by countries for 1992.

Country	Stock	Microtags[5]	External tags	Untagged fish		Comments
				Adipose clip only	Other finclip combinations	
Canada	H[3]	24,265	58,091[1]	1,621,733	-	[1] 40,838 ext. tagged fish were finclipped.
	W[4]	26,214	12,096[2]	3,487	-	[2] 1,175 ext. tagged fish include some of hatchery origin.
Denmark	H	-	11,095	-	-	
	W	-	-	-	-	
Finland	H	-	-	-	8,469	[1] Adults, radiotagged in cooperation with Norway.
	W	-	91[1]	97,795	-	
France	H	19,188	13,541[1]	97,795	8,469	[1] Including 480 Visible Implant tags; colour markings.
	W		-	330		
Iceland	H	347,771	1,531[1]	-	-	[1] Adults tagged with Spaghetti tags.
	W	5,182	-	-	-	
Ireland	H	296,515	-	-	-	
	W	2,503	-	-	-	
Norway	H	34,700	163,472[1]	166,400	5,000[2]	[1] Includes 35,800 Visible Implant tags.
	W	-	3,598	-		[2] Maxillary bone clips.
Russia	H	-	2,600	265,900	-	
	W	-	-	-	-	
Sweden (West coast)	H	-	5,969	-	28,280	
	W	-	-	-	-	
UK (England & Wales)	H	388,079	28[1]	75,155	-	[1] Adults.
	W		2,043[2]			[2] Adults and kelts with radio tags.
UK Scotland)	H	21,591	3,562[1]	-	-	[1] Includes 79 adults.
	W	16,538	-	-	-	
UK (N. Ireland)	H	22,384[1]	-	-	-	[1] Includes 5057 fish with dye marks.
	W	998	-	-	-	
USA	H	622,428	50,075[2]	-	50,342[1]	[1] Left ventral.
	W	1,193	47[2]	-		[2] Includes 132 adults.
Total	H	1,776,921	309,964	2,226,983	92,091	4,405,959
	W	65,725	17,784	3,817	243	87,569
Grand Total		**1,842,646**	**327,748**	**2,230,800**	**92,334**	**4,493,528**

[3]Hatchery origin.
[4]Wild origin.
[5]Micro-tagged fish are also adipose clipped unless otherwise noted.

Figure 3.2.1.1. Wild juvenile Atlantic salmon production in monitored European rivers.

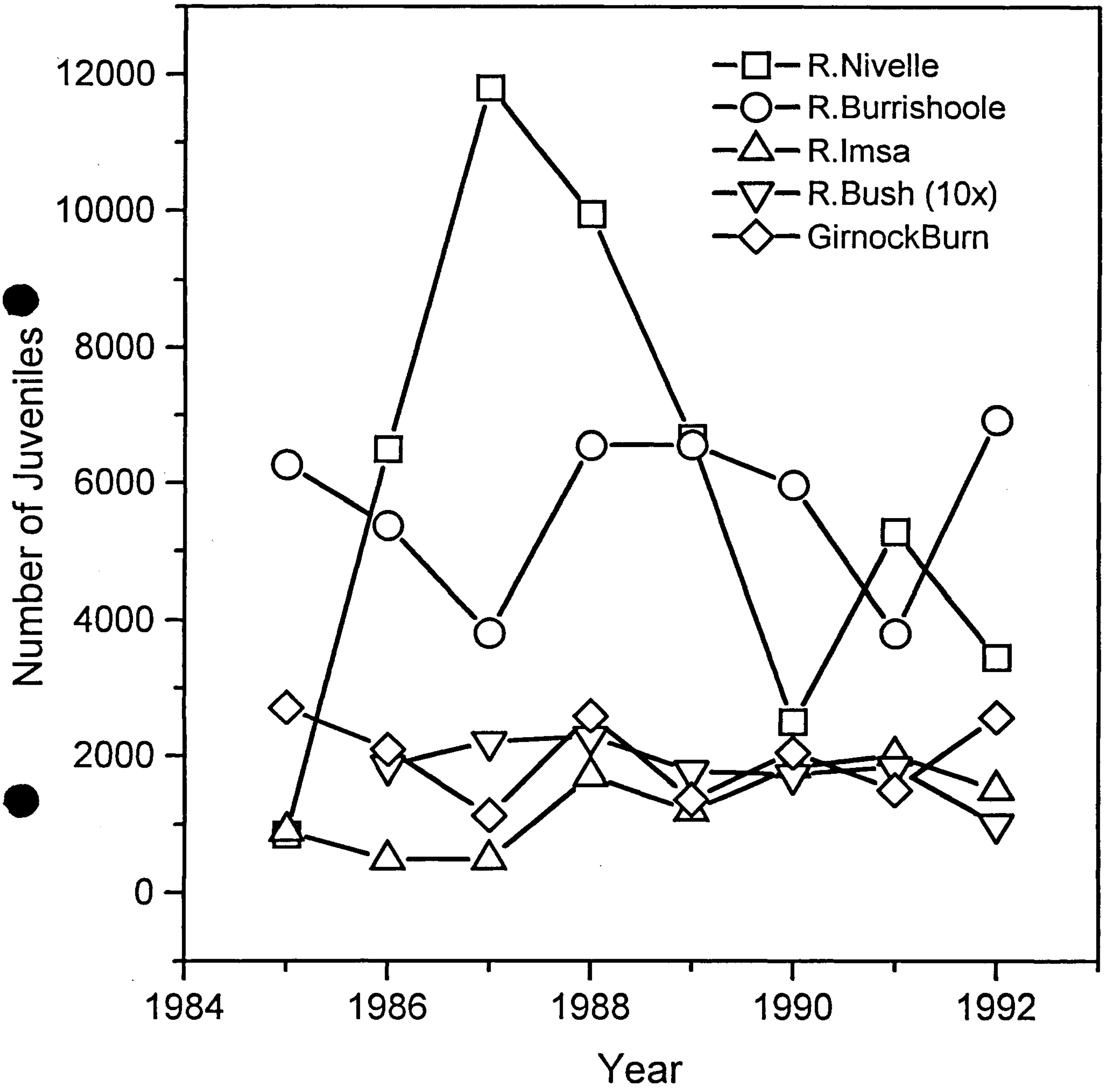


Figure 3.2.2.1. Counts of wild Atlantic salmon in monitored European rivers.

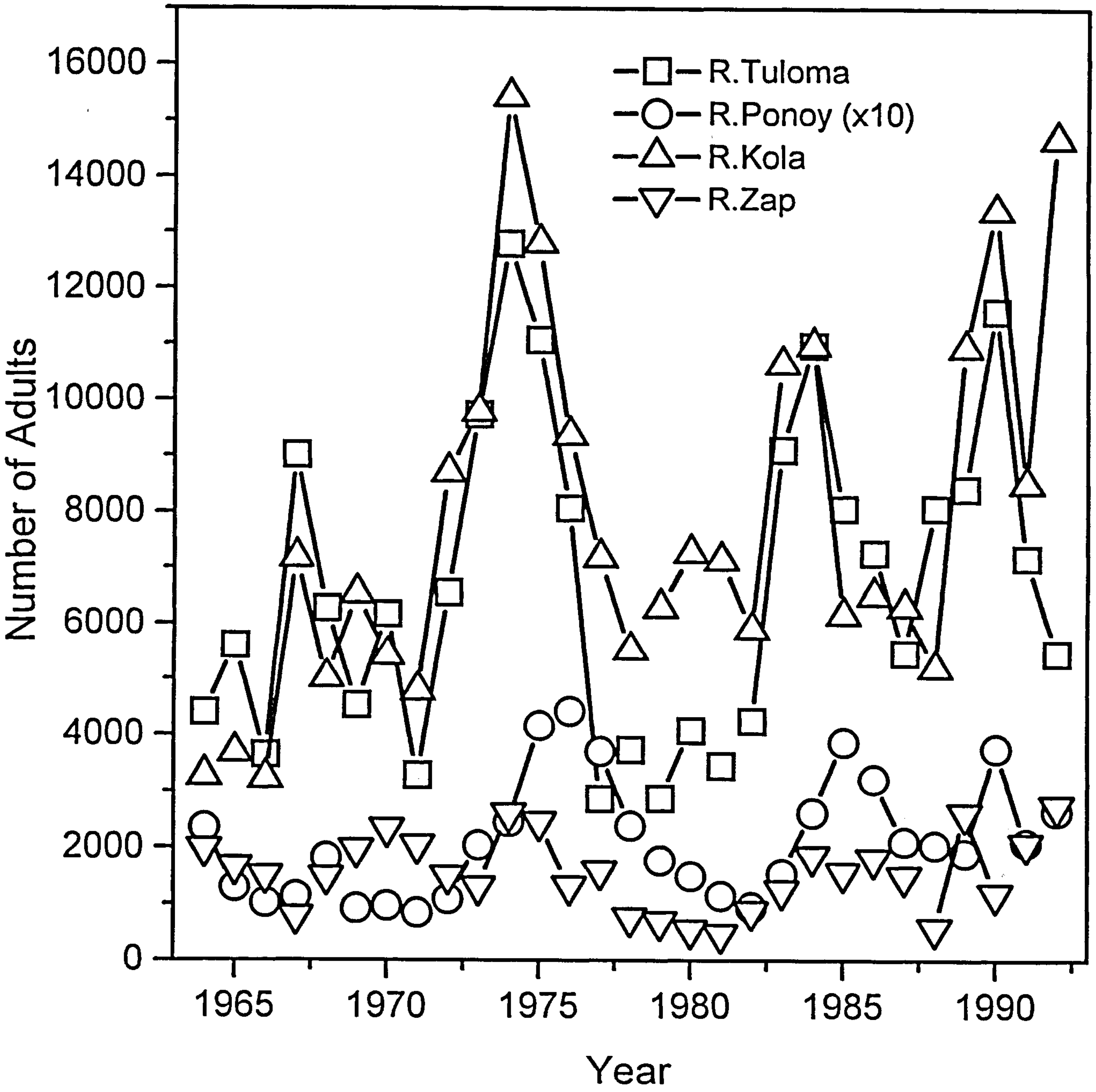


Figure 3.2.3.1. Percent survival of wild 1SW Atlantic salmon to freshwaters for monitored European rivers.

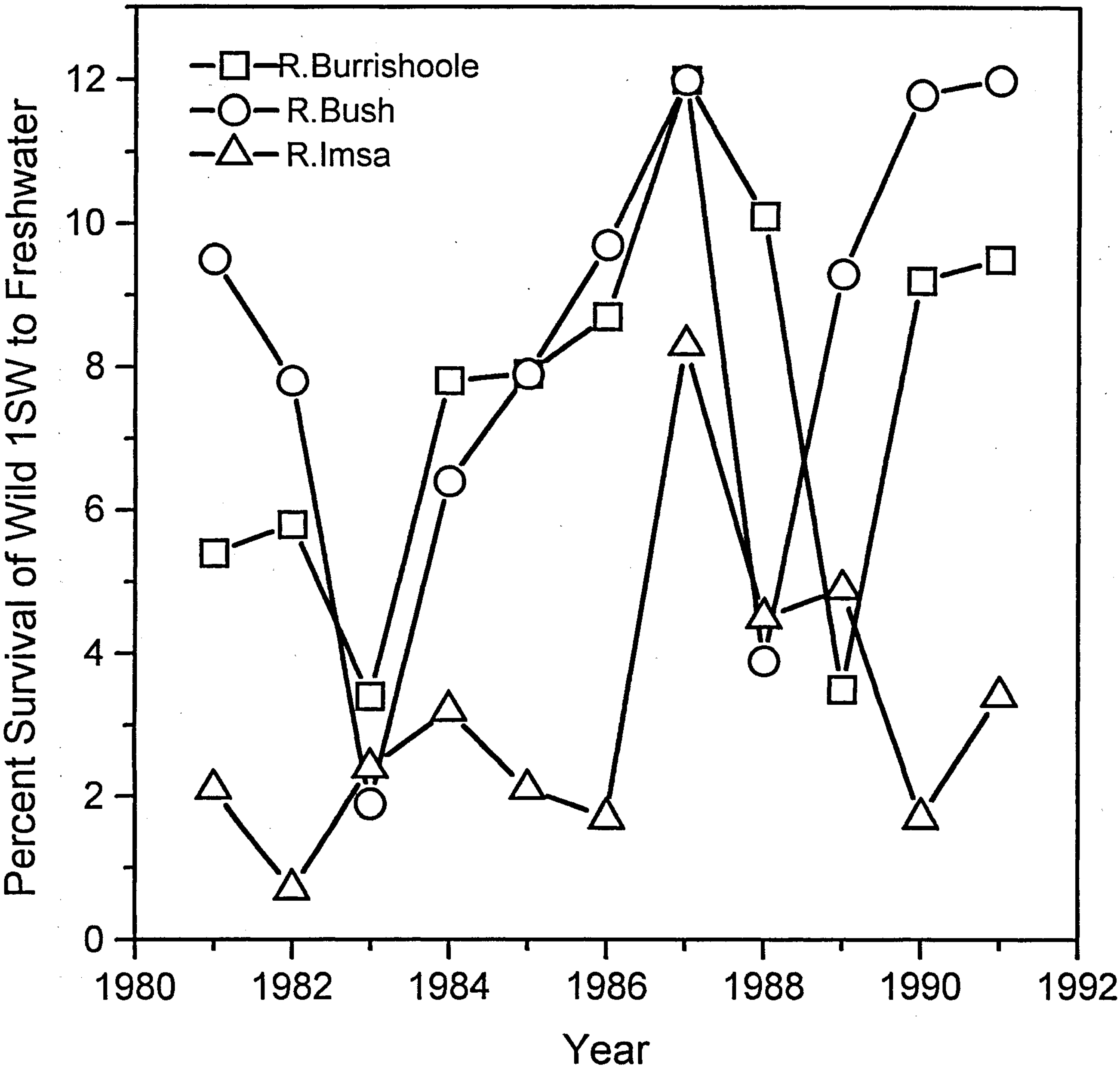


Figure 3.2.3.2. Percent survival of hatchery origin 1SW Atlantic salmon to homewater areas for monitored European rivers.

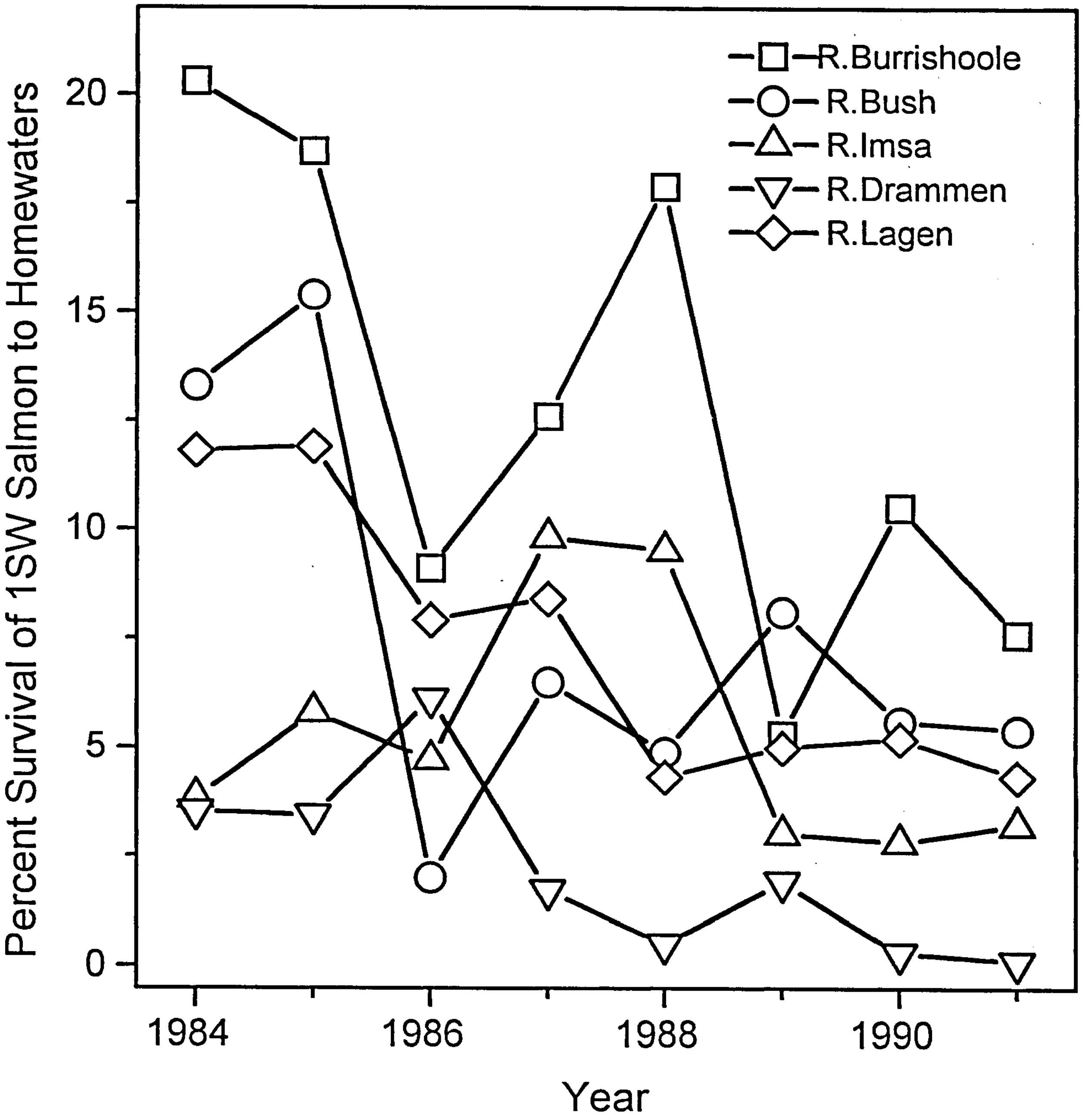


Figure 3.3.1.1. Map of Eastern Canada showing Salmon Fishing Areas (SFA).

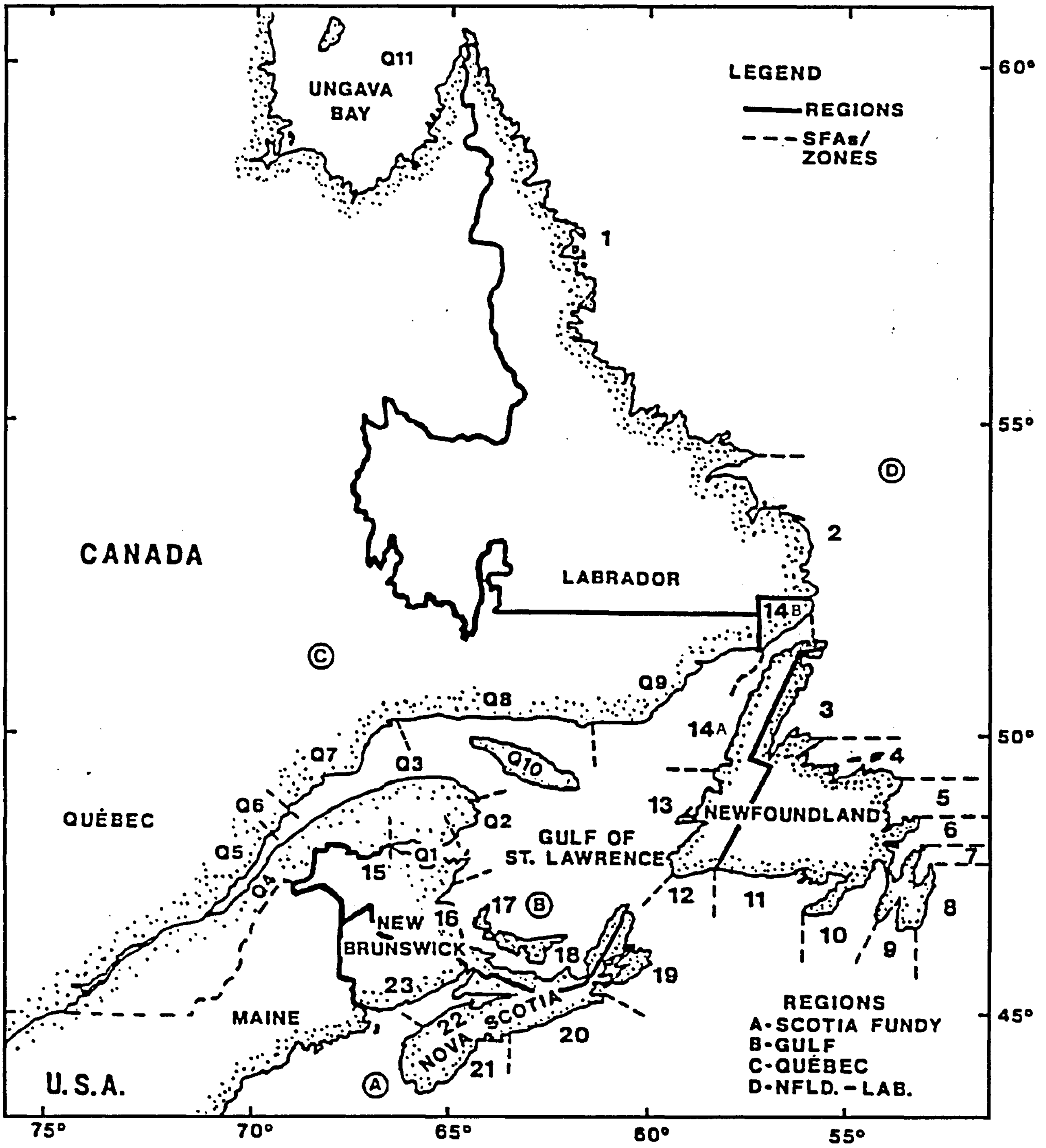


Figure 3.3.1.2. Recreational harvest of wild 2SW Atlantic salmon from Maine, USA (limited to the Dennys, E. Machias, Machias, Narraguagus, and Sheepscot rivers).

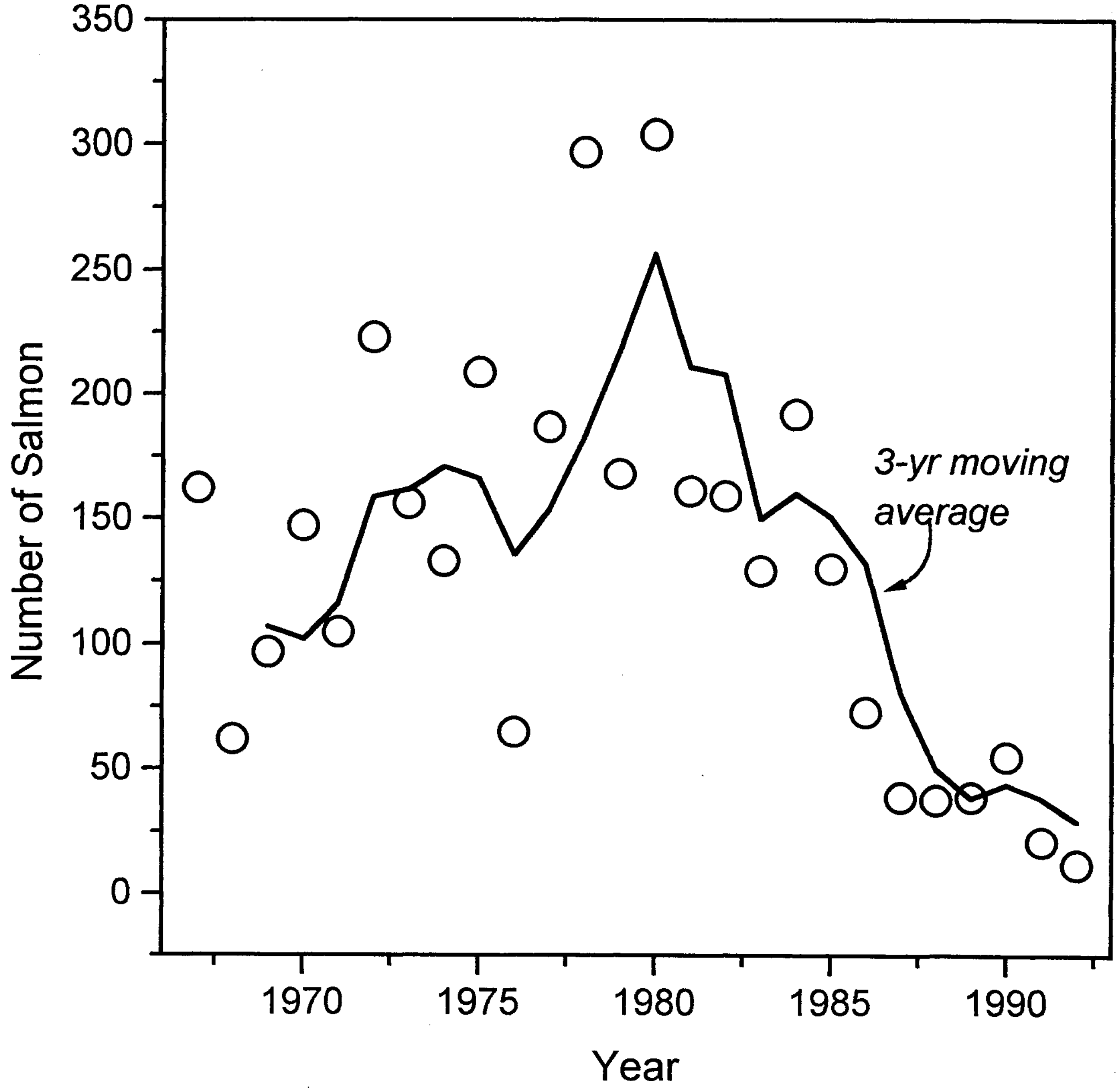


Figure 3.3.1.3. Smoothed Z-scores of counts and estimates of small salmon ascending 21 rivers in Canada.

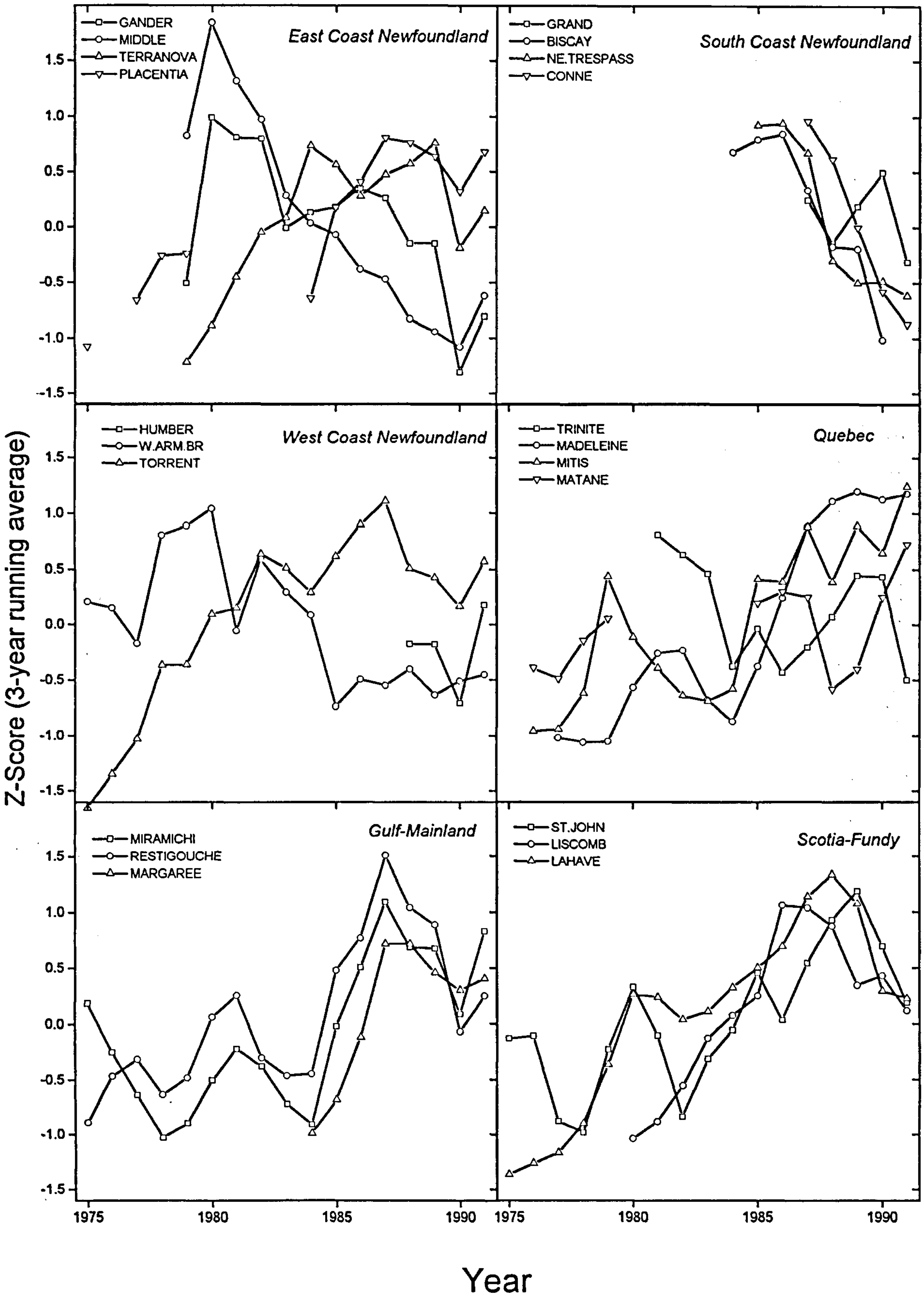


Figure 3.3.1.4. Smoothed Z-scores of counts and estimates of large salmon ascending 21 rivers in Canada.

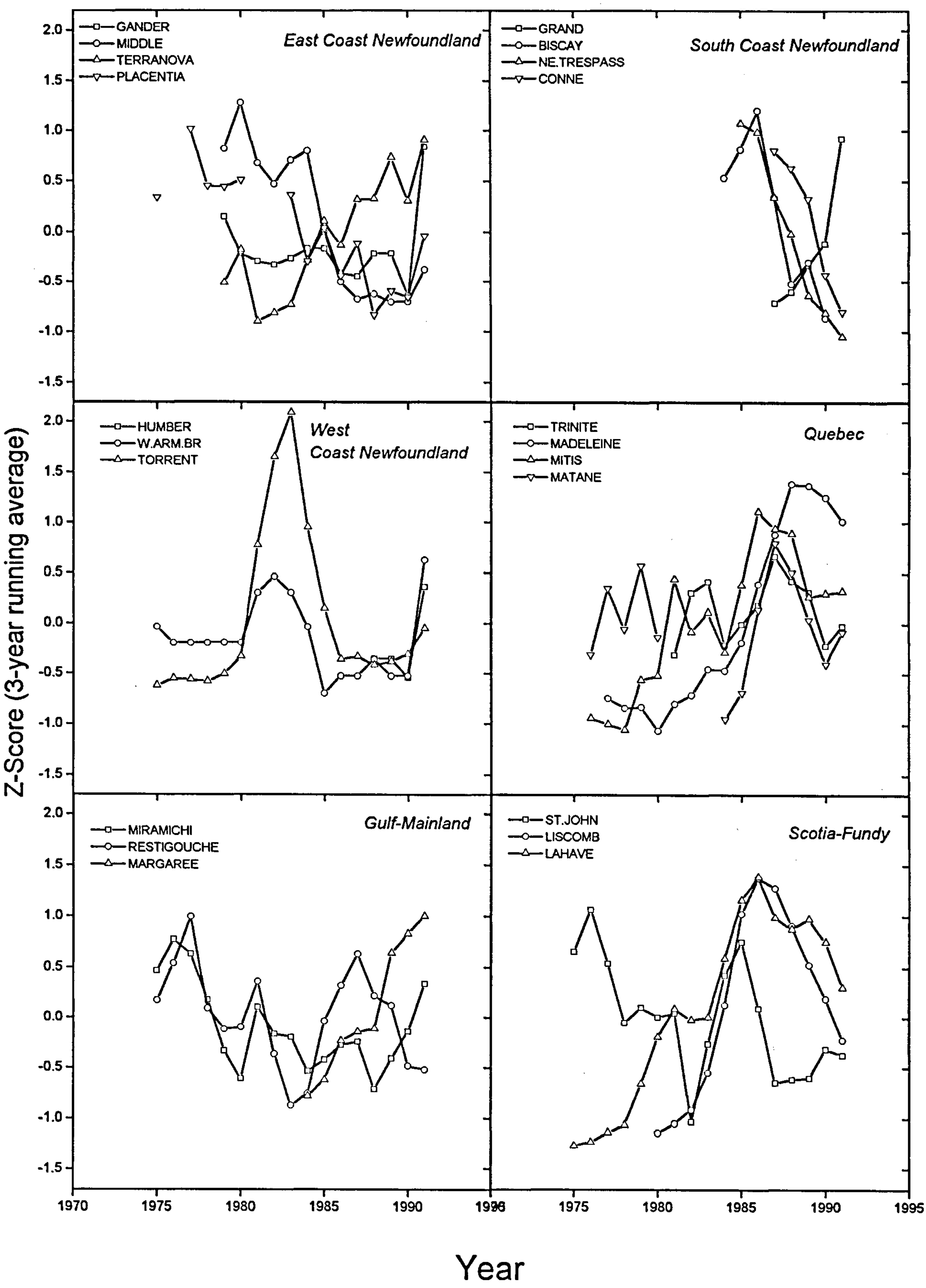


Figure 3.3.2.1. Percent change in 1992 egg deposition from 1987-1991 for specific rivers in Salmon Fishing Areas of Canada.

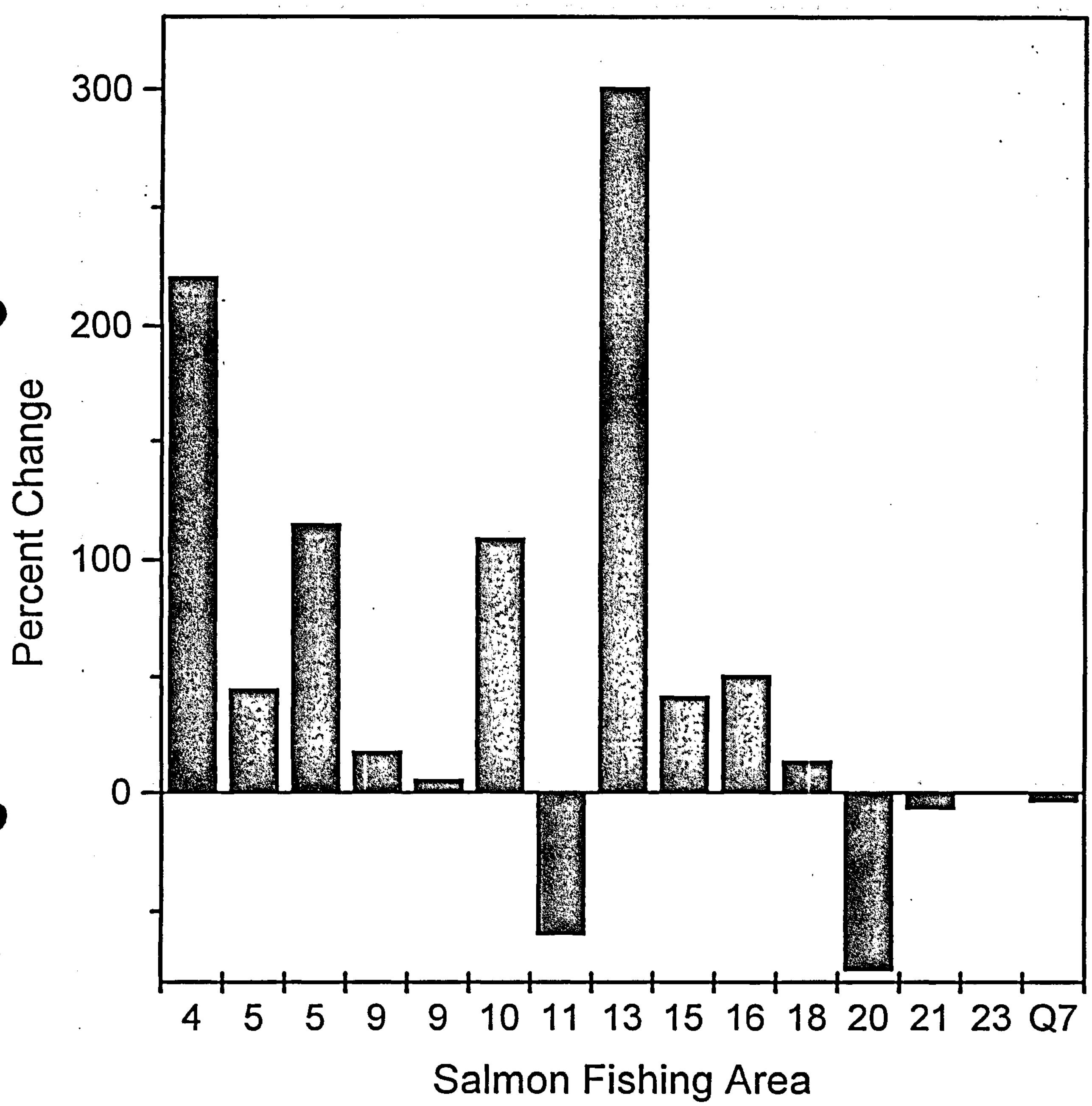


Figure 3.3.3.1. Indices of smolt survival for Western North Atlantic salmon. Top: Wild smolts Canada, Middle: Hatchery smolts Canada, Bottom: Penobscot River hatchery smolts. Data smoothed by three year means.

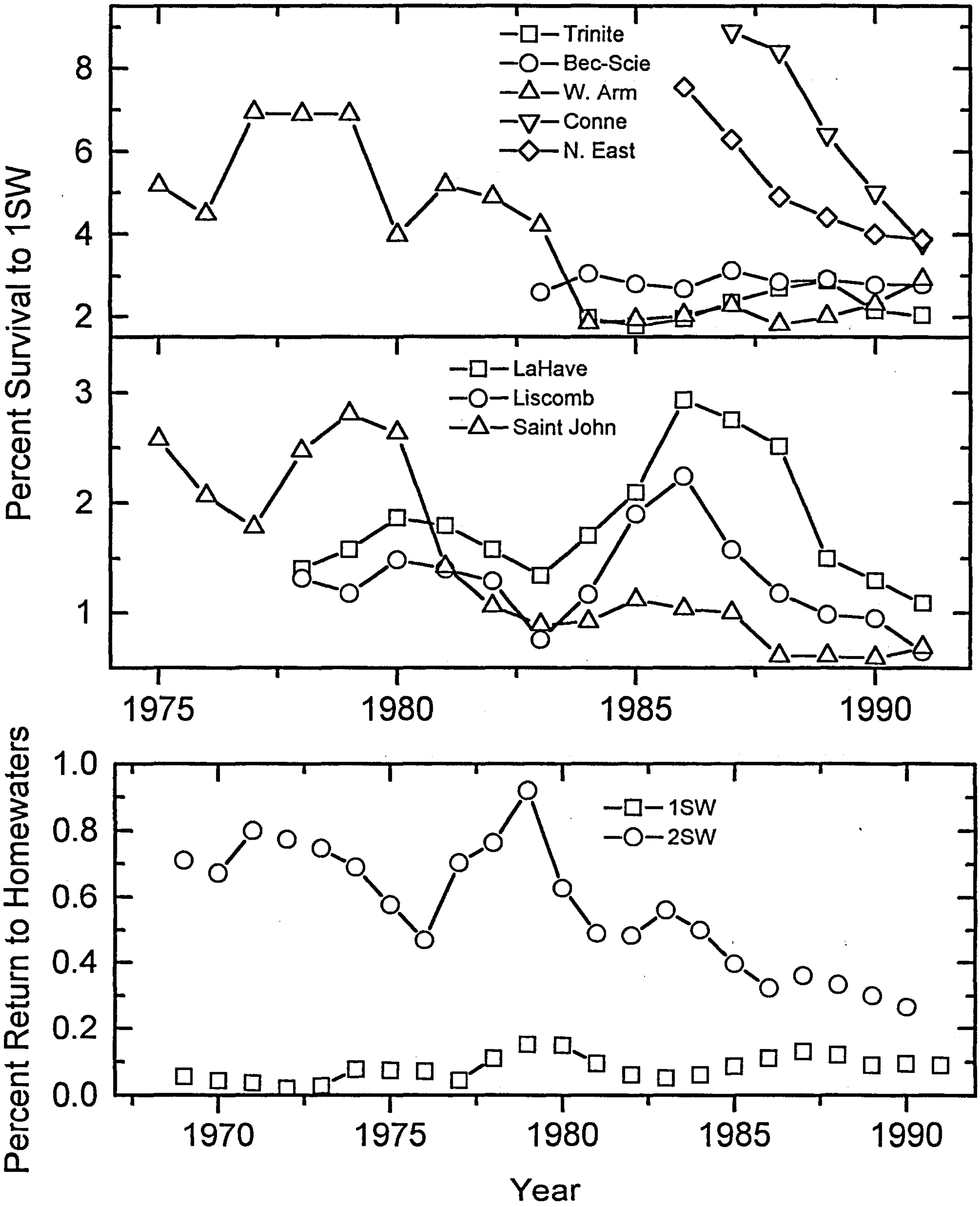


Figure 3.4.4.1. Return rates for several North American stocks (A), standardized return rates for same group of stocks (B).

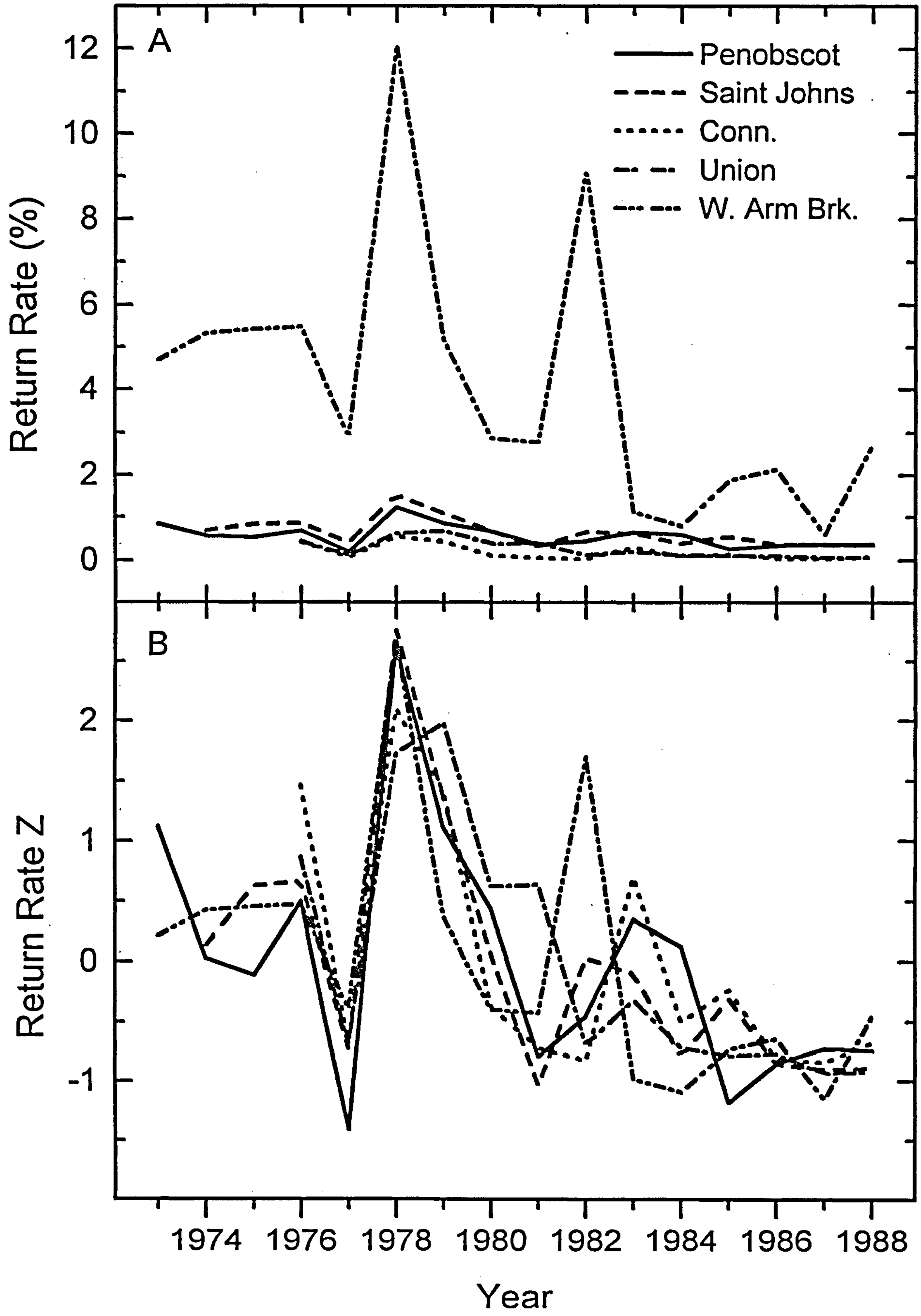


Figure 3.4.4.2. Estimated pre-fishery abundance of 1SW non-maturing salmon of North American origin.

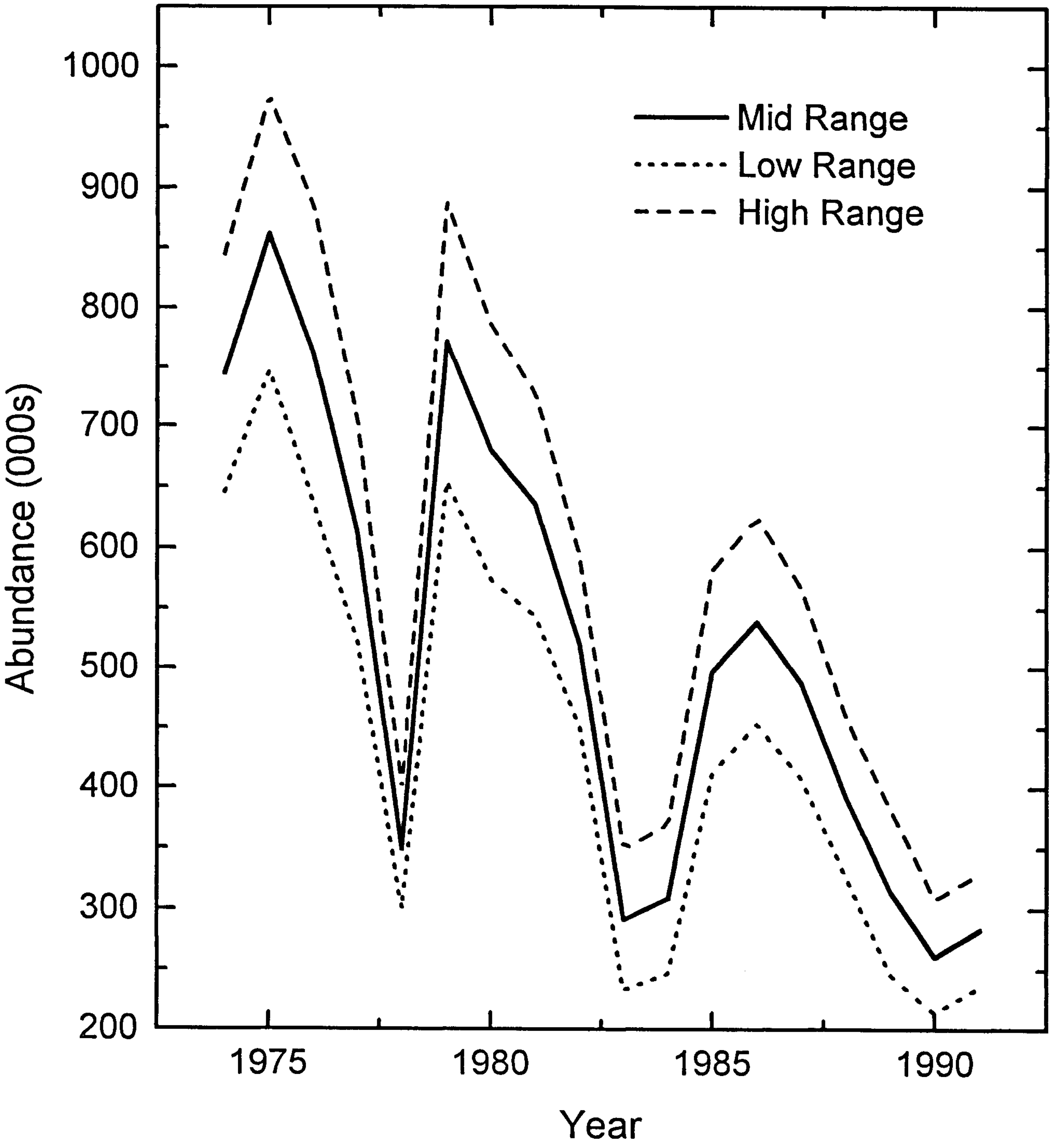


Figure 3.4.4.3. Atlantic salmon smolt to 1SW survival for Northeast Brook, Trepassey (SFA 9) and Conne RIver (SFA11), Newfoundland Region.

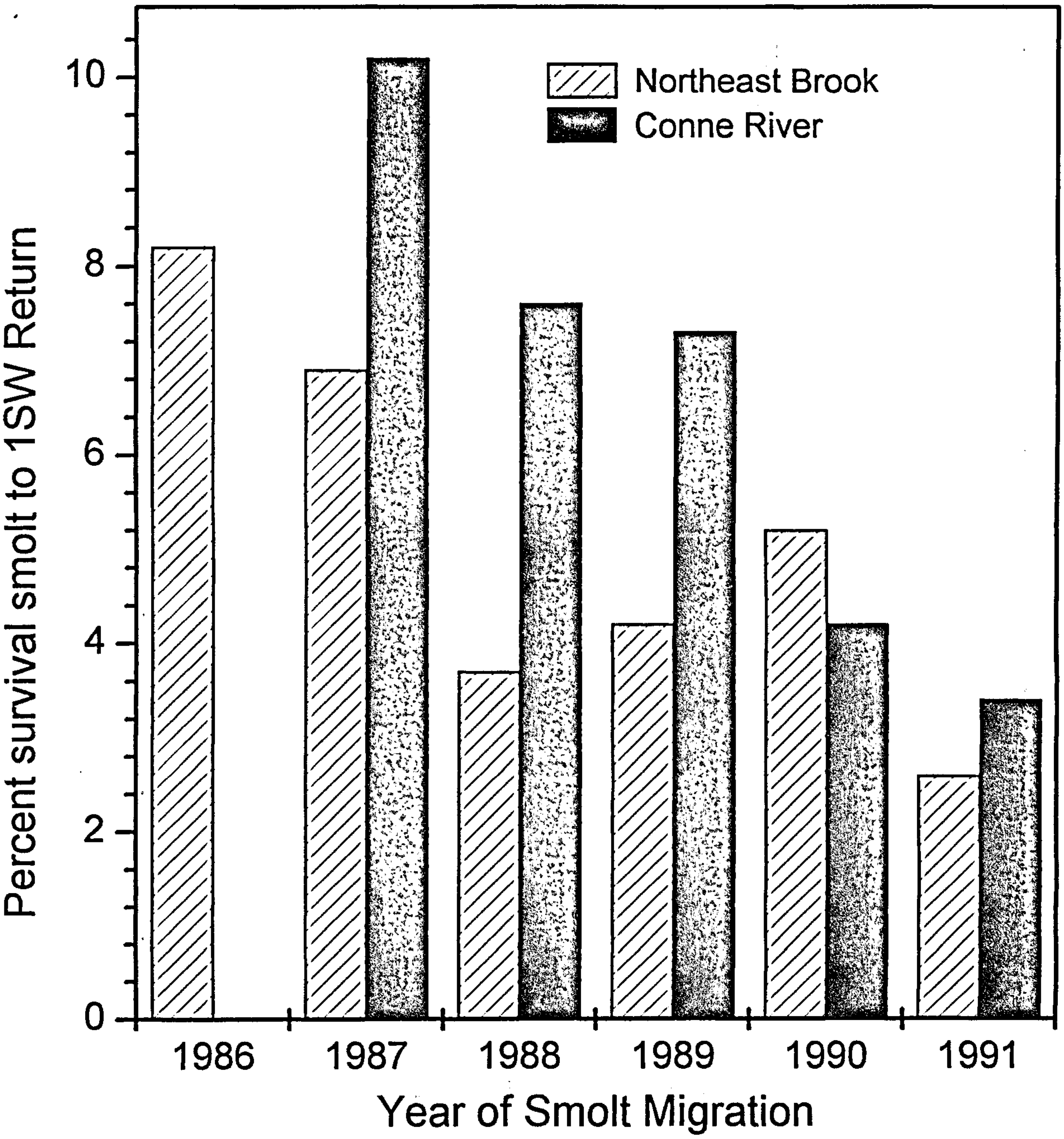


Figure 3.4.4.4. Association between condition and sea survival of Atlantic salmon smolts from the Conne River and Northeast Brook, Trepassey.

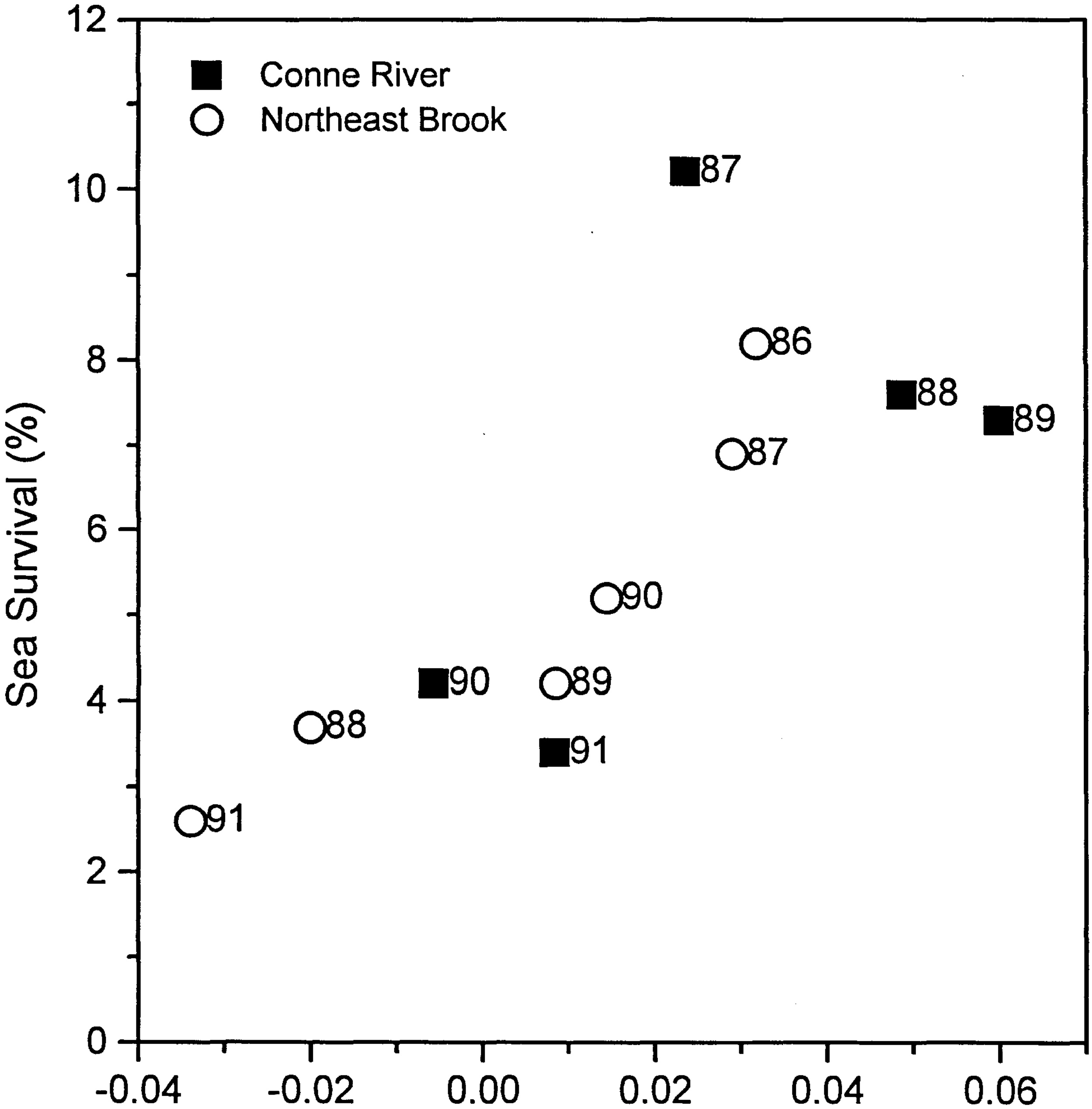


Figure 3.4.4.5. Circuli spacing pattern for post-smolt growth zone with seasonal growth index areas marked.

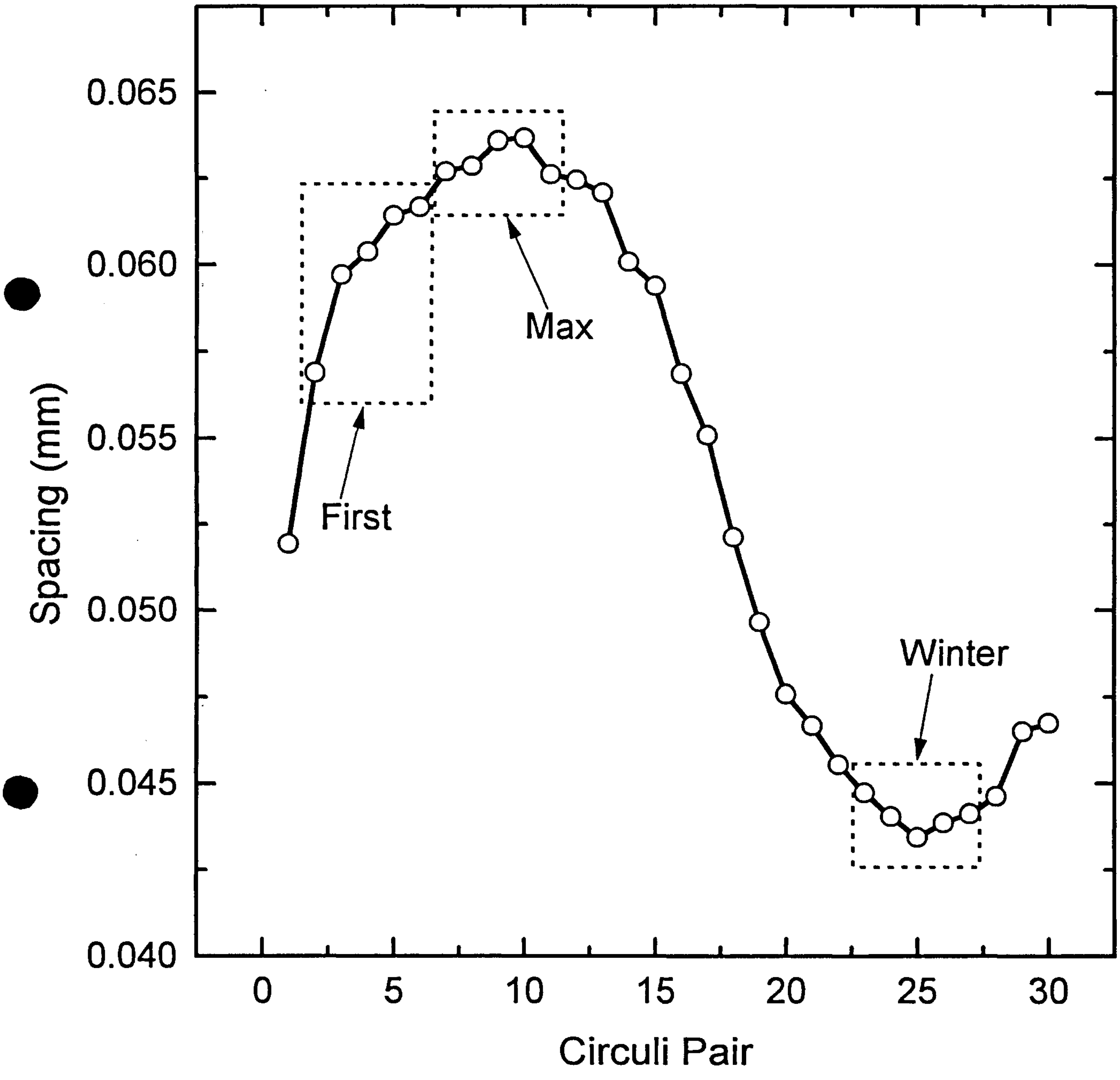


Figure 3.4.4.6. Annual mean fork length of Atlantic salmon caught at West Greenland, 1969-1992.

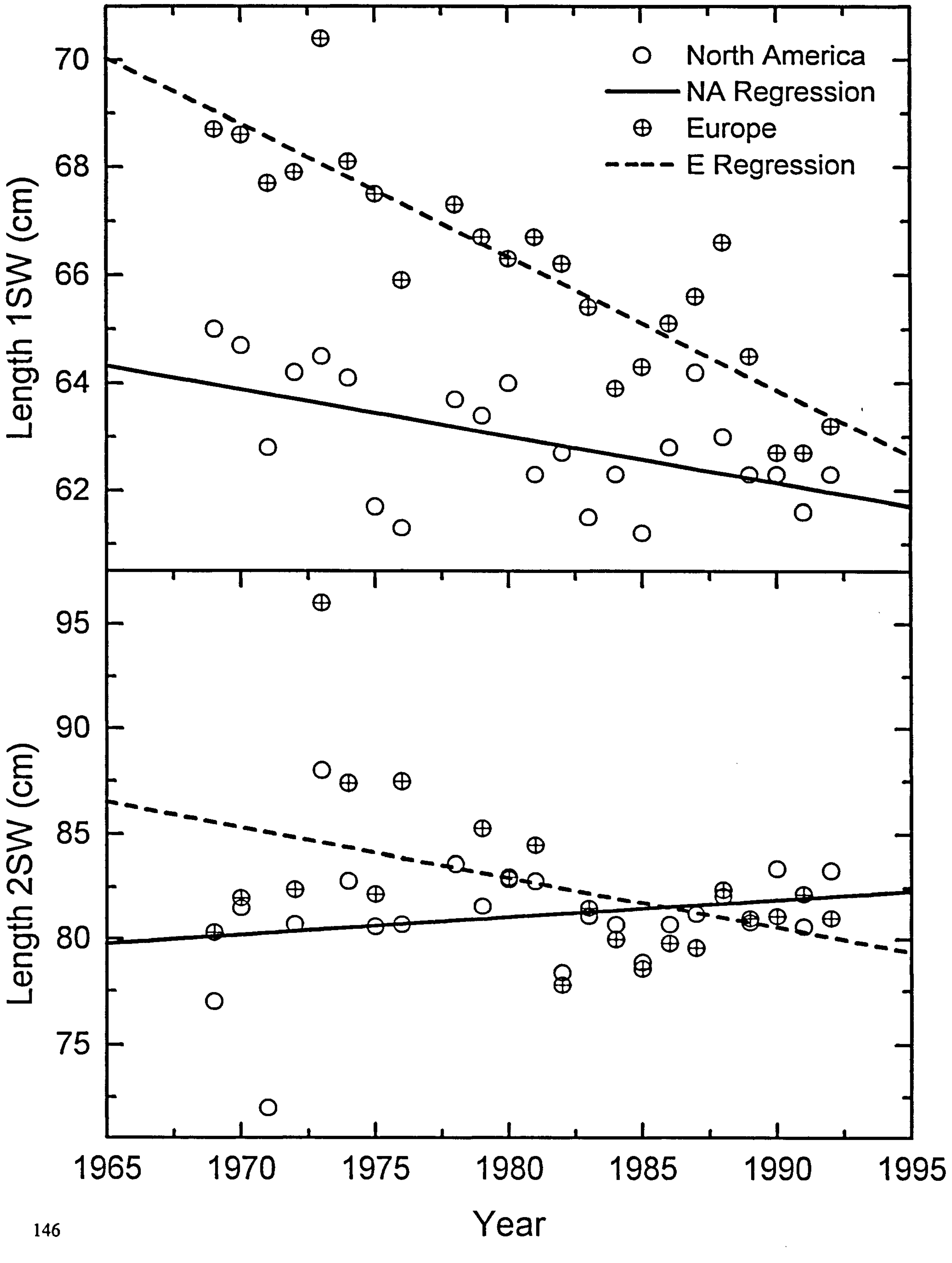


Figure 3.4.4.7. Annual mean weight of Atlantic salmon caught at West Greenland, 1969-1992.

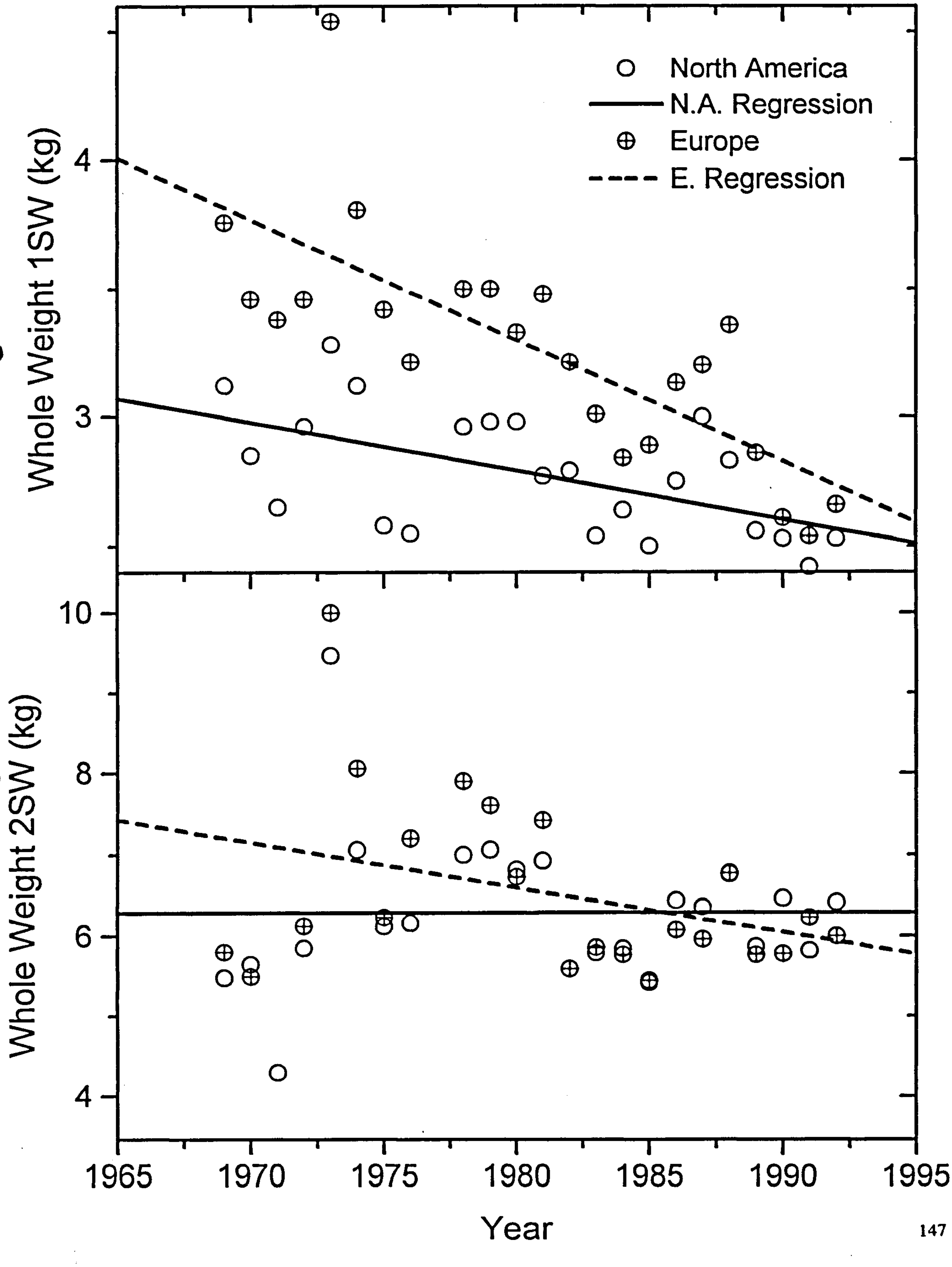


Figure 3.4.4.8. Relationship between estimated stock abundance and mean length of 1SW European origin salmon at West Greenland.

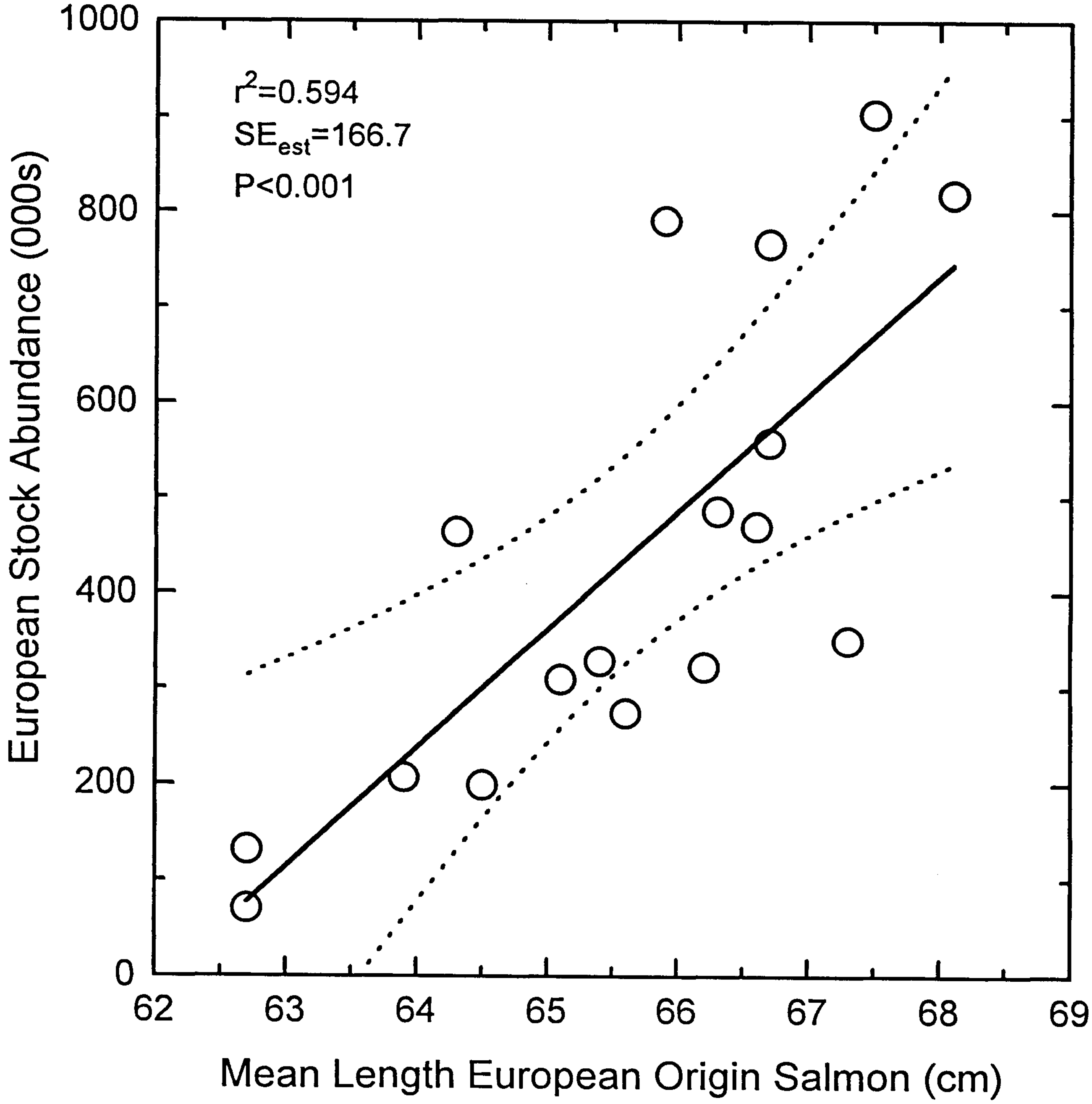


Figure 3.4.4.9. Relationship between estimated stock abundance and mean length of 1SW N. American origin salmon at West Greenland.

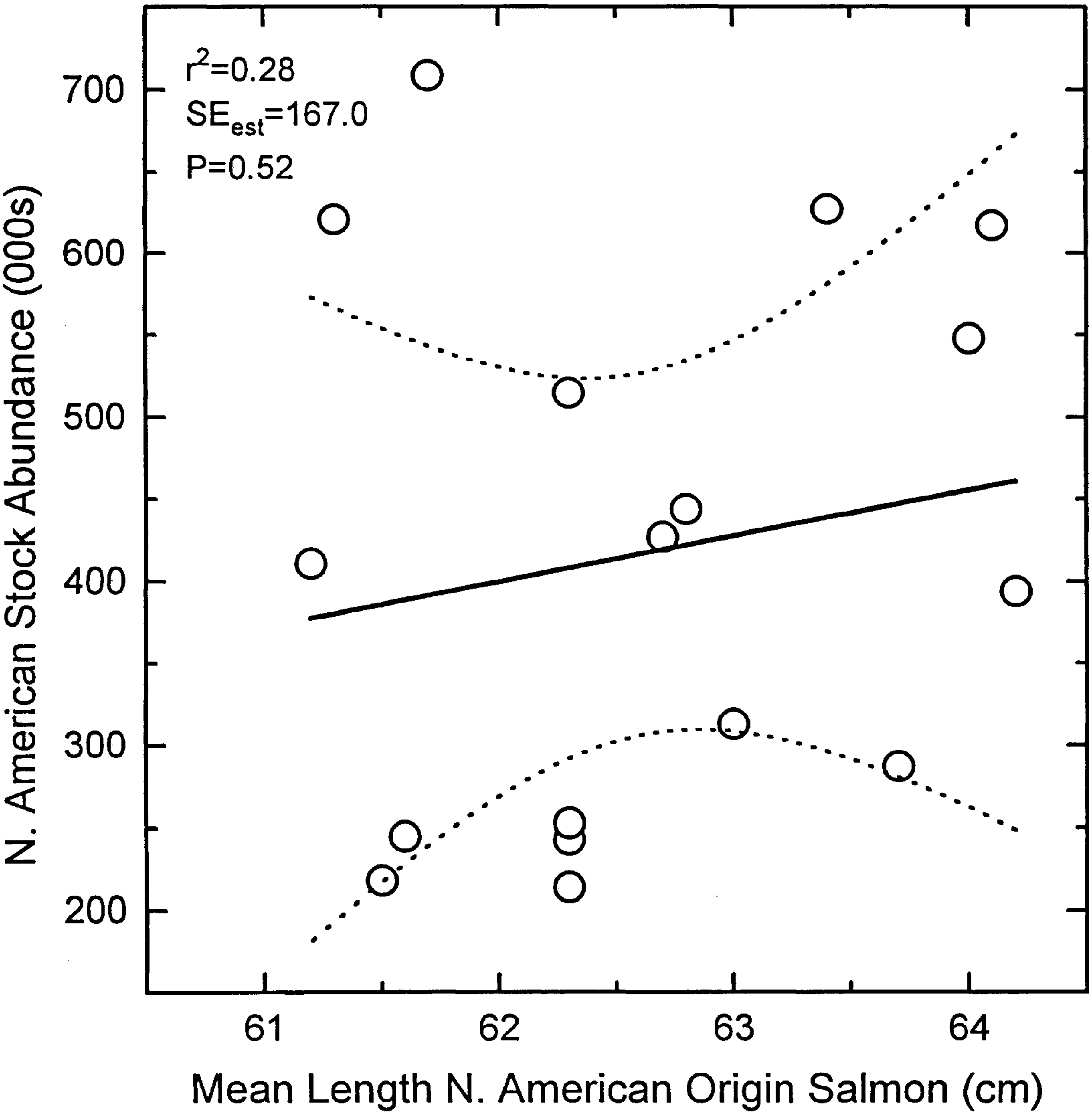


Figure 3.4.4.10. Post-smolt habitat estimates for North American stocks.

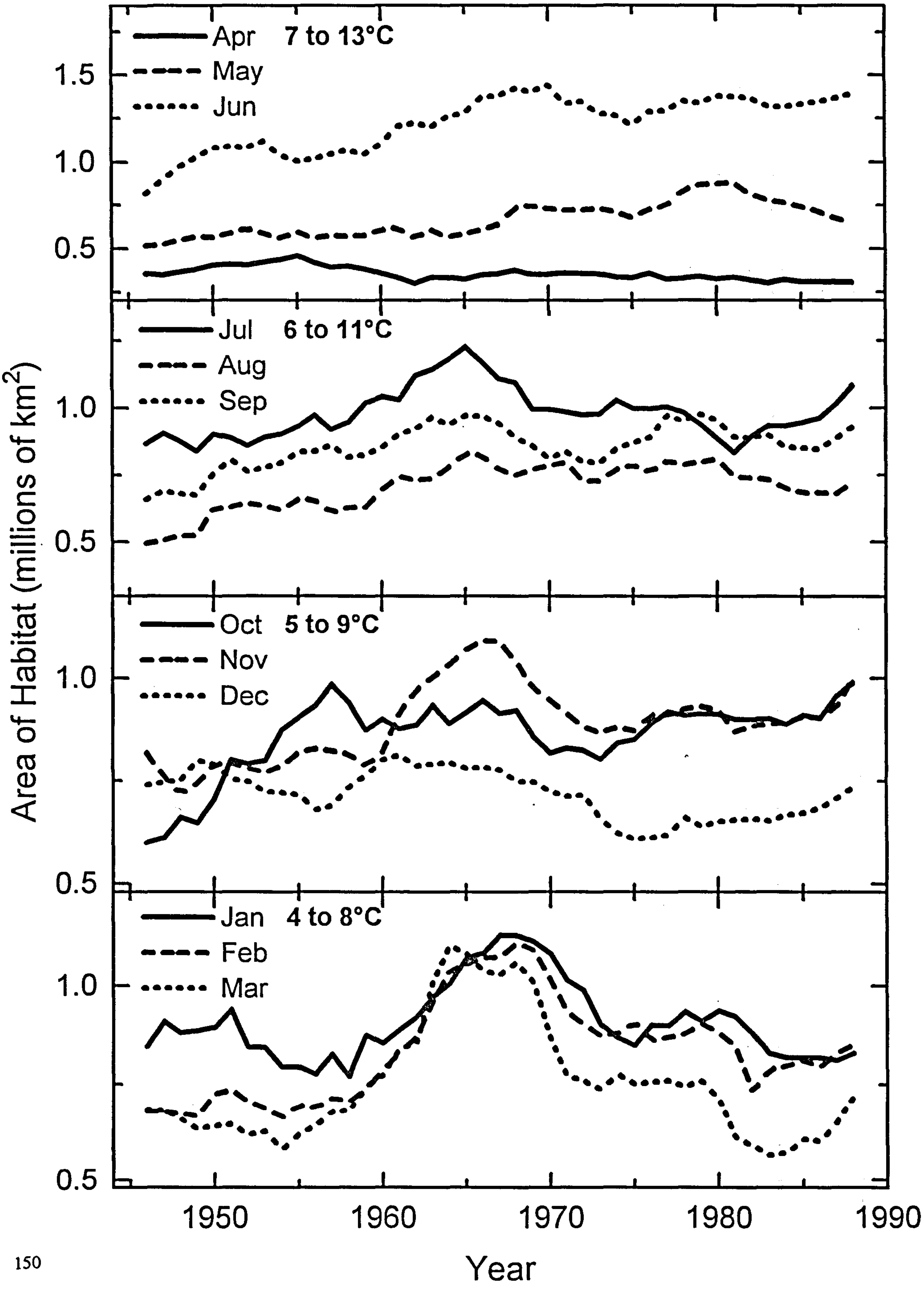


Figure 3.4.4.11. Estimate of catch of North American stock complex (A), standardized catch estimate, first principal component of winter habitat indices, and January index (B).

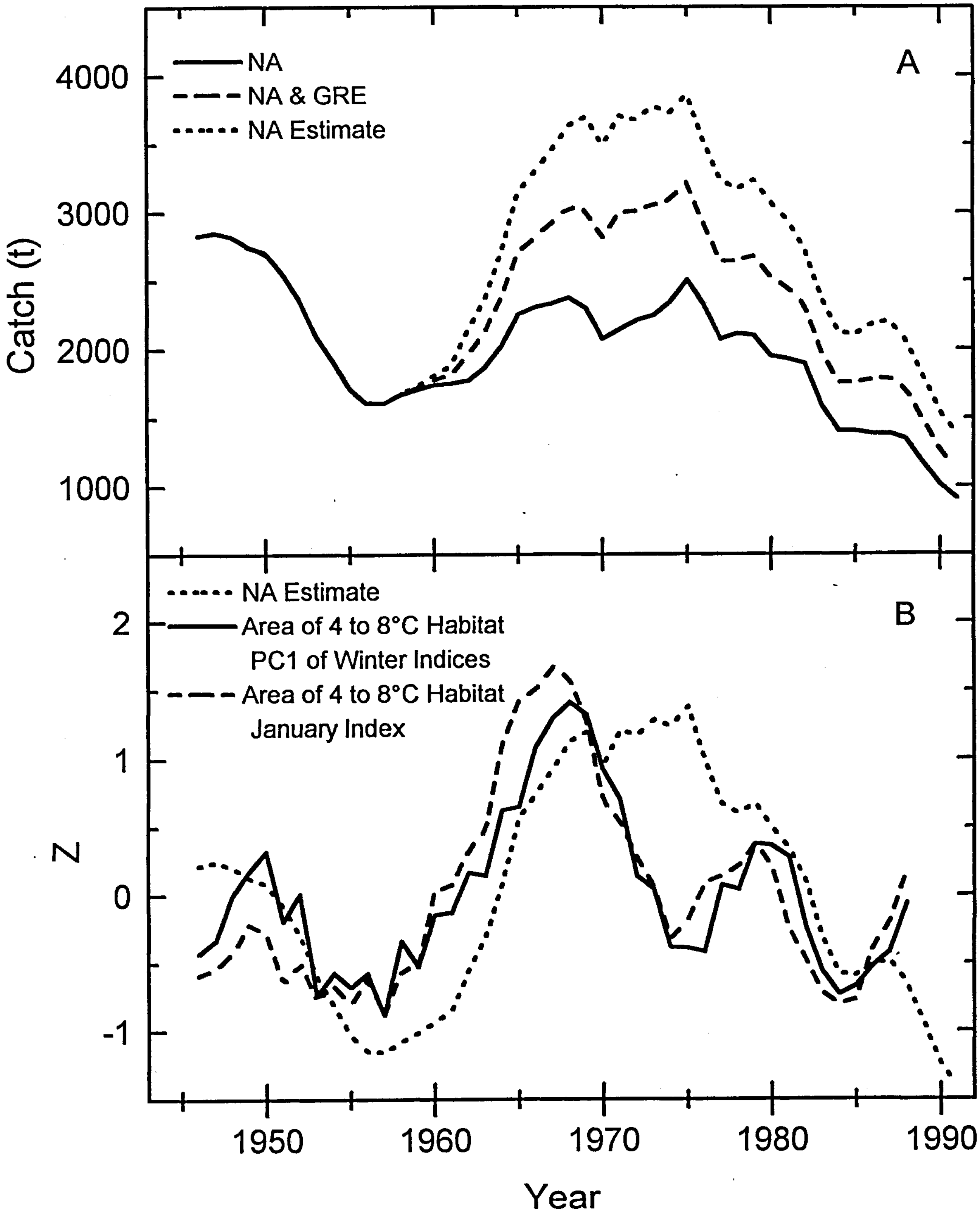


Figure 3.4.4.12. Estimate of catch of European stock complex (A), standardized catch estimates and first principal component of spring habitat indices (B).

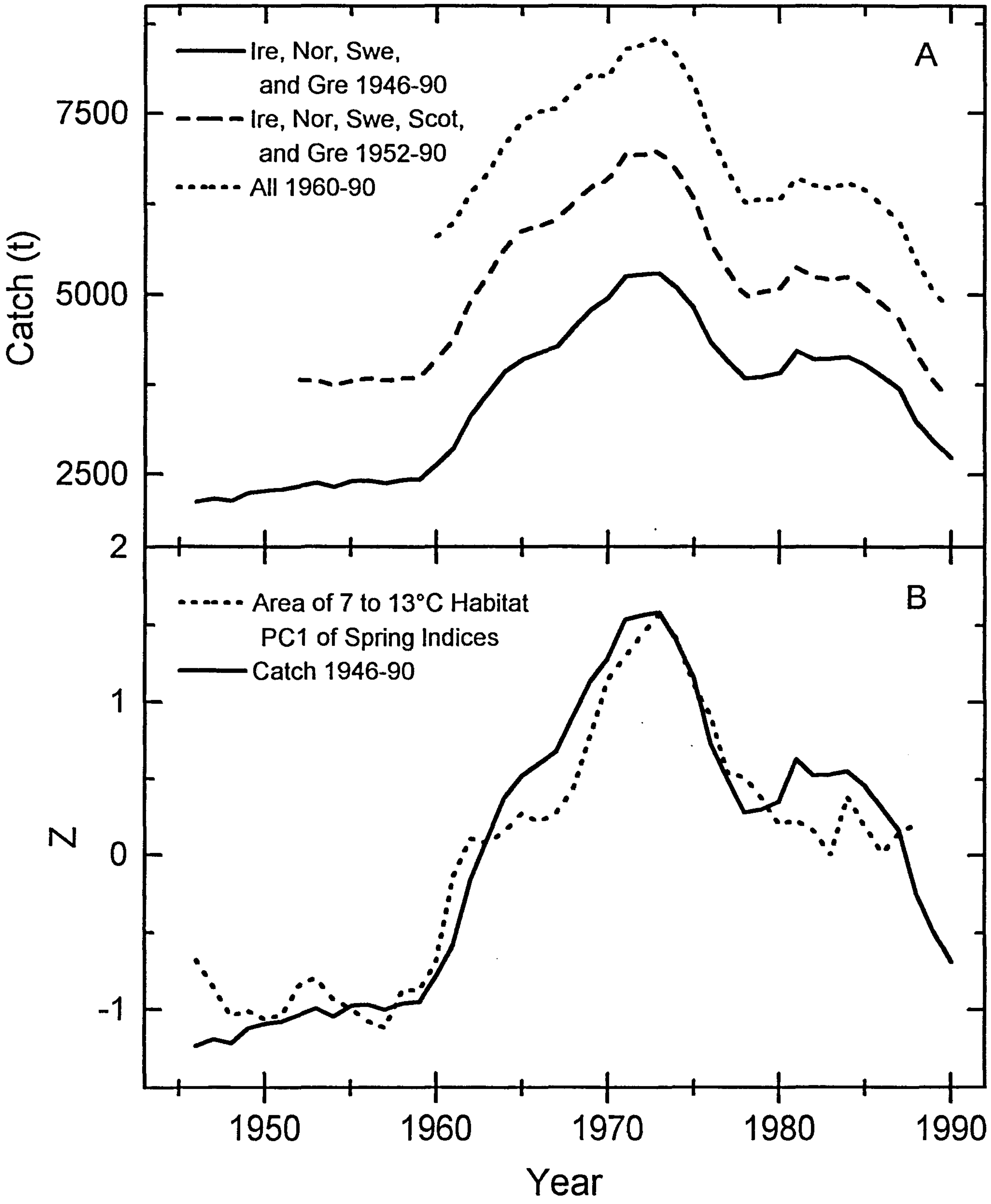


Figure 4.1.2.1. The Faroese Exclusive Economic Zone (EEZ) marked by dark line and catch per unit effort (1000 hooks) by statistical rectangle for the fishery during the 1991/92 season.

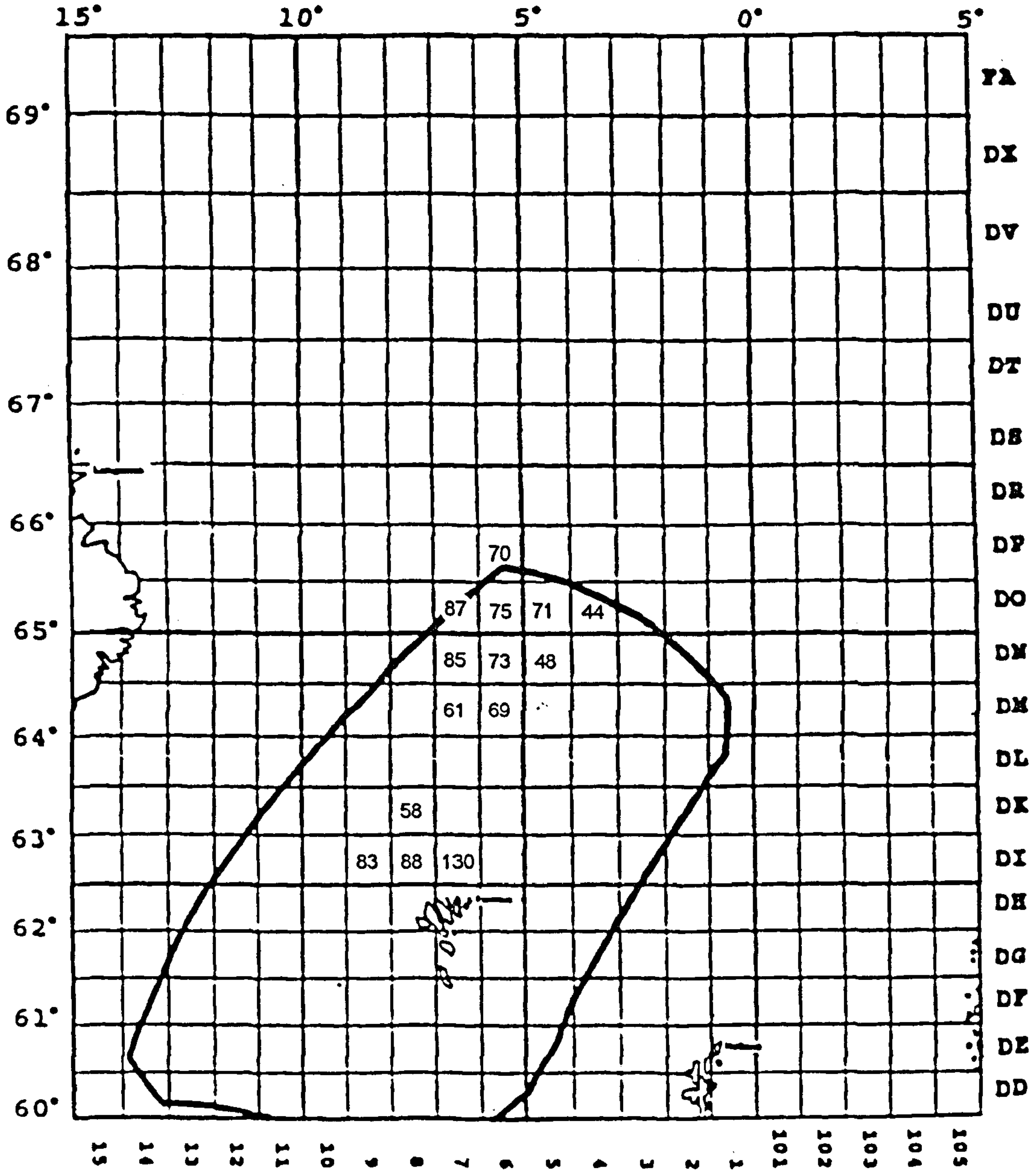


Figure 4.1.4.1. Length distribution of wild and reared salmon within sea age groups in pooled samples from the Faroes salmon fisheries.

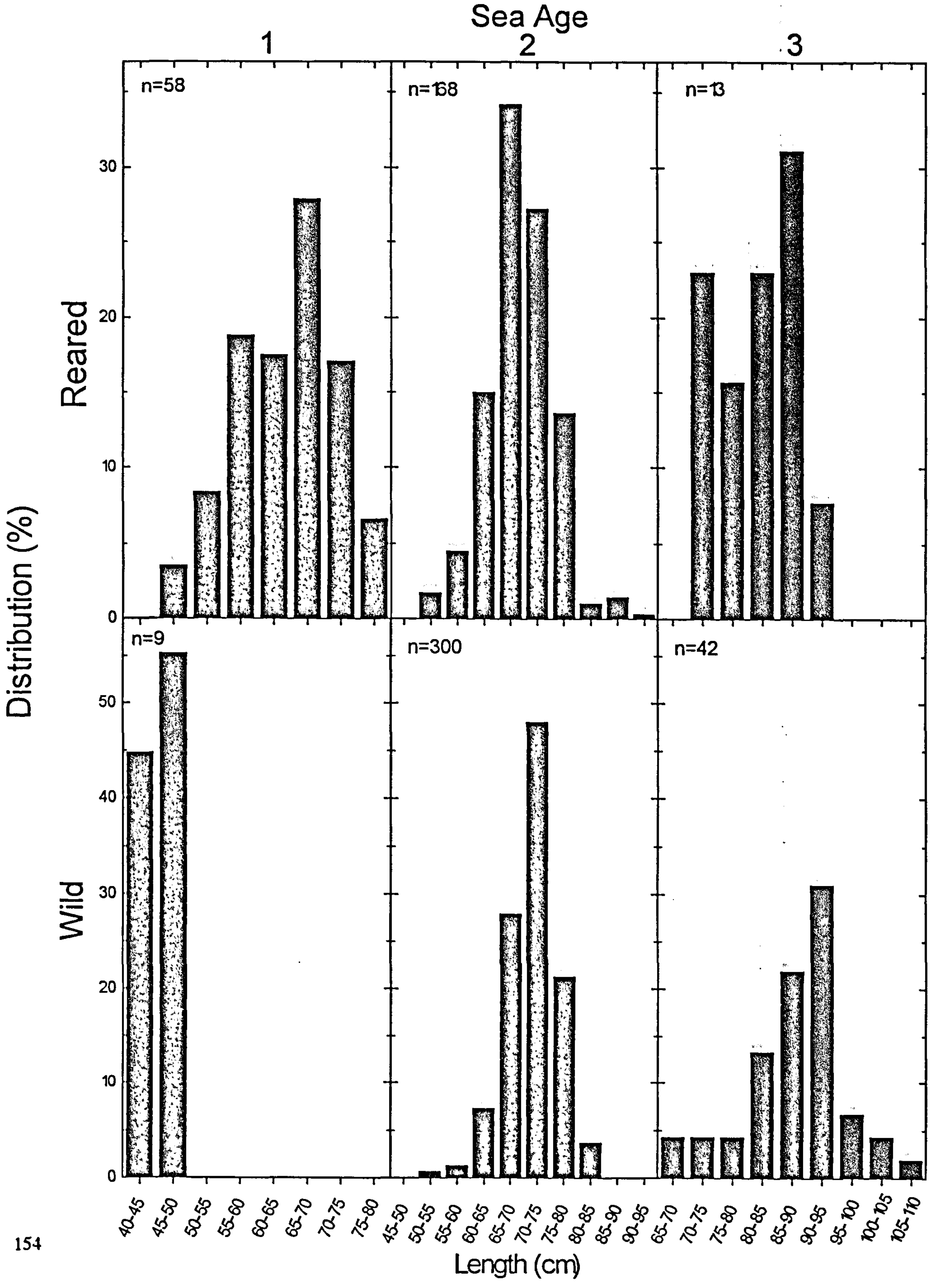


Figure 4.1.4.2. Sea age distribution estimated from scale reading of wild and reared salmon in pooled samples from the Faroes salmon fisheries.

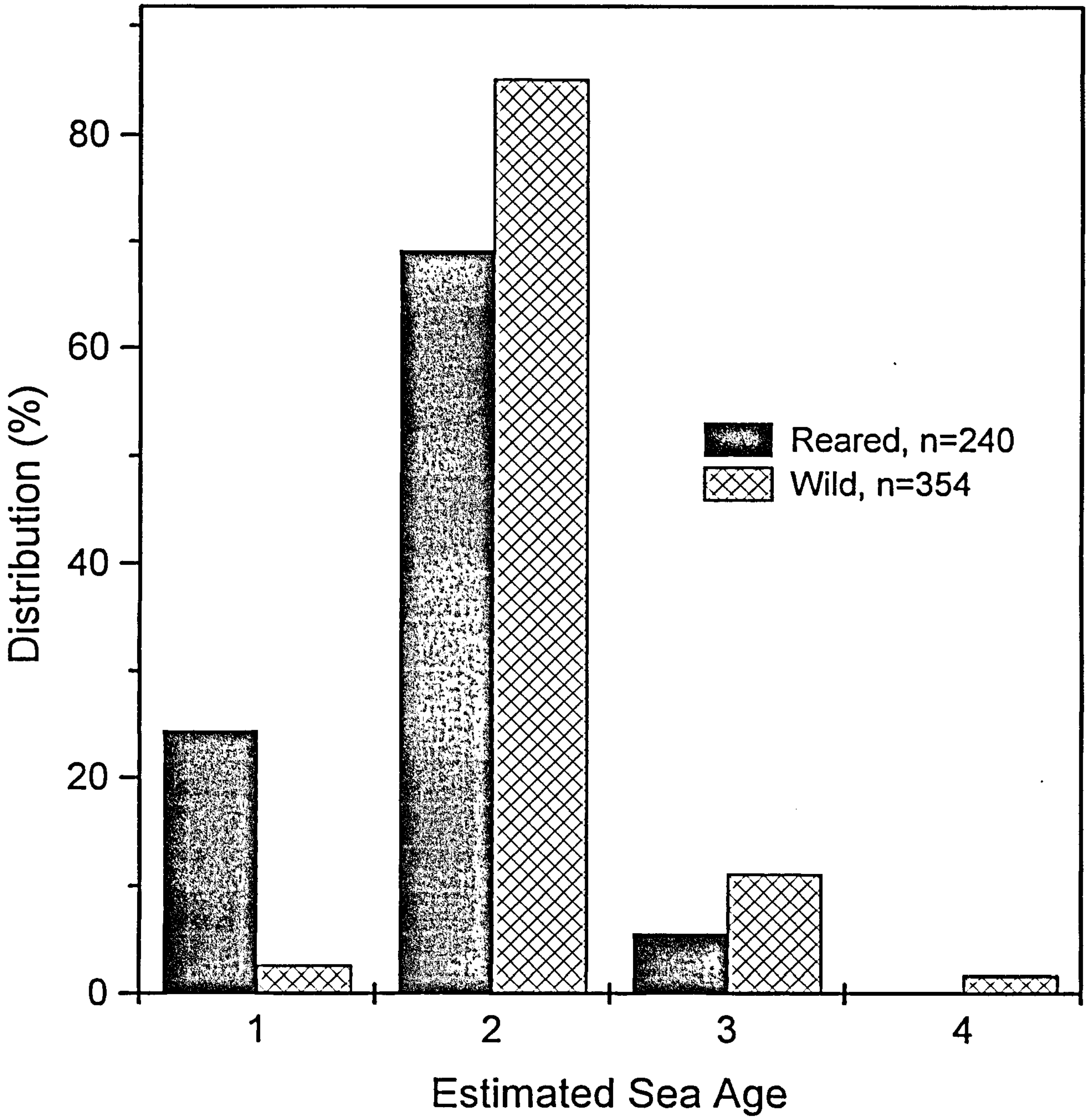


Figure 4.1.4.3. Smolt age distribution estimated from scale reading of wild and reared salmon in pooled samples from the Faroes salmon fisheries.

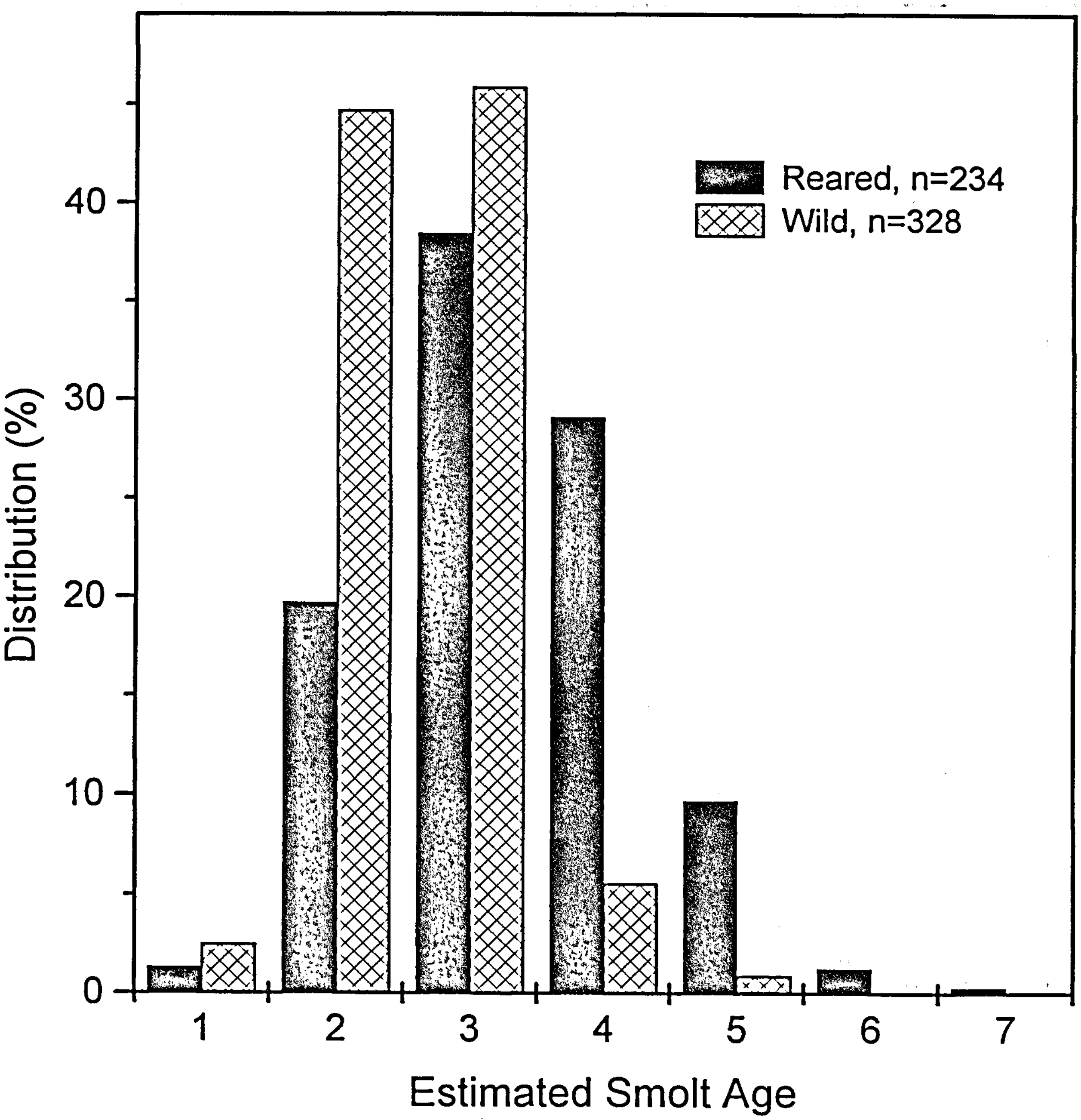


Figure 4.1.4.4. Smolt length distribution of wild and reared salmon in pooled samples from Faroes salmon fisheries.

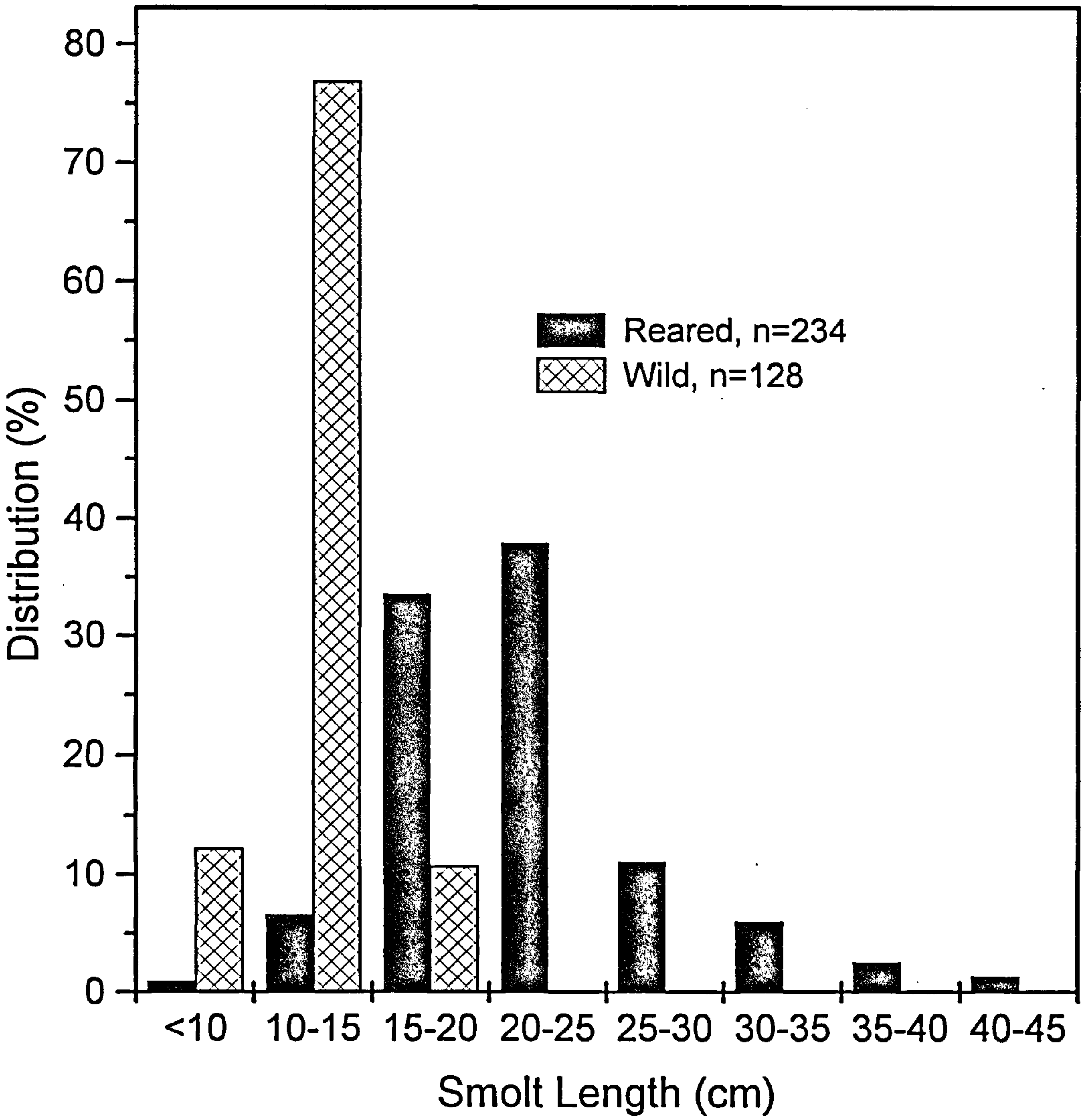


Figure 4.2.1.1. Numbers of some gear units authorized or operating in countries in the North-East Atlantic, 1980-92.

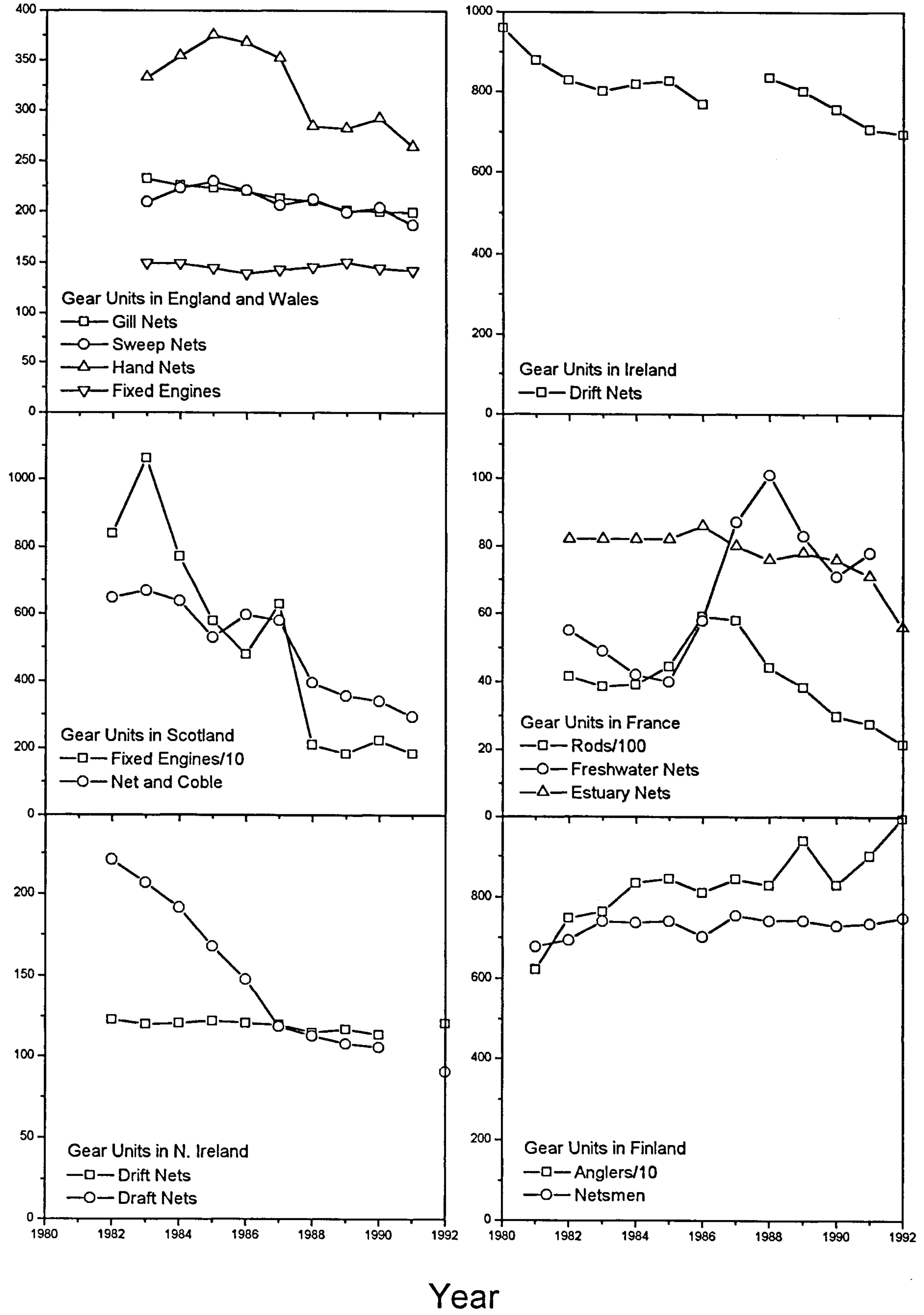


Figure 4.2.7.1. Nominal catches in Norwegian homewaters broken down by method, 1982-92.

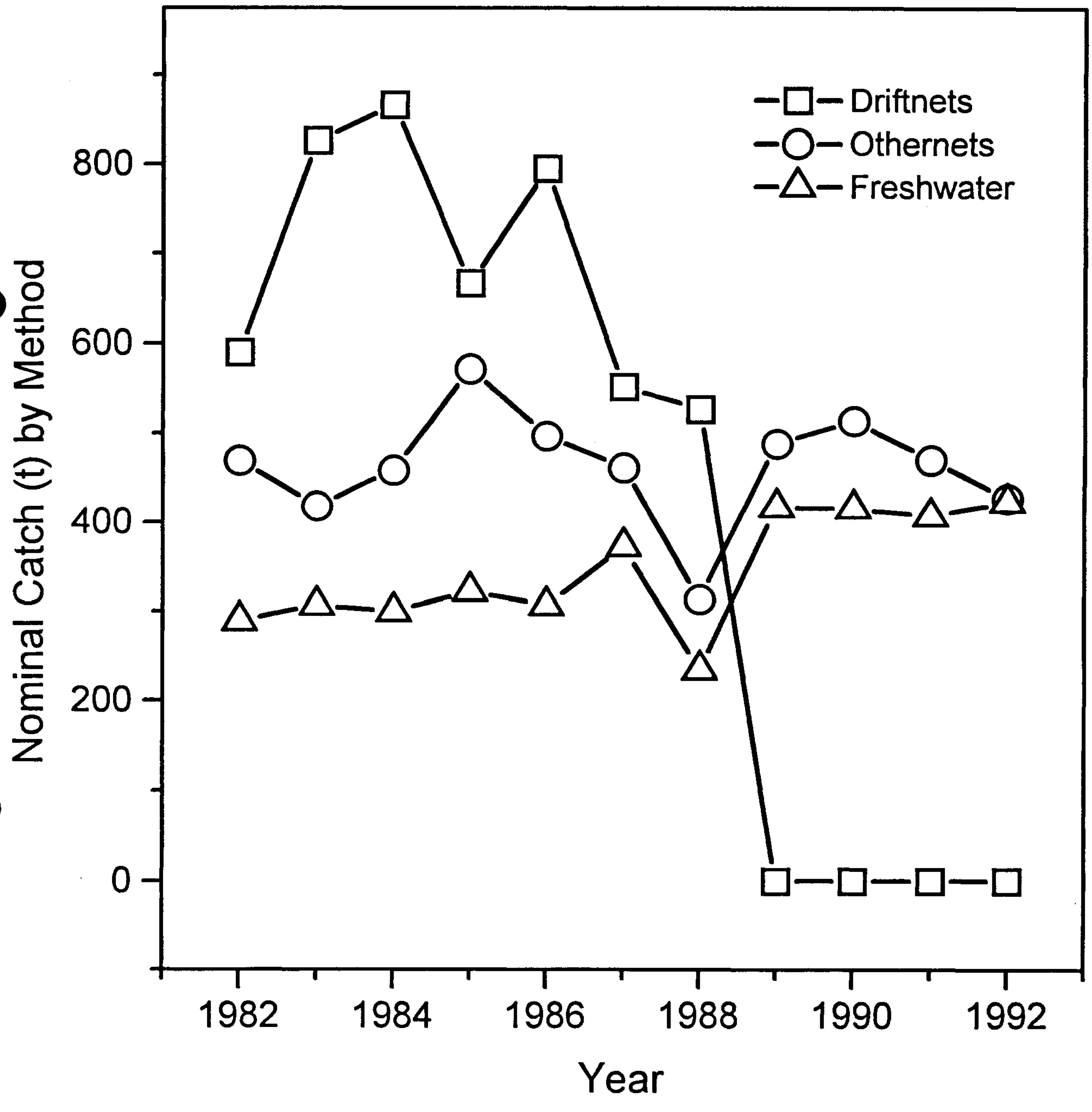


Figure 5.1.3.1. Annual river age distribution of European origin salmon at West Greenland, 1972-1992.

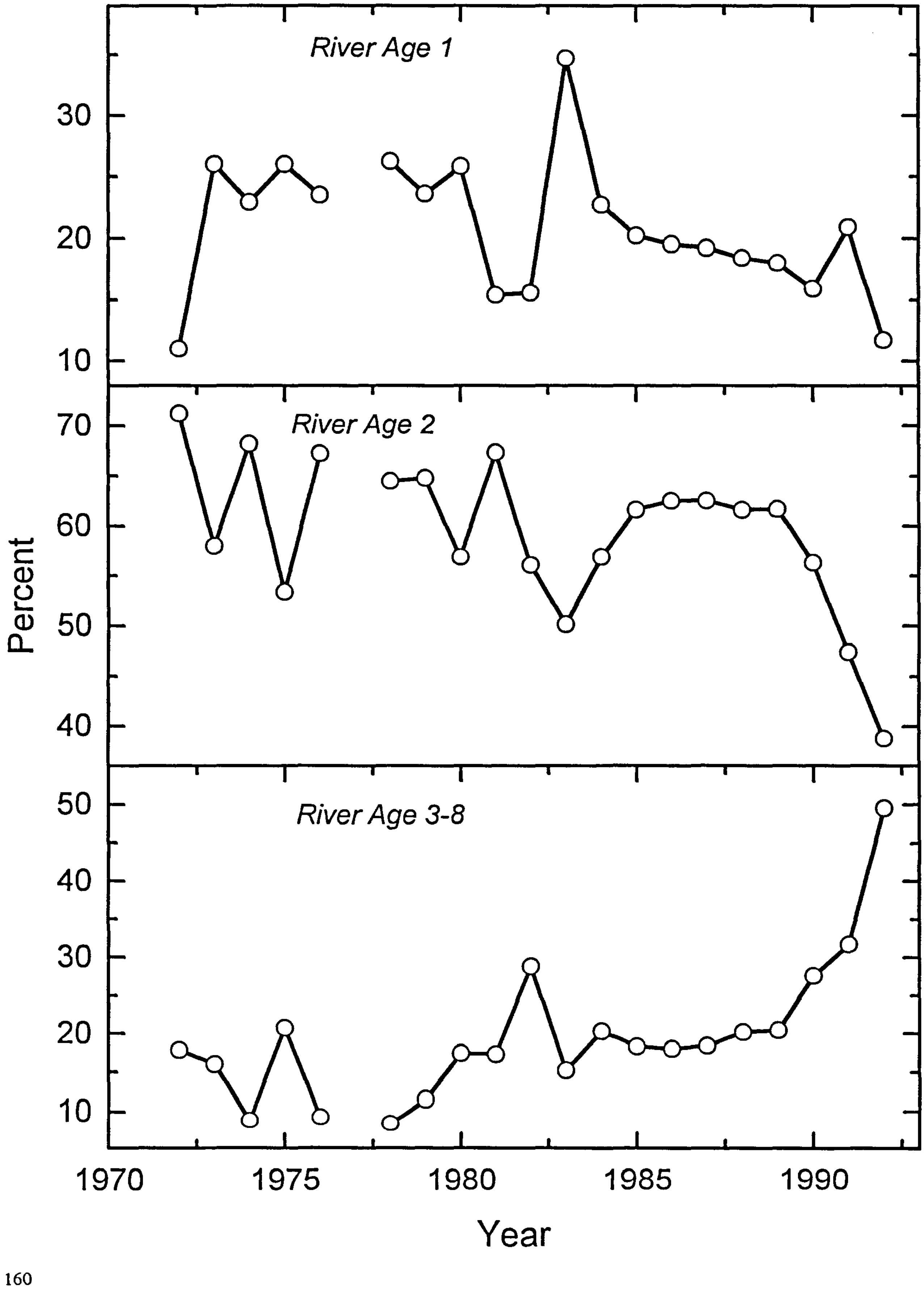


Figure 5.1.3.2. Annual river age distribution of North American origin salmon at West Greenland, 1972-1992.

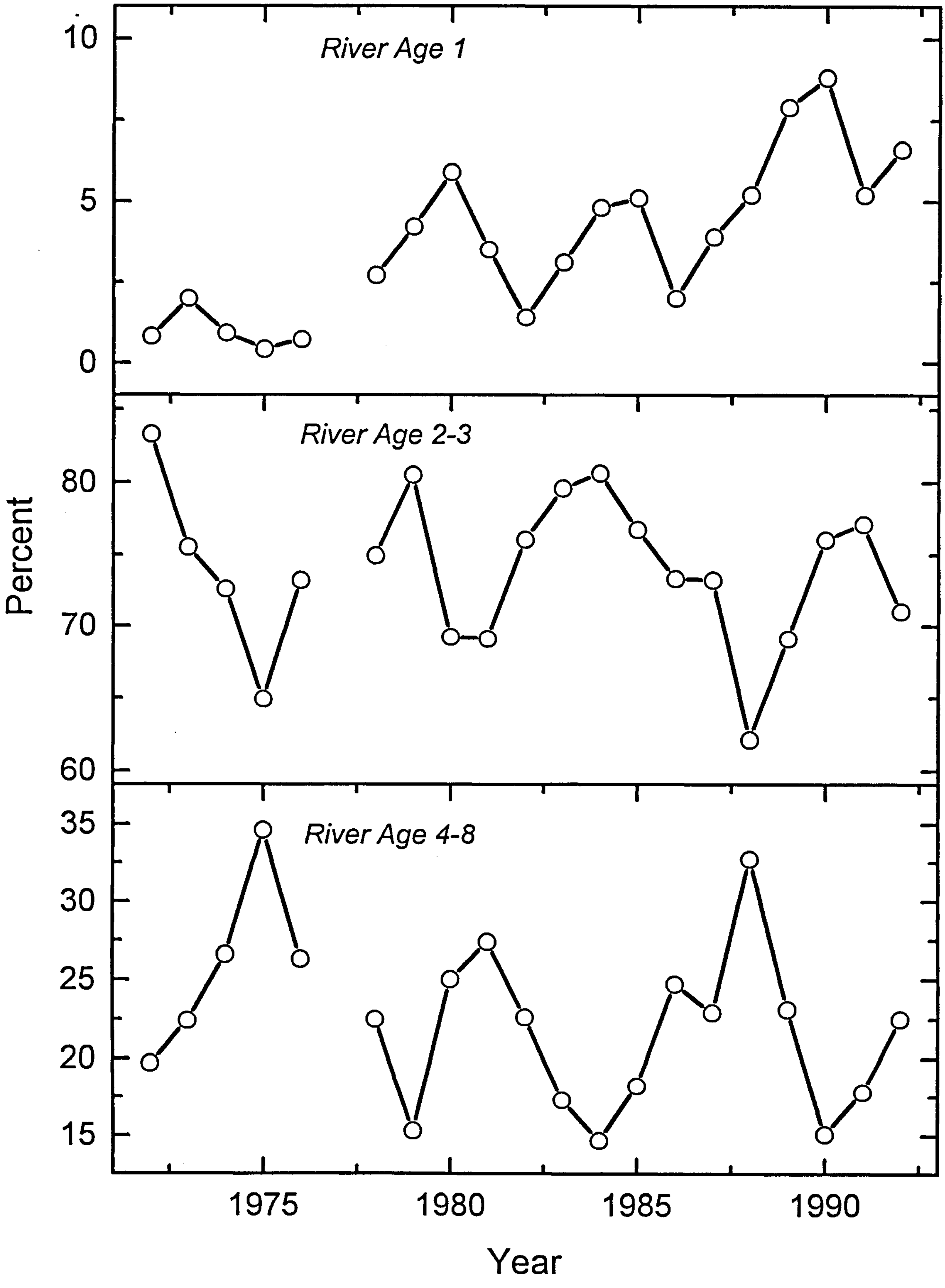


Figure 5.1.4.1. Comparison of harvest estimates of Maine origin salmon at West Greenland, 1987-92.

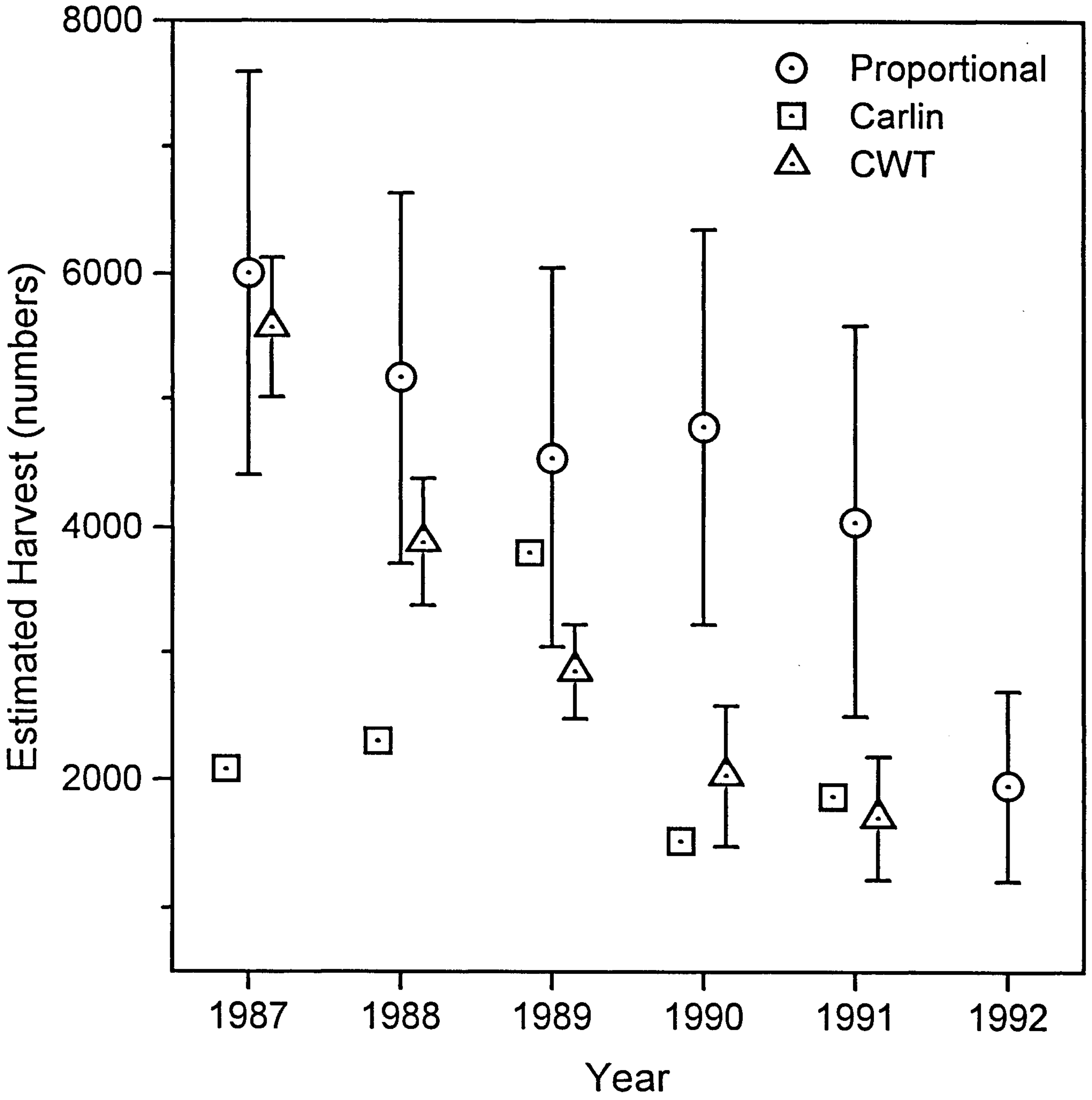


Figure 5.3.1.1. Minimum and maximum estimates of exploitation rates on non-maturing 1SW North American salmon at West Greenland, 1974-91.

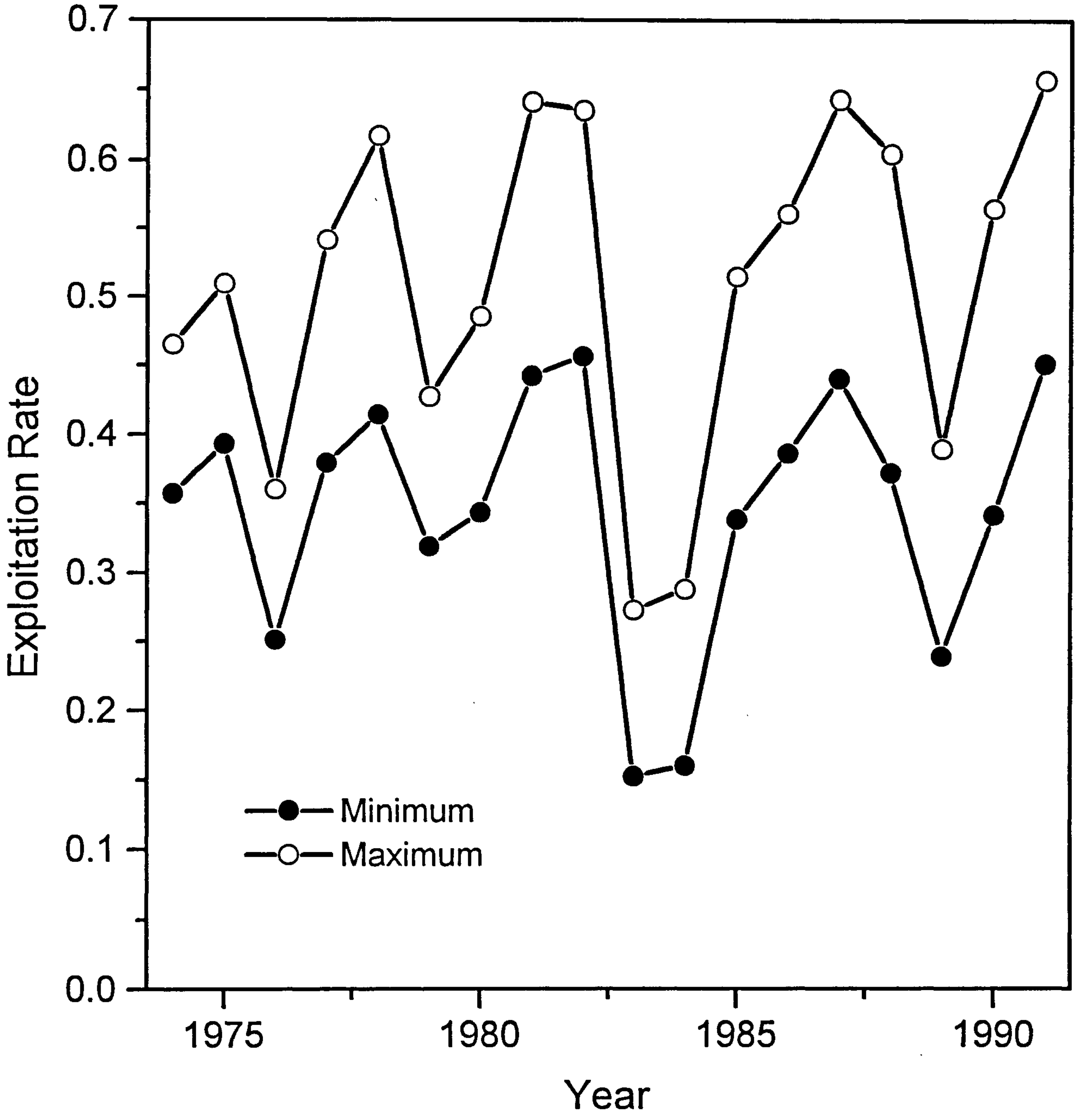


Figure 5.3.1.2. Minimum and maximum estimates of total stock abundance of Atlantic salmon at West Greenland, 1974-91.

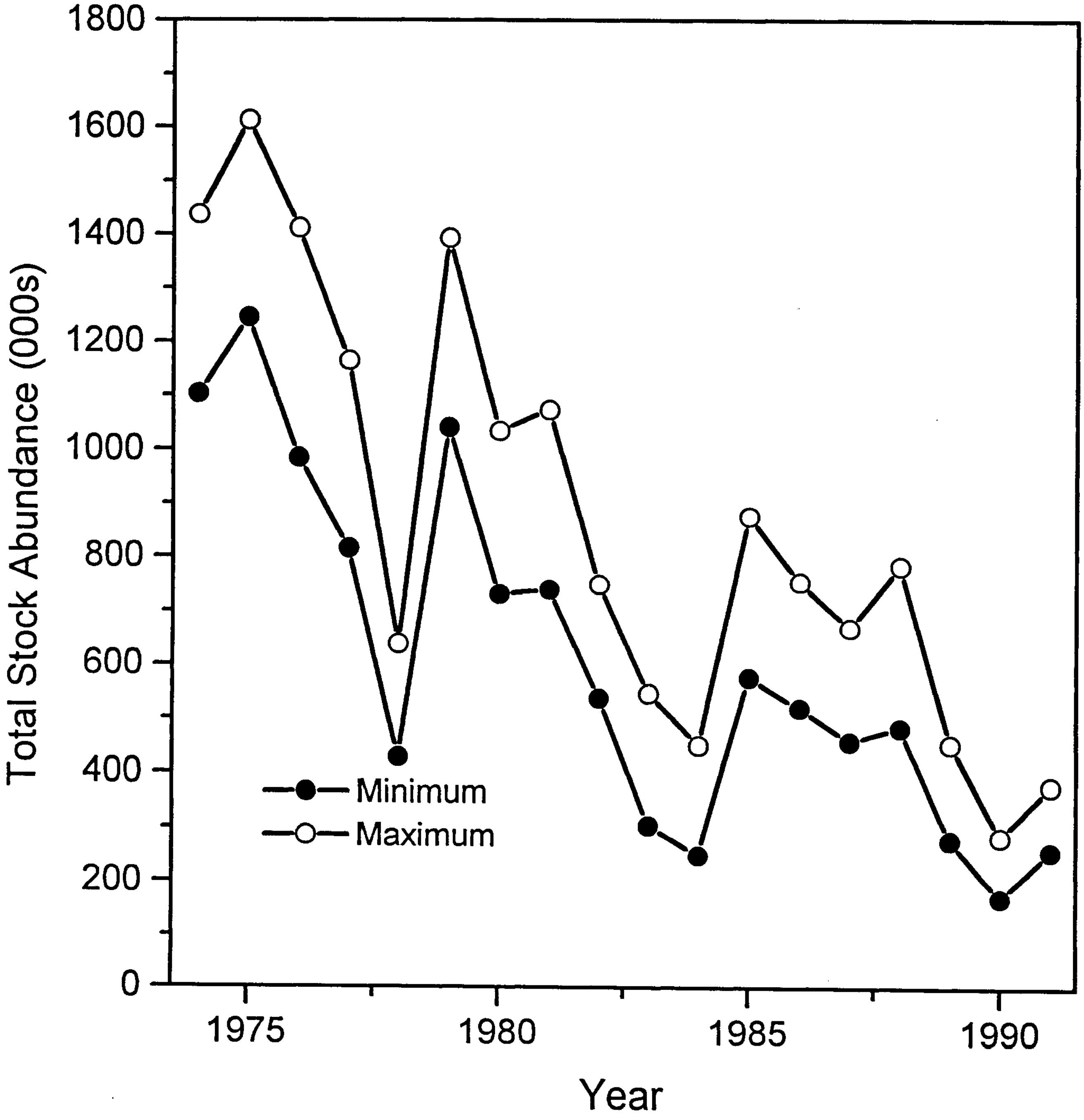


Figure 5.3.1.3. Minimum and maximum estimates of stock abundance of North American and European Atlantic salmon at West Greenland, 1974-91.

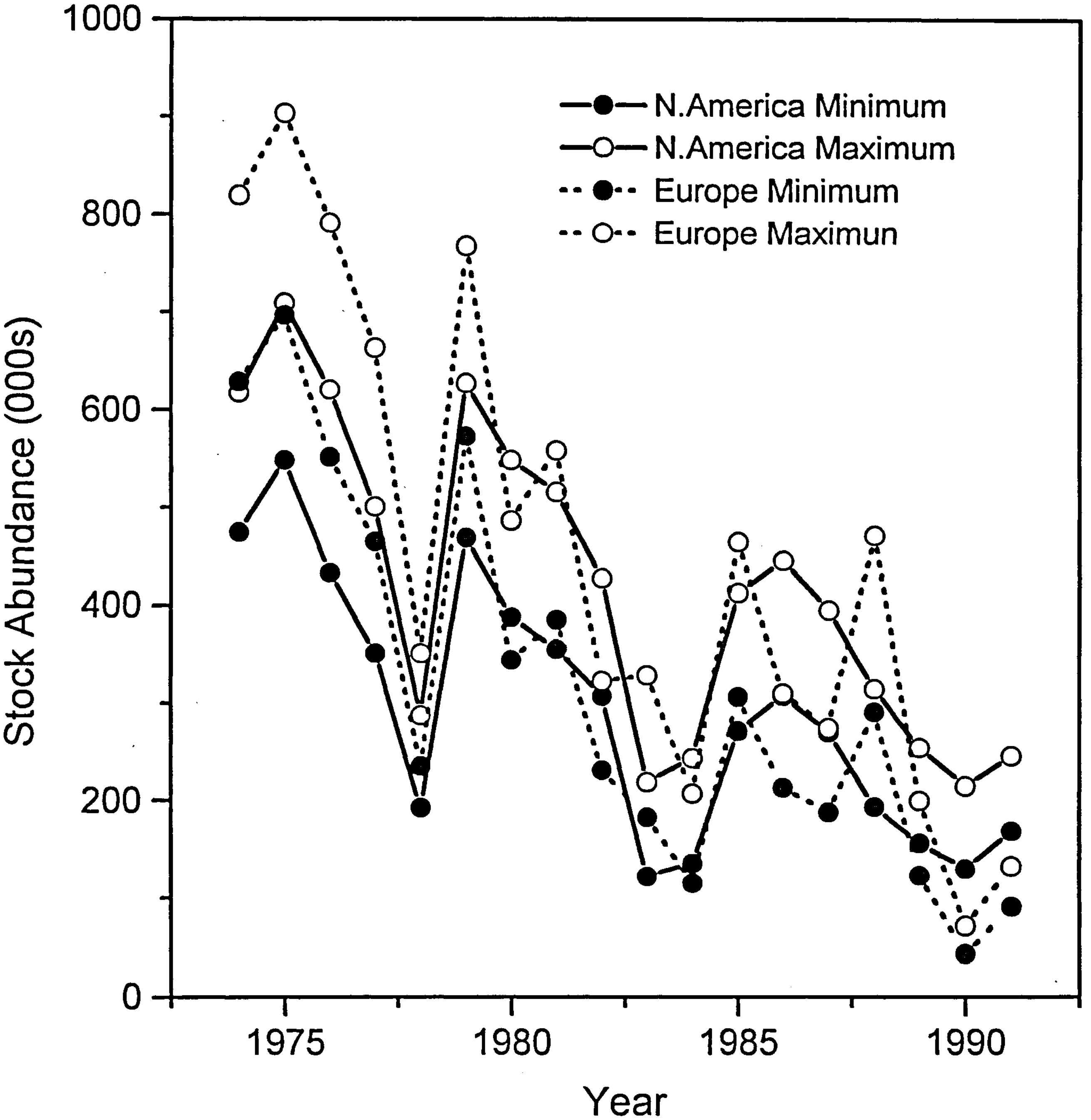


Figure 5.3.1.4. Minimum and maximum estimates of exploitation rates on non-maturing 1SW North American salmon in SFAs 3-7, Newfoundland, Canada, 1974-91.

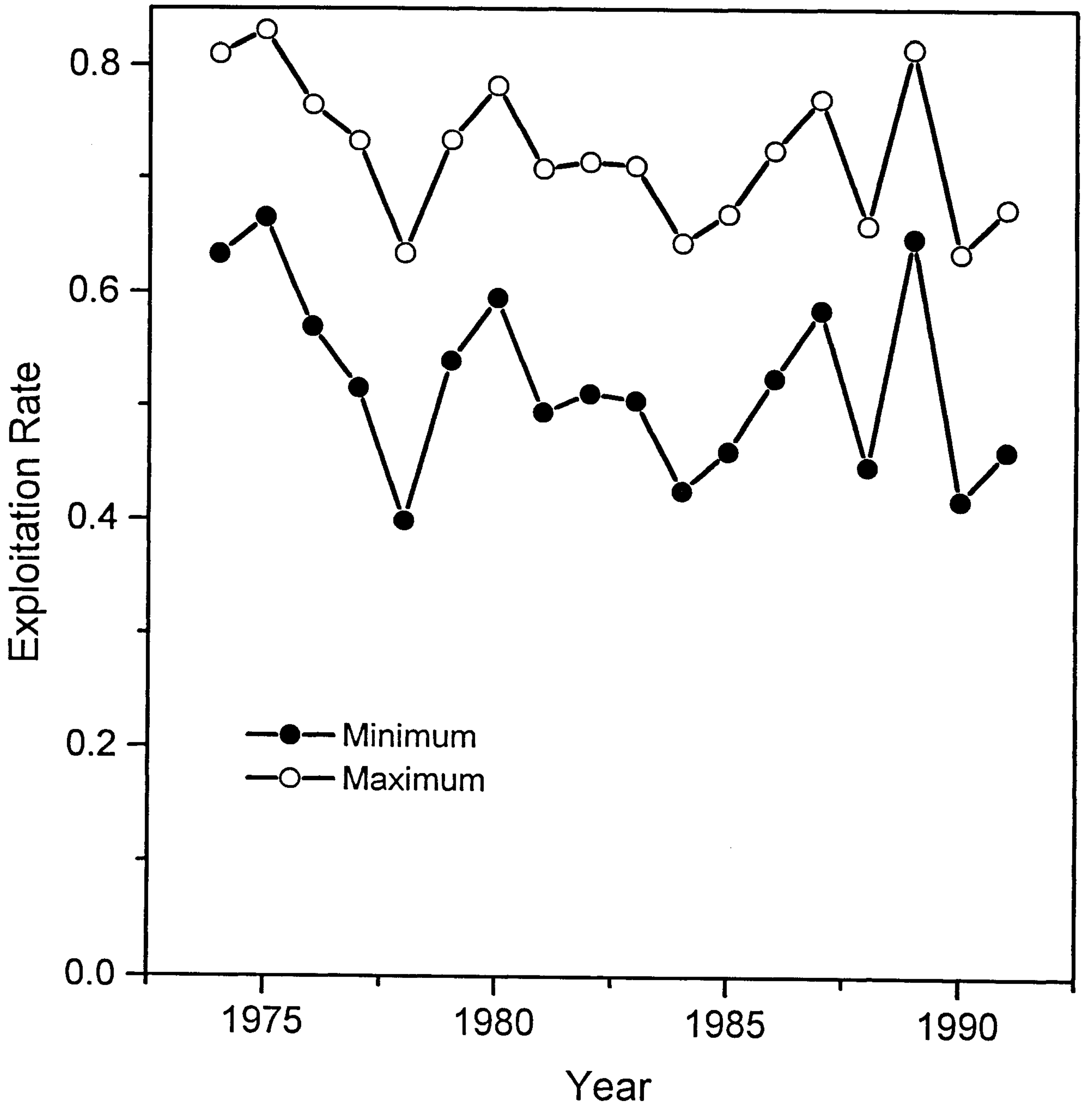


Figure 5.3.1.5. Minimum and maximum estimates of the proportion of North American 1SW non-maturing stocks available to the Canadian fishery, 1974-91.

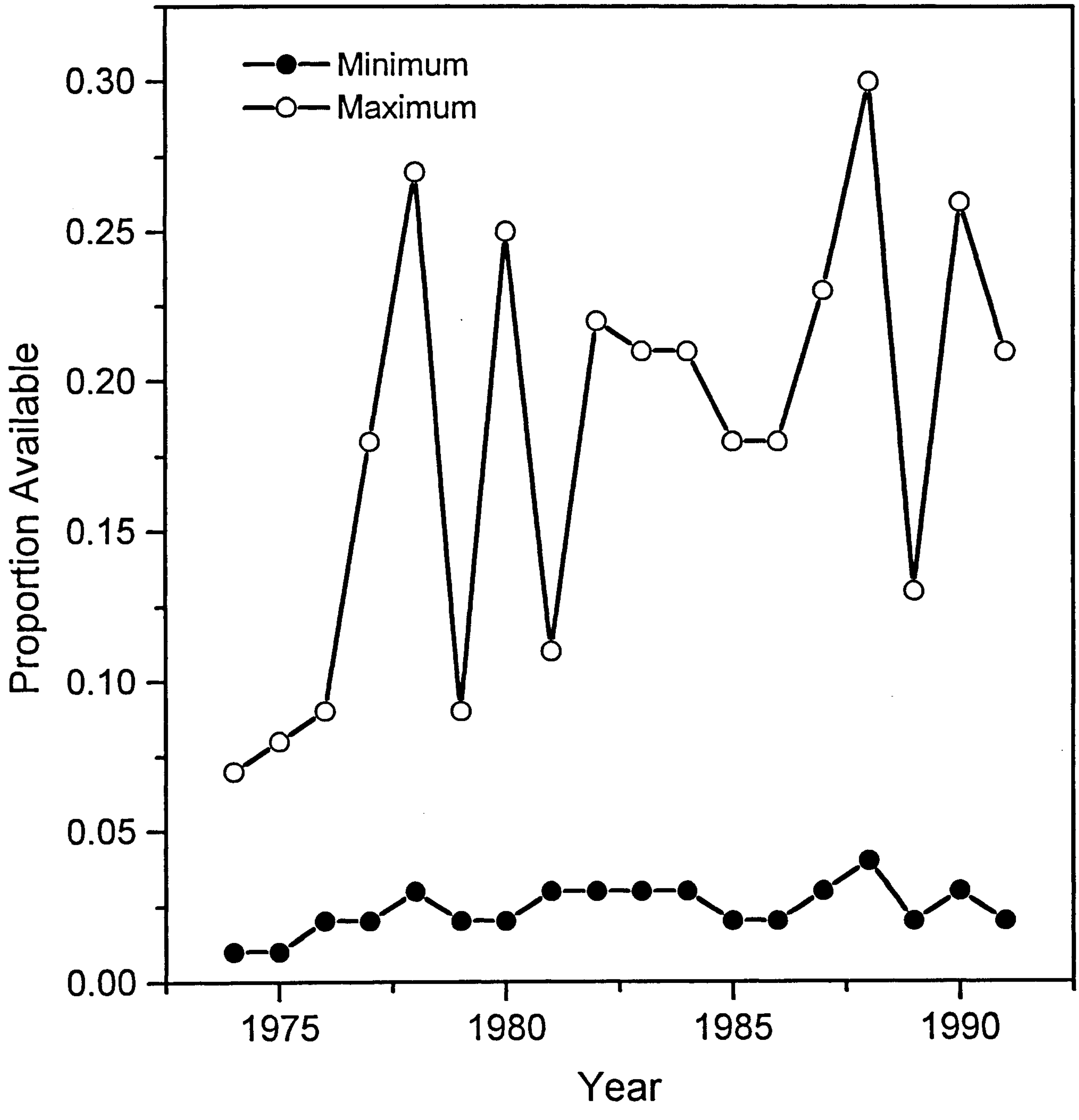


Figure 5.3.2.1. Comparison of exploitation rates in Canada and Greenland as determined by tagging experiments with Maine stocks (P=0.1) and by the continental run-reconstruction model.

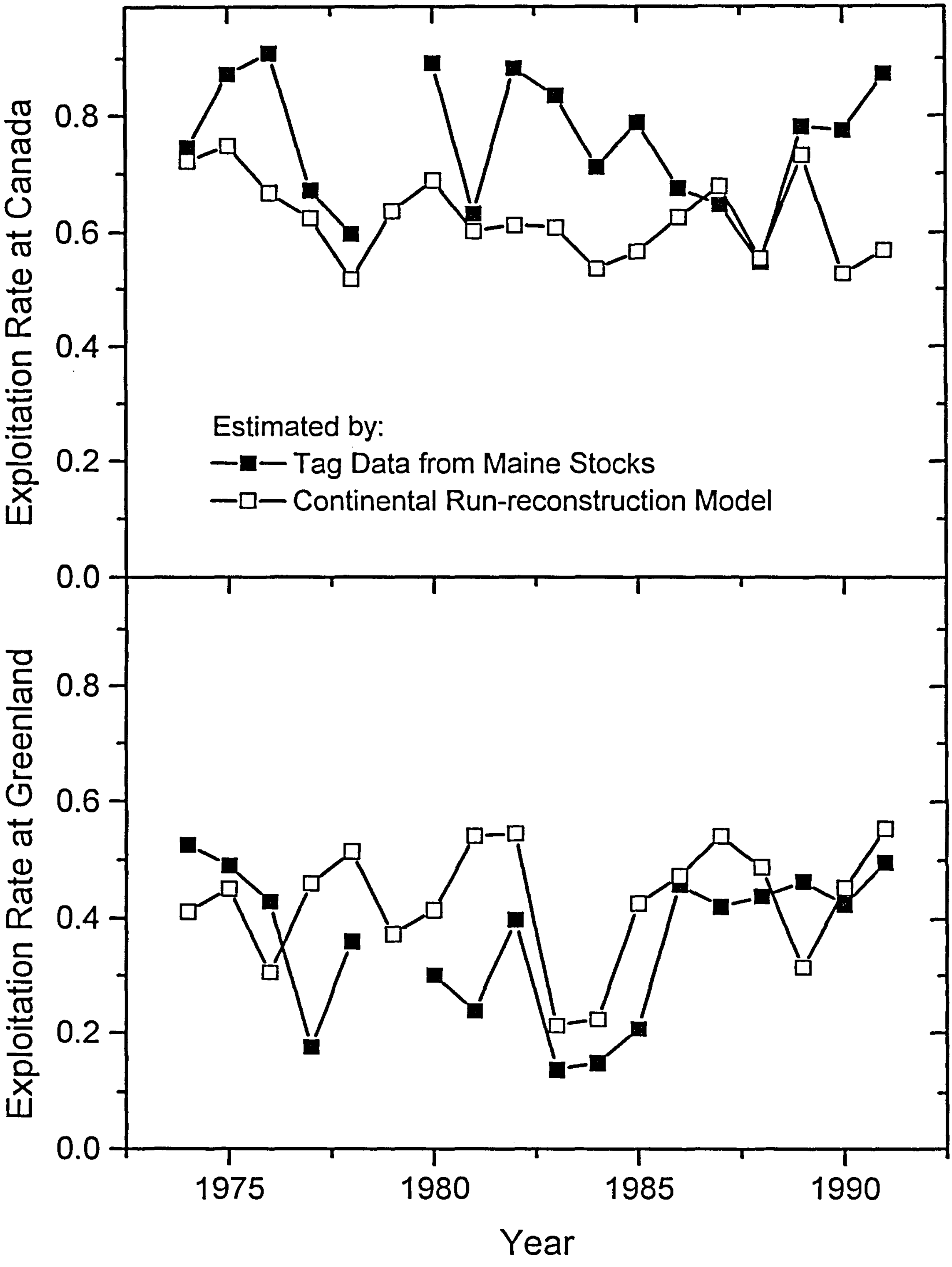


Figure 5.3.3.1. Schematic diagram of the contribution of northern and southern stocks to the 1974 West Greenland fishery. The composite for the fishery reflects contributions from both stock components.

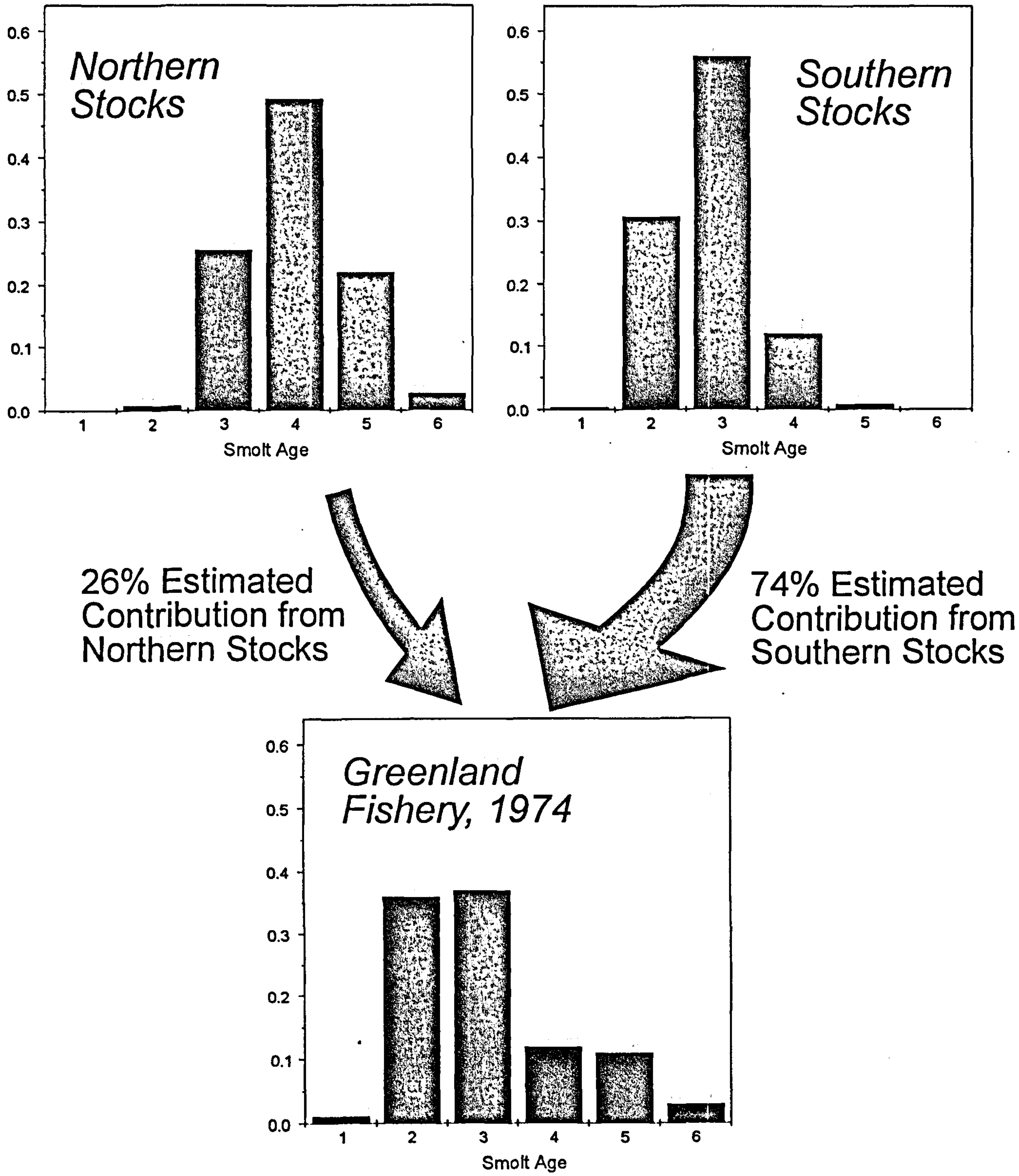


Figure 5.3.3.2. Proportional contribution of the northern North American stock complex to the West Greenland fishery, 1974-92.

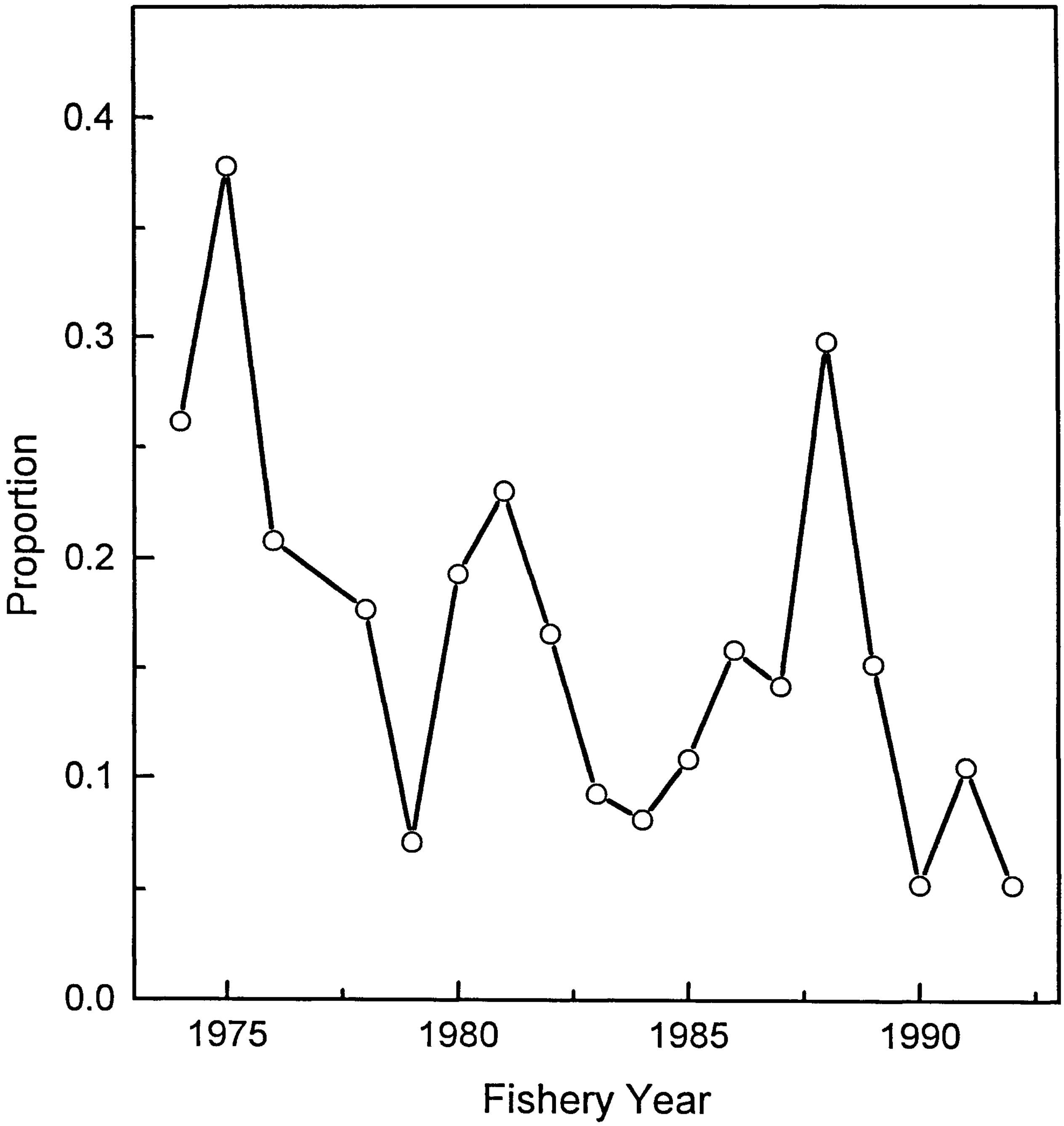


Figure 5.3.3.3. Estimated catches of northern and southern North American stock complexes at West Greenland, 1974-92.

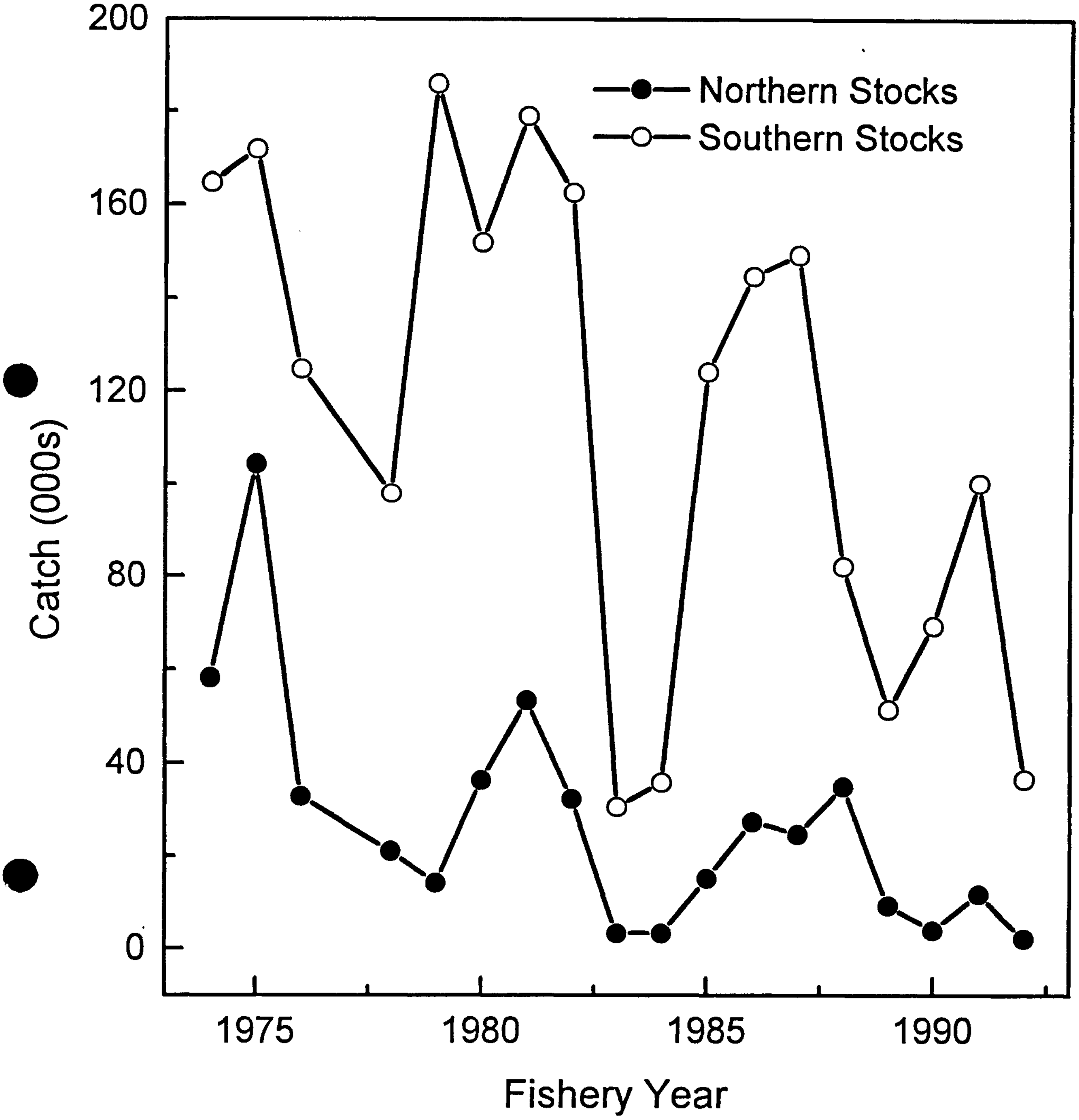


Figure 5.3.4.1. Comparison of observed returns of 2SW salmon to North America and projected returns assuming that the Greenland quota had not been reduced from 1190t. See text for details.

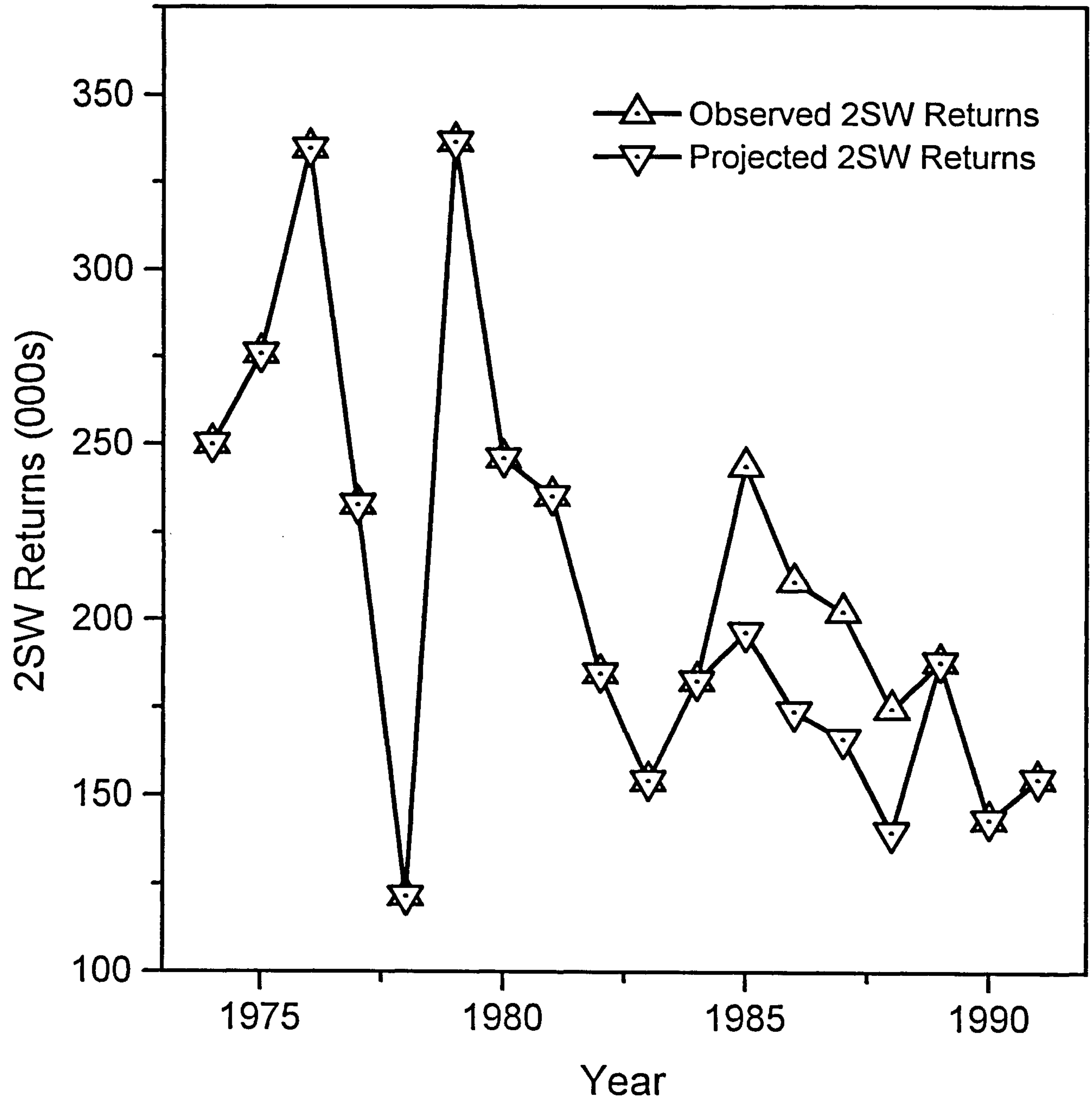


Figure 5.3.4.2. Exploitation of extant North American origin 2SW salmon in Newfoundland-Labrador as estimated from total returns and catches of 2SW salmon.

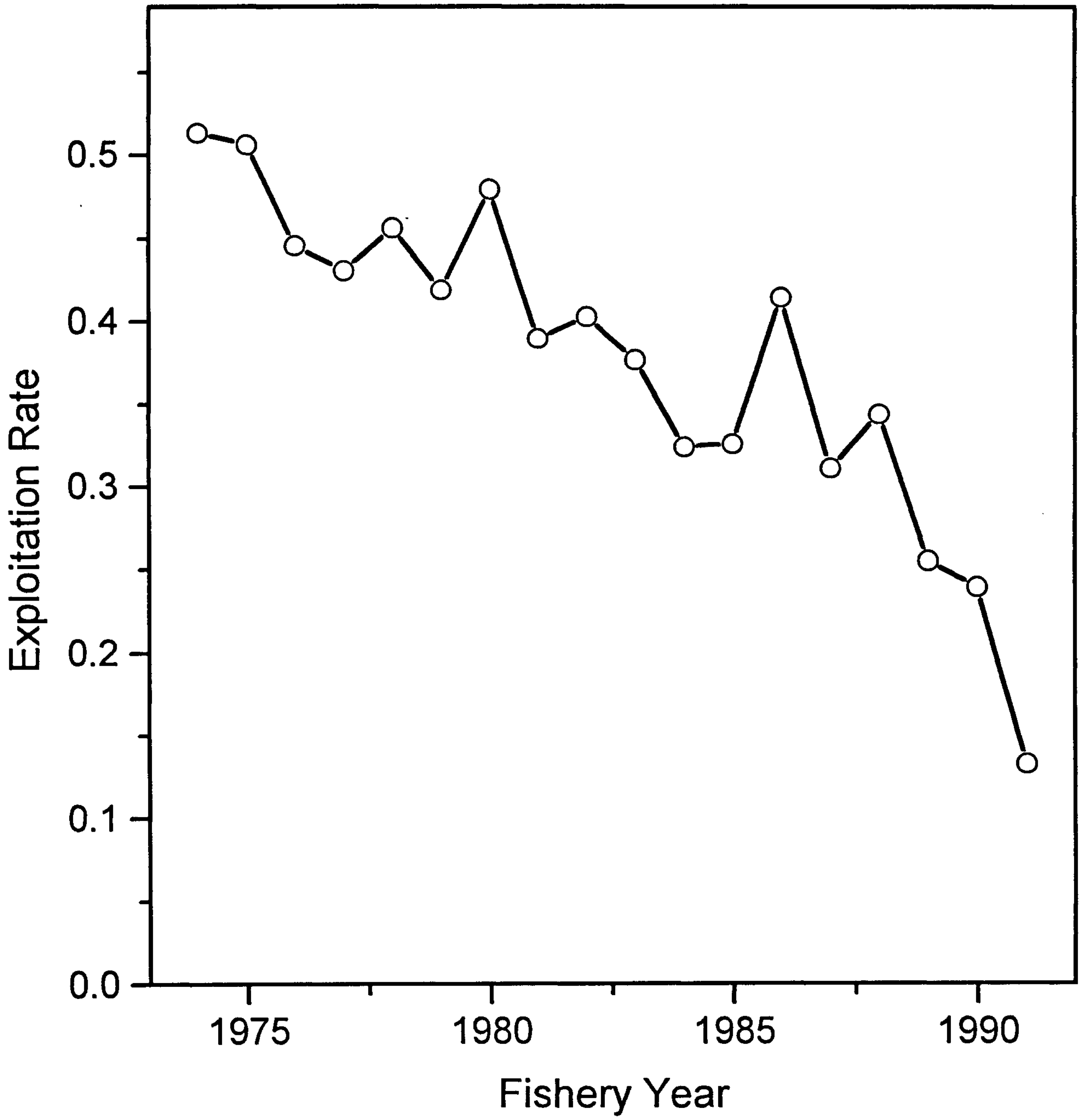


Figure 5.3.4.3. Comparison of observed returns of 2SW salmon to North America and projected returns assuming that Canada had not reduced fishing mortality from the average exploitation rate of 0.44 in 1974-77 in the Newfoundland-Labrador fishery. See text for details.

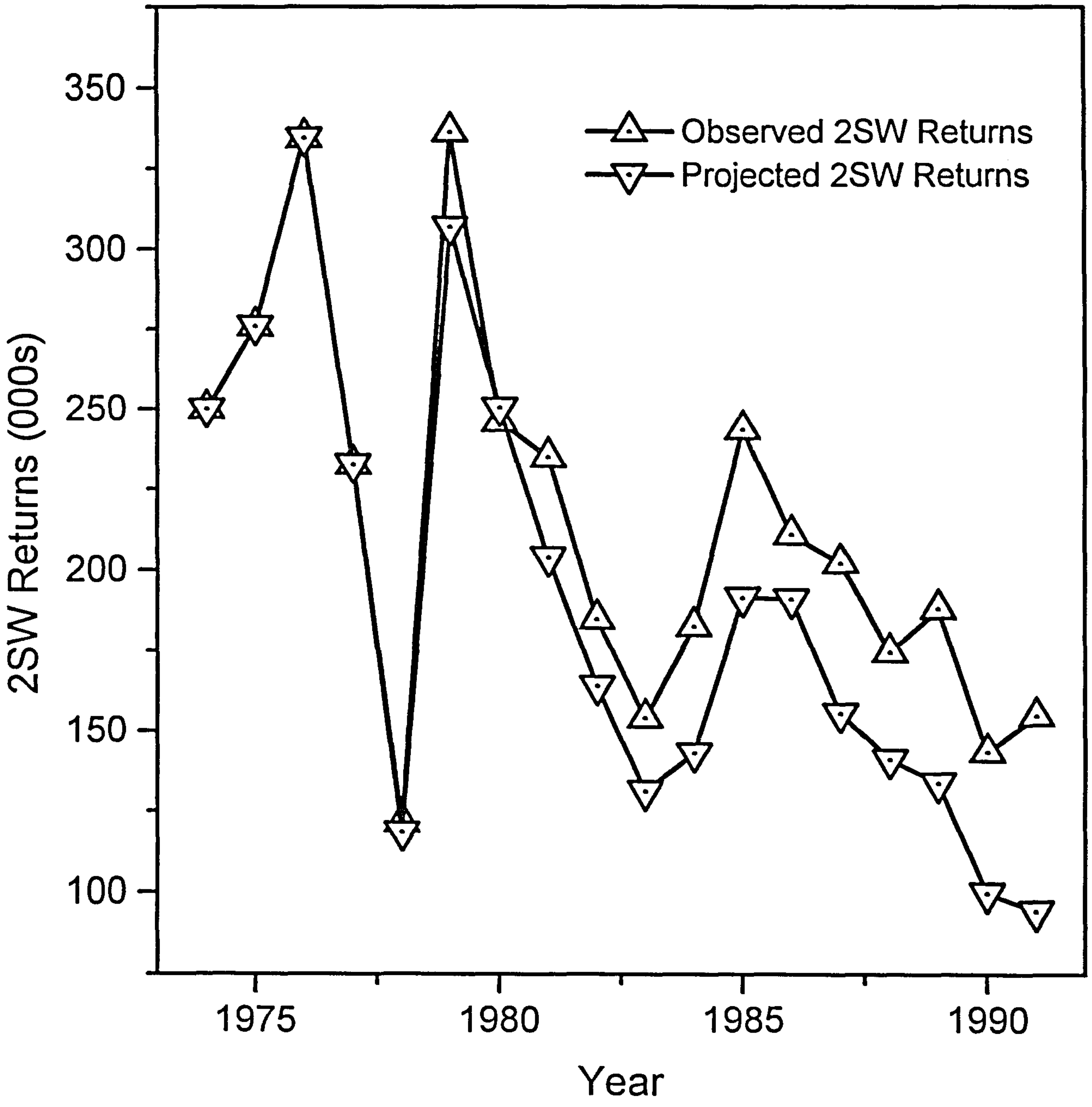


Figure 5.3.4.4. Comparison of observed returns of 2SW salmon to North America and projected returns based on the combined effects of 1) no reduction of the Greenland quota from 1190t and 2) no reduction in exploitation rate in Nfld.-Lab. from 1974-77 average of 0.44. See text for details.

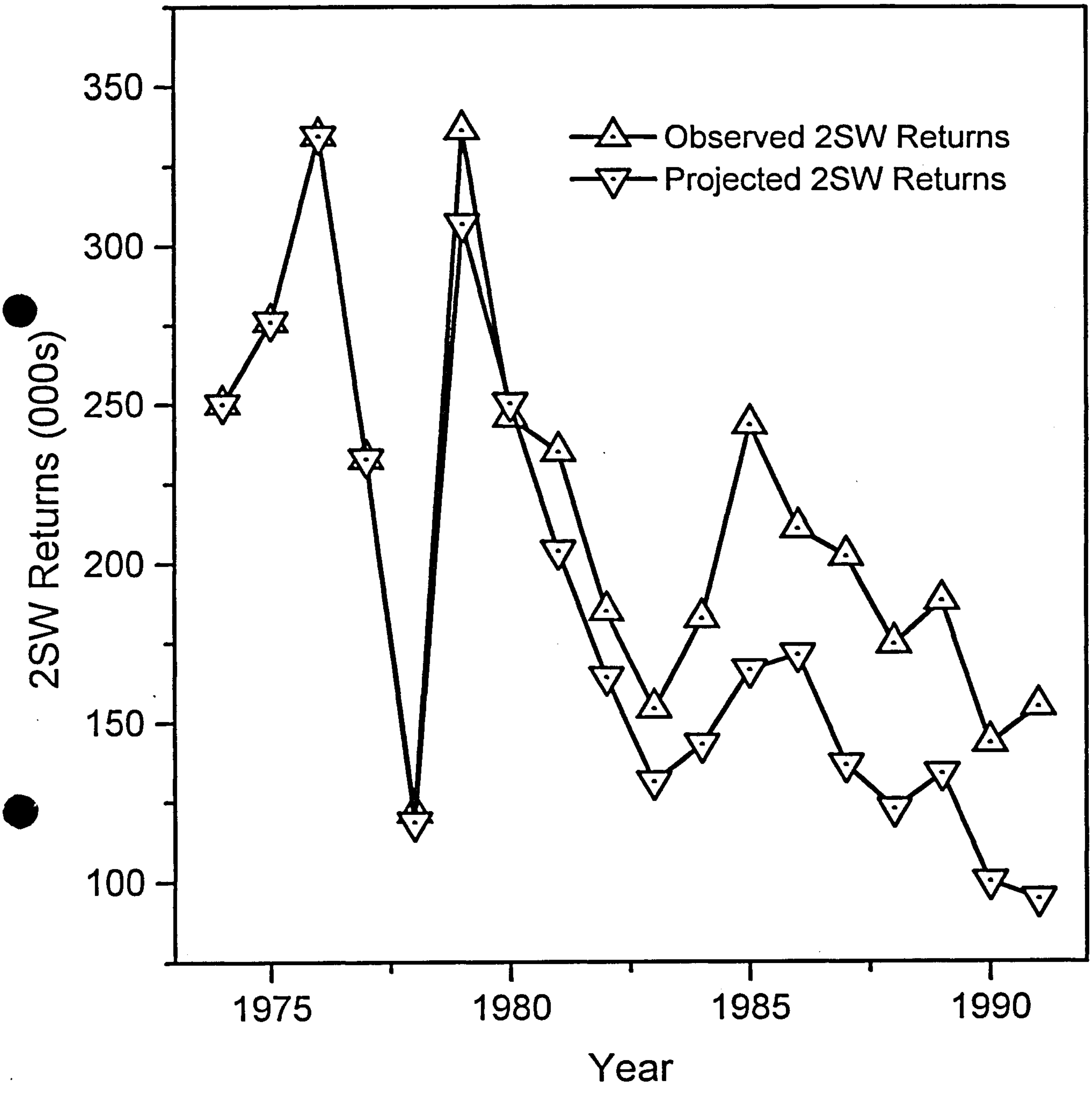


Figure 5.4.1.1. Time series of pre-fishery abundance estimates and fitted Holt exponential smoothing model with 25 to 75% confidence limits. The pre-fishery abundance estimates represent mid range values. The Holt trend parameter weight was 0.67.

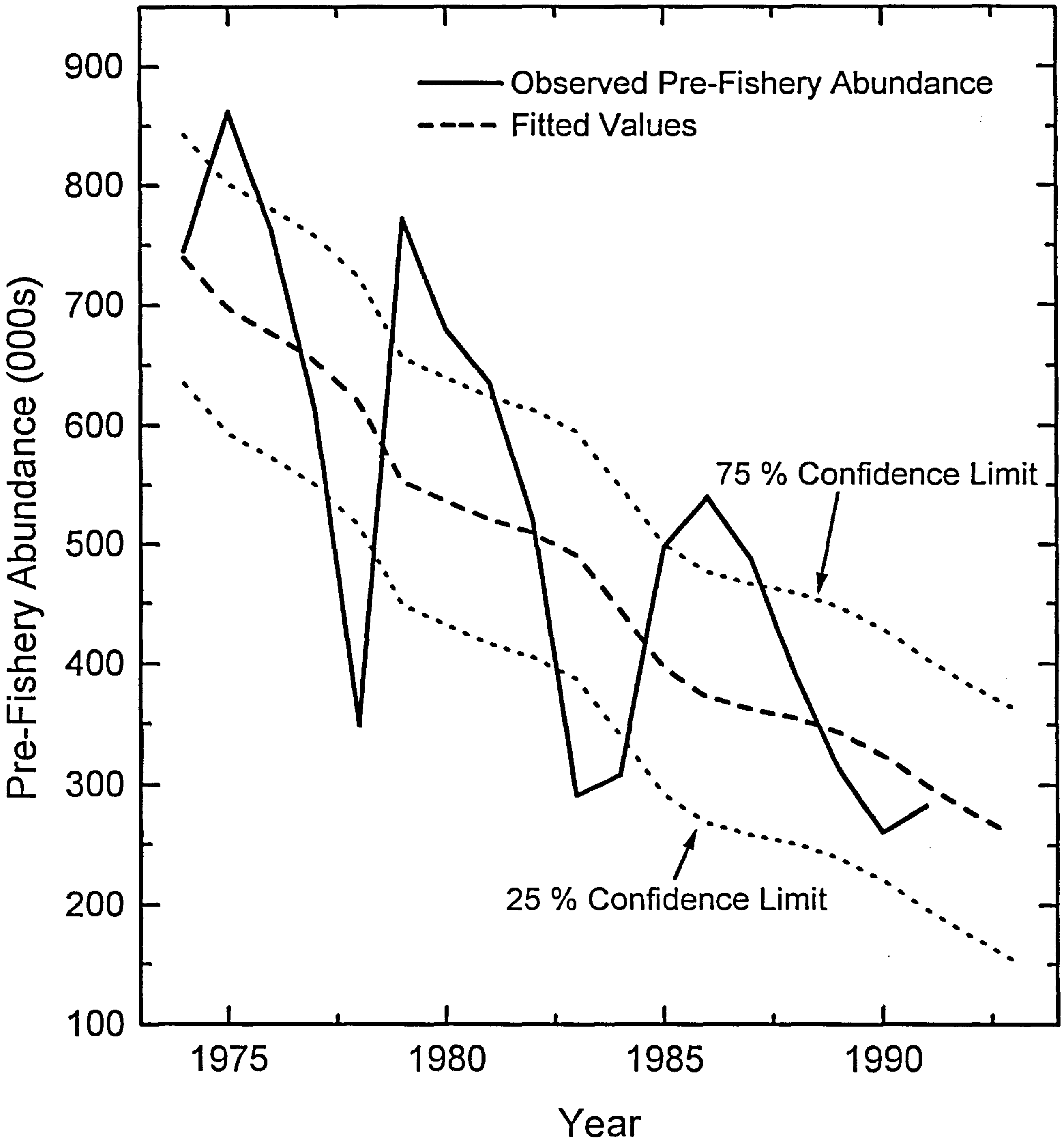


Figure 5.4.1.2. Univariate and regression forecasts of pre-fishery abundance in 1992 and univariate forecasts only for 1993. 1992 forecasts based on mid range values, 1993 forecasts compares estimates based on mid, high and low values.

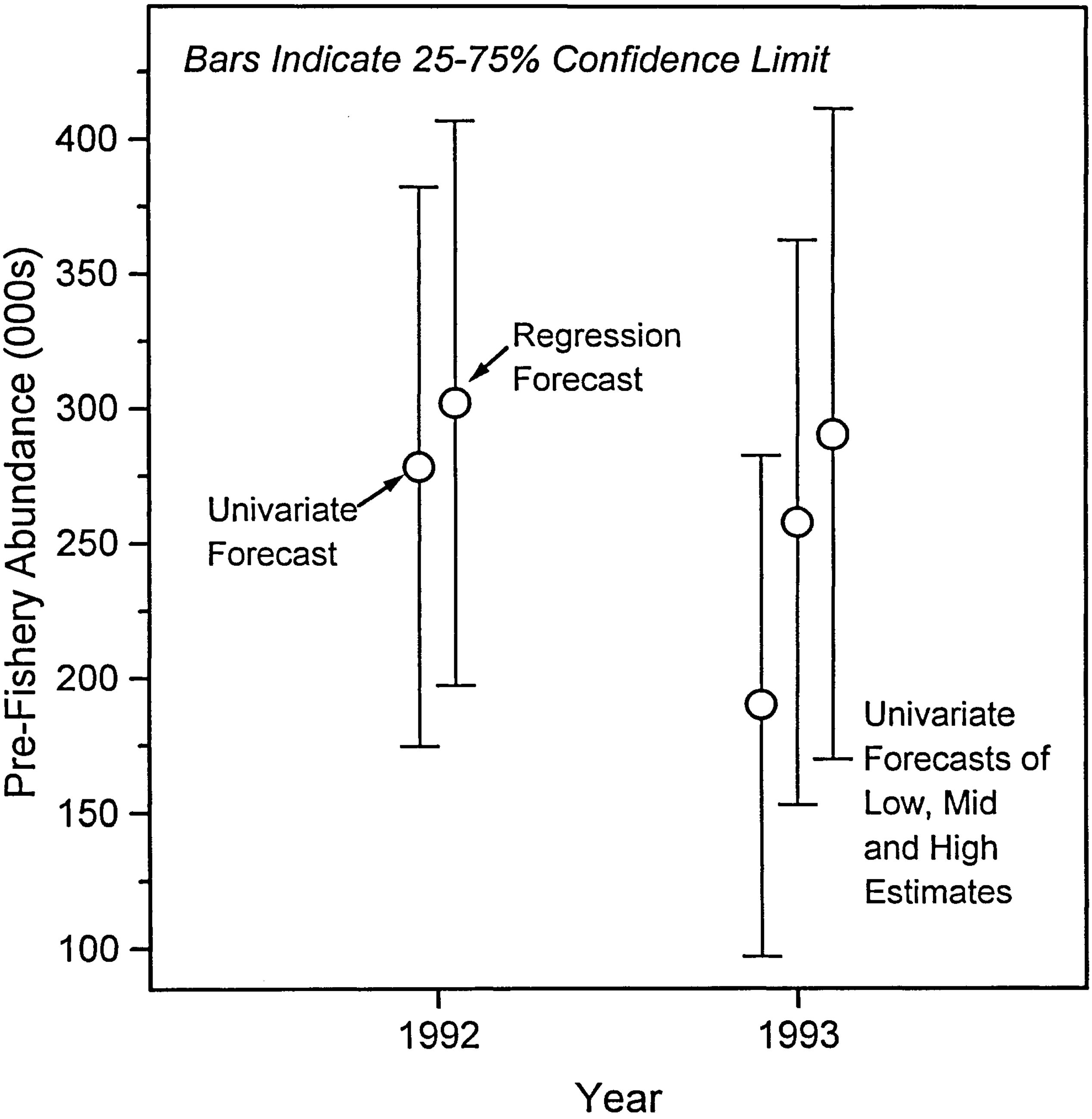


Figure 5.4.1.3. Research vessel catches rates used as weighting factors for potential salmon habtitat in the Labrador Sea, 1965-91.

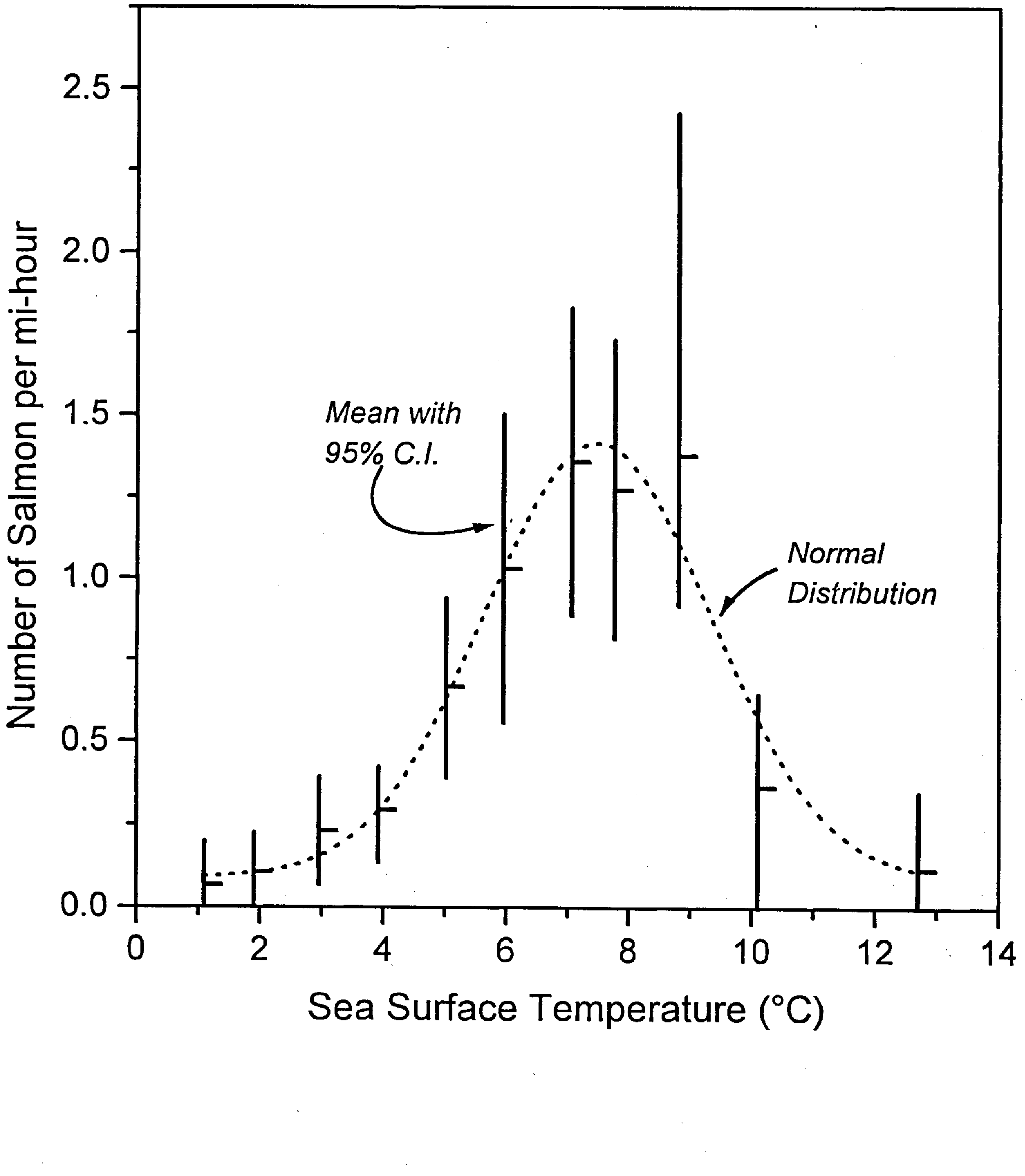


Figure 5.4.1.4. Area used for determination of available salmon habitat.

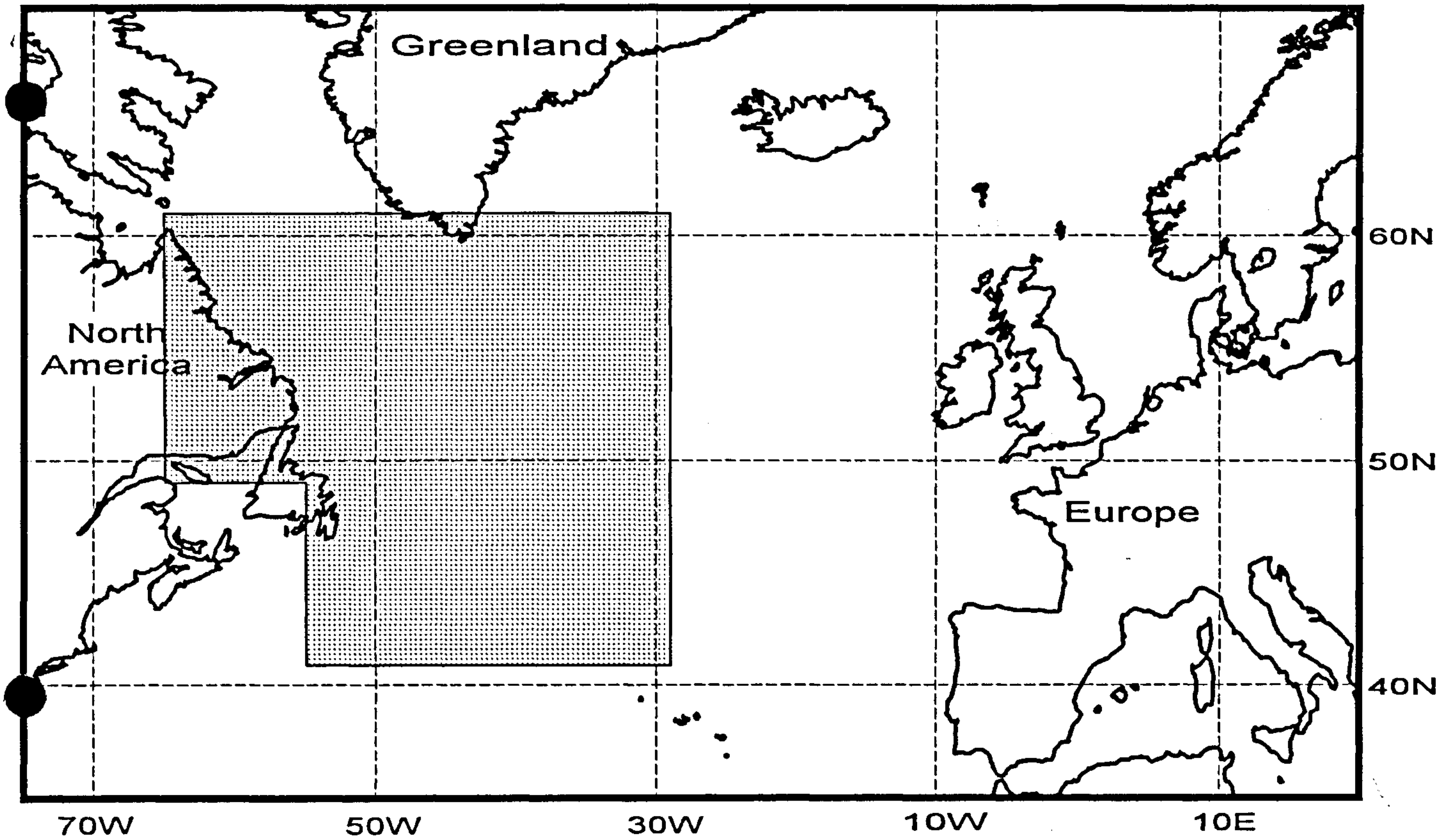


Figure 5.4.1.5. Pre-fishery abundance and predicted values based on habitat area in March (A). Relationship pf pre-fishery abundance on weighted habitat area in March (B).

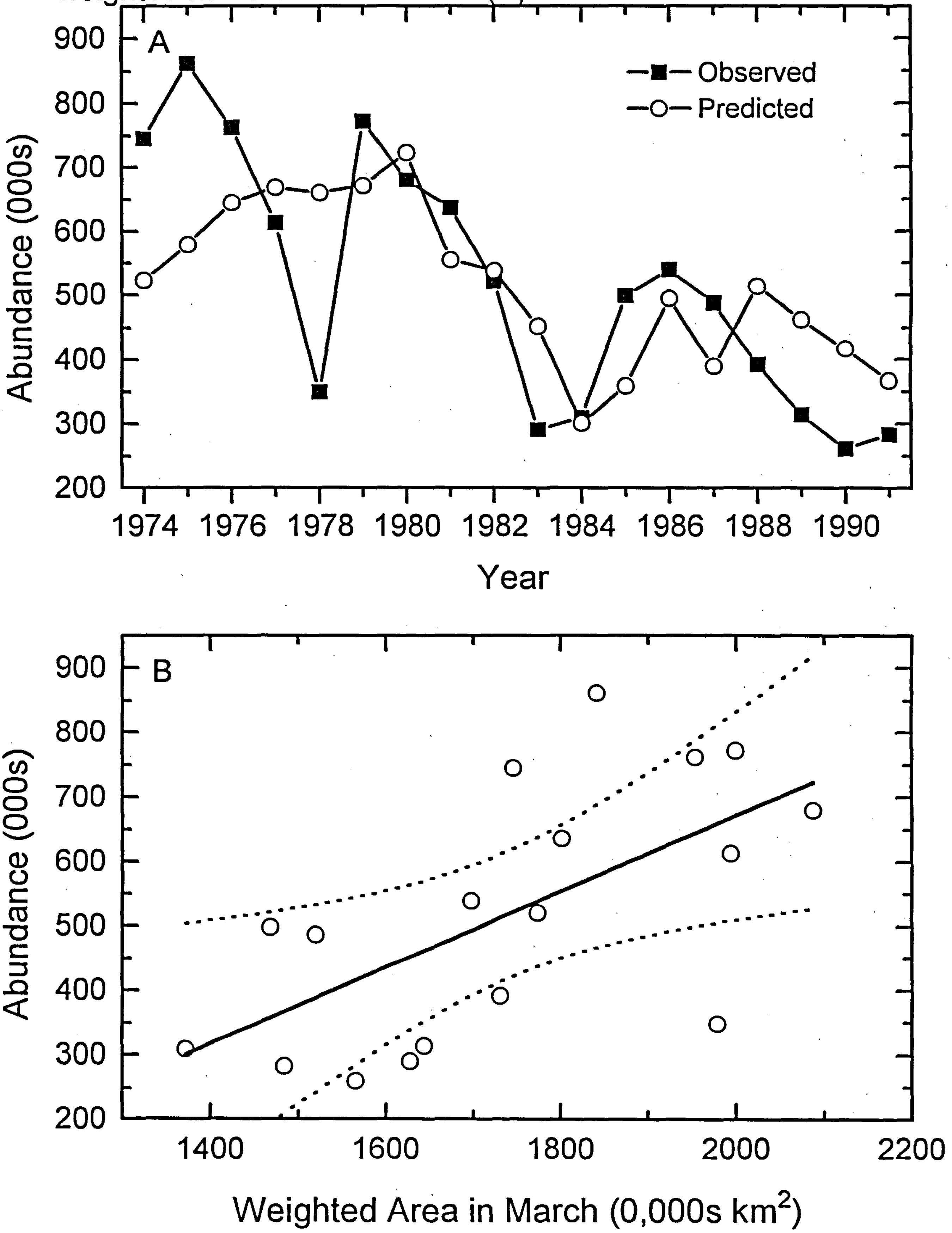


Figure 5.4.1.6. Estimated 2SW spawners in North America, 1974-92.

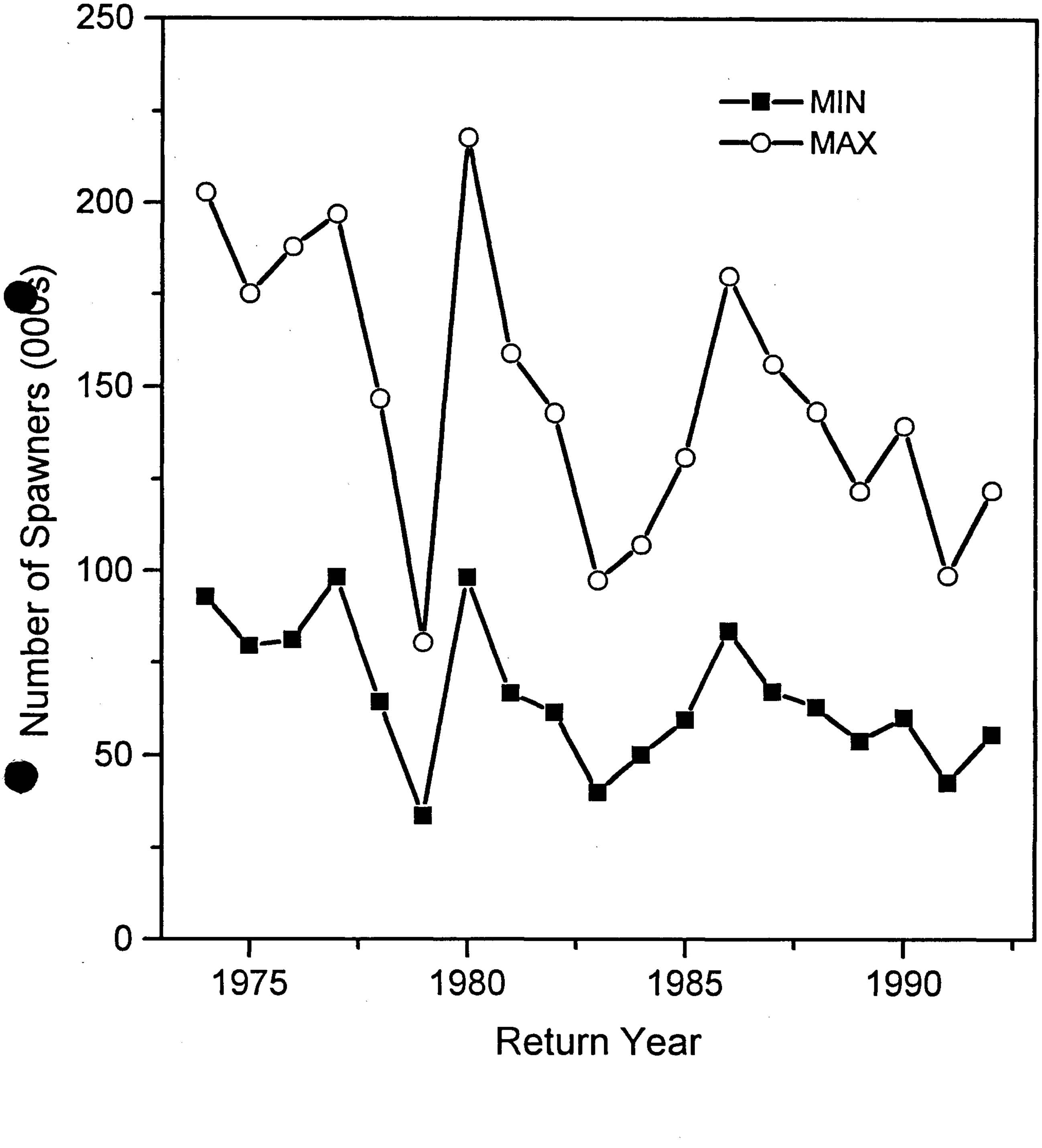


Figure 5.4.2.1. Probability profile and North America and Greenland allocations for pre-fishery abundances.

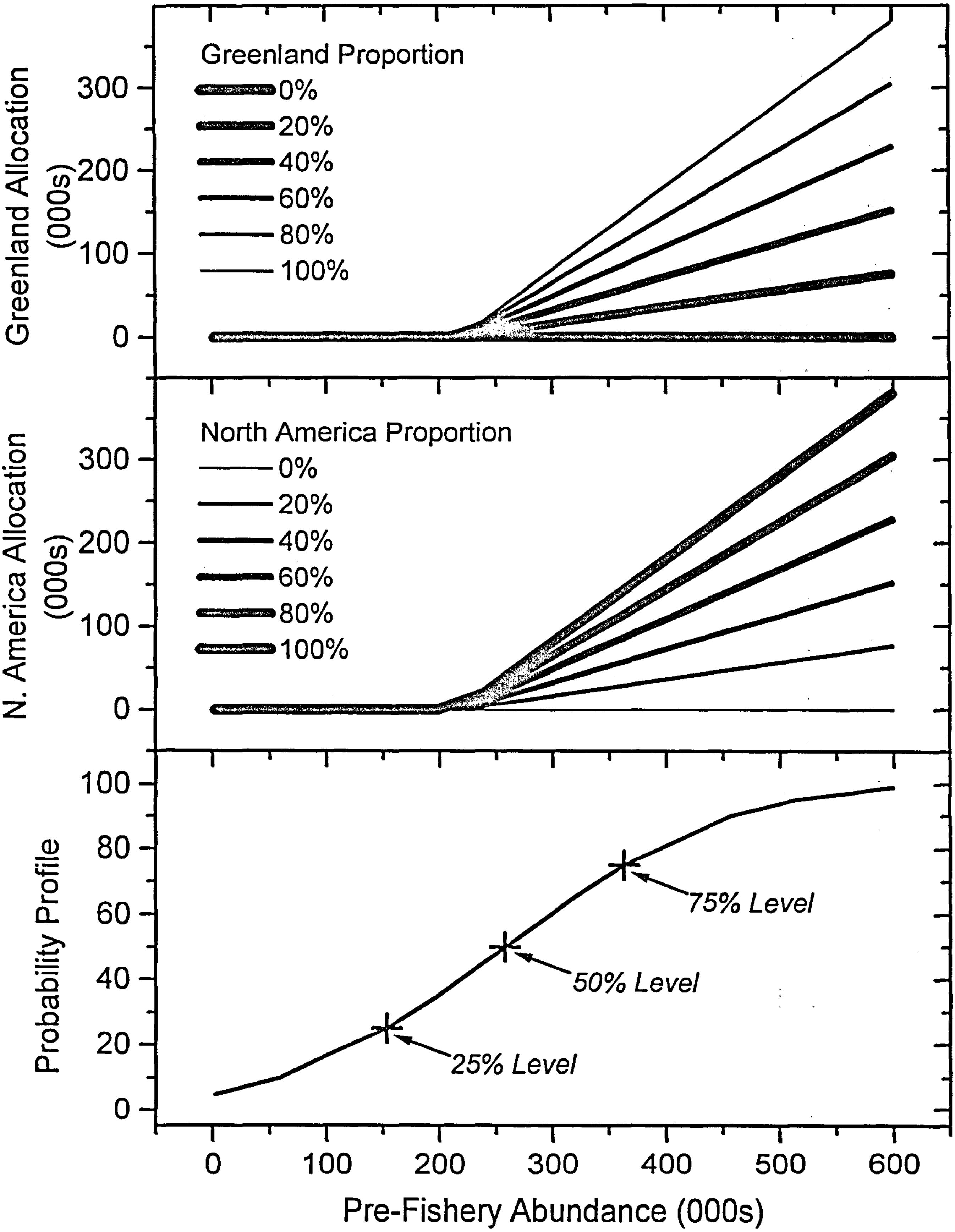


Figure 5.6.1. Reporting rate estimates at West Greenland based on comparison of Carlin and CWT recoveries.

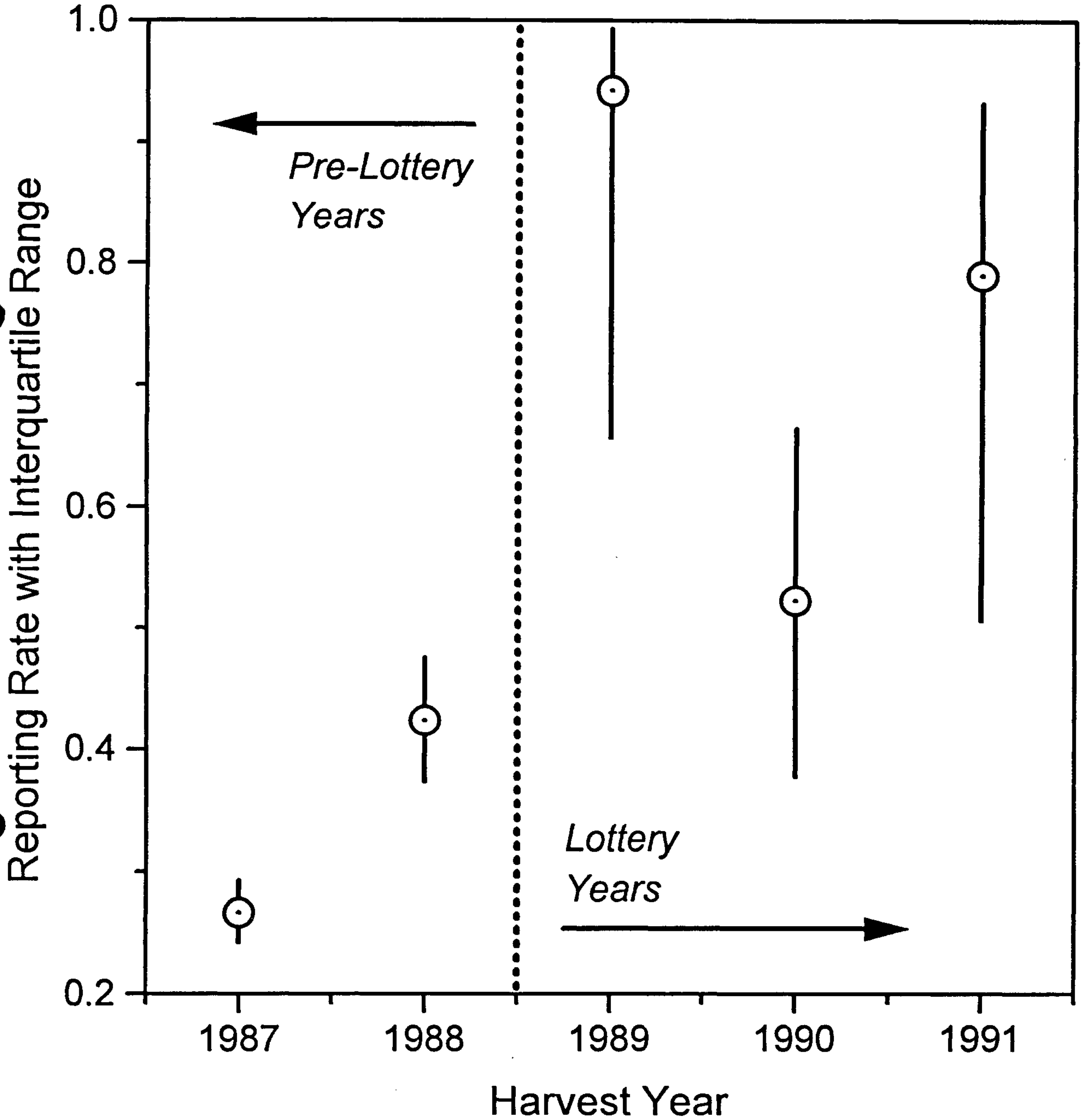
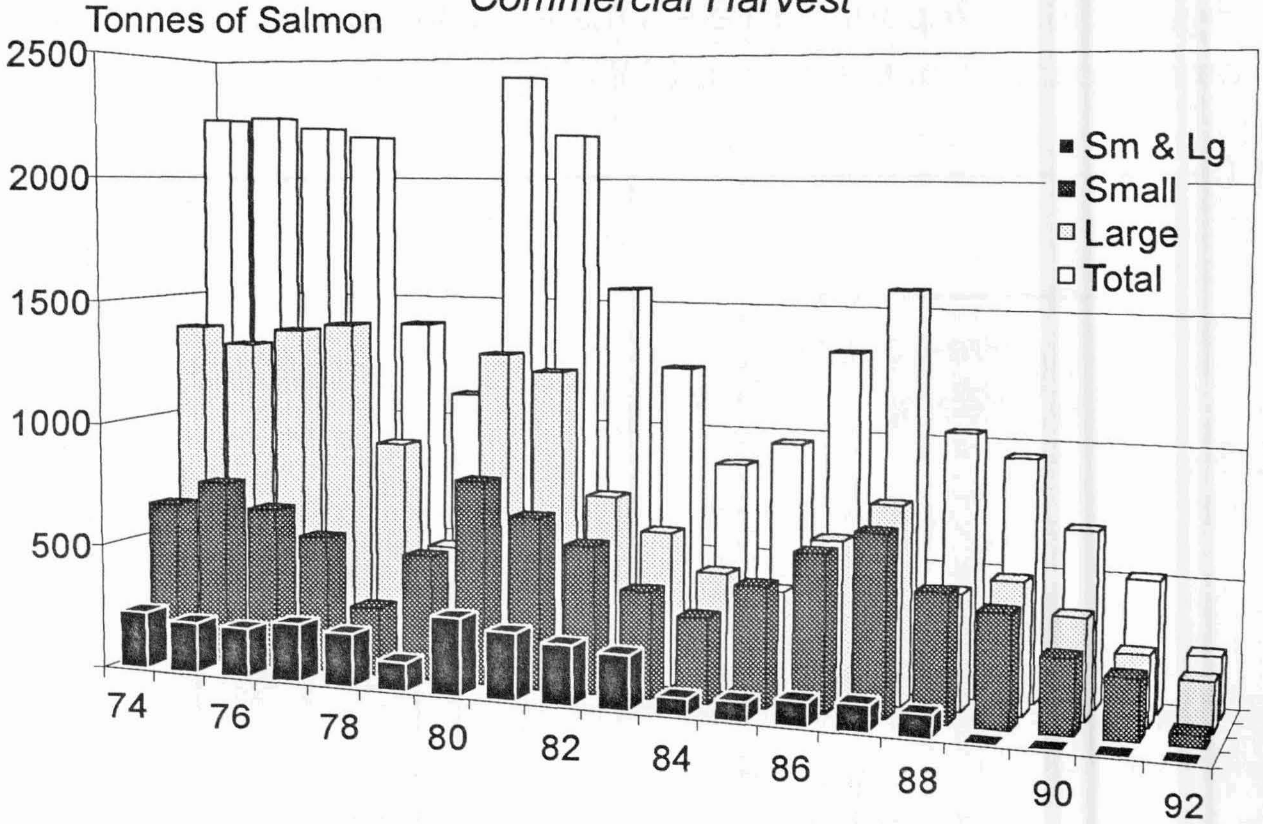
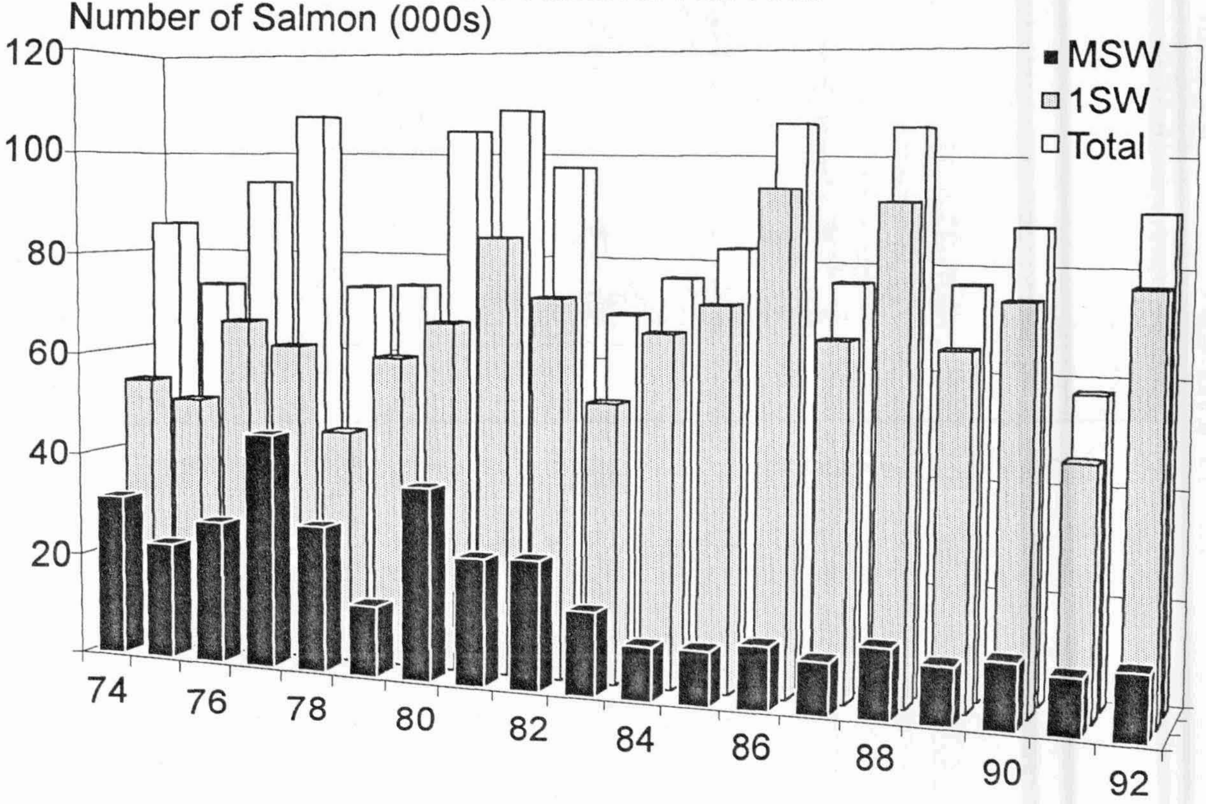


Figure 6.1.1. Canadian landings of Atlantic salmon, 1974-92.



Commercial Harvest



Recreational Harvest

Figure 6.3.1. Canadian and French maritime boundries.

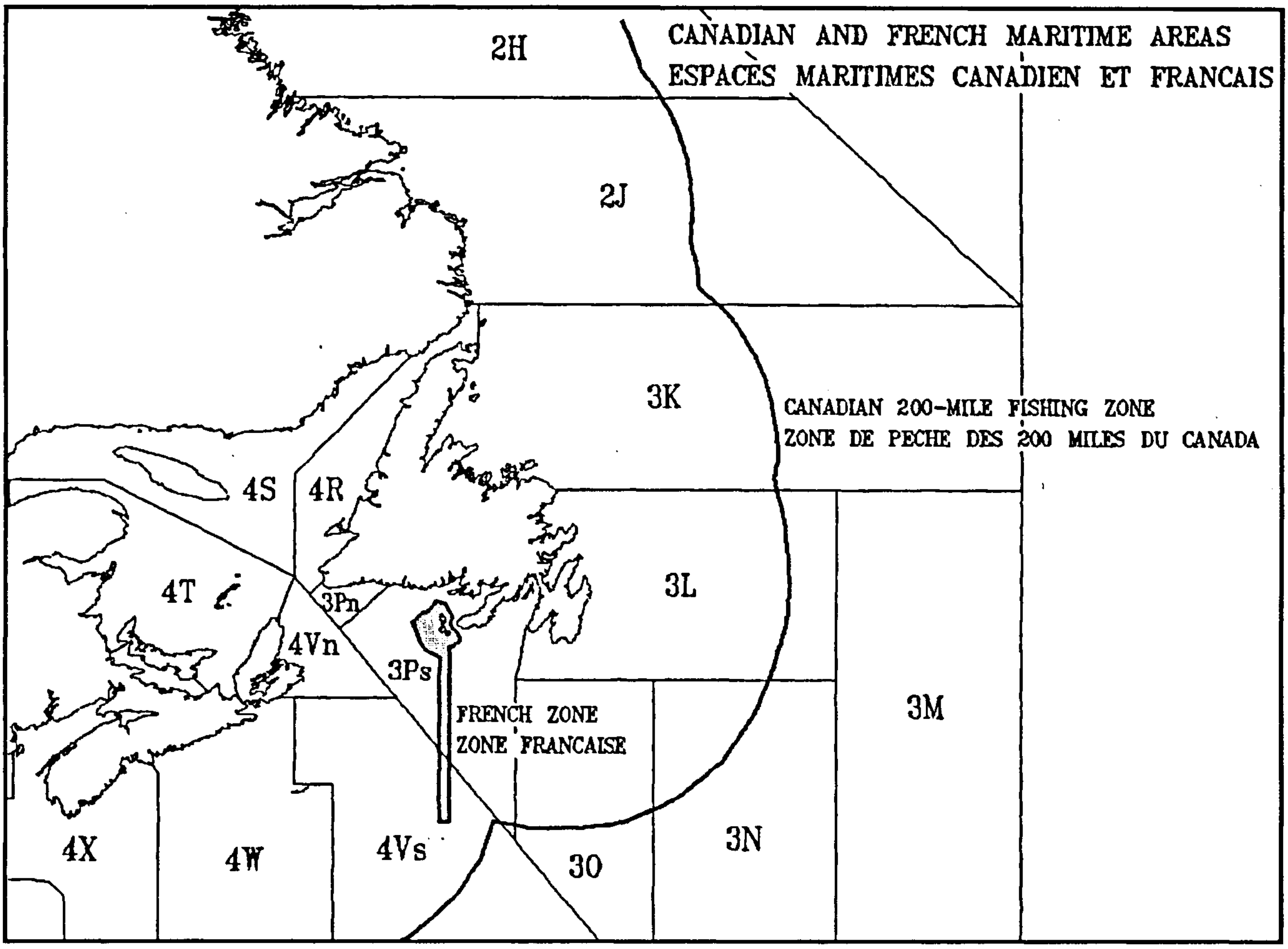


Figure 6.4.1.1. Counts of small and large salmon from fishways and counting fences in insular Newfoundland indicating 1992 returns as a percentage of 1984-89 mean.

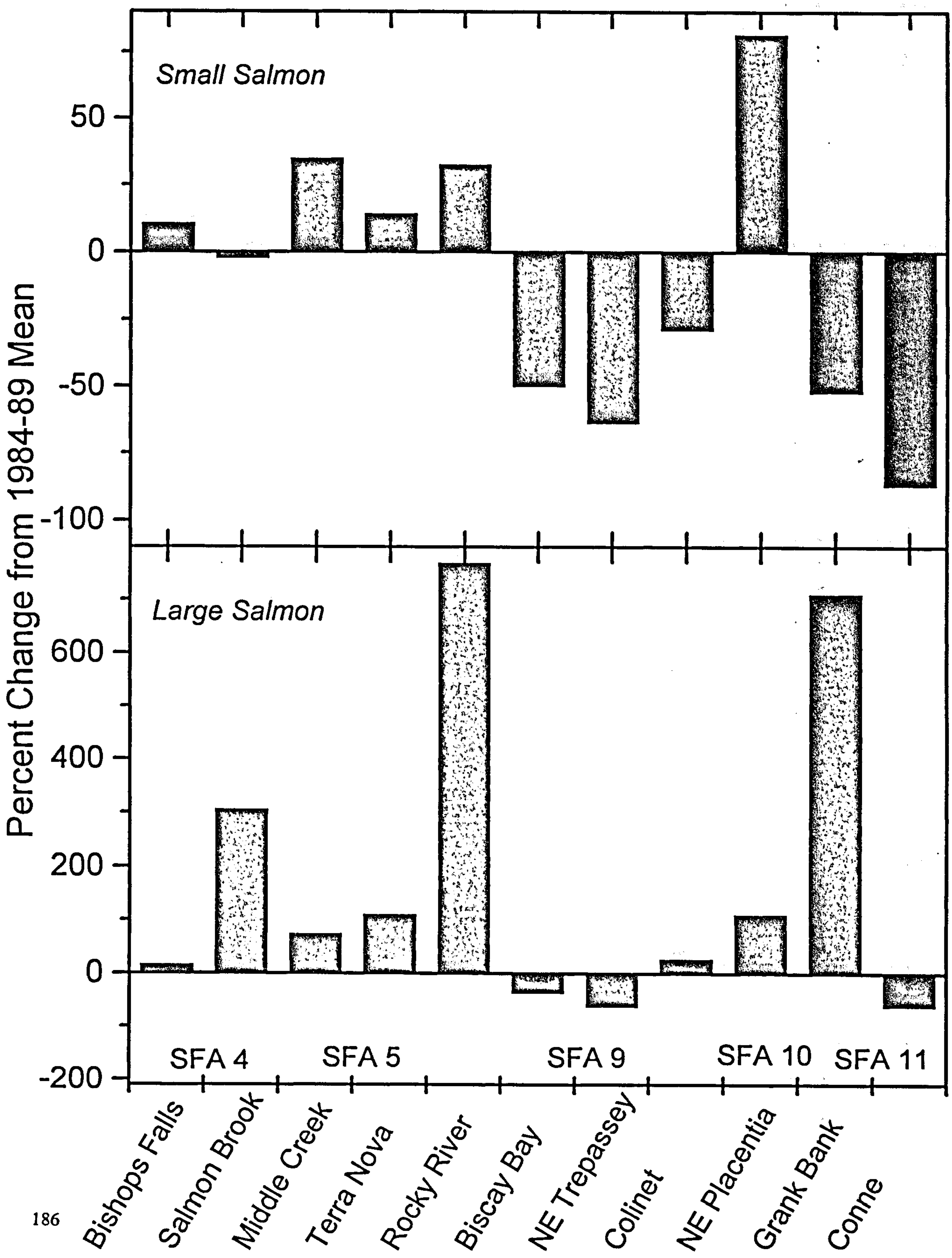


Figure 6.4.1.2. Comparison of the ratio of small-to-large salmon for 1984-89 and 1992 for various rivers in insular Newfoundland. A lower ratio in 1992 infers a proportional increase in the number of large salmon returning.

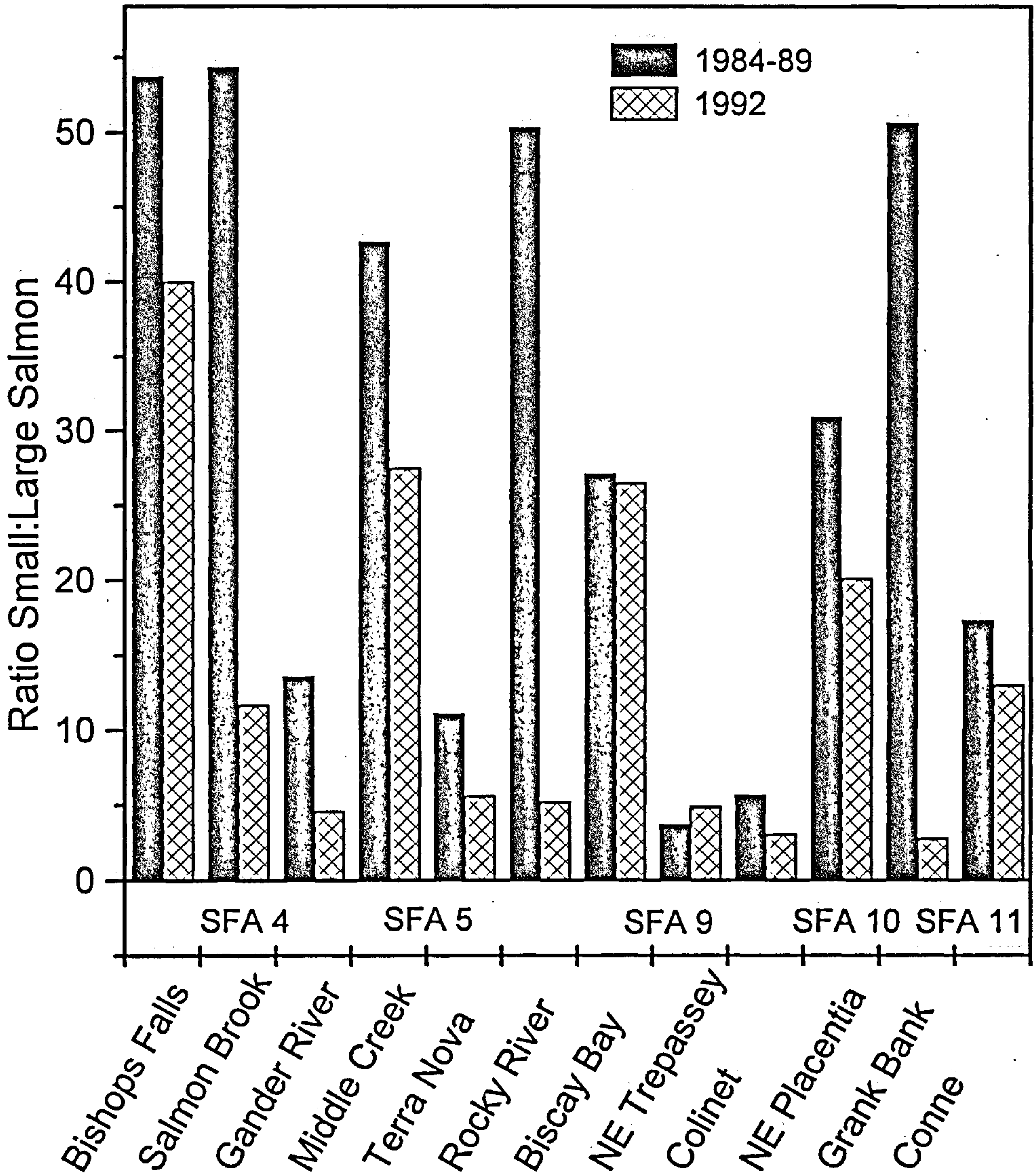
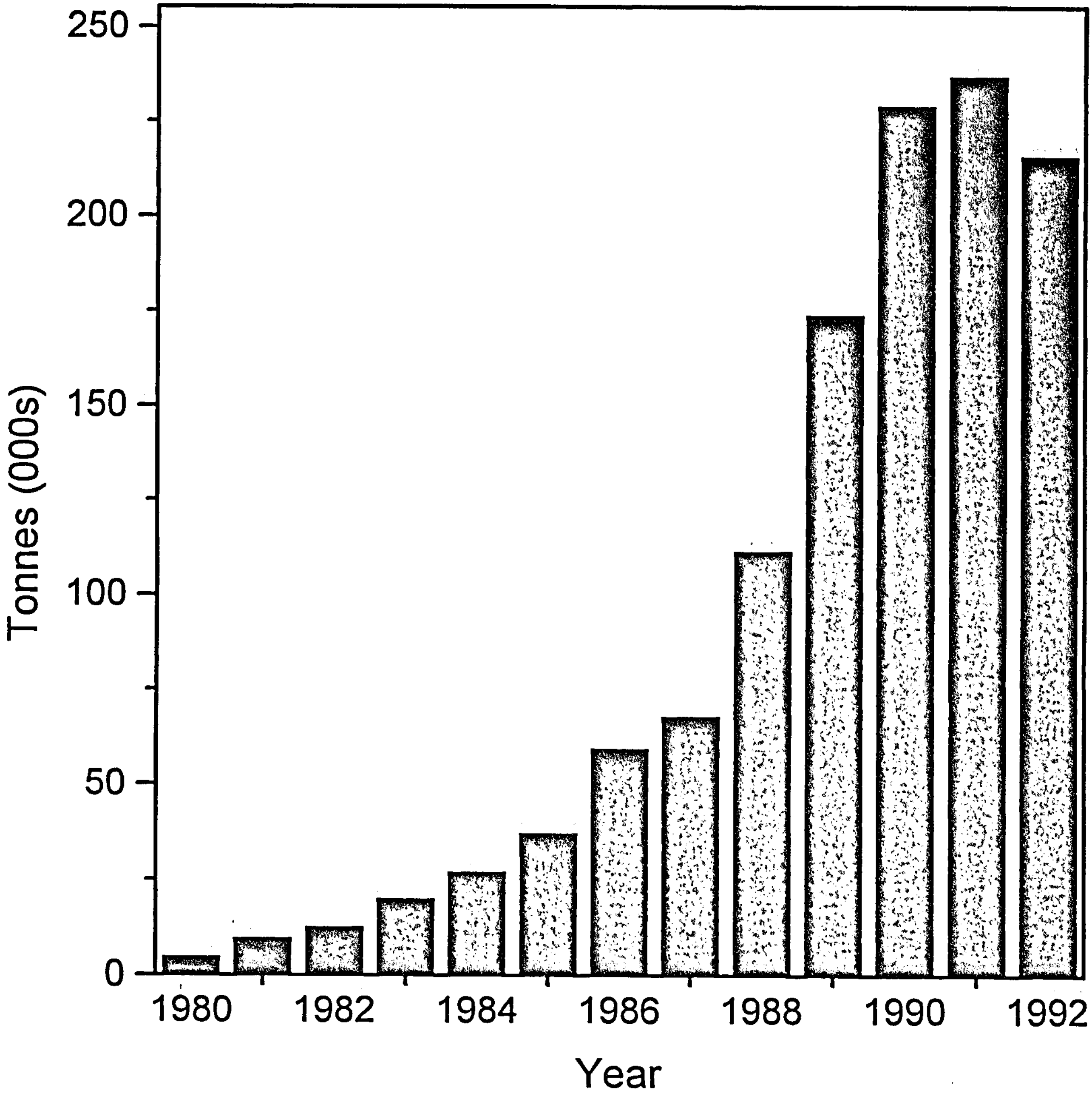


Figure 7.1. Production of farmed salmon in the North Atlantic area.



APPENDIX 1

TERMS OF REFERENCE

The Working Group on North Atlantic Salmon (Chairman: Dr K. Friedland, USA) will meet at ICES Headquarters from 5-12 March 1993 to:

a) with respect to Atlantic salmon in each Commission area, where relevant

  i) describe the events of the 1992 fisheries with respect to catches (including unreported catches), gear, effort, composition and origin of the catch (including escapees and sea-ranched fish), and rates of exploitation;

  ii) describe the status of the stocks occurring in the Commission area, and where possible evaluate escapement against targets;

  iii) evaluate causes of the apparent reduced survival of salmon in recent years;

  iv) evaluate the by-catch and mortality of salmon in non-salmon directed fisheries;

  v) specify data deficiencies and research needs;

b) evaluate the following management measures on the stocks and fisheries occurring in the respective Commission areas:

  i) quota management measures and closures implemented in 1991 and 1992 in the Newfoundland and Labrador commercial salmon fisheries;

  ii) regulations introduced into the Norwegian salmon fisheries in 1989;

  iii) the effects of cessation of fishing activity at Faroes;

c) with respect to the West Greenland Commission area:

  i) describe which stocks make the greatest numerical contributions of salmon to the fishery and which stocks are most heavily exploited in the fishery;

  ii) describe the relative importance to stocks of regulatory measures in the fishery and in homewaters;

  iii) describe the relationship between the abundance of grilse and multi-sea-winter salmon in returns to homewaters and the effects of this on the management of the fishery;

  iv) continue the development of a model which could be used in the setting of catch quotas in relation to stock abundance and provide worked examples with an assessment of risks relative to the management objective of achieving adequate spawning biomass;

  v) estimate the pre-fishery abundance of non-maturing 1SW salmon at the time of the fishery;

d) review biological indicators, if any, which would make it possible to assess trends in the abundance of salmon in the North-East Atlantic;

e) with respect to the assessment of fisheries in each Commission area, evaluate the effects of the NASCO tag return incentive scheme;

f) with respect to Atlantic salmon in the NASCO area, provide a compilation of microtag, finclip, and external tag releases by ICES Member Countries in 1992.

APPENDIX 2

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP ON NORTH ATLANTIC SALMON

Doc. No. 1 MacLean, J.C. and Milne, J.M.A.. The Effect on the reported Scottish Salmon Catch Statistics of the misreporting of grilse as salmon in 1991.

Doc. No. 2 Dunkely, D.A.. Mean weights of fish reported as salmon and grilse in catches in Scotland 1952-1991.

Doc. No. 3 Friedland, K.D., and Reddin, D.G. The use of otolith morphology in stock discriminations of Atlantic salmon (*Salmo salar* L.).

Doc. No. 4 Friedland, K.D., Stolte, L.W., Meyers, T.F., and Baum, E.T.. Estimated Harvest of USA-origin 1-SW salmon in Greenland in 1991.

Doc. No. 5 Friedland, K.D., Rago, P.J., and Spencer, R.C.. Carlin tag returns and harvest estimates of USA origin salmon in Greenland, 1967-1992.

Doc. No. 6 Potter, E.C.E. A sensitivity analysis on the national salmon run-reconstruction model.

Doc. No. 7 Part 1 and 2. Russell, I.C., Potter, E.C.E., Reddin, D.G., and Friedland, K.D.. Recoveries of coded wire microtags from salmon caught at West Greenland in 1992.

Doc. No. 8 Reddin, D.G., and Short, P.B. A new database for discrimination at Greenland in 1989.

Doc. No. 9 Reddin, D.G., and Short, P.B. Identification of North American and European Atlantic salmon (*Salmo salar* L.) caught at West Greenland in 1992.

Doc. No. 10 Møller Jensen, J. The salmon fishery at West Greenland 1992.

Doc. No. 11 Møller Jensen, J. Some information about effort.

Doc. No. 12 Kell, L., and Potter, E.C.E. The use of a genetic algorithm to discriminate salmon from Europe and North America on the basis of scales characteristics.

Doc. No. 13 Potter, E.C.E. Some details on the workings of neural networks.

Doc. No. 14 Report of the Study Group on North-East Atlantic Salmon Fisheries(ICES Doc. C.M. 1993/Assess:13).

Doc. No. 15 Report of the Study Group on the North American Salmon Fisheries (ICES Doc. C.M. 1993/M...)

Doc. No. 16 Zubchenko, A.G., Loenko, A.A., and Sharov, A.F. Estimate of the Norwegian drifnet fishery influence on salmon populations status in some rivers of Russia.

Doc. No. 17 Zubchenko, A.V., and Sharov, A.F. Status of Atlantic salmon stocks on Kolsky Peninsula.

Doc. No. 18 Isaksson, I. Reduction in marine survival in Icelandic salmon stocks in the 1988-1990 smolt classes.

Doc. No. 19 Hansen, L.P., Reddin, D.G., and Lund, R.A. The incidence of reared Atlantic salmon in the commercial fishery at West Greenland.

Doc. No. 20 Reddin, D.G., Short, P.B., and Downton, P.D. Length, weight, and age characteristics of Atlantic salmon (*Salmo salar* L.) of North American and European origin caught at West Greenland in 1992.

Doc. No. 21 Rago, P.J. A simple nonparametric test for comparing Atlantic salmon abundance indices.

APPENDIX 3

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Anon. 1984a. Report of the Working Group on North Atlantic Salmon, Aberdeen, 28 April - 4 May 1984. ICES, Doc. C.M.1984/Assess:16.

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Anon. 1992c. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery, Dublin, 2 - 4 March 1992. ICES, Doc. C.M.1992/M:4.

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Anon. 1993b. Report of the Study Group on North-East Atlantic Salmon Fisheries, Copenhagen, 1 - 4 March 1993. ICES, Doc. C.M.1993/Assess:13.

Anon. 1993c. ICES Compilation of Microtag, Finclip and External Tag Releases in 1992. ICES, Doc. C.M.1993/M:4.

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APPENDIX 4

STUDY GROUP RECOMMENDATIONS

Recommendations from the Study Group on North-East Atlantic Salmon, 1993

1. The Study Group noted that although it was desirable to prepare data from the NE Atlantic prior to the Working Group meeting, there was no advantage in holding a separate meeting unless it could be organised at least a full week earlier. Unfortunately many members of the Study Group would be unable to attend both meetings in such circumstances. The Study Group, therefore, recommended that they should not meet in 1994 unless specific questions were asked of it. Instead, an extra 3 days should be added to the Working Group meeting to permit it to collate the data from the NASCO Commission areas in split sessions.

2. The Study Group recommends that a workshop be held, to consider available evidence that might be used to set targets and to identify what further data are necessary to implement assessment of stock status with respect to targets. Attempts to set spawning targets should be made wherever possible before the next meeting.

3. The Study Group recommends that countries should attempt to estimate the numbers and stages of fish farm escapees each year.

4. The Study Group recommends that the available time series of scales be examined to investigate the development of occurrence of farmed fish in the Faroese waters.

5. The Study Group recommends that an attempt be made to estimate the contributions of non-national origin stocks to national catches.

Extract from Report of the Study Group on North American Salmon Fisheries

(Section 7.3) Future meetings

The need to meet again will be driven by the nature of the questions posed to the Working Group and the extent to which advance meetings will enhance the quality of the Working Group. The Study Group suggests that future remits may be effectively addressed to the Working Group. Concurrent sessions for North American and other task-assigned sub-groups within the Working Group would permit effective compilation of Commission area material for consideration by the Working Group as a whole.

APPENDIX 5

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Working Group on North Atlantic Salmon

Copenhagen, 5-12 March 1993

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APPENDIX 6

DATA SUMMARY FILES FOR COMPUTATION OF 2SW SPAWNERS IN NORTH AMERICA

Appendix 6 Table A
ESTIMATED NUMBER OF 2SW SPAWNERS IN SCOTIA-FUNDY REGION

	TOTAL RETURNS 0F 2SW BY SFA																			
	19	19	20	20	21	21	2SW SPAWN + ANGLED(19-2		ANGLED IN 19-21		2SW SPAWNERS 19-21		SFA 23						S-F TOTAL	
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	HAT CH 2SW	MIN WILD	MAX WILD	MIN TOT	MAX TOT	MIN	MAX
1974							2327	5310	740	1088	1587	4222	1238	4851	6383	6089	7621	7676	11843
1975							1647	3853	505	817	1142	3036	1423	7453	9853	8876	11276	10018	14312
1976							1679	3796	538	776	1141	3020	1140	6160	8082	7300	9222	8441	12242
1977							2697	6126	841	1281	1856	4845	1463	7726	10165	9189	11628	11045	16473
1978							1961	4586	641	961	1320	3625	1467	3370	4398	4837	5865	6157	9490
1979							1542	3537	480	740	1062	2797	651	2224	2914	2875	3565	3937	6362
1980							3977	9088	1249	1911	2728	7177	1357	8772	11498	10129	12855	12857	20032
1981							3781	8930	1164	1901	2617	7029	597	2334	3079	2931	3676	5548	10705
1982							2101	4815	673	934	1428	3881	472	2361	3128	2833	3600	4261	7481
1983							1617	3759	513	824	1104	2935	90	1522	1990	1612	2080	2716	5015
1984	926	2034	436	1053	934	2199					2296	5286	500	7379	9676	7879	10176	10175	15462
1985	1680	3713	184	4551	2633	6581					4497	14845	399	7695	10083	8094	10482	12591	25327
1986	3918	8342	1696	4314	2704	6377					8318	19033	341	4133	5417	4474	5758	12792	24791
1987	2763	5966	724	1886	1367	3199					4854	11051	241	3382	4421	3623	4662	8477	15713
1988	3151	6797	1377	3441	1441	3461					5969	13699	353	1502	1973	1855	2326	7824	16025
1989	2480	5494	995	2569	1954	4592					5429	12655	266	3740	4924	4006	5190	9435	17845
1990	2742	5757	726	1799	1566	3945					5034	11501	484	3071	4041	3555	4525	8589	16026
1991	2159	4613	642	1676	518	1240					3319	7529	416	3958	5233	4374	5649	7693	13178
1992	2066	4348	438	1099	601	1415					3105	6862	360	3796	4952	4156	5312	7261	12174

BY SUBTRACTING SFA23 AND COMM 19-21 FROM S-F TOTAL RETURNS

PROP 2SW RANGE FROM .7-.9,.3-.6,.5-.9 IN SFA'S19,20,21 RESPECTIVELY

Appendix 6 Table B
GULF 2SW SPAWNERS

													SFA 15													
	SFA 18				SFA 12		SFA 13		SFA 14A		SFA 14B		RESTIGOUCHE					SFA 16				SFA 17		TOTAL	
Year	MIN	MAX			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	PROP 2S	0THER MI	OTHER M	LARGE	PROP 2S	MIN	MAX	MIN	MAX	MIN	MAX
1974	182	391	197	694	2	108	0	1963	0	473	0	1088	5948	13879	0.73	183	1936	34445	0.908	28086	49510	0	0	32810	65904
1975	109	234	118	416	0	80	0	3535	7	764	0	1588	2901	6769	0.79	179	1887	21448	0.868	16718	29470	0	0	19313	43088
1976	140	299	151	531	1	49	0	3114	26	1185	0	3741	5510	12857	0.76	334	3537	14332	0.854	10991	19375	0	0	15691	41304
1977	238	511	257	907	0	77	0	1755	0	758	0	2257	6707	15650	0.83	419	4432	32917	0.947	27993	49346	0	0	34235	72521
1978	269	577	291	1025	0	55	0	1372	0	480	0	791	5025	11725	0.75	285	3015	10829	0.861	8373	14760	0	0	12717	30291
1979	138	296	149	526	3	122	69	1902	12	1045	0	1345	1823	4254	0.51	124	1312	4541	0.689	2810	4953	0	0	4096	13374
1980	238	511	257	907	0	129	0	2167	0	549	0	1273	6157	14366	0.81	370	3915	18873	0.949	16084	28352	0	0	21698	48929
1981	236	508	255	902	4	175	0	2948	0	921	0	2537	4240	9893	0.47	287	3035	4608	0.666	2756	4858	0	0	5294	20025
1982	305	654	329	1161	10	261	0	2861	0	748	56	1950	2582	6025	0.59	228	2415	13258	0.809	9632	16979	0	0	11779	29930
1983	253	544	273	966	4	112	0	1809	6	603	85	3066	2068	4825	0.59	201	2125	8458	0.805	6114	10778	0	0	7903	22305
1984	206	442	223	785	19	331	148	2518	43	798	0	1441	3796	6785	0.79	344	1953	14687	0.944	12450	21948	0	0	16226	35134
1985	1198	3936	1198	3936	11	189	101	1718	33	611	23	1657	7556	13309	0.63	516	5502	20122	0.869	15702	27680	0	0	22345	49678
1986	2967	10085	2967	10085	9	161	140	2380	45	838	0	1574	10669	18910	0.76	735	3655	30216	0.853	23145	40801	0	0	35150	73865
1987	3214	11612	3214	11612	8	143	114	1950	42	767	6	2837	7079	12514	0.64	509	4338	18056	0.796	12907	22752	0	0	21330	52408
1988	1389	4426	1389	4426	14	243	156	2662	56	1038	0	2352	9899	17303	0.72	661	3520	20980	0.816	15373	27100	0	0	24777	53800
1989	1845	6557	1845	6557	6	96	60	1028	29	532	69	1812	7558	13487	0.57	543	2894	15540	0.654	9127	16088	0	0	15987	36695
1990	8718	29484	8718	29484	9	147	126	2155	45	838	23	1617	6324	11304	0.65	467	1493	27588	0.616	15261	26902	0	0	28759	69983
1991	2001	10271	2001	10271	6	111	99	1681	32	592	70	1782	5093	9276	0.5	394	3780	29089	0.605	15804	27859	0	0	20952	50714
1992	3094	10012	3094	10012	11	190	113	1934	48	881	0	1303	7383	13190	0.67	284	3895	30686	0.625	17538	27045	0	0	26034	54098

1973-84 FROM RES DOC FOR 5 &95 PERLE SPAWNERS IN MARG
1985-92 FROM TABLE A.9 DIRECT
1973-84 FACTOR MIN=.403, MAX=1.041
1.403 2.041
0.77 0.87 PROP. 2SW

EST TOTAL LARGE RETURNS FROM RES DOC

MIN FAC 0.898
MAX FAC 1.583
EXCEPT FOR 1992

Appendix 6 Table C
NFLD 2SW SPAWNERS

Year	Insular Nfld						Labrador SFA1					Labrador SFA2					Total Labrador 2SW Sapwner	
	Ins Nfld 2SW Min Return	Ins Nfld 2SW Max Return	Angled Large	Angled 0.067	Min 2SW Spawner	Max 2SW Spawner	Min 2SW Return	Max 2SW Return	Angled Large Salmon	Min 2SW Spawner	Max 2SW Spawner	Min 2SW Return	Max 2SW Return	Angled Large Salmon	Min 2SW Spawner	Max 2SW Spawner	Min	Max
1974	209	1257	171	11	198	1246	3319	7316	311	3039	7098	39916	91236	201	39755	91115	42794	98214
1975	217	1301	245	16	201	1285	8215	18106	117	8110	18024	32866	75123	56	32821	75089	40931	93114
1976	221	1329	320	21	200	1308	14412	31764	368	14081	31506	34188	78143	152	34066	78052	48147	109558
1977	289	1731	1186	79	210	1652	9355	619	533	8875	246	31308	71561	160	31180	71465	40055	71711
1978	26	1598	616	41	0	1557	12283	27073	432	11894	26771	21375	48857	152	21253	48766	33148	75536
1979	241	1446	379	25	216	1421	7674	16914	430	7287	16613	12768	29184	60	12720	29148	20007	45761
1980	316	1893	720	48	268	1845	10424	22975	232	10215	22813	37392	85467	320	37136	85275	47351	108088
1981	411	2465	552	37	374	2428	11598	25563	195	11423	25427	31950	73029	105	31866	72966	43289	98393
1982	351	2105	531	36	315	2069	6536	14406	379	6195	14141	25308	57848	162	25178	57751	31373	71892
1983	292	1751	695	47	245	1704	6178	13617	137	6055	13521	15794	36100	161	15665	36003	21720	49525
1984	335	2011	47	3	332	2008	3188	7027	222	2988	6872	12061	27568	103	11979	27506	14967	34378
1985	358	2149		0	358	2149	5296	11673	135	5175	11579	7477	17090	59	7430	17055	12604	28633
1986	326	1959		0	326	1959	5983	13187	129	5867	13097	16161	36939	154	16038	36847	21905	49943
1987	351	2108		0	351	2108	6104	13454	141	5977	13355	21990	50264	277	21768	50098	27746	63453
1988	323	1941		0	323	1941	4209	9278	171	4055	9158	14395	32902	288	14165	32729	18220	41888
1989	156	934		0	156	934	5832	12854	144	5702	12753	12240	27977	264	12029	27819	17731	40572
1990	235	1410		0	235	1410	2085	4596	90	2004	4533	8064	18433	169	7929	18332	9933	22865
1991	150	902		0	150	902	482	1063	8	475	1057	3206	7327	36	3177	7305	3652	8363
1992	331	1988		0	331	1988	1650	3636	286	1393	3436	9873	22566	257	9667	22412	11060	25848
			PROP	0.067				MIN=	0.7				MIN=	0.6				
								MAX=	0.9				MAX =	0.8				

Appendix 6 Table D
US 2SW SPAWNERS

YEAR	2SW RETURNS	2SW ANGLED	2SW SPAWNER
1974	1412	198	1214
1975	2348	314	2034
1976	1343	154	1189
1977	2032	438	1594
1978	4235	717	3518
1979	1928	347	1581
1980	5826	1226	4600
1981	5635	1021	4614
1982	6144	1150	4994
1983	2101	311	1790
1984	3186	540	2646
1985	5363	533	4830
1986	5963	483	5480
1987	2861	229	2632
1988	3008	199	2809
1989	3137	328	2809
1990	4859	561	4298
1991	2594	185	2409
1992	2540	137	2403

APPENDIX 7

ROUTE REGRESSION METHODOLOGY

The Working Group considered a general approach for analysing composite trends in indices of Atlantic salmon stock status. The methodology relies heavily upon recently developed techniques for assessment of avian abundance as described in Sauer and Droege (1990) and emphasizes the use of graphical techniques for exploratory data analyses. Biologists and statisticians dealing with avian populations have addressed many of the issues relevant to the assessment of Atlantic salmon. The term "route regression analysis" has been used by avian biologists to describe the process of assessing population trends over broad geographical regions (Geissler and Noon, 1981; Geissler, 1984). "Route" typically refers to a time series of bird counts at a particular site. Bird migration paths are often well known so that an individual site is analogous to a stream. A collection of "routes" along broad geographical region constitutes a flyway, which is analogous to a "stock complex" (Anon., 1991a) for salmon.

Analysis of time-series data for trends can be envisioned as three distinct steps: identification, grouping, and hypothesis testing. The basic principles of these steps are described below.

IDENTIFICATION

Identification is the process by which the underlying signal (e.g. trend or cycles) is distinguished from the noise (i.e., random error). Sophisticated statistical tools described in Box and Jenkins (1970) and Nelson (1973) can be applied, but such techniques may have limited utility when time series are short in duration or have missing values. Moreover, the assumption of statistical stationarity may be difficult to satisfy.

An alternative approach is to apply statistical smoothing procedures which do not make any particular assumptions about the underlying distribution of error terms. Smoothing is especially useful when short term trends are important. Conservation of the resource demands that downward trends be detected early so that management measures can be taken. Identification of long term cycles is useful for retrospective analyses. Prior cyclic behaviour, however, does not guarantee that a current population depression will rebound to earlier highs. Thus, detection of trends over periods of less than a decade is important.

Recently developed graphical methods (Chambers *et al.*, 1983) not only have a strong theoretical basis but also allow for visual examination of short and long term trends. LOWESS, the acronym for "locally weighted regression scatter plot smoothing" (Cleveland, 1979), techniques fall into the general category of "robust" statistical procedures which, in general terms, are resistant to outliers. Mathematical details of LOWESS smoothing are presented in Chambers *et al.* (1983).

GROUPING

When it is desirable to make inferences about broad geographical regions, LOWESS smoothing can also assist in the identification of systems with similar behaviour and facilitate grouping. When two systems are behaving similarly over some time interval, a LOWESS pairwise plot of one times series against another will have straight line segments. During time periods in which two time series have divergent responses, the LOWESS plot will be erratic. Similar behaviour among time series suggests, but does not confirm, similar underlying factors and may aid in identifying causative factors.

Identification and grouping suggest appropriate time intervals and combinations of systems (populations) which can then be examined with route regression analysis. Route regression analysis provides estimates of slope parameters ($\hat{b}_k$) for the individual populations and derives a composite slope estimate for the group.

HYPOTHESIS TESTING

The objective of route regression is to make a probabilistic statement about the overall trend (b) for some subset of the salmon populations under consideration. The general statistical model for counts (Y(t)) at time t is of the form

(1) $Y(t) = a * c^t * e(t)$

where a and c are coefficients and e(t) is the error term. Eq. 1 can be written equivalently as

(2) $Y(t) = a * \exp(b * t) * e(t)$

where $b = \log_e(c)$

Like salmon, birds often arrive in groups, resulting in a contagious statistical distribution with a variance that increases with the mean. Transformations are often necessary to stabilize the variance and to more closely meet the assumptions of general linear models (Neter, *et al.* 1990). Although there is a great deal of literature on the subject of statistical transformations (e.g. Box and

Cox, 1964), the most commonly used transformation for count data is of the form $\log_e(Y + c)$ where c is some constant. Collins (1990) conducted a simulation study which indicated that a value of $c=0.23$ would yield the greatest probability of correctly detecting both short (5 yr) and long (20 yr) trends. Collins' conclusions were based on random samples drawn from a negative binomial model with different mean densities and different levels of the aggregation parameter k. In lieu of a similar study for salmon counts a value of $c=0.23$ is used herein. The transformed linear model corresponding to Eq. 2 is

$$\log_e[Y(t) + 0.23] = b * t + \log_e[e(t)] \tag{3}$$

Suppose that K river systems have been identified as belonging to a particular group. Each time series $Y_k(t)$ would be analyzed using Eq. 3 to obtain estimates of b_k over some time interval t_{min} to t_{max}. Note that each time series for which b_k is estimated has an equal range of t_{min} and t_{max}. Missing data with a time range can be incorporated into the estimate of b_k. Unequal time ranges, however, complicate the analysis because the estimate of the overall trend B applies to different time intervals.

The next step is to obtain a valid estimate of the overall trend (B) among populations. Simple averaging of regression slope parameters would be appropriate only if all of the systems had equal temporal variability and all time series were similar in magnitude (i.e., $a_1 = a_2 = \ldots = a_K$. Temporal variability and the magnitude of the time series have important implications for the detectability of the true underlying trend. A basic tenet for grouping time series is that highly variable time series should have a lower weight than a less variable one. Conversely, a time series for a river with an average of 20,000 returns would be weighted more heavily than a minor river with an average return of 500 fish. The average slope of several independent time series slopes could be estimated using analysis of covariance (ANCOVA). Satisfying the assumptions of homogeneity of variance and independence of observations in ANCOVA however, is likely to be difficult.

Avian biologist have proposed an weighted average estimator of B where

$$B = \sum_{k=1}^{K} W_k\, b_k \,/\, \sum_{k=1}^{K} W_k \tag{4}$$

where $W_k = Z_k / \mathrm{Var}(b_k)$. Collins (1990) recommends estimating Z_k as the back transformed predicted mean of the fitted regression from Eq. 3. Thus,

$$Z_k = \exp(\hat{a}_k + \hat{b}_k\, t) \tag{5}$$

where t is the mean year for the time series. There appears to be some controversy in the literature about an appropriate measure of the variance of the slope. Collins (1990) noted that several measures have been proposed (Geissler and Noon, 1981; Robbins *et al.*, 1986; Geissler; 1984) and noted that $\mathrm{Var}(b_k)$ can be unreliable when the number of observations are small. James *et al.* (1990) recommend additional work on this aspect of route regression analysis.

In order to develop a confidence interval for B it is necessary to approximate its sampling distribution. The most common method is to use a bootstrap or jackknife technique but Collins (1990) makes a strong case for the use of re-randomization approach. In the re-randomization approach, each time series $Y_k(t)$ is randomly shuffled and a new $\hat{b}_{k,i}$ estimate is obtained, where the i refers to the i-th of realization for the k-th series. The weighted mean slope for each realization is denoted as B_i (Eq. 4). The process is repeated an arbitrarily large number of times, say N, for each of the K time series and the sampling distribution B is approximated by the set of B_i. The probability level associated with the observed B is simply the number of $B_i < B$ divided by N.

A users guide to the program ROUTREGR.EXE, a copy of the source code, and sample input and output files are available upon request.

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APPENDIX 8

NON-PARAMETRIC RATIO TEST METHODOLOGY

The Working Group considered a general methodology for assessing short term changes in Atlantic salmon stock indices. The methodology is based on a randomization test, a concept first proposed by Fisher (1935, see Lehmann, 1975 for more recent treatment of randomization tests). Randomization tests are particularly well suited for assessing changes in stock status because such tests require few assumptions, the results are readily interpretable, and the sampling distribution of the test statistic can be easily approximated on a portable computer.

In recent years the Working Group has been asked to assess the status of Atlantic salmon populations, particularly changes in abundance that may be the result of fishery management actions. Although numerous abundance indices are measured in many different rivers, it has been difficult to draw general conclusions. In many instances, the patterns are equivocal, with some indices increasing while others decline. In part, the effects of management changes have been masked by reductions in marine survival. If reductions in marine survival are real, then fishery changes simply have slowed the rate of decline in spawning escapement but have not been sufficient to offset the reduced survival. Nonetheless, it is important to synthesize the available information about salmon abundance, and apparent rates of change.

Details on the proposed methodology are described and the approach is applied to the estimated numbers of returns of small and large salmon in Newfoundland, 1987-1992. A computer program, NPRATIO.BAS written in BASIC, is available upon request.

MODEL DESCRIPTION

Consider a simple example in which one wants to compute the ratio of means between two periods of time. The first period of time is called the baseline period and consists of m years; the second period is the treatment period of n years. Let the time series of observations be denoted as:

$$X_i = \{X_1, X_2, \ldots, X_m, X_{m+1}, X_{m+2}, \ldots, X_{m+n}\}$$

The ratio of the means for these two periods can be estimated as

$$(1) \qquad r_0 = \sum_{i=m+1}^{m+n} X_i/)/(\sum_{i=1}^{m} X_i/m)$$

Usual t-tests could be used to draw inference for such a problem, but testing assumptions might be difficult, particularly independence of observations and equality of variances (especially when $n=1$). Time series models also require long series of observations in order to satisfy the usual conditions of stationarity. An alternative way of treating the problem is to ask, "Under the null hypothesis that the observations are randomly ordered, what is the probability of obtaining a value of r greater than or equal to the observed r_0?" In other words, is the observed time series simply a random ordering of observations or is the observed value rather unlikely? If the observed value is unlikely, then it may provide evidence of a true change in the underlying process. Fortunately it is possible to evaluate how unlikely r_0 is by considering all possible orderings of the time series X_i. By computing a value of r for each ordering, the sampling distribution of r can be obtained. Then the observed value of r can be compared to the set of possible r values to estimate its probability. The number of possible orderings is obtained as the combinatorial of m+n with n and is written as

$$\begin{bmatrix} m+n \\ n \end{bmatrix} = \frac{m!}{(m-n)!\ n!}$$

where

m! is the factorial of m (i.e., m*(ml)*(m-2)*...*1).

Consider the following simple example. Suppose we have a set of 5 observations {1,2,3,4,5}. The baseline period is 3 years and the treatment period is 2 years. We compute r_0 as in Eq. (1) as 2.25 and we want to know the probability of obtaining such a value for this set of data. The combinatorial of 5 things taken 2 at time is 10. The following table enumerates the possible orderings and computes the ratio for each ordering.

j=1	j=2	j=3	j=4	j=5	j=6	j=7	j=8	j=9	j=10
1	1	1	2	1	1	2	1	2	3
2	2	3	3	2	3	3	4	4	4
3	4	4	4	5	5	5	5	5	5
4	3	2	1	3	2	1	2	1	1
5	5	5	5	4	4	4	3	3	2
2.25	1.71	1.31	1	1.31	1	0.75	0.75	0.55	0.38

Obviously, the observed ordering has the highest possible value for this data set and we could state that the p robability of obtaining such a value or greater would be 1 in 10. That wouldn't be a particularly strong inference. But suppose you had two time series of 5 observations and in both of them the values were ranked in order of increasing size. Let the second set be {10,20,30,40,50}. In this case the probability of obtaining two such series due to chance alone would be 1 in 10^2 since every possible ordering in the first time series could be matched with every possible ordering in the second series. In general terms, the resolving power of the test is determined by the number of observations in each group (m, n) and the number of time series (K) and is defined as:

$$\begin{bmatrix} m+n \\ n \end{bmatrix}^{-K} = \begin{bmatrix} \frac{m!}{(m-n)} \end{bmatrix}^{-K}$$

Thus, as the number of time series increases, the trivial example defined above can be expanded to provide relatively accurate estimates of probability.

The simple model in Eq. 1 can be generalized to K time series as follows:

$$(2)\quad r_0 = \Big(\sum_{k=1}^{K} \Big(\sum_{i=m+1}^{m+n} X_{i,k}/n\Big)\Big) \Big/ \Big(\sum_{j=1}^{K}\Big(\sum_{i=1}^{M} X_{i,k}/m\Big)\Big)$$

The advantage of formulating the ratio as in Eq. 2 is that large counts contribute more to the ratio than small counts. Thus inferences about underlying changes would be more heavily influenced by abundance observations in the Miramichi River, with abundances ranging to 10^4 than by changes in the Liscomb River where returns range from 10^2 to 10^3.

APPLICATION TO RETURNS OF SMALL AND LARGE SALMON TO NEWFOUNDLAND

As an illustration, the model was applied to the estimated returns of small and large salmon to Newfoundland indicator rivers during the period 1987 to 1992. The purpose of the test was to determine whether the closure of fisheries in insular Newfoundland had any effect on returns to the Humber River, Rocky River, Terra Nova, Middle Brook, Biscay Bay, Northeast River (Placentia) and the Conne River. Data were obtained from Table 2.2.3.1 in Anon., 1993a. For both groups, 1992 observations were compared to the 1987-1991 mean. Example input and output data are summarized in Tables A8.1 and A8.2. Data for small and large returns were analyzed separately using the computer program NPRATIO.BAS..

Results of the nonparametric ratio test suggest that the probability of the observed ratio of 1.46 in small salmon returns is about 12.9%. In the usual statistical parlance we would accept the null hypothesis (or more precisely, fail to reject the null hypothesis) and conclude no significant increase in small salmon returns had occurred. In contrast the observed ratio for large salmon of 3.91 had a probability level of 0.035 (Table A8.1) . Thus we would conclude that large salmon returns were significantly higher in 1992.

Table A8.1 Example input and output files for comparison of counts of small-sized salmon at counting fences of Newfoundland.

```
========(input file for small salmon in Newfoundland rivers, in 000s)==========
```

labels for variables

Year	Humber	Rocky	TNova	MdBrook	BiscayB	NEriver	Conne)
1987	12.3	0.008	1.4	1.1	1.4	0.35	10.2
1988	16.2	0.3	2.1	1.3	1.8	0.64	7.7
1989	4.9	0.2	1.4	0.6	1.0	0.81	5.0
1990	12.2	0.4	1.5	1.1	1.7	0.7	5.4
1991	5.7	0.2	1.1	0.8	0.4	0.37	2.4
1992	22.3	0.3	1.8	1.6	1.3	0.96	2.5

```
===========output of NPRATIO.BAS for small salmon in Nfld=====

TITLE: <<< b        >>> INPUT file = <<<sml_nfld>>>
            OUTPUT file: sml_nfld.o2
            <<Randomized Ratio Parameter>>: Number of simulations= 2000
               <<Baseline>>   Begin at yr = 87  End yr= 91
               <<Treatment>>  Begin at yr = 92  End yr= 92

Simulated mean = 1.018644 {Min, Max SimVal} = { .3965407 ; 2.016062 }

<<Test Statistic>> Rcrit = 1.469661.
Number of times simulated value = Rcrit = 0.
Number of times that Rcrit >= Random Ratio estimate = 260.
Probability of observing value >= Rcrit = .13.
Percentiles for the simulated distribution.
```

Index	Percentile	Ratio
19	.01	.4477793
50	.025	.4821862
100	.05	.507158
200	.1	.5514103
500	.25	.7596768
1000	.5	.9836497
1500	.75	1.248154
1799	.9	1.5283
1899	.95	1.657325
1950	.975	1.810683
1980	.99	1.919264

Table A8.2 Example input and output files for comparison of counts of large-sized salmon at counting fences of Newfoundland.

======(input file for large salmon in Newfoundland --in numbers)======

labels for variables

Year	Humber	TNova	MdBrook	BiscayB	NEriver	Conne)
1987	900	60	19	110	16	500
1988	1100	210	14	60	11	40
1989	300	140	19	100	15	30
1990	900	140	13	70	25	40
1991	400	110	14	40	8	100
1992	3700	270	43	50	46	200

==========output for Large salmon returns in Newfoundland=======

For this configuration of 5 yr baseline period and 1 treatment period there are 6 combinations per time series and 46656 possible ratio values overall

TITLE: <<< Newfoundland Large 2000 iterations >>> INPUT file = <<<lrg_nfld>>>
OUTPUT file: lrg_nfld.ou3
<<Randomized Ratio Parameter>>: Number of simulations= 2000
<<Baseline>> Begin at yr = 87 End yr= 91
<<Treatment>> Begin at yr = 92 End yr= 92

Simulated mean = 1.163612 {Min, Max SimVal} = { .2470324 ; 4.482992 }

<<Test Statistic>> Rcrit = 3.914426
Number of times simulated value = Rcrit = 0
Number of times that Rcrit >= Random Ratio estimate = 65
Probability of observing value >= Rcrit = .0325
Percentiles for the simulated distribution

Index	Percentile	Ratio
19	.01	.282054
50	.025	.2974519
100	.05	.3221608
200	.1	.3570259
500	.25	.4680709
1000	.5	.7446435
1500	.75	.9798903
1799	.9	3.499047
1899	.95	3.664136
1950	.975	4.081066
1980	.99	4.200263

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Addendum to

Report of the Working Group on North Atlantic Salmon (C.M.1993/Assess:10)

1. Section 5.3.4, equation (4) should read: $R2^{*}(i+1)= [(N1(i)-G1^{*}(i)-C1(i))\ S2-C2(i)]\ S1$

   equation (5) should read: $U2(i+1) = C2(i+1)\ /\ [(N1(i)-G1(i)-C1(i))S2]$

2. In Table 5.3.1. the line for t1 should end with 1 month instead of 2 months

3. The last two columns of Table 5.3.2.2 should read as follows:

0.24	0.24
0.1	0.1
1	2
0.30	0.41
0.21	0.26
0.41	0.54
0.52	0.63
0.60	0.73
0.32	0.45
0.45	0.60
0.54	0.69
0.60	0.75
0.60	0.73
0.28	0.42
0.39	0.55
0.53	0.69
0.30	0.45
0.55	0.69
0.38	0.55
0.28	0.43
0.37	0.53
0.49	0.66
0.45	0.61
0.44	0.60
0.53	0.69
0.49	0.64
0.61	0.76
0.46	0.62
0.44	0.59