Advisory Committee on Fishery Management

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REPORT OF THE

WORKING GROUP ON NORTH ATLANTIC SALMON

Québec City, Canada
12–22 April 1999

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Main Tasks

At its 1998 Statutory Meeting, ICES resolved (C. Res. 1998/2:4:11) that the Working Group on North Atlantic Salmon (Chairman: Dr T.L. Marshall, Canada) will meet in Québec City, Canada, from 12-22 April, 1999 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). The terms of reference and sections of the report in which the answers are provided, follow.

a) With respect to Atlantic salmon in the North Atlantic area:	Section
i. provide an overview of salmon catches, including unreported catches and catch and release, and worldwide production of farmed and ranched salmon in 1998;	2.1 & 2.2
ii. evaluate non-catch fishing mortality for all salmon gear;	2.3
iii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.4
iv. develop a framework for stock rebuilding programmes;	2.5
v. provide a compilation of egg collections and juvenile releases in 1998;	2.6
vi. provide a compilation of microtag, finclip and external tag releases by ICES Member Countries in 1998.	2.7
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	
i. describe the events of the 1998 fisheries and the status of the stocks;	3.1-3.4
ii. update the evaluation of the effects on stocks and homewater fisheries of the suspension of commercial fishing activity at Faroes since 1991;	3.5
iii. further develop the age-specific stock conservation limits for smaller stock units in the Commission area, where possible based upon individual river-based estimates;	3.7
iv. further develop methods to estimate the expected abundance of salmon for smaller stock units in the Commission area;	3.6
v. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	3.8
vi. provide an estimate of the by-catch of salmon post-smolts in pelagic fisheries;	3.9
vii. identify relevant data deficiencies, monitoring needs and research requirements.	3.10
c) With respect to Atlantic salmon in the North American Commission area:	
i. describe the events of the 1998 fisheries and the status of the stocks;	4.1 & 4.2
ii. update the evaluation of the effects on US and Canadian stocks and fisheries of management measures implemented after 1991 in the Canadian commercial salmon fisheries;	4.3
iii. update age-specific stock conservation limits based on new information as available;	4.4
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	4.5
v. identify relevant data deficiencies, monitoring needs and research requirements.	4.6
d) With respect to Atlantic salmon in the West Greenland Commission area:	
i. describe the events of the 1998 fisheries and the status of the stocks;	5.1 & 5.2

ii. evaluate the effects on European and North American stocks of the West Greenlandic management measures since 1993;	5.3
iii. provide a detailed explanation of any changes to the model used to provide catch advice and of the impacts of any changes to the model on the calculated quota;	5.4
iv. provide age-specific stock conservation limits (spawning targets) for all stocks occurring in the Commission area based on best available information;	5.5
v. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	5.6
vi. identify relevant data deficiencies and research requirements;	5.7
vii. comment on the report of Workshop on Peer Review of ICES Salmon Model *or in the absence of a Workshop,* examine critically the model used to provide catch advice, looking at all the assumptions, and comment on the confidence limits on the output from the model.	5.8

The Working Group considered 44 Working Documents submitted by participants (Appendix 1); other references cited in the report are given in Appendix 2.

1.2 Participants

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

2 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

2.1 Catches of North Atlantic Salmon

2.1.1 Nominal catches of salmon

Total nominal catches of salmon reported by country in all fisheries for 1960–98 are given in Table 2.1.1.1, and nominal catches in homewater fisheries, divided into size or age categories where such data are available, are given in Table 2.1.1.2. Catch statistics in the North Atlantic also include fish farm escapees and, in some north-east Atlantic countries, ranched fish (see Section 3).

The Icelandic catches are presented under two separate categories; wild and ranched. Iceland is the only North Atlantic country where large scale ranching takes place and where the intent is to harvest all returns at the release site. While ranching does occur in other countries it is on a much smaller scale than in Iceland, some are experimental operations and at others harvesting does not occur solely at the release site. As such, the ranched component in these countries has been left in the nominal catches.

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

The updated total nominal catch for 1997 of 2,377 t is 755 t less than the total for 1996 of 3,132 t. While the 1998 catches in most countries remain below the previous 5-year and 10-year averages, about 50% of the countries reported an increase in catch compared to the final 1997 values. Figures for 1998 (2,401 t) are provisional, but the final total is likely to exceed the 1997 value.

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

Reported nominal catches for several countries by number and weight are summarised in Table 2.1.1.3. As in Tables 2.1.1.1 and 2.1.1.2, catches in some countries include both wild and reared salmon (excluding ranched fish from Iceland) and fish farm escapees and the figures for 1998 are provisional. Different countries use different methods to partition their catches by sea-age class. These methods are described in the footnotes to Table 2.1.1.3. The composition of catches in different areas is discussed in more detail in Sections 3, 4 and 5.

2.1.2 Catch and release

The practice of catch and release (often termed hook and release) in rod (recreational) fisheries has been used as a conservation measure for large salmon in some areas of Canada and USA since 1984. Recent declines in salmon abundance in the North Atlantic has resulted in an increased use of this management option. The nominal catches presented in Section 2.1 are comprised of fish which have been caught and retained and do not include catch-and-release salmon. Table 2.1.2.1 presents catch-and-release information from 1991 for those countries which have records. Catch-and-release may be being practised in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released among countries ranging, in recent years, from less than 10% in Iceland to 100% in the USA, reflecting the varying management practices among these countries.

2.1.3 Unreported catches

Unreported catches by year and Commission Area are presented in Table 2.1.3.1. While comparisons of the 1998 unreported catch can be compared to previous values, it must be remembered that these figures are at best guess-estimates, and that the methods used to arrive at these figures have varied both within and among countries. Consequently, these figures should be interpreted with caution. A discussion of the methods used to evaluate the unreported catches is provided in Section 13 of the 1996 report (ICES 1996/Assess:11). A description of the methods used in Canada to evaluate unreported catches from 1997 onwards is presented in Section 4.1.2 of the 1998 report (ICES 1998/ACFM:15).

The total unreported catch in NASCO areas in 1998 was estimated to be 1210 t. Estimates were derived for the North American (91 t) and West Greenland (11 t) Commission Areas and for two sub-groupings, Scandinavia and Russia

(504 t) and Southern Europe (604 t), within the North East Atlantic Commission Area. Figure 2.1.3.1 shows that the unreported catch has remained a relatively constant proportion (30%) of the total catch since 1987. No data for the combined three Commission Areas is available prior to 1987.

No data were available on fishing for salmon in international waters in the Norwegian Sea or on vessels landing catches from this area in the 1997/1998 season. Very few surveillance flights were reported to have been undertaken by the Icelandic and Norwegian Coastguards over the winter period when fishing for salmon would be most likely to occur. Furthermore, these flights were associated primarily with the pelagic fisheries in the area rather than possible salmon fisheries.

2.2 Farming and Sea Ranching of Atlantic Salmon

2.2.1 Production of farmed Atlantic salmon

The worldwide production of farmed Atlantic salmon in 1998 was 710,342 t (Table 2.2.1.1 and Figure 2.2.1.1). This was the highest production in the history of the farming industry and represented a further 12% increase compared to 1997 (634,418 t) and a 50% increase on the 1993-97 average (475,032 t). The worldwide production of farmed Atlantic salmon in 1998 was over 295 times the nominal catch of Atlantic salmon in the North Atlantic.

The production of farmed Atlantic salmon in the North Atlantic area in 1998 was 538,011 t, which was a further 7% increase compared to 1997 (501,067 t) and a 37% increase on the 1993-97 average (391,627 t). The countries with the largest production were Norway and Scotland, which accounted for 64% and 21% of the total respectively. Proportional increases in production in the other seven countries were limited to between 0% and 4%.

In areas other than the North Atlantic, the production of farmed Atlantic salmon in 1998 was 172,331 t, 24% of the world production of farmed Atlantic salmon. As in the North Atlantic, production has increased throughout the time series. However, the current rate of increase in these countries is greater than that in the North Atlantic countries, the 1998 figure showing an increase of 29% compared to 1997 (133,351 t) and a 107% increase on the 1993-97 average (83,406 t). The areas with the largest production were Chile and the West Coast of Canada, which accounted for 73% and 19% of the total respectively. Proportional increases in production in the other seven areas were limited to between less than 1% and 6%.

2.2.2 Production of ranched Atlantic salmon

Ranching has been defined as the production of salmon through smolt releases with the intent of harvesting the total population that returns to freshwater (harvesting may include collecting fish for broodstock) (ICES 1994/Assess:16). The total production of ranched Atlantic salmon in countries bordering the North Atlantic in 1998 was 47 t, 10 t lower than in 1997 (57 t) and the lowest value since 1987 (Table 2.2.2.1 and Figure 2.2.2.1). Production in Iceland continued to show a decrease, due to fewer ranching facilities operated, but still accounted for 72% of the total ranched production in 1998. Production at experimental facilities in Ireland, UK(N. Ireland) and Norway has remained low. Production in Ireland includes catches in net, trap and rod fisheries. Icelandic catches, on the other hand, are entirely from estuarine and freshwater traps at the ranching stations.

2.3 Evaluation of Non-Catch Fishing Mortality for all Atlantic Salmon Gear

Fishing mortalities generated directly or indirectly by fishing but not included in recorded catches are referred to as non-catch fishing mortality. This type of mortality occurs as a result of various types of fishing gears that are used to capture salmon. Commercial fishing reportedly dates back to the 12th century and typically involves nets, traps and weirs whereby salmon are enmeshed, encircled or actively or passively swim into the device where they are captured. Nets may be stationary (often referred to as fixed engines), portable, drifted, thrown (cast) or used to dip salmon. Salmon are also taken commercially by long line, hand line (hook and line), and rod and line using natural or artificial baits or lures; these types of gears are currently more typically used in recreational or sport fisheries for salmon. As a result of the various types of fishing gear utilized to catch salmon in marine and freshwater areas of the North Atlantic, non-catch fishing mortality is extremely variable. Some of the factors known to contribute to variation in non-catch fishing mortality within and among fisheries include gear type, mesh type, duration of time that the gear is fished or set, gear selectivity, fish size and state of maturity, weather conditions and the care used in releasing fish which are not retained.

No new data or quantitative estimates of non-catch fishing mortality were available in 1999, although information relating to six sources of non-catch mortality was presented to the Working Group in 1979 (ICES 1981) and another source was extensively reviewed in 1998 (ICES 1998/ACFM:15). The following sources of non-catch fishing mortality for Atlantic salmon gear are known to occur throughout the North Atlantic.

1. *Predation mortality* is caused by salmon caught in various types of fishing gear that are subsequently removed, eaten, lost, or released from the gear (or badly damaged) by the activity of seals, otters, other species of fish, gulls or other predators.

Predation mortality is known to take place where salmon fishing and salmon predators occur in the same localities. The magnitude of such mortality is influenced by the abundance of predators, the method of fishing used and other factors such as the frequency of gear inspection and removal of the catch. Thus, no universally applicable estimate of predation mortality is available for the North Atlantic. Predation mortality is not limited to salmon caught in commercial fishing gear; it may also occur in recreational fisheries, as a result of salmon that escape or are voluntarily released in a weakened physical condition. While predation mortality is normally thought to be low in commercial fisheries, anecdotal evidence obtained from Labrador in 1997 indicated that predation mortality may have been in the neighborhood of 50% of the landings in that fishery for that year.

2. *Dropout mortality* refers to fish caught and killed by the gear but lost prior to hauling the net.

Dropout mortality does not apply to many of the currently operating fisheries for salmon, since the methods and types of gear used are not immediately lethal to the fish. Observations of dropout losses from research vessel fishing with drift-nets at West Greenland in 1979 provided an estimate of 2-4% of the catch, while limited available evidence at that time suggested that dropout losses in gill-net fisheries in homewaters were similarly small.

3. *Haul-back mortality* refers to fish caught and killed by the gear but lost as a result of hauling back.

As with dropout mortality, haul-back mortality does not apply to many of the currently operating fisheries for salmon, since the fishing methods and gear used are not immediately lethal to the fish. Previous estimates of haul-back mortalities in gill-net fisheries ranged from 2-4% in West Greenland and 1-2% for commercial fisheries in Canada and homewater fisheries in the UK and Norway (ICES 1981). The types of fishing gears that were important sources of haul-back mortality are no longer extensively used in the North Atlantic.

4. *Escapement mortality* is caused when fish encounter and are temporarily caught by the gear, escape (or are intentionally released) from it or pass immediately through the gear but die later from various injuries or stress from the "encounter," or from increased predation due to their greater vulnerability to various predators.

Previous estimates of escapement mortality in commercial fisheries in West Greenland ranged from 5-15% of the recorded catch (ICES 1981). Escapement mortality in commercial salmon fisheries in homewaters is expected to be lower than at West Greenland because the fish exploited by them are approaching maturity and are physically and physiologically hardier. Escapement mortality in homewater recreational fisheries is considered to be lower than that for homewater commercial fisheries, due to the differences in the various types of gear used and how and when they are operated.

5. *Discard mortality* occurs when fish that are caught are discarded (dead or alive) and not included in the reported catches.

Discard losses are assumed to occur in all commercial fisheries for Atlantic salmon, although losses of this nature are likely to be small in most existing fisheries. Estimates of discard mortality in the Faroes fishery in 1983-84 ranged from 5-15% of the total catch and up to 80% for those fish that were discarded. In 1980 the Working Group concluded that its magnitude in homewaters was negligible (ICES 1981). The recent shift to catch and release angling in many homewater fisheries has resulted in a similar type of potential "discard" mortality which is discussed in greater detail below.

6. *Catch and release mortality* (often termed hook and release) occurs in recreational angling fisheries as a result of salmon that are caught and released, either voluntarily or as a result of mandatory requirements to do so.

Most studies to date have indicated that catch and release angling and associated handling results in mortalities of 0-10%, although at water temperatures of 20^{0}C, and especially above 23^{0}C, mortality can increase to much higher levels as temperatures continue to rise. However, at these higher water temperatures, the magnitude of rod catches also tends to decline very rapidly. Other factors may also increase mortality associated with catch and release, such as how long salmon have been in freshwater prior to being angled, various water quality parameters (including levels and flows) and the care used by anglers when releasing hooked fish. Although more than 80,000 salmon were estimated to have been caught and released in 1998 (Table 2.1.2.1), the Working Group was unable to apply a general estimate of mortality due to a lack of information concerning the magnitude and extent of catch and release angling in many countries and the varying management practices in effect throughout the North Atlantic.

7. *Unreported catch* includes local sales, salmon eaten by fishermen or sold directly to the consumer, by-catch of salmon taken in gear not licensed to harvest salmon, and catches not otherwise recorded in official catch statistics.

The Working Group has provided annual estimates of unreported catches for all Commission areas of the North Atlantic since 1986 (Table 2.1.3.1).

2.4 Significant Developments towards Management of Salmon

2.4.1 Atlantic salmon post-smolt nurseries in the Northwest Atlantic

The Working Group considered research on the early marine life history of Atlantic salmon and considered how this new information may improve the procedures used to estimate pre-fishery abundance of the two seawinter stock component. The abundance forecast is a multiple regression model that uses a sea surface temperature index and a spawning stock size index to predict abundance in the current fishery year. The relationship between spawning stock and recruitment is direct, but the underlying factors related to the environmental factors are not well understood. The return of salmon from the ocean phase is affected by survival at sea and maturation at the end of the first winter which sends part of the cohort to natal rivers to spawn as grilse. The winter environmental signal has been hypothesized to be related to migration patterns and their effect on maturation variation (Friedland *et al.* 1998b). Post-smolt survival factors are equally difficult to assess due the difficulties in capturing and studying post-smolts.

Recent investigations in the Northeast Atlantic suggest that spring temperature conditions may be important to post-smolt survival, which supports a range of possible mechanisms affecting feeding, growth, and predation (Friedland *et al.* 1998a). These investigations have been extended by the examination of post-smolt growth for a stock in the area which shows that growth during the post-smolt year is correlated with the thermal conditions (Friedland *et al.*, in press, b). Similar associations have not been shown for North American stocks, possibly due to the nature of the distribution of the post-smolt nursery area along the Atlantic coast of Canada and the United States. Reports of inshore nursery areas (Dutil and Coutu, 1988) are in stark contrast to the ocean distributions of post-smolts reported in Europe. Using scale growth signals, Friedland *et al.* (1999) suggests that the North American post-smolt nursery area shifts in location annually and may include both offshore and estuarine waters. Considering the growth and catch rates for the three collection years, the first year, 1982, clearly supported higher growth and abundance in the Gulf of St Lawrence. The following years, 1983 and 1984, support slower growth and lower local abundance.

The Working Group considered temperature and chlorophyll abundance data as indicators of the nursery habitat suitability for the same years. From the analysis, 1982 was cooler in the Gulf during summer than the other years (Figure 2.4.1), suggesting these conditions either favor growth or are related to other factors that co-vary with growth. In addition, chlorophyll abundance in spring, which was taken as an indicator of likely recruitment success of the forage base, showed gradients between the Gulf and other areas. This preliminary work suggests optimal thermal conditions for post-smolts and production conditions for forage species may define nursery areas.

2.4.2 Migration of kelts in relation to sea water temperatures in Newfoundland

Data storage tags (DST) manufactured by Kiwi Inc. were applied to 139 Atlantic salmon kelts at enumeration facilities on Western Arm Brook, Humber, Campbellton and Highlands rivers, Newfoundland. In total, 12 of these Kiwi DSTs were subsequently recaptured and water temperatures downloaded. Control DSTs for verification purposes were applied to kelts held in a freshwater fluvarium and indicated that water temperatures recorded by the DSTs were accurate.

Results from 11 recaptured tags indicated differences between rivers and among fish within a river (Figure. 2.4.2.1). Water temperature profiles are useful for indicating water temperatures encountered by salmon in freshwater and in the sea and may prove useful for determining temperature preferences. This information is important for marine climate change models and water temperature protocols for opening/closing angling fisheries in freshwater due to high water temperatures. Unlike some Pacific salmon no diurnal movements could be inferred. Salmon spent most of their time in water from 4.7 to 16.8° C.

2.4.3 Influence of release location of hatchery smolts on location of return as adults

Data from 401 recaptures of 56,960 Carlin-tagged reared smolts released between 1989 and 1997 in the River Dalälven (Bothnian Sea, Baltic) indicated that small distances between release sites effected differences in upstream migration patterns. Smolts were produced in and released directly from two hatcheries situated some 700 meters apart. In-river recovery rates of spawners recovered at a fishway located 800 m upriver of the most upriver hatchery were significantly higher for fish originating from the upriver station than those originating at the station 700m further down river. Salmon observed jumping at the outlet of the lowest station just prior to spawning suggested that hatchery return rates for the two stations could be equal. In that case, the difference in recovery rates at the fishway might be considered a proportionate measure of the stray rate effected by a distance of 700 m.

2.4.4 Relationships between biomass of Norwegian spring spawning herring and survival of Atlantic salmon

Post-smolts of Atlantic salmon from large areas of Europe have been observed in oceanic areas in the Norwegian Sea a few weeks and months after leaving their home rivers (Holm *et al.* 1998). In this area the distribution of Norwegian spring spawning herring (NSSH) and mackerel overlaps with salmon post-smolts in space and time (Holst *et al.* 1996). Post-smolts of Atlantic salmon may compete for food and space with other marine fish species. Herring larvae may be important food for post-smolts in coastal areas, but adult herring may be competitors in the ocean. The biomass of NSSH has increased considerably in recent years, and at the same time marine survival of Atlantic salmon stocks in the northeast Atlantic have declined. Thus it is reasonable to ask if herring affect growth and survival of post-smolt salmon.

Spawning biomass of NSSH and recapture rates of salmon tagged as smolts in the River Figgjo, southeast Norway, were inversely related (Figure 2.4.4.1). This supports the hypothesis that the presence of large numbers of Norwegian spring spawning herring in the Norwegian Sea may contribute to increased mortality of salmon in the ocean.

Many factors can affect survival of salmon in the marine environment, abiotic as well as biotic, and the interaction between them are little known. Species interaction may occur at several levels, and in the present case it may be asked if salmon post-smolts and herring compete for food. It is recommended that this should be tested.

2.4.5 Description of marine growth checks observed on the scales of salmon returning to Scottish homewaters in 1997

Samples of scales were routinely collected and examined from salmon caught in a number of fisheries throughout Scotland in 1997. Scales from adult recaptures in Scottish homewaters of North Esk salmon tagged as emigrating smolts were also analysed.

Substantial proportions of these scales exhibited summer checks (Table 2.4.5.1). Such summer checks are recognised as a number of successive narrowly spaced circuli occuring within a period of otherwise more widely-spaced circuli. Evidence that checks were not misclassified winter annuli is provided by the observation that the incidence of validated summer checks from scale samples taken from the North Esk recapture data set was within the range observed in the fisheries examined throughout Scotland.

For both 1SW and 2SW salmon, the incidence of summer checks in 1997 was outside the 95% confidence limits for the historical data sets examined.

All summer checks occurred during the first marine growing season in 1SW salmon or during the second marine growing season in 2SW salmon indicating that the checks were laid down in the same calendar year (1996) in both sea age groups. The incidence of summer checks in 2SW salmon was significantly less than in 1SW salmon. Furthermore, the incidence of summer checks varied significantly among months of capture for 1SW, although not for 2SW returns. In contrast, the position of the checks on the scales was estimated to have been the same across all groups.

The incidence of checks observed in maturing salmon returning to the Scottish coast in 1997 was the highest on record. While no significant link was shown with either growth or survival these observations further focus attention on the marine phase of the salmon's life cycle and on changes in the marine environment that may have an impact upon growth and survival.

2.4.6 Potential impact of seal and seabird predation on salmon in the Northwest Atlantic

Although declining salmon numbers in eastern North America are statistically associated with increasing harp seal populations, it cannot presently be determined whether predation by seals and sea birds is a cause of the declines in North American salmon returns. For such a cause-and-effect relation to be plausible, it must be shown that seals or other predators can account for a substantial fraction of salmon mortality at sea, and that such predation mortality could have increased.

Only nine records of seal (among a total of 5,680 grey, harbour and harp) and one record of seabird (other than gannet) predation on Atlantic salmon are available from marine diet studies in eastern Canada. Four of the seal records may, however, been of salmon taken from nets. Of the six remaining records, two are for grey seals, two are for harp seals, one is for a harbour seal and one is for a common murre. Three of these records are based on otoliths, the growth characteristics of which yielded unexpected calculated fish lengths for the time of year of capture, i.e., length calculations or species identification are erroneous. The remaining six records were used to derive consumption rate estimates.

Working Group reviewed a model which estimated numbers of smolts leaving North American rivers, daily numbers alive as post-smolts, salmon biomass, and vulnerability windows (size and age at which salmon are susceptible) to predation by estimated seal populations and potential seabird predators (inc. kittiwakes, fulmars, murres, shearwaters, gulls, and gannets). Estimates of salmon harvest based on calculated consumption rates and estimated seal populations were subject to numerous sources of error. Analysis suggests that predators could conceivably account for a substantial fraction, and possibly the majority, of salmon mortality at sea. Analyses also suggested that extremely large sample sizes would be required to detect and accurately characterize salmon predation.

Gannets are large seabirds which plunge-dive on pelagic prey, including post-smolts near the water's surface. Gannet diet is measured annually in August at Funk Island, off the northeast coast of Newfoundland. Salmon were infrequent in their diet, 1977-89, but increased in the 1990s to a peak of 6.4% of diet in 1993. The mean value, 1990-98, was 3.1%. Mean salmon consumption in August during the 1990s was estimated to be 3.6% of post-smolt biomass. Gannet diet is unknown for other months at Funk Island, and for other colonies in Newfoundland. If diet at Funk in August represents July-September diet at the two gannetries in northeast Newfoundland, then gannets could have consumed a mean of 13.7% of post-smolt biomass in the 1990s. Salmon have not been found in the diet of gannets in the Gulf of St. Lawrence where gannet populations are much larger than those of Newfoundland. Should these larger colonies participate even rarely in the harvest of post-smolts the loss of salmon biomass could be greater.

Populations of grey, harp, and hooded seals and of gannets and common murres have increased in eastern North America since the 1970s. Population trends for other seabird predators are unknown. The rising populations of seals and some seabirds, suggest that it is plausible that consumption by these predators may have contributed to declining returns of North American salmon. However, marine trophic interactions are complex and rising predator numbers do not necessarily depress prey populations.

2.4.7 Stock-recruitment relationships to define a conservation threshold and targets for Québec salmon rivers

Conservation thresholds for Atlantic salmon in Québec are being established using stock-recruitment (SR) analysis. The Ricker model (Ricker 1954) is appropriate for the species, which exhibits density dependence, at least during the freshwater phase.

Ricker's parameters (α, β) were replaced respectively with the mean maximal catch over many years (Copt), and the catch rate at Copt (h*) (Schnute and Kronlund 1996). The catch rate is equal to (Copt/(Sopt + Copt)) where Sopt is the average spawner requirement needed to obtain Copt. A Bayesian approach was used to assess the uncertainties around the estimates, and to provide a risk analysis for suggested management actions (Walters and Ludwig 1994, Richards and Maguire 1998). Management plans favoring fixed escapements provide the best management and conservation results, providing the underlying assumptions are biologically realistic.

Québec salmon managers use two reference points: a conservation threshold and a management target. The new conservation thresholds will be defined by taking the MSY points determined from available SR relationships. These MSY points will initially be precautionarily fixed at 75% probability levels ($Sopt^{75\%}$). Management targets should be set at a higher level than the conservation threshold, depending on long-term management objectives.

SR relationships, associated reference points, and probability distributions, were calculated for six rivers (the Cascapédia, Dartmouth, Saint-Jean, York, Matane and de la Trinité, Figures 2.4.7.1 and 2.4.7.2) for which good data were available. To export the reference points to other rivers for which data were more limited, a measure of eggs/unit of production (UP) or eggs/m^2 which corresponded to the conservation threshold, was used (see below). This permits comparisons among different rivers.

Habitat suitability indicies (HSI) (Terrell *et al.* 1995) were derived to classify river production units. These related parr densities with physical parameters (substrate, type of flow, river width, and a length of the growing season factor for different geographic areas (Power 1981)). HSIs were combined with basin wide habitat maps to generate estimates of Units of Production (UP). The HSI method is believed to be the most accurate approach, especially for rivers on the North Shore of the Gulf of St. Lawrence. An alternate way of evaluating production units consists in simply determining the wetted area accessible to the salmon.

Two regressions were derived correlating either UP, $Y=1.67*UP$, $r^2= 0.89$, or wetted areas $Y=1.04*m^2$, $r^2= 0.96$, with $Sopt^{75\%}$ values. The regression equations can be used to export Sopt values to rivers where SR relationships are unavailable; the slope is the eggs/units value, and Y is the number of eggs needed to meet the conservation threshold.

Further analysis on transporting conservation limits across rivers is underway using Bayesian hierarchical analysis. The objectives are:

1) to confer more consistency in the overall data processing by working under a common Bayesian framework from the river-by-river analyses, to the transport across rivers;

2) to provide an evaluation of the uncertainty of the conservation limit when extrapolating the results obtained on the 6 index rivers to a new river where no SR data are available.

The Bayesian hierarchical analysis (Gelman *et al.* 1995) has been undertaken under the following model and hypotheses:

- after standardizing the SR data for river size (in UP), the 6 index rivers are considered as a set of exchangeable SR experiments;

- the likelihood is derived from the SR data using a Ricker model with lognormal process errors;

- each of the six index rivers has a common, prior lognormal probability distribution for Sopt whose parameters are included in the analysis and thus considered as uncertain.

The output of this analysis is both an *a posteriori* probability distribution of Sopt (eggs/UP) for each of the index rivers, and an *a posteriori* predictive probability distribution of Sopt for a new river where no SR data are available. These probability distributions are presented in Figure 2.4.7.2. *A posteriori* distributions of Sopt for the six index rivers are consistent among systems. The *a posteriori* predictive distribution of Sopt for a new river falls among but has a greater dispersion than the dispersions observed for the index rivers. This reflects the absence of SR data for the new river.

2.4.8 Forecasting 1999 returns and assessment of alternative management options on the R. Scorff, Brittany

Since 1994, a scientific programme has been carried out on the Atlantic salmon population of the River Scorff (Southern Brittany, France). It aims at providing a better insight in the population dynamics of the species and developing methods to improve the assessment of stock status and management strategies. Smolt output and adult returns are estimated annually by trapping and mark/recapture techniques. At present the 1SW returns (1996, 1997, 1998) from three smolt cohorts (1995, 1996, 1997) have been observed. Information on the return rates as grilse can be derived from these data. By combining this information and the estimate of smolt output for 1998, a first attempt was made to forecast 1999 1SW returns. The analysis was undertaken under a Bayesian framework and followed two successive steps:

- a predictive posterior probability distribution of the 1SW return rate was built by means of a Bayesian hierarchical analysis which regarded the first 3 cohorts observed as a set of exchangeable experiments belonging to the same family of experiments (Gelman *et al.* 1995);

- the posterior predictive distribution of the 1SW return rates was then incorporated into a forecasting procedure to produce a predictive probabilty distribution of the 1999 1SW returns on the basis of the 1998 smolt output estimate.

At both steps, the uncertainty of the estimates of smolt production and adult returns (measurement errors) were taken into account.

The posterior predictive distribution of the 1SW return rate reflects the uncertainty on this parameter for a new year in the absence of data, given the observed data for the first 3 cohorts observed. It was obtained under the following model and hypotheses:

- adult return is a binomial process where each smolt has equal probability of coming back into its natal river, this probabilty representing the return rate which we attempt to make inferences on;

- prior knowledge is entered into the analysis by restricting prior probability distribution of the grilse return rate to conform to Beta distributions with a mode ranging from 0.025 to 0.2 and with a variance lower than that of a uniform distribution between 0 and 0.4.

A comparison of the posterior predictive distribution of the 1SW return rate with its prior probability distribution (Figure 2.4.8.1a) shows that the information provided by the data available led to a reduction in the uncertainty on this parameter, although a wide range of values are still seemingly probable. This uncertainty might be reduced in the future through additional data collected on forthcoming cohorts or by the introduction of covariables that can explain some the variability of the return rate, such as the mean size of the smolts.

The forecasting procedure used the same binomial model for adult returns from the smolt stage and the 1998 estimate of smolt production. Its output was a posterior predictive probability distribution for the 1999 grilse returns which showed a very wide 90% probability interval, from 130 to 1340 (Figure 2.4.8.1b). Although this result might appear rather disappointing, it must be emphasized that it certainly gives a more realistic view of our actual ability to predict returns one year in advance, compared to a point estimate, such as the most probable value.

Since the grilse represent about 90% of the returns in the Scorff R. and account for most of the egg deposition, further analyses were carried out to evaluate the probability that 1999 escapement will be above the conservation limit. Current knowledge on the ranges of the MSW returns and of the exploitation rates by sea age class, together with the current TAC based system of regulation of the exploitation (Porcher and Prévost 1996) were taken into account. The distribution of the egg deposition indicates that the probability of exceeding the conservation limit in 1999 is only 55% under current levels of exploitation and TAC (Figure 2.4.8.2a). Even if no fishery was allowed, the probability of falling below the conservation limit is still 30% (Figure 2.4.8.2b), mainly because of the rather poor smolt production in 1998.

In order to evaluate the effect of the current TAC based control of the exploitation, the probability distribution of the egg deposition obtained with or without TAC were compared. Both distributions could be exactly superimposed, suggesting that the TAC was not providing any protection against overexploitation (i.e. escapement below conservation limit). Even when considering an eventual doubling of the exploitation rates in 1999 relative to previous years (from [5%, 20%] to [10%, 40%]), the TAC, as currently set, was not reducing the probability of not achieving the conservation limit. An alternative and much more constraining management option was then evaluated. It delayed the opening of the fishing season to the 1st of July (from the present begining of March), conditioned this opening on the number of returns observed up to this date and used a TAC approximately reduced by half from actual level. This alternative management option seemed to provide a better protection against overexploitation if the exploitation rates were to double in 1999.

Although preliminary the analyses suggest:

- current TAC levels used for regulating exploitation on the salmon rivers of Brittany might be too high and further evaluation of the performance of the management strategy currently applied is required;

- Bayesian statistics are of great interest for providing more realistic view of stock status or management strategies as they allow for a better description of the uncertainty in the assessment process. Further work in this field should be promoted, such as full risk analysis considering consequences of management options beyond the next year.

2.4.9 Salmon survey in the Labrador Sea in 1998

Experimental fishing was conducted by a Canadian research vessel fishing in the Labrador Sea in the fall of 1998. In total, nine stations were fished with fleets of monofilament gillnets of mesh size 77 mm, 89 mm, 102 mm, 115 mm, and 127 mm set to fish on the surface. In total, 38 salmon were caught, 24 of which were post-smolts and the remainder were 1SW salmon. Catch data and biological information from whole fish are:

Date	No. of fish	Life stage	Fork length (cm)	Whole weight (kg)
Sept 22	4	post-smolt	33 – 35	0.42 – 0.45
Sept 25	17	post-smolt	33 – 38	0.37 – 0.62
Sept 26	5	adult	60 – 71	2.99 – 3.78
Sept 27	6	adult	63 – 68	2.47 – 3.47

Catch rates ranged from 0 to 1.24 salmon per mile-hour of gear fished. Catch rates were lower than previously experienced by research vessels fishing in the same area in the late 1980s. These data will be added to the information base of research in the Labrador Sea. More research on post-smolt and adult salmon at sea is encouraged.

2.4.10 North American salmon recruitment, smolt indices, marine habitat and harp seal populations

A negative trend in recruitment of North American (NA) Atlantic salmon (*Salmo salar*) has persisted in spite of severely reduced commercial salmon fisheries. At the same time juvenile salmon production may have increased as a result of reduced home water exploitation. The Working Group reviewed a document that explored the relationship between recruitment of NA salmon, indices of smolt production based on fifteen standard electrofishing sites in the Miramichi River and either an index of salmon marine habitat (SHI) or annual population estimates of harp seals (*Phoca groenlandica)*. Further analysis conducted at the meeting explored a weighted index of North American pre-smolts (see Section 4.2.1).

Over the range of years observed, 1972 to 1998, recruits (the summation of harvests and spawning escapements of NA salmon) were significantly negatively correlated with pre-smolt indices and harp seal populations for either one-sea-winter or two-sea-winter salmon (Figure 2.4.10). There was correlation among the predictive variables. Habitat in either February or March of the first sea-winter was positively correlated with pre-smolt indices. Habitat was positively correlated with the residuals of a simple recruitment model of logarithmic transformed pre-smolt indices for both one and two-sea-winter recruits. Harp seal populations were not significantly correlated with the residuals of the simple model of one-sea-winter recruits but were negatively correlated with the residuals of a simple model of two-sea-winter recruitment.

Models proposing the use of habitat and harp seals accounted for a high proportion of the variation in recruitment of the NA stock of salmon, had been reviewed previously (ICES 1998/ACFM:15). It was recommended that the appropriate recruitment model be further specified and supported (see Section 5.7.3). The development of a more comprehensive index of the relative change in marine predators of salmon in the Western North Atlantic Ocean is required. Also, verification of the assumption of direct proportionate production of smolts from the pre-smolt indices is required in order to isolate the life-stage underlying the negative relationship between pre-smolt abundance and adult recruitment.

The Working Group noted the high degree of correlation among variables and the paucity of evidence of the consumption of salmon by harp seals. These conditions prevent the derivation of specific conclusions concerning the nature of the relationships among recruits, habitat or the harp seal population. Because these variables cannot be controlled in the experimental sense, only additional years of data may provide the natural variation required for testing the validity of these models.

2.5 Framework for Stock Rebuilding Programs

The maintenance of self-sustaining stocks of salmon by means of targets or conservation limits requires that stock rebuilding programs are carried out when monitoring indicates that compliance with conservation values has not been achieved. It will be necessary to consider a range of issues before a decision is made to introduce a rebuilding program. It will also be necessary to decide which of a range of approaches to stock rebuilding is appropriate. In some cases, no action beyond increased vigilance during future monitoring cycles will be required. The flow-chart in Figure 2.5.1 has been constructed to provide a standard framework for decision making where targets or conservation levels are not being met and stock rebuilding programs are being considered. Terms used in the flow-chart cells are underlined in the following text, in order to aid cross-referencing of the text and the chart.

The approach envisages that a conservation limit or target has been set previously as part of a stock management plan, and that the plan requires that the stock is monitored in order to assess compliance. If assessment shows that compliance has been achieved, the monitoring cycle can be resumed without further action. In the special case of a recovering stock for which interim targets have been set, compliance will be exceeded at each stage of recovery. In these circumstances it will be necessary to set new, greater conservation values as each step in the recovery process is achieved.

If a deficit is detected and the conservation value has not been met, it becomes necessary to consider the introduction of a stock rebuilding program. The first course will be to assess the validity of the value of the original conservation limit or target. Setting values is expected to be a particular problem in the early stages of any new management plan. Initial values will often be set in the absence of precise prior knowledge of the stock in question - some values will be set too high and some too low. If the original value is considered to be erroneous then the conservation value is reset at a new, lower level and the cycle of monitoring and assessment resumes.

If the original conservation value is considered to be valid, and the observed deficit is real, a more complex sequence of decisions must be made. In a well-established assessment program, an occasional failure to meet conservation limits might be judged acceptable. Indeed, frequency standards for the acceptance of occasional annual deficits may be a part of the assessment plan. Occasional non-compliance may also be acceptable for other reasons - perhaps on the basis of sustained, superior levels of performance in the past. Occasional failures will be most significant for stocks showing low levels of variation in total age at spawning. Where variation is greater, the effects of single-year deficits in egg deposition will be spread among several future spawning years. Considered in context, therefore, it may be possible to restrict action on a sporadic deficit to noting its occurrence, reserving other options for the future.

If instead an occasional failure of compliance is considered a significant deficit - perhaps because of the large magnitude of the deficit, or because it is part of a sequence of marginal events, or part of a developing trend - a further sequence of decisions must be made. In particular, it may be possible to establish causes or correlates of non-compliance by linking deficits or trends with specific changes in environmental or fishery variables. There are many possible effects of this kind, acting on a variety of scales, and they can be considered under a number of categorizations. Each of a suggested set of categories is discussed separately towards the end of this section.

If the causes, or candidate causes, of non-compliance can be identified , it may be possible to target action on the causes themselves as part of a stock rebuilding program. Alternatively, compensatory actions of other types, such as enhancement, can be directed at the appropriate level. If the cause of non-compliance is known but no remedy is available, it may be necessary to reset the conservation value before monitoring and assessment resumes. In the case of a deficit of indeterminate cause, the precautionary principle requires that a stock rebuilding program is initiated, in order to expedite recovery while further information on the underlying problem is sought. It will be necessary to monitor the response of the stock during any rebuilding program, as part of the continuing assessment cycle.

In some circumstances, a legal imperative may forbid the resetting of conservation values and a stock rebuilding program will be required even when the cause of the deficit is known to be irremediable. In the most unusual circumstances, where salmonids can no longer live in previously productive habitat, the conservation value may reset to zero. In this case, mitigation can be considered for temporary support of the stock while the problem is resolved. If the problem has no solution, self-sustaining salmon fisheries are lost, and put-and-take fisheries or fisheries on other species are the only options which remain.

As regards targeting a stock rebuilding program, it is suggested that consideration of causes and correlates of non-compliance centre on changes with time in four categories of effect. The proposed categories are climate, biological interactions, physical habitat and fisheries and each of these is considered separately below. It is important to note, however, that the categories are not totally discrete and that, in many cases, interactive effects among categories are expected to occur.

There are two primary steps in considering the relevance of any of the four categories in the context of particular instances of non-compliance. Firstly, it is necessary to establish the geographical scale of non-compliance by comparing the stock unit in question with other stocks. This context - whether the violation is local, or part of a regional, national or range-wide pattern - will direct attention to variables or issues operating on similar geographical scales. Secondly, it is necessary to determine at which stage of life the size of the stock is being restricted by unexpectedly low levels of performance. For example, low fry densities resulting from adequate spawning escapement will direct attention towards adverse factors acting in fresh water - during spawning, egg incubation, hatch or dispersal. Low adult return rates from adequate levels of smolt production will suggest that the limiting factor has operated at a later stage of life. It is important to note that this general guidance is not completely secure. The salmon life-cycle is complex and factors acting at any stage of life have the potential to affect growth and survival later on. For example, variation in smolt size is likely to affect predation risk early in the marine phase.

Climatic variables are those that directly affect the conditions in which fish live and grow. Temperature and precipitation are the principle factors of concern. Temperature is of primary importance, both in fresh water and in the sea, since it is a direct determinant of growth and other related performance variables. In addition, brief episodes of high temperature prove lethal in fresh water and, in the sea, salmon demonstrate a strong preference for a relatively narrow temperature range and thus tend to limit their distribution. The second climatic variable of importance is precipitation which affects ground-water discharge, and therefore stream temperature, and stream-flow. Stream discharge affects pH values, it determines wash-out rates for eggs and wetted habitat area for juveniles, and allows access for adults moving upstream. Climatic variables are expected to have a strong affect on levels of compliance with conservation values. Although climatic variations are beyond management control, it may be possible to limit adverse effects by using compensatory management actions to alter variables in other categories of effect.

Biological interactions include a wide range of temporally variable effects relating to interactions with other species. These include the adverse effects on wild salmon of inter-specific competition in streams, introduction of non-native species, low abundance of prey species in fresh water and in the sea, excessive mortalities due to predation, and mortality due to outbreaks of disease or parasites, such as *Gyrodactylus salaris*. The category also includes interactions with other fish of the same species, because of the possible adverse effects of escapees from aquaculture on the productivity of wild salmon stocks and the negative effects of indiscriminate stocking from hatcheries. With the exception of aquaculture and hatchery effects, remedial action is not a realistic possibility for many interactive effects.

Physical habitat effects that vary among years or over decadal scales are likely to affect compliance with conservation values. All of the physical habitat effects that have the potential to affect production and survival of salmon exert their effects in fresh water. Many of these effects are attributable to the effects of non-fishery forms of land- and water management. They include siltation of spawning gravels following changes in land-use, channelization and destruction of stream habitat, stream enrichment through fertiliser run-off and sewage discharge. Impoundment works reduce habitat by drowning streams, and they alter temperature regimes. In-stream construction works may limit access to potential habitat. Because these effects are often caused by the activities of man, they are often open to direct remedy.

Fishery effects are dealt with extensively in the other parts of this Report. Fisheries are particularly likely to contribute to non-compliance with conservation values because they exploit adult fish towards the end of the life-cycle after other restrictions on stock size have had their effect. In addition, the effect of uniform fisheries on adult recruitment is variable since exploitation rate often rises when abundance is reduced. Fishery effort is inherently manageable. The fisheries are well-documented relative to the other factors affecting stock size. So, fishery regulation is likely to remain the most effective route towards ensuring compliance with conservation limits or targets. Management of the fisheries is also a practicable route towards managing compliance, because of the close association of the regulatory authorities with the various parties who benefit from exploiting the resource, and because of close association of both parties with those attempting to optimise production.

2.6 Compilation of Egg Collections and Juvenile Releases for 1998

2.6.1 Egg collections and juvenile releases for 1998

The Working Group compiled 1998 data summaries of artificially spawned eggs and egg and juvenile releases in Table 2.6.1.1. These data were provided to estimate the effects of egg collection on wild production and to characterize the overall scale of enhancement work by ICES member countries. Although all countries except Finland artificially spawn eggs to support enhancement activities, only eight countries reported summaries of artificially spawned egg numbers for 1998. Two countries (Canada and the United States) collect eggs from domestic/captive broodstock and/or captive sea run kelts in addition to collections from sea run fish. Where possible, the number of eggs collected from each of these sources is reported.

For most countries, the database has been expanded to include historical data from 1990 to 1997, and these data are summarized in Appendix 4. As data reporting becomes more complete for the pre-1998 period, this information can be used to describe temporal trends in enhancement activities.

2.7 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 1998

2.7.1 Compilation of tag releases and finclip data for 1998

Data on releases of tagged and fin-clipped salmon in 1998 were provided by the Working Group and are compiled as a separate report (Annex to ICES CM 1999/ACFM:14). A summary of Atlantic salmon marking in 1998 is given in Table 2.7.1.1. Slightly over 2.59 million salmon were marked in 1998, a 14% decline from the 3.02 million fish marked in 1997. Primary marks are summarized by four types; Microtag, External Tag, Adipose Clip, and Other Visible Marks. Secondary marks (primarily adipose clips on microtagged fish) are also recorded. The Adipose clip was the most used primary mark (1.66 million), with microtags (0.70 million) the next most used primary mark. Microtag marking declined by 5% from 1997. Secondary marks (primarily adipose fin clips) were applied to 0.87 million fish. Most marks were applied to hatchery-origin juveniles (2.53 million), while 0.04 million wild juveniles and 0.02 million adults were marked.

Table 2.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1998. (1998 figures include provisional data).

Year	Canada (1)	Den.	Faroes (2)	Finland	France	East Grld.	West Grld. (3)	Iceland Wild	Iceland Ranch	Ireland (4,5)	Norway (6)	Russia (7)	Spain (8)	St. P. & M.	Sweden (West)	UK (E & W)	UK N.Irelanc (6,9)	UK Scotland	USA	Other (10)	Total Reportec Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100		743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127		707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125		1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145		1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135		1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133		1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	2	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-	-
1967	2863	-	-	-	-	-	1601	144	2	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-	-
1968	2111	-	5	-	-	-	1127	161	1	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-	-
1969	2202	-	7	-	-	-	2210	131	2	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-	-
1970	2323	-	12	-	-	-	2146	182	13	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-	-
1971	1992	-	-	-	-	-	2689	196	8	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-	-
1972	1759	-	9	32	34	-	2113	245	5	1804	1578	462	40	-	18	442	210	1727	1	486	10965	-	-
1973	2434	-	28	50	12	-	2341	148	8	1930	1726	772	24	-	23	450	182	2006	2.7	533	12670	-	-
1974	2539	-	20	76	13	-	1917	215	10	2128	1633	709	16	-	32	383	184	1628	0.9	373	11877	-	-
1975	2485	-	28	76	25	-	2030	145	21	2216	1537	811	27	-	26	447	164	1621	1.7	475	12136	-	-
1976	2506	-	40	66	9	<1	1175	216	9	1561	1530	542	21	2.5	20	208	113	1019	0.8	289	9327	-	-
1977	2545	-	40	59	19	6	1420	123	7	1372	1488	497	19	-	10	345	110	1160	2.4	192	9414	-	-
1978	1545	-	37	37	20	8	984	285	6	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-	-
1979	1287	-	119	26	10	<0.5	1395	219	6	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-	-
1980	2680	-	536	34	30	<0.5	1194	241	8	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-	-
1981	2437	-	1025	44	20	<0.5	1264	147	16	685	1656	463	25	-	26	493	101	1233	6	313	9954	-	-
1982	1798	-	606	54	20	<0.5	1077	130	17	993	1348	364	10	-	25	286	132	1092	6.4	437	8395	-	-
1983	1424	-	678	58	16	<0.5	310	166	32	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-	-
1984	1112	-	628	46	25	<0.5	297	139	20	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-	-
1985	1133	-	566	49	22	7	864	162	55	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-	-
1986	1559	-	530	37	28	19	960	232	59	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9255	315	-
1987	1784	-	576	49	27	<0.5	966	181	40	1239	1385	564	18	2	47	302	56	922	1.2	-	8159	2788	-
1988	1311	-	243	36	32	4	893	217	180	1874	1076	420	18	2	40	395	114	882	0.9	-	7738	3248	-
1989	1139	-	364	52	14	-	337	140	136	1079	905	364	7	2	29	296	142	895	1.7	-	5903	2277	-
1990	911	13	315	60	15	-	274	146	280	586	930	313	7	1.9	33	338	94	624	2.4	-	4943	1890	180-350
1991	711	3.3	95	70	13	4	472	130	345	404	876	215	11	1.2	38	200	55	462	0.8	-	4106	1682	25-100
1992	522	10	23	77	20	5	237	175	460	630	867	167	11	2.3	49	186	91	600	0.7	-	4133	1962	25-100
1993	373	9	23	70	16	-	-	160	496	541	923	139	8	2.9	56	263	83	547	0.6	-	3711	1644	25-100
1994	355	6	6	49	18	-	-	140	308	804	996	141	10	3.4	44	307	91	649	-	-	3927	1276	25-100
1995	260	-	5	48	9	2	83	150	298	790	839	128	9	0.8	37	295	83	588	-	-	3625	1060	n/a
1996	292	-	-	44	14	<0.5	92	122	239	685	787	131	7	1.5	33	180	77	427	-	-	3132	1123	n/a
1997	229	-	-	45	8	1	58	106	50	570	630	111	3	1.5	19	156	93	296	-	-	2377	827	n/a
1998	149	-	6	48	9	-	11	130	34	624	740	131	4	2.3	15	143	75	280	-	-	2401	1210	n/a
Means																							
1993-19	302	3	7	51	13	1	47	136	278	678	835	130	7	2	38	240	85	501	<0.5	-	3354	1186	-
1988-19	610	-	107	55	16	2	245	149	279	796	883	213	9	2	38	262	92	597	1	-	4359	1699	-

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

Table 2.1.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1998. (1998 figures include provisional data).
S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). Sm = small. Lg = large. T = S + G or Lg + Sm

Year	Canada (1)			Finland			France	Iceland		Ireland (2,3)			Norway (4)			Russia	Spain (5)	Sweden (West)	UK (E&W)	UK(N.I.) (3,6)	UK(Scotland)			USA	Total
	Lg	Sm	T	S	G	T	T	Wild T	Ranch T	S	G	T	S	G	T	T	T	T	T	T	Lg	Sm	T	T	T
1960	-	-	1636	-	-	-	-	100		-	-	743	-	-	1659	1100	33	40	283	139	971	472	1443	1	7177
1961	-	-	1583	-	-	-	-	127		-	-	707	-	-	1533	790	20	27	232	132	811	374	1185	1	6337
1962	-	-	1719	-	-	-	-	125		-	-	1459	-	-	1935	710	23	45	318	356	1014	724	1738	1	8429
1963	-	-	1861	-	-	-	-	145		-	-	1458	-	-	1786	480	28	23	325	306	1308	417	1725	1	8138
1964	-	-	2069	-	-	-	-	135		-	-	1617	-	-	2147	590	34	36	307	377	1210	697	1907	1	9220
1965	-	-	2116	-	-	-	-	133		-	-	1457	-	-	2000	590	42	40	320	281	1043	550	1593	1	8573
1966	-	-	2369	-	-	-	-	104	2	-	-	1238	-	-	1791	570	42	36	387	287	1049	546	1595	1	8422
1967	-	-	2863	-	-	-	-	144	2	-	-	1463	-	-	1980	883	43	25	420	449	1233	884	2117	1	10390
1968	-	-	2111	-	-	-	-	161	1	-	-	1413	-	-	1514	827	38	20	282	312	1021	557	1578	1	8258
1969	-	-	2202	-	-	-	-	131	2	-	-	1730	801	582	1383	360	54	22	377	267	997	958	1955	1	8484
1970	1562	761	2323	-	-	-	-	182	13	-	-	1787	815	356	1171	448	45	20	527	297	775	617	1392	1	8206
1971	1482	510	1992	-	-	-	-	196	8	-	-	1639	771	436	1207	417	16	18	426	234	719	702	1421	1	7575
1972	1201	558	1759	-	-	32	34	245	5	200	1604	1804	1064	514	1578	462	40	18	442	210	1013	714	1727	1	8357
1973	1651	783	2434	-	-	50	12	148	8	244	1686	1930	1220	506	1726	772	24	23	450	182	1158	848	2006	2.7	9768
1974	1589	950	2539	-	-	76	13	215	10	170	1958	2128	1149	484	1633	709	16	32	383	184	912	716	1628	0.9	9567
1975	1573	912	2485	-	-	76	25	145	21	274	1942	2216	1038	499	1537	811	27	26	447	164	1007	614	1621	1.7	9603
1976	1721	785	2506	-	-	66	9	216	9	109	1452	1561	1063	467	1530	542	21	20	208	113	522	497	1019	0.8	7821
1977	1883	662	2545	-	-	59	19	123	7	145	1227	1372	1018	470	1488	497	19	10	345	110	639	521	1160	2.4	7756
1978	1225	320	1545	-	-	37	20	285	6	147	1082	1229	668	382	1050	476	32	10	349	148	781	542	1323	4.1	6514
1979	705	582	1287	-	-	26	10	219	6	105	922	1027	1150	681	1831	455	29	12	261	99	598	478	1076	2.5	6341
1980	1763	917	2680	-	-	34	30	241	8	202	745	947	1352	478	1830	664	47	17	360	122	851	283	1134	5.5	8120
1981	1619	818	2437	-	-	44	20	147	16	164	521	685	1189	467	1656	463	25	26	493	101	834	389	1223	6	7342
1982	1082	716	1798	49	5	54	20	130	17	63	930	993	985	363	1348	364	10	25	286	132	596	496	1092	6.4	6275
1983	911	513	1424	51	7	58	16	166	32	150	1506	1656	957	593	1550	507	23	28	429	187	672	549	1221	1.3	7298
1984	645	467	1112	37	9	46	25	139	20	101	728	829	995	628	1623	593	18	40	345	78	504	509	1013	2.2	5883
1985	540	593	1133	38	11	49	22	162	55	100	1495	1595	923	638	1561	659	13	45	361	98	514	399	913	2.1	6668
1986	779	780	1559	25	12	37	28	232	59	136	1594	1730	1042	556	1598	608	27	54	430	109	745	526	1271	1.9	7744
1987	951	833	1784	34	15	49	27	181	40	127	1112	1239	894	491	1385	564	18	47	302	56	503	419	922	1.2	6615
1988	633	677	1311	27	9	36	32	217	180	141	1733	1874	656	420	1076	420	18	40	395	114	501	381	882	0.9	6596
1989	590	549	1139	33	19	52	14	140	136	132	947	1079	469	436	905	364	7	29	296	142	464	431	895	1.7	5200
1990	486	425	911	41	19	60	15	146	280	-	-	586	545	385	930	313	7	33	338	94	423	201	624	2.4	4339
1991	370	341	711	53	17	70	13	130	345	-	-	404	535	342	876	215	11	38	200	55	177	285	462	0.8	3531
1992	323	199	522	49	28	77	20	175	460	-	-	630	566	301	867	167	11	49	186	91	362	238	600	0.7	3856
1993	214	159	373	53	17	70	16	160	496	-	-	541	611	312	923	139	8	56	263	83	320	227	547	0.6	3676
1994	216	139	355	38	11	49	18	140	308	-	-	804	581	415	996	141	10	44	307	91	400	248	649	-	3912
1995	153	107	260	37	11	48	9	150	298	-	-	790	590	249	839	128	9	37	295	83	364	224	588	-	3534
1996	154	138	292	23	21	44	14	122	239	-	-	685	571	215	787	131	7	33	180	77	267	160	427	-	3038
1997	126	103	229	29	16	45	8	106	50	-	-	570	389	241	630	111	3	19	156	93	182	114	296	-	2316
1998	70	79	149	29	19	48	9	130	34	-	-	624	445	296	740	131	4	15	143	75	157	123	280	-	2382
Means																									
1993-97	173	129	302	36	15	51	13	136	278	-	-	678	548	286	835	130	7	38	240	85	307	195	501	<0.5	3295
1988-97	327	284	610	38	17	55	16	149	279	-	-	796	551	332	883	213	9	38	262	92	346	251	597	1	4000

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

Table 2.1.1.3 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1998 may be provisional. Methods used for estimating age composition given in footnotes.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,559
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,311
	1989	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	233,690	425	-	-	-	-	-	-	-	-	106,379	486	-	-	340,069	911
	1991	189,324	341	-	-	-	-	-	-	-	-	82,532	370	-	-	271,856	711
	1992	108,901	199	-	-	-	-	-	-	-	-	66,357	323	-	-	175,258	522
	1993	91,239	159	-	-	-	-	-	-	-	-	45,416	214	-	-	136,655	373
	1994	76,973	139	-	-	-	-	-	-	-	-	42,946	216	-	-	119,919	355
	1995	61,940	107	-	-	-	-	-	-	-	-	34,263	153	-	-	96,203	260
	1996	82,490	138	-	-	-	-	-	-	-	-	31,590	154	-	-	114,080	292
	1997	58,988	103	-	-	-	-	-	-	-	-	26,270	126	-	-	85,258	229
	1998	46,687	79	-	-	-	-	-	-	-	-	13,270	70	-	-	59,957	149
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/86	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/87	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/88	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/89	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/90	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/92	16	-	7,611	-	837	-	-	-	-	-	-	-	-	-	8,464	31
	1992/93	-	-	4,212	-	1,203	-	-	-	-	-	-	-	-	-	5,415	22
	1993/94	-	-	1,866	-	206	-	-	-	-	-	-	-	-	-	2,072	7
	1994/95	-	-	1,807	-	156	-	-	-	-	-	-	-	-	-	1,963	6
	1995/96	-	-	268	-	14	-	-	-	-	-	-	-	-	-	282	1
	1996/97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1997/98	339	-	1,315	-	109	-	-	-	-	-	-	-	-	-	1,763	6
Finland	1982	2,598	5	-	-	-	-	-	-	-	-	5,408	49	-	-	8,406	54
	1983	3,916	7	-	-	-	-	-	-	-	-	6,050	51	-	-	9,966	58
	1984	4,899	9	-	-	-	-	-	-	-	-	4,726	37	-	-	9,625	46
	1985	6,201	11	-	-	-	-	-	-	-	-	4,912	38	-	-	11,113	49
	1986	6,131	12	-	-	-	-	-	-	-	-	3,244	25	-	-	9,375	37
	1987	8,696	15	-	-	-	-	-	-	-	-	4,520	34	-	-	13,216	49
	1988	5,926	9	-	-	-	-	-	-	-	-	3,495	27	-	-	9,421	36
	1989	10,395	19	-	-	-	-	-	-	-	-	5,332	33	-	-	15,727	52
	1990	10,084	19	-	-	-	-	-	-	-	-	5,600	41	-	-	15,684	60
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
	1995	7,786	11	-	-	-	-	-	-	-	-	5,344	38	-	-	13,130	48
	1996	10,726	21	1,103	5	1,359	13	242	4	13	1	-	-	-	-	13,443	44
	1997	9,469	16	2,357	10	1,742	17	163	2	10	0	-	-	-	-	13,741	45
	1998	11,410	19	1,642	7	1,945	19	162	10	10	0	-	-	-	-	15,169	48
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,124	3	1,971	9	311	2	-	-	-	-	-	-	-	-	3,406	14
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
	1991	1,362	3	1,935	9	190	1	-	-	-	-	-	-	-	-	3,487	13
	1992	2,490	7	2,450	12	221	2	-	-	-	-	-	-	-	-	5,161	20
	1993	3,581	10	987	4	267	2	-	-	-	-	-	-	-	-	4,835	16
	1994	2,810	7	2,250	10	40	1	-	-	-	-	-	-	-	-	5,100	18
	1995	1,669	4	1,073	5	22	0	-	-	-	-	-	-	-	-	2,764	9
	1996	2,063	5	1,891	9	52	0.4	-	-	-	-	-	-	-	-	4,005	14
	1997	1,060	3	964	5	37	0.3	-	-	-	-	-	-	-	-	2,061	8
	1998	2,065	5	824	4	22	0.2	-	-	-	-	-	-	-	-	2,911	9
Iceland	1991	30,011	-	11,935	-	-	-	-	-	-	-	-	-	-	-	41,946	130
	1992	38,955	-	15,416	-	-	-	-	-	-	-	-	-	-	-	54,371	175
(Wild fish	1993	37,611	-	11,611	-	-	-	-	-	-	-	-	-	-	-	49,222	160
only,	1994	25,480	62	14,408	78	-	-	-	-	-	-	-	-	-	-	39,888	140
ranched	1995	34,046	93	13,380	57	-	-	-	-	-	-	-	-	-	-	47,426	150
fish not	1996	28,039	69	9,971	53	-	-	-	-	-	-	-	-	-	-	38,010	122
included)	1997	23,945	62	8,872	44	-	-	-	-	-	-	-	-	-	-	32,817	106
	1998	35,537	90	8,872	40	-	-	-	-	-	-	-	-	-	-	43,328	130
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330,558	1,079
	1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	194,785	586
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,600	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,153	630
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,120	541
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286,266	804
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288,225	790
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	248,901	685
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	209,214	570
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	237,663	624
Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348

	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	235,703	491	-	-	-	-	-	-	-	-	153,554	894	-	-	389,257	1,385
	1988	217,617	420	-	-	-	-	-	-	-	-	120,367	656	-	-	337,984	1,076
	1989	220,170	436	-	-	-	-	-	-	-	-	80,880	469	-	-	301,050	905
	1990	192,500	385	-	-	-	-	-	-	-	-	91,437	545	-	-	286,466	930
	1991	171,041	342	-	-	-	-	-	-	-	-	92,214	535	-	-	263,255	876
	1992	151,291	301	-	-	-	-	-	-	-	-	92,717	566	-	-	244,008	867
	1993	153,407	312	62,403	284	35,147	327	-	-	-	-	-	-	-	-	251,957	923
	1994	-	415	-	319	-	262	-	-	-	-	-	-	-	-	-	996
	1995	134,341	249	71,552	341	27,104	249	-	-	-	-	-	-	-	-	232,977	839
	1996	110,085	215	69,389	322	27,627	249	-	-	-	-	-	-	-	-	207,101	787
	1997	124,387	241	52,842	238	16,448	151	-	-	-	-	-	-	-	-	193,677	630
	1998	162,185	296	66,767	306	15,568	139	-	-	-	-	-	-	-	-	244,520	740
Russia	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	139,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,066	420
	1989	78,023	-	23,123	-	4,118	-	26	-	-	-	-	-	2,187	-	107,477	364
	1990	70,595	-	20,633	-	2,919	-	101	-	-	-	-	-	2,010	-	96,258	313
	1991	40,603	-	12,458	-	3,060	-	650	-	-	-	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	-	-	-	-	824	-	47,452	167
	1993	28,100	-	11,780	-	4,280	-	377	-	-	-	-	-	1,470	-	46,007	139
	1994	30,877	-	10,879	-	2,183	-	51	-	-	-	-	-	555	-	44,545	141
	1995	27,775	62	9,642	50	1,803	15	6	0	-	-	-	-	385	2	39,611	128
	1996	33,878	79	7,395	42	1,084	9	40	0.5	-	-	-	-	41	0.5	42,586	131
	1997	31,857	72	5,837	28	672	6	38	0.5	-	-	-	-	559	3	39,003	111
	1998	34,870	92	6,815	33	181	2	28	0.3		-			638	3	42,532	131
Sweden	1989	3,181	7	-	-	-	-	-	-	-	-	4,610	22	-	-	7,791	29
	1990	7,428	18	-	-	-	-	-	-	-	-	3,133	15	-	-	10,561	33
	1991	8,987	20	-	-	-	-	-	-	-	-	3,620	18	-	-	12,607	38
	1992	9,850	23	-	-	-	-	-	-	-	-	4,656	26	-	-	14,507	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,695	44
	1995	9,761	22	-	-	-	-	-	-	-	-	2,770	14	-	-	12,531	37
	1996	6,008	14	-	-	-	-	-	-	-	-	3,542	19	-	-	9,550	33
	1997	2,747	7	-	-	-	-	-	-	-	-	2,307	12	-	-	5,054	19
	1998	2,421	6	-	-	-	-	-	-	-	-	1,702	9	-	-	4,123	15
Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
UK (England & Wales)	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296
	1990	53,143	-	-	-	-	-	-	-	-	-	33,533	-	-	-	86,676	338
	1991	34,596	-	-	-	-	-	-	-	-	-	17,053	-	-	-	51,649	200
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48,168	186
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	69,773	263
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88,121	307
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80,478	295

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46,696	180
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44,506	156
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42,194	143
UK (Scotland)	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	81,094	201	-	-	-	-	-	-	-	-	87,924	423	-	-	169,018	624
	1991	73,608	177	-	-	-	-	-	-	-	-	65,193	285	-	-	138,801	462
	1992	101,676	238	-	-	-	-	-	-	-	-	82,841	361	-	-	184,517	600
	1993	94,517	227	-	-	-	-	-	-	-	-	71,726	320	-	-	166,243	547
	1994	99,459	248	-	-	-	-	-	-	-	-	85,404	400	-	-	184,863	649
	1995	89,921	224	-	-	-	-	-	-	-	-	78,452	364	-	-	168,373	588
	1996	66,413	160	-	-	-	-	-	-	-	-	57,920	267	-	-	124,333	427
	1997	46,878	114	-	-	-	-	-	-	-	-	40,421	182	-	-	87,299	296
	1998	54,294	123	-	-	-	-	-	-	-	-	38,105	157	-	-	92,399	280
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1.0	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
	1990	52	0.1	562	2.2	12	-	-	-	-	-	-	-	16	-	642	2.4
	1991	48	0.1	185	0.7	1	-	-	-	-	-	-	-	4	-	238	0.8
	1992	54	0.1	138	0.6	1	-	-	-	-	-	-	-	-	-	193	0.7
	1993	17	-	133	0.5	-	-	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	0	-	-	-	-	-	-	-	-	-	-	-	12	0
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,478	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,052	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,381	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1995	31,241	-	558	-	-	-	-	-	-	-	-	-	478	-	32,270	83
	1996	30,613	-	884	-	-	-	-	-	-	-	-	-	568	-	32,062	92
	1997	20,980	-	134	-	-	-	-	-	-	-	-	-	124	-	21,238	58
	1998	3,901	-	17	-	-	-	-	-	-	-	-	-	88	-	4,006	11

[1] MSW includes all sea ages >1, when this cannot be broken down.
Different methods are used to separate 1SW and MSW salmon in different countries:
- Scale reading: Faroe Islands, Finland (1996), France, Russia, UK (England and Wales), USA and West Greenland.
- Size (split weight/length): Canada (2.7 kg for nets; 63cm for rods), Finland up until 1995 (3 kg), Iceland (various splits used at different times and places), Norway (3 kg), UK (Scotland) (3 kg in some places and 3.7 kg in others). All countries except Scotland report no problems with using weight to catergorise catches into sea age classes.

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

Table 2.1.2.1 Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for various countries in the North Atlantic, 1991-1998.

Year	Canada (1)				Iceland		Russia		UK(E&W) (2)		UK(Scot) (2)				USA	
	Small	Large	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	1SW	MSW	Total	% of total rod catch	Total	% of total rod catch
1991							3,211	51							239	50
1992	17,945	28,505	46,450	34			10,120	73							407	67
1993	30,970	22,879	53,849	41			11,246	82	1,448	10					507	77
1994	24,074	21,730	45,804	39			12,056	83	3,227	13	1,535	5,067	6,602	8	249	95
1995	18,601	12,610	31,211	36			11,904	84	3,187	20	3,292	8,846	12,138	14	370	100
1996	26,225	10,709	36,934	33	669	2	10,745	73	3,428	20	2,282	8,127	10,409	15	542	100
1997	26,810	21,759	48,569	49	1,558	5	14,823	87	3,132	24	2,790	8,116	10,906	18	333	100
1998	29,518	20,797	50,315	52	2,826	7	12,776	81	5,116	30	4,951	8,460	13,411	19	273	100

1. Figures for 1992 to 1996 are minimal estimates as not all areas have reported catch and release. The 1998 figure is provisional.
2. Figures for 1998 are provisional.

Table 2.1.3.1 Guess-estimates of unreported catches in tonnes within national EEZs in the North-East Atlantic, North America and West Greenland Commissions of NASCO, 1986-1998. In 1998, unreported catches in the North-East Atlantic have been split into two regions.

Year	North-East Atlantic Scandinavia & Russia	North-East Atlantic Southern Europe	North-East Atlantic Total	North American	West Greenland	Total
1986			-	315	-	315
1987			2,554	234	-	2,788
1988			3,087	161	-	3,248
1989			2,103	174	-	2,277
1990			1,779	111	-	1,890
1991			1,555	127	-	1,682
1992			1,825	137	-	1,962
1993			1,471	161	12	1,644
1994			1,157	107	12	1,276
1995			942	98	<20	1,060
1996			947	156	<20	1,123
1997			732	90	5	827
1998	504	604	1108	91	11	1,210
Mean 1993-1997	-	-	1,050	122	-	1,186

Table 2.2.1.1 Production of farmed salmon in the North Atlantic area and in areas other than the North Atlantic (in tonnes round fresh weight), 1980-1998.

Year	North Atlantic Area										Outside North Atlantic Area							Worldwide
	Norway	UK (Scot.)	Faroes	Canada	Ireland	USA	Iceland	UK (N.Ire.)	Russia	Total	Chile	West Coast USA	West Coast Canada	Australia	Turkey	Other	Total	Total
1980	4,153	598	0	11	21	0	0	0	0	4,783	0	0	0	0	0	0	0	4,783
1981	8,422	1,133	0	21	35	0	0	0	0	9,611	0	0	0	0	0	0	0	9,611
1982	10,266	2,152	70	38	100	0	0	0	0	12,626	0	0	0	0	0	0	0	12,626
1983	17,000	2,536	110	69	257	0	0	0	0	19,972	0	0	0	0	0	0	0	19,972
1984	22,300	3,912	120	227	385	0	0	0	0	26,944	0	0	0	0	0	0	0	26,944
1985	28,655	6,921	470	359	700	0	91	0	0	37,196	0	0	0	0	0	0	0	37,196
1986	45,675	10,337	1,370	672	1,215	0	123	0	0	59,392	0	0	0	20	0	0	0	59,392
1987	47,417	12,721	3,530	1,334	2,232	365	490	0	0	68,089	3	0	0	50	0	0	53	68,142
1988	80,371	17,951	3,300	3,542	4,700	455	1,053	0	0	111,372	174	0	0	250	0	0	424	111,796
1989	124,000	28,553	8,000	5,865	5,063	905	1,480	0	0	173,866	1,864	1,100	1,000	400	0	700	5,064	178,930
1990	165,000	32,351	13,000	7,810	5,983	2,086	2,800	<100	5	229,035	9,500	700	1,700	1,700	0	800	14,400	243,435
1991	155,000	40,593	15,000	9,395	9,483	4,560	2,680	100	0	236,811	14,991	2,000	3,500	2,700	0	1,400	24,591	261,402
1992	140,000	36,101	17,000	10,380	9,231	5,850	2,100	200	0	220,862	23,769	4,900	6,600	2,500	0	400	38,169	259,031
1993	170,000	48,691	16,000	11,115	12,366	6,755	2,348	<100	0	267,275	29,248	4,200	12,000	4,500	1,000	400	51,348	318,623
1994	215,000	64,066	14,789	12,441	11,616	6,130	2,588	<100	0	326,630	34,077	5,000	16,100	5,000	1,000	800	61,977	388,607
1995	295,000	70,060	9,000	12,550	11,811	10,020	2,880	259	0	411,580	41,093	5,000	16,000	6,000	1,000	0	69,093	480,673
1996	305,000	83,121	18,600	17,715	14,025	10,010	2,772	338	0	451,581	69,960	5,200	17,000	7,500	1,000	600	101,260	552,841
1997	331,367	99,197	22,205	19,354	14,025	12,140	2,554	225	0	501,067	87,700	6,000	28,751	9,000	1,000	900	133,351	634,418
1998	345,590	115,483	20,362	22,610	18,000	13,166	2,686	114	0	538,011	125,000	3,000	32,931	10,000	1,000	400	172,331	710,342
Mean 1993-1997	263,273	73,027	16,119	14,635	12,769	9,011	2,628	204	0	391,627	52,416	5,080	17,970	6,400	1,000	540	83,406	475,032

1998 data for some countries are provisional.

Source of production figures for non-Atlantic areas: Misc. Fishing Publications/ Govt. Reports. An exception to the above are the figures for West Coast Canada in 1997 and 1998 which were supplied by the provincial government.

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

Table 2.2.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight) as harvested at ranching facilities, 1980-1998.

Year	Iceland commercial ranching	Ireland River[1]	UK(N.Ireland) River Bush[1]	Norway various facilities[1]	Total production
1980	8				8
1981	16				16
1982	17				17
1983	32				32
1984	20				20
1985	55	17.5	17		90
1986	59	22.9	22		104
1987	40	6.4	7		53
1988	180	11.5	12	4	204
1989	136	16.3	17	3	169
1990	280	5.7	5	6	291
1991	345	3.6	4	5	353
1992	460	9.4	11	10	480
1993	496	9.7	8	11	514
1994	308	15.2	0.4	9.5	324
1995	298	16.8	1.2	2	316
1996	239	18.5	3	8	261
1997	50	4.1	2.8	2	57
1998	34	12	1	2	47
Mean 1993-97	278	13	3	7	294

[1] Total yield in homewater fisheries and rivers. 1998 figure for Ireland is provisional.

Table 2.4.5.1

Incidence of summer checks in 1SW and 2SW salmon sampled from sites around Scotland in 1997.

Sample site	1SW salmon		2SW salmon	
	Number sampled	Number with summer checks (%)	Number sampled	Number with summer checks (%)
Recaptures of North Esk smolts. Various sites	50	13 (26.0)	41	5 (12.2)
North Esk, net & coble.	1115	223 (20.0)	528	14 (2.7)
North Esk, rod & line	52	15 (28.8)	185	3 (1.6)
Redpoint, fixed engine	32	13 (40.6)	1	0 (0)
Achiltiebuie, fixed engine	20	9 (45.0)	1	0 (0)
Strathy, fixed engine	285	66 (23.2)	16	0 (0)
River Don, netting for broodstock	73	28 (38.4)	20	1 (5.0)

Table 2.6.1.1. **Eggs taken and juvenile Atlantic salmon and eggs stocked (excluding private commercial sea ranching).**

Blank fields indicate data not available.

Estimated number (nearest 1,000) of eggs spawned by artificial methods from (Year) sea-run adults in autumn/winter period of Year / Year +1).

Example = eggs artificially spawned and recorded for 1997 were spawned during the fall/winter period of 1997/1998

Country / Year	Total Eggs Artificially Spawned	Eggs Stocked (rounded to nearest 1,000)			No. Fry Stocked (rounded to nearest 1,000)			No. Parr Stocked (rounded to nearest 100)				No. Smolts (rounded to nearest 100)		
		Green	Eyed	All	Unfed	Fed	All	0+	1 & 1+	2 or >	All	1	2 or more	All
1998														
Total	38472000	1749000	1537000	3286000	21787000	6697000	28484000	4125100	1763570	10800	5899470	2808094	1101000	3909094
Belgium	0	0	0	0	0	0	0	193900	0	0	193900	4500	0	4500
Canada (1)	5234000	2000	160000	162000	1303000	332000	1635000	1492400	1046000	10800	2549200	639500	118400	757900
Denmark		0	0	0	0	68000	68000	263600	212500		476100	95500	20700	116200
Finland		0	0	0	0	0	0	0	0	0	0	0	0	0
France		0	150000	150000	188000	2228000	2416000	414300	40500	0	454800	150900	3300	154200
Iceland		0	0	0	80000	289000	369000	253100	0	0	253100	515600	44700	560300
Ireland	10591000	0	1112000	1112000	4159000	502000	4661000	348900	0	0	348900	460300	0	460300
Norway (2)														
Russia	1906000	0	0	0	0	0	0	0	33000	0	33000	0	834200	834200
Spain	950000	0	0	0	0	0	0	432000	107500	0	539500	33500	0	33500
Sweden		0	0	0	0	0	0	0	0	0	0	92300	45700	138000
UK (England - Wales		0	2000	2000	0	173000	173000	264800	158200	0	423000	124500	0	124500
UK (Northern Ireland)		1745000	0	1745000	485000	0	485000	0	0	0	0	1000	10000	11000
UK (Scotland)		2000	113000	115000	3671000	2258000	5929000	0	123100	0	123100	0	24000	24000
USA (3) (4)	19791000	0	0	0	11901000	847000	12748000	462100	42770	0	504870	690494	0	690494

(1) Total eggs artifically spawned for Canada includes 4.08 million eggs from sea-run fish, and 1.16 million eggs from captive sea-run kelts.

(2) 1998 egg collection and stocking information from Norway is unavailable.

(3) Total eggs artifically spawned by the United States includes 4.77 million eggs from sea-run fish, 13.24 million eggs from captive/domestic broodstock, and 1.78 million eggs from captive sea-run kelts.

(4) The United States also stocked 6,628 captive and domestic adult Atlantic salmon.

Table 2.7.1.1. Number of microtags, external tags, marks and finclips applied to Atlantic salmon by countries for 1998. ('Hatchery' and 'wild' refer to smolts or parr; adults are 'wild' and/or 'hatchery')

Country	Origin	Primary Marking Method				Auxillary Marks Applied
		Microtags	External Tags	Adipose Clip Only	Other Visible Clips/Marks	
Belgium	Hatchery	16961				4548
	Wild					
	Adult					
	Total	16961				4548
Canada	Hatchery		12448	556830		4450
	Wild					
	Adult		12535			
	Total		24983	556830		4450
Denmark	Hatchery	27107	1900	45371	24000	27107
	Wild					
	Adult					
	Total	27107	1900	45371	24000	27107
Finland	Hatchery					
	Wild					
	Adult					
	Total	0	0	0	0	0
France	Hatchery	35463		305423		3579
	Wild	123		524		123
	Adult					
	Total	35586		305947		3702
Iceland	Hatchery	146717	36			146717
	Wild	3852				3852
	Adult		2439			
	Total	150569	2475			150569
Ireland	Hatchery	257365		160089		257365
	Wild	3776				3776
	Adult					
	Total	261141		160089		261141
Norway	Hatchery		99741			
	Wild		3720			
	Adult		800			800
	Total		104261			800
Russia	Hatchery			404000		
	Wild			215		
	Adult		1911			
	Total		1911	404215		
Spain	Hatchery	45331		97100		142431
	Wild					
	Adult					
	Total	45331		97100		142431
Sweden	Hatchery		6456			
	Wild		637			
	Adult					
	Total		7093			
UK (England & Wales)	Hatchery	103153		79420		174984
	Wild	2799				2799
	Adult		1425			
	Total	105952	1425	79420		177783
UK (Northern Ireland)	Hatchery	34725		3368		34725
	Wild	2328				2328
	Adult				306	306
	Total	37053		3368	306	37359
UK (Scotland)	Hatchery	5997	2000	5400		7997
	Wild	14413	4593			19006
	Adult		182			
	Total	20410	6775	5400		27003
USA	Hatchery			5672	49894	31222
	Wild				775	
	Adult		2204		79	227
	Total		2204	5672	50748	31449
TOTALS	Hatchery	672819	122581	1662673	73894	835125
	Wild	27291	8950	739	775	31884
	Adult	0	21496	0	385	1333
	Total by Type	700110	153027	1663412	75054	868342
Grand Total Salmon Marked =			**2591603**			

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960-98.

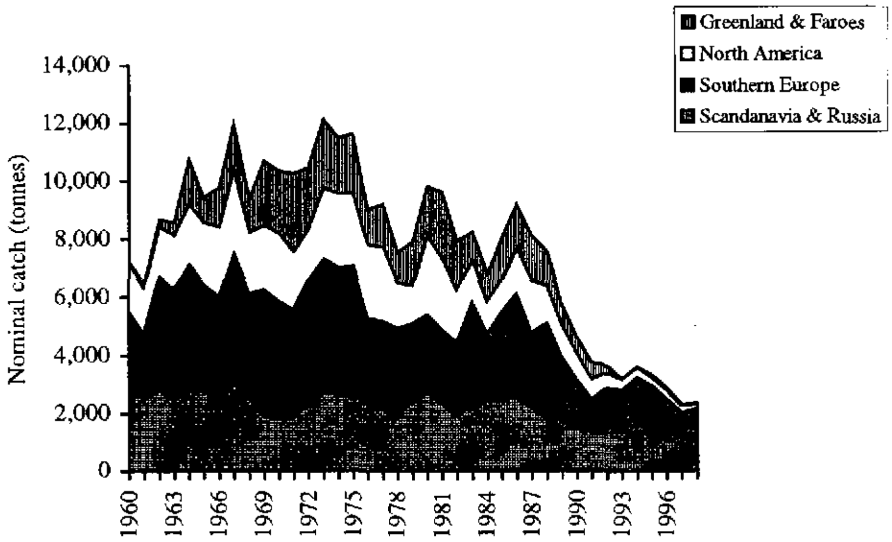


Figure 2.1.3.1. Total reported catch, unreported catch (in NASCO Areas) and % unreported catch of combined catch 1986-1998.

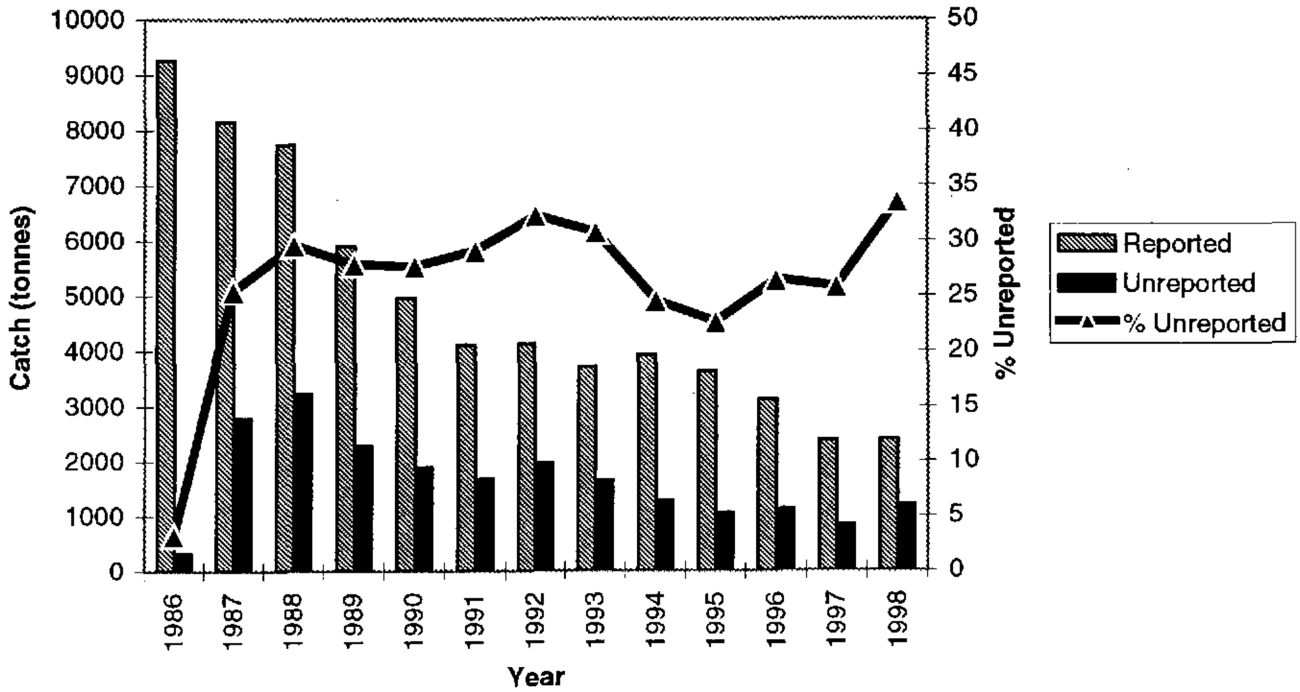


Figure 2.2.1.1. Worldwide farmed Atlantic salmon production, 1980-1998.

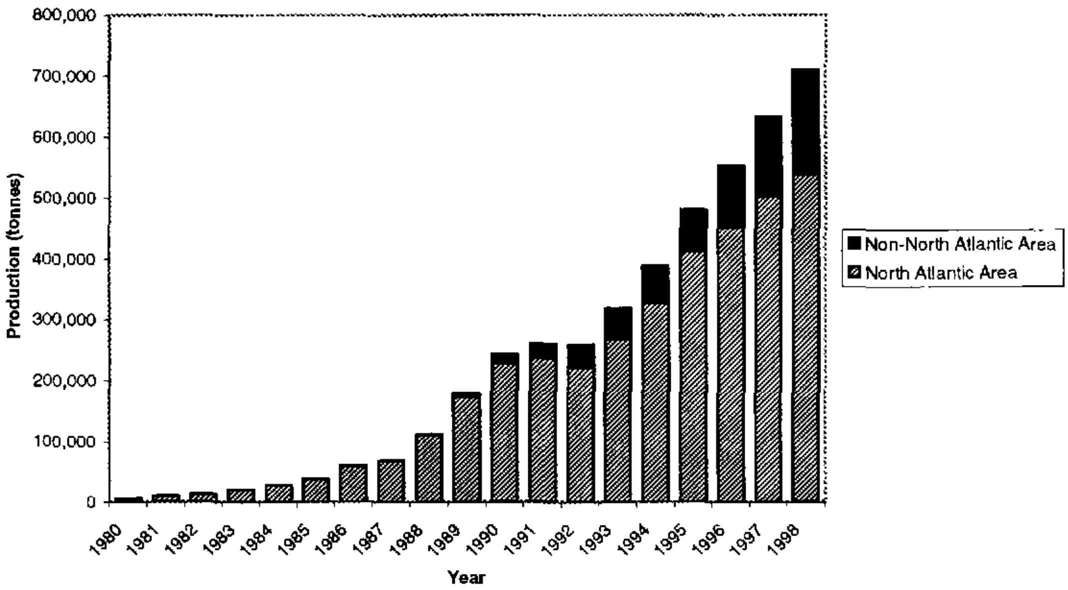


Figure 2.2.2.1. Production of ranched salmon in the North Atlantic, 1980-1998.

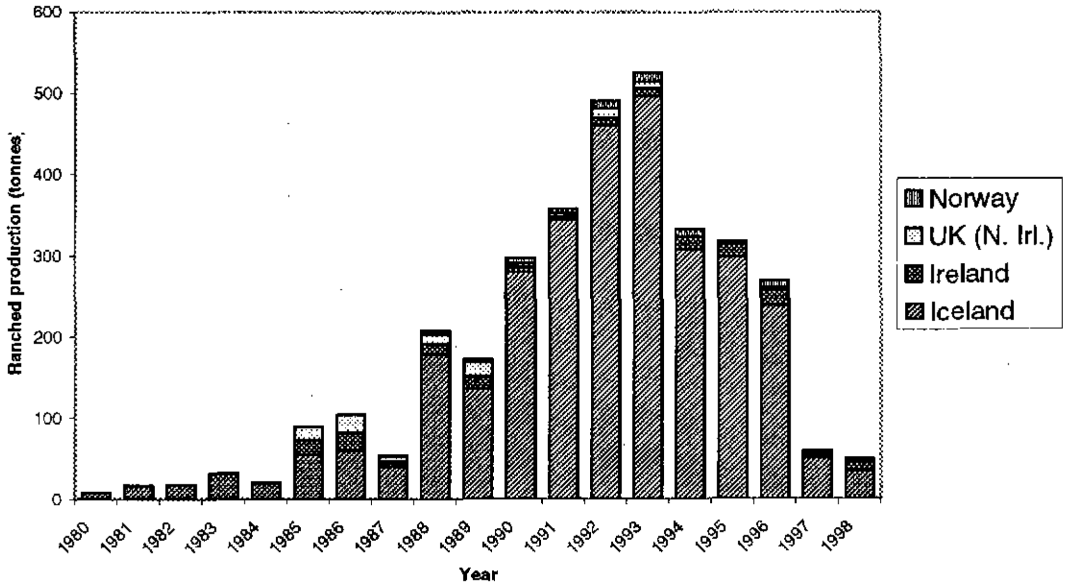


Figure 2.4.1. Temperature (°C) and chlorophyll (mg/m^3) distributions from satellites data during 1982-1984.

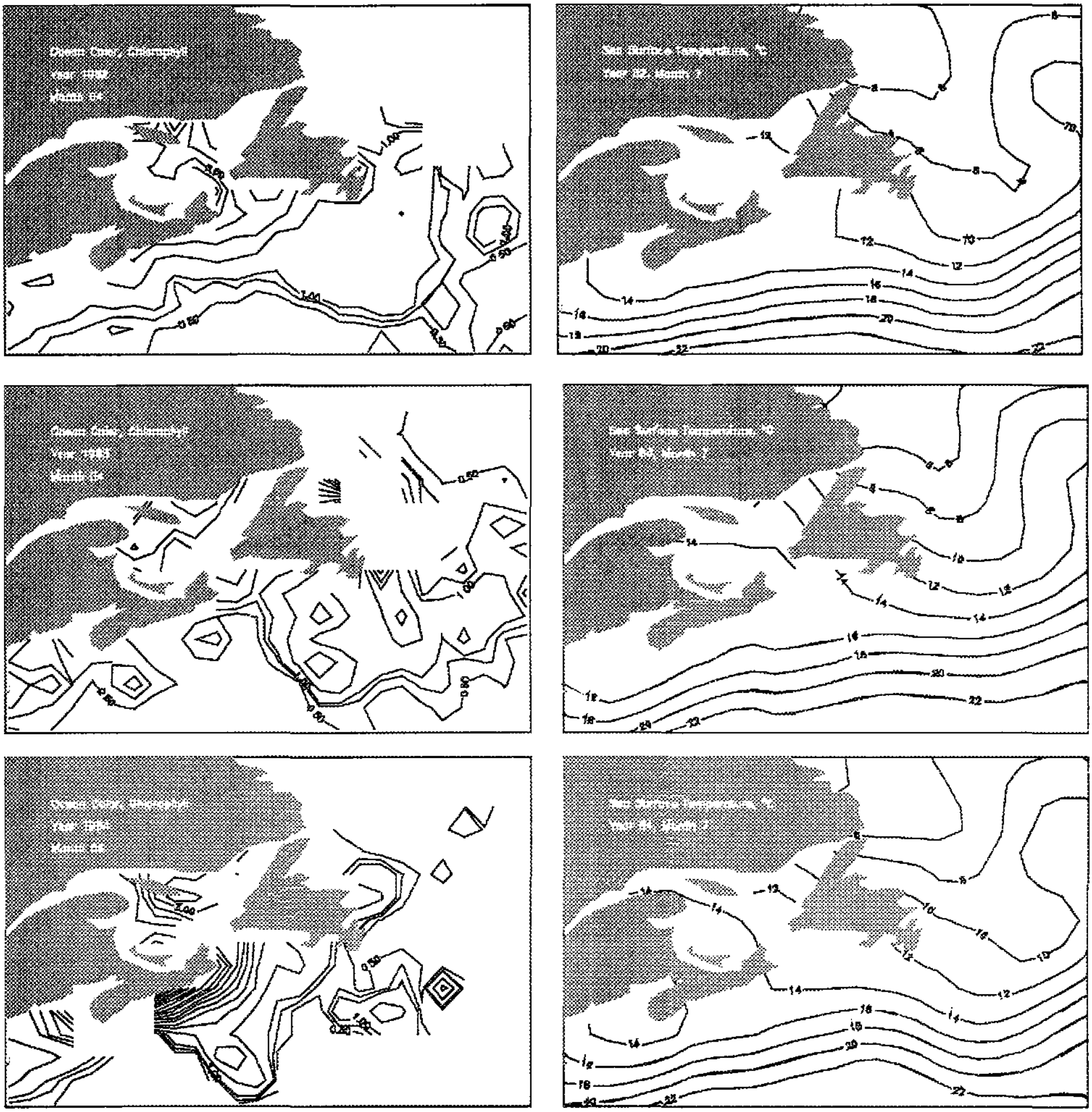


Figure 2.4.2.1 Frequency distribution of water temperatures recorded by data storage tags applied to salmon kelts at Western Arm Brook, Campbellton, and Highlands rivers in Newfoundland.

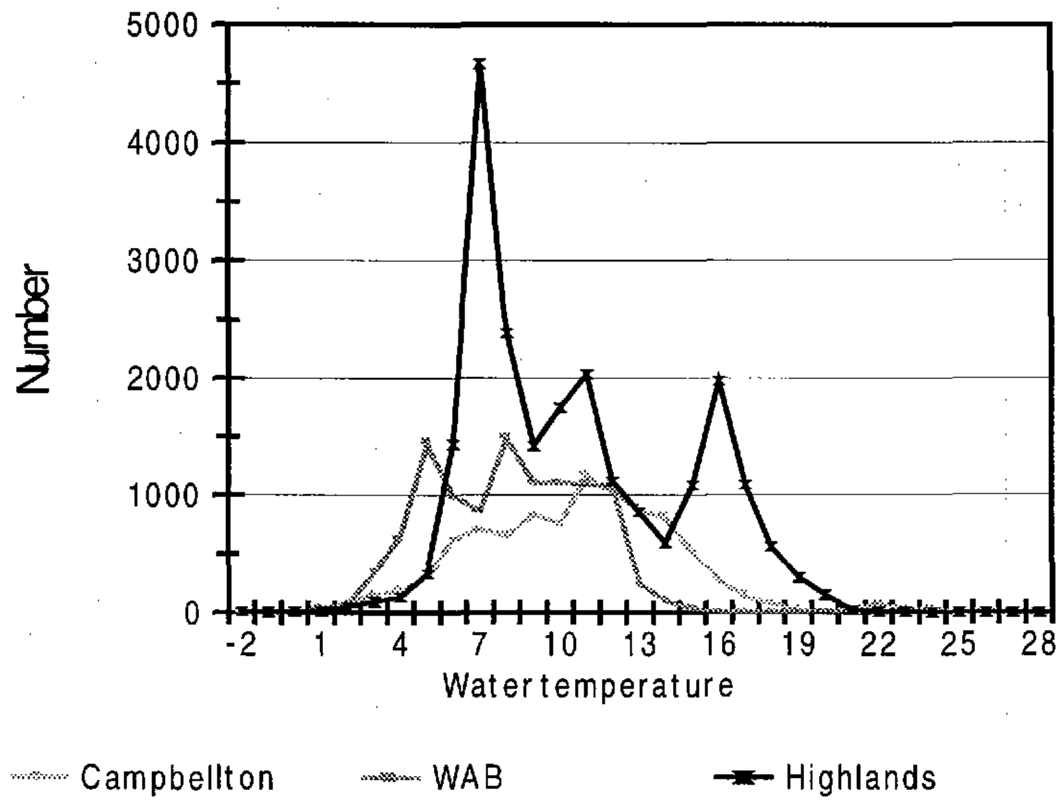
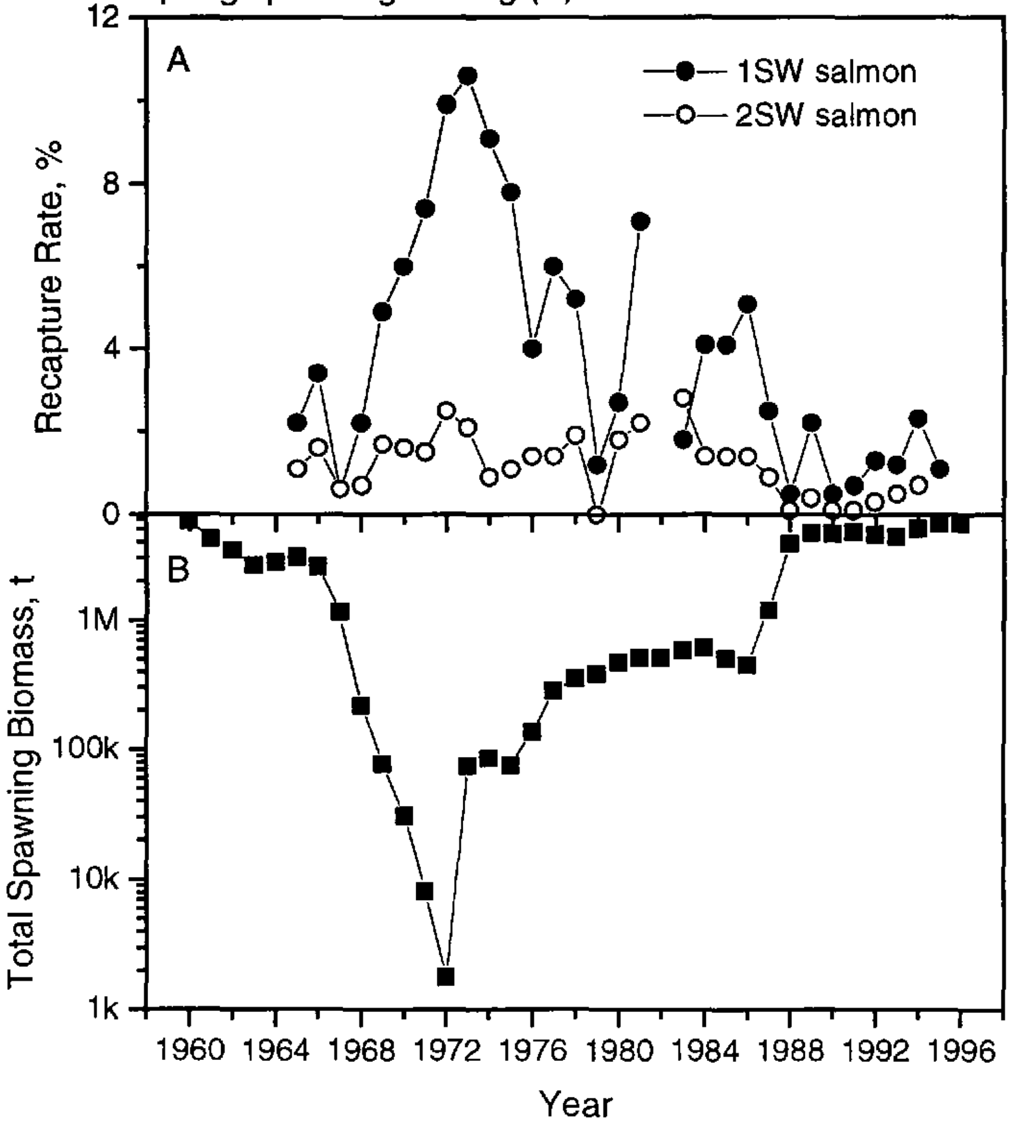


Figure 2.4.4.1. Recapture rates for salmon in the River Figgjo (A) and total spawning biomass for Norwegian spring spawning herring (B).



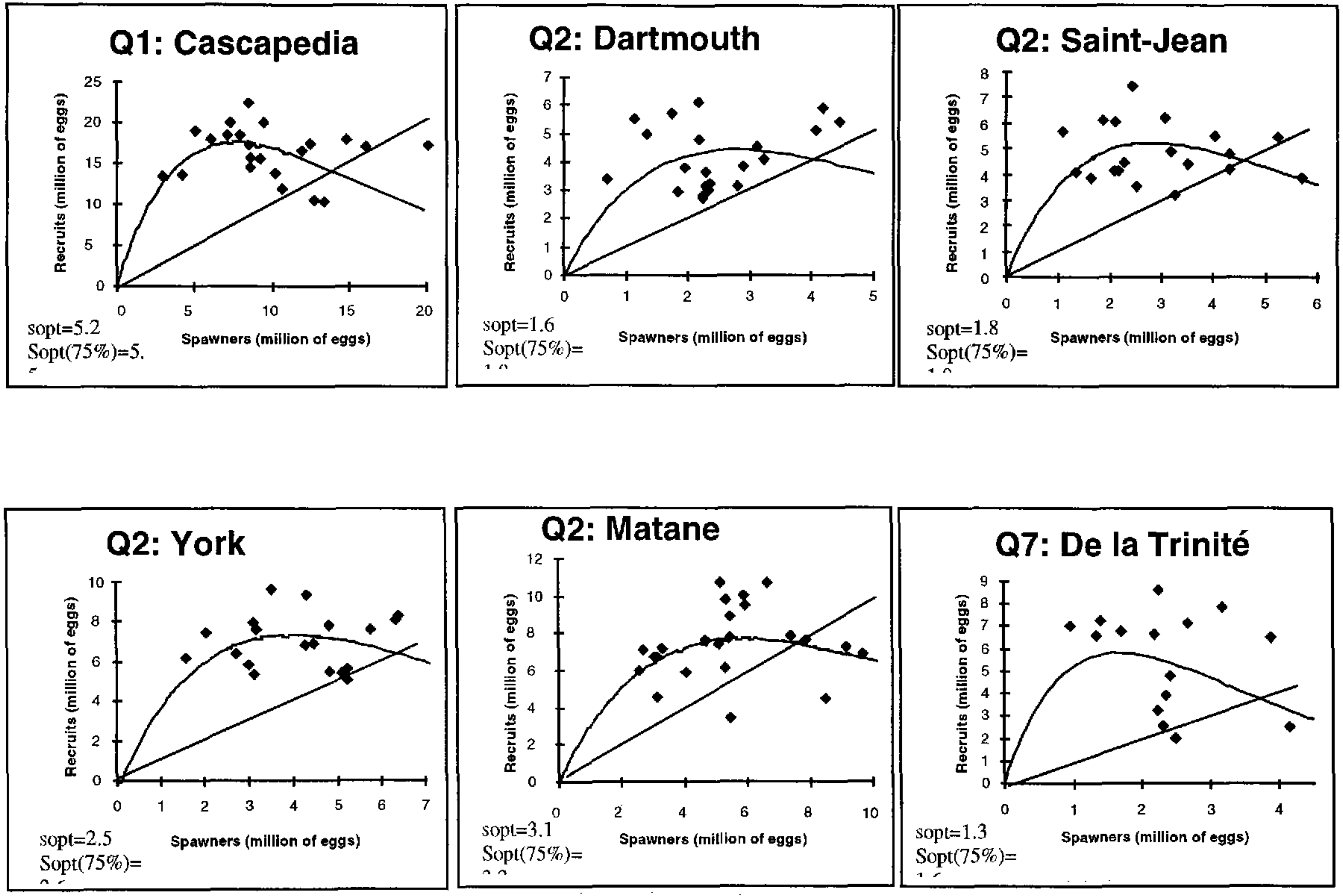
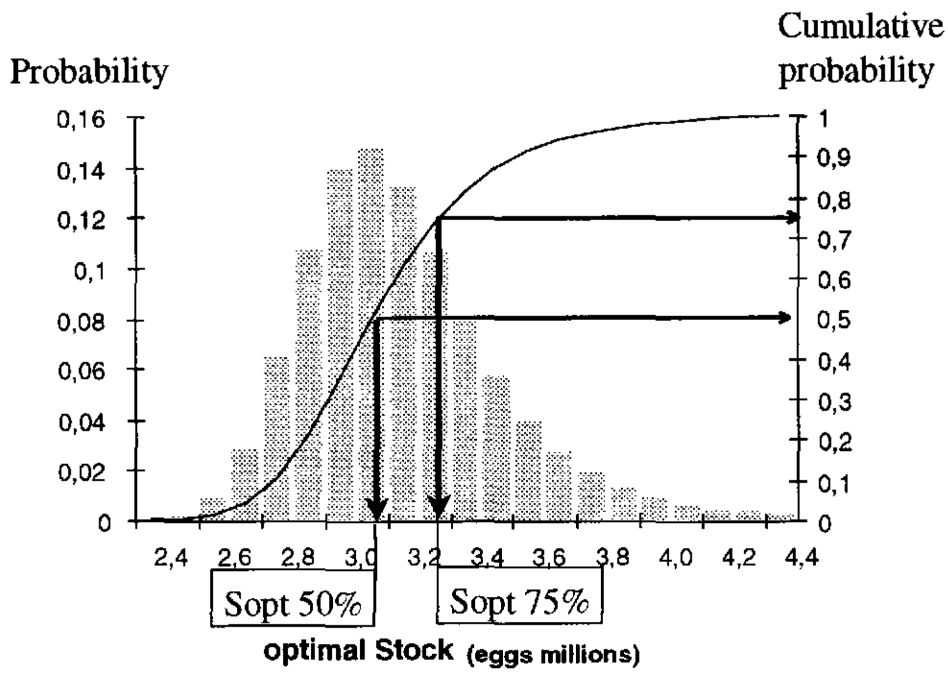


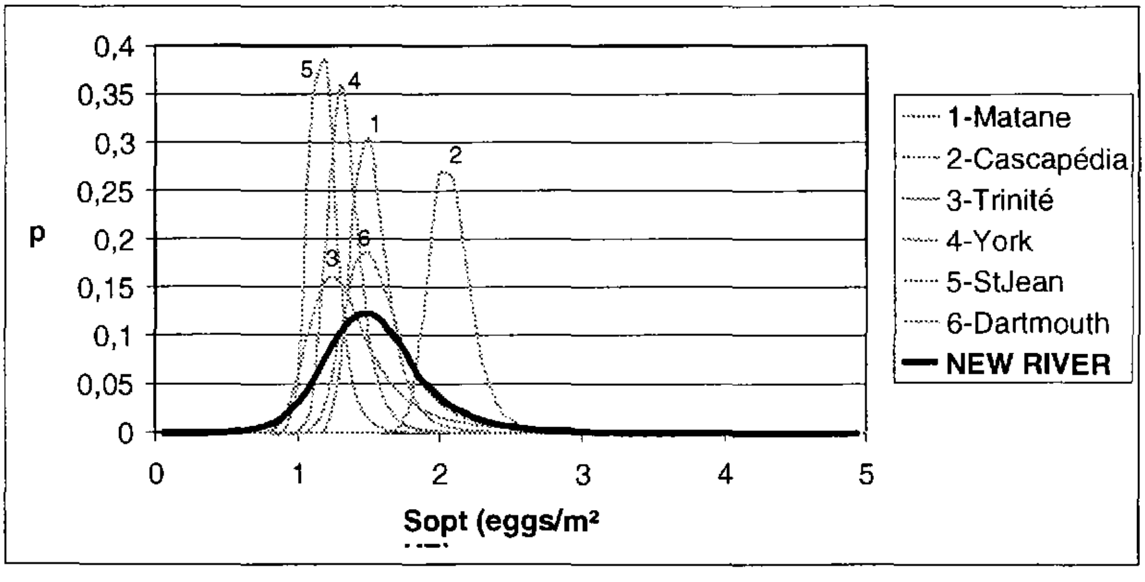
Figure 2.4.7.1 : Stock/Recruitment relationships for the six rivers studied

Figure 2.4.7.2: a) posteriori distribution of the Sopt value on Matane river; b)posterior probability distribution of Sopt (eggs/UP) for each of the index rivers and posterior predictive probability distribution of Sopt for a new river where no SR data are available.

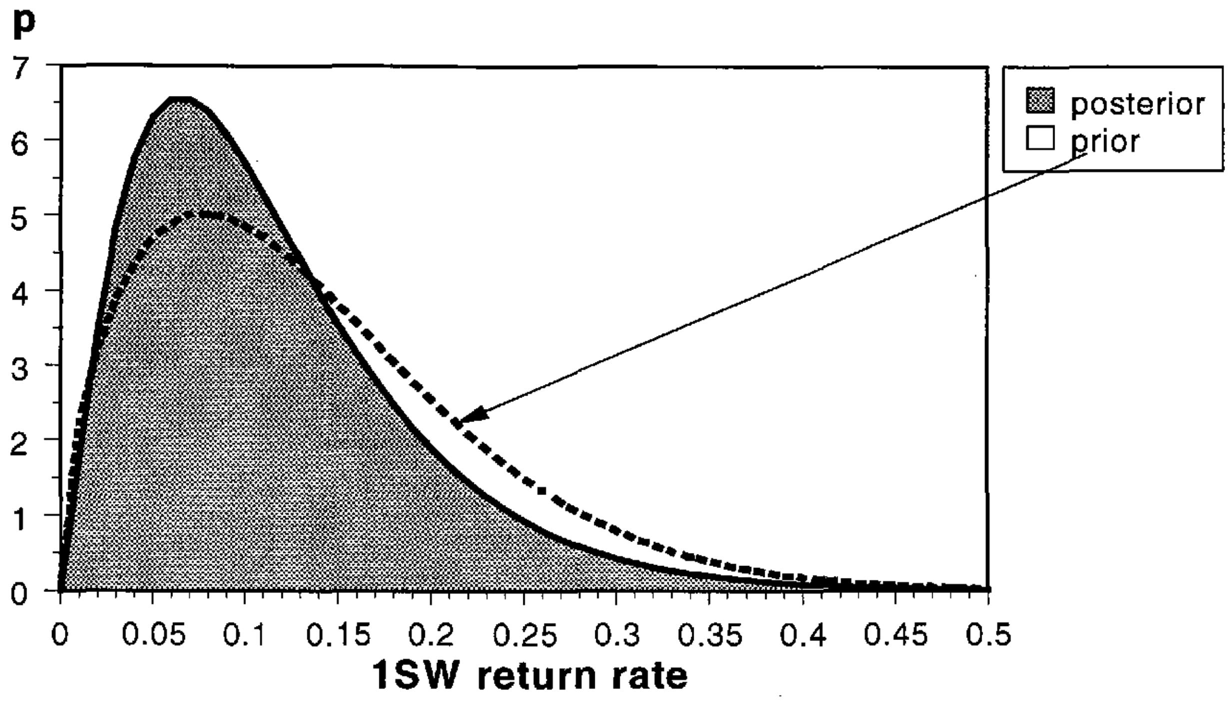
a)



b)



A



B

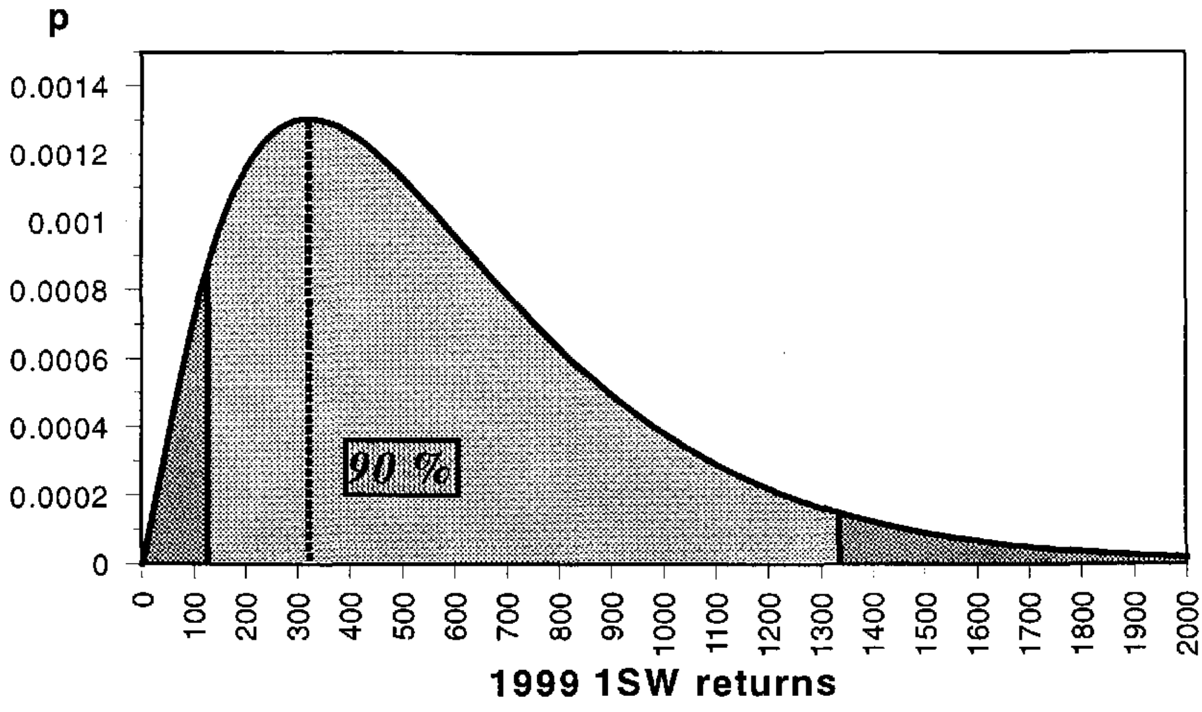
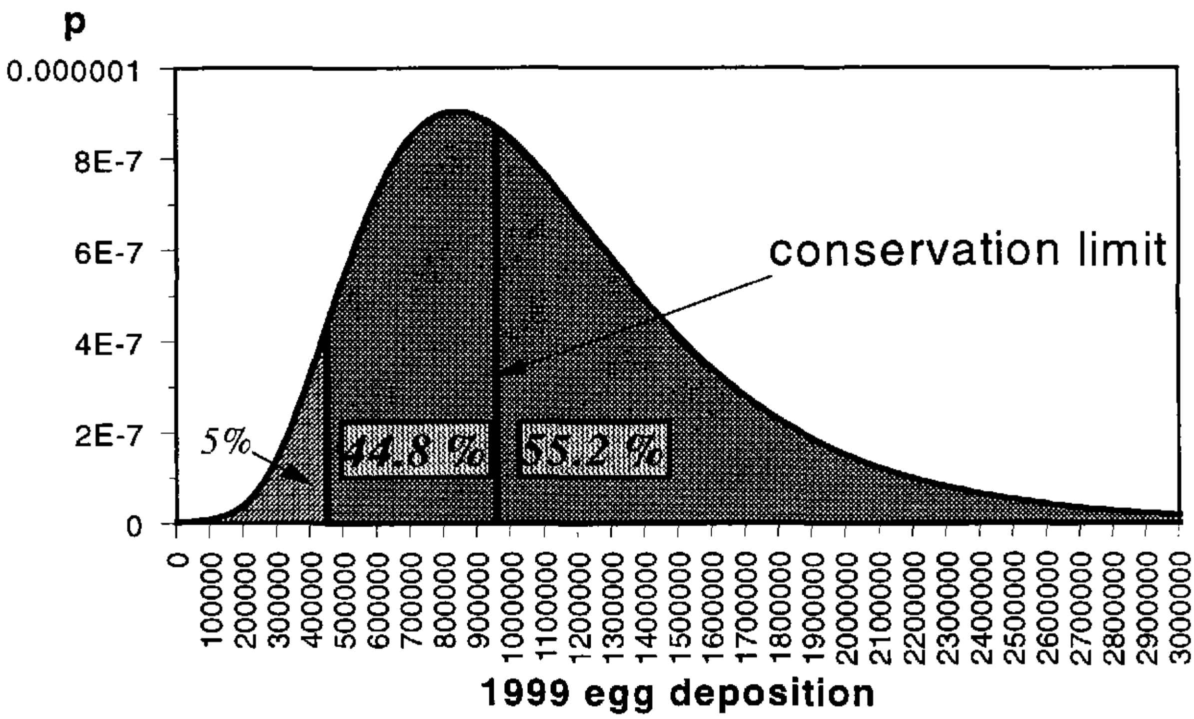


Figure 2.4.8.1: A - Prior and posterior predictive probability distributions of 1SW return rate for 1999 on the Scorff (Brittany, France). B - Posterior predictive probability distribution of 1SW returns for 1999 on the Scorff.

A



B

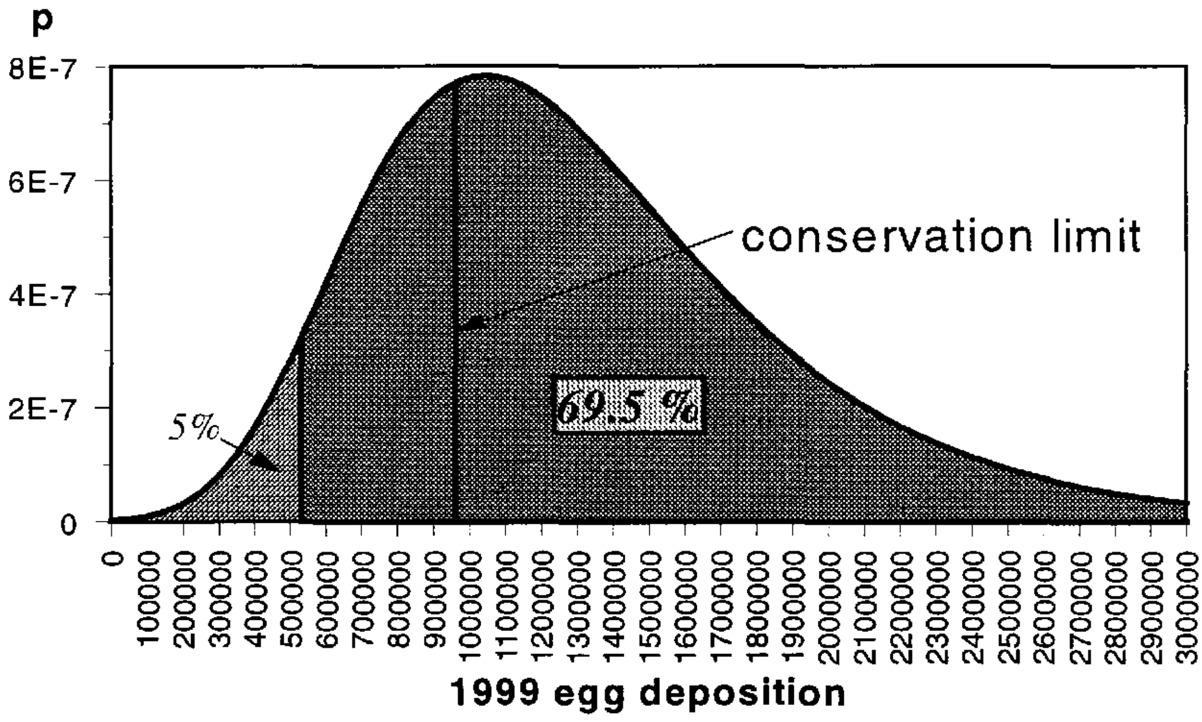
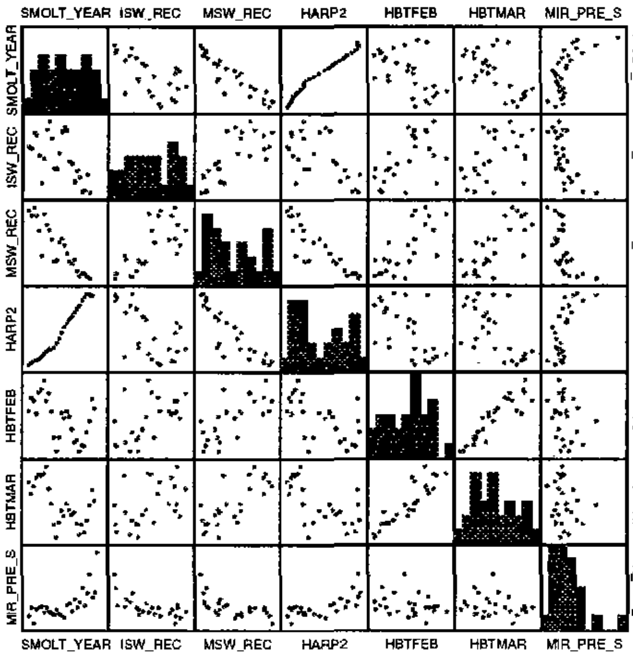


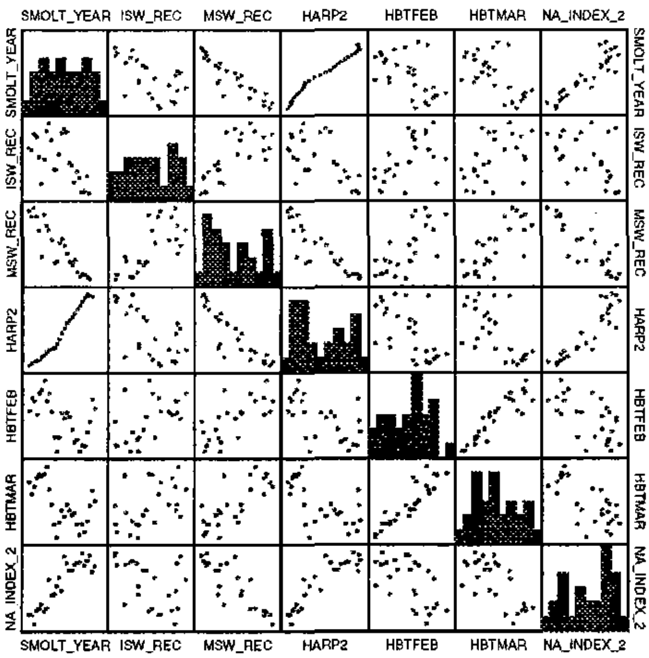
Figure 2.4.8.2: A - Probability distribution of 1999 egg deposition on the Scorff (Brittany, France) under current exploitation rates levels and TAC based fishery regulation. B - Probability distribution of 1999 egg deposition on the Scorff if no exploitation was allowed.

Figure 2.4.10 Scatter plots of variables explored in North American salmon recruitment models.

Miramichi pre-smolt



NA index



Variable Definitions

SMOLT_YEAR

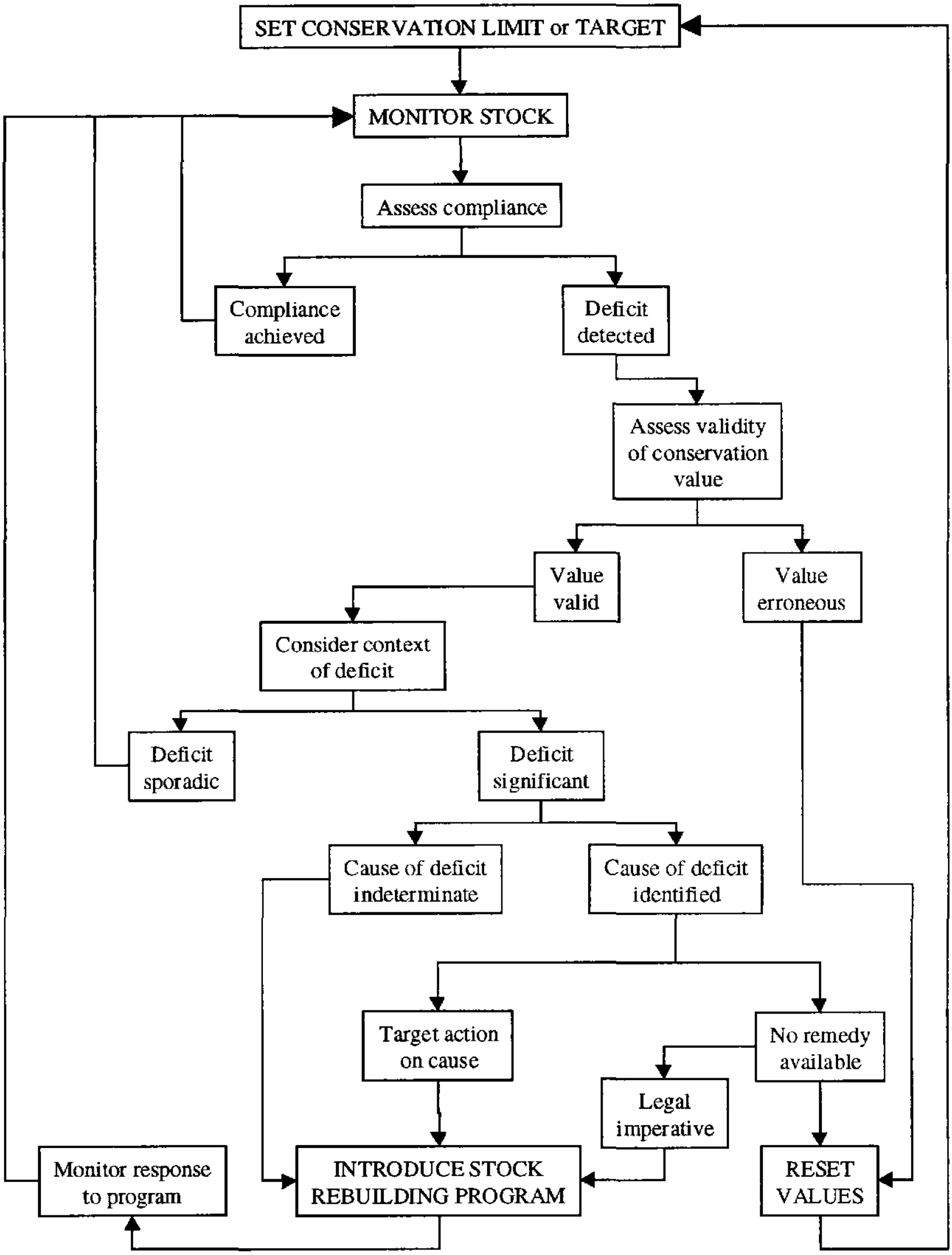
ISW_REC = 1SW Recruits

MSW_REC = Multi sea-winter recruits

HBTFEB = Salmon Habitat Index in February of the first sea-winter

HBTMAR = Salmon Habitat Index in March of the first sea-winter

Figure 2.5.1. Flow chart for decision making in relation to compliance or non-compliance with conservation limits or targets.



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

3.1 Fishing at the Faroes in 1997/1998 and 1998/1999

In the period 1991-98 inclusive the Faroese salmon quota was bought out. However, the Faroese Government continued sampling inside the 200 mile EEZ during most of the period (ICES 1997/Assess:10), including January-April, 1998. No buyout has been arranged for 1999 and the prospects for a salmon fishery in the coming 1999/2000 fishing season is unknown.

3.2 The Research Programme at the Faroes

3.2.1 Gear, effort and catch in the research fishery

The salmon long-liner M/S "Polarlaks" conducted a research fishery from January to early April 1998. Four separate trips were carried out with 31 sets fished which caught 5.8 t (1,763 salmon) including discards (Table 3.2.1.1). The catch rate (CPUE) in 1998 was 30 salmon per 1,000 hooks employed. This is below the range of 36 to 84 fish per 1,000 hooks for the fishery 1981 through 1995 (ICES 1996/Assess:11).

3.2.2 Composition of the research fishery catch

The length distribution of salmon in the Faroese area in the winter of 1998 is shown in Figure 3.2.2.1. The sea age was determined from previous age-at-length data (ICES 1996/Assess:11). As in previous fishing seasons, the 2SW salmon dominated (75%), 1SW (19%) and 3+SW (6%) were caught in lower proportions (Table 3.2.2.1).

The proportion of discards in the catch (i.e., salmon <60 cm) was 16.9% which is higher than the previously noted range of 1.8 to 15.6 (ICES 1996/Assess:11). However, the fishery only took place from January to April and not over the entire season as in previous years and it is known that the proportion of discards is higher in the early part (October-November) of the season.

3.2.3 Origin of the research fishery catch

Approximately 1000 scale samples were collected from salmon in 1998, but they have not been analysed. Therefore there is currently no available information on the proportion of escaped farmed salmon in the Faroese area.

In total, eight external tags were recovered in the 1998 sampling with "Polarlaks". Seven tags came from salmon which had originated in Norway and one tag originated from Sweden. Although 25 finclipped salmon were caught, none of these bore coded wire tags. Despite the small sample size, the recovery of tags is consistent with previously estimated proportions of tagged fish from other countries (ICES 1996/Assess:11).

3.3 Homewater Fisheries in the NEAC Area

3.3.1 Significant events in NEAC home-waters

A committee was appointed by the Norwegian Ministry of Environment to discuss and describe the causes of the decline of wild salmon in Norway and to propose measures to counter-act the decline. The report of this committee has recently been published and will be considered by government following public hearings.

While Iceland has had a general ban on fishing for salmon in the ocean, (with the exception of coastal fishery at five locations at the west coast), the rights to fish in these waters have now been permanently bought out by fishery associations in nearby rivers with the support from the Icelandic state. Consequently, practically all the fisheries in 1998 were carried out in freshwater.

The restrictive measures introduced in Ireland in 1996 to reduce fishing effort were also applied in 1998. Efforts continued in Ireland to comply with the recommendations of the Salmon Management Task Force which reported in 1996. A national carcass tagging scheme for salmon caught by commercial and recreational fisheries has been designed and proposed. Funding was obtained to install and operate fish counters on 22 rivers in Ireland for the purposes managing fisheries on a real time basis. These initiatives will be linked to a quota scheme which should come into effect within the next two years.

In Russia, significant changes occurred in the operation of the barrier fences at the Tuloma and Umba Rivers where all salmon returning to these rivers were allowed to ascend to the spawning grounds. Therefore, only five barrier fences were operated commercially compared to 7 in the two previous years, and 10 in 1995.

A Swedish working group on the evaluation and further development of the status of the salmon populations on the West Coast was established in 1998.

In April 1999, new national measures were introduced in the UK (England and Wales) to protect early running MSW ("spring") salmon. Most nets and fixed engine fisheries will be closed until 31 May each year and anglers will be required to release all salmon caught before June 16. The measures will be reviewed after 5 years.

3.3.2 Gear

Changes in gear regulation were introduced in two countries within the NEAC Area. The ban on the use of bend nets along the Norwegian coast from Rogaland County to Troms County introduced in 1997 was again applied in 1998. In Iceland, the coastal gillnet fishery, which in recent years has accounted for only a very small percentage of the nominal catch, was permanently bought out prior to the beginning of the season.

3.3.3 Effort

The number of gear units licenced in several of the NEAC Area countries are shown in Table 3.3.3.1. This provides a relative assessment of effort. However, there is no indication from these data on the actual number of licences fished or the amount of time each licencee fished. In most cases shown, the number of net licences has declined compared to the previous 5- and 10-year means.

In 1998, the number of net fishing licences showed further decreases compared to 1997 in UK (England and Wales), UK (Scotland), Norway. In UK (Northern Ireland) all three netting methods showed a small increase in effort compared to 1997. In Ireland, the number of draft net licences issued increased while the number of drift net licences has remained constant over a number of years.

The number of rod licences showed no clear trend, in contrast to the general decline in licences issued to the net fisheries over the last decade. In Ireland, the number of salmon licences issued in 1998 shows an increase on 1997 and on the previous 5- and 10-year means. In Finland, although effort in 1998 was up on 1997 it was down on both the previous 5- and 10-year means. In France, rod effort was up on the previous 5 year mean but down on the 1997 value and on the previous 10-year mean.

In Ireland and UK (N. Ireland) weather conditions were poor in the June and July. Water levels in many rivers were exceptionally high.

3.3.4 Catches

NEAC area catches are presented in Table 3.3.4.1. Figure 3.3.4.1 shows the percentage change in the 1998 NEAC homewater catches relative to the previous 5-year (1993-97) and 10-year (1988-97) means. With the exception of Russia the 1998 catch in all countries showed substantial decreases compared to the previous 5-and 10-year means. This is believed to reflect reductions in fishing effort (Section 3.3.3) and reductions in stock (Section 3.4). The 1998 catch in Russia showed a small increase over the previous 5-year mean but was substantially less than the previous 10-year mean.

3.3.5 Catch per unit effort (CPUE)

CPUE data for the NEAC area are presented in Tables 3.3.5.1, 3.3.5.2 and 3.3.5.3. In the UK (England, Wales) and UK (Scotland), CPUE for net fisheries has decreased from the previous year. Route regression analysis showed a significant decreasing trend for UK (Scotland) net fisheries ($p = 0.996$) for the last 10 years (Table 3.3.5.4). No trend was detected for the UK (England and Wales) net fisheries ($p = 0.3$).

In Finland (River Näätämö), France and in UK (Northern Ireland) (River Bush) CPUE for rod fisheries increased in 1998 compared to 1997. However, CPUE of the River Teno (Finland) was slightly lower than in 1997. Catch per angler season (Finland, France) showed a significant increasing trend in the past 10 years (Table 3.3.5.4, $p = 0.06$) but not for Finland or N. Ireland ($p = 0.12$). Catch per angler season for rod fisheries in the Russian rivers of the White Sea basin showed a significant increase ($p = 0.001$), whereas that of the Barents Sea basin rivers decreased ($p = 0.997$).

3.3.6 Age composition of catches

The percentage of 1SW salmon in catches are presented in Table 3.3.6.1 and Figure 3.3.6.1 for those countries where a time series of data exist. The proportion of 1SW fish in the 1998 catches is presented as a percentage of the 1993-97 mean, and, where data are available, the 1988-97 mean. In Finland, France, Norway, Russia and UK (Scotland) the proportion of 1SW fish in the 1998 catch has increased relative to both long term indices. Compared to the previous 5-year mean, the proportion of the catch comprising 1SW fish in 1998 had increased in the UK (England and Wales), and decreased in Sweden.

3.3.7 Farmed and ranched salmon in catches

The contribution of wild , farm-origin and ranched salmon to national catches in the NEAC Area 1991-1998, is shown in Table 3.3.7.1. In 1998, farmed salmon continue to account for a relatively large proportion of the nominal catch in Norway (28%). Although no fishing was carried out in the Faroes in the 1996/1997 fishing season and no determination of origin of catches is yet available for the 1997/1998 fishing season, data from previous years suggest that there is a relatively high proportion of farmed salmon in this area as well.

In Norway, the incidence of farmed salmon in coastal fisheries in 1998 was estimated to be 45%, and in fjord fisheries the corresponding value was 43% (Table 3.3.7.2). These values are similar to those recorded in 1997. In 1998, the proportion of farmed salmon in rod catches was 8% whereas in broodstock samples the incidence was estimated to be 22% (Table 3.3.7.3). There was a large amount of variation around the mean values for both the rod fisheries and the broodstock collections among the various sampling localities.

In the River Teno (Finland and Norway), the incidence of farmed salmon during the fishing season in June-August has been low, varying mostly between 0.1 and 0.4%. However, some occasional sampling after the fishing season in September-October has resulted in much higher proportions of farmed fish, reaching the level of 30-50% (Table 3.3.7.4) indicating that the proportion of farmed fish in the spawning stock may be higher than reflected from the in-season samples. This is similar to the findings presented from other parts of Norway (Table 3.3.7.3).

In UK (Northern Ireland), only 0.20% of the reported catch comprised farmed salmon, a value similar to the previous two years (Table 3.3.7.5).

Inshore coastal catches of salmon in both UK (Northern Ireland) and Ireland are examined for escaped farmed salmon (Table 3.3.7.6). Data for both countries are presented together as they constitute a continuous part of the species' geographic range. Escaped farmed fish have been detected every year; the frequency being less than 1% in most years. The 1998 figures remain at this level.

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

There were no significant catches of farmed salmon reported from the other NEAC countries.

3.3.8 National origin of catches

In Sweden, it was estimated that 10% of the salmon catch in 1998 consisted of recaptures of tagged salmon which originated from Danish experimental releases at the islands of Møn and Bornholm. No other new information was made available to the Working Group.

3.3.9 Exploitation rates in homewater fisheries

Exploitation rates for 14 wild stocks and three mixed stocks are shown in Table 3.3.9.1. Exploitation rates increased in 1998 from those of 1997 for 12 stocks but decreased for four of the stocks where data were available. Compared to previous year exploitation rates increased for the rod catch in five rivers in UK (England and Wales) but decreased in two rivers. In the North Esk (UK Scotland) exploitation rates increased for 1SW but were the same for 2SW as the previous year. Exploitation rates increased for 1SW fish in the rod catch in River Ellidaar (Iceland) and in the net catch in River Lagan (Sweden) for both 1SW and 2SW fish. Of eight rivers reported for Russia, exploitation rates had decreased in seven from the 1997 fishing season. Route regression analysis shows that there was a significant downward trend for rivers flowing to the Barents Sea for both the past 10-year and 5-year periods and for the past 10-year period for the rivers flowing to the White Sea (Table 3.3.5.4). Route regression analysis also shows a significant downward trend in exploitation rates for 2SW stocks in UK Scotland, Iceland, Norway and Sweden for the past 5-year period.

3.3.10 Summary of homewater fisheries in the NEAC area

Since the late 1980s there has been a declining trend in salmon catches in the NEAC area. This reflects attempts by many countries to reduce commercial fishing activities because of conservation needs. Other associated factors are lower stock levels and a reduction in the value of commercially caught salmon.

Provisional figures show an increase in salmon catch from 1997 to 1998 in most northern European countries (Iceland, Norway, Finland, Russia) and in Ireland, Spain and France. This increase is due mainly to increased grilse catches. In contrast, catches in UK and Sweden have decreased from the previous year. Proportions of 1SW salmon were generally above the 1997 values and the 10-year and 5-year means.

Farmed salmon continue to represent a large proportion of the coast, fjord and brood stock catches in Norway (22-45%), although the proportion has remained relatively stable over the past few years. The proportion of farmed fish is generally less than 1% in fisheries in UK, Ireland and Finland. Ranched fish comprise 40% of the salmon catch in Sweden and 20% in Iceland, whereas the proportion in other countries is generally less than 1%.

Commercial fishery effort continued to decrease in net fisheries in UK. CPUE of the commercial fishery in UK (Scotland) has decreased. In Finland and France, catch per angler season show an increasing trend. Similarly, CPUE of rod fisheries in the Russian rivers of the White Sea basin showed a significant increase, whereas that of the Barents Sea basin rivers has decreased.

3.4 Status of Stocks in the NEAC Area

3.4.1 Attainment of conservation limits

In order to provide a composite view for the NEAC area over the last 10 years (1989-98), escapement levels were examined for rivers where egg deposition can annually be equated to a conservation limit (CL). Data was available for 18 rivers in the NEAC area. Egg depositions were assessed on the basis of pooled 1SW and MSW spawners but future efforts will attempt to account for stock composition. Sixteen rivers, five from Russia, five from UK (England and Wales), three from France and one each from Ireland, UK (Northern Ireland), and UK (Scotland) had sufficient data to be included in the 10-year analysis (Table 3.4.1.1). (The River Dee, UK [England & Wales] was included even though there were only seven years of data). For each river, escapement was divided by its CL so that escapement status could be readily compared across rivers independent of various river CLs.

Of the 157 cells (year-by-river) 81 (52%) had escapement levels below the CL (Table 3.4.1.1). One river never attained its CL during the last ten years while three rivers were always above their CL. By ranking the rivers according to the mean rate of CL attainment, four categories were distinguished:

- five rivers in which egg deposition was mostly below CL (means of the river CL attainment rates of 0.44 to 0.78). Within this group, only 10% of year-by-river cells had depositions in excess of the CL, 36% of cells had an escapement lower than half of the CL;

- five rivers in which egg deposition fluctuated around CL (means of the CL attainment rates of: 0.94 to 1.17). Forty-seven percent of the river-by-year cells had deposition in excess of the CL. In 9% of the cells escapement was more than twice the CL while in 6 % of the cases, deposition was less than 50% of the CL. As a result, escapement varied between one-half and twice the CL 85% of the time;

- four rivers in which egg deposition was mostly in excess their CL (means of the CL attainment rates of 1.44 to 1.89). For these rivers, 73% of the river-by-year cells had depositions in excess of the CL, and of these 38% had levels in excess of twice the CL. No cells had less than one-half of the CL;

- two rivers in which deposition was well above CL (means of the CL attainment rates of 2.48 and 2.88). These rivers never fell below CL during the last 10 years and in 80% of the cases, egg deposition exceeded twice the CL.

On the basis of change in CL values over the last 10 years, the 16 rivers examined could be classified into two groups (Figure 3.4.1.1):

- nine rivers showing a decreasing trend ($p < 0.01$, route regression);

- seven rivers with no trend around their mean ($p = 0.12$, route regression).

No rivers had an increasing trend.

In combination the two categories indicate that:

- rivers having the lowest and the highest egg depositions are stable (4/7) or decreasing (3/7);
- rivers with escapement levels intermediate to the two extremes (fluctuating around the CL or mostly above CL) are mainly decreasing (6/9).

For all rivers, the period 1994-97 had the poorest egg depositions with 10 to 12 rivers below their CL in each year. In contrast, 1989, 1993 and 1998 tended to be the most favourable years with 9 to 10 rivers out of the 16 being in excess of the CL. In 1998, depositions in 12 of the 16 rivers improved over those of 1997.

No overall conclusion could be drawn at a regional scale within the NEAC area. This was because of the absence of consistent patterns within each country or region represented in the set of rivers, the small number of rivers with data available and the absence of information for rivers in Scandinavia.

In summary, the rivers of the NEAC area show a broad range of situations in term of escapement levels from rivers that never reached their CL over the last 10 years to rivers which were consistently well above their CL. This variation in status is evident at an even lower geographical scale (region or country). In total, low CL attainment rates and their slope during the last 10 years is cause for concern:

- no tendency to recover is observed for the stock at low escapement levels;

- in most instances, stocks having average egg deposition levels equal or greater than their CL tend to exhibit some deterioration in their escapement; at best they just fluctuate around their mean.

Within this context, 1998 was a relatively good year and showed an improvement in most cases over 1997 (Figure 3.4.1.2). Further efforts are to be made to obtain estimates of egg deposition broken down by sea-age classes of spawners (1SW vs MSW).

3.4.2 Measures of juvenile abundance

Smolt counts or estimates of juvenile abundance are available for 17 rivers (Table 3.4.2.1). About half of the values for smolt counts in 1998 are higher than in the previous year, whereas most of the values are higher than the 5-year means. The values for rivers Burrishoole (Ireland) and Bush (UK, Northern Ireland) were well above the earlier levels, whereas those for the Scottish rivers were lower than before. The Scandinavian rivers showed both higher and lower smolt abundances than in the previous year. Two groups were roughly identified from plots of the data. Regression analysis revealed a significant positive trend for the past five years for the group that comprised the rivers Halselva, Imsa (Norway), Hogvadsån (Sweden), Oir (France), Burrishoole and Bush (Table 3.4.2.2.). No trend was detected for the last 10 years. A significant 10-year decreasing trend was detected for the other group (rivers Orkla (Norway), Ellidaar (Iceland), North Esk, Girnock and Baddoch (UK, Scotland)), whereas no trend was detected for the past 5-year period.

Estimates of juvenile salmon (fry and parr) abundance in 1998 were at the same level as in 1997 in the River Teno (Finland and Norway) and its two tributaries but lower than the 5-year means. The fry abundance estimate for the River Bush was well below the level of 1997 and the 5-year mean. In UK (Northern Ireland), record high flow levels during the spring and throughout the summer of 1998 are believed to have contributed to much lower than normal survival of juvenile salmon (and trout) in the R. Bush and raise concerns about the knock-on effects on smolt runs in years 2000 and 2001.

Preliminary analyses of long-term trends in juvenile survey data in three rivers in the UK (England and Wales) indicated significant declining trends at five of the ten sites and a significant increasing trend at only one site.

3.4.3 Measures of adult returns back to the rivers

In order to depict temporal trends in the adult returns into the rivers of the NEAC area, an analysis was carried out using adult counts provided in Table 3.4.3.1. These data of adult returns are intermediate between recruitment back to the coast and spawning escapement, because in most cases the counting facilities are located below riverine fisheries. MSW and 1SW fish are pooled. In the case of the Girnock and the Baddoch burns, two small tributaries of the Dee (Scotland) where fish enter at spawning time, only the females were taken into account. These were considered to better reflect overall abundance due to the difference between both sexes in their behaviour relative to the trapping facilities at the time of spawning.

In order to provide the widest possible geographical view, only the data for the last ten years (1989-98) were considered. All rivers with at least seven years of data out of ten were included in the analysis. In order to look only at temporal trends, independent stock size, each series was divided by its mean. As a result, all the transformed series had a mean = 1. Therefore any data lower or greater than 1 corresponds to returns lower or greater than the last 10 year average respectively. Cluster analysis (Ascending Hierarchical Classification based on an inertia criteria with a chi-square distance) was used to help define groups of rivers showing common features in temporal trends. This method provides a hierarchy of classes which is of interest when trying to subdivide categories into sub-categories (Lebart *et al.* 1984). Inertia criteria take into account not only the distance between elements to be aggregated but also their size, thus avoiding chain effects i.e., when groups of categories are not identified due to overlap with smaller groups or single categories. Chi-square is the separation measure used when looking at the profiles i.e., comparing relative importance of series of positive numbers.

Two broad categories can be distinguished at first (Figure 3.4.3.1 and Figure 3.4.3.2):

- 19 rivers (58%) which had decreasing salmon returns over time whereas 13 (39%) showed no trend;
- one river out of 33 which tended to increase (although no data was available for it for the last 2 years).

The broad category of decreasing rivers could be split into four subgroups:

- The first subgroup (five rivers) showed a continuous trend over the study period.

The other three showed a two-step pattern i.e. fluctuations around values higher than the mean, followed by fluctuations around values lower than the mean. The years of transition between these two steps were lagged between the 3 subgroups:

- The second subgroup (5 rivers) showed a strong decrease at the beginning of the period analysed (1989-91) with no recovery thereafter;
- The third subgroup (5 rivers) had a drop from 1992 to 1994;
- The last subgroup (4 rivers) was affected by an abrupt change between 1994 and 1995.

Within the category of rivers showing no trend over time two subgroups could be identified: one subgroup of these (nine rivers) reflected inconsistent variations between rivers whereas the other (four rivers) was characterised by a notable improvement in 1998 over 1997.

In terms of geographical patterns (Figure 3.4.3.3), a partition of the 33 rivers into two broad regions, north-east (Scandinavian countries and Russia, 14 rivers) and south-west (UK, Ireland and France, 19 rivers) revealed differences in returns over the last 10 years. In the north-east region, most rivers showed a decline (10/14, 71%) whereas in the south-west region the split between rivers decreasing or with no trend was about balanced (9 declining against 10 stable or showing some improvement).

The pooling of MSW and 1SW fish in the data sets available was a major limitation to the analyses. Each sea-age represents alternative life history strategies which potentially maximise stock survival (e.g., coping with changes of the environment). As illustrated by the apparent decline in MSW stocks relative to grilse stocks, there is little reason for sea-age components to have same pattern of return over time. More insight into the trends in adult returns over time could be provided if the data were available for MSW and 1SW salmon separately.

In summary, it must be emphasised that adult returns to index rivers within the NEAC area have been declining or showed no trend over the last 10 years, but were almost never (1/33) improving. Within the rivers having declining returns, a broad range of patterns of decrease was observed. Within the rivers showing no trends a small fraction (4/13) improved notably in 1998. Within this rather pessimistic overall picture, stocks of the Northeast region (Scandinavia and Russia) seemed to be more of a concern than those from the Southwest region (UK, Ireland and France).

3.4.4 Survival indices

Estimates of marine survival for wild smolts from 10 stocks returning to homewaters (i.e. before homewater exploitation) and for 11 stocks returning to freshwater in 1998 are presented in Tables 3.4.4.1 and 3.4.4.2, respectively. Returns to homewaters are likely to present a clearer picture of marine survival than returns to freshwater because of variation in exploitation in coastal fishery. In Table 3.4.4.2, indices of survival are also provided for autumn age-0^+ parr for the Nivelle River (France). This provides an approximation of marine survival as more than 80% of juveniles migrate after only one year in freshwater. In most areas marine survival was under the 5-year mean.

For 1SW fish route regression analysis showed no significant trend for the past 10-years but there was a significant downward trend for the past 5-years. No significant trend was noted for 2SW fish for the past 5- and 10-year periods.

Return rates of hatchery released fish may not always reflect the survival of wild fish due to differences in release conditions. Marine survival rates for six hatchery stocks are given in Table 3.4.4.3 and Table 3.4.4.4. For the past 10-year period, route regression analysis showed a downward trend for survival to home waters for 1SW and 2SW fish but no significant trend was observed for the past 5-year period.

In general, there appears to be an overall decreasing trend in survival.

3.4.5 Status of early-running (or spring) salmon

Early-running MSW salmon occur in the rivers of the central and southern European coasts. Catches of these fish have declined throughout the range, notably in Ireland, France and UK (England and Wales). Analysis of rod catch data for UK (Scotland) for each of the five separate months February - June show steeply declining trends (1952-present). The trends are progressively less pronounced through the sequence of months. New pairwise comparisons of each of the five monthly trends for February - June has shown that the developing trends diverged after about 1990. Since 1990, the February rod catch has declined rapidly. March and April catches have continued to decline at comparable rates, while May and June catches have recovered slightly - although they are still below the long-term average. In Scottish rivers, run-timing is strongly related to the distance fish move into rivers before they spawn. The graded trends for the monthly rod catch figures are reflected in graded egg deposition rates at different levels in the rivers. Egg deposition rates have declined most rapidly in the uppermost parts of catchments.

The Baddoch and Girnock Burns are upland spawning tributaries of the River Dee (UK: Scotland). They receive mostly early-running MSW fish and microtag data indicate that they fish enter the river before April. In 1998, the trap catch of adults ascending the Girnock Burn comprised only 29 fish of which only 11 were female. In the Baddoch Burn, 48 fish were captured of which only ten were female. In spite of greatly decreased levels of exploitation by estuary and coastal nets and the introduction in 1995 of an advisory (and effective) catch-and-release policy on the river, spawning escapement is at an extremely low level. In both streams, minimum egg deposition levels equivalent to about 40 females are considered to be required to ensure maximal smolt production. Current failure to approach these levels is a result of high marine mortality rates among early-running MSW fish.

3.4.6 Summary of status of stocks in the NEAC area

The analysis of smolt output data indicated that the temporal patterns were not consistent between different rivers or regions. Some rivers showed a significant improvement in smolt production whereas the smolt output of other rivers declined. A significant downward trend was detected for wild smolt survival (1 SW returns) over the past five years and for hatchery smolt survival (1 SW and 2 SW returns) over the past ten years.

In most cases, adult salmon counts in index rivers within the NEAC area increased from 1997 to 1998. However, over the last ten years, adult returns have been declining or showed no trend, and were improving in only one case. Analysis of attainment of conservation limits (CL) indicated variable status of salmon stocks in different rivers of the NEAC area. Some rivers have never or seldom reached their CL over the last 10 years, whereas others have been consistently above their CL. Many rivers that have reached their CL in most years show a decreasing trend in escapement, however, and no tendency to recover was observed for rivers with low escapement levels.

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

Since 1991 the Faroese fishermen have agreed to suspend commercial fishing for the salmon quota set by NASCO, in exchange for compensation payments. The number of fish spared as a result of this suspension is the catch that would have been taken if the fishery had operated, minus the catch in the research fishery. As for last year (ICES 1998/

ACFM:15), the Working Group concluded that the full quota would have been taken, had the quota purchase not been in effect. Thus, the maximum catch that would have been taken in 1997/98 would have been 380 t (Table 3.2.1.1).

Data on the discard rate in 1997/98 was obtained from the research fishery, while the age composition of the catch was derived from length-splits previously applied (ICES 1996/Assess:11). No new values were available for the proportion of farm escapees in catches, or to expected time to return to homewaters, so the same values used for the previous three years were applied. The assessment is shown in Table 3.5.1. This suggests that if the full quota was not taken, between 3,000 and 21,000 additional 1SW salmon and between 70,000 and 138,000 additional MSW salmon would have returned to homewaters each year from 1992 to 1998. For the 1997/98 season, the numbers of fish believed saved were 20,000 1SW and 103,000 MSW, respectively.

In addition, between 20,000-55,000 escaped farmed fish each season would have been saved from capture in the Faroese fishery, however data from tagging experiments suggest it is probable that almost all might be expected to return to Norway (ICES 1998/ACFM:15). The analysis carried out suggests that, for the 1997/98 season, up to 30,000 escaped farmed fish may have been saved.

Estimates (means of 1000 simulations) of the total numbers of 1SW and MSW salmon returning to homewaters (i.e., Pre Fishery Abundance estimates) in the NEAC area and to countries of northern and southern Europe are provided in Tables 3.6.2.1 and 3.6.2.2. The calculated additional returns represent between 6% and 14% of MSW fish and 0% to 1% of 1SW fish returning to homewaters between 1992 and 1998 (Table 3.5.1). However, data from adult tagging studies (Hansen and Jacobsen 1997), indicate that the majority (about 65%) of MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. If this were the case, they might have represented from 8% to 19% of MSW returns and from 0% to 1% of 1SW returns to northern European homewaters between 1992 and 1998 (Table 3.5.1). If stocks and fisheries had remained stable, total catches would have been expected to increase by approximately the same proportions in respective areas.

Catches in homewater fisheries in four areas of Europe (Table 3.5.2) were examined for any significant change following the suspension of fishing at Faroes in 1991. There have been significant reductions in catches for 1SW salmon in Northern Europe (Finland, Sweden and Norway) (Rcrit, $p = 0.004$) and southern Europe (Ireland, UK (Scotland) and France) (Rcrit, $p = 0.04$). No detectable change was noted for MSW catches in northern Europe (Finland, Sweden and Norway) or for adult counts to Russian rivers in the same period. (It should be noted that catches of MSW salmon in Europe in 1994 and 1995 should also have been affected by the suspension of salmon fishing in Greenland). MSW catches were significantly lower in the period following the cessation of commercial fishing at Faroes from 1992 to 1998, compared to the period 1987 to 1991 for southern Europe (UK [Scotland] and France) (Rcrit, $p = 0.01$). Although the additional returns would have been expected to have contributed to catches and spawning stocks, it appears that any expected increase has been masked by other factors such as changes in marine survival or management measures in homewaters.

3.6 Expected Abundance of Salmon in the North East Atlantic for 1999/2000

3.6.1 Previous development of a NEAC - PFA model

In 1995, the Working Group presented a model to estimate the pre-fishery abundance (PFA) of salmon from countries in the NEAC area at the beginning of their second year in the sea (ICES 1995/Assess:14). The method employed a basic run-reconstruction approach similar to that described by Rago *et al* (1993b) and Potter and Dunkley (1993). The model estimated the PFA from the catch in numbers of 1SW and MSW salmon in each country. These were raised to take account of minimum and maximum estimates of non-reported catches and exploitation rates of the two age groups. Finally these values were raised to take account of the natural mortality between January 1 in the first sea winter, which is taken as the date they recruit to the first fishery (Faroes), and the mid-point of the respective national fishery season.

In 1997, the Working Group presented a Monte Carlo simulation ('@Risk' in Excel) to generate distributions around the estimated PFA values(ICES, 1997:Assess:10). The same minimum and maximum parameter values were used as previously (except where these were updated or corrected). These were thought to encompass the full range of true values and were therefore used as the limits of uniform distributions for each parameter in the simulation. The model was run separately to estimate the total numbers of maturing and non-maturing 1SW recruits in the NEAC area; and in southern and northern European countries each run was based on 500 simulations.

The Working Group further refined and updated this approach in 1998 (ICES 1998/ACFM:15). The Monte Carlo simulation was reformulated using the software package 'Crystal Ball' (Decisioneering, 1996) in Excel and was run separately for each country using 1000 simulations.

Thus, for each country in year 'n', the number of fish of sea age 'i' killed in fisheries (including unreported catches) (K_{ni}), the number returning to home waters (H_{ni}), the number of maturing 1SW recruits (P_{n1}), the number of non-maturing recruits (P_{nm}) and the number of spawners (W_{ni}) were estimated as follows:

$$K_{ni} = C_{ni} / (1 - R_{ni})$$

$$H_{ni} = K_{ni} / U_{ni}$$

$$P_{n1} = H_{n1} / e^{-M1t1}$$

$$P_{nm} = H_{(n+1)m} / e^{-Mmtm}$$

$$W_{ni} = H_{ni} - K_{ni}$$

where suffix 'i' refers to age groups 'i', while '1' and 'm' refer to the 1SW or MSW age groups specifically.

and: C = catch of salmon in numbers;

R = estimated proportion of the total catch that is unreported (*);

U = average level of exploitation of the salmon stock (*);

M = natural mortality on salmon greater than 1SW in the sea (*);

t = time between homewater fisheries and the time of recruitment (*).

Those variables marked with an asterisk (*) indicate variable for which minimum and maximum values were provided.

Full details of the model and a sensitivity analysis are provided by Potter *et al.* (1998).

3.6.2 Improvements to the NEAC - PFA model

The Working Group reviewed the model used to estimate pre-fishery abundance of salmon in the NEAC area, and the data inputs, and made the following improvements:

1. catch data and other parameter values were added for 1998;
2. parameter values for earlier years were modified where new data or new estimation procedures were available;
3. the numbers of recruits estimated from the catches in the distant water fisheries was allocated to national production on the basis of estimates provided by Potter (1996) for the West Greenland fishery and Hansen and Jacobsen (1997) for the Faroes fishery;
4. farm escapees were excluded from the recruitment estimates derived from catches in the Faroes fishery using estimates given by Hansen *et al* (In press);
5. estimated catches of salmon from UK (Scotland) in the UK (England & Wales) coastal drift net fishery were incorporated into the recruitment estimates for UK (Scotland).

The input data for the model for ten salmon producing countries in the NEAC area and for the Faroes and West Greenland fisheries (as updated for the 1998 assessment) are shown in Appendix 8a-8l. The maximum and minimum values denote the limits of the uniform distributions used in the Monte Carlo simulation.

Full results for each NEAC country are shown in Appendix 9a-9l. Tables 3.6.2.1 to 3.6.2.6 summarise the outputs from the simulation, giving the mean estimates of the numbers of returns (1SW and MSW), recruits (maturing and non-maturing 1SW), spawners (1SW and MSW) and total 1SW recruits (plus variances/ standard deviations). The tables suggest that the national stocks fall into two categories. Ireland, Norway, Russia and UK (Scotland) appear to be producing around 400k to 700k maturing 1SW recruits. With the exception of Ireland, these countries also produce 200k to 600k non-maturing 1SW recruits. Ireland and the remaining countries produce less than 100k maturing 1SW recruits and less than 50k non-maturing 1SW recruits. The Working Group did not consider this to be inconsistent with their best understanding of the stocks.

3.6.3 Grouping of national stocks

The Working Group has previously divided the NEAC PFA estimates into two groups, representing the Nordic countries and Russia (northern Europe) and the UK, Ireland and France (southern Europe). However, the Working Group had previously noted particular similarities between the marine survival trends for the River Figgio (in southern Norway) and North Esk (eastern Scotland).

In 1998, the Working Group recommended that work be undertaken to assess whether alternative groupings might be more appropriate. Examination of time series of 1SW catches in south, mid and north Norway revealed that catches from the south and mid areas were correlated with each other but not with catches in the north. It may therefore be appropriate to split the Norwegian stock into two regions: (1) from the Swedish border to Lofoten, and (2) from Lofoten to the Russian border. The Working Group did not have the data to do this separation in the PFA model, but recommended that it be explored further in the coming year.

The Working Group has therefore used the following groups of countries to present the PFA data:

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

These groupings differ from those used in 1998 because recruitment estimates derived from catches at Faroes and West Greenland are now included in the national recruitment estimates and Iceland has been included in the Northern group.

Tables 3.6.2.1 to 3.6.2.6 show combined results from the PFA assessment for the Northern and Southern European groups and the whole NEAC area. The PFA of maturing and non-maturing 1SW salmon and the numbers of 1SW and MSW spawners for these areas are shown in Figures 3.6.3.1 to 3.6.3.3.

3.6.4 Trends in the PFA for NEAC stocks

The 95% confidence limits (dotted lines for PFA and vertical bars for the spawning escapement) shown in Figures 3.6.3.1 to 3.6.3.3 indicate the high level of uncertainty in this assessment. However, the Working Group recognised that the model provided an interpretation of our current understanding of national fisheries and stocks based upon simple parameters. Errors or inconsistencies in the output must largely reflect errors in our best estimates of these parameters.

Figure 3.6.3.1 suggests that there has been no overall trend in the recruitment of maturing 1SW salmon (potential grilse) in the northern countries, although the numbers have fluctuated quite widely around a level of approximately one million recruits. However, it must be noted that this pattern is largely driven by a simultaneous decline in Norway with an increase in Russia (Figure 3.6.4.1). The increase in the spawning escapement reflects the decrease in exploitation of these stocks in both the Faroes and homewater fisheries, particularly Norway and Russia.

Numbers of non-maturing 1SW recruits (potential MSW returns) for the northern group of countries appear to have fallen from approximately one million in the 1970s to about 0.6 million in the 1990s. The majority of this overall decline appears to have occurred in the mid 1980s, but recruitment also fell for a two year period in the late 1970s. This reflects very similar patterns in the estimated production of MSW salmon for Norway and Russia over this period. Reductions in the level of exploitation have resulted in a proportionally smaller overall decline in the spawning escapement, from an average of 330k in the early 1970s to an average of 250k in the past five years, although there have been quite large fluctuations (between about 200k to 400k) over the period.

For the southern European group of countries (Figure 3.6.3.2), the numbers of maturing 1SW recruits is driven largely by the Irish and UK (Scottish) stocks which are each estimated to have produced an annual average of about 650k fish in the past 10 years. Recruitment for both of these countries has fallen substantially since the 1970s. Thus the southern group of countries show an overall halving of the number of maturing 1SW recruits over the period, with stocks falling to their lowest level in 1997.

The abundance of non-maturing 1SW recruits in the southern European countries is largely driven by the UK(Scottish) stocks which account for about 80% of the estimated numbers of recruits over the past 10 years. Ireland and UK(England & Wales) together account for about 15% of the recruits. All these countries have shown a very marked decline in the numbers of non-maturing 1SW recruits, such that overall production has fallen relatively steadily to about one third of its level in the early 1970s. For these stocks, reductions in exploitation does not appear to have kept pace with the stock declines and the spawning escapement has also fallen over the period.

3.6.5 Forecasting the PFA for NEAC stocks

In order to use the PFA estimates to provide catch advice, a forecast is required of the PFA of recruits in the year preceding the fisheries. Thus, for example, the PFA of non-maturing 1SW recruits must be predicted for 1999 if we are to provide advice for: the West Greenland fishery in 1999; the Faroes fishery (MSW stock) in 1999/2000; and homewater fisheries in 2000. Because the latest estimate of non-maturing 1SW recruits is for 1997, the PFA must be forecast two years ahead, as is currently practised for the North American assessment. For maturing 1SW stocks, a single year's projection is sufficient.

No new information was presented on methods to predict future levels of PFA from the historic time-series. In view of the uncertainty in these PFA assessments, the Working Group considered that the catch advice should be based upon qualitative extrapolations from the historic estimates. These are discussed in Section 3.8.

3.7 Development of Age-Specific Conservation Limits

3.7.1 Progress with river-specific conservation limits

The Working Group reviewed the progress that was being made with the development of river specific stock conservation limits, and alternative management approaches, in different countries in the NEAC area.

Finland and Iceland: No progress was reported.

France: Conservation limits have been set on a river-by-river basis for most of the north western stocks (33 out of 44 salmon rivers in France). The conservation limits are computed on the basis of the assessment of production potential (running water surface area) and the stock-recruitment relationship derived from the population dynamic survey of the River Oir (Prévost and Porcher, 1996; Porcher and Prévost, 1996). The TAC per river is adapted each year during the fishing season according to the annual fluctuations of returns. Provisional conservation limits have been developed for southern rivers (Loire and Adour).

Ireland: Potential spawning escapement requirements have been estimated for all rivers by applying reference egg deposition rates from the River Bush stock-recruitment relationship to the wetted area or catchment areas of each river to calculate spawning targets. While this provides a very approximate estimate, it is believed that the order of magnitude is broadly indicative of the spawning requirements for these rivers. This preliminary analysis is gradually being superseded by river specific analyses or on advice from regional fisheries managers.

Norway: Progress has been made with the use of GIS methods to estimate the productive capacity of Norwegian rivers using GIS (Erikstad *et al.* 1998). Digital maps (1:50 000) were used to estimate the wetted area of 11 Norwegian salmon rivers from the river mouths to the limit of upstream migration of salmon (usually easily defined by a waterfall) (Table 3.7.1.1). Tributaries and lakes were excluded in this preliminary analysis.

Production of salmon smolts in the River Imsa, where emigrating smolts have been counted since 1976, has shown an average annual production of about 15 individuals per 100 m^2 (Jonsson *et al.* 1998). Smolt production in the River Kvassheimsåna which is in the same area as River Imsa were estimated at 15 individuals per 100 m^2 in a single year. Johnsen *et al.* (1999) reported a time series of smolt production estimates from a large area of the River Orkla since 1983, based on tagging and recapture, to be an average of seven smolts per 100 m^2 with annual variations from four to eleven. Data from these investigations were modified and transported to other systems after personal communications and discussions with biologists working on the different rivers, taking into account local conditions such as temperatures and water flows, and unpublished data on electrofishing surveys and habitat quality. Guess-estimates of smolt production per unit of area were then applied for the individual rivers, and the estimated smolt productions are shown in Table 3.7.1.1. There was a significant relationship between estimated smolt production and mean catch in the last 20 years (r^2 =0.63, p =0.02, n =8), suggesting that the provisional smolt production estimates are within reasonable limits.

The use of GIS will be further developed to produce objective smolt production estimates based on habitat area, and should incorporate information on river gradient, local vegetation and estimates of parr densities.

Russia: Provisional conservation limits have been set for the Kola rivers where the fisheries have been conducted for 30-40 years at estuary barrier fences which have provided comprehensive catch statistics and biological data. Conservation limits have been defined for five rivers as MSY points on stock recruitment curves as recommended by the Working Group. For those rivers where habitat data are available, conservation limits have been established by transporting reference points (2.73 eggs per m^2 for the Barent Sea and 3.85 eggs per m^2 for the White Sea rivers). An approach using total catchment area has been applied for other rivers.

Sweden: The evaluation and further development of the status of salmon stocks on the Swedish west coast is being considered by a Working Group established in 1998. Provisional estimates of salmon smolt production are now available for 17 rivers in western Sweden (Table 3.7.1.2).

UK (Northern Ireland): Spawning targets that have been set to date range from single river targets derived from river-specific stock-recruitment data (Rivers Bush and Foyle) to targets derived from the transport of these data to other systems. On the River Foyle spawning targets are being used for the management of fisheries, while the majority elsewhere are still being developed and are mainly used for illustrative and modelling purposes at present.

UK (England & Wales): Provisional conservation limits (referred to as 'spawning targets') have been developed for all principal salmon rivers. These are being reviewed and finalised as Salmon Action Plans are developed for each river; a Ministerial Direction issued to the Environment Agency in September 1998 requires that the Salmon Action Plans be completed for 68 salmon rivers by the year 2002. The 'spawning targets' are set using a nationally agreed methodology (Environment Agency 1998). This adjusts a stock-recruitment relationship for the River Bush, UK (Northern Ireland) according to the quality and quantity of juvenile habitat in each river, derived from a simple habitat model (Wyatt and Barnard 1997).

UK (Scotland): Previous studies of genetic structuring among salmon populations in Scottish rivers has identified important structural differences within catchments. Radio-tracking studies in several rivers have demonstrated that those fish homing to spawn in locations distant from the sea enter fresh water earlier than fish homing to spawn in locations lower in the same catchments. Habitats left vacant by particular seasonal runs is not taken up by fish of other types. These observations suggest that the appropriate biological scales for setting conservation levels or targets for Scottish rivers lies far below the levels considered appropriate elsewhere. In order to overcome these difficulties an approach is being developed that is appropriate for Scottish circumstances. It is intended to derive estimates of optimal values for escapement based upon an analysis of rod catch data and estimates of local juvenile production.

3.7.2 National conservation limits - Lagged spawner analysis

In 1998, the Working Group noted that it was likely to be a number of years before conservation limits were developed for all river stocks in the NEAC area. A method was therefore proposed for estimating national conservation limits based upon the output of the PFA analysis described in Section 3.6. A full description of the model along with a sensitivity analysis was provided by Potter *et al.* (1998).

In brief, the model provides a means for relating the estimates of spawners and recruits derived from the PFA model. This is addressed by converting the numbers of 1SW and MSW spawners into numbers of eggs deposited. Thus, in each country and for each year the total egg deposition (E) may be estimated as:

$$E = (W_1 \times F_1 \times G_1) + (W_m \times F_m \times G_m)$$

where: suffixes '1' and 'm' refer to 1SW and MSW age groups respectively

and: W = the number of spawners in the age group (from the PFA simulation model);

F = the % female in the age group;

G = the average number of eggs produced by a female in the age group.

The approach assumes that there have been no significant changes in the egg production or in the proportion of females for 1SW and MSW salmon over the time period. Males are also ignored in the foregoing analysis, the assumption being that their numbers have not limited the deposition of fertilised eggs, and thus the production, during the period 1971 to the present.

The egg deposition in year 'n' is assumed to contribute to the recruitment in years 'n+3' to 'n+8' in proportion to the numbers of smolts produced of ages 1 to 6 years. Thus the number of 'lagged eggs' (L) which will contribute to the recruitment of maturing and non-maturing 1SW fish in year 'n+8' is estimated as:

$$L_{n+8} = (E_n \times p_6) + (E_{n+1} \times p_5) + (E_{n+2} \times p_4) + (E_{n+3} \times p_3) + (E_{n+4} \times p_2) + (E_{n+5} \times p_1)$$

where: E_n = the estimated number of eggs deposited in year 'n'

and p_i = the proportion of smolts of age 'i'.

The lagged egg deposition estimates for each national stock is given in Appendix 10a-10j along with the estimated numbers of 1SW recruits, which have been carried over from the PFA analyses. The relationships between the lagged eggs ('stock') and 1SW recruits are also shown in the Figures included in Appendix 10a-10j.

The plots of lagged eggs (stock) against the 1SW adults in the sea (recruits) have been presented as 'pseudo-stock-recruitment' relationships. As in 1998, three non-parametric methods have been used to estimate conservation limit 'options' from these relationships. These have been proposed as methods for estimating the minimum biological acceptable level (MBAL) for marine fish stocks (ICES 1993/Assess:12). (Conservation limits for salmon have been defined as being equivalent to MBAL (ICES 1995/Assess:14)). These methods therefore provide approaches for estimating provisional conservation limits from the 'pseudo-stock-recruitment' relationships.

These are:

Option 1: the minimum observed spawning stock level [i.e., $CL_{opt1} = \min L$],

Option 2: the stock size where the 90[th] percentile of survival intersects the median recruitment level. [i.e., $CL_{opt3} = (R/L)_{90\%ile} \times R_{med}$], and

Option 3: the stock size where the 90[th] percentile of survival intersects the 90th percentile of recruitment (Serebryakov, 1991); [i.e., $CL_{opt2} = (R/L)_{90\%ile} \times R_{90\%ile}$].

To be compared with any forecast of PFA, the egg deposition conservation limit levels must be converted back to fish numbers. NASCO has also asked that the conservation limits be split by age-groups; this is clearly a necessity where decisions have to be made about the management of fisheries exploiting predominantly one age group of fish. As in 1998, the egg deposition conservation limit has been converted to numbers of 1SW and MSW salmon based upon the average age composition of the spawning stock in the past 10 years. These results are shown in Appendix 10a –10j. The three conservation limit 'options' derived for each country are summarised in Table 3.7.2.1. Where river specific conservation limits have been derived, these are provided as a fourth option.

3.7.3 Evaluation of conservation limit options

As with the output from the PFA model, the lagged egg deposition analysis provides a further interpretation of our best understanding of the dynamics of national stocks. While the concept of 'national stocks' has little meaning biologically, it is possible, mathematically, to consider a national stock-recruitment relationship as the sum of a large number of population stock-recruitment relationships. The Working Group noted the following points about the conservation limit options derived for each country from this model.

In UK (England & Wales) and France conservation limits have been independently derived for every river, although some values are still provisional. The sum of these river specific conservation limits in UK (England and Wales) is 226 million eggs. This lies between the conservation limits given by Option 2 (205 million eggs) and Option 3 (253 million eggs) in the lagged egg deposition assessment. Similarly for France, the sum of the river specific conservation limits (55 million eggs) lies between Option 2 (47 million eggs) and Option 3 (70 million eggs) conservation limits from the lagged egg deposition analysis.

Although conservation limits have not been derived for all rivers in Ireland and UK (Northern Ireland), the output from the lagged egg deposition analysis was consistent with preliminary analyses by alternative methods such as those proposed by the Workshop on Setting Conservation Limits for salmon in the NE Atlantic (ICES 1998/ACFM:13).

The Working Group had some concerns about the estimated conservation limits options for UK (Scotland), which appeared rather high in comparison with other countries. The high conservation limit estimates may imply substantial differences in the dynamics of Scottish stock, in comparison to Norway in particular, or over or under-estimates of some of the input parameters. There are substantial differences between Scottish and Norwegian stocks, for example in the time period over which the fish return to freshwater, but the effects of these differences on population dynamics is not known. Errors in the input data are most likely to be in the estimated exploitation rates; changes in other parameters are either unlikely to have significant effects on the conservation limit options in this case (e.g. unreported catch) or would be expected to have similar effects on all the national stock assessments (e.g. major changes in 'M').

The Working Group felt that they had no basis for modifying the data inputs for the model without further information and concluded that the conservation limit estimates remained the best available information on which to base the catch advice. However, it was recognised that the uncertainty in these data must be taken into account when providing catch advice.

In 1998, the Working Group provided three conservation limit options for each country; ACFM chose to use the minimum summed value (Option 1), which is clearly the least precautionary, in the advice to NASCO. Following further review of the approach, the Working Group decided to select the most appropriate conservation limit option for each country based upon the nature of the 'pseudo-stock-recruitment relationships' (Appendices 10a-10j) and local knowledge. This evaluation is summarised below:

Country	Option	Reason
Finland	3	Recruitment lower at Option 1 and 2 levels.
France	4	Based upon river specific estimates.
Iceland	1	Options 1 & 2 equal; no increase in recruitment for Option 3.
Ireland	3	Very wide spread of historic stock estimates.
Norway	3	Recruitment lower at Option 1 and 2 levels.
Russia	1	No decrease in recruitment at Option 1 level.
Sweden	3	Recruitment lower at Option 1 and 2 levels.
UK(Eng. & Wales)	4	Based upon river specific estimates.
UK(N. Ireland)	3	Recruitment lower at Option 1 and 2 levels.
UK(Scotland)	2	Recruitment lower at Option 1 level.

The selected options have been summed in the appropriate stock groups. These are then increased to take account of the natural mortality between recruitment and the time of return in order to provide spawner escapement reserves (SERs) for maturing and non-maturing 1SW salmon from the Northern and Southern stock groups. The SERs are shown as horizontal lines in Figures 3.6.3.1 and 3.6.3.2; the dashed line indicates that these SERs may be less appropriate for evaluating the historic status of stocks. The SERs are not shown on the total NEAC data (Figure 3.6.3.3) because evaluation of stocks against conservation limits is thought to be inappropriate at that level.

3.8 Catch Options or Alternative Management Advice

3.8.1 Overview of the provision of catch options or management advice

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

The Working Group also emphasized that 'national' stock conservation limits are not appropriate for the management of homewater fisheries, particularly where these exploit separate river stocks. This is both because of the relative imprecision of the national conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations. Nevertheless, the Working Group accepted that the combined conservation limits for the main stock groups (national stocks) exploited by the distant water fisheries could be used to provide catch advice for these fisheries.

3.8.2 Catch options and management advice for 1999/2000

In 1998, the Working Group provided catch advice for Northern and Southern European stock complexes. The Working Group reiterated the view that 'national' stock conservation limits are not appropriate for the management of homewater fisheries, particularly where these exploit separate river stocks. This is both because of the relative imprecision of the national conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations.

In view of the uncertainties expressed above about the most appropriate stock groupings and the preliminary nature of the conservation limit estimates, the Working group considered that it would be inappropriate to provide quantitative catch options at this stage. However, the Working Group felt that the following qualitative catch advice was appropriate based upon the PFA data and estimated SERs shown in Figures 3.6.3.1 and 3.6.3.2:

Maturing 1SW stocks: very few 1SW salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea. The Working Group therefore recommends that management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks.

Northern European MSW stocks: These are the main stocks that have contributed to the fisheries in the Norwegian Sea in past years. The PFA of non-maturing 1SW salmon from Northern Europe has been declining since the mid 1980s and is now approaching the conservation limit estimates. The exploitable surplus has declined from over 800,000 recruits in the 1970s to around 250,000 recruits in 1996 and 1997. The Working Group therefore suggests that great caution should be exercised in the management of these stocks particularly in mixed stock fisheries. Management of single stock fisheries should be based upon local assessments of the status of stocks.

Southern European MSW stocks: This group includes the main European stock contributing to the West Greenland fishery. The PFA of non-maturing 1SW salmon from Southern Europe has been declining since the 1970s and the Working Group's analysis suggests that it fell below the conservation limits in 1996 and 1997. Simple projection of these data by eye suggests that the PFA is also likely to fall below the conservation limits in 1999. The Working Group considers that extreme caution should be exercised in the management of these stocks in mixed stock fisheries and that reductions in levels of exploitation should be pursued. Management of single stock fisheries should be based upon local assessments of the status of stocks.

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

3.9.1 Post-smolt surveys 1990–1998

Post-smolt sampling cruises have been undertaken by the Institute of Marine Research (IMR), Norway since 1990 with the primary aim of describing the post-smolt distribution in the northeast Atlantic (Figure 3.9.1.1). Similar cruises were undertaken by Fisheries Research Services) FRS Scotland in 1996 and 1997. The results of these surveys were reported to the Working Group in 1998 (ICES 1998/ACFM:15). In summary, a surface trawl technique was developed and proved successful in capturing post-smolts. Around 1,000 hauls were undertaken covering an area from the south west of Ireland (50°N) to the east of Bear Island (75°N), and in the order of 1,000 post smolts and 25 1SW salmon were caught. While large concentrations of post-smolts were found within the strong north-east running slope current along the north-west European continental shelf edge, large numbers were also caught in the Norwegian Sea.

In 1998, IMR undertook six further cruises (Table 3.9.1.1), extending the areas surveyed to include both the Greenland Sea and the Barents Sea. Post-smolts were successfully captured in both the Norwegian and Greenland Seas and the Norwegian fjords (Figure 3.9.1.2). In contrast, no post-smolts were caught in the Barents Sea. Analysis of the distribution patterns of post-smolts caught in Norwegian and Scottish cruises since 1990 shows that capture sites coincide, to a large extent, with the prevailing surface current patterns in the area. This suggests that the strong Atlantic Slope current and the Norwegian coastal current (Figure 3.9.1.3) are the main carriers of post-smolts to the northern feeding areas. Analyses of the hydrographical regimes at the capture sites show a strong concentration of the captures to the 9.0-10.9°C temperature interval and in salinities of ≥35.000 ppm (Figure 3.9.1.4), indicating a preference for the warm, saline, productive Atlantic water masses over the colder and less saline Arctic water in the north west and the warmer but less saline waters of the Norwegian coastal current in the east.

Examination of the smolt age distribution of the fish captured in the different areas in 1998 supported the conclusion from earlier cruises that due to their young sea age a relatively high proportion of the post-smolts caught in the Norwegian Sea was of southern European origin. This is in contrast to fish caught west of Lofoten that were older, and those caught in fjords in west Norway where the smolts were mainly 3 and 4 years of age (Figure 3.9.1.5).

FRS conducted an inshore survey (within the limits of the Moray Firth) on the north-east coast of Scotland (Table 3.9.1.1). A large number of post-smolts were caught and analysis of stomach contents did not indicate any shortage of food. In contrast to the Norwegian findings from offshore sampling surveys, no relationship was evident between the inshore distribution of post-smolts and temperature and salinity gradients.

The Polar Research Institute of Marine Fisheries and Oceanography (PINRO) carried out a survey in the northern Norwegian Sea (Table 3.9.1.1). No post-smolts were captured in this area. Interestingly, four adult salmon, three of which were classified as farmed salmon were caught.

3.9.2 Estimates of post-smolt by-catch in pelagic fisheries

Post-smolt and herring seem to overlap spatially mostly in July early August in the areas north of 68°N (Holst *et al.* 1998). The purse seine fishery for herring takes place in the areas west of Iceland up to the Jan Mayen Island as early as April and into June and is therefore not likely to intercept young salmon. In 1998, a limited effort was made by the Fishery Laboratory of the Faroes to collect information on salmon by-catches in a Faroese purse seine fishery for herring which was taking place in June in these areas. Crew members on two of ten Faroese purse seine vessels were asked to look specifically for post-smolts when sampling the herring catch for mandatory documentation of weight distributions to the buyers on land. No post-smolts were reported. In addition post-smolts were not found in a sample of 1-3% of the landed catch of herring from one vessel and mackerel from another specifically screened for the presence of posts-smolts.

The Fishery Laboratory of the Faroes and the Russian Polar Institute (PINRO) have initiated a bilateral collaboration on the by-catch of salmon post-smolts north of the Faroese in the 1999 fishery for herring and mackerel.

Information by Belikov *et al.* (1998) shows that both the migratory pattern and the distribution of older year classes of mackerel are very similar to that of the post-smolts. The mackerel start a northward summer migration from the waters north and west of Ireland in May, and some stock components may migrate as far into the Norwegian Sea to 74°N in July before they turn back to their southerly winter feeding areas. The stocks are believed to be large at the moment and the seasonal distribution changes somewhat with variations in hydrographical conditions. Catch distribution diagrams for 1989-97 for mackerel indicate for some years a strong overlap with the inferred northward migratory routes of post-smolts in June and July in the Shetland Faroes Channel, the North Sea and the Norwegian Sea (Belikov *et al.* 1998). One Norwegian Carlin tagged post-smolt found in a mackerel trawlcatch in 1996 is the only evidence of interception so far. The fishery with the greatest potential for catching post-smolts is probably the trawl fishery for mackerel in the Faroes EEZ and the international area of the Norwegian Sea. This fishery is presently at a high level and is not anticipated to diminish in the near future.

Observing post-smolts in large herring and/or mackerel catches is difficult due to their resemblance both in size and coloration. To be certain of the absence of post-smolts in such catches the whole catch must be screened. Assessment of by-catches on board commercial fishing vessels may prove too time consuming to be carried out in practice. However, efforts should be made to arrange screening of whole catches at landing sites.

Although preliminary investigations have been carried out, the Working Group was unable to provide estimates of the by-catch of post-smolts in pelagic fisheries. While observations on catch on pelagic fishing vessels is a possibility, in reality this is likely to provide only a qualitative assessment of post-smolt by-catch. An alternative approach would be to carry out directed research fisheries with similar gear, locations and time as commercial fishing boats or carry out co-operative fishing with a commercial fishing vessel.

Despite the limitations of the current data, the Norwegian salmon surveys seem to indicate a clear correspondence with the trawl depth related to the on-surface position of the upper trawl panel, and the likelihood of .catching post-smolts where they are more densely distributed. A simple precautionary measure against post-smolt catches in commercial fisheries may therefore be to negotiate that the fleet does not operate their trawl with a flotation that will keep the floatline closer to the surface than 5 -10 m during longer periods of towing.

The ICES Working Group on Northern Pelagic and Blue Whiting Fisheries, Working Group on the Assessment of Mackerel, Horse Mackerel Sardine and Anchovy, and the Herring Assessment Working Groups asked WGNAS to expand on its' request for information useful in the assessment of potential problems with by-catch of Atlantic salmon in pelagic fisheries. Details required are as follows:

- May: The number of vessels fishing purse seines and the number of trawls at the surface in which the upper panel is close to the surface and keeps within 0-15 m during prolonged periods of a tow. It would also be useful to know if the surface trawl is fitted with extra flotation on the upper panel and sweepers. Areas of interest in May are ICES Statistical areas IV b-c and VII a-K (see attached map). Catches, swept area (or information allowing the calculation thereof), CPUE for such gear in May and possible recordings of post-smolt (12 -17 cm salmon) and older salmon (≥30) in these catches. Other types of gear and trawl tows carried out with the upper panel deeper than 15 -20 m are of lesser importance;

- June: Same catch characteristics as above for the above types of gear and depths but recorded in ICES areas VI a-b; IVa and Vb1-2. Possible by-catch of post-smolt and salmon in this month will comprise size groups 13–20 cm and ≥30 cm, respectively;

- July: Same catch characteristics as above for the above types of gear and depths but recorded in ICES area IIa delineated by -5°W to 13°E longitude and 66° to 72°N latitude. Possible by-catch of post-smolt and salmon in this month will comprise size groups 16–26 cm and ≥30 cm, respectively;

- August: Effort and catches by the above specified gear in ICES area IIb delineated by -3°W -21°E longitude and 72° -76°N latitude. Possible by-catch of salmon may comprise all sizes ≥28 cm.

It is recommended that the sampling programme for post-smolt should be maintained and further extended with surveys in July in the Norwegian Coastal current along the northern most coast of Norway and Russia and into the Barents Sea.

3.10 Data Deficiencies and Research Needs in the NEAC Area

3.10.1 Progress on items cited in 1998 report of NASWG

1. Estimates of marine mortality of salmon should be re-examined in the North-East Atlantic, and causes for this mortality should be identified and quantified.

No substantial progress was reported.

2. The Working Group strongly endorses the continuation of the post-smolt surveys in the North-East Atlantic, and recommends this to be extended to presently uncovered areas.

A single in-shore cruise was undertaken by UK (Scotland), between 14-25 May, in the inner Moray Firth on the north-eastern coast of Scotland.

Six cruises covering three fjords in south-west Norway captured both wild and escaped-farmed smolts. Norway extended post-smolt surveys, for the first time, beyond the 73.5°N in the northern Norwegian Sea and into the Barents Sea, as far as 40°E longitude. Three cruises were undertaken.

3. Efforts should be made to provide estimates of by-catch of salmon in marine waters.

Progress is reported in Section 3.9.

4. The Working Group recommends that the Working Group on Northern Pelagic and Blue Whiting Fisheries, the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy, and the Herring Assessment Working Group are asked for data regarding by-catches.

A request for data has gone to the Working Groups via ICES.

5 The Working Group recommends a continuation of the research fishery at Faroes.

A small research fishery took place in late winter, 1999.

6. Alternative ways to group salmon stocks, or stock complexes should be examined to improve the catch advice for salmon in the North-East Atlantic.

Studies of catches of 1SW fish in Norway showed a correlation between the southern and mid-Norway portions of the catch. No correlation was found between these catches and those made in northern Norway (see Section 3.4).

7. The quality of data used to set conservation limits in the North-East Atlantic should be improved and provided for smaller stock complexes. Furthermore, a sensitivity analysis of the input parameters to the pre-fishery abundance model should be carried out.

A joint paper addressing the item was presented at the annual statutory meeting of ICES in September, 1998. Additional progress is reported in Sections 3.6 -3.8.

8. More information is required on a river by river basis relating to catches, exploitation rates and habitat assessment and this should be referenced to the appropriate scale (eg., tributary populations etc.). Specific information on required age class composition of the stocks should be established on a river by river basis (historical and current).

See Item 12.

9. Life history models are required for as many index rivers as possible.

No action was reported but models are under development.

10. Transportability of existing targets derived from known S/R relationships must be evaluated in comparison with other indices of abundance

No progress was reported.

11. Further refinement is required to the model to estimate PFA and Conservation Limits particularly with regard to the examination of the input data from each country to explain differences between the model output and current estimates of abundance from other analyses.

See Sections 3.6 -3.8.

12. Further research and development is required, particularly with regard to establishing stock size (counters) and relating productivity to suitable habitat area (catchment surveys, juvenile production studies and application of GIS and other techniques).

A comprehensive programme of fish counter installation is being carried out in Ireland. There are approximately 135 main stem salmon producing rivers in Ireland. It is hoped to have a total of 30 fish counters operational. Several Geographic Information Systems (GIS) are being developed for important catchments which are aimed at producing productivity estimates from habitat indices.

In Norway, some counters have been installed and testing is in progress and the development of a GIS application to estimate smolt producing areas in rivers is under-way.

In UK, a collaborative investigation is underway on four rivers to investigate the use of hydroacoustic counters and to develop validation procedures.

The two existing counters in the River Foyle Fisheries Commission area, which is jointly managed by Ireland and the UK (N. Ireland) are being supplemented by another three. It is planned to install up to five more in rivers elsewhere. Habitat area is being quantified using GIS with a view to refining conservation limits and defining relationships between productivity and habitat.

In UK (Scotland) progress has been made in developing new statistical methods to derive measures of adult abundance from rod catch data.

On the River Teno a split-beam hydroacoustic counter system (SIMRAD) underwent preliminary testing. Pilot studies will continue. Possible development of a permanent monitoring system will be decided after the 1999 experiment.

13. The implications of combining required adult escapement levels over districts must be examined and the scale to which this is appropriate identified.

No action reported.

3.10.2 Continuing requirements for data, research and monitoring

1. More research into the biology of salmon in the early marine phase is required and extension of recent research on the biology of post-smolts is recommended. Competitive interactions with other marine species should be explored. Additionally, by-catches of post-smolts in marine fisheries for other species should be monitored and estimates of mortality from this source should be derived. There is a continuing requirement to monitor trends in marine mortality for a wider range of stocks than at present, and to identify causes for current low levels of marine survival. In the latter context, it is noteworthy that an ICES Workshop on the Usefulness of Scale Growth Analyses and Other Measures of Condition in Salmon will be held in Amherst, USA in July, 1999.

2. It is recommended that a research fishery at Faroes should be continued and that material gained during previous study should continue to be worked-up.

3. The quality of data used to set conservation limits should continue to be improved and the PFA model should continue development. More and better input data should be obtained from a greater range of sources. Data collection should be targeted at finer scales. New ways of handling data, including GIS applications, and particularly new methods for grouping sub-divisions (eg., populations, or alternative divisions based on biological characteristics such as sea-age or run-timing) should continue to be explored, developed and validated. In particular, sensitivity analyses are essential to assess the confidence with which data derived from the theoretical models can be used in an applied management context.

4. Assessment methods for juvenile salmon and for freshwater habitat parameters should continue to be developed. Attempts should be made to couple these parameters with adult return parameters, via life-history models of appropriate scale. Habitat and life-history variables should be used together to examine the extent to which stock-recruitment relationships from a limited range of index rivers are transferable to other rivers.

5. The status of southern and central European rivers with respect to Gyrodactylus species, and particularly *G. salaris*, should be established without delay. Monitoring of the spread and occurrence of *G. salaris* should be encouraged in salmon-producing countries, and in other countries that are possible sources for transfer of the parasite.

Table 3.2.1.1 Nominal landings of Atlantic salmon by Faroese vessels in years 1982-1998 and the 1981/1982 to 1998/1999 fishing seasons.

Year	Catch (t)	Quota (t) a	Season	Catch (t)
1982	606		1981/1982	796
1983	678		1982/1983	625
1984	628		1983/1984	651
1985	566	625	1984/1985	598
1986	530	625	1985/1986	545
1987	576	597 b	1986/1987	539
1988	243	597 b	1987/1988	208
1989	364	597 b	1988/1989	309
1990	315	550 c	1989/1990	364
1991	95	550 c	1990/1991	202
		Research fishery		
1992	23	550	1991/1992	31
1993	23	550	1992/1993	22
1994	6	550	1993/1994	7
1995	5	550	1994/1995	6
1996	-	470	1995/1996	1
1997	-	425	1996/1997	-
1998	6	380	1997/1998	6
1999	NA	330	1998/1999	-

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

Table 3.2.2.1 Sea age distribution of Atlantic salmon caught in Faroese waters in the 1997/1998 fishing season.

Sea age	1SW	2SW	3+SW	Total
Number	339	1315	109	1763
%	19.2	74.6	6.2	100

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

Year	England & Wales				UK (Scotland)		UK (N. Ireland)			Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Fixed engine[1]	Net and coble	Driftnet	Draftnet	Bagnets and boxes	Bagnet	Bendnet	Liftnet	Driftnet (No. nets)
1966	-	-	-	-	3,513	861	-	-	-	7,101	-	55	-
1967	-	-	-	-	2,982	836	-	-	-	7,106	2,827	48	11,498
1968	-	-	-	-	3,495	970	-	-	-	6,588	2,613	36	9,149
1969	-	-	-	-	3,239	849	139	311	17	6,012	2,756	32	8,956
1970	-	-	-	-	2,861	775	138	306	17	5,476	2,548	32	7,932
1971	-	-	-	-	3,069	802	142	305	18	4,608	2,421	26	8,976
1972	-	-	-	-	3,437	810	130	307	18	4,215	2,367	24	13,448
1973	-	-	-	-	3,241	884	130	303	20	4,047	2,996	32	18,616
1974	-	-	-	-	3,182	777	129	307	18	3,382	3,342	29	14,078
1975	-	-	-	-	2,978	768	127	314	20	3,150	3,549	25	15,968
1976	-	-	-	-	2,854	756	126	287	18	2,569	3,890	22	17,794
1977	-	-	-	-	2,742	677	126	293	19	2,680	4,047	26	30,201
1978	-	-	-	-	2,572	691	126	284	18	1,980	3,976	12	23,301
1979	-	-	-	-	2,698	747	126	274	20	1,835	5,001	17	23,989
1980	-	-	-	-	2,892	670	125	258	20	2,118	4,922	20	25,652
1981	-	-	-	-	2,704	647	123	239	19	2,060	5,546	19	24,081
1982	-	-	-	-	2,377	641	123	221	18	1,843	5,217	27	22,520
1983	232	209	333	74	2,514	659	120	207	17	1,735	5,428	21	21,813
1984	226	223	354	74	2,438	630	121	192	19	1,697	5,386	35	21,210
1985	223	230	375	69	1,999	524	122	168	19	1,726	5,848	34	20,329
1986	220	221	368	64	1,976	583	121	148	18	1,630	5,979	14	17,945
1987	213	206	352	68	1,693	571	120	119	18	1,422	6,060	13	17,234
1988	210	212	284	70	1,536	390	115	113	18	1,322	5,702	11	15,532
1989	201	199	282	75	1,224	347	117	108	19	1,888	4,100	16	0
1990	200	204	292	69	1,276	334	114	106	17	2,375	3,890	7	0
1991	199	187	264	66	1,144	306	118	102	18	2,343	3,628	8	0
1992	203	158	267	65	857	296	121	91	19	2,268	3,342	5	0
1993	187	151	259	55	909	266	120	73	18	2,869	2,783	≤2	0
1994	177	158	257	55	753	245	119	68	18	2,630	2,825	≤2	0
1995	163	156	249	47	737	226	122	68	16	2,542	2,715	≤2	0
1996	151	132	232	42	614	203	117	66	12	2,280	2,860	≤2	0
1997	139	131	231	35	672	198	116	63	12	2,002	1,075	≤2	0
1998	130	129	196	35	529	126	117	70	13	1,865	1,027	≤2	0
Mean 1993-97	163.4	145.6	245.6	46.8	737	227.6	118.8	67.6	15.2	2464.6	2451.6		
% change[2]	-20.4	-11.4	-20.2	-25.2	-28.2	-44.6	-1.5	3.6	-14.5	-24.3	-58.1		
Mean 1988-97	183	168.8	261.7	57.9	972.2	281.1	117.9	85.8	16.7	2251.9	3292		
% change[2]	-29.0	-23.6	-25.1	-39.6	-45.6	-55.2	-0.8	-18.4	-22.2	-17.2	-68.8		

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

[2] (97/mean - 1) * 100

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

	Ireland [5]				Finland				France		
					The Teno River			R. Näätämö			
	Driftnets No.	Draftnets	Other nets	Rod	Recreational fishery Tourist anglers		Local rod and net fishery	Recreational fishery	Rod and line licences	Com. nets in freshwater[3]	Licences in estuary[3,4]
Year					Fishing days	Fishermen	Fishermen	Fishermen			
1966	510	742	214	11,621	-	-	-	-	-	-	-
1967	531	732	223	10,457	-	-	-	-	-	-	-
1968	505	681	219	9,615	-	-	-	-	-	-	-
1969	669	665	220	10,450	-	-	-	-	-	-	-
1970	817	667	241	11,181	-	-	-	-	-	-	-
1971	916	697	213	10,566	-	-	-	-	-	-	-
1972	1,156	678	197	9,612	-	-	-	-	-	-	-
1973	1,112	713	224	11,660	-	-	-	-	-	-	-
1974	1,048	681	211	12,845	-	-	-	-	-	-	-
1975	1,046	672	212	13,142	-	-	-	-	-	-	-
1976	1,047	677	225	14,139	-	-	-	-	-	-	-
1977	997	650	211	11,721	-	-	-	-	-	-	-
1978	1,007	608	209	13,327	-	-	-	-	-	-	-
1979	924	657	240	12,726	-	-	-	-	-	-	-
1980	959	601	195	15,864	-	-	-	-	-	-	-
1981	878	601	195	15,519	16,859	5,742	677	467	-	-	-
1982	830	560	192	15,697	19,690	7,002	693	484	4,145	55	82
1983	801	526	190	16,737	20,363	7,053	740	587	3,856	49	82
1984	819	515	194	14,878	21,149	7,665	737	677	3,911	42	82
1985	827	526	190	15,929	21,742	7,575	740	866	4,443	40	82
1986	768	507	183	17,977	21,482	7,404	702	691	5,919	58 [1]	86
1987	-	-	-	-	22,487	7,759	754	689	5,804 [1]	87 [2]	80
1988	836	-	-	11,539	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	16,484	24,118	8,681	742	696	3,826	83	78
1990	756	525	189	15,395	19,596	7,677	728	614	2,977	71	76
1991	707	504	182	15,178	22,922	8,286	734	718	2,760	78	71
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71
1993	673	497	161	23,875	29,461	10,198	755	705	2,111	53	55
1994	732	519	176	24,488	26,517	8,985	751	671	1,680	17	59
1995	773	446	176	25,000	24,951	8,141	687	716	1,881	17	59
1996	773	446	176	25,000	17,625	5,743	672	814	1,806	21	69
1997	773	446	176	25,000	16,255	5,036	616	588	2,974	10	59
1998	773	509	149	30,078	18,700	5,759	772	673	2,358	16	53
Mean 1993-97	744.8	470.8	173	24672.6	22961.8	7620.6	696.2	698.8	2090.4	23.6	60.2
% change [6]	3.8	8.1	-13.9	21.9	-18.6	-24.4	10.9	-3.7	12.8	-32.2	-12.0
Mean 1988-97	751.5	489.8	177.4	20222.2	22990.1	7956.0	717.5	693.5	2658.8	50.8	67.3
% change [6]	2.9	3.9	-16.0	48.7	-18.7	-27.6	7.6	-3.0	-11.3	-68.5	-21.2

[1] Common licence for salmon and seatrout.

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

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

[4] Adour estuary only southwest of France.

[5] Since 1995 data for Ireland are provisional.

Table 3.3.4.1 Nominal catch of SALMON in NEAC area (in tonnes round fresh weight), 1960-1998. (1998 figures are provisional)

Year	Homewater countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches NEAC Area	Unreported catches International waters
1960	5540	-	-	5540	-	-
1961	4753	-	-	4753	-	-
1962	6709	-	-	6709	-	-
1963	6276	-	-	6276	-	-
1964	7150	-	-	7150	-	-
1965	6456	-	-	6456	-	-
1966	6052	-	-	6052	-	-
1967	7526	-	-	7526	-	-
1968	6146	5	403	6554	-	-
1969	6281	7	893	7181	-	-
1970	5882	12	922	6816	-	-
1971	5582	-	471	6053	-	-
1972	6597	9	486	7092	-	-
1973	7331	28	533	7892	-	-
1974	7027	20	373	7420	-	-
1975	7116	28	475	7619	-	-
1976	5314	40	289	5643	-	-
1977	5209	40	192	5441	-	-
1978	4966	37	138	5141	-	-
1979	5121	119	193	5433	-	-
1980	5434	536	277	6247	-	-
1981	4909	1025	313	6247	-	-
1982	4471	606	437	5514	-	-
1983	5873	678	466	7017	-	-
1984	4769	628	101	5498	-	-
1985	5533	566	-	6099	-	-
1986	6183	530	-	6713	-	-
1987	4830	576	-	5406	2554	-
1988	5284	243	-	5527	3087	-
1989	4059	364	-	4423	2103	-
1990	3439	315	-	3754	1779	180-350
1991	2822	95	-	2917	1555	25-100
1992	3343	23	-	3366	1825	25-100
1993	3311	23	-	3334	1471	25-100
1994	3563	6	-	3569	1157	25-100
1995	3274	5	-	3279	942	n/a
1996	2746	-	-	2746	947	n/a
1997	2087	-	-	2087	827	n/a
1998	2233	6	-	2239	1108	n/a
Means						
1993-1997	2996	7	-	3003	1069	-
1988-1997	3393	107	-	3500	1569	-

1. Estimates refer to season ending in given year.

Table 3.3.5.2 CPUE data for net and fixed engine salmon fisheries by Region in UK (England & Wales), 1988-1998. (Data expressed as catch per licence-day.)

	Region			
Year	North East	Southern [1]	Welsh	North West
1988	5.49	10.15	-	-
1989	4.39	16.80	0.90	0.82
1990	5.53	8.56	0.78	0.63
1991	3.20	6.40	0.62	0.51
1992	3.83	5.00	0.69	0.40
1993	6.43	-	0.68	0.63
1994	7.53	-	1.02	0.71
1995	7.84	-	1.00	0.79
1996	3.74	-	0.73	0.59
1997	5.30	-	0.77	0.35
1998	5.12	-	0.69	0.32
Mean 1993-97	6.17	-	0.84	0.61

[1] Fishery has not operated since 1993.

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

Year	Fixed engine	Net and coble CPUE
	Catch/trap month 1	Catch/crew month
1952	33.91	156.39
1953	33.12	121.73
1954	29.33	162.00
1955	37.09	201.76
1956	25.71	117.48
1957	32.58	178.70
1958	48.36	170.39
1959	33.30	159.34
1960	30.67	177.80
1961	31.00	155.17
1962	43.89	242.00
1963	44.25	182.86
1964	57.92	247.11
1965	43.67	188.61
1966	44.86	210.59
1967	72.57	329.80
1968	46.99	198.47
1969	65.51	327.64
1970	50.28	241.91
1971	57.19	231.61
1972	57.49	248.04
1973	73.74	240.60
1974	63.42	257.11
1975	53.63	235.71
1976	42.88	150.79
1977	45.58	188.67
1978	53.93	196.07
1979	42.20	157.19
1980	37.65	158.62
1981	49.60	183.86
1982	62.26	181.89
1983	56.20	206.83
1984	58.98	160.98
1985	54.48	156.55
1986	75.93	204.87
1987	64.34	147.14
1988	51.91	204.53
1989	71.68	268.78
1990	33.31	148.37
1991	35.62	100.44
1992	59.10	151.85
1993	52.29	124.06
1994	93.23	123.40
1995	75.03	139.72
1996	60.35	109.56
1997	33.72	55.45
1998	36.85	76.23

1 - Excludes catch and effort for Solway Region

Table 3.3.5.4 Fisheries in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations) (p <0.1 means significance upward trend, p>0.9 means significant downward trend).

Section/Data type	**Fisheries**	**Life stage**	**Period (years)**	**'p' value**	**Trend**
Section 3.3.5					
CPUE	UK (Scotland) net fisheries. Catch/trap month		10	0.996	**Dn**
	UK (England & Wales) net and fixed engines. Catch per licence-day		10	0.3	Nt
	Finland (Teno, Näätämö) and France. Rod catch/season,		10	0.06	**Up**
	Finland (Teno, Näätämö) and UK (N Ireland) (Bush). Rod catch/day		10	0.12	Nt
	Russia (Barents Sea basin: Rynda, Kharlovka, Varzina, Iokanga). Rod catch/day		7	0.997	**Dn**
	Russia (White Sea basin: Ponoy, Varzuga, Kitsa, Umba). Rod catch/day		8	0.001	**Up**
Section 3.3.9					
Exploitation rates	Burrishoole + Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe), Frome + Leven + Lune (UK (E&W))	1 SW	10	>0.1	Nt
	Burrishoole + Corrib (Irl), North Esk (UK Scot), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe), Frome + Leven + Lune (UK (E&W))	1 SW	5	>0.1	Nt
	Corrib (Irl), North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	2 SW	10	0.97	**Dn**
	North Esk (UK Scot), Bush (UK NI), Imsa + Drammen (Nor), Ellidaar (Ice), Lagan (Swe)	2 SW	5	>0.1	Nt
	B.Z.Litsa, Ura, Tuloma, Kola (Russia, Barents Sea basin)	All ages	10	0.999	**Dn**
			5	0.999	**Dn**
	Ponoy, Kitsa,Varzuga, Umba (Russia, White Sea basin)	All ages	10	0.999	**Dn**
			5	0.22	Nt

Table 3.3.6.1 The percent of 1SW salmon in catches from countries in the North East Atlantic Commission, 1987-1998.

Year	Finland	France	Norway	Russia	Sweden	UK (Scot)	UK (E&W) (1)
1987	66	77	61	71		61	
1988	63	29	64	53		57	
1989	66	33	73	73	41	63	
1990	64	45	68	73	70	48	
1991	59	39	65	70	71	53	
1992	70	48	62	72	68	55	77
1993	58	74	61	61	62	57	78
1994	55	55	-	69	64	54	75
1995	59	60	58	70	78	53	70
1996	80	51	53	80	63	54	63
1997	70	51	74	82	54	54	73
1998	75	71	66	82	59	59	83
1993-97 mean	64	58	49	72	64	54	72
1988-97 mean	64	49	58	70		55	

1. Refers to rod and line catches only.

Table 3.3.7.1 Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic (figures for 1998 include provisional values).

Country	Catches of Salmon						
	Year/ Season	Wild	FW Farmed	SEA Farmed	Total Farmed	Ranched	Total
Norway	1989	707	29	166	195	3	905
	1990	709.8	29	185	214	6.2	930
	1991	682.5	20	169	189	5.5	877
	1992	653.7	27	176	203	10.3	867
	1993	707	18	191	209	7	923
	1994	781	18	187	205	10	996
	1995	654	13	170	183	2	839
	1996	557	19	203	222	8	787
	1997	430	21	177	198	2	630
	1998	533	26	180	206	1	740
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
	1992/1993	16.1			5.9	0	22
	1993/1994	5.8			1.2	0	7
	1994/1995	4.8			1.2	0	6
	1995/1996	0.8			0.2	0	1
	1996/1997	0			0	0	0
	1997/1998[5]						6
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
	1993	70			<1	0	70
	1994	49			<1	0	49
	1995	48			<1	0	48
	1996	44			<1	0	44
	1997	45			<1	0	45
	1998	48			<1	0	48
France	1991	13			0	0	13
	1992	20			0	0	20
	1993	16			0	0	16
	1994	18			0	0	18
	1995	9			0	0	9
	1996	14			0	0	14
	1997	8			0	0	8
	1998	9			0	0	9
Iceland[1]	1991	130			3	345	478
	1992	175			+	460	635
	1993	160			-	496	656
	1994	140			-	308	448
	1995	150			-	298	448
	1996	122			-	239	361
	1997	106			-	50	156
	1998	130				34	164
Ireland[2]	1991	400			1.7	2.3	404
	1992	621			2.3	6.7	630
	1993	532			1.1	8.1	541
	1994	789			2.6	12.5	804
	1995	774			0.7	14.8	790
	1996	667			1.8	15.9	685
	1997	566			1.1	3.0	570
	1998	616			2.1	6.0	624

Table 3.3.7.1 (cont'd) Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic (figures for 1998 include provisional values).

Country	Catches of Salmon					
	Year/ Season	Wild	Farmed	Total Farmed	Ranched	Total
Russia	1991	215		0	0	215
	1992	167		0	0	167
	1993	139		0	0	139
	1994	141		0	0	141
	1995	128		0	0	128
	1996	131		0	0	131
	1997	111		0	0	111
	1998	131		0	0	131
Sweden	1991	23		1	14[3]	38
	1992	24		1	24[3]	49
	1993	35		1	20[3]	56
	1994	15		1	29[3]	44
	1995	12		1	24[3]	37
	1996	10		1	22[3]	33
	1997	9		0	10[3]	19
	1998	9		0	6[3]	15
UK (E&W)	1991	200		0	0	200
	1992	186		0	0	186
	1993	263		0	0	263
	1994	307		0	0	307
	1995	295		0	0	295
	1996	180		0	0	180
	1997	156		0	0	156
	1998	143		0	0	143
UK (N.Ire)	1991	54		<1	-	55
	1992	85.3		1.1	2.6	89
	1993	80.5		0.2	2.3	83
	1994	90.1		0.5	0.4	91
	1995	80.6		1.5	0.9	83
	1996	74.7		n/a	2.3	77
	1997	90.7		0.07	2.2	93
	1998	74		0.03	1.0	75
UK (Scot)[4]	1991	448		14	0	462
	1992	569		31	0	600
	1993	516		31	0	547
	1994	644		5	0	649
	1995	586		2	0	588
	1996	427		<1	0	427
	1997	296		<1	0	296
	1998	280		<1	0	280

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

Table 3.3.7.2 Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989-1998. n=number of salmon examined.

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

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

Table 3.3.7.3 Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June–18 August) and brood stock catches (18 August–30 November) in Norway in 1989–1998. (n=number of salmon examined; R= number of rivers sampled).

	1 June–18 August				18 August–30 November			
Year	n	R	%	Range	n	R	%	Range
1989	5970	39	7	0 - 26	1892	19	35	2 - 77
1990	5380	39	7	0 - 55	2071	23	34	2 - 82
1991	4563	31	5	0 - 23	1738	25	24	0 - 82
1992	4259	32	5	0 - 24	1489	22	26	0 - 71
1993	3979	27	4	0 - 22	1207	19	20	0 - 64
1994	3243	18	4	0 - 19	1699	19	22	0 - 75
1995*	3554	27	4	0 - 20	1057	19	28	0 - 71
1996*	3020	29	7	0 - 54	1443	23	31	0 - 82
1997	2747	30	9	0 - 34	1892	36	29	0 - 83
1998	3419	29	8	0 - 37	1492	26	22	0 - 95

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

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

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

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

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

Table 3.3.7.6 Geographical distribution by frequency (%) of escaped farmed fish located among commercial catch samples for UK (Northern Ireland) and Ireland inshore catches (1991–1998).

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

Table 3.3.7.7 Frequency of occurrence of escaped farmed salmon among Scottish fisheries for wild salmon (1981–1998).

Year	Net											Rod
	East Riggs %	Redpoint %	Achiltibuie %	Culkein Clachtol %	Strathy %	Bonar B. %	Spey %	Dee %	N. Esk %	Tay %	Tweed %	N. Esk %
1981	[a]0				[a]0	[a]0	[a,b]0		[a,b]0			
1982	[a]0				[a]0.3	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1983	[a]0				[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1984	[a]0				[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	
1985	[a]0			[a]0	[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0
1986				[a]0.6	[a]0	[a]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0	[a,b]0
1987	[a]0			[a]1.3	[a]0	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1988				[a]1.5	[a]0.6	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1989				[a]6.6	[a]6.1	[a]0.7	[a,b]0.08		[a,b]0	[a,b]0	[a,b]0	[a,b]0
1990		[a,b,c]22		[a]4.7	[a]3.8	[a]0	[a,b]0		[a,b]0	[a,b]0	[a,b]0.13	[a,b]0
1991		[a,b,c]19.8		[a]8.6	[a]7.3	[a]0.4	[a,b]0.14		[a,b]0.13	[a,b]0	[a,b]0	[a,b]0
1992		[a,b,c]18.5		[a]3.5	[a]2.3	[a]0.5	[a,b]0		[a,b]0	[a,b]0.13	[a]0	[a,b]0.16
1993		[a,b,c]37.5		[a,b]14.4	[a,b]15.2	[a,b]0.7			[a,b]0	[a,b]0	[a,b]0	[a,b]0.15
1994				[a,b]7.7	[a,b]7.1	[a,b]0.6			[a,b]0	[a,b]0.18	[a,b]0.4	[a,b]0.3
1995		[a,b]14.5	[a,b]4.2		[a,b]4.1				[a,b]0	[a,b]0	[a,b]0	[a,b]0
1996		[a,b]4.84	[a,b]6.9		[a,b]3.4				[a,b]0	[a,b]0	[a,b]0	[a,b]0
1997		[a,b]0	[a,b]0		[a,b]2.1				[a,b]0			[a,b]0
1998			[a,b]3.45	[a,b]2.8	[a,b]0.5				[a,b]0.05		[a,b]0	[a,b]0.35

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

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

	Ireland[1]			UK (England and Wales)								UK (Northern Ireland)[1]				UK (Scotland)[2]	
	Burrishoole	Corrib		Dee	Dee	Itchen	Test	Frome	Leven	Lune	Lune	River Bush				North Esk	
	net	net	net	rod	rod	rod	rod	rod	rod	rod	net	net	net	net	net	In-river netting	
Year	HR	W	W	W	W	W	W	W	W	W	W	W	W/HR	HR1+	HR2+	W	W
	1SW	1SW	2SW	1SW	MSW	(all ages)	(all ages)	(all ages)	(all ages)	(all ages)	(all ages)	1SW	2SW	1SW	1SW	1SW	2SW
1985	86	66	11	-	-	-	-	-	-	-	-	-	-	93	-	23	35
1986	86	52	34	-	-	-	-	-	-	-	-	-	-	82	75	40	29
1987	78	-	5	-	-	-	-	-	-	-	-	69	46	94	77	29	37
1988	75	29	-	-	-	33	39	9	-	-	-	65	36	72	57	35	37
1989	82	43	35	-	-	47	29	7	-	22	44	89	60	92	83	25	26
1990	52	31	45	-	-	47	36	10	-	30	36	61	38	63	70	36	34
1991	65	19	19	6	10	43	26	8	-	27	30	65	43	57	46	10	15
1992	71	24	28	14	18	29	25	9	-	33	30	56	33	74	75	28	27
1993	71	31	82	11	15	39	33	11	27	21	30	41	12	67	71	25	18
1994	73	50	0	15	21	39	32	13	28	35	35	-	40	71	64	19	18
1995	84	50	18	7	11	25	28	9	37	24	27	67	42	69	-	14	12
1996	81	52	75	9	11	36	23	13	45	23	24	-	-	81	77	19	10
1997	68	38	-	8	9	14	14	7	26	25	29	60	-	79	75	12	12
1998[3]	n/a	n/a	n/a	10	10	36	23	9	n/a	24	14	n/a	n/a	n/a	n/a	23	12
Mean																	
1988-97	72	37	38	10	14	35	29	10	33	27	32	63	38	73	69	22	21
1993-97	75	44	44	10	13	31	26	11	33	26	29	56	31	73	72	18	14

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

[2] Estimate based on counter and catch figures.

[3] Provisional figures.

[4] Probably underestimated.

HR = Hatchery reared.

W = Wild.

'-' = no data

Continued..........

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

	Iceland[1]	Norway[2]							Sweden[3]	
	Ellidaar	Drammen			Imsa				Lagan	
	rod	rod	net		net		net		net	
Year	W	W/HR	HR[4]		W		HR[4]		HR[4]	
	1SW		1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW
1985	40	33	57	-	73	94	81	100	81	-
1986	34	50	81	50	79	82	78	90	93	82
1987	54	44	64	52	56	95	83	95	78	55
1988	45	53	70	47	51	80	78	91	73	91
1989	41	35	40	59	65	74	44	65	76	86
1990	41	33	23	40	42	42	47	68	80	82
1991	37	28	54	59	37	72	50	66	91	92
1992	48	46	-	51	61	76	74	91	73	98
1993	41	45	20	-	53	80	85	89	89	82
1994	49	42	42	34	58	80	70	94	70	100
1995	43	53	29	40	-	86	56	88	58	70
1996	56	47	7	23	66	-	80	89	64	78
1997	50	45	15	23	58	80	66	-	55	58
1998	55	47	20	36	13	40	10	66	83	66
Mean										
1988-97	45	43	33	42	55	74	65	82	73	84
1993- 97	48	46	23	30	59	82	71	90	67	78

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

Reporting rates for external tags:

Norway	0.50
Sweden	0.65
Elsewhere	0.50

Continued.........

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

	Russia[1,6] Barents sea basin				Russia[1,6] White sea basin			
	B.Z.Litsa	Ura	Tuloma	Kola	Ponoi	Kitsa	Varzuga	Umba
	net	net	net	net	net and rods	net	net	net
Year	W	W	W	W+HR	W	W	W	W
				all sea ages				
1985	48	49	47	90	47	46	39	50
1986	49	50	50	77	50	44	49	50
1987	49	49	49	91	48	35	37	35
1988	49	48	51	87	77	35	36	34
1989	49	48	50	84	78	35	37	31
1990	49	47	50	80	50	35	35	3
1991	51	48	48	58	20	32	31	13
1992	42	49	45	77	11	30	29	5
1993	48	64	39	79	10	23	27	9
1994	38	48	42	73	14	15	30	15
1995	44	45	49	77	14[7]	22	27	8
1996	42	49	43	66	10 7	20	14	8
1997	30	32	16	43	19	21	12	9
1998	24	24	0	31	14	20	32	0
Mean								
1988-97	44	48	43	72	35	27	28	14
1993- 97	40	48	38	68	14	20	22	10

[1]Estimate based on counter and catch figures.

[6]Net only.

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

Table 3.4.1.1 Conservation limits achievement (egg deposition /conservation limit) in rivers in the NEAC area.

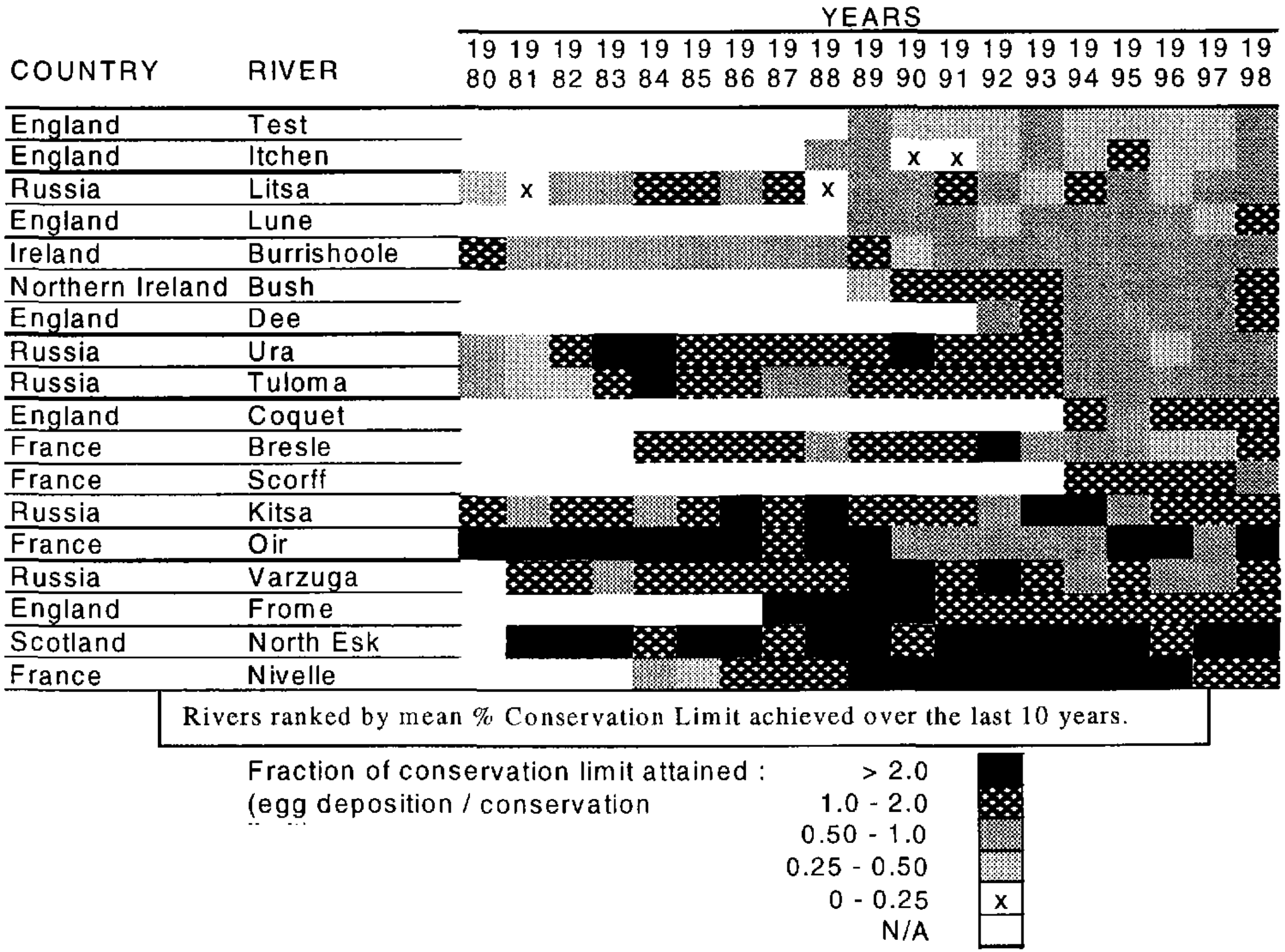


Table 3.4.2.1 Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Finland, Norway and Sweden).

Year	Finland							Norway			Sweden
	River Teno	River[1] Inarijoki	River[1] Utsjoki	River[2] Ylapulmankijoki	River[2] Tsarsjoki	River[2] Karigasjoki	River[2] Kuoppilajoki	River Halselva	River Imsa	River Orkla	River Hogvadsån
	Juvenile Survey[3]	Juvenile Survey[3]	Juvenile Survey[3]	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total count	Smolt Total Count	Smolt Estimate	Smolt Partial Count[4]
1964											9,771
1965											2,610
1966											367
1967											627
1968											1,564
1969											4,742
1970											242
1971											-
1972											-
1973											1,184
1974											184
1975											363
1976											247
1977											-
1978											38
1979	19.9	18.0	93.2								103
1980	26.4	37.2	46.2								1,064
1981	13.4[5]	17.9	52.3						3,214		500
1982	36.6	19.7	70.5						736		1,566
1983	53.4	51.8	86.5						1,287	121,000	2,982
1984	39.1	40.6	70.7						936	183,000	4,961
1985	60.8	40.8	84.2						892	173,000	4,989
1986	52.0	40.5	41.5						477	227,000	2,076
1987	45.1	45.5	70.8						480	238,000	3,173
1988	33.4	46.2	49.0						1,700	152,000	2,571
1989	36.1	37.9	81.3	2,500	2,495			788	1,194	-	882
1990	35.3	51.1	101.5	3,058	2,615	2,576		812	1,822	323,000	1,042
1991	40.7	53.2	32.3	2,447	1,828	1,349	739	1,377	1,995	243,000	1,235
1992	25.8[5]	48.2	51.2	3,538	4,219	435	257	865	1,500	262,534	1,247
1993	34.0	41.5	66.7	2,825	3,078	189[5]	70	613	398	297,264	1,305
1994	50.8	60.9	96.9	1,268	2,794	706	142	494	-	165,875	993
1995	45.7	40.5	63.5	-	-	-	-	497	338	174,677	1,525
1996	32.3	27.1	48.7	-	-	-	-	558	682	162,522	795
1997	27.2	38.3	56.7	-	-	-	-	1,013	1,180	225,471	703
1998	24.1	38.4	57.0	-	-	-	-	1,106	887	124,545	1,140
Mean 93–97	38.0	41.7	66.5	-	-	-	-	635	650	205,162	1,064

[1] Major tributary of River Teno [2] Tributary of River Teno. Smolt traps out of commission since 1995.
[3] Juvenile survey represents mean fry and parr abundance (number 100 m² caught by electrofishing) at 35, 10 and 12 sites respectively.
[4] Smolt trap catch represents part of the run. [5] Incomplete data. Minimum numbers due to high water levels.

Continued.....

Table 3.4.2.1 (Cont'd) Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Iceland, France, Ireland, UK(N.Ireland), UK(E&W),UK(Scotland).

Year	Iceland		France			Ireland	UK (N Ireland)		UK (Scotland)		
	River Ellidaar	River Vesturdalsa	River Nivelle	River Oir	River Bresle	River Burrishoole	River Bush		River North Esk	Girnock Burn	Baddock Burn
	Smolt Estimate	Smolt Estimate	Juvenile Survey[6]	Smolt est.	Smolt est.	Smolt Total trap	Smolt Total Trap	Juvenile Survey[7]	Smolt est.	Smolt Total trap	Smolt Total trap
1964									275,000		
1965									183,000		
1966									172,000		
1967									98,000	2,057	
1968									227,000	1,440	
1969									-	2,610	
1970									-	2,412	
1971									167,000	2,461	
1972									260,000	2,830	
1973									165,000	1,812	
1974							43,958		106,000	2,842	
1975							33,365		173,000	2,444	
1976							21,021		93,000	2,762	
1977							19,693		-	3,679	
1978							27,104		-	3,149	
1979							24,733		-	2,724	
1980						11,208	20,139		132,000	3,074	
1981						9,434	14,509		195,000	1,640	
1982					3,120	10,381	10,694		160,000	1,626	
1983					3,155	9,383	26,804	32.6	-	1,747	
1984					2,095	7,270	30,009[8]	19.5	225,000	3,247	
1985	29,000		882	529	4,130	6,268	30,518[8]	7.6	130,000	2,716	
1986	-		6,881[9]	1,312	1,940	5,376	18,442	11.3	-	2,091	
1987	-		11,039[9]	363	1,080	3,817	21,994	10.3	199,000	1,132	
1988	23,000		9,946[9]	419	2,400	6,554	22,783	8.9	-	2,595	
1989	22,500	14,642	6,658[9]	830	-	6,563	17,644	16.2	141,000	1,360	
1990	24,000	11,115	2,505[9]	808	-	5,968	17,133	5.6	175,000	2,042	1,907
1991	22,000	9,300	5,287[9]	202	-	3,804	18,218	12.5	236,000	1,503	2,582
1992	27,700	19,100	3,452	672	1,160	6,926	10,021	13.0	-	2,572	2,029
1993	18,000	-[11]	2,640	226	1,700	5,429	11,583[10]	7.8	-	2,147	-
1994	14,500	-[11]	8,092[9]	539	2,400	5,971	14,145	11.5	148,000	1,223	1,280
1995	18,000	6,750	2,841	733	-	5,998	5,718	8.5	138,000	2,056	1,789
1996	23,200	11,500	5,068	1,003	1,320	5,854	12,449	9.9	162,000	1,636	1,627
1997	16,500	17,200	5,888	724	6,300	6,331	10,783	6.9	143,000	2,788	2,913
1998			5,392	1,034	1,650	9,588	14,819	3.5	-	1,652	1,417
Mean 93–97	18,040	11,817	5,456	645	1,640	5,917	12,269	8.9	147,750	1,970	1,902

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

[7] Juvenile surveys represent index of fry (0+) abundance (number per 5 minutes electrofishing) at 137 sites, based on natural spawning in the previous year.

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

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

Type of data	Rivers (Countries)	Life stage	Period (years)	'p' value	Trend
Section 3.4.2 Smolt counts	Oir (Fra), Imsa, Halselva (Nor), Burrishoole (Irl), Bush (UK NI), Hogvadsån (Sweden),	Smolts	5	0.056	**Up**
			10	0.59	Nt
	Orkla (Nor), North Esk, Girnock, Baddoch (UK Scot), Ellidaar (Ice).	Smolts	5	0.523	Nt
			10	0.997	**Dn**
Section 3.4.4 Wild smolt	Corrib (Irl), Bush (UK NI), Imsa (Nor), North Esk (UK Scot), Elidaar + Midfjardara(Ice)	1SW return to homewaters	10	0.73	Nt
survival	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Elidaar+Midfjardara (Ice)	1SW return to homewaters	5	0.99	**Dn**
	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Midfjardara (Ice)	2SW return to homewaters	10	0.88	Nt
	Corrib (Irl), Imsa (Nor), North Esk (UK Scot), Midfjardara (Ice)	2SW return to homewaters	5	0.46	Nt
Section 3.4.4 Hatchery smolt	Kollafjordur+Midfjardara (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	10	0.966	**Dn**
survival	Kollafjordur + Midfjardara (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	5	0.547	Nt
	Kollafjordur + Midfjardara (Ice), Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	10	1	**Dn**
	Kollafjordur + Midfjardara (Ice), Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	5	0.931	Nt

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

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

Year	Iceland	Sweden	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia
	River Ellidaar	River Högvadsån	River Ura	River Kitsa	River Tuloma	River Varzuga	River Keret	River Ponoy[1]	River Kola	River Yokanga	R. Zap. Litca
	Estimate	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap	Total trap
1952	3792				4800						
1953	2526				2950						
1954	2794	364			4010						
1955	4118	210			4600				4855		
1956	2911	144			4800				2176		
1957	2965	126			4300				2949		
1958	3057	632	983		6228				1771		1051
1959	4773	197	997		6125				2790		1642
1960	4815	209	3293		10360				5030		2915
1961	3779	229	2178		11050	55480			5121		2091
1962	3126	385	1184	1884	10920	69388			5776	3655	2196
1963	4031	217	811	3431	7880	64210			3656	3253	1983
1964	4526	390	787	2936	4400	21424		23666	3268	2642	1664
1965	3249	442	1334	-	5600	63812		12998	3676	4482	1506
1966	4274	375	925	1574	3648	21086		10333	3218	2488	787
1967	4839	90	2679	1258	9011	20534		11527	7170	4993	1486
1968	3024	172	1996	2755	6277	47258		18352	5008	3357	1971
1969	3580	321	967	2329	4538.	53048		9267	6525	1437	2341
1970	2187	610	1792	2171	6175	55556		9822	5416	1117	2048
1971	2590	173	1172	4406	3284	71400		8523	4784	2300	1502
1972	4627	281	1693	1717	6554	48858		10975	8695	1620	1316
1973	6014	100	2502	2091	9726	45750		20553	9780	869	1319
1974	6925	270	1968	2352	12784	39360		24652	15419	280	2605
1975	7184	138	3249	6702	11074	89836		41666	12793	736	2456
1976	3331	65	2110	4310	8060	57246		44283	9360	2767	1325
1977	3756	49	2784	4166	2878	35354		37159	7180	2488	1595
1978	4372	23	1358	2047	3742	18483		24045	5525	1715	766
1979	4948	15	888	2838	2887	40992		17920	6281	598	700
1980	2632	260	957	1073	4087	43664		15069	7265	1052	548
1981	2656	512	438	2173	3467	32158		11670	7131	472	477
1982	4275	572	1205	1953	4252	26824		9585	5898	1200	889
1983	3257	447	2108	1712	9102	59784		15594	10643	1769	1254
1984	1659	629	4458	3372	10971	39636		26330	10970	2498	1859
1985	2896	768	2634	5123	8067	48566		38787	6163	1774	1563
1986	2651	1632	2474	3240	7275	71562	3230	32266	6508	3212	1815
1987	2191	1475	1788	3495	5470	137419	3427	21212	6300	3468	1498
1988	4435	1283	1252	3667	8069	72528	3294	20620	5203	2270	575
1989	4329	480	2434	1305	8413	65524	3531	19214	10929	2850	2613
1990	3383	879	1558	2299	11594	56000	2520	37712	13383	3376	1194
1991	3020	534	1328	988	7253	63000	690	21000	8500	1704	2081
1992	2917	345	3391	2619	5377	61300	536	26600	14670	5208	2755
1993	3363	603	1972	674	4516	68300	687	26800	11400	2600	2267
1994	2298	640	1738	487	3316	77800	753	28600	9730	2500	2100
1995	2509	156	1461	700	4737	42290	1066	33100	6051	1153	1916
1996	2170	249	1171	976	4424	67900	391	32600	7700	2700	2330
1997	1132	189	2028	1076	4405	73430	180	32685	6180	2700	1350
1998	875	160	1100	1031	3338	83050	607	41786	4848	-	1510
Mean 93–97	2294	367	1674	783	4280	69236	615	30757	8212	2263	1993

[1]Mark recapture estimate from 1994.

Continued....

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

Year	Russia	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (E&W)	UK (NI)	UK (NI)	UK (NI)	UK (NI)
	Umba	Usk	Frome	Test	Itchen	Kent	Leven	Tamar	Dee	Lune	Roe	Bush	Faughan	Mourne
	Total trap	Counter	Counter	Counter + catch	Counter + catch	Counter	Counter	Counter	Counter + catch	Counter	Counter	Total trap	Counter	Counter
1966													6792	15112
1967													1723	7087
1968													1657	2147
1969	2030												1195	1569
1970	1316												3214	5050
1971	288												1758	4401
1972	548												1020	1453
1973	2536											2614	1885	2959
1974	2692											3483	2709	3630
1975	5432											3366	1617	1742
1976	1926											3124	2040	2259
1977	3692											1775	2625	2419
1978	3308											1621	2587	5057
1979	3772											1820	3262	2226
1980	5924											2863	3288	3146
1981	6252											1539	3772	2399
1982	8690											1571	2909	4755
1983	7850											1030	2410	1271
1984	6326											672[1]	2116	1877
1985	12190											2443	9077	8149
1986	8568											2930	4915	6295
1987	10040											2530	907	2322
1988	8455	7446	4093	1507	1336							2832	3228	7572
1989	12029	1719	3186	1730	791	1137				8785		1029	8287	9497
1990	9040	2532	1880	790	367	2216				8261		1850	6458	11541
1991	6400	2746	805	538	152	1736	667			7591		2341	4301	7987
1992	8400	3108	900	614	357	1816	394		4643	5567		2546	7375	7420
1993	8500	5197	1182	1249	852	1526	469		9757	10852		3235	8655	17855
1994	6800	9120	1078	775	374	2072	562	6343	5285	9236		2010	7439	19908
1995	7340	6189	1016	647	880	2762	329	5623	5703	6111		1521	5838	7547
1996	6450	6926	1353	623	437	3246	387	3975	4931	6080		1097	13297	5475
1997	6200	n/a	1157	361	246	1476	233	2813	5496	4371		1677	-	6979
1998	6440	n/a	1210	898	453	4871	-	3132	6661	7457	2600	2995	-	6077
Mean 93–97	7058	6108	1157	731	558	2216	396	4689	6234	7330	-	1908	6127.2	11553

[1]Minimum count.

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

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

	UK (Scotl.)	UK (Scotl.)	UK (Scotl.)	UK (Scotl.)	France	France	France	France	Norway	Norwa y	Ireland
Year	N. Esk	West Water	Girnock	Baddoch	Nivelle	Oir	Scorff	Bresle	Halselva	Imsa	Burrishoole
	Counter	Counter	Total trap Females	Total trap Females	Trap est.	Trap est.	Trap est.	Trap est.	Total trap	Total trap	Total trap
1966			156								
1967			115								
1968			111								
1969			31								
1970			34								
1971			61								
1972			79								
1973			127								
1974			105								
1975			65								
1976			90								
1977			49								
1978			16								
1979			49								
1980			121								832
1981	9025		41								348
1982	8121		43							66	510
1983	8972		26							14	602
1984	7007		58		33	307		110		32	319
1985	9912		30		61	296		135		31	567
1986	6987		75		204	216		210		22	495
1987	7014		110		138	180		200	52	9	468
1988	11243		112	47	130	235		105	77	44	458
1989	11026		43	67	263	235		220	64	83	662
1990	4762		29	52	291	84		125	68	67	231
1991	9127	2962	57	46	184	47		215	89	43	547
1992	10795	2809	35	32	234	60		225	35	70	360
1993	10887	2699	21	27	472	176		75	18	39	528
1994	11341	2976	37	40	317	155	694[1]	105	29	-	516
1995	9864	2391	71	16	195	128	982	80	9	-	561
1996	7993	2656	41	26	214	196	756	40	25	2	405
1997	11315	2926	9	9	126	67	542	45	77	11	538
1998	10474	2422	11	10	160	189	551	270	38	16	516
Mean 93–97	10280	2730	36	24	265	144	744	69	32	17	510

[1] Grilse only

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

Smolt	Iceland[1]					Ireland		UK (N.Ireland)[8]	Norway[2]		UK (Scotland)[2]			France	
migration	Ellidaar	R.Vesturdalsa[4]		R.Midfjardara[4]		River Corrib	River Corrib	R. Bush	R. Imsa		North Esk			Nivelle[6]	Bresle
year	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW[3]	1SW	2SW	1SW	2SW	3SW	All ages	All ages
1975	20														
1980						9.4	1.6								
1981						11.8	3.8		17.3	4	13.7	6.9	0.3		
1982						15.6	2.7		5.3	1.2	12.6	5.4	0.2		
1983		2				10.6	1.2		13.5	1.3	-	-	-		
1984						19.8	1.7		12.1	1.8	10	4.1	0.1		
1985	9.4					15.4	1.4		10.2	2.1	26.1	6.4	0.2		
1986						-	-	31.3	3.8	4.2	-	-	-	15.1	
1987				2.4	1.4	12.0	1.0	35.1	17.3	5.6	13.9	3.4	0.1	2.6	
1988	12.7			0.6	0.9	12.4	0.5	36.2	13.3	1.1	-	-	-	2.4	
1989	8.1	1.1	2	0.2	0.7	5.3	1.0	25.0	8.7	2.2	7.8	4.9	0.1	3.5	
1990	5.4	1.0	1.0	1.2	1.3	4.4	0.6	34.7	3.0	1.3	7.3	3.1	0.2	1.8	
1991	8.8	4.2	0.6	1.1	0.5	5.6	0.1	27.8	8.7	1.2	11.2	4.5	-	9.2	
1992	9.6	2.4	0.8	1.4	0.5	5.9	-	29.0	6.7	0.9	-	-	-	8.9	6.9
1993	9.8	-	-	1.0	1.1	9.0	0.8	-	15.6		-	-	-	8.3	10.3
1994	9.0	-	-	1.4	0.6	7.8	0.7	27.1	-	-	17.2	2.3	0.1	7.2	7.5
1995	9.4	1.6	1.2	0.3	0.9	6.7	n/a	n/a	1.8	1.5	11.5	5.1	0.1	2.3	n/a
1996	4.6	1.4	0.3	1.2	0.4	4.1	n/a	31	3.5	0.7	10.7	3.2	-	4.2	n/a
1997	5.3	0.7	-	1.2		n/a	n/a	n/a	1.7		10.3	-	-	2.6[7]	4.8[7]
Mean 1993-1997	7.6	1.2	0.8	1.0	0.8	6.9	0.8	29.1	5.7	1.1	12.4	3.5	0.1	5.5	8.9

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Microtags, corrected for tagging mortality.
[4] Assumes 50% exploitation in rod fishery.
[5] Minimum estimates.
[6] From 0+ stage in autumn.
[7] Incomplete returns.
[8] Assumes 30% exploitation in trap fishery.

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

Smolt year	Iceland[1]					Ireland		Ireland	UK(N.Ireland)		Norway[2]		UK (Scotland)[1]			France		
	River Ellidaar	River Vesturdalsa[5]		River Midfjardara[5]		River Corrib[8]		River Burrishoole	River Bush		River Imsa		North Esk[4]			Oir[3]	Nivelle[6]	Bresle
	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	7.3	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	2.6	0.8	3.1	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	3.3	1.8	5.4	9.5	0.9	2.1	0.3	4.2	2.0	0.2	-	-	-
1982	-	-	-	-	-	5.7	1.6	5.8	7.8	0.8	0.7	0.1	4.9	2.2	0.2	-	-	-
1983	-	2.0	-	-	-	3.2	0.7	3.4	1.9[3]	1.7	2.4	0.1	-	-	-	3.2	-	-
1984	-	-	-	-	-	4.5	0.7	7.8	6.4	1.4	3.2	0.3	3.9	2.1	0.1	7.7	-	-
1985	9.4	-	-	-	-	4.0	0.8	7.9	7.9	1.9	2.1	0.1	5.9	2.9	0.2	7.5	-	-
1986	-	-	-	-	-	-	-	8.7	9.7	1.9	1.7	0.8	-	-	-	3.6	15.1	-
1987	-	-	-	2.4	1.4	6.0	0.4	12.0	12.0	0.4	8.3	1.5	6.7	2.1	0.1	7.3	2.6	-
1988	12.7	-		0.6	0.9	3.7	0.1	10.1	3.9	0.8	4.5	0.6	-	-	-	2.0	2.4	-
1989	8.1	1.1	2.0	0.2	0.7	2.5	0.4	3.5	9.3	1.4	4.9	0.6	3.5	2.7	0.1	1.6	3.5	-
1990	5.4	1.0	1.0	1.2	1.3	2.3	0.6	9.2	11.8	1.7	1.7	0.3	4.2	2.1	0.2	3.5	1.8	-
1991	8.8	4.2	0.6	1.1	0.5	2.5	0.1	9.5	12.0	2.2	3.4	0.2	5.2	2.3	0.2	11.3	9.2	-
1992	9.6	2.4	0.8	1.4	0.5	2.7	-	7.6	16.8	2.0	3.1	0.2	-	-	-	5.4	8.9	5.8
1993	9.8	-	-	1.0	1.1	1.9	0.2	9.5	15.1	2.0	7.0	-	-	-	-	17.0	8.3	6.3
1994	9.0	-	-	1.4	0.6	1.8	0.1	9.4	8.9	0.7	-	-	4.9	2.0	0.1	3.0	7.2	4.3
1995	9.4	1.6	1.2	0.3	0.9	1.9	n/a	6.8	n/a	2.4	0.6	0.3	5.2	3.2	0.1	4.0	2.3	n/a
1996	4.6	1.4	0.3	1.3	0.4	1.6	n/a	9.2	12.1	2.1	1.5	0.4	5.5	2.8	-	4.0	4.2	2,7
1997	5.3	0.7	-	1.2	-	n/a	n/a	n/a	14.5	-	1.7	-	6.1	-	-		2.6	4.4[7]

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Minimum estimate.
[4] Before in-river netting.
[5] Assumes 50% exploitation in rod fishery.
[6] Survival of 0+parr to adults.
[7] Incomplete returns.
[8] Assumes 30% exploitation in trap fishery.

Table 3.4.4.3 Estimated survival of hatchery smolts (%) to adult return to homewaters, (prior to coastal fisheries) for various monitored rivers and experimental facilities in the NE Atlantic area.

Smolt year	Iceland[1] R. Midfjardara[3]		Ireland[1] R. Burris-hoole[3]	N. Ireland[1] R. Bush (1SW)		Norway[2] R. Imsa		Norway[2] R. Drammen		Sweden[2] R. Lagan	
	1SW	2SW	1SW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981			10.5	-	-	10.1	1.3	-	-	-	-
1982			9.7	-	-	4.2	0.6	-	-	-	-
1983	0.0	0.2	3.64	1.9	8.1	1.6	0.1	-	-	-	-
1984	0.5	0.2	25.1	13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	0.4	0.1	28.9	15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	0.4	0.7	9.4	2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	2.7	0.7	13.6	6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988	0.7	0.2	17.9	4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	0.7	0.4	5.1	8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	1.9	0.5	10.5	5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	1.8	0.2	8.4	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	1.3	0.2	7.5	6.0	7.8	3.8	0.7	0.4	0.6	1.5	0.4
1993	0.5	0.2	12.3	1.1	5.8	6.5	0.5	3.0	1.0	2.6	0.9
1994	1.0	0.2	11.5	1.6	-	6.2	0.6	1.2	0.9	4.0	1.2
1995	0.8	0.1	16.8	3.1	2.3	0.4	0.0	0.7	0.3	3.9	0.6
1996	0.1	0.0	5.6	2.0	n/a	2.1	0.2	0.4	0.3	3.5	0.5
1997	0.9		n/a	n/a		0.9		0.5		0.9	

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

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

Smolt year	Iceland[1] R. Midfjardara[3]		Ireland[1] R.Burri-shoole[3]	N. Ireland[1] R. Bush (1SW)		Norway[2] R. Imsa		Norway[2] R. Drammen		Sweden[4] R. Lagan	
	1SW	2SW	1SW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981			1.3	-	-	2.0	0.1	-	-	-	-
1982			1.7	-	-	0.2	0.03	-	-	-	-
1983	0.0	0.2	0.5	0.1	0.4	0.1	0.0	-	-	-	-
1984	0.5	0.2	3.4	0.9	-	0.6	0.03	2.5	1.2	-	-
1985	0.4	0.1	4.0	2.8	4.3	1.3	0.13	0.6	0.9	-	-
1986	0.4	0.7	0.1	2.1	1.1	0.07	2.2	1.1	-	-	-
1987	2.7	0.7	3.4	1.8	8.2	2.1	0.3	0.5	0.3	-	-
1988	0.7	0.2	3.3	0.4	1.0	4.8	0.2	0.3	0.2	-	-
1989	0.7	0.4	2.5	2.9	6.8	1.5	0.3	1.4	0.6	-	-
1990	1.9	0.5	3.7	2.4	3.0	1.3	0.1	0.1	0.2	-	-
1991	1.8	0.2	2.5	1.4	2.2	0.8	0.1	-	-	-	-
1992	1.3	0.2	2.2	2.0	2.3	0.6	0.1	0.3	0.4	-	0.1
1993	0.5	0.2	3.3	0.3	2.0	2.2	0	1.7	0.6	1.1	0.6
1994	1.0	0.2	1.8	0.5	-	2.6	0.1	0.8	0.6	3.0	0.6
1995	0.8	0.1	3.1	0.57	0.55	0.1	0.0	0.7	0.3	1.4	0.3
1996	0.1	0.0	1.8	0.41	0.57	0.7	0.1	0.3	0.2	1.6	0.5
1997	0.9		n/a	no release	2.76	0.9		0.4		0.2	

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

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

		Fishing season						
		1991/92	**1992/93**	**1993/94**	**1994/95**	**1995/96**	**1996/97**	**1997/98**
NASCO quota (t) for the calender year if fishery operated [a]		550	550	550	550	470	425	380
Expected No. fish **landed** if quota had been taken [b]		147,048	162,850	182,027	172,931	142,037	128,438	140,927
Discard rate		8.8%	9.4%	14.4%	15.1%	11.9% [c]	11.9% [c]	16.9%
Discard mortality		80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80%
Expected No. fish killed if fishery operated		158,399	176,367	206,524	197,536	157,422	142,350	163,855
No. fish **killed** in research fishery		9,350	9,099	3,035	4,187	282	0	1465
Total number of fish saved per year		149,049	167,268	203,489	193,349	157,140	142,350	162,390
Proportion of farmed fish in catch		37.0%	27.0%	17.0%	19.0%	19.0%	19.0%	19.0% [f]
Number farm escapees spared		55,148	45,162	34,593	36,736	29,857	27,046	30,854
Number of wild fish spared		93,901	122,106	168,896	156,613	127,283	115,303	131,536
Sea age composition of wild fish:	1SW	4.0%	12.0%	16.0%	10.6%	10.7% [d]	10.7% [d]	19.2%
	2SW	83.0%	61.0%	64.0%	80.8%	72.2% [d]	72.2% [d]	74.6%
	2SW+	13.0%	27.0%	20.0%	8.6%	17.2% [d]	17.2% [d]	6.2%
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Additional salmon	**1SW**	**2,842**	**11,429**	**21,078**	**12,949**	**10,573**	**9,578**	**19,699**
expected to have returned:	**MSW**	**70,809**	**106,307**	**134,159**	**138,533**	**122,196**	**105,368**	**103,169**
Estimated **1SW** returns to all European homewaters: [e]		2,288,367	2,120,034	2,403,850	2,065,777	2,031,660	1,987,470	2304352
% 1SW returns derived from suspension of commerial fishing at Faroes:		0%	1%	1%	1%	1%	0%	1%
Estimated **MSW** returns to all European homewaters: [e]		1,161,890	1,095,400	1,210,235	1,104,759	1,010,548	780,398	773018
% MSW returns derived from suspension of commerial fishing at Faroes:		6%	10%	11%	13%	12%	14%	13%
Estimated **1SW** returns to Northern European homewaters: [e]		1,049,894	914,669	985,292	909,448	906,526	940,116	1091123
% 1SW returns derived from suspension of commerial fishing at Faroes: (Assuming 65% from N. Europe)		0%	1%	1%	1%	1%	1%	1%
Estimated **MSW** returns to Northern European homewaters: [e]		552,741	546,852	541,139	482,513	468,991	378,683	402698
% MSW returns derived from suspension of commerial fishing at Faroes: (Assuming 65% from N. Europe)		8%	13%	16%	19%	17%	18%	17%

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

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

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

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

e. Includes farmed escapees.

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

Table 3.5.2 Results of non-parametric ratio analysis to examine changes in homewater catches or returns after the cessation of commercial fishing at Faroes in 1991

Type of data	Area considered	Periods compared	p value	Effect
1SW catches in Northern Europe	Finland, Sweden, Norway, Iceland	1987-91 vs 1992-96	0.004	**Lower catch**
	Norway only	1987-91 vs 1992-96	< 0.001	**Lower catch**
1SW catches in Southern Europe	Ireland (total catch), UK(Scot), UK (E&W), France	1987-91 vs 1992-96	< 0.04	**Lower catch**
MSW catches in Northern Europe	Finland, Sweden, Norway, Iceland	1987-91 vs 1992-96	0.12	Not significant
	Norway only	1987-91 vs 1992-96	0.12	Not significant
MSW catches in Southern Europe	UK (Scot), UK (E&W), France	1987-91 vs 1992-96	0.01	**Lower catch**
Russian adult counts All ages	R. Varzuga, Ponoy, Kola, Yokanga, Zap Litca, Tuloma, Kitsa, Ura	1988-91 vs 1991-98	0.838	Not significant

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

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
1971	8,675	15,572	43,618	820,291	554,111	172,536	11,887	122,919	130,291	1,306,300	**2,395,373**	384,041	**790,827**	81,878	**3,186,200**	392,673
1972	13,459	30,669	39,103	897,076	715,537	190,675	9,599	159,544	118,801	1,332,102	**2,538,193**	406,258	**968,372**	108,307	**3,506,565**	420,448
1973	20,979	19,124	40,588	966,827	784,514	319,477	12,001	148,788	102,374	1,571,368	**2,808,481**	494,492	**1,177,558**	124,284	**3,986,040**	509,872
1974	19,114	8,564	28,017	1,064,073	737,511	299,420	17,292	163,564	103,291	1,427,414	**2,766,906**	425,305	**1,101,354**	114,887	**3,868,260**	440,549
1975	19,278	17,405	40,101	1,109,097	695,371	316,749	18,437	174,603	90,278	1,184,116	**2,575,501**	370,154	**1,089,936**	116,229	**3,665,436**	387,973
1976	16,141	16,063	35,014	779,163	695,837	237,445	10,457	123,598	63,139	929,808	**1,911,771**	311,263	**994,894**	102,794	**2,906,665**	327,798
1977	14,064	13,021	40,073	688,131	670,254	185,963	4,920	135,681	63,428	985,213	**1,885,474**	305,219	**915,274**	94,945	**2,800,749**	319,645
1978	10,514	13,104	48,960	618,716	469,594	216,633	5,731	151,043	83,447	1,039,931	**1,906,241**	286,785	**751,431**	77,588	**2,657,672**	297,095
1979	11,236	14,708	47,412	547,698	807,887	246,014	5,948	105,569	55,712	958,334	**1,682,020**	290,145	**1,118,497**	123,880	**2,800,518**	315,485
1980	11,278	29,818	15,422	426,906	791,931	163,299	7,649	123,943	68,541	706,149	**1,355,357**	251,344	**989,579**	113,198	**2,344,935**	275,658
1981	10,482	24,901	31,968	259,379	569,950	137,327	13,456	165,004	57,359	870,713	**1,377,355**	296,563	**763,181**	87,529	**2,140,536**	309,210
1982	7,473	14,708	23,429	470,158	416,960	172,114	12,075	98,141	74,358	1,211,260	**1,868,624**	448,236	**632,052**	69,200	**2,500,676**	453,546
1983	10,958	16,172	32,301	858,358	703,695	247,607	16,182	127,709	106,869	1,201,000	**2,310,107**	391,398	**1,010,743**	111,986	**3,320,850**	407,103
1984	13,186	26,273	20,187	379,292	751,198	227,195	22,086	106,972	44,868	1,185,696	**1,743,103**	423,848	**1,033,852**	110,634	**2,776,955**	438,049
1985	18,654	9,830	41,303	702,963	775,190	307,529	25,873	108,864	55,018	875,380	**1,752,054**	283,146	**1,168,550**	133,881	**2,920,604**	313,203
1986	17,141	30,561	63,457	728,167	694,785	266,212	28,493	140,001	62,191	1,152,834	**2,113,755**	399,257	**1,070,087**	112,717	**3,183,842**	414,863
1987	24,184	54,027	41,701	559,275	595,915	412,601	22,441	122,836	31,327	937,996	**1,705,461**	338,631	**1,096,842**	120,651	**2,802,303**	359,483
1988	17,074	19,339	76,619	1,128,528	555,098	221,545	19,044	172,298	69,539	852,272	**2,241,976**	279,741	**889,379**	92,521	**3,131,355**	294,644
1989	27,508	10,323	41,334	469,599	759,687	336,554	5,984	126,376	64,322	1,154,350	**1,824,969**	539,071	**1,171,067**	141,056	**2,996,036**	557,220
1990	26,029	17,196	38,537	365,342	655,456	298,102	14,648	119,395	53,326	543,102	**1,098,362**	256,647	**1,032,772**	122,247	**2,131,134**	284,275
1991	24,757	15,237	46,763	290,602	628,644	414,014	17,462	68,448	30,095	505,561	**909,943**	234,620	**1,131,640**	143,398	**2,041,583**	274,972
1992	39,384	26,887	61,195	426,569	509,807	420,552	18,955	63,476	58,738	662,806	**1,238,475**	286,632	**1,049,892**	131,043	**2,288,367**	315,167
1993	29,044	33,475	58,808	375,253	434,152	372,700	19,965	108,205	71,651	616,781	**1,205,365**	264,418	**914,669**	119,019	**2,120,034**	289,970
1994	19,567	24,905	35,781	530,417	436,896	475,605	17,443	154,845	50,050	658,341	**1,418,558**	283,859	**985,292**	144,366	**2,403,850**	318,462
1995	19,989	14,994	50,770	424,826	371,712	441,461	25,517	71,747	46,845	597,915	**1,156,326**	266,035	**909,448**	133,870	**2,065,774**	297,819
1996	31,644	18,958	43,121	451,037	307,603	508,739	15,420	65,375	48,987	540,775	**1,125,133**	243,327	**906,526**	149,317	**2,031,660**	285,488
1997	27,930	9,554	42,983	533,969	360,454	501,861	6,889	71,921	54,698	377,212	**1,047,354**	184,516	**940,116**	143,708	**1,987,470**	233,877
1998	33,326	18,313	71,304	634,682	467,801	514,736	3,956	83,118	84,320	392,796	**1,213,229**	232,495	**1,091,123**	152,815	**2,304,352**	278,220
10yr Av	27,918	18,984	49,060	450,230	493,221	428,432	14,624	93,291	56,303	604,964	**1,223,772**	928,572	**1,013,255**	437,955	**2,237,026**	1,026,670

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

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
1971	8,839	14,141	22,034	103,756	343,231	287,089	850	67,846	27,089	609,204	**822,036**	152,357	**662,043**	70,433	**1,484,079**	167,850
1972	13,555	28,156	35,038	114,582	449,756	240,096	588	81,484	23,494	803,129	**1,050,846**	196,311	**739,032**	79,187	**1,789,878**	211,681
1973	21,489	17,370	30,005	122,734	495,198	409,396	2,236	80,168	20,470	892,875	**1,133,617**	222,622	**958,323**	102,529	**2,091,940**	245,098
1974	20,683	7,991	24,498	134,590	475,653	363,356	1,430	78,699	21,000	708,240	**950,520**	164,454	**885,620**	94,091	**1,836,140**	189,468
1975	18,911	17,311	30,121	140,683	432,157	457,407	337	92,400	18,311	769,346	**1,038,051**	152,401	**938,934**	101,262	**1,976,985**	182,975
1976	18,200	12,523	23,065	99,165	438,916	406,821	1,005	58,833	12,705	502,541	**685,767**	134,212	**888,007**	95,707	**1,573,774**	164,842
1977	16,169	9,930	29,334	87,405	417,251	299,321	755	63,486	12,180	593,438	**766,439**	159,643	**762,830**	76,625	**1,529,269**	177,080
1978	10,098	9,561	37,909	78,637	299,856	211,674	581	70,052	16,481	708,932	**883,662**	193,347	**560,119**	59,038	**1,443,781**	202,160
1979	6,790	11,285	27,284	69,378	526,868	223,941	1,698	47,900	11,099	572,611	**712,275**	149,866	**786,581**	78,366	**1,498,856**	169,118
1980	8,543	24,086	34,213	78,210	529,435	345,649	2,868	51,903	13,757	661,072	**829,028**	166,040	**920,708**	96,788	**1,749,736**	192,191
1981	13,865	15,316	15,819	63,580	546,021	221,891	863	66,559	11,246	801,909	**958,612**	222,769	**798,459**	93,021	**1,757,071**	241,410
1982	15,341	9,216	16,010	26,271	437,430	175,028	3,020	41,357	14,576	599,623	**691,043**	180,074	**646,830**	70,677	**1,337,873**	193,448
1983	17,372	10,058	18,948	58,700	435,781	291,395	2,062	50,987	20,999	676,435	**817,178**	219,207	**765,557**	81,153	**1,582,736**	233,746
1984	13,245	16,342	20,042	51,728	452,341	324,205	2,844	43,144	8,757	487,570	**607,540**	145,326	**812,677**	86,505	**1,420,217**	169,124
1985	14,146	12,482	11,784	47,161	413,434	348,458	1,224	41,262	11,229	517,018	**629,153**	147,586	**789,046**	96,436	**1,418,199**	176,300
1986	9,032	12,613	21,447	50,976	484,474	372,528	1,201	54,115	12,239	836,160	**966,103**	289,564	**888,682**	98,102	**1,854,785**	305,731
1987	12,806	6,567	21,799	72,712	386,778	181,462	3,468	46,460	6,193	580,236	**712,168**	200,950	**606,314**	70,993	**1,318,482**	213,122
1988	9,612	18,638	17,823	66,664	303,600	203,869	3,352	61,579	16,359	614,340	**777,581**	190,437	**538,255**	58,410	**1,315,836**	199,193
1989	13,735	8,731	15,584	47,933	281,516	123,342	9,742	45,409	12,433	536,726	**651,232**	180,434	**443,919**	51,722	**1,095,152**	187,701
1990	14,520	8,855	17,544	22,860	303,138	109,955	6,507	40,276	11,499	445,517	**529,008**	153,414	**451,664**	52,029	**980,672**	161,996
1991	16,191	7,907	14,633	19,119	320,293	180,854	7,690	22,153	5,932	425,729	**480,841**	199,877	**539,660**	68,232	**1,020,501**	211,202
1992	15,857	9,889	19,316	35,998	336,695	171,132	9,741	20,776	13,259	529,226	**609,148**	237,130	**552,741**	70,722	**1,161,890**	247,452
1993	21,208	4,826	16,023	19,737	257,931	238,401	13,289	25,462	32,075	466,526	**548,625**	209,157	**546,852**	80,115	**1,095,477**	223,975
1994	15,989	8,621	17,817	47,139	287,295	209,975	10,063	47,996	11,517	553,823	**669,097**	243,225	**541,139**	67,402	**1,210,235**	252,391
1995	14,726	4,121	14,946	41,895	285,304	161,298	6,239	27,438	9,888	538,905	**622,246**	249,105	**482,513**	55,932	**1,104,759**	255,307
1996	7,793	7,362	13,223	27,946	267,100	173,332	7,543	36,172	10,844	459,232	**541,557**	214,204	**468,991**	62,553	**1,010,548**	223,150
1997	11,730	3,783	12,199	35,044	203,492	146,187	5,074	27,149	12,907	322,831	**401,714**	146,956	**378,683**	51,206	**780,398**	155,622
1998	10,822	3,184	13,003	40,182	233,575	142,394	2,904	17,233	14,286	295,435	**370,320**	132,937	**402,698**	51,853	**773,018**	142,692
10yr Av	14,257	6,728	15,429	33,785	277,634	165,687	7,879	31,006	13,464	457,395	**542,379**	634,337	**480,886**	195,839	**1,023,265**	663,879

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

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
1971	9,434	17,022	46,735	889,893	589,592	186,643	12,843	133,700	141,109	1,409,926	**2,591,649**	296,994	**845,246**	87,905	**3,436,895**	309,730
1972	14,591	33,410	41,903	973,497	761,222	206,116	10,404	173,454	128,618	1,438,145	**2,747,124**	316,358	**1,034,236**	116,293	**3,781,360**	337,056
1973	22,679	20,917	43,485	1,049,016	834,724	345,354	12,990	161,656	110,950	1,696,471	**3,039,010**	384,125	**1,259,231**	134,601	**4,298,241**	407,025
1974	20,617	9,392	30,030	1,154,105	784,628	323,443	18,605	177,712	111,848	1,541,013	**2,994,070**	331,368	**1,177,324**	125,305	**4,171,393**	354,269
1975	20,806	19,019	42,985	1,203,223	739,402	342,139	19,854	190,017	97,780	1,278,337	**2,788,376**	290,377	**1,165,186**	122,215	**3,953,562**	315,048
1976	17,402	17,494	37,535	845,158	739,758	256,594	11,272	134,313	68,418	1,003,792	**2,069,175**	243,223	**1,062,561**	109,183	**3,131,736**	266,606
1977	15,158	14,192	42,952	746,454	712,315	200,887	5,328	147,301	68,690	1,064,428	**2,041,066**	241,432	**976,641**	99,351	**3,017,707**	261,074
1978	11,327	14,259	52,447	671,081	499,344	234,067	6,177	164,111	90,300	1,121,590	**2,061,341**	218,014	**803,363**	83,872	**2,864,704**	233,591
1979	12,136	16,032	50,796	594,351	859,198	265,943	6,450	114,771	60,334	1,034,993	**1,820,481**	227,324	**1,194,523**	134,220	**3,015,004**	263,991
1980	12,339	32,567	16,523	463,418	843,138	176,855	8,421	134,974	74,407	763,488	**1,468,853**	195,506	**1,057,276**	122,804	**2,526,128**	230,876
1981	11,617	27,371	34,244	282,054	607,914	148,995	14,749	179,833	62,413	941,381	**1,493,051**	229,092	**817,520**	94,266	**2,310,571**	247,728
1982	8,344	16,281	25,110	510,651	445,192	186,357	13,252	107,176	80,781	1,308,484	**2,023,373**	344,102	**678,255**	74,695	**2,701,628**	352,116
1983	12,152	17,925	34,616	931,689	750,128	268,278	17,708	139,402	115,953	1,299,056	**2,504,026**	309,455	**1,082,882**	120,613	**3,586,908**	332,129
1984	14,339	28,706	21,627	411,758	799,418	245,611	23,816	116,559	48,740	1,280,693	**1,886,456**	325,870	**1,104,811**	118,689	**2,991,267**	346,812
1985	20,157	10,805	44,259	762,829	824,792	332,466	27,821	118,484	59,653	945,999	**1,897,770**	224,342	**1,249,495**	145,278	**3,147,265**	267,274
1986	18,592	33,363	68,015	790,174	739,342	287,647	30,677	152,413	67,455	1,245,306	**2,288,711**	309,457	**1,144,272**	119,891	**3,432,984**	331,869
1987	26,099	58,826	44,664	606,877	634,336	445,922	24,148	133,553	34,041	1,012,610	**1,845,908**	259,266	**1,175,170**	130,734	**3,021,077**	290,362
1988	18,501	21,151	82,094	1,224,476	590,807	239,519	20,523	187,347	75,378	919,709	**2,428,059**	222,755	**951,443**	98,939	**3,379,503**	243,739
1989	29,642	11,327	44,277	509,618	808,081	363,672	6,523	137,401	69,659	1,246,791	**1,974,795**	415,224	**1,252,195**	151,819	**3,226,990**	442,109
1990	28,012	18,735	41,284	396,352	697,164	322,157	15,753	129,755	57,766	585,782	**1,188,389**	194,969	**1,104,370**	132,112	**2,292,760**	235,514
1991	26,614	16,585	50,107	315,285	668,670	446,581	18,721	74,387	32,595	545,843	**984,696**	180,052	**1,210,692**	154,568	**2,195,388**	237,298
1992	42,190	29,177	65,549	462,674	541,775	454,405	20,303	68,916	63,562	715,770	**1,340,099**	222,265	**1,124,222**	142,582	**2,464,321**	264,067
1993	31,149	36,330	62,994	407,020	461,421	402,921	21,358	117,550	77,542	666,575	**1,305,017**	206,806	**979,843**	129,819	**2,284,860**	244,176
1994	21,024	27,055	38,348	575,304	464,324	512,855	18,675	168,106	54,166	710,237	**1,534,868**	216,510	**1,055,226**	152,490	**2,590,094**	264,820
1995	21,478	16,305	54,415	460,833	395,047	476,734	27,328	77,957	50,707	645,518	**1,251,321**	205,001	**975,002**	144,078	**2,226,323**	250,567
1996	33,989	20,571	46,223	489,214	327,135	549,842	16,510	71,022	53,014	584,001	**1,217,822**	187,278	**973,698**	163,854	**2,191,520**	248,840
1997	29,955	10,369	46,033	579,349	383,228	542,145	7,370	78,048	59,186	407,481	**1,134,433**	160,707	**1,008,731**	157,027	**2,143,164**	224,687
1998	35,745	19,866	76,391	688,211	497,208	554,900	4,229	90,234	91,194	424,530	**1,314,035**	188,872	**1,168,474**	162,091	**2,482,509**	248,890
10yr Av.	29,980	20,632	52,562	488,386	524,405	462,621	15,677	101,338	60,939	653,253	**1,324,548**	721,449	**1,085,245**	472,618	**2,409,793**	862,471

Table 3.6.2.4 Estimated pre-fishery abundance of NON-MATURING 1SW salmon by NEAC country and year

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
1971	16,710	40,496	42,968	183,290	591,498	305,786	4,309	140,368	27,798	1,156,474	**1,548,426**	183,529	**961,271**	97,637	**2,509,697**	207,884
1972	26,210	24,664	36,891	177,196	648,693	508,691	6,285	122,393	24,216	1,192,570	**1,541,039**	200,466	**1,226,771**	127,259	**2,767,810**	237,447
1973	25,193	15,137	30,150	197,899	612,745	447,555	4,652	128,373	24,858	1,000,952	**1,367,218**	143,133	**1,120,296**	117,635	**2,487,515**	185,270
1974	22,950	22,870	36,888	188,525	566,180	562,506	3,489	126,866	21,675	999,728	**1,359,664**	134,740	**1,192,014**	125,447	**2,551,678**	184,097
1975	22,381	21,053	28,350	157,620	562,964	495,601	3,840	107,097	15,046	767,055	**1,067,871**	123,575	**1,113,137**	117,201	**2,181,008**	170,314
1976	19,715	15,758	35,641	129,896	524,694	365,192	2,704	99,799	14,413	816,463	**1,076,328**	140,293	**947,946**	99,773	**2,024,274**	172,153
1977	12,438	16,099	45,840	122,846	380,071	258,178	2,250	111,692	19,512	971,666	**1,241,814**	176,931	**698,776**	74,658	**1,940,590**	192,037
1978	8,344	15,967	33,207	101,579	660,398	278,161	4,023	73,731	13,133	761,143	**965,552**	131,887	**984,133**	102,155	**1,949,686**	166,823
1979	10,567	34,308	42,345	136,361	712,733	443,112	8,464	98,988	16,285	966,357	**1,252,299**	148,962	**1,217,221**	120,358	**2,469,520**	191,509
1980	16,949	22,278	21,046	117,472	782,779	320,411	8,912	110,669	13,325	1,120,309	**1,384,053**	189,940	**1,150,097**	115,100	**2,534,150**	222,093
1981	18,697	13,572	21,085	63,219	643,275	261,904	10,814	71,432	17,251	840,063	**1,005,538**	166,358	**955,775**	87,516	**1,961,313**	187,973
1982	21,113	13,685	24,189	93,654	615,273	387,878	8,125	76,751	24,858	899,121	**1,108,068**	200,590	**1,056,578**	99,635	**2,164,647**	223,972
1983	16,112	20,502	25,051	77,909	605,976	413,403	7,311	62,292	10,374	643,834	**814,911**	129,918	**1,067,854**	108,603	**1,882,765**	169,331
1984	17,143	15,422	15,158	69,693	559,794	442,731	5,394	57,094	13,301	666,780	**822,290**	133,375	**1,040,220**	120,020	**1,862,511**	179,426
1985	11,041	17,597	26,871	85,816	651,477	472,910	5,846	83,863	14,488	1,097,088	**1,298,852**	247,956	**1,168,146**	124,392	**2,466,998**	277,409
1986	15,608	9,612	27,238	107,162	532,558	246,465	8,363	70,057	7,329	772,132	**966,292**	176,936	**830,233**	88,861	**1,796,525**	197,996
1987	11,722	23,737	21,992	94,687	402,356	258,989	6,416	85,594	19,385	793,826	**1,017,229**	166,772	**701,476**	74,072	**1,718,705**	182,481
1988	16,743	13,457	19,545	81,730	388,613	169,038	14,786	74,886	14,715	741,753	**926,542**	161,163	**608,724**	64,561	**1,535,266**	173,613
1989	17,612	11,229	21,794	38,646	411,865	152,772	10,663	55,485	13,615	574,820	**693,794**	132,995	**614,706**	65,957	**1,308,500**	148,452
1990	19,670	9,519	17,856	26,883	402,726	223,178	10,358	28,832	7,022	523,299	**595,555**	172,512	**673,789**	83,362	**1,269,344**	191,598
1991	19,258	12,455	23,296	48,525	411,050	206,167	12,136	29,631	15,704	655,328	**761,642**	205,329	**671,907**	85,772	**1,433,548**	222,523
1992	25,702	6,299	19,320	28,061	316,503	286,113	16,277	34,400	37,991	576,126	**682,877**	181,049	**663,914**	101,586	**1,346,791**	207,602
1993	19,385	10,215	21,482	57,936	351,870	252,210	12,482	58,388	13,628	668,655	**808,821**	216,844	**657,428**	82,682	**1,466,249**	232,072
1994	17,902	4,895	18,073	51,823	350,360	195,757	8,004	33,748	11,707	651,465	**753,638**	219,002	**590,096**	68,793	**1,343,733**	229,552
1995	9,475	8,843	15,992	35,583	328,647	209,154	9,517	44,728	12,831	557,380	**659,365**	186,961	**572,785**	77,544	**1,232,150**	202,404
1996	14,244	4,690	14,618	43,287	243,906	173,145	6,087	33,934	15,297	390,298	**487,506**	121,005	**452,000**	63,399	**939,506**	136,608
1997	13,100	3,883	15,574	48,730	278,691	168,354	3,455	21,318	16,890	354,951	**445,772**	111,587	**479,174**	64,618	**924,946**	128,946
10yr Av.	17,309	8,548	18,755	46,120	348,423	203,589	10,377	41,535	15,940	569,407	**681,551**	552,622	**598,452**	242,736	**1,280,004**	603,583

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

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
eggs/F	5,000	3,450	5,800	3,400	3,500	4,500	3,000	4,800	3,400	5,000	4204		4453		4402	
% Fem	12%	77%	47%	60%	40%	45%	50%	50%	60%	40%	43%		48%		46%	
1971	4,536	13,832	22,215	344,450	114,265	113,554	2,147	70,188	40,618	930,768	1,399,856	380,921	234,501	63,021	1,656,572	386,099
1972	6,993	27,189	19,515	373,332	148,226	125,943	1,771	93,135	37,552	962,920	1,494,128	403,661	282,933	81,769	1,796,575	411,859
1973	11,119	16,994	20,535	406,501	159,719	211,343	2,121	84,243	32,019	1,150,315	1,690,072	491,602	384,302	99,195	2,094,909	501,509
1974	10,058	7,574	13,813	446,263	149,663	199,193	3,201	96,569	31,736	1,014,823	1,596,964	422,597	362,116	86,471	1,972,894	431,353
1975	10,330	15,425	19,773	465,739	147,830	208,761	3,236	95,206	27,778	864,717	1,468,865	367,915	370,157	93,839	1,858,795	379,694
1976	8,336	14,243	17,665	325,967	149,510	104,117	1,963	74,828	19,920	660,251	1,095,209	309,569	263,926	79,819	1,376,799	319,693
1977	7,042	11,621	20,619	289,807	135,636	118,113	937	79,453	20,385	704,161	1,105,427	303,164	261,727	69,218	1,387,774	310,965
1978	5,423	11,669	24,839	261,618	94,263	142,193	1,106	87,072	26,327	748,671	1,135,356	284,580	242,985	64,126	1,403,181	291,716
1979	5,893	13,063	23,653	229,212	158,488	161,327	1,086	59,875	17,445	688,526	1,008,121	288,373	326,794	94,346	1,358,568	303,414
1980	6,071	26,388	7,773	178,572	153,074	107,170	1,342	65,612	21,259	549,385	841,216	250,841	267,657	81,768	1,116,645	263,831
1981	5,667	22,181	16,424	85,711	118,682	97,549	2,278	85,313	17,779	674,685	885,669	295,841	224,176	68,085	1,126,269	303,575
1982	4,005	13,028	11,557	160,157	85,198	123,386	2,311	48,497	23,429	942,077	1,187,187	447,671	214,901	56,468	1,413,646	451,218
1983	5,722	14,372	16,270	356,355	140,719	176,507	2,914	63,729	34,396	930,475	1,399,328	390,653	325,863	91,049	1,741,461	401,123
1984	6,648	23,313	10,199	136,625	150,549	160,251	3,968	50,049	14,154	909,542	1,133,683	423,043	321,416	83,846	1,465,298	431,272
1985	10,375	8,730	21,239	204,628	162,478	218,620	4,571	49,484	17,196	670,554	950,592	282,484	396,045	108,696	1,367,875	302,675
1986	8,967	27,161	32,688	230,040	149,188	187,955	5,328	63,770	19,371	892,086	1,232,428	398,501	351,438	93,072	1,616,554	409,226
1987	12,554	48,027	21,309	200,432	122,531	293,704	3,770	55,476	9,653	724,038	1,037,626	337,971	432,558	105,977	1,491,493	354,197
1988	9,180	17,239	39,058	569,228	109,461	156,339	3,760	80,905	24,663	660,058	1,352,093	278,888	278,740	75,535	1,669,890	288,936
1989	13,579	9,223	20,967	163,931	315,097	240,910	1,070	52,825	6,949	948,768	1,181,695	538,793	570,656	129,784	1,773,319	554,203
1990	12,560	15,296	19,581	185,224	267,369	211,576	2,781	48,861	20,360	447,021	716,762	256,301	494,286	112,689	1,230,629	279,980
1991	12,507	13,837	23,885	165,212	262,638	346,730	3,301	29,536	10,845	418,713	638,143	234,496	625,175	136,341	1,287,203	271,251
1992	19,388	24,387	30,519	209,122	202,976	352,064	3,391	27,616	25,674	543,014	829,811	286,512	577,819	125,861	1,438,149	312,938
1993	14,177	29,875	29,448	188,351	174,340	310,420	3,631	52,940	42,621	505,782	819,569	264,078	502,568	115,980	1,351,585	288,424
1994	9,596	22,105	18,219	261,577	181,770	397,231	5,025	76,384	15,482	541,144	916,691	283,223	593,622	142,045	1,528,533	316,847
1995	9,660	13,325	25,218	187,052	147,753	370,672	10,006	37,742	15,587	491,608	745,314	265,976	538,090	131,854	1,308,622	296,865
1996	17,362	16,895	21,497	220,210	124,133	424,419	5,973	37,334	21,485	462,621	758,546	243,291	571,886	148,045	1,351,929	284,794
1997	15,358	8,494	21,507	339,781	166,395	420,947	2,643	47,381	22,249	322,280	740,185	184,492	605,344	142,612	1,367,036	233,186
1998	18,051	16,248	35,767	414,914	215,121	426,991	1,115	54,439	54,747	332,488	872,836	232,472	661,277	150,861	1,569,881	277,132
10yr.av.	13,337	17,067	24,990	248,969	195,193	323,131	4,158	49,152	20,591	534,101	869,881		535,819		1,430,689	

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

Year	Finland	France	Iceland	Ireland	Norway	Russia	Sweden	UK(EW)	UK(NI)	UK(Scot)	Southern Europe		Northern Europe		Total	
											Est.	SD	Est.	SD	Est.	SD
eggs/F	13,000	6,900	10,800	7,000	9,000	10,500	6,000	7,900	7,000	10,000						
% Fem	77%	77%	72%	85%	80%	80%	70%	70%	85%	60%						
1971	4,612	13,832	8,951	50,884	68,850	188,581	214	39,088	14,913	374,068	492,785	152,276	262,257	63,232	763,993	164,883
1972	6,973	27,189	13,904	56,389	90,755	157,693	125	46,757	12,781	493,733	636,848	196,239	255,547	65,105	906,299	206,757
1973	11,477	16,994	11,984	60,476	105,865	271,305	596	46,513	11,058	549,903	684,944	222,555	389,243	89,480	1,086,171	239,870
1974	11,054	7,574	10,173	65,944	96,701	238,687	394	44,969	11,440	437,325	567,253	164,360	346,837	82,201	924,263	183,770
1975	9,370	15,425	12,089	69,199	84,490	299,306	87	53,616	9,865	465,119	613,224	152,273	393,253	93,692	1,018,566	178,788
1976	9,912	14,243	9,191	48,810	92,610	271,596	247	36,099	6,892	337,077	443,120	134,154	374,366	86,394	826,677	159,566
1977	8,733	11,621	11,914	43,146	84,413	197,656	185	37,250	6,575	395,377	493,968	159,588	290,987	65,061	796,870	172,341
1978	5,471	11,669	15,025	38,959	59,511	141,210	146	40,832	8,919	472,372	572,750	193,291	206,338	50,053	794,114	199,667
1979	3,725	13,063	11,303	33,991	112,339	146,057	430	27,298	6,025	379,519	459,897	149,821	262,551	62,285	733,751	162,252
1980	4,418	26,388	14,055	38,602	108,280	227,060	718	26,537	7,476	437,320	536,323	165,991	340,476	82,746	890,854	185,472
1981	7,358	22,181	6,303	31,421	112,976	157,535	226	33,803	6,079	574,047	667,531	222,709	278,095	77,119	951,929	235,684
1982	8,114	13,028	6,532	13,918	89,096	123,251	731	20,975	7,864	434,054	489,839	180,041	221,192	58,654	717,563	189,354
1983	9,285	14,372	7,465	29,289	91,185	207,644	493	25,097	11,358	487,416	567,531	219,158	308,607	71,727	883,603	230,597
1984	6,935	23,313	8,113	31,924	87,931	235,743	675	20,090	4,752	347,305	427,384	145,274	331,285	75,250	766,782	163,606
1985	7,570	8,730	4,902	27,553	86,298	249,227	281	18,555	6,087	367,922	428,846	147,536	343,376	88,589	777,124	172,090
1986	4,718	27,161	8,926	22,641	99,380	263,569	276	24,328	6,626	644,747	725,502	289,518	367,943	86,943	1,102,371	302,291
1987	6,782	48,027	8,901	45,103	77,893	130,486	827	20,979	3,346	444,983	562,437	200,910	215,988	61,151	787,326	210,010
1988	4,954	17,239	7,307	36,065	60,678	146,670	866	28,419	10,494	469,284	561,501	190,347	213,168	51,052	781,976	197,074
1989	6,597	9,223	6,185	23,042	115,273	87,471	2,461	19,333	5,044	414,550	471,192	180,366	211,803	47,480	689,180	186,510
1990	7,003	15,296	7,217	8,192	122,384	78,457	1,492	16,618	7,155	341,599	388,860	153,367	209,335	48,011	605,412	160,706
1991	7,823	13,837	6,019	8,909	132,464	151,254	1,896	9,226	3,384	349,088	384,443	199,863	293,436	64,650	683,898	210,059
1992	7,546	24,387	7,683	18,291	136,585	144,336	2,289	9,336	8,874	432,270	493,157	237,124	290,757	67,167	791,597	246,453
1993	10,312	29,875	6,358	4,517	103,696	198,859	3,296	12,559	28,235	382,541	457,726	209,132	316,164	78,614	780,248	223,419
1994	7,672	22,105	7,337	25,247	117,862	175,888	2,707	24,473	6,963	452,941	531,730	243,169	304,129	65,417	843,195	251,815
1995	7,634	13,325	6,257	22,532	118,259	136,410	1,822	14,372	5,752	446,728	502,709	249,104	264,124	53,972	773,091	254,884
1996	4,162	16,895	5,411	9,149	109,103	144,238	2,079	21,077	7,206	390,977	445,304	214,202	259,582	60,614	710,297	222,613
1997	6,042	8,494	5,035	19,231	94,998	122,313	1,484	18,035	8,605	275,401	329,766	146,955	224,837	50,228	559,638	155,302
1998	5,762	16,248	5,212	22,286	104,793	118,781	893	11,360	10,379	253,340	313,613	132,936	230,229	50,643	549,054	142,256
10yr.av.	6,864	16,993	6,366	17,951	110,554	136,789	1,935	16,801	9,281	382,611	443,636		256,142		706,144	

Table 3.7.1.1 Provisional estimates of salmon smolt production in 11 rivers in Norway, and mean annual catch the last 20 years in 8 of them.

River	Estimated area	Estimated smolt production per unit area	Estimated total smolt production	Mean annual catch (kg) last 20 years
Altaelva	5636918	3	169108	15252
Figgjo	480660	15	72099	4176
Gaula	6725297	5	336265	21663
Orkla	6677277	7	467409	12590
Imsa	12712	15	1907	
Lærdalselva	1799922	5	89996	
Numedalslågen	7645377	5	382269	19868
Reppafjordselva	2463332	2	49267	3307
Saltdalselva	2671002	1.5	40065	
Suldalslågen	1682614	3	50478	3009
Surna	3103479	4	124139	6607

Table 3.7.1.2. Estimates of areas of useable salmon rearing habitat in Swedish west-coast rivers.

River No	Main River All tributaries included	Estimated* rearing area (ha)	Estimated* production in '000	
1	R. Enningdalsälven	5.7 (1.2)	2 (0.3)	(Swedish part)
2	R. Örekilsälven	23	3.5	
3	R. Göta älv	15	15.1	
4	R. Kungsbackaån	4.4	5.1	
5	R. Rolfsån	3.1	3	
6	R.Löftaån	1	2.5	
7	R.Viskan	9.4	18	
8	River Himleån	3.6	4.3	
9	R. Tvååkersån	1.2	1.4	
10	R. Ätran	55	37.6	
11	R. Suseån	9.5	9.6	
12	R. Nissan	10.5	8.6	
13	R. Fylleån	17.8	15.1	
14	R. Genevadsån	13.9	17.6	
15	R. Lagan	8.8	5	
16	R. Stensån	12.4	21.3	
17	R. Rönneån	27	20	
	Total	**216.8**	**188**	Swedish part

* Estimates are based on aerial inspections and random electro-fishing surveys.

Rivers listed are only those estimated to have an annual production of 1,000 smolt or more. Six unlisted rivers are estimated to have an annual production of less than 1000 smolt. In total, there are currently about 229 ha of habitat with an estimated production potential of 223,000 smolt.

Table 3.7.2.1 Conservation limit options for NEAC stock groups from lagged egg deposition analysis (options 1-3) and river specific assessments (option 4)

Option	Individual countries										European stock groupings	
	Finland	France	Iceland	Ireland	Norway	Russia	Swed'n	UK(EW)	UK(NI)	UK(Sc)		
Choice	3	4	1	3	3	1	3	4	3	2	Southern	Northern
1SW												
Opt. 1	8,189	16,103	19,329	160,969	132,633	227,742	671	29,268	12,311	476,278	694,929	369,235
Opt. 2	9,067	13,454	19,329	142,945	112,623	248,769	986	48,838	12,553	565,489	783,278	371,445
Opt. 3	12,527	20,060	27,008	224,565	155,982	274,536	1,391	60,681	16,585	637,381	959,273	444,435
Opt. 4	0	17,400	0	0	0	0	0	53,000	0	0		
Chosen	**12,527**	**17,400**	**19,329**	**224,565**	**155,982**	**227,742**	**1,391**	**53,000**	**16,585**	**565,489**	**877,039**	**397,641**
MSW												
Opt. 1	4,062	4,688	4,915	11,124	74,479	88,315	352	9,842	4,778	355,247	385,680	167,207
Opt. 2	4,497	3,916	4,915	9,879	63,242	96,469	517	16,423	4,872	421,788	456,878	164,725
Opt. 3	6,213	5,840	6,868	15,520	87,590	106,461	729	20,406	6,437	475,411	523,613	200,994
Opt. 4	0	5,100	0	0	0	0	0	17,500	0	0		
Chosen	**6,213**	**5,100**	**4,915**	**15,520**	**87,590**	**88,315**	**729**	**17,500**	**6,437**	**421,788**	**466,345**	**182,847**

Spawner escapement reserve:		Southern	Northern
	1SW	**945,347**	**430,759**
	MSW	**552,761**	**216,730**

Table 3.9.1.1. Details of post-smolt cruises carried out during 1998.

Year/ Institute ID	Gear used Surface trawls	Time-frame	Area	Total number of hauls	Mean towing speed in knots	Surface hauls with smolt %	Number of poststsmolts captured
1998[1]	Firkløver trawl	30.06- 21.07.	West of Lofoten Islands	46	3.2	11	16
1998[1]	Åkra trawl	01-30.07.	Norwegian Sea (SE - NW)	84	3.3	21	61
1998[1]	Åkra trawl	01-23.08.	Norwegian Sea (N)/ Greenland Sea (E)	22	3.7	16	8
1998[1]	Åkra trawl	28.08- 09.09.	Barents Sea NW	9	3.4	0	0
1998[1]	Åkra trawl	25.08-09.09.	Barents Sea	10	3.0	0	0
1998[1]	Harstad float	20.05- 02.06	Fjords SW Norway, Trawl device tests	50	2-3	30	120
1998[2]	Pelagic trawl	14-25.05	Moray Firth, north east Scotland	49	>3.0	22	173
1998[3]	Pelagic trawl	02.06-01.07	Norwegian Sea (N)	28	4.3	0	0

[1] Inrstitute of Marine Research, Norway
[2] Fisheries Research Services, Scotland
[3] Polar Research Institute of Marine Fisheries and Oceanography, Russia

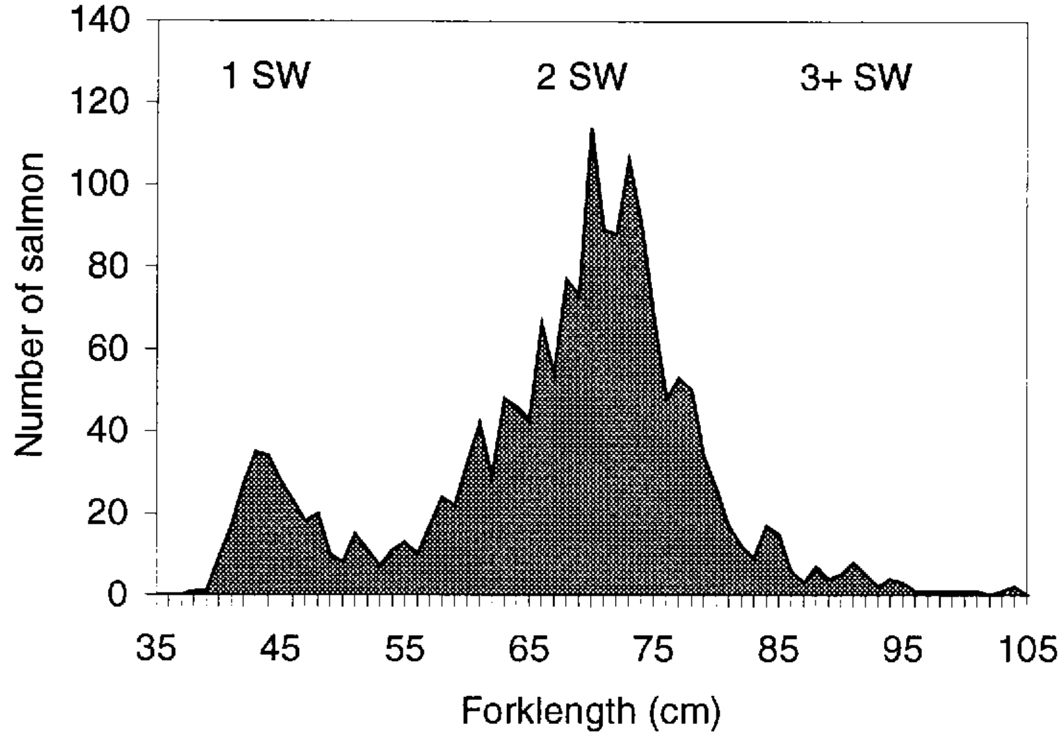


Figure 3.2.2.1 Length distribution of Atlantic salmon north of the Faroes in the 1997/1998 fishing season. Sea age groups are indicated.

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

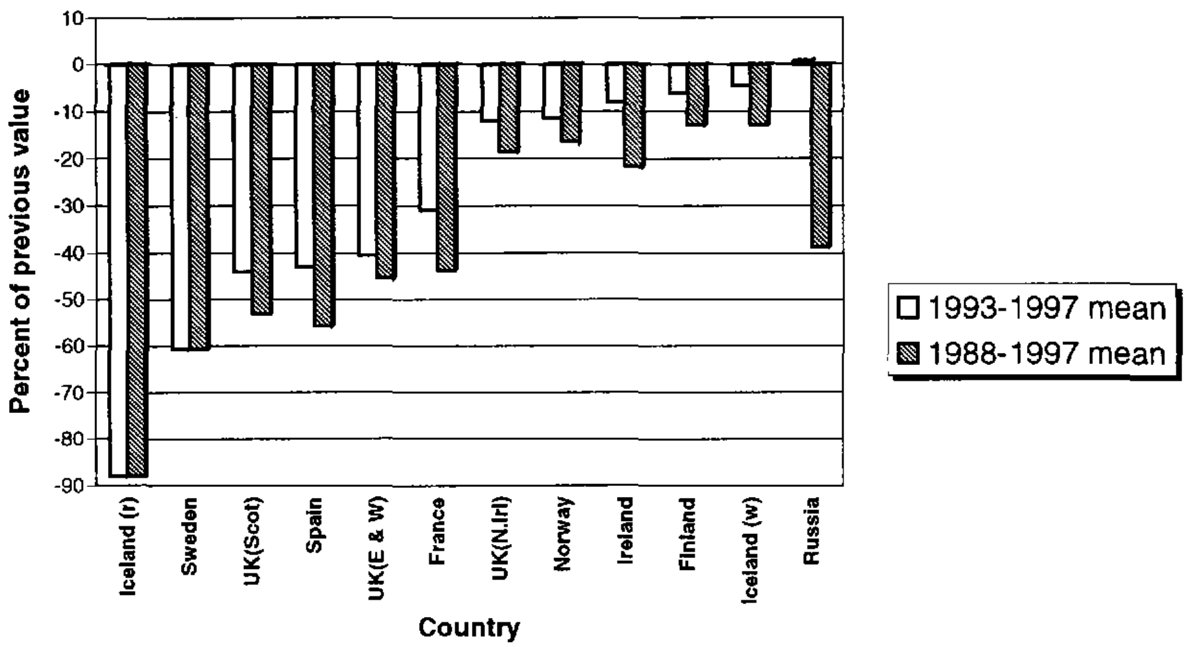
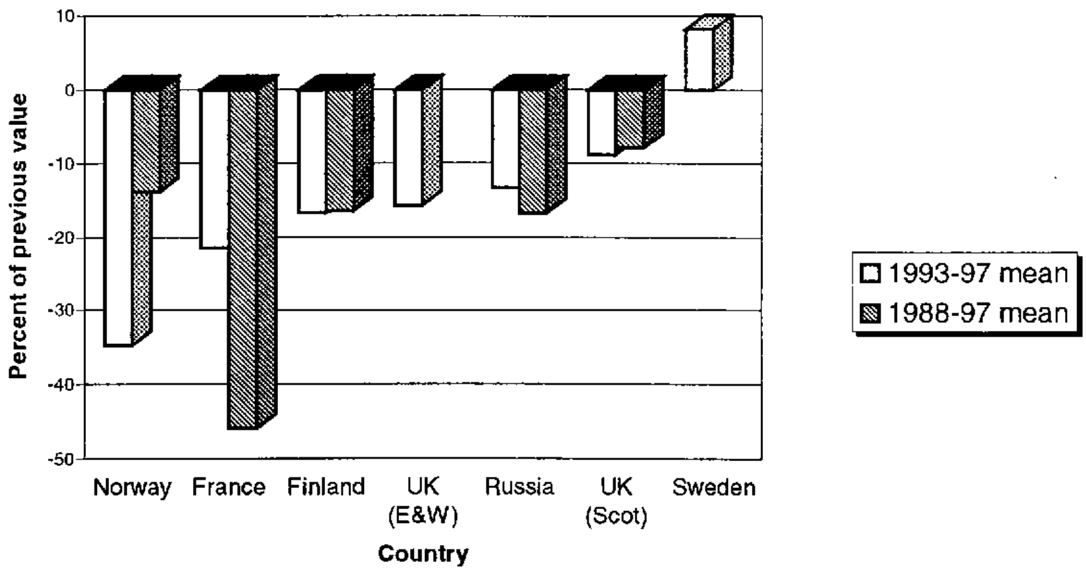


Figure 3.3.6.1. The proportions of 1SW salmon in the NEAC catches in 1998 relative to previous indices



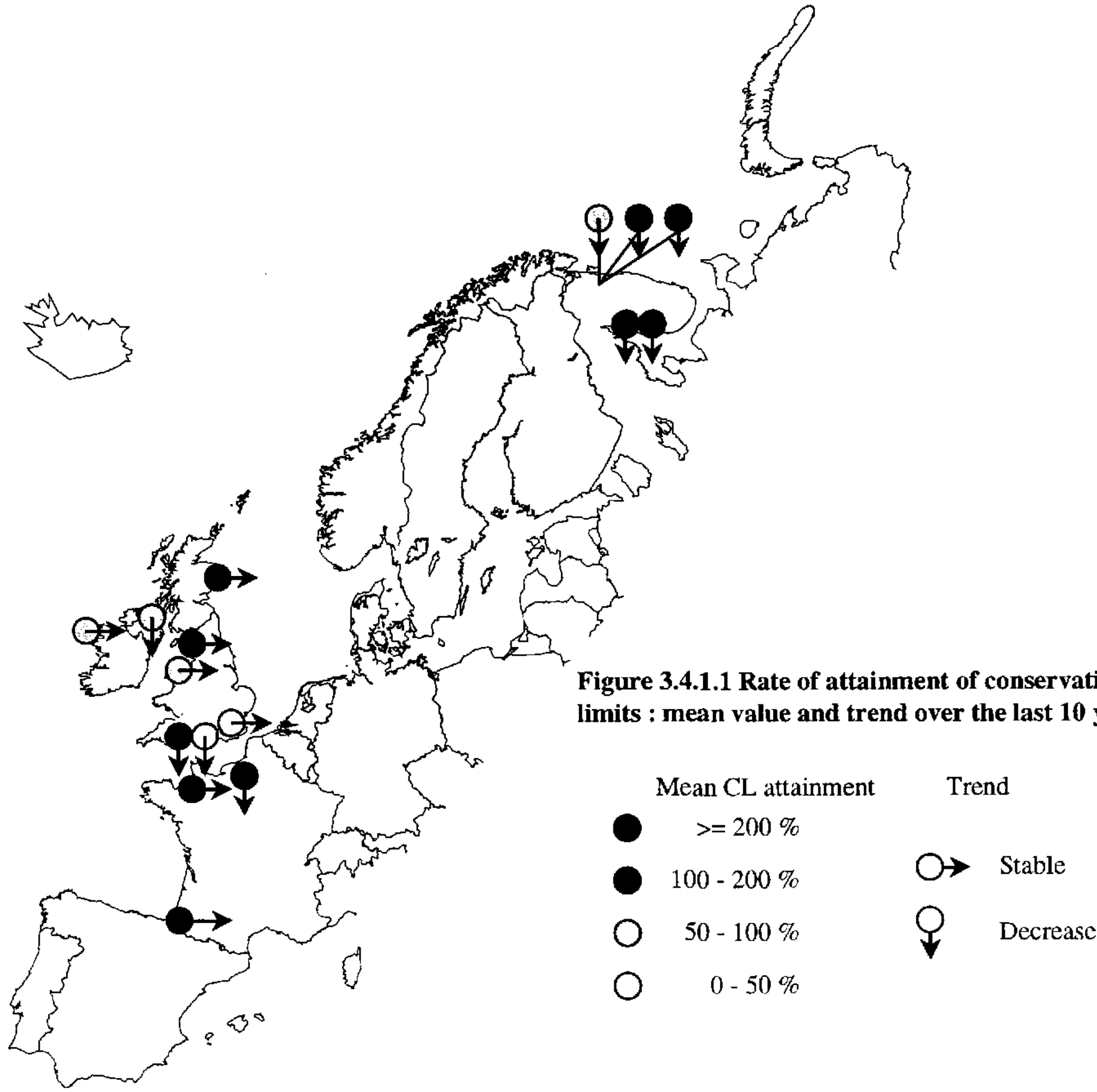


Figure 3.4.1.1 Rate of attainment of conservation limits : mean value and trend over the last 10 years

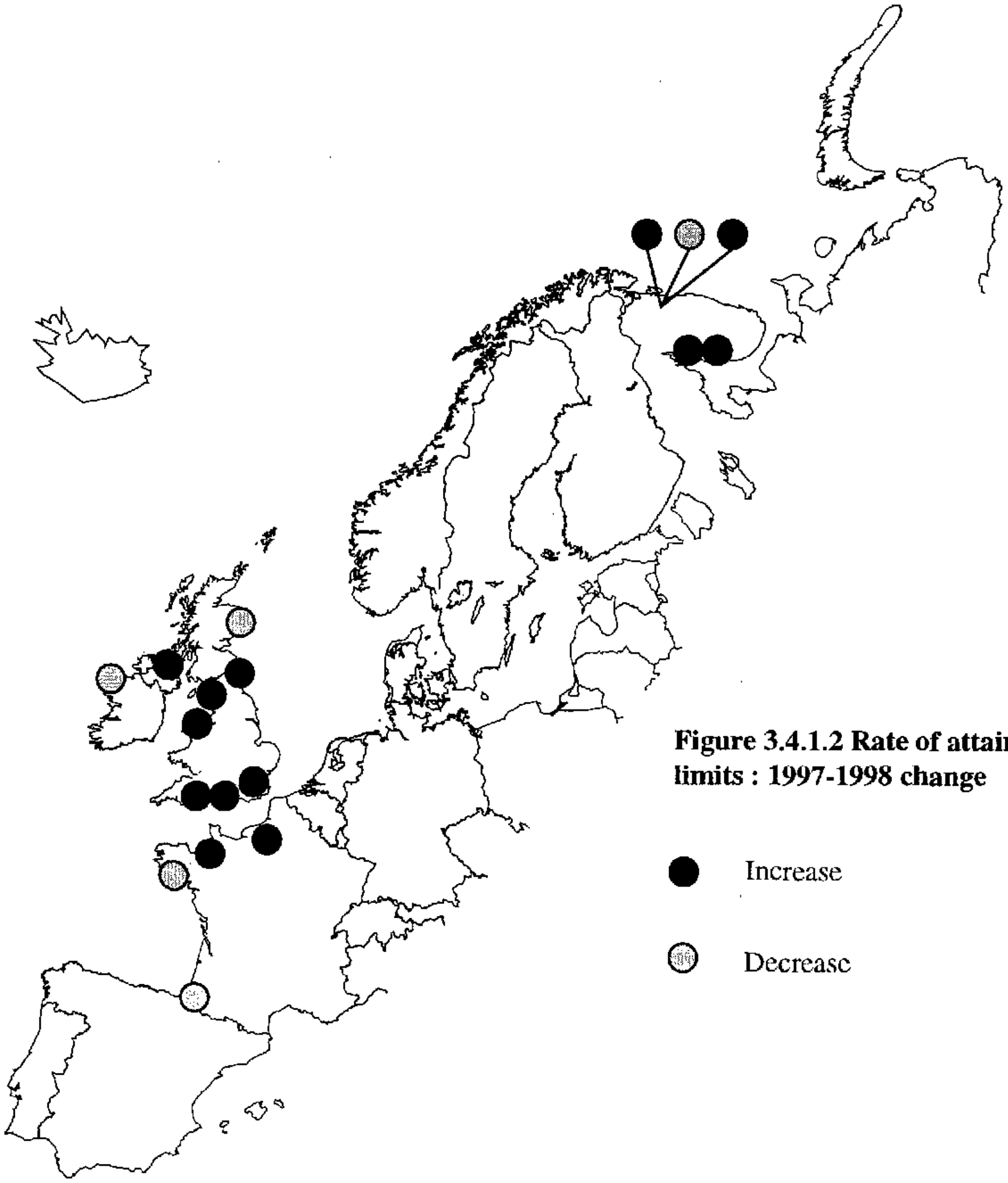
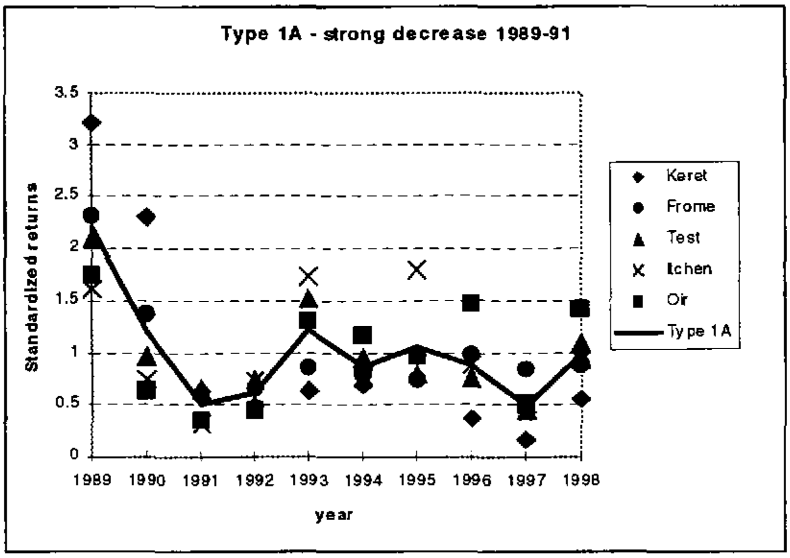


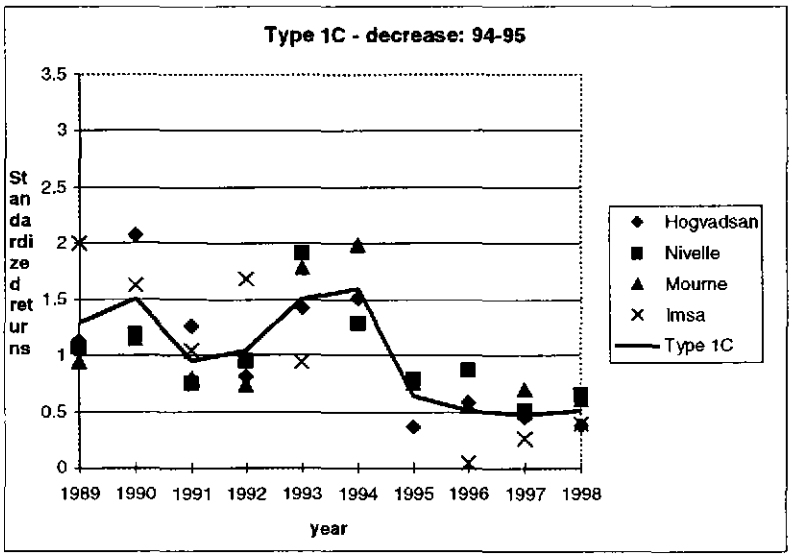
Figure 3.4.1.2 Rate of attainment of conservation limits : 1997-1998 change

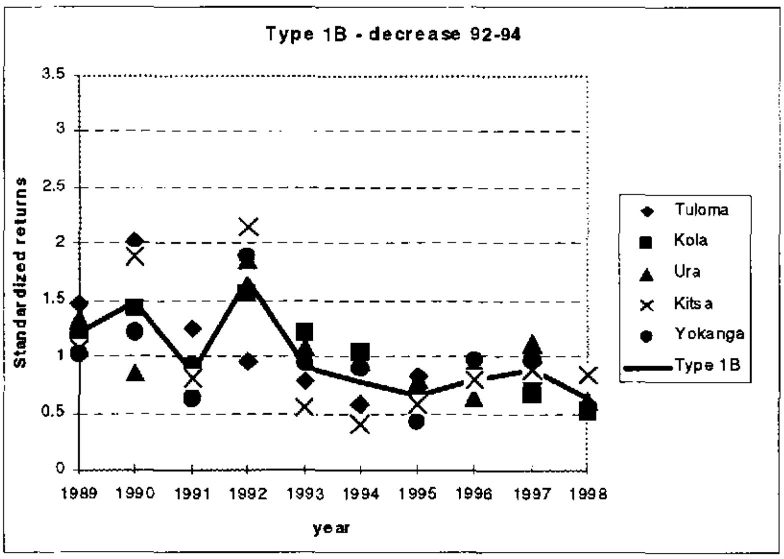
● Increase

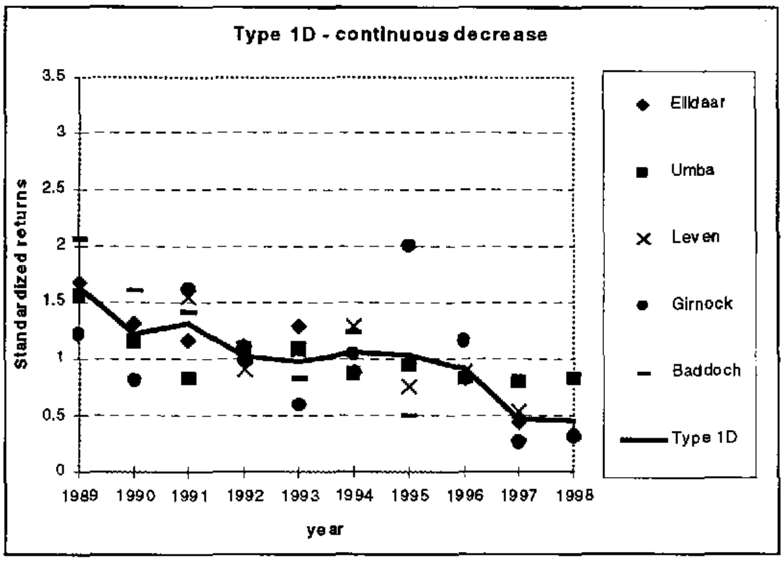
◎ Decrease

Figure 3.4.3.1 Standardized returns (Number of fish/Mean number of the last 10 years) for Index Rivers showing a decreasing trend



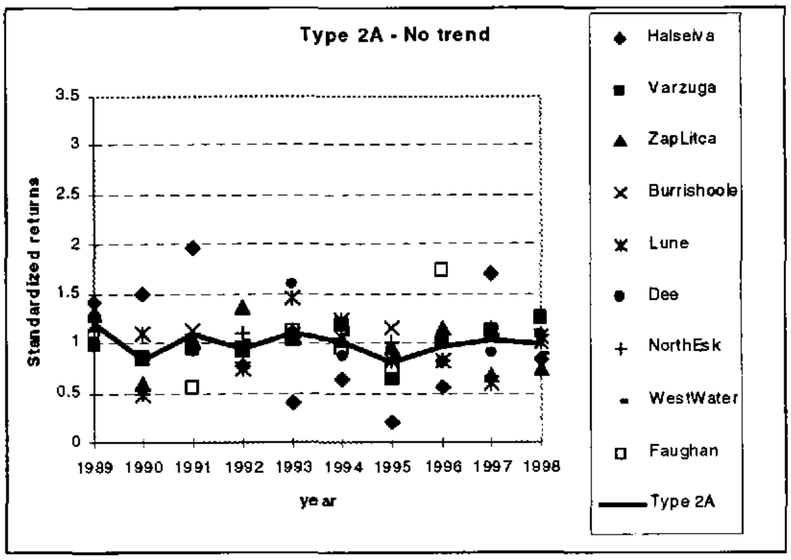


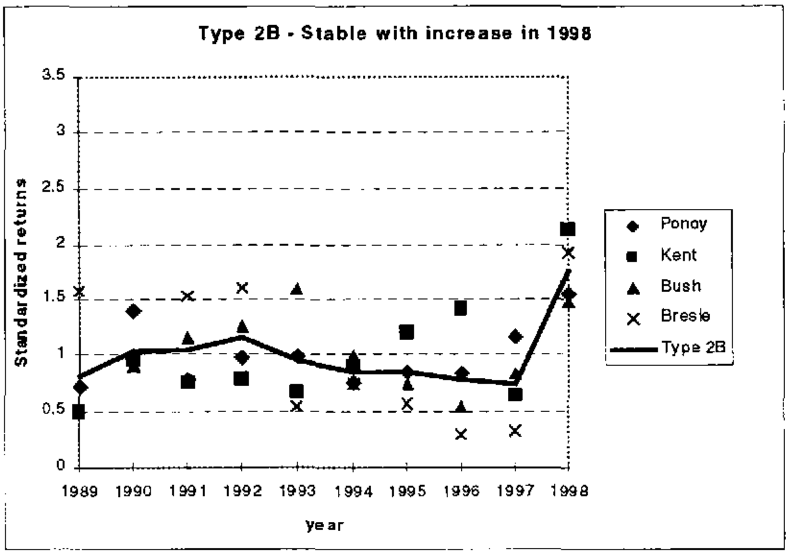


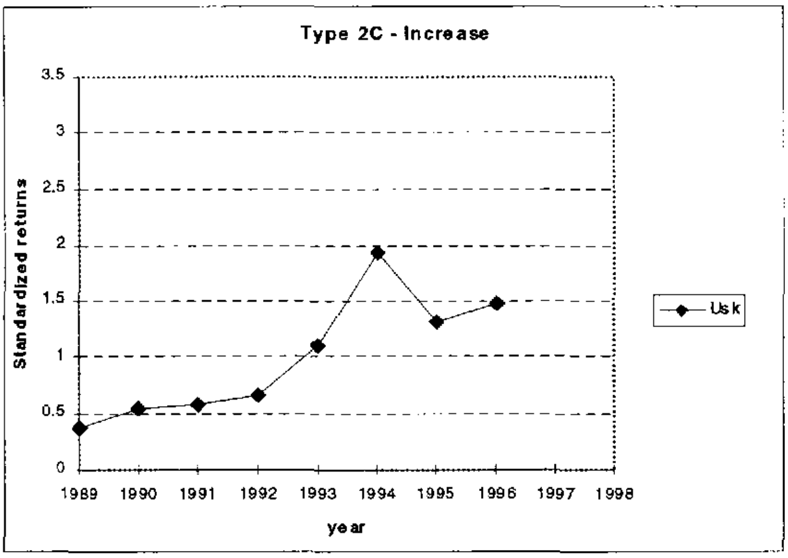


Type 1D - continuous decrease
Standardized returns
3.5
3
2.5
2
1.5
1
0.5
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
year
Elldaar
Umba
Leven
Girnock
Baddoch
Type 1D

Figure 3.4.3.2 Standardized returns (Number of fish/Mean number of the last 10 years) for Index Rivers showing a stable or increasing trend







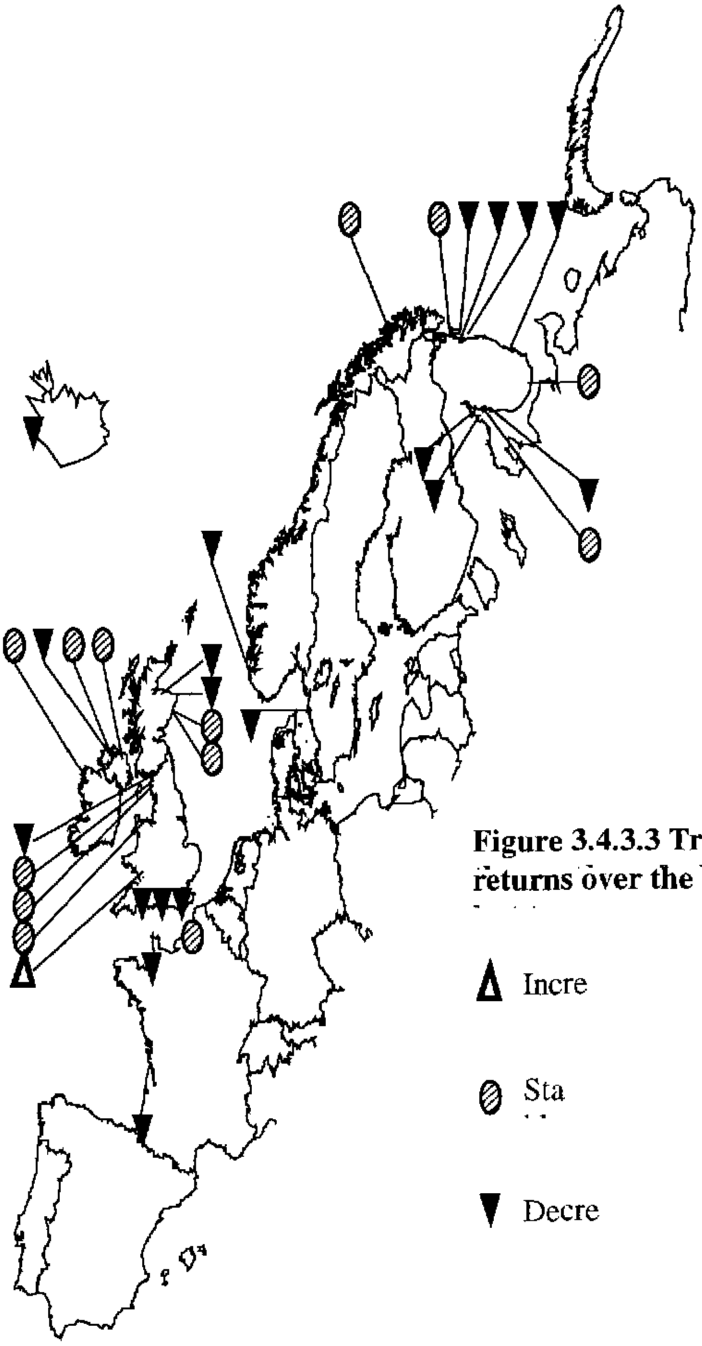


Figure 3.4.3.3 Trends in returns over the

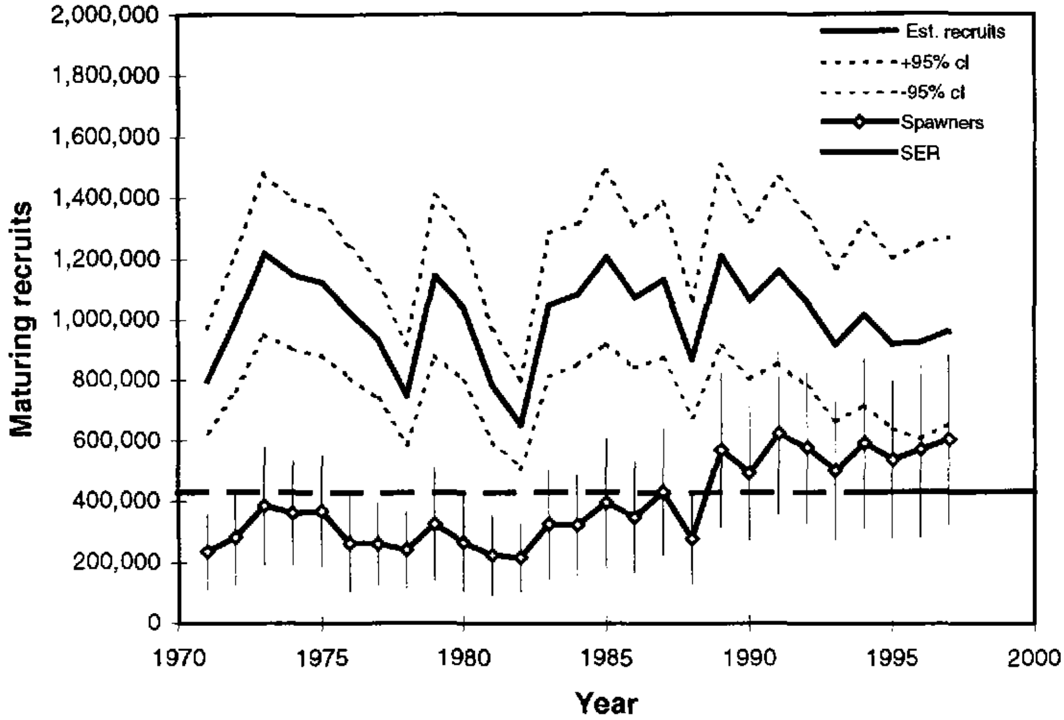
Incre

Sta

Decre

Figure 3.6.3.1 Estimated PFA, spawning escapement and SER for maturing and non-maturing 1SW components of Northern European stocks, 1971-98.

a) Maturing 1SW recruits



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

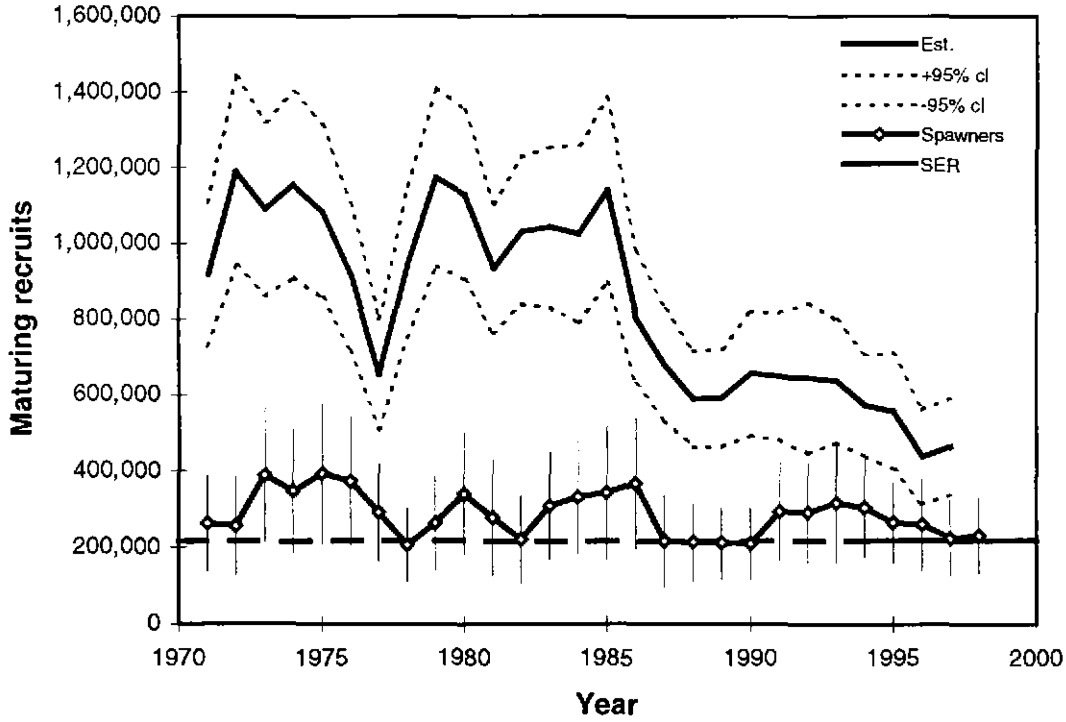
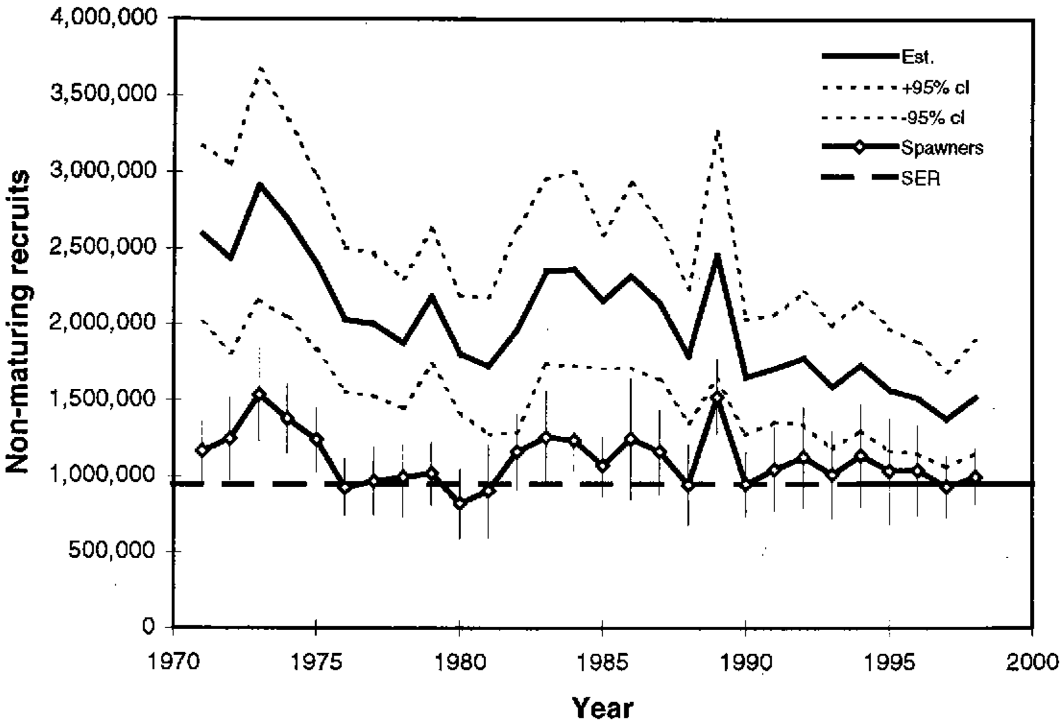


Figure 3.6.3.2 Estimated PFA, spawning escapement and SER for maturing and non-maturing 1SW component of Southern European stock groups, 1971-98

a) 1SW salmon (Southern)



b) MSW salmon (Southern) (Recruits in Year N become spawners in Year N+1)

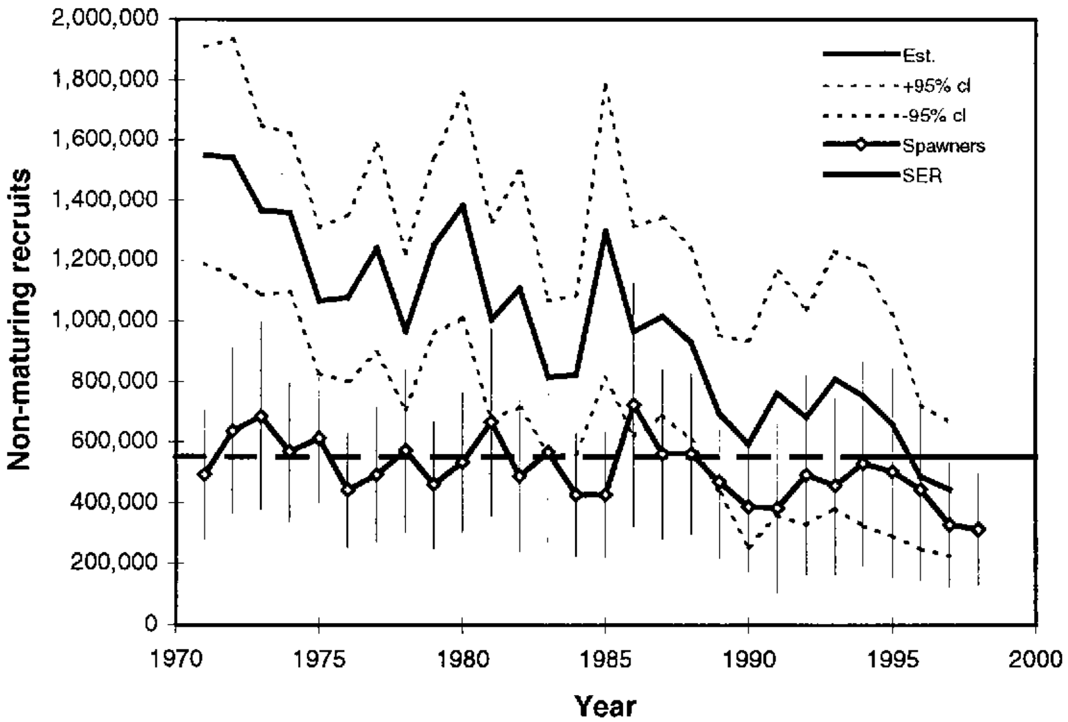
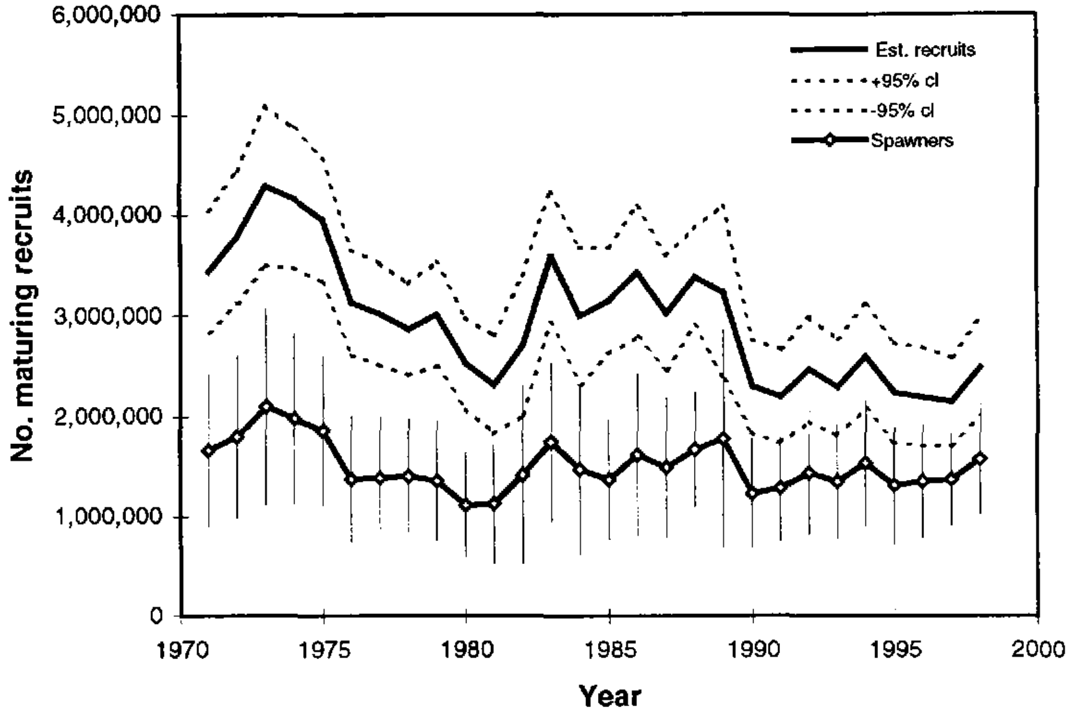


Figure 3.6.3.3 Estimated prefishery abundance of salmon stocks and spawning escapement in the NEAC Area, 1971-98

a) 1SW salmon (NEAC total)



b) MSW salmon (NEAC total) (Recruits in Year N become spawners in Year N+1)

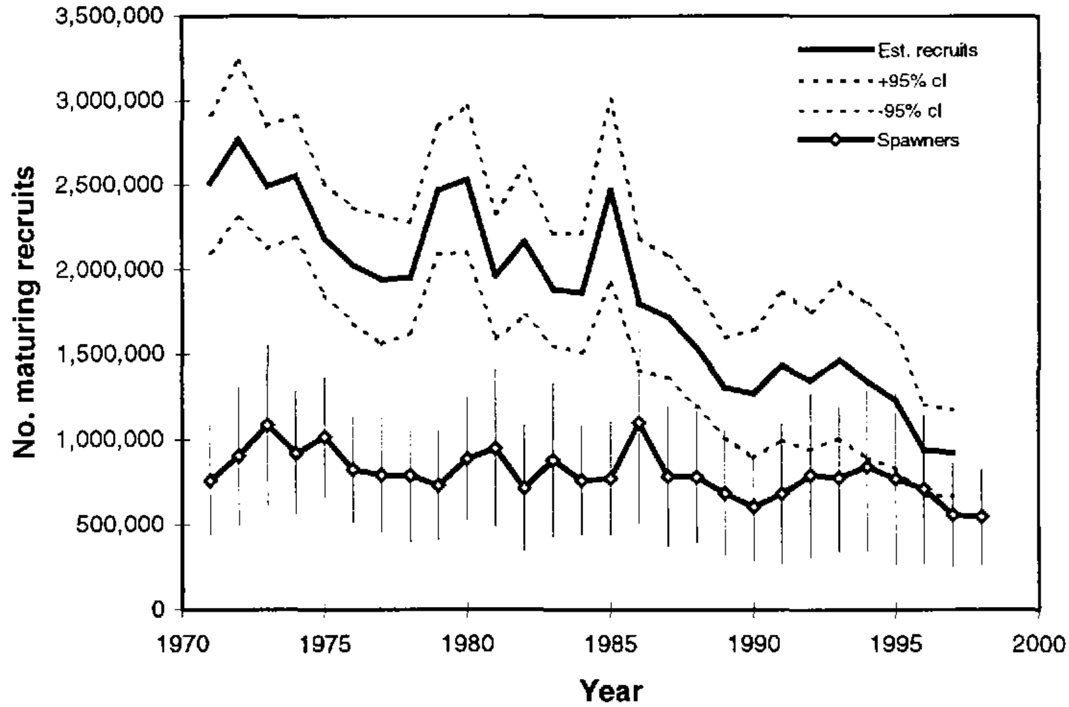
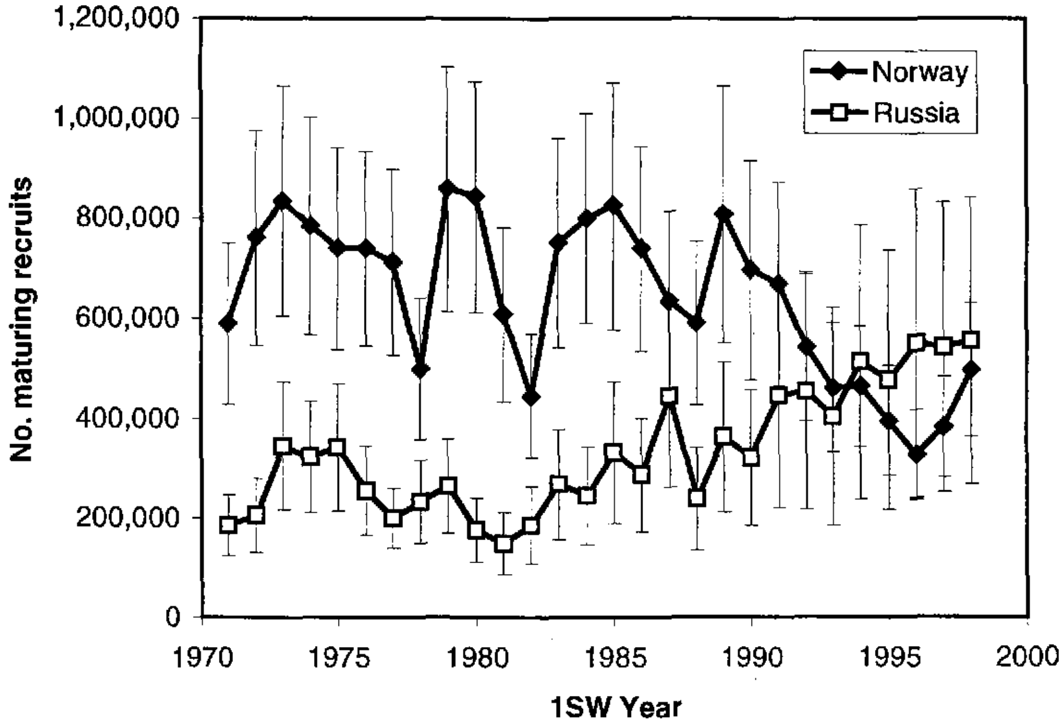


Figure 3.6.4.1 Estimated PFA of maturing 1SW salmon for Norwegian and Russian stocks, 1971-98



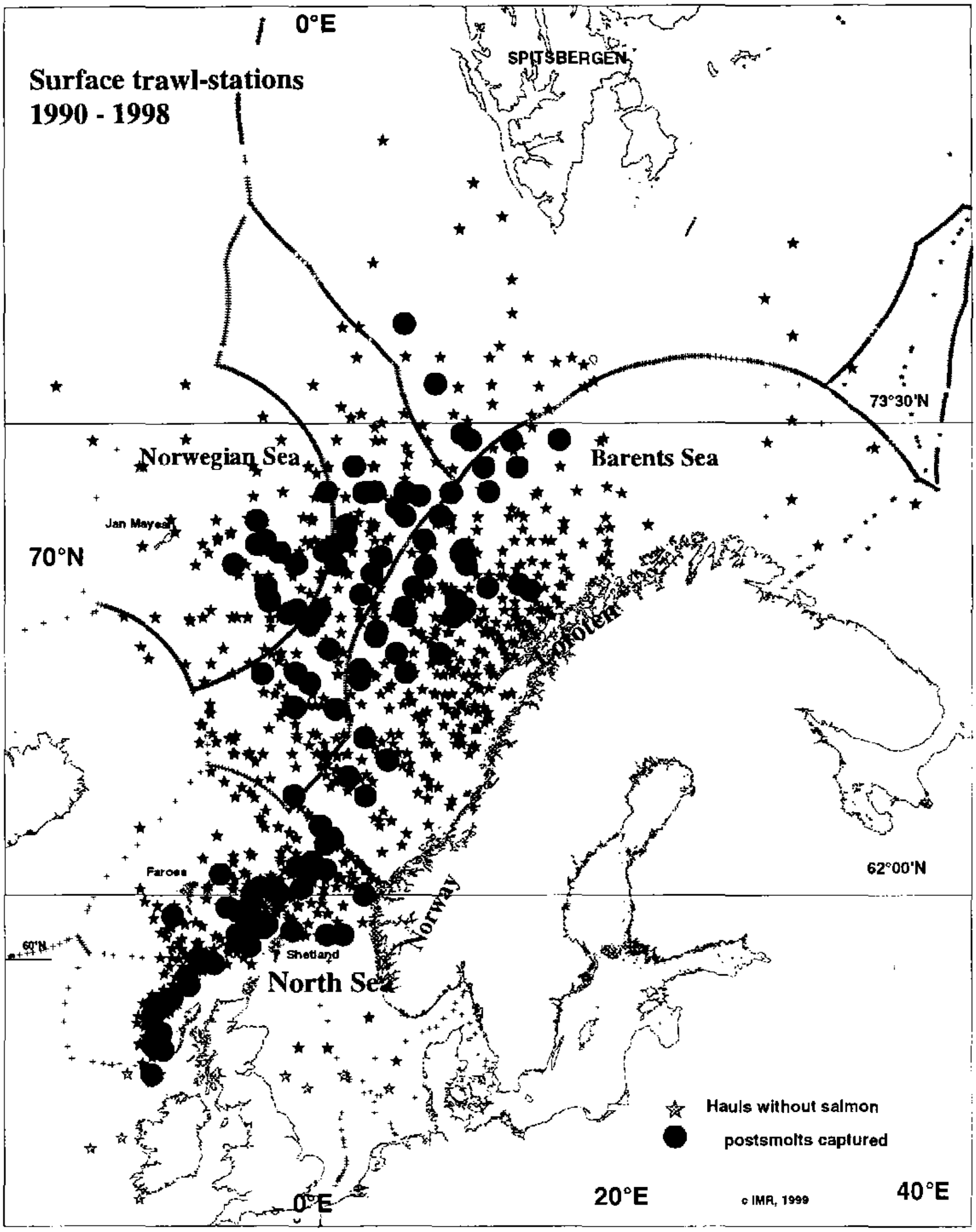


Figure 3.9.1.1. Total distribution of post-smolts captures in 1990 - 1998 in the Norwegian Sea and adjacent areas. Legends in figure. The EEZz of the boardering countries indicated

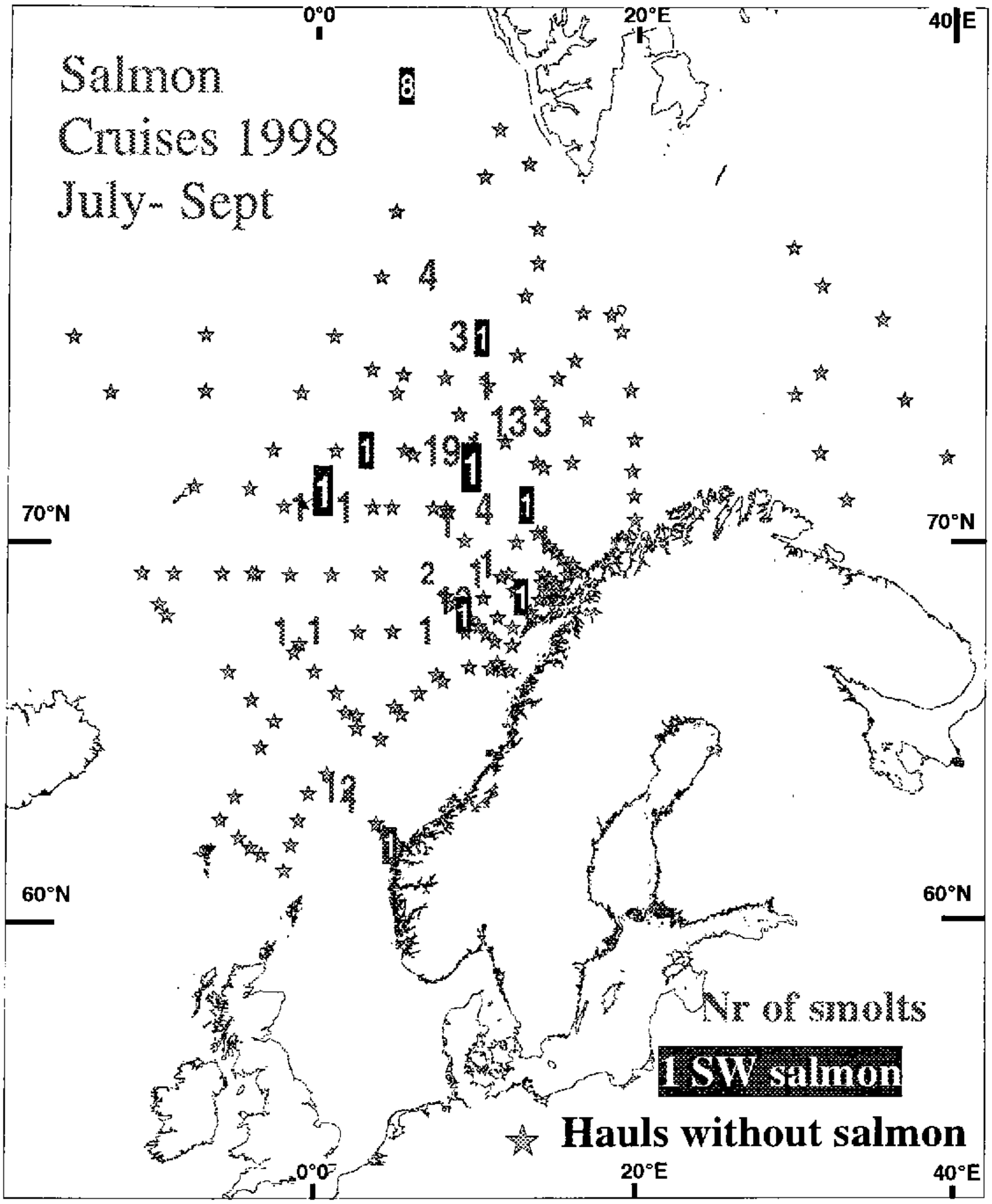


Fig. 3.9.1.2. Captures of post-smolts and salmon in 1998 in the Norwegian Sea and adjacent areas. Midpoint of number indicates trawl site. Legends in figure.

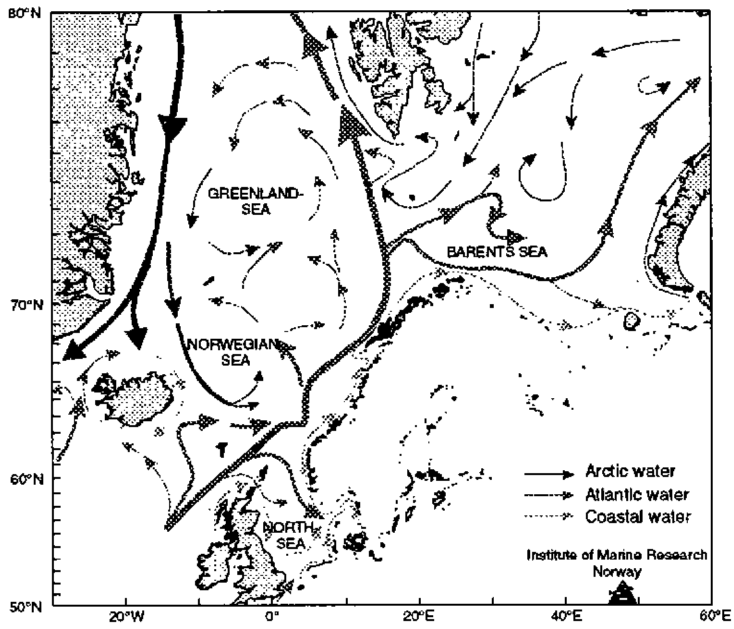


Figure 3.9.1.3. Overview of the dominating currents in the Norwegian Sea and adjacent sea areas.

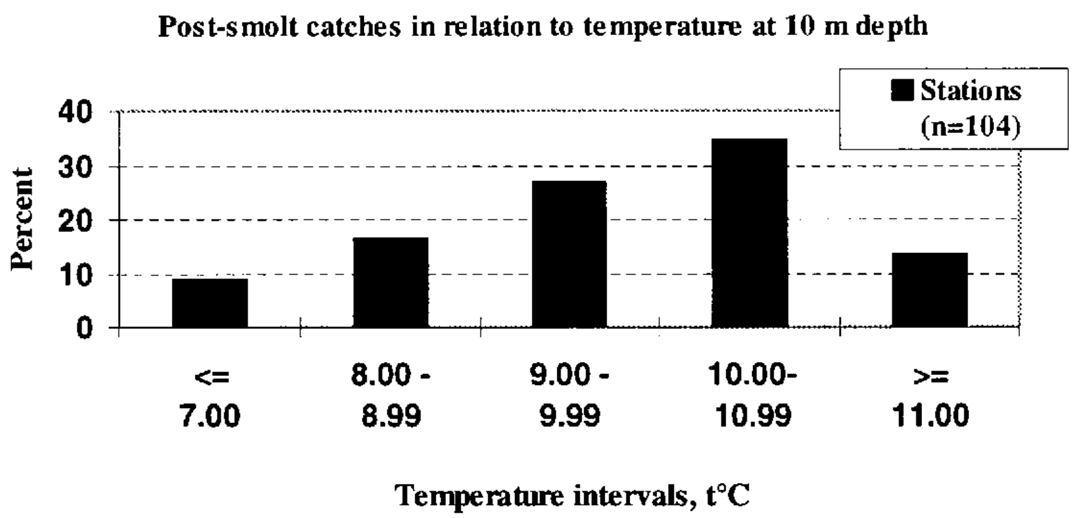


Figure 3.9.1.4 Distribution of trawl catches in relation temperature at 10 m depth at the fishing stations

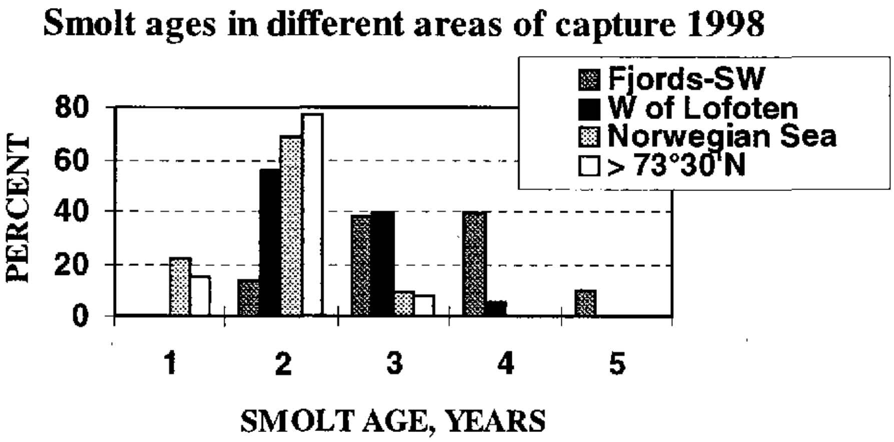


Figure 3.9.1.5. Age distribution of salmon and post-smolts captured in 1998 in four different areas

4 FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA

4.1 Description of Fisheries

4.1.1 Gear and effort

Canada

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

Three user groups exploited salmon in Canada in 1998: Native peoples, commercial fishers, and recreational fishers. The following management measures were in effect in 1998:

Native peoples' fisheries: In Québec, Native peoples' food fisheries took place subject to agreements or through permits issued to the bands. There are nine bands with food fisheries in addition to the fishing activities of the Inuit in Ungava. The permits generally stipulate gear, fishing effort and catch limits. In the Maritimes and Newfoundland (SFAs 1 to 23), food fishery harvest agreements were signed with several Native peoples' groups (mostly First Nations) in 1998. The signed agreements often included allocations of small and large salmon. For the first time, harvests by Native peoples in Labrador (SFA 1) are also reported. Harvests which occurred both within and outside agreements were obtained directly from the Native peoples or, estimated by local enforcement staff, in the case of Labrador. Harvest by Native peoples with recreational or commercial licenses are reported under the recreational and commercial harvest categories.

Commercial fisheries: The moratorium which was placed on the commercial fishery in insular Newfoundland in 1992 continued in 1998. In addition, the commercial fishery in southern Labrador (SFA 14B) remained closed in 1998, as in 1997. The commercial fishery in the remainder of Labrador was closed in 1998, with a voluntary buyback of licenses offered (Table 4.1.1.1). Commercial fisheries in Québec in 1998 occurred only in zone Q9 (July 1 to August 23) as the commercial quota normally fished by Native peoples' in Ungava Bay (zone Q11) was closed. The quota for Q9 in 1998, established in terms of number of fish, was the same as in 1997, however, a voluntary buyback of licenses was announced for this fishery before the season and resulted in many fishermen not fishing.

Recreational fisheries: Recreational fisheries management in 1998 varied by area (Figure 4.1.1.2). Except in Québec and Labrador (SFA 1 and 2), only small salmon could be killed and retained in the recreational fisheries. The seasonal bag limits in the recreational fishery remained at eight small salmon in New Brunswick (SFA 15, 16) and in SFA 18 of Nova Scotia, although in SFAs 15 and 16, the small salmon retention limit was reduced from two to one fish and the maximum daily catch limit was reduced from four to two fish. For the Miramichi River only, the daily catch limit was increased to four fish per day after a mid-July in-season review. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. Catch-and-release fishing only for all sizes of Atlantic salmon was in effect in SFA 19 of Nova Scotia and on ten rivers in Newfoundland. SFAs 20-23 of Nova Scotia and New Brunswick was closed to all salmon angling, except for four acid-impacted rivers on the Atlantic coast of Nova Scotia, where retention of returning small hatchery salmon was allowed. For insular Newfoundland (SFAs 3 to 14A) and the Strait of Belle Isle shore of Labrador (SFA 14B), the daily limits were either one small salmon retained or two fish, caught and released. The season started with a seasonal bag limit of one small salmon and was increased to four small salmon after an in-season review in July. In the northern and southern SFAs of Labrador (SFA 1 and 2), there was a seasonal limit of four fish, only one of which could be a large salmon. In Québec, season and bag limits varied by zone: for Q1 to Q8 and Q10, the season limit was seven fish of any size. For rivers in zone Q9 and Q11, the season limit was 10 fish with daily limits of two fish in Q8, three fish in Q9 and four fish in Q11. In most rivers of zones Q1 to Q7 and Q10, fishing for the day would end if the first fish kept was a large salmon. If the first fish kept was a small salmon, then fishing could continue until a second fish was caught, regardless of the size of the second fish. Seven rivers in Québec were restricted to retention of small salmon only at the start of the season, and this regulation was extended to eleven more rivers after mid-season reviews detected low returns of large salmon (Figure 4.1.1.2).

USA

Angling for sea-run Atlantic salmon in the USA is permitted only in the State of Maine, and in 1998 the sport fishery continued to be restricted to catch and release. Effort, as measured by license sales, declined by 16% in 1998 and was 46% and 53% below the 5- and 10-year averages, respectively.

France (Islands of Saint-Pierre and Miquelon)
For the Saint-Pierre and Miquelon fisheries in 1998, there were nine professional and 42 recreational licenses issued. The number of professional fishermen has decreased slightly since 1995 and the number of recreational licenses has remained about the same.

Year	Number of Professional Fishermen	Number of Recreational Licenses
1995	12	42
1996	12	42
1997	6	36
1998	9	42

4.1.2 Catch and catch per unit effort (CPUE)

Canada
The provisional harvest of salmon in 1998 by all users was 149 t, a decrease of 35% by weight from the 1997 harvest of 229 t (Table 4.1.2.1; Figure 4.1.2.1).

The 1998 harvest was 46,687 small salmon and 13,270 large salmon, a 21% and 49% decrease from the 1997 harvests for small salmon and large salmon, respectively. The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort, the closure of the insular Newfoundland commercial fishery in 1992 and the closure of the Labrador commercial fishery in 1998 (Figure 4.1.2.1). These reductions were introduced as a result of declining abundance of salmon.

The 1998 harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and the fish-size group exploited (Table 4.1.2.1). Newfoundland reported the largest proportion of the total harvest of small salmon and Québec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in each provinces, accounting for 88% of the total small salmon harvests in eastern Canada. Unlike previous years when commercial fishers took the largest share of large salmon, Aboriginal fisheries accounted for the largest share in 1998 (57% by number). Commercial fisheries harvested 2% (by number) of the total small salmon and 8% of the total large salmon taken in eastern Canada.

Native peoples' fisheries: In many cases, Native peoples' food fisheries harvests in 1998 were less than the allocations. Harvests in 1998 (by weight) were up 22% from 1997 and 17% above the previous 5-year average harvest.

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

Recreational fisheries: Harvest in recreational fisheries in 1998 totalled 45,959 small and large salmon, 30% below the previous 5-year average and 7% below the 1997 harvest level (Figure 4.1.2.2). The small salmon harvest of 41,246 fish was a decrease of 27 % from the previous 5-year mean. The large salmon harvest of 4,713 fish was a 48% decline from the previous five-year mean. Small salmon harvests were down 4% and large salmon harvests were down 30% from 1997. The small salmon size group has contributed 86% on average of the total harvests since the imposition of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland (SFA 3 to 14B, 15 to 23) in 1984 (Figure 4.1.2.2).

Recreational catches (including retained and released fish) of small salmon in 1998 were similar or above the 1984 to 1991 mean in most fishing areas of Québec, and the north-east coast and northern peninsula of Newfoundland and throughout Labrador (Figure 4.1.2.3). Small salmon catches were among the lowest observed in the majority of the Maritimes (with the exception of PEI) and in the west and south coasts of Newfoundland. Large salmon catches were among the lowest observed throughout mainland Canada (with the exception of the Gulf shore rivers of Nova Scotia) but were among the highest in the west coast of Newfoundland, (SFA 12, 13, 14A) and Labrador (SFAs 1,2, and 14B). Catches in PEI (SFA 17) were above average but more than 90% of the returns originate from smolt stocking programs.

In 1984, anglers were required to release all large salmon in the Maritime provinces and insular Newfoundland. Changes in the management of the recreational fisheries since 1984 have compromised the use of angling catches as indices of abundance. Therefore, the interpretation of trends in abundance relies mostly on rivers where returns have been estimated or completely enumerated. Caught-and-released fish are not considered equivalent to retained fish and their inclusion in catch statistics further compromises the reliability of interpretation of trends. In more recent years, anglers have been required to release all salmon on some rivers for conservation reasons and, on others, they are voluntarily releasing angled fish. In addition, numerous areas in the Maritimes Region in 1998 were closed to retention of all sizes of salmon (Figure 4.1.1.2).

In 1998, over 50,000 salmon (about 21,000 large and 30,000 small) were caught and released (Table 4.1.2.2), representing about 52% of the total number caught, including retained fish. This was a 4% increase from the number released in 1997, the only other year where there are estimates available for all areas. Most of the fish released were in Newfoundland (45%), followed by New Brunswick (41%), Nova Scotia (7%), Québec (6%) and Prince Edward Island (<1%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, Nova Scotia released the highest percentage (87%), followed by New Brunswick and Newfoundland (56% each), Prince Edward Island (55%) and Québec (22%).

Commercial fisheries: The commercial harvest in 1998 declined to 5 t from a peak of more than 2,400 t in 1980 (Figure 4.1.2.4) with only area Q9 of Québec reporting a commercial harvest. In Québec, the harvest of large salmon in the commercial fishery continued to decline in 1998, as a result of license retirements.

Unreported catches: Canada has been providing estimates of unreported catches of Atlantic salmon since 1986. Until 1997, these numbers have previously been confidential and summed in the Working Group reports either as part of a total for the North Atlantic or as a subset expressed as a total for the North American Commission area. However, it has been obvious that most of the unreported catch estimated for the North American Commission area has been Canada's as based on its much higher reported catch compared to the USA and Sainte-Pierre and Miquelon.

Canada's unreported catch estimate for 1998 is about 91 t, about the same as estimates made for 1997. Estimates were included for all provinces and were provided mainly by enforcement staff. In some cases where enforcement staff did not respond to requests for estimates, values previously provided were assumed for 1998. Most unreported catch arises from illegal retention of salmon.

By stock groupings used for Canadian stocks throughout the report, the unreported catch estimates for 1998 were:

Stock Area	Unreported Catch (t)
Labrador	7.5
Newfoundland	24.5
Gulf	37.8
Scotia-Fundy	1.1
Québec	20.1
Total	91.0

USA

There was no harvest of sea-run Atlantic salmon in the USA in 1998. The estimated number of salmon caught and released was 273 fish, which represented decreases of 18% from the previous year (333 fish) and 32% and 33% from the previous 5- and 10-year averages, respectively. Most of the reduced catch in 1998 occurred in the Penobscot River and was attributed to a decline in salmon abundance, a reduction in the length of the angling season (initiated in 1997), and a reduction in angler effort (as evidenced by reduced license sales). Unreported catches were estimated to be 0 in 1998.

France (Islands of Saint-Pierre and Miquelon)

The harvest in 1998 was reported to be 2.3 t, up from about 1.5 t in 1997 and the largest value since 1994. Professional fishermen harvested 1.0 t and recreational fishermen, 1.3 t in 1998. There was no estimate made of unreported catch for 1998.

4.1.3 Origin and composition of catches

In the past, salmon from both Canada and USA have been taken in the commercial fisheries of Labrador. These fisheries were closed in 1998. The remaining Aboriginal food fisheries that exist in this area may intercept some salmon from other areas of North America although there are no reports of tagged fish being captured there in 1998.

Canada

Origin of returns in 1998: Fish designated as being of wild origin are defined as the progeny of fish where mate selection occurred naturally (eggs not stripped and fertilised artificially) and whose life cycle is completed in the natural environment (ICES 1997/Assess:10). Hatchery-origin fish, designated as fish introduced into the rivers regardless of life stage, were identified on the basis of the presence of an adipose clip, from fin deformations, and/or from scale characteristics. Not all hatchery fish could be identified as such in the returns because of stocking in the early life stages. Aquaculture escapees were identified from hatchery fish on the basis of fin erosion (especially of the tail) and from scale characteristics.

The returns to the majority of the rivers in Newfoundland and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon (Figure 4.1.3.1). Hatchery origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy and the Atlantic coast of Nova Scotia. Aquaculture escapees were present in the returns to three rivers of the Bay of Fundy (St. Croix, Magaguadavic and Saint John), two rivers of the Gulf of Maine (Dennys and Narraguagus), as well as three rivers (Middle, Baddeck and North) in Cape Breton Island (Table 4.1.3.1).

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to almost 23,000 t in 1998 (Table 2.2.1.1). Escapes of Atlantic salmon have occurred annually. In 1994, escapes of Atlantic salmon in the Bay of Fundy area were estimated at 20,000 to 40,000 salmon, an amount greater than the total returns of wild and hatchery origin salmon (both small and large) (13,000 to 21,000 fish) to the entire Bay of Fundy and Atlantic coast of Nova Scotia area (SFA 19 to 23) in the same year. The level of escapes in 1993 was similar to that of 1994. Levels of escapes for 1995 to 1998 are unknown.

The proportion of the run that are aquaculture escapees has increased in the Magaguadavic River (SFA 23; Table 4.1.3.1) which is in close proximity to the centre of the aquaculture production area (Figure 4.1.3.2 upper panel; lower panel is historical occurences). Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of the total counts at the fishway. Aquaculture escapees comprised between 13% and 54% of the total run of salmon to the St. Croix River during 1994 to 1998 (Table 4.1.3.1).

USA

Some salmon that were caught in the sport fishery in 1998 may have been escapees from aquaculture operations in Maine and New Brunswick. In addition, a few of those caught and released originated from captive broodstock that were released into four Maine rivers. The incidence of aquaculture escapes was low in 1998, although most Maine rivers in the vicinity of aquaculture operations were not monitored. There were no aquaculture escapees observed in the Narraguagus River in 1998.

4.1.4 Exploitation rates in Canadian and USA fisheries

Canada

In previous years, overall Canadian exploitation rates were calculated as the harvest of salmon divided by the estimated returns to North America. No estimates of returns to Labrador are possible for 1998, as there was no commercial fishery and no information was collected on freshwater escapements. For this reason, exploitation rates cannot be calculated for 1998. Harvests of 46,687 small and 13,270 large salmon were less than those of 1997, substantially in the case of large salmon, and it is expected that exploitation rates decreased from those of 1997 when values were estimated to be between 0.14 and 0.26 for small and 0.15 and 0.25 for large salmon.

USA

There was no exploitation of USA salmon in home waters and no salmon of USA origin were detected in Canadian catches in 1998.

4.2 Status of Stocks in the North American Commission Area

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

4.2.1 Measures of abundance in monitored rivers

Canada

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

A total of 90 rivers were assessed in eastern Canada in 1998. Estimates of total returns of small and large salmon were obtained using various techniques: 43 were derived from counts at fishways and counting fences; six were obtained using mark and recapture experiments; 32 using visual counts by snorkeling or from shore; and 9 from angling catches or redd counts.

1998 compared to 1997 adult returns: Of the 90 stocks for which returns of salmon were determined in 1998, comparable data were available for 76 of these in 1997. For 51 of these rivers, returns were estimated by small salmon and large salmon size groups separately in both years (Table 4.2.1.1). For both size groups combined, returns in 1998 were less than 50% of the 1997 returns in three of the 76 rivers assessed (4%), between 50% and 90% of 1997 returns in 41% of the rivers and were 90% or greater than 1997 returns in 55% of the rivers.

Large salmon returns in 1998 decreased from 1997 in rivers throughout the Maritime provinces and Québec but were equally down or improved in Newfoundland (Table 4.2.1.1; Figure 4.2.1.1). In most of the rivers of Newfoundland, except for rivers of the south-west coast (SFA 13), large salmon are mostly repeat-spawning 1SW fish. Small salmon returns in 1998 relative to 1997 were generally improved throughout eastern Canada (Figure 4.2.1.1). Returns were similar to or improved (>90% in 1998 relative to 1997) in 71% of the assessed rivers. The north-west and north-east coast Newfoundland rivers showed the most consistent improvement in returns.

1985-98 patterns of adult returns: Annual returns of salmon by size group are available for 24 rivers in eastern Canada since 1985. These returns do not account for commercial fisheries removals in Newfoundland, Labrador, Québec and Greenland and in some rivers include returns from hatchery stocking. Peak return years differed for regions within eastern Canada (Figure 4.2.1.2). The returns during the Newfoundland commercial fishery moratorium years (1992 to 1998) for all areas except Newfoundland are lower than returns in 1986 to 1988 when there were commercial fisheries in Newfoundland, Labrador, Québec and Greenland harvesting mainland Canada origin salmon. The total returns to six Newfoundland rivers doubled during 1993 to 1996 from the low levels observed during 1989 to 1991 (Figure 4.2.1.2). The returns in-river of small salmon in 1998 were collectively the second highest observed in the time series and the large salmon are the highest recorded.

The returns of large salmon in all areas except Newfoundland were the lowest observed during 1985 to 1998 (Figure 4.2.1.2). Returns of small salmon to six Gulf rivers (NB, NS) in 1998 improved from 1997 but were 44% of the average returns during 1985 to 1991, prior to the Newfoundland commercial fishery moratorium. The returns of large salmon in 1998 were the lowest of the time series at less than 23,000 fish. Returns to the rivers of the Atlantic coast of Nova Scotia and Bay of Fundy declined to new lows for large salmon. Returns to nine rivers of Québec in 1998 were the second lowest since 1985 with large salmon returns declining the most to the lowest since 1985. The low abundance of 2SW salmon was most evident in the Québec and Gulf rivers. Low abundance of 2SW salmon in 1998 had been anticipated from the low abundance of 1SW salmon in 1997.

Smolt and juvenile abundance: Counts of smolts provide direct measurements of the outputs from the freshwater habitat. Previous reports have documented the high annual variability in the annual smolt output: in tributaries, smolt output can vary by five times but in the counts for entire rivers, annual smolt output has generally varied in magnitude by a factor of two. Wild smolt production has been estimated in 11 rivers of eastern Canada, although only nine rivers have several years of data (Figure 4.2.1.4). In other rivers, juvenile abundance surveys have been conducted (Figure 4.2.1.4).

In the Québec rivers where smolt production has been monitored, the 1997 and 1998 smolt productions were less than half the 1990 to 1995 average (Figure 4.2.1.5). The low smolt production in the Québec Zone Q7 was attributed to the July 1996 flood which physically reconfigured a large number of rivers in that zone and resulted in a near complete loss of the juveniles in 1996. In Newfoundland, smolt production in 1996 to 1998 remained above the 1990 to 1995 average in the indexed rivers except for the southwest coast river (Highlands) (Figure 4.2.1.5).

Juvenile salmon abundance has been monitored annually since 1971 in the Miramichi (SFA 16) and Restigouche (SFA 15) rivers and for shorter and variable time periods in other rivers (Figure 4.2.1.4). In the rivers of the southern Gulf, densities of young-of-the-year (fry) and parr (juveniles of one or more years old) have increased since 1985 in response to increased spawning escapements (Figure 4.2.1.6). Densities of parr in 1998 declined from recent years but remained high relative to the 1970s. In the Restigouche River, both fry and parr densities remain high and near record levels. High densities of juveniles have also been reported from Nova Scotia rivers along the Gulf of St. Lawrence (SFA 18) and in several Cape Breton Island streams (SFA 19). This is in contrast to juvenile densities from an inner Bay of Fundy river (Stewiacke River; SFA 22) which have declined since 1984, as a result of reduced spawning escapement. Densities of juveniles in the Stewiacke River in 1998 were at record low level (Figure 4.2.1.6).

The total number of smolts leaving Canadian rivers is unknown. However, a combination of smolt counts and juvenile abundance indices, considered as surrogates of smolt production, allow development of indices of total smolt production from eastern Canada. To allow for the combined analysis of smolt counts and juvenile abundance surveys from all the rivers, the individual river surveys were standardized by the average within river abundance for the period 1995 to 1998.

$$Ind_{ij} = Abund_{ij} \,/\, Average_{i'j}$$

where

Ind_{ij}	=	Adjusted index of juvenile or smolt abundance for year i and river j,
$Abund_{ij}$	=	Measured abundance of juvenile or smolts for year i and river j, and
$Average_{i'j}$	=	Average abundance for years i' (1995 to 1998) in river j.

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

The index of smolts from the broader geographic areas of eastern North America (Labrador, Newfoundland, Quebec, Gulf, Scotia-Fundy and U.S.) was obtained by weighting the annual river indices by the relative proportion of the conservation egg requirements (O'Connell *et al.* 1997) of the SFA or Zone to the total conservation egg requirements of the zones under consideration (Table 4.2.1.2). The longest time series are from Western Arm Brook (SFA 14A) in Newfoundland and the Miramichi and Restigouche rivers in the Gulf (SFAs 15 and 16). The number of rivers with available data has increased from two in 1971 to between 19 and 20 rivers in 1995 to 1998. The proportion of the indexed areas represented by the index rivers has increased from 11% in 1971 to 25% in 1998 (Table 4.2.1.3).

The relative change in smolt production or juvenile abundance differs among the three rivers with the longest time series (Figure 4.2.1.7). Smolts from Western Arm Brook peaked in the mid 1980s and again in the mid 1990s. This contrasts with the Miramichi juvenile index which was low through the 1970s to mid 1980s and rose quickly to maximum levels in the 1990s. The Restigouche index has essentially increased continually from 1972 to 1998. The relative index weighted by the area-index proportions suggests relative smolt production at three levels since 1971 - at about one-third the 1995 to 1998 average between 1971 and 1979, at about 60% of the average during 1980 to 1985 and at about average since 1986 (Figure 4.2.1.7). Weighted relative to the index river size, the trend in smolt index is similar to the Miramichi index since this river represents at least 45% of the total river-weight index (Figure 4.2.1.7, Table 4.2.1.2).

Estimates of the relative smolt index in the four geographic areas correspond to the previously documented status of rivers (Figure 4.2.1.8). Smolt production from Newfoundland rivers has approximately doubled over the 1971 to 1998 time period (Figure 4.2.1.8). The Gulf smolt index is at its highest level in the 1990s. The Quebec smolt index has declined between 1983 and 1998, driven by de la Trinité time series which for Quebec has a large area-index weight (Table 4.2.1.2). The relative index for Scotia-Fundy peaked around 1990 and has since declined.

USA

Documented adult salmon returns to rivers in New England in 1998 amounted to 1,745 salmon (Figure 4.2.1.3), which was about the same number observed (1,746) in 1997. Total salmon returns to the rivers of New England continued their downward trend, and were 15% and 37% lower than the previous 5-r and 10-year averages, respectively. Returns of 1SW salmon increased by 13% (310 to 356), while MSW returns declined by 3% (1,436 to 1,389) from the previous year. The documented adult returns are minimal estimates, since many rivers in Maine do not contain counting facilities and all counting facilities throughout New England are less than 100% effective at capturing adult salmon.

Most of the USA salmon returns were recorded in the rivers of Maine, with the Penobscot River accounting for about 69% of the total. Returns to the Penobscot River (1,210 fish) were 11% lower than the previous year, 20% lower than the previous 5-year average and 42% lower than the previous 10-year average.

Adult salmon returns to many other Maine rivers with fish counting facilities were similar to those observed in 1997, although the trap catch of salmon on the Narraguagus River (22 salmon) was the smallest number counted since trapping of salmon began in 1960.

About 17% of the USA returns (300 salmon) were recorded in the Connecticut River, a 51% increase from the previous year. Returns to the Connecticut River in 1998 were 28% and 29% above the previous 5- and 10-year averages, respectively.

Salmon returns to the Merrimack River numbered 123 fish. This represented a 73% increase from the previous year, and increases of 132% and 3% above the previous 5- and 10-year averages, respectively.

4.2.2 Estimates of total abundance by geographic area

For assessment purposes, the following regions were considered: Labrador (SFA 1, 2, & 14B), Newfoundland (SFA 3–14A), Québec (Q1-Q11), Gulf of St. Lawrence (SFA 15-18), Scotia-Fundy (SFA 19-23) and USA. Returns of 1SW and 2SW salmon to each region (Tables 4.2.2.1 and 4.2.2.2; Figures 4.2.2.1 and 4.2.2.2; and Appendix 6) were estimated by updating the methods and variables used by Rago *et al.* (1993b) and reported in ICES 1993/Assess:10. The returns for both sea-age groups were derived using a variety of methods using data available for individual river systems and management areas. These methods included counts of salmon at monitoring facilities, population estimates from mark-recapture studies, and the application of angling and commercial catch statistics, angling exploitation rates, and measurements of freshwater habitat (Appendix 6). MSW returns were proportioned to 2SW returns on the basis of sea-age composition of one or more indicator stocks.

In the context used here "returns" are the number of salmon that returned to the geographic region, including homewater commercial fisheries, except in the case of Newfoundland and Labrador regions where returns do not include commercial fisheries. The addition of catches of Newfoundland and Labrador origin salmon in commercial fisheries in Newfoundland and Labrador to "returns" to Newfoundland and Labrador are referred to as total "recruits". Estimation of "recruits" to Québec, Gulf of St. Lawrence, Scotia Fundy and USA regions are not possible because the origin of intercepted salmon in the Newfoundland-Labrador commercial fisheries are not specifically known. In part this was done to avoid double counting of fish when commercial catches in Newfoundland and Labrador are added to returns of all geographic in North America to create the PFA of North American salmon.

Labrador
The basis for estimates of 2SW and 1SW salmon returns and spawners for Labrador (SFAs 1, 2 & 14B) prior to 1998 are catch data from angling and commercial fisheries. Catch and effort data from the angling fishery were collected by DFO enforcement staff in conjunction with angling reports submitted by fish camp operators and processed by DFO Science Branch personnel. In 1997 for SFA 14B, the angling catch statistics were derived from a licence stub system similar to insular Newfoundland while in SFAs 1 & 2 the camp statistics data were used. Commercial catch data were collected by DFO enforcement staff from fish plant landing slips and processed by DFO Statistics and Informatics Branch personnel.

In 1998, there was no commercial fishery in Labrador and no complete counts exist for any Labrador river in 1998. Hence, it was not possible to estimate the returns or spawners to Labrador for this year.

Newfoundland
The estimates of 1SW and 2SW returns and spawners for insular Newfoundland (SFAs 3–12 & 14A) are updated for 1998. They are derived from exploitation rates estimated from rivers with counting facilities which are subsequently applied to angling catches of small salmon, adjusted for the proportions of large:small salmon at counting facilities, and finally the proportion of large salmon that are 2SW. Exploitation rates for small salmon (retained only) were calculated by dividing the total count and the catch (retained) from rivers with enumeration facilities. In 1998, for SFAs 3–12 and 14A, angling catch data was derived from the licence stub return system (O'Connell *et al.* 1997) while in previous years angling catch data was collected by DFO Fishery Officers and Guardian staff. For SFA 13, returns and spawners come from four assessment facilities expanded to the entire drainage area based on their proportionate contribution.

The mid-point of the estimated returns (187,000) of 1SW salmon to Newfoundland rivers in 1998 is 61% higher than 1997 and 10% lower than the average 1SW returns (170,300) for the period 1992–94 (Figure 4.2.2.1, Appendix 6). The 1992–95 1SW returns are higher than the returns in 1989-91, but similar to the returns to the rivers between 1971 and 1988. The 1SW recruits to Newfoundland, before commercial fisheries, have declined significantly from about 500,000 in 1988 to 187,000 in 1998.
The mid-point (8,000) of the estimated 2SW returns to Newfoundland rivers in 1998 is 60% higher than in 1997 and the highest value in the time series (1971-98) of returns (Figure 4.2.2.2, Appendix 6). The 2SW recruits however in 1998 are similar to 1992-97 and these years are the lowest observed in the time series (1969-98).

Québec
The procedure to estimate returns was revised by using individual river information for 117 rivers for each year between 1984 and 1998 as described last year. The mid-point (31,600) of the estimated returns of 1SW salmon to

Québec in 1998 is a 10% increase from the returns observed in 1997 and a 9 % decrease from the 1992-97 average (Figure 4.2.2.1).

The mid-point (33,700) of the estimated returns of 2SW salmon in Québec in 1998 is a 8% decrease from the returns observed for 1997 and a 25% decrease from the average of the years 1992-97 (Figure 4.2.2.2). Within the 1971-98 time series, the 1998 value is the lowest estimated and continues a downward trend from the high of 98,000 2SW salmon in 1980.

Gulf of St. Lawrence, SFAs 15–18
The mid-point (53,300) of the estimated returns in 1998 of 1SW salmon returning to the Gulf of St. Lawrence was a 31% increase from 1997, however it is the second lowest value since 1984. The low values noted in 1997 and 1998 continue a downward trend from the high value of about 188,000 in 1992 (Figure 4.2.2.1, Appendix 6).

The mid-point (13,700) of the estimate of 2SW returns in 1998 is 50% lower than the estimate for 1997 and the second lowest of the time series (Figure 4.2.2.1, Appendix 6), the lowest being 1979 at 11,500. Returns of 2SW salmon have declined steadily since 1995.

Scotia-Fundy, SFAs 19-23
The mid-point (16,700) of the estimate of the 1SW returns in 1998 to the Scotia-Fundy Region was an 89% increase from the 1997 estimate, which was the lowest value in the time series, 1971-1998. Returns have generally been low since 1990 (Figure 4.2.2.1, Appendix 6).

The mid-point (4,400) of the 2SW returns in 1998 is 9% lower than the returns in 1997 and the lowest value in the time series, 1971–97 (Figure 4.2.2.2, Appendix 6). A declining trend in returns has been observed from 1985 to 1998.

USA
Total salmon returns and spawners for USA rivers in 1998 were calculated as described in ICES 1996/Assess:11. Since harvest of salmon is not permitted in Maine and many rivers do not contain fish counting facilities, run sizes for several small rivers in Maine continue to be underestimated. In recent years, the number of USA spawners is considered to be the same as the number of estimated returns because it is not possible to determine the age and origin of salmon caught in the sport fishery, nor mortality associated with catch-and-release angling in Maine.

The estimated 1SW returns and spawners to USA rivers in 1998 were 403 salmon. This was 10% above the estimated returns in 1997, and 3% and 35% below the previous 5- and 10-year averages, respectively (Table 4.2.2.1, Figure 4.2.2.1).

The estimated 2SW returns and spawners to USA rivers in 1998 was 1,526 salmon. This was 5% below the 1997 estimate, and was 18% and 41% below the previous 5- and 10-year averages, respectively.

North America (combined Canada and USA)
It is not possible to calculate the total numbers of returns in 1998 of either 1SW or 2SW salmon to North America as no estimates exist for Labrador for reasons previously described.

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

North American run-reconstruction model
The Working Group has used the North American run-reconstruction model to estimate pre-fishery abundance, which serves as the basis of abundance forecasts used in the provision of catch advice. The catch statistics used to derive returns and spawner estimates have been updated from those used in ICES 1998/ACFM:15 (Table 4.2.3.1). The North American run-reconstruction model has also been used to estimate the fishery exploitation rates for West Greenland and in homewaters.

Non-maturing 1SW Salmon
The non-maturing component of 1SW fish, destined to be 2SW returns (excludes 3SW and previous spawners) is represented by the pre-fishery abundance estimator for year i designated as [NN1(i)]. Definitions of the variables are given in Table 4.2.3.2. It is constructed by summing 2SW returns in year i+1 [NR2(i+1)], 2SW salmon catches in commercial and Aboriginal food fisheries in Canada [NC2(i+1)] and catches in year i from fisheries on non-maturing 1SW salmon in Canada [NC1(i)] and Greenland [NG1(i)].

There are two important changes to the calculations that determine pre-fishery abundance of non-maturing 1SW salmon for 1997. The first change was made because of the inclusion of Aboriginal food harvests of small (AH_s) and large salmon (AH_l) in the reported catches for 1998. As Aboriginal harvests occurred in both Lake Melville and coastal areas of northern Labrador, a new parameter was added to define the fraction of these catches that are immature (af_imm). This was necessary because non-maturing salmon do not occur in Lake Melville where approximately half the catch originated. However, non-maturing salmon do occur in coastal marine areas in the remainder of northern Labrador. Consequently, af_imm for the fraction of Aboriginal harvests that were non-maturing was set at 0.05 to 0.1 which is half of f_imm from commercial fishery samples. The new equations to calculate NC1 and NC2 are as follows:

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

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

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

The second change was necessitated by the closure of the commercial fishery in Labrador in 1998. In past reports, salmon returns and spawners for Labrador which make up one of the six geographical areas contributing to NR2 for Canada were based on commercial fishery data. Since the commercial fishery was closed in Labrador in 1998 the time series also ended. However, in order to estimate pre-fishery abundance it was still necessary to include Labrador returns for 1998. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time series of Labrador recruit estimates and pre-fishery abundance data from 1971-96. The raising factor (RFL2) to estimate returns to Labrador for 1998 for 2SW salmon was set to the low and high range of values in the time series which was 1.05 to 1.27. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the back-calculated numbers between the salmon fisheries on the 1SW and 2SW salmon (10 months) and between the fishery on 2SW salmon and returns to the rivers (1 month) as shown below:

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

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

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for some of the fisheries harvesting potential or actual 2SW salmon. Thus, commercial catches used in the run-reconstruction model for the West Greenland fishery (1993 and 1994), Newfoundland fishery (1992–97) and Labrador fishery (1998) were set to zero in order to remain consistent with catches used in other years in both of these areas (see Section 4.1.1) There were no commercial fisheries in these areas for the years indicated.

As the pre-fishery abundance estimates for potential 2SW salmon require estimates of returns to rivers, the most recent year for which an estimate is available is 1997. The minimum and maximum values of the catches and returns for the 2SW cohort are summarized in Table 4.2.3.3. The 1997 abundance estimates ranged between 69,710 and 126,088 salmon. The mid-point of this range (97,899) is 23% lower than the 1996 value (126,600) and is the lowest in the 26-year time series (Figure 4.2.3.1). The most recent year is shown with hollow symbols as no Labrador values were estimated for this year and the raising factor described previously was used. The results suggest a continuation of the general decline from 807,000 in 1975. The Working Group expressed concern about the continued decline in the pre-fishery abundance and its impact on spawner levels. The low pre-fishery abundance estimates in 1997 are consistent with the low numbers of maturing 1SW salmon in 1997 which came from the same cohort.

Maturing 1SW salmon (grilse)

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

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

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

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

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

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

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

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for the fisheries harvesting 1SW salmon. Thus, catches used in the run-reconstruction model for the Newfoundland commercial fishery were set to zero for 1992–97 to remain consistent with catches used in other years in this area (see Section 4.1.1).

The minimum and maximum values of the catches and returns for the 1SW cohort are summarised in Table 4.2.3.4 and the mid-point values are shown in Figure 4.2.3.1. The most recent year is shown with hollow symbols as no Labrador values were estimated for this year and the raising factor described previously was used. The mid-point of the range of pre-fishery abundance estimates for 1998 (412,500) is 29% higher than 1997 (319,000) which was the lowest estimated in the time series 1971-97. Estimates for 1995 and 1994 decreased over those of the previous two years. The reduced values observed in 1978 and 1983–84 were followed by large increases in pre-fishery abundance.

Total 1SW recruits (maturing and non-maturing)
Figure 4.2.3.1 shows the pre-fishery abundance of 1SW maturing and 1SW non-maturing salmon from North America for the period 1971 to 1997 and Figure 4.2.3.2 shows these data combined to give the total 1SW recruits. The steady decline in recruits over the last ten years is alarming. Although the declining trend appears common to both maturing and non-maturing portions of the cohort, non-maturing 1SW salmon have declined at a steeper rate. Causes for the differences in rate of decline are uncertain. Figure 4.2.3.1 shows that grilse are becoming an increasingly larger proportion of the total North American stock complex. This proportion has risen from about 45% at the beginning of the 1970s to almost 80% in the last year. The Working Group expressed concerns about these stock trends and recommended further investigation into their causes.

4.2.4 Spawning escapement and egg deposition

Canada
Egg depositions in 1998 exceeded or equalled the river specific conservation requirements in 21 of the 71 assessed rivers (30%) and were less than 50% of conservation in 24 other rivers (34%) (Figure 4.2.4.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where eight of the 12 rivers assessed (67%) had egg depositions which were less than 50% of conservation requirements. Proportionally fewer rivers in Gulf (19%) and Quebec (35%) had egg depositions less than 50% of conservation. Only 25% of the Gulf rivers and 12% of the Quebec rivers had egg depositions which equalled or exceeded conservation (Figure 4.2.4.1). In insular Newfoundland, 71% of the rivers assessed met or exceeded the conservation egg requirements and almost all the others (24%) had egg depositions which were less than 50% of requirement. The deficits occurred in the southwest rivers of Newfoundland (SFA 13).

Nineteen rivers in Newfoundland and Québec are under rehabilitation or colonization programs where in recent years salmon have gained access to previously inaccessible habitat or to re-establish the wild production (Figure 4.2.4.1). Four of these rivers met or exceeded the conservation requirements in 1998. Egg depositions in 79% of these rivers were less than 50% of requirements. Egg depositions in 1998 relative to 1997 were similar or improved in 53% of these rivers.

Escapements over time relative to conservation requirements have improved in some areas of eastern Canada but have declined in others (Figure 4.2.4.2). The status of three Bay of Fundy/Atlantic coast of Nova Scotia rivers has severely declined, especially since 1991. The proportion of the conservation requirements achieved were the lowest in all three rivers in 1998. For the Québec rivers, spawning escapements declined continually from a peak median value in 1988 with a slight recovery in 1995. Escapements relative to conservation were among the lowest in the series with a few rivers showing improvements in 1998. The eight rivers of the Gulf of St. Lawrence have been the most consistent in equalling or exceeding the conservation requirements but the median escapements were below conservation requirements in the last five years. Newfoundland rivers have shown the greatest improvement in the proportion of the spawning requirement achieved as a direct result of the commercial salmon and groundfish moratoria initiated in 1992. There was a decline in 1997 relative to 1996 but escapements increased again in 1998 to their highest median values since the 1992 closure of the commercial salmon fishery.

Run-reconstruction estimates of spawning escapement

Updated estimates for 2SW spawners were derived for the six geographic regions referenced in Section 4.2.2 (Table 4.2.4.1). Estimates of 1SW spawners, 1971-98 are provided in Table 4.2.4.2. These estimates were derived by subtracting the in-river removals from the estimates of returns to rivers. A comparison between the numbers of spawners, returns and spawning requirements for 1SW and 2SW salmon are shown in Figures 4.2.2.1 and 4.2.2.2 respectively (there are no spawning requirements defined specifically for 1SW salmon).

Labrador: As previously explained, it was not possible to estimate spawners in Labrador in 1998 due to lack of assessment information.

Newfoundland: The mid-point of the estimated numbers of 2SW spawners (8,000) in 1998 is 60% higher than that estimated in 1997 and is 198% of the total 2SW spawner requirements for all rivers. This year is the fifth time that the 2SW spawner requirement has been met or exceeded since 1984 (Figure 4.2.2.2). The 1SW spawners in 1998 increased by 73% from 99,000 in 1997 to 170,900 in 1998. The 1992–96 and 1998 1SW spawners are higher than the spawners in 1989–91 and similar to levels in the late 1970s and 1980s (Figure 4.2.2.1). The spawning level in 1997 however was the third lowest in the data series, with 1989 and 1991 being lower. There had been a general increase in both 2SW and 1SW spawners during the period 1992–96 and 1998 and this is consistent with the closure of the commercial fisheries in Newfoundland. For 1997, decreases occurred most strongly in the 1SW spawners.

Québec: The mid-point of the estimated numbers of 2SW spawners (17,000) in 1998 is lower (6%) than that estimated in 1997 and is about 28 % of the total 2SW spawner requirements for all rivers (Figure 4.2.2.2). The spawning escapement in 1998 is the third lowest in the time series (1971-98) and the lowest since 1979. Estimates of the numbers of spawners have consistently been about one-third to three-quarters of the spawner requirement over the time series (1971–98). The mid-point of the estimated 1SW spawners in 1998 (20,500) was an 11% increase from 1997 (Figure 4.2.2.1). Spawning escapement of 1SW fish has generally been higher since the early 1980s than it was before this period.

Gulf of St. Lawrence: The mid-point of the estimated numbers of 2SW spawners (11,300) in 1998 is 55% lower than that estimated in 1997 and is about 37% of the total 2SW spawner requirements for all rivers in this region (Figure 4.2.2.2). This is the third time in nine years that these rivers have not exceeded their 2SW spawner requirements. The mid-point of the estimated spawning escapement of 1SW salmon (29,600) increased by 21% from 1997 and is the sixth lowest in the time series, 1971–98; the trend has been downwards since the peak of about 153,000 reached in 1992 (Figure 4.2.2.1). Spawning escapement has on average, however, been higher since the mid-1980s than it was before this period.

Scotia-Fundy: The mid-point of the estimated numbers of 2SW spawners (4,000) in 1998 is a 4% decrease from 1997 and is about 16 % of the total 2SW spawner requirements for rivers in this region (Figure 4.2.2.2). Neither the spawner estimates nor the spawner requirements include rivers of the inner Bay of Fundy (SFA 22 and parts of SFA 23) as these rivers do not contribute to distant water fisheries and spawning escapements are extremely low. The 2SW spawning escapement in the rest of the area has been generally declining since 1985. The mid-point of the estimated 1SW spawners (16,200) in 1998 is a 108% increase from 1997 and is the eighth lowest in the time series, 1971-98. There has been a general downward trend in 1SW spawners since 1990 (Figure 4.2.2.1).

Canada: It is not possible to calculate the total numbers of spawners in 1998 of either 1SW or 2SW salmon to North America as no estimates exist for Labrador for reasons previously described.

USA

The estimated 2SW returns (1,526 salmon) to USA rivers in 1998 represents about 5% of the spawner requirements for all rivers. Estimated spawning escapements in the Penobscot, Connecticut and Merrimack rivers remained at very low levels (about 10% for the Penobscot River spawning requirement, and about 2% of requirements established for the Connecticut and Merrimack rivers).

Escapement variability in North America

The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of the pre-fishery abundance taking into consideration the 11 months of natural mortality at 1% per month. These values, termed potential 2SW recruits, along with total North American 2SW returns, spawners and requirements are shown in Figure 4.2.4.3 and indicate that the overall North American spawner requirement could have been met, in the absence of all fisheries, in all years except 1993 to 1998. The difference between the potential 2SW recruits and actual 2SW returns reflect the extent to which mixed stock fisheries at West Greenland and in SFAs 1–14 have reduced the populations.

Similarly, the impact of the Greenland fishery can be considered by subtracting the non-maturing 1SW salmon (accounting for natural mortality) harvested there from the total potential 2SW recruits. These values, termed 2SW recruits to North America, are also shown in Figure 4.2.4.3. The difference between the 2SW recruits to North America and the 2SW returns reflects the impact of removals by the commercial fisheries of Newfoundland and Labrador. The 2SW recruits to North America indicate that, even if there had not been a West Greenland commercial fishery, spawner requirements could not have been met since 1990. The difference between the actual 2SW returns and the spawner numbers reflects in-river removals throughout North America and coastal removals in Québec, Gulf and Scotia Fundy regions.

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

Following on the technique outlined in previous reports (ICES 1994/Assess:16, ICES 1995/Assess:14), the spawners in each geographic area were allocated (weighted forward) to the year of the non-maturing 1SW component in the Northwest Atlantic using the weighted smolt age proportions from each area (Table 4.2.4.3). The total spawners for a given recruitment year in each area is the sum of the lagged spawners. Because the smolt age distributions in North America range from one to six years and the time series of estimated 2SW spawners to North America begins in 1971, the first recruiting year for which the total spawning stock size can be estimated is 1979 (although a value for 1978 was obtained by leaving out the 6-year old smolt contribution which represents 4% of the Labrador stock complex (Table 4.2.4.3)). Since the 1998 2SW spawners to North America (except for Labrador) are known, the spawning stock contributing to the pre-fishery abundance up to 2001 is known for North America and up to 2002 except for Labrador (Figure 4.2.4.4, Table 4.2.4.4).

Spawning escapement to several stock complexes has been below the spawner requirement (Labrador, Québec, Scotia-Fundy, USA) 1980s (Figure 4.2.4.4). In the last four years, lagged spawner abundance has been increasing in Labrador and Newfoundland but decreasing in all other areas. The relative contributions of the stocks from geographic area to the total spawning escapement of 2SW salmon has varied over time (Figure 4.2.4.5). The reduced potential contribution of Scotia-Fundy stocks and the increased proportion of the spawning stock from the Gulf of St. Lawrence and recently Labrador rivers to future recruitment is most evident. Thus production of non-maturing 1SW salmon would not be expected to increase dramatically from most areas of North America even if the sea survival improves. Only the Gulf and Newfoundland stock complexes have received spawning escapements which have exceeded the area requirements, all other complexes were below requirement and some declined further in 1998.

4.2.5 Survival indices

Canada

Counts of smolts and adult salmon returns enable estimates of marine survival to be derived. Examination of trends over time provide insight into the impact of changes in management measures or other factors that can influence the production of salmon. Information from 13 rivers in Atlantic Canada with smolt counts and corresponding adult counts are available; four are hatchery stocks and ten are wild populations. Geographically, populations for which data were available for the 1998 adult returns ranged from the Saint John River (SFA 23 Bay of Fundy) in the south, LaHave River (SFA 21) and Liscomb River (SFA 20) along the Atlantic coast of Nova Scotia, Saint-Jean (Q2) in the Gaspé region, de la Trinité and aux Rochers (Q7) on the Québec North Shore, and several populations from southern (SFAs 9 and 11), and eastern and northern Newfoundland (SFA 4, 14). In general, survival of hatchery stocks is lower and more variable than that of wild.

There was a large decline in the return rates of both hatchery and wild smolts as 1SW salmon in 1997. The decline was generally observed throughout eastern Canada. Survival rates to the river as 1SW salmon improved for most rivers of eastern Canada in 1998 relative to survival rates observed in 1997 (Figure 4.2.5.1 to 4.2.5.3). Survival rates to 1SW salmon of hatchery smolts in 1998 were less than 1% while survival rates to 2SW salmon have been less than 0.3% in the recent five years (Figure 4.2.5.1).

In 1998, the survival rate to 1SW salmon was greatly improved from 1997 in de la Trinité River but remained well below the rates observed during the late 1980s (Figure 4.2.5.2). The LaHave River smolt survivals to 1SW salmon improved in 1998 relative to 1997 and were twice those observed for the Québec rivers. The survivals to 2SW salmon in the Quebec rivers declined in 1998 to the lowest levels of the time series (Figure 4.2.5.2).

Following a brief period of increasing survival of smolts in recent years, return rates to most rivers of Newfoundland exhibited a substantive decline in 1997 but generally recovered in 1998 (Figure 4.2.5.3). Considering that the historical survival rates (prior to 1992) represent survival to the river after commercial fisheries, the recent survival rates and in particular the low rates in 1997 are dismal. The survival rates declined in the south (SFA 9, 10) and southwest coast (SFA 13) rivers of Newfoundland and remained at near record low levels. Despite major changes to fisheries and corresponding reductions in marine exploitation, marine survival rates are still low and sea survival of the salmon populations from eastern Canada has not increased as expected.

The Working Group noted that induced freshwater habitat constraints were substantial in some areas and productive capacity has been reduced. Causes include physical, chemical and biological induced constraints. Documented losses include hydropower development, acidification, and siltation. Suspected losses include interactions caused by the introduction of competitive or predator species, chemicals that disrupt endocrine development and localized effects associated with aquaculture. Mitigation of these losses has, for the most part, been insufficient. Fish passage is not generally complete, hatchery production has not generally replaced the loss of natural production, the reduction in atmospheric pollutants has not declined and numbers of suspected negative factors and sites has continued to increase.

Fish passage efficiency, both upstream and downstream, limit populations at hydropower facilities such as on the Saint John River, St. Croix River, and several US rivers. The distribution of endocrine disrupting chemicals has been reduced in some forest spraying programs but these chemicals may also be associated with industrial and municipal wastes and agricultural practises. Aquaculture has continued to increase and documented negative interaction with wild salmon stocks has occurred. Salmon populations of the Southern Uplands of Nova Scotia have fallen to critically low levels in acid-impacted areas while the frequency and duration of acid episodes has increased.

Collectively these factors have reduced the productive capacity of North American salmon populations but cannot account for the decline in adult returns in recent years.

USA

The survival of hatchery-reared smolts released in the Penobscot River in 1996 was 0.18%. This was the second lowest survival observed in the time series (Figure 4.2.5.4), and was 22% and 44% lower than the 5- and 10-years averages, respectively.

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

The North American run-reconstruction model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971–98. The estimate of pre-fishery abundance of 97,899 for 1997 of **non-maturing** 1SW salmon was the lowest on record, and 23% below the previous year. Similarly, for **maturing** 1SW salmon, there was a 32% decrease from 1996 in the 1997 estimate (319,065) of pre-fishery abundance. An estimate of 412,480 maturing 1SW fish in 1998 is 29% greater than that of 1997 and the sixth lowest in the 28-year time series. The results suggest a continuing decline of North American adult salmon abundance. In addition to the steady decline in total recruits over the last 10 years, grilse have become an increasingly larger proportion of the total North American stock complex. This proportion has risen from about 45% at the beginning of the 1970s to between 65 and 80% in the last five years.

The rank of the estimated returns in 1998 in the 1971–98 time series for six regions in North America is shown below:

Region	Rank of 1998 returns in 1971-98 time series (1=highest)		Mid-point estimate of 2SW spawners as proportion of escapement requirement
	1SW	2SW	(%)
Labrador	Unknown	Unknown	unknown
Newfoundland	9	1	198
Québec	13	28	28
Gulf	22	27	37
Scotia-Fundy	23	28	16
USA	13	22	5

In most regions the returns of 2SW fish are near the lower end of the 28-year time series except Newfoundland where they are at the highest level. Returns of 1SW salmon were at the lower end of the time series in Gulf and Scotia-Fundy, and about at the mid-point in Newfoundland, Quebec and USA.

The text table above also shows the estimated total spawning escapement of 2SW salmon in each region expressed as a percentage of the spawning escapement requirement. Only in Newfoundland were requirements exceeded in 1998. The overall 2SW spawning escapement requirement for Canada could have been met or exceeded in only three (1974, 1977 and 1980) of the past 28 years (considering the mid-points of the estimates) by reduction of in-river fisheries (Figure 4.2.4.3). In the remaining years, spawning requirements could not have been met even if all in-river harvests had been eliminated.

The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has oscillated around a generally declining trend since the 1970s, and the abundance recorded in 1993–98 was the lowest in the time series (Figure 4.2.3.2). During 1993 to 1997, the total population of 1SW and 2SW Atlantic salmon was about one-half million fish, 45% of the average abundance during 1972 to 1990. The decline has been more severe for the 2SW salmon component than for the small salmon (maturing as 1SW salmon) age group.

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

Trends in abundance of small salmon and large salmon within the geographic areas show a general synchronicity among the rivers. Returns of large salmon were generally the lowest observed since 1987 while grilse returns improved marginally for stocks in many areas. For the rivers of Newfoundland, large salmon returns were among the highest in the last 12 years but large salmon returns in the Gulf of St. Lawrence and Québec were among the lowest. The differences in the relative abundance of large salmon in Newfoundland as compared with the other areas of eastern Canada are consistent with the age structure. Large salmon in Newfoundland are predominantly repeat-spawning 1SW salmon while in other areas of eastern Canada, 2SW and 3SW salmon make up varying proportions of the returns.

The continuing absence of any clear factor(s) to explain the lower 1SW returns in 1997 and the low 2SW returns in 1998 make any predictions of river-specific abundance of small and large salmon in eastern Canada in 1999 very uncertain. An additional concern is the low abundance levels which currently describe many salmon stocks in rivers in eastern Canada, particularly in the Bay of Fundy and Atlantic coast of Nova Scotia, and the south coast of Newfoundland. Despite major changes in fisheries management, returns have continued to decline in these areas and many populations are currently threatened with extirpation. Although no direct evidence yet exists that can conclusively indicate that predators are the cause of salmon declines, increasing numbers of predators, particularly seals and seabirds, at the same time that marine survival is declining, suggests that there is a strong possiblity that predators and salmon populations are linked (see Section 2.4.6 and 2.4.10, as well as last year's report).

USA salmon stocks exhibit the same downward trend that has been shown for many Canadian salmon stocks, especially those located in the Bay of Fundy and along the Atlantic coast of Nova Scotia. Most salmon rivers in the USA are hatchery-dependent and remain at low levels compared to conservation requirements.

The Working Group noted that induced freshwater habitat constraints were substantial in some areas and productive capacity has been reduced. Causes include physical, chemical and biological induced constraints. Documented losses include hydropower development, acidification, and siltation. Suspected losses include interactions caused by the introduction of competitive or predator species, chemicals that disrupt endocrine development and localized effects associated with aquaculture.

4.3 Effects on US and Canadian Stocks and Fisheries of Quota Management and Closure after 1991 in Canadian Commercial Salmon Fisheries

There were no new analyses available to the Working Group. Previously, to evaluate the results of the reductions and closures in these commercial fisheries, the Working Group considered a detailed assessment of the impact of the Newfoundland-Labrador changes on Newfoundland stocks (ICES 1997/Assess:10). At that time, estimates were made of commercial exploitation rates on small salmon during premoratorium years (1984-91) which ranged from 29% to 66%, averaging 49% for all areas combined. On large salmon, they ranged from 64% to 98% and averaged 76%.

4.4 Update of Age-Specific Stock Conservation Limits

No new information was available to the Working Group to revise the 2SW salmon conservation requirements for North American rivers, although as indicated in Section 2.4.7, conservation requirements for Québec will be revised next year.

The Working Group recommends that return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that do contribute to distant fisheries be developed and, when these are available, the SFA 22 spawning requirements for these rivers (476 fish) be included in the total.

Spawner requirements for 2SW salmon for Canada now total 154,653 and for the USA, 29,199 for a combined total of 183,852 (Table 4.4.1). The Working Group again recommends that these requirements be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

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

Overview
This is the third year that the Working Group has been asked to provide catch options for the North American Commission Area. Catch options are provided only for the non-maturing 1SW and maturing 2SW components which migrate between two Commission areas and the waters of two, three or four nations. The maturing 1SW component (grilse) is of a lesser migrational tendency, and in the absence of significant marine interceptory fisheries, managed in homewaters by the producing nations.

Catch histories of salmon exposed to the Greenland fishery, 1972-98, are provided in Tables 4.5.1 and 4.5.2. and expressed as 2SW salmon equivalents. The Newfoundland-Labrador commercial fisheries have historically harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. The harvest in these fisheries of repeat spawners and older sea-ages has not been considered in the run reconstructions. Harvests of 1SW non-maturing salmon in Newfoundland-Labrador commercial fisheries have been adjusted by natural mortalities of 1% per month for 11 months and 2SW harvests in these same fisheries have been adjusted by one month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. Starting in 1998, the Labrador commercial fishery was closed. An Aboriginal food fishery occurred in 1998 which may have harvested, to some degree, mixed stocks and catches for this fishery have been included in Tables 4.5.1 and 4.5.2. Mortalities (principally in fisheries) in mixed stock and terminal fisheries areas in Canada are summed with those of USA to estimate total 2SW equivalent mortalities in North America (Table 4.5.1). Mortalities within North America peaked at about 382,000 in 1976 and are now about 23,100 2SW salmon equivalents. In the most recent three years estimated, those taken as non-maturing fish in Labrador comprise about 5% of the total in North America.

The percentage of the cohort destined to be 2SW salmon which were taken in terminal fisheries during 1972–97 in Canada and the USA has ranged from as low as 19% in 1973, 1976 and 1987 to values of 76-85% in 1996-98 fisheries (Table 4.5.1). The percentage increased significantly with the reduction and closures of the Newfoundland and Labrador commercial fisheries, particularly since 1992.

Table 4.5.2 shows the mortalities expressed as 2SW equivalents in Canada, USA and Greenland for 1972–98. Harvests within the USA of the total within North America approached 0.6 % on a few occasions in the time series and as recently as in 1990. As well as these harvests in the USA, USA-origin salmon were also harvested in Canada during the time period indicated. The percentage of the total 2SW equivalents that has been taken in North American waters has ranged from 43-100%, with the most recent year estimated at 67%. The two years when 100 % of the mortality occurred in North America were the years when the Greenland commercial fishery did not operate.

It is possible to provide catch advice for the North American Commission area for two years. The revised forecast for 1999 for 2SW maturing fish is based on a new forecast of the 1998 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 1998 as 1SW non-maturing fish. The second is a new estimate for 2000 based on the pre-fishery abundance forecast for 1999 from Section 5.6. A consequence of these annual revisions is that the catch options for 2SW equivalents in North America may change compared to the options developed the year before.

4.5.1 Catch advice for 1999 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 1998 is provided in Table 5.6.1.1. This value of 99,956 is lower than the value forecast last year at this time of 113,899 (See Section 5.2 for more detailed derivation of the models used, etc.). A pre-fishery abundance of 99,956 in 1998 can be expressed as 2SW equivalents by considering natural mortality of 1% per month for 10 months (a factor of 0.904837), resulting in 90,444 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 1998 for both the Labrador (239) and Greenland (11,345) fisheries (Tables 4.5.1 and 4.5.2) for a total of 11,584 2SW salmon equivalents already harvested. The text table below uses the probability density projections for the revised pre-fishery abundance estimate of 99,956 and subtracts the spawning reserve (205,230), converts it to 2SW salmon equivalents and then subtracts the 11,584 2SW equivalents already harvested (Tables 4.5.1 and 4.5.2). The calculation is as follows:

[[PFA_i - spawning reserve] x exp - (0.01 *10 months)] - harvest in Greenland and Labrador in 1998 of 1SW non-maturing fish

where PFA_i = values from 25–90%
spawning reserve = 205,230
harvests WG = 1SW non-maturing in 2SW equivalents

Catch Options for 1999 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability Level	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	16,337	0
30	34,995	0
35	52,277	0
40	68,585	0
45	84,405	0
50	99,956	0
55	115,444	0
60	131,402	0
65	147,627	0
70	164,803	0
75	183,333	0
80	204,038	0
85	228,282	9,274
90	258,795	36,884
95	304,286	78,046

4.5.2 Catch advice for 2000 fisheries on 2SW maturing salmon

The text table below, as an example, assumes a 40% Greenland/60% North America division of the surplus for harvest (after reserving the spawner requirement of 205,230) and expresses catch options as 2SW salmon equivalents for 2000 (by considering 10 months of mortality at 1% per month, a factor of 0.904837). As is noted in Section 5.2, there is a wide variability in the forecast and caution is warranted in the use of the 50% level. Precautionary approaches would utilise probabilities much lower than 50%. The calculation is as follows:

[[PFA_i - spawning reserve] x exp - (0.01 x 10 months) x 0.60]

Catch Options for 2000 North American fisheries (probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability Level	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	795	0
30	18,398	0
35	34,579	0
40	49,917	0
45	64,810	0
50	79,450	0
55	94,097	0
60	108,959	0
65	124,344	0
70	140,537	0
75	158,302	0
80	177,300	0
85	200,047	0
90	229,030	12,921
95	272,057	36,281

The above table provides catch options for 2000 which can be refined next year when information becomes available from harvests of the cohort as non-maturing fish in Greenland and Canada in 1999.

It should be clear from the above that the numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, it is obvious that river-by-river management is necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

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

While some progress was made on research needs identified last year, particularly in the areas of refinement of spawner requirements and the initiation of some wild smolt sampling programs, the Working Group felt that further work is required, and accordingly reiterates last year's recommendations and suggests some further ones.

1. There is an urgent need to monitor salmon returns and develop habitat-based spawner requirements in Labrador and Ungava regions of Québec.

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks, and total recruits prior to fisheries. These data and new information on measures of habitat and stock recruitment are necessary to reevaluate existing estimates of spawner requirements in Canada and USA.

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

4. Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates.

Table 4.1.1.1. Licensed effort, quota, harvests and percent of total harvest comprised of large salmon in the Labrador and Québec commercial fisheries, 1992 to 1998. The commercial fishery in SFA 14B of Labrador was closed in 1997. A commercial byback was in effect in Labrador in 1998. The commercial fishery in Québec Zone Q7 was closed in 1993 and in Zone Q8 in 1994. A voluntary commercial buyback was in effect in Québec Zone Q9 in 1998.

	1992	1993	1994	1995	1996	1997	1998
Labrador (SFA 1, 2 and 14B)							
Licensed effort	495	288	218	218	218	205	0
Quota (t)	273	178	92	73.5	55	50	0
Harvest (t)	204	112	93	55	48	47	0
Harvest (number)	56,590	34,170	24,017	19,156	15,116	16,696	0
% Large (by number)	57%	50%	64%	59%	48%	38%	
Québec (Q7 to Q9)							
Licensed effort	147	94	90	90	87	87	31
Quota (number)	23,400	15,325	15,175	15,175	12,068	12,068	2,230
Harvest (number)	19,363	14,657	13,800	13,653	11,718	10,437	2,110
Harvest (t)	63	46	43	42	32	30	5
% Large (by number)	80%	75%	72%	71%	61%	66%	49%
Québec (Q11)							
Licensed effort	5	5	5	5	5	5	5
Quota (number)	3,125	3,125	3,125	3,125	3,125	3,125	0
Harvest (number)	337	212	485	300	268	296	0
Harvest (t)	2	1	3	2	1	2	0

Table 4.1.2.1. Percentages by user group and province of small and large salmon harvested (by number) in the Atlantic salmon fisheries of eastern Canada during 1998.

	% of Provincial Harvest			% of	
	Aboriginal fisheries	Recreational fisheries	Commercial fisheries	eastern Canada	Number of fish
Small salmon					
Newfoundland / Labrador	14.3	85.7	0.0	44.8	20,930
Québec	0.1	84.7	15.2	15.1	7,047
New Brunswick	6.9	93.1	0.0	37.9	17,712
P.E.I.	7.7	92.3	0.0	0.8	365
Nova Scotia	19.7	80.3	0.0	1.4	633
Large salmon					
Newfoundland / Labrador	88.2	11.8	0.0	19.4	2,572
Québec	46.2	43.6	10.3	76.3	10,124
New Brunswick	100.0	0.0	0.0	3.5	466
P.E.I.	-	-	-	0.0	0
Nova Scotia	100.0	0.0	0.0	0.8	108
Eastern Canada		**% by User Group**			
Small salmon	9.4	88.3	2.3		46,687
Large salmon	56.7	35.5	7.8		13,270

Table 4.1.2.2 Hook-and-Released Atlantic salmon caught by recreational fishermen in Canada, 1984-98

Year	Newfoundland			Nova Scotia			New Brunswick					Prince Edward Island			Quebec			CANADA*		
	Small	Large	Total	Small	Large	Total	Small Kelt	Small Bright	Large Kelt	Large Bright	Total	Small	Large	Total	Small	Large	Total	**SMALL**	**LARGE**	**TOTAL**
1984				939	1,655	2,594	661	851	1,020	14,479	17,011							**2,451**	**17,154**	**19,605**
1985		315	315	1,323	6,346	7,669	1,098	3,963	3,809	17,815	26,685			67				**6,384**	**28,285**	**34,669**
1986		798	798	1,463	10,750	12,213	5,217	9,333	6,941	25,316	46,807							**16,013**	**43,805**	**59,818**
1987		410	410	1,311	6,339	7,650	7,269	10,597	5,723	20,295	43,884							**19,177**	**32,767**	**51,944**
1988		600	600	1,146	6,795	7,941	6,703	10,503	7,182	19,442	43,830	767	256	1,023				**19,119**	**34,275**	**53,394**
1989		183	183	1,562	6,960	8,522	9,566	8,518	7,756	22,127	47,967							**19,646**	**37,026**	**56,672**
1990		503	503	1,782	5,504	7,286	4,435	7,346	6,067	16,231	34,079			1,066				**13,563**	**28,305**	**41,868**
1991		336	336	908	5,482	6,390	3,161	3,501	3,169	10,650	20,481	1,103	187	1,290				**8,673**	**19,824**	**28,497**
1992	5,893	1,423	7,316	737	5,093	5,830	2,966	8,349	5,681	16,308	33,304			1,250				**17,945**	**28,505**	**46,450**
1993	18,196	1,731	19,927	1,076	3,998	5,074	4,422	7,276	4,624	12,526	28,848							**30,970**	**22,879**	**53,849**
1994	11,105	2,343	13,448	796	2,894	3,690	4,153	7,443	4,790	11,556	27,942	577	147	724				**24,074**	**21,730**	**45,804**
1995	12,383	2,588	14,971	979	2,861	3,840	770	4,260	880	5,220	11,130	209	139	348		922	922	**18,601**	**12,610**	**31,211**
1996	22,227	3,092	25,319	3,526	5,661	9,187						472	238	710		1,718	1,718	**26,225**	**10,709**	**36,934**
1997	17,362	3,810	21,172	729	3,528	4,257	3,457	4,870	3,786	8,874	20,987	210	118	328	182	1,643	1,825	**26,810**	**21,759**	**48,569**
1998	19,318	3,543	22,861	711	2,688	3,399	3,154	5,760	3,452	8,298	20,664	278	136	414	297	2,680	2,977	**29,518**	**20,797**	**50,315**

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

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

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

Three rivers of eastern Maine						
	St. Croix		Dennys		Narraguagus	
Year	Total run	% Aqua'	Total run	% Aqua'	Total run	% Aqua'
1994	181	54	47	89	52	2
1995[1]	60	22	9	44	56	0
1996	152	13	31	68	64	22
1997	70	39	2[2]	100	37	0
1998	65	37	1[2]	100	22	0

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

[2] Incomplete count of total run

Table 4.2.1.1. Comparison of returns of small salmon, large salmon, and size groups combined to assessed rivers of eastern Canada in 1998 relative to returns in 1997 and to returns in 1988 to 1997.

	Number of rivers in each category			
		Returns in 1998 relative to returns in 1997		
Size group	Total	<50%	50% to 90%	>= 90%
Bay of Fundy and Atlantic Coast of Nova Scotia (SFA 19 to 23)				
Small	9	0	4	5
Large	9	3	3	3
Small & Large	10	0	5	5
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	10	0	3	7
Large	10	1	7	2
Small & Large	10	0	6	4
Quebec (Zones Q1 to Q11)				
Small	12	0	2	10
Large	12	1	9	2
Small & Large	36	0	17	19
Newfoundland and Labrador (SFA 1 to 14)				
Small	20	3	3	14
Large	20	1	6	13
Small & Large	20	3	3	14

		Rank of 1998 within the 1988 to 1998 period		
Size group	Number of rivers	Lowest	Median	Highest
Bay of Fundy and Atlantic coast of Nova Scotia (SFA 19 to 23)				
Small	3	11	5	8
Large	4	11	9.5	8
Small & Large	4	11	7	4
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	6	11	8.5	5
Large	6	11	9.5	5
Small & Large	6	10	9	6
Quebec (Zones Q1 to Q11)				
Small	11	11	8	5
Large	11	11	11	8
Small & Large	27	11	9	1
Newfoundland and Labrador (SFA 1 to 14)				
Small	10	7	3	1
Large	10	8	2	1
Small & Large	10	7	2.5	1

Table 4.2.1.2. Index rivers in eastern North America with available juvenile abundance or smolt abundance estimates for 1971 to 1998. The index area refers to the SFAs or Zones which are assumed to be represented by the index rivers surveyed in those zones. River locations are shown in Figure 4.2.1.4.

				Egg requirement (millions)				
Geographic Area	SFA, Zone	Index river	Abundance Type	SFA, Zone	Index river	Index river / all index rivers	River relative to SFA, Zone	River as % of Total
Labrador	1							
	2							
	14B							
Newfoundland	3							
	4	Campbellton	Smolts	158.6	2.9	1.0%	1.8%	0.2%
	5			37.9				
	6							
	7							
	8							
	9	NE Trepassey	Smolts	16.2	0.1	0.0	0.9%	0.0%
		Rocky	Smolts		3.4	0.0	21.0%	0.3%
	10			7.8				
	11	Conne	Smolts	41.1	7.8	2.6%	19.0%	0.7%
		Little	Smolts		0.3	0.1%	0.8%	0.0%
	12							
	13	Highlands	Smolts	75.4	1.5	0.5%	2.0%	0.1%
	14A	WAB	Smolts	19.1	0.9	0.3%	4.8%	0.1%
Gulf	15	Restigouche	Juveniles	71.9	53.6	17.9%	74.5%	4.5%
	16	Miramichi	Juveniles	143.5	131.0	43.7%	91.3%	11.0%
		Buctouche	Juveniles		1.6	0.5%	1.1%	0.1%
	17	Morell	Juveniles	1.9	0.6	0.2%	29.7%	0.0%
	18	Margaree	Juveniles	23.1	6.7	2.2%	29.0%	0.6%
		West	Juveniles		0.8	0.3%	3.5%	0.1%
Scotia-Fundy	19			21.2				
	20	St. Marys	Juveniles	55.2	9.6	3.2%	17.3%	0.8%
	21	LaHave	Juveniles	77.6	12.2	4.1%	15.7%	1.0%
	22			21.2				
	23	Saint John	Juveniles	99.5	32.3	10.8%	32.5%	2.7%
Quebec	Q1			38.7				
	Q2	Saint-Jean	Smolts	17.9	3.8	1.3%	21.0%	0.3%
	Q3			21.5				
	Q4							
	Q5			6.0				
	Q6			11.2				
	Q7	de la Trinité	Smolts	39.7	3.0	1.0%	7.6%	0.3%
		Moisie	Smolts		21.8	7.3%	54.9%	1.8%
	Q8			119.1				
	Q9			46.4				0.0%
	Q10	Bec-scie	Smolts	15.2	0.2	0.1%	1.5%	0.0%
U.S.	Maine		Juveniles	5.5	5.5	1.8%		0.5%
North America	Subtotal			1192.5	299.7	100.0%		25.1%

Table 4.2.1.3. Number of rivers and percent of total indexed area represented by the indexed rivers in 1971 to 1998.

Year	Rivers Monitored	River as % of Total Indexed Area
1971	2	11.10%
1972	3	15.60%
1973	3	15.60%
1974	3	15.60%
1975	5	16.20%
1976	4	16.10%
1977	5	16.30%
1978	6	16.30%
1979	7	20.00%
1980	6	16.80%
1981	7	20.00%
1982	8	20.10%
1983	6	19.90%
1984	9	20.20%
1985	9	20.00%
1986	9	19.90%
1987	10	20.80%
1988	9	20.20%
1989	9	19.50%
1990	12	21.60%
1991	14	22.30%
1992	14	22.30%
1993	17	22.70%
1994	19	22.80%
1995	20	24.70%
1996	18	23.60%
1997	18	24.30%
1998	19	24.70%

Table 4.2.2.1 Estimated numbers of 1SW returns in North America by geographic regions, 1971-98.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	32966	115382	112266	224994	14969	22453	33118	57935	11515	19525	32	204866	440322	322594
1972	24675	86362	108509	217092	12470	18704	42202	73635	9522	16915	18	197395	412726	305061
1973	5399	18897	143729	287832	16585	24877	43681	76802	14766	24823	23	224183	433253	328718
1974	27034	94619	84667	169103	16791	25186	65673	113974	26723	44336	55	220943	447273	334108
1975	53660	187809	111847	223890	18071	27106	58613	101822	25940	36316	84	268214	577027	422621
1976	37540	131391	114787	229853	19959	29938	90308	155519	36931	55937	186	299711	602823	451267
1977	33409	116931	109649	219106	18190	27285	31322	55963	30860	48387	75	223506	467748	345627
1978	16155	56542	97070	194133	16971	25456	26008	45368	12457	16587	155	168816	338241	253529
1979	21943	76800	106791	213327	21683	32524	50872	92258	30875	49052	250	232414	464212	348313
1980	49670	173845	120355	240449	29791	44686	45716	81434	49925	73560	818	296274	614792	455533
1981	55046	192662	156541	312697	41667	62501	70238	127028	37371	62083	1130	361994	758102	560048
1982	38136	133474	139951	279115	23699	35549	79874	142291	23839	38208	334	305833	628971	467402
1983	23732	83061	109378	218548	17987	26981	25337	43799	15553	23775	295	192282	396459	294371
1984	12283	42991	129235	257256	21566	30894	37696	63675	27954	47493	598	229331	442907	336119
1985	22732	79563	120816	240985	22771	33262	61255	110125	29410	51983	392	257376	516310	386843
1986	34270	119945	124547	248688	33758	46937	114718	203902	30935	54678	758	338986	674908	506947
1987	42938	150283	125116	249856	37816	54034	86564	155359	31746	55564	1128	325307	666223	495765
1988	39892	139623	132059	263363	43943	62193	123578	222234	32992	56935	992	373457	745340	559399
1989	27113	94896	59793	119261	34568	48407	72944	129134	34957	59662	1258	230634	452619	341626
1990	15853	55485	98830	197276	39962	54792	83670	157477	33939	60828	687	272941	526546	399743
1991	12849	44970	64016	127698	31488	42755	59721	112206	19759	31555	310	188143	359493	273818
1992	17993	62094	116116	231954	35257	48742	146539	230349	22832	37340	1194	339931	611673	475802
1993	25186	80938	131045	261721	30645	42156	89934	145477	16714	27539	466	293990	558297	426144
1994	18159	56888	95487	190655	29667	40170	55639	117120	8216	11583	436	207603	416852	312227
1995	25022	76453	111889	223758	23851	32368	26019	96450	14239	21822	213	201233	451064	326148
1996	51867	153553	141232	287587	32008	42558	50311	98459	22795	36047	651	298864	618855	458860
1997	66812	155963	86230	146833	24300	33018	27514	53919	7173	10467	365	212395	400565	306480
1998	.	.	119033	255093	26588	36547	38049	68540	13511	19826	403	.	.	.

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

Table 4.2.2.2 Estimated numbers of 2SW returns in North America by geographic regions, 1971-98.

Year	Labrador Min	Labrador Max	Newfoundland Min	Newfoundland Max	Quebec Min	Quebec Max	Gulf of St. Lawrence Min	Gulf of St. Lawrence Max	Scotia-Fundy Min	Scotia-Fundy Max	USA	North America Min	North America Max	North America Mid-points
1971	4312	29279	2385	9104	34568	51852	29483	46780	11187	16410	653	82588	154078	118333
1972	3706	25168	2494	9129	45094	67642	35640	59880	14028	19731	1383	102347	182933	142640
1973	5183	35196	2995	11808	49765	74647	34911	59487	10359	14793	1427	104640	197358	150999
1974	5003	34148	1968	6702	66762	100143	49081	83344	21902	29071	1394	146110	254802	200456
1975	4772	32392	2382	8002	56695	85042	31175	51829	23944	31496	2331	121298	211093	166196
1976	5519	37401	2327	7663	56365	84547	29266	51382	21768	29837	1317	116562	212148	164355
1977	4867	33051	1880	6309	66442	99663	58822	100690	28606	39215	1998	162615	280928	221771
1978	3864	26147	2005	6419	59826	89739	30465	51395	16946	22561	4208	117314	200469	158891
1979	2231	15058	1103	3691	32994	49491	8671	14280	8962	12968	1942	55903	97430	76667
1980	5190	35259	2447	7794	78447	117670	43407	73765	31897	44823	5796	167184	285107	226145
1981	4734	32051	2317	7475	61633	92449	17743	29518	19030	28169	5601	111058	195263	153161
1982	3491	23662	2975	9228	54655	81982	31652	51031	17516	24182	6056	116344	196140	156242
1983	2538	17181	2511	7915	44886	67329	29038	46793	14310	20753	2155	95438	162125	128782
1984	1806	12252	2273	7117	44661	59160	20478	34063	17938	27899	3222	90379	143712	117045
1985	1448	9779	961	3319	45916	61460	23106	43274	22841	38784	5529	99802	162144	130973
1986	2470	16720	1592	5402	55159	72560	36214	70258	18102	33101	6176	119714	204217	161966
1987	3289	22341	1338	4629	52699	68365	22668	47156	11529	20679	3081	94604	166251	130427
1988	2068	14037	1553	5346	56870	75387	26140	49665	10370	19830	3286	100287	167550	133919
1989	2018	13653	704	2452	51656	67066	17311	34907	11939	21818	3197	86825	143092	114959
1990	1148	7790	1341	4562	50261	66352	24616	52184	10248	18871	5051	92665	154810	123738
1991	548	3740	1057	3577	46841	60724	20983	43771	10613	17884	2647	82690	132343	107517
1992	2515	15548	3024	10354	46917	61285	29101	60028	9777	16456	2459	93793	166130	129962
1993	3858	18234	1487	5217	37023	46484	25753	51074	6764	11087	2231	77117	134328	105722
1994	5653	24396	1889	6255	37703	47180	22097	56529	4379	6908	1346	73067	142613	107840
1995	12368	44205	2296	7462	43755	54186	24276	62505	4985	8317	1748	89428	178423	133926
1996	9113	32759	2606	9007	39413	49846	20379	42491	7227	12054	2407	81145	148563	114854
1997	9384	23833	2837	7213	32443	41017	17563	37169	3645	5922	1611	67483	116765	92124
1998	.	.	4327	11735	29472	37859	8261	19057	2728	6003	1526	.	.	.

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

Table 4.2.3.1 Run reconstruction data inputs used to estimate pre-fishery abundance of maturing (MM1) and non-maturing (NN1) 1SW salmon of North American origin (terms defined in Table 4.2.3.2).

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

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

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

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

1SW	NG1	NC1		NC2		NR2		NN1		
Fishery		min	max	min	max	min	max	min	max	mid-point
Year (i)	(i)	(i)	(i)	(i+1)	(i+1)	(i+1)	(i+1)	(i)	(i)	(i)
1971	287,672	17,881	43,730	144,008	172,907	102,347	182,933	578,955	726,699	652,827
1972	200,784	15,768	37,316	203,072	248,628	104,640	197,358	557,789	733,183	645,486
1973	241,493	21,150	51,412	223,422	262,767	146,110	254,802	672,662	867,737	770,200
1974	220,584	21,187	50,243	223,332	266,337	121,298	211,093	623,993	800,812	712,403
1975	278,839	32,385	73,371	243,315	285,486	116,562	212,148	710,244	904,537	807,391
1976	155,896	24,285	57,005	225,424	271,703	162,615	280,928	610,837	826,772	718,805
1977	189,709	24,323	57,902	146,535	177,644	117,314	200,469	506,934	667,717	587,326
1978	118,853	11,796	29,813	86,644	103,079	55,903	97,430	288,809	371,345	330,077
1979	200,061	19,478	42,242	202,634	245,013	167,184	285,107	630,107	831,343	730,725
1980	187,999	31,132	70,739	186,367	228,568	111,058	195,263	549,070	729,314	639,192
1981	227,727	31,000	70,441	125,578	151,442	116,344	196,140	527,385	684,484	605,935
1982	194,715	23,583	52,338	104,116	125,802	95,438	162,125	439,899	567,062	503,481
1983	33,240	17,688	39,712	76,554	94,103	90,379	143,712	236,421	337,375	286,898
1984	38,916	13,255	30,019	74,062	88,256	99,802	162,144	245,428	347,472	296,450
1985	139,233	18,582	40,002	97,329	118,841	119,714	204,217	399,013	538,538	468,776
1986	171,745	23,343	50,988	121,610	150,859	94,604	166,251	435,092	575,040	505,066
1987	173,687	29,639	65,127	74,996	92,205	100,287	167,550	398,157	527,749	462,953
1988	116,767	20,709	44,860	75,300	92,364	86,825	143,092	317,617	423,435	370,526
1989	60,693	18,139	39,691	53,173	65,040	92,665	154,810	241,038	345,076	293,057
1990	73,109	11,072	24,518	37,739	45,590	82,690	132,343	218,194	295,743	256,969
1991	110,680	9,302	20,175	22,639	29,107	93,793	166,130	249,702	348,471	299,086
1992	41,855	2,748	6,790	11,967	15,386	77,117	134,328	143,913	215,597	179,755
1993	0	1,878	4,441	10,764	13,839	73,067	142,613	95,337	178,931	137,134
1994	0	1,018	2,651	7,823	10,058	89,428	178,423	109,491	212,937	161,214
1995	20,263	910	2,267	5,090	6,545	81,145	148,563	117,379	195,601	156,490
1996	16,181	858	2,006	4,860	6,249	67,483	116,765	97,740	155,435	126,588
1997	12,538	1,045	2,367	1,588	2,269	46,314	76,180	69,710	126,088	97,899
1998	3,026	161	367							

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

1SW Year (i)	MC1 min (i)	max (i)	MR1 min (i)	max (i)	GN1 min (i)	max (i)	mid-point (i)
1971	213,987	267,720	204,866	440,322	420,912	712,467	566,690
1972	237,286	279,064	197,395	412,726	436,665	695,938	566,302
1973	346,109	408,260	224,183	433,253	572,545	845,868	709,206
1974	322,772	379,370	220,943	447,273	545,936	831,137	688,536
1975	351,015	422,105	268,214	577,027	621,925	1,004,931	813,428
1976	313,060	375,300	299,711	602,823	615,783	984,182	799,983
1977	252,058	318,032	223,506	467,748	477,810	790,480	634,145
1978	132,546	172,340	168,816	338,241	303,059	513,981	408,520
1979	218,442	252,711	232,414	464,212	453,192	721,588	587,390
1980	343,344	412,617	296,274	614,792	642,596	1,033,588	838,092
1981	308,670	377,651	361,994	758,102	674,302	1,143,372	908,837
1982	265,678	312,538	305,833	628,971	574,585	947,830	761,207
1983	197,184	234,389	192,282	396,459	391,398	634,833	513,115
1984	158,852	187,900	229,331	442,907	390,487	635,258	512,873
1985	227,928	259,284	257,376	516,310	487,890	780,783	634,337
1986	278,654	321,357	338,986	674,908	621,046	1,003,049	812,048
1987	319,510	375,472	325,307	666,223	648,087	1,048,391	848,239
1988	240,291	276,488	373,457	745,340	617,501	1,029,319	823,410
1989	205,998	239,495	230,634	452,619	438,950	696,663	567,807
1990	134,630	156,382	272,941	526,546	410,314	688,220	549,267
1991	117,141	133,509	188,143	359,493	307,174	496,616	401,895
1992	21,986	30,556	339,931	611,673	365,334	648,377	506,855
1993	15,027	19,983	293,990	558,297	311,972	583,890	447,931
1994	8,142	11,928	207,603	416,852	217,832	432,969	325,400
1995	7,278	10,200	201,233	451,064	210,533	465,797	338,165
1996	6,861	9,028	298,864	618,855	308,729	634,102	471,416
1997	8,358	10,652	212,395	400,565	222,888	415,243	319,065
1998	3,054	3,302	197,584	380,410	210,729	614,232	412,480

Table 4.2.4.1 Estimated numbers of 2SW spawners in North America by geographic regions, 1971-98.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy			North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	USA	Min	Max	Mid-points
1971	4012	28882	1810	8230	11822	17733	4303	8185	4496	9032	490	26933	72551	49742
1972	3435	24812	1985	8358	23160	34741	17803	32941	7459	12699	1038	54880	114588	84734
1973	4565	34376	2275	10720	23564	35346	20505	38068	3949	7844	1100	55957	127453	91705
1974	4490	33475	1534	6043	28657	42985	31702	57859	9526	15979	1147	77056	157487	117272
1975	4564	32119	1959	7355	23818	35726	18477	33167	11861	18830	1942	62620	129139	95880
1976	4984	36701	2003	7160	22653	33980	14821	29640	11045	18337	1126	56633	126944	91788
1977	4042	31969	1134	5131	32602	48902	32535	60108	13578	23119	643	84533	169872	127202
1978	3361	25490	1564	5728	29889	44834	11511	22725	6517	11428	3314	56157	113520	84838
1979	1823	14528	992	3506	12807	19210	3575	6770	4683	8234	1509	25389	53756	39573
1980	4633	34525	1894	6928	35594	53390	19947	37544	14270	25628	4263	80602	162278	121440
1981	4403	31615	1935	6874	26132	39199	4657	9937	5870	13353	4334	47331	105312	76322
1982	3080	23127	2635	8691	26492	39738	11036	20218	5656	11335	4643	53542	107752	80647
1983	2267	16824	2167	7364	17308	25963	7436	14191	1505	6529	1769	32452	72639	52545
1984	1478	11822	2082	6829	22345	32659	15332	27133	14245	23650	2547	58030	104640	81335
1985	1258	9530	949	3300	20668	31742	21168	39733	18185	33580	4884	67111	122768	94940
1986	2177	16334	1560	5354	24088	35939	32991	64335	15435	30120	5570	81821	157652	119737
1987	2895	21821	1322	4605	21723	31727	19877	42370	10235	19233	2781	58833	122536	90684
1988	1625	13452	1529	5310	25390	38343	23392	44584	9074	18381	3038	64048	123108	93578
1989	1727	13270	697	2441	25016	35905	14758	30450	11689	21539	2800	56686	106403	81545
1990	923	7493	1321	4532	24422	36219	22554	48567	9688	18245	4356	63262	119412	91337
1991	491	3665	1044	3557	19959	29052	19590	41299	9356	16479	2416	52856	96468	74662
1992	2012	14889	2968	10270	19337	28833	27448	53092	8725	15280	2292	62783	124655	93719
1993	3624	17922	1437	5139	15774	21428	25218	45605	5710	9921	2065	53828	102080	77954
1994	5339	23981	1825	6156	15631	21147	20315	53592	3682	6093	1344	48137	112313	80225
1995	12006	43726	2223	7350	22575	28703	22634	60072	4672	7971	1748	65857	149570	107714
1996	8838	32395	2519	8874	19010	25421	18416	39309	6507	11242	2407	57698	119648	88673
1997	9221	23646	2809	7167	15531	20780	15832	34540	3095	5311	1611	48099	93055	70577
1998	.	.	4278	11656	14402	19614	6408	16238	2424	5663	1526	.	.	.

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

Table 4.2.4.2 Estimated numbers of 1SW spawners in North America by geographic regions, 1971-98.

Year	Labrador Min	Labrador Max	Newfoundland Min	Newfoundland Max	Quebec Min	Quebec Max	Gulf of St. Lawrence Min	Gulf of St. Lawrence Max	Scotia-Fundy Min	Scotia-Fundy Max	USA	North America Min	North America Max	North America Mid-points
1971	29032	111448	85600	198328	9338	14007	19874	35504	4800	12810	29	148673	372126	260399
1972	21728	83415	84107	192690	8213	12320	24319	43258	2992	10385	17	141376	342085	241731
1973	0	11405	108247	252350	10987	16480	28105	51021	8658	18715	13	156009	349983	252996
1974	24533	92118	58182	142618	10067	15100	48343	84600	16209	33822	40	157374	368298	262836
1975	49688	183837	78457	190500	11606	17409	42668	74869	18232	28608	67	200718	495289	348003
1976	31814	125665	80324	195390	12979	19469	56021	99673	24589	43595	151	205878	483943	344911
1977	28815	112337	75297	184754	12004	18006	14045	27487	16704	34231	54	146920	376870	261895
1978	13464	53851	68451	165514	11447	17170	13768	25439	5678	9808	127	112935	271909	192422
1979	17825	72682	75622	182158	15863	23795	29764	56533	18577	36754	247	157897	372168	265033
1980	45870	170045	84506	204600	20817	31226	26450	50060	28878	52513	722	207243	509165	358204
1981	49855	187471	109871	266027	30952	46428	39421	76222	18236	42948	1009	249345	620106	434726
1982	34032	129370	98080	237244	16877	25316	52020	96088	12179	26548	290	213478	514856	364167
1983	19360	78689	76958	186128	12030	18045	13611	24586	7747	15969	255	129961	323672	226816
1984	9348	40056	89904	217925	16316	24957	17990	33483	17964	37503	540	152062	354465	253263
1985	19631	76462	84264	204433	15608	25140	39514	73650	18158	40731	363	177539	420779	299159
1986	30806	116481	87051	211192	22230	33855	82122	149339	21204	44947	660	244072	556474	400273
1987	37572	144917	100634	225374	25789	40481	59330	109989	21589	45407	1087	246000	567253	406627
1988	34369	134100	92218	223522	28582	44815	85644	159124	23288	47231	923	265025	609715	437370
1989	22429	90212	41331	100799	24710	37319	44715	81557	23873	48578	1080	158138	359546	258842
1990	12544	52176	68863	167309	26594	39826	56161	111716	22753	49642	617	187531	421288	304410
1991	10526	42647	43487	107169	20582	30433	44350	86653	13814	25610	235	132994	292747	212870
1992	15229	59331	92434	208272	21754	33583	118723	188535	15125	29633	1124	264389	520477	392433
1993	22499	78251	104712	235387	17493	27444	70969	116845	11539	22252	444	227656	480623	354140
1994	15228	53958	65691	160859	16758	25642	32651	90032	6918	10218	427	137673	341136	239404
1995	22144	73575	81877	193746	14409	21548	15408	60911	12114	19697	213	146164	369689	257927
1996	48362	150048	102657	249011	18923	27805	24410	69238	19253	32472	651	214256	529226	371741
1997	64049	153200	68519	129122	14724	22210	12706	36324	6143	9428	365	166507	350650	258578
1998	.	.	102827	238887	16152	24801	15971	43259	13083	19373	403	.	.	.

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

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

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

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

	North America		Prefishery	Recruits/	Labrador (L)		Newfoundland (N)		Quebec (Q)		Gulf of St. Lawrence (G)		Scotia-Fundy (S)		USA (US)	
	Total 2SW	Lagged 2SW	abundance	2SW lagged												
Year	spawners	spawners	recruits	spawner	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged
71	49742		652827		16447		5020		14777		6244		6764		490	
72	84734		645486		14124		5171		28951		25372		10079		1038	
73	91705		770200		19470		6497		29455		29286		5896		1100	
74	117272		712403		18982		3788		35821		44780		12752		1147	
75	95880		807391		18341		4657		29772		25822		15345		1942	
76	91788		718805		20842		4582		28316		22231		14691		1126	
77	127202		587326		18006		3132		40752		46321		18348		643	
78	84838	95492	330077	3.46	14425	14759	3646	5901	37362	28016	17118	35340	8973	10034	3314	1442
79	39573	107083	730725	6.82	8175	17486	2249	4752	16008	32232	5172	36790	6459	14270	1509	1553
80	121440	96196	639192	6.64	19579	18903	4411	4441	44492	31940	28745	24947	19949	14937	4263	1029
81	76322	104089	605935	5.82	18009	18795	4404	4517	32666	30266	7297	31923	9612	16888	4334	1699
82	80647	107258	503481	4.69	13104	19695	5663	3679	33115	34821	15627	34005	8496	12699	4643	2358
83	52545	82157	286891	3.49	9546	18710	4765	3457	21636	36526	10813	13216	4017	7514	1769	2733
84	81335	79784	296450	3.72	6650	15422	4456	2822	27502	28065	21233	14900	18947	14569	2547	4006
85	94940	85256	468776	5.50	5394	11576	2124	3682	26205	32359	30450	19528	25882	13668	4884	4443
86	119737	79229	505066	6.37	9255	15361	3457	4377	30013	35728	48663	11236	22777	8998	5570	3528
87	90684	77705	462953	5.96	12358	17772	2963	5171	26725	33119	31123	13471	14734	5813	2781	2359
88	93578	78779	370526	4.70	7538	14762	3420	5029	31866	27538	33988	15100	13728	13002	3038	3347
89	81545	93669	293057	3.13	7498	10875	1569	4506	30461	25762	22604	24599	16614	23026	2800	4901
90	91337	103269	256969	2.49	4208	7799	2926	3032	30320	26580	35561	37432	13966	23978	4356	4449
91	74662	99689	299086	3.00	2078	6285	2300	3043	24506	28072	30445	41159	12917	17965	2416	3166
92	93719	89280	179755	2.01	8451	8072	6619	3110	24085	28227	40270	32777	12002	14173	2292	2922
93	77954	91716	137134	1.50	10773	10649	3288	3197	18601	29616	35411	29378	7816	15464	2065	3410
94	80225	88733	161214	1.82	14660	9247	3990	2275	18389	30646	36954	28093	4888	15007	1344	3464
95	107714	89142	156490	1.76	27866	7453	4786	2480	25639	30138	41353	33151	6322	13350	1748	2570
96	88673	84338	126588	1.50	20617	5299	5697	2652	22216	27289	28862	34506	8875	12373	2407	2219
97	70577	82372	97899	1.19	16434	3511	4988	4946	18155	24550	25186	38055	4203	9493	1611	1817
98	.	75776			.	6285	7967	4358	17008	21312	11323	36170	4044	6080	1526	1571
99		79664				9930		3894		19459		38663		5764		1954
00		86805				14098		4509		22055		36259		7845		2039
01		85807				22118		5309		22898		27766		6056		1661

Spawners lagged by:

Labrador = 0.0768 x i-5 spawners + 0.542 x i-6 + 0.341 x i-7 + 0.0401 x i-8

Newfoundland = 0.0408 x i-4 spawners + 0.5979 x i-5 + 0.3237 x i-6 + 0.0375 x i-7

Quebec = 0.0577 x i-4 spawners + 0.4644 x i-5 + 0.3783 x i-6 + 0.0892 x i-7 + 0.0104 x i-8

Gulf = 0.3979 x i-4 spawners + 0.5731 x i-5 + 0.0291 x i-6

Scotia-Fundy = 0.6002 x i-4 spawners + 0.3942 x i-5 + 0.0055 x i-6

USA = 0.3767 x i-3 spawners + 0.520 x i-4 + 0.1033 x i-5.

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

Country	Stock Area	Management zone	2SW spawner requirement	
Canada	Labrador	SFA 1		7,992
		SFA 2		25,369
		SFA 14B		1,390
	Subtotal		34,746	
	Newfoundland	SFA 3		240
		SFA 4		488
		SFA 5		233
		SFA 6 to 8		13
		SFA 9 to 12		212
		SFA 13		2,544
		SFA 14A		292
	Subtotal		4,022	
	Gulf of St. Lawrence	SFA 15		5,656
		SFA 16		21,050
		SFA 17		537
		SFA 18		3,187
	Subtotal		30,430	
	Québec	Q1		5,002
		Q2		3,116
		Q3		3,596
		Q5		1,326
		Q6		1,966
		Q7		6,461
		Q8		20,026
		Q9		7,794
		Q10		3,963
		Q11		7,500
	Subtotal		60,750	
	Scotia-Fundy	SFA 19		3,138
		SFA 20		2,691
		SFA 21		5,817
		SFA 22		0
		SFA 23		13,059
	Subtotal		24,705	
Total			154,653	
USA	Connecticut			9,727
	Merrimack			2,599
	Penobscot			6,838
	Other Maine rivers			9,668
	Paucatuck			367
Total			29,199	
North American Total			183,852	

Table 4.5.1 Fishing mortalities of 2SW salmon equivalents by North American fisheries, 1972-98.
Only mid-points of the estimated values have been used.

Year	CANADA										USA	Total
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i							
	NF-LAB Comm 1SW (Yr i-1) b	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) b	NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	Yr i	
1972	27874	11	156881	184755	314	640	27417	22389	6801	242316	346	242661
1973	24016	8	223603	247619	719	904	32751	17913	6680	306586	327	306913
1974	32828	9	240676	273504	593	547	47631	21432	12734	356441	247	356688
1975	32316	9	242398	274715	241	535	41097	15680	12375	344641	389	345031
1976	47846	13	261770	309616	618	414	42139	18093	11111	381991	191	382182
1977	36777	10	246090	282867	954	962	42301	33435	15562	376081	1355	377436
1978	37200	14	160477	197677	580	566	37421	23812	10781	270836	894	271730
1979	18825	13	93918	112742	469	148	25234	6303	4506	149403	433	149837
1980	27923	8	221596	249520	646	709	53567	29841	18411	352692	1533	354225
1981	46088	14	205403	251492	384	491	44375	16334	13988	327064	1267	328331
1982	45894	18	137132	183026	473	438	35204	25715	12353	257208	1413	258621
1983	34348	15	113815	148163	313	448	34472	27102	13515	224014	386	224399
1984	25969	18	84479	110448	379	239	24408	6038	3971	145484	675	146159
1985	19578	14	80351	99929	219	16	27483	2740	4930	135318	645	135963
1986	26504	15	107010	133514	340	40	33846	4573	2824	175137	606	175743
1987	33629	16	134879	168508	457	21	33807	3788	1370	207950	300	208251
1988	42874	26	82769	125643	514	30	34262	3914	1373	165735	248	165983
1989	29665	20	82998	112663	337	9	28901	3505	265	145679	397	146076
1990	26163	22	58518	84682	261	25	27986	2839	593	116387	696	117083
1991	16102	18	41250	57352	66	17	29277	1932	1331	89975	231	90206
1992	13336	18	25616	38952	581	70	30016	4294	1114	75027	167	75194
1993	4315	9	13540	17856	273	64	23153	3002	1110	45458	166	45624
1994	2859	7	12179	15038	365	82	24052	2359	756	42652	1	42653
1995	1660	5	8852	10511	420	93	23331	2037	330	36723	0	36723
1996	1437	4	5760	7197	320	109	22413	2573	766	33378	0	33378
1997	1296	5	5499	6795	175	37	18574	2180	581	28342	0	28342
1998	1544	7	1909	3453	268	64	16657	2336	322	23100	0	23100
1999	239	-	-	-	-	-	-	-		-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.904837
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.99005
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998

Table 4.5.2 History of fishing-related mortalities of North American salmon as 2SW equivalents 1972-98.

Year	Canadian total	USA total	North America Grand Total	% USA of Total Nortl American	Greenland total	NW Atlantic Total	Harvest in homewaters as %of total NW Atlantic
1972	242316	346	242661	0.14	260296	502958	48
1973	306586	327	306913	0.11	181677	488590	63
1974	356441	247	356688	0.07	218512	575200	62
1975	344641	389	345031	0.11	199593	544623	63
1976	381991	191	382182	0.05	252304	634486	60
1977	376081	1355	377436	0.36	141060	518497	73
1978	270836	894	271730	0.33	171656	443386	61
1979	149403	433	149837	0.29	107543	257379	58
1980	352692	1533	354225	0.43	181023	535248	66
1981	327064	1267	328331	0.39	170108	498439	66
1982	257208	1413	258621	0.55	206056	464677	56
1983	224014	386	224399	0.17	176185	400585	56
1984	145484	675	146159	0.46	30077	176236	83
1985	135318	645	135963	0.47	35213	171175	79
1986	175137	606	175743	0.34	125983	301726	58
1987	207950	300	208251	0.14	155401	363652	57
1988	165735	248	165983	0.15	157158	323141	51
1989	145679	397	146076	0.27	105655	251732	58
1990	116387	696	117083	0.59	54917	172000	68
1991	89975	231	90206	0.26	66152	156357	58
1992	75027	167	75194	0.22	100147	175342	43
1993	45458	166	45624	0.36	37872	83496	55
1994	42652	1	42653	0.00	0	42653	100
1995	36723	0	36723	0.00	0	36723	100
1996	33378	0	33378	0.00	18335	51713	65
1997	28342	0	28342	0.00	14641	42983	66
1998	23100	0	23100	0.00	11345	34445	67

Greenland harvest of 2SW equivalents = NG1 * 0.904837

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

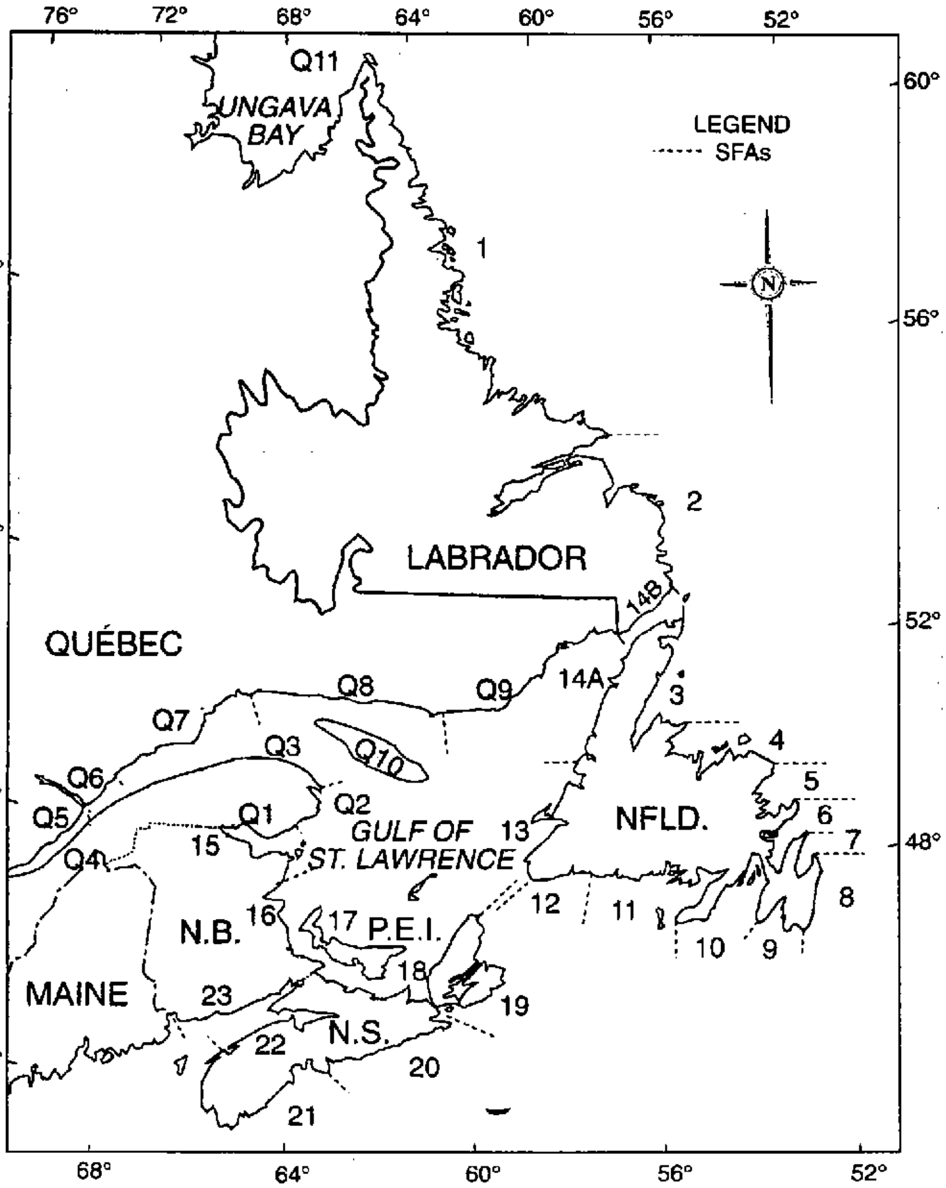
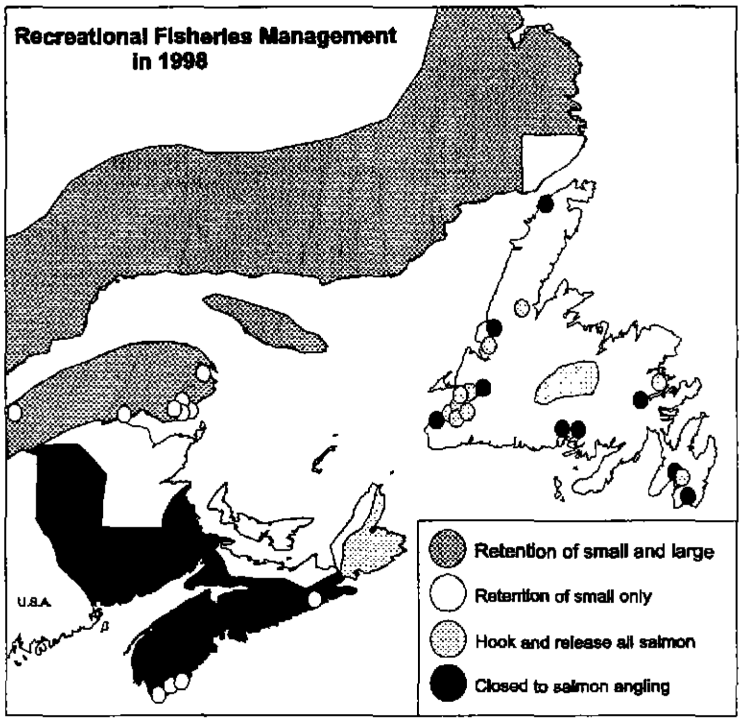


Figure 4.1.1.2. Summary of recreational fisheries management in eastern Canada at the start of the angling season (upper map) and after adjustments stemming from river/area specific inseason assessments during 1998.



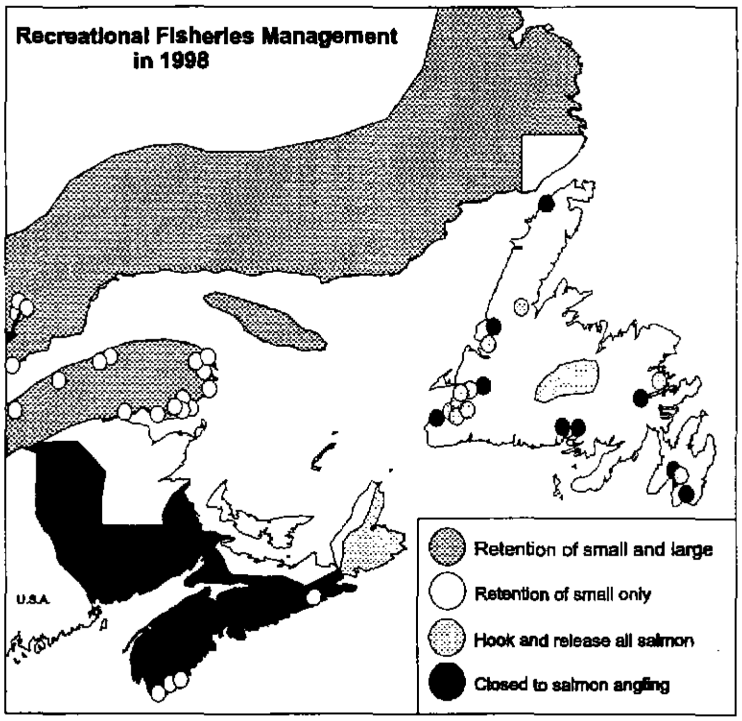


Figure 4.1.2.1. Harvest (t) of small salmon, large salmon, and combined in Canada, 1960 to 1998.

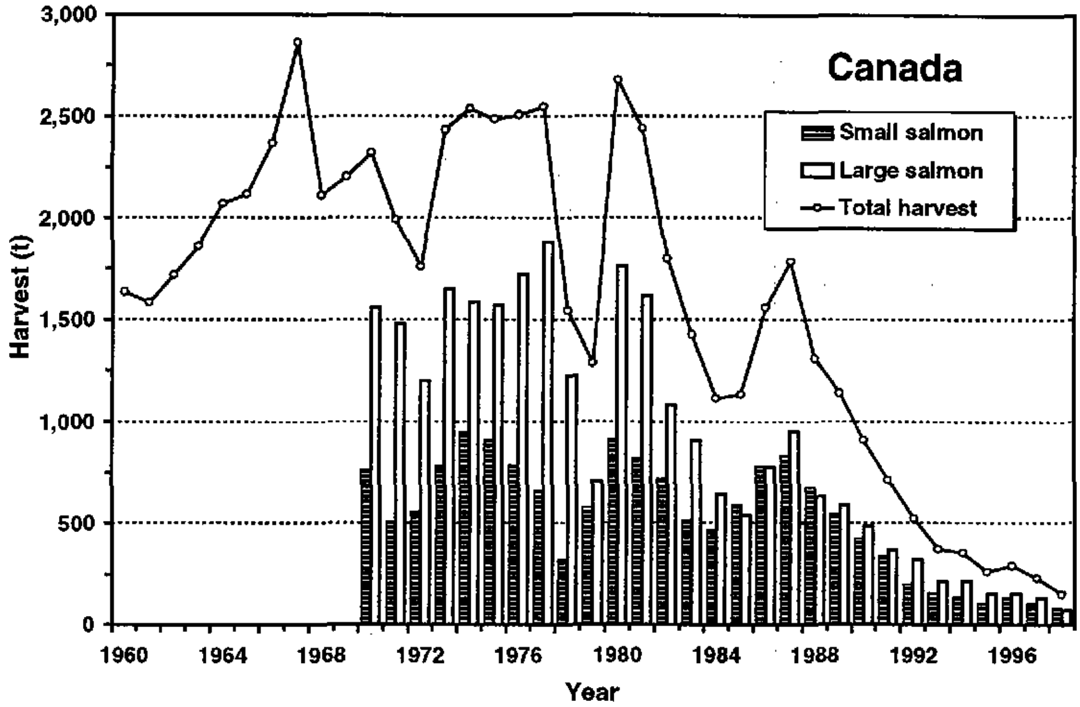


Figure 4.1.2.2. Harvest (number) of small salmon and large salmon and both sizes combined in the recreational fisheries in Canada, 1974 to 1998.

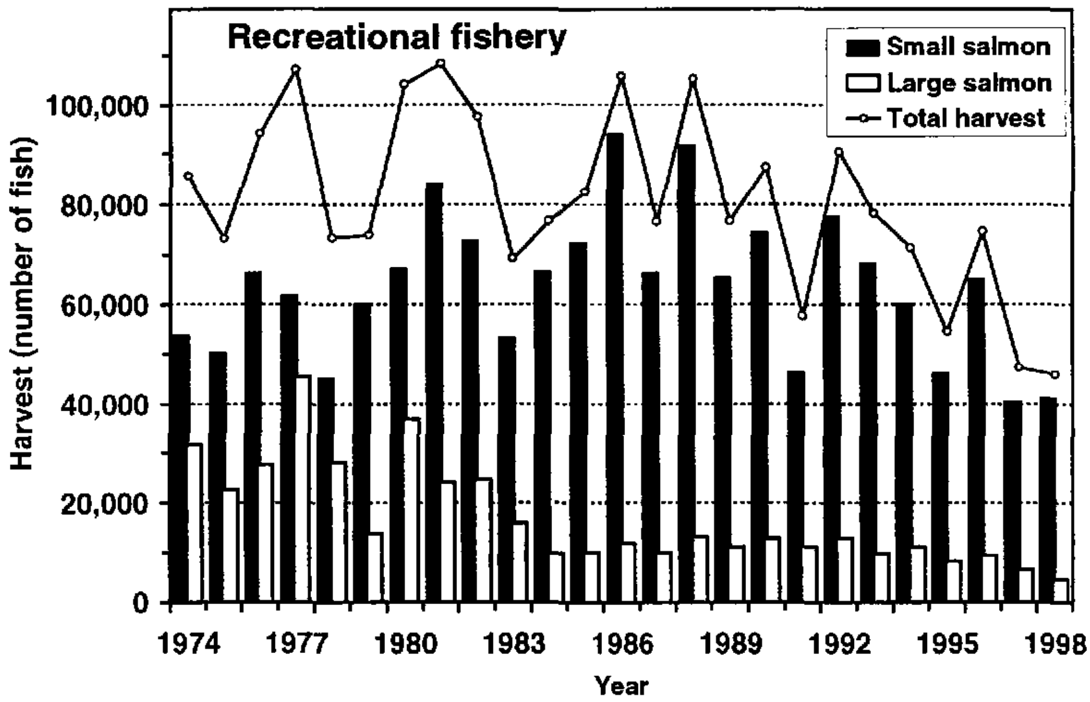


Figure 4.1.2.3. Angling catches (including kept and released fish) of small and large salmon by management area in 1998 (black square) expressed as a percentage of the average catches for the period 1984 to 1991. The vertical lines represent the minimum to maximum range. The 1984 to 1991 standard period was selected to represent the period of no commercial fisheries in SFAs 15 to 23 and Zones Q1 to Q6 and before the commercial salmon moratorium in Newfoundland SFAs 3 to 14A introduced in 1992.

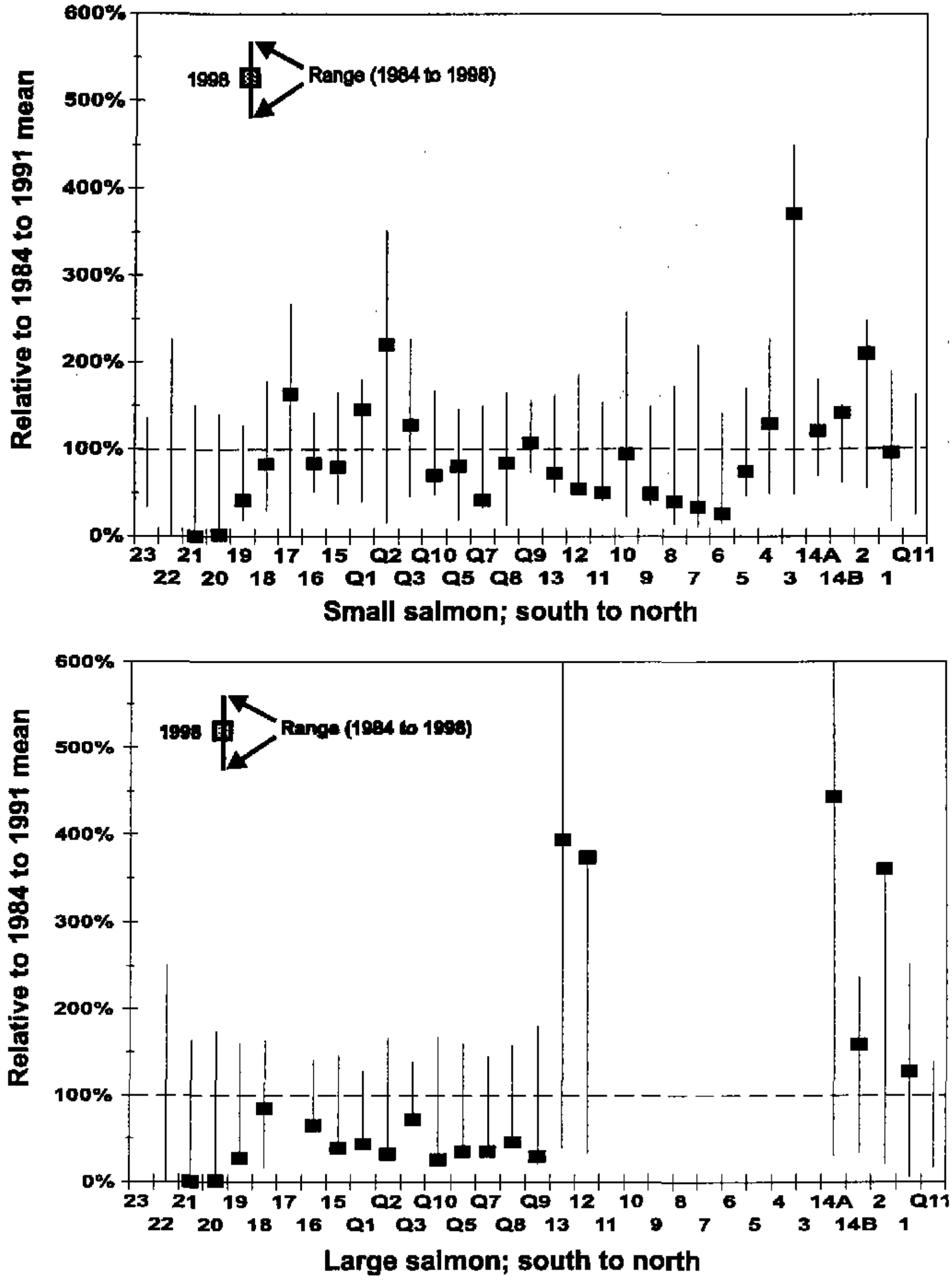


Figure 4.1.2.4. Harvest (t) of small salmon and large salmon and both size groups combined in the commercial fisheries of Canada, 1974 to 1998.

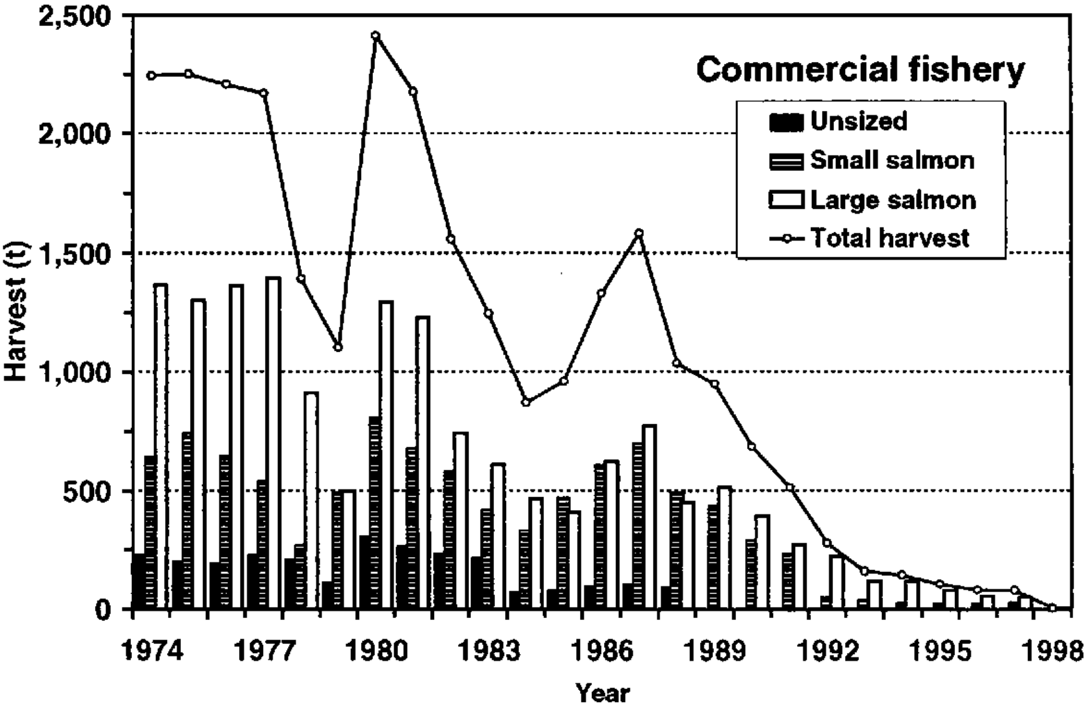


Figure 4.1.3.1. Origin (wild, hatchery, aquaculture) of Atlantic salmon returning to monitored rivers of eastern Canada in 1998. Only rivers in which more than one origin type were observed are indicated.

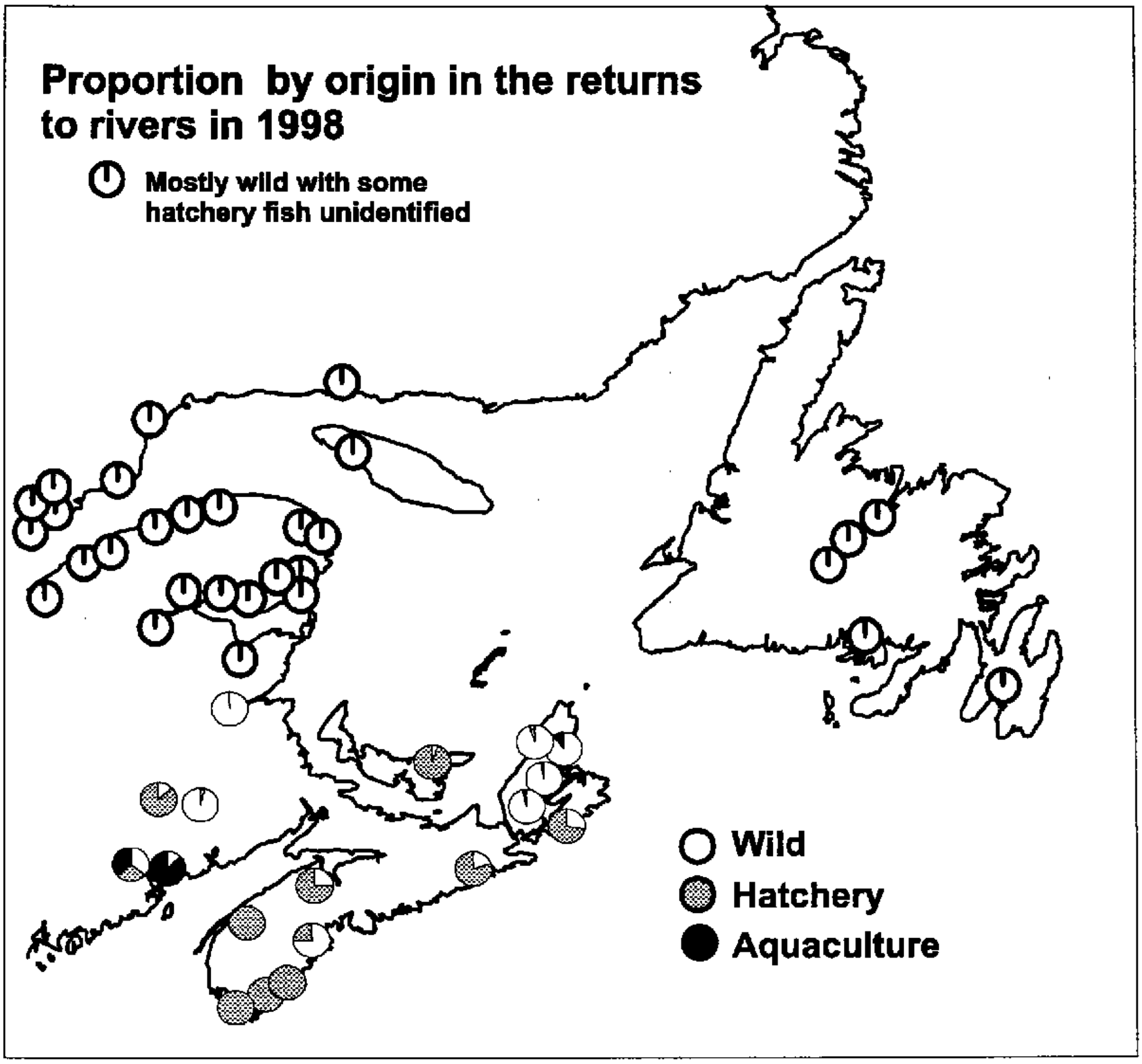


Figure 4.1.3.2. Location of Atlantic salmon marine grow-out sites in eastern North America (upper panel) and distribution of rivers with observed juvenile or adult aquaculture escaped Atlantic salmon (lower panel).

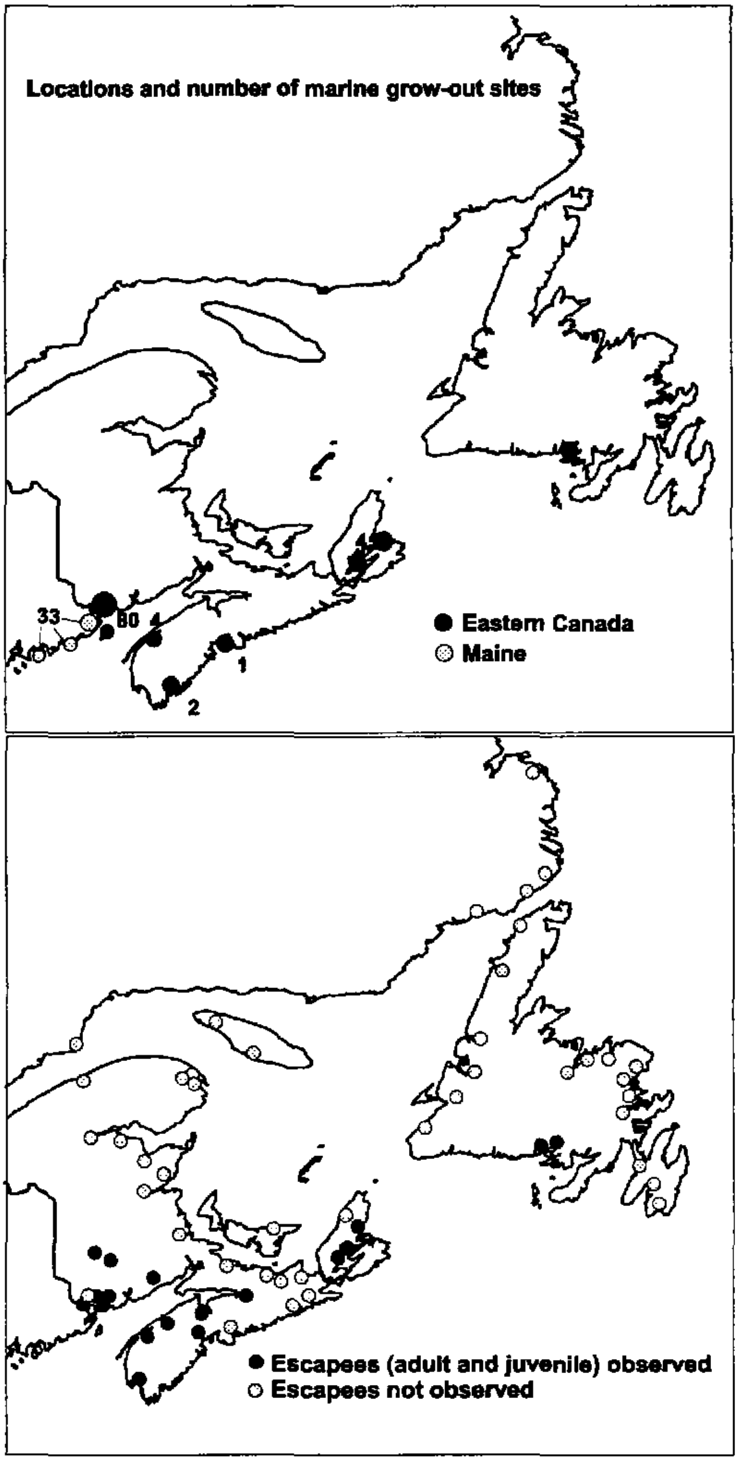
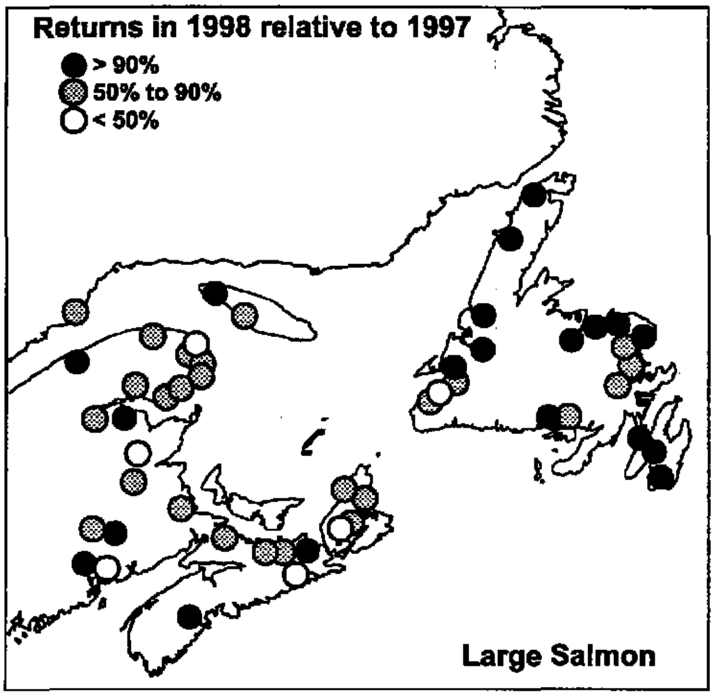


Figure 4.2.1.1. In-river returns of small salmon and large salmon for 51 monitored rivers of eastern Canada in 1998 relative to 1997.



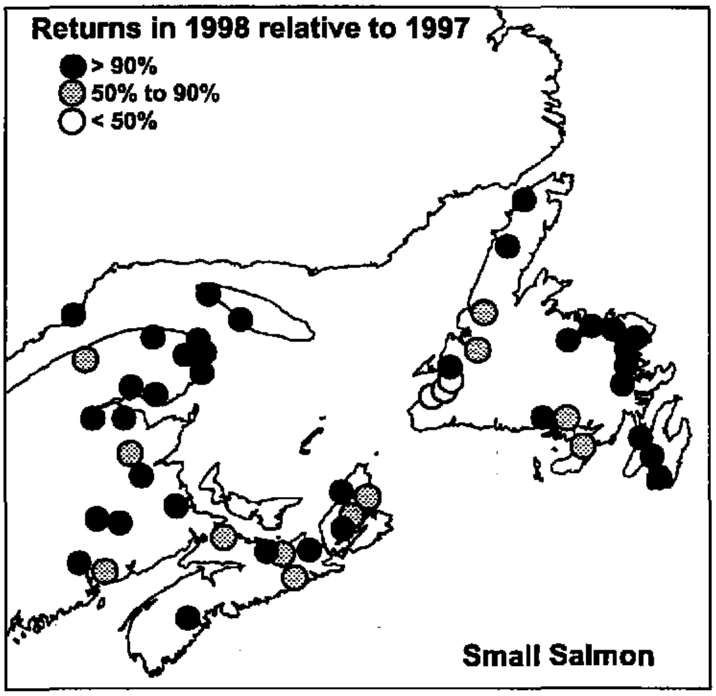


Figure 4.2.1.2. In-river returns of small salmon and large salmon for 24 monitored rivers in four geographic areas of eastern Canada from 1985 to 1998. The in-river returns do not account for removals in marine fisheries. Rivers by area are: Newfoundland (Exploits, Middle Brook, Terra Nova, Northeast Brook, Torrent, Western Arm Brook), Québec (Bonaventure, Cascapédia, St-Jean, York, Darmouth, Madeleine, Matane, de la Trinité, Bec-scie), Gulf (Restigouche, Miramichi, Philip, East Pictou, West Antigonish, Margaree), and Scotia-Fundy (Liscomb, LaHave, Saint John at Mactaquac).

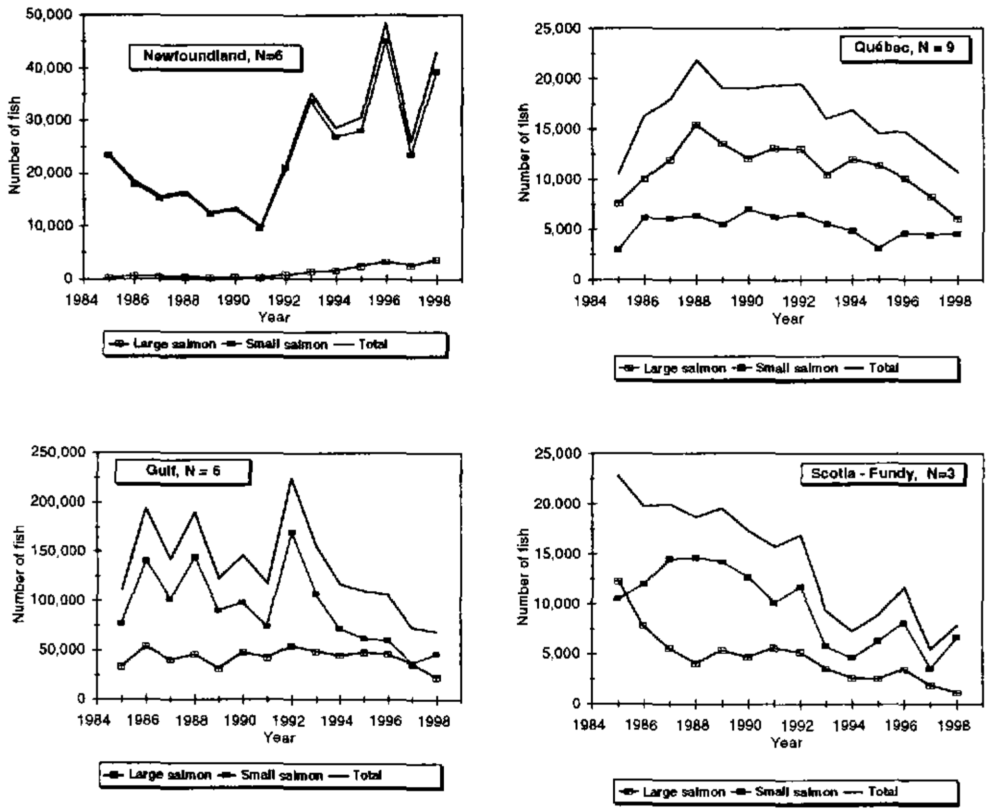


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Figure 4.2.1.3. Documented Atlantic salmon returns to USA rivers.

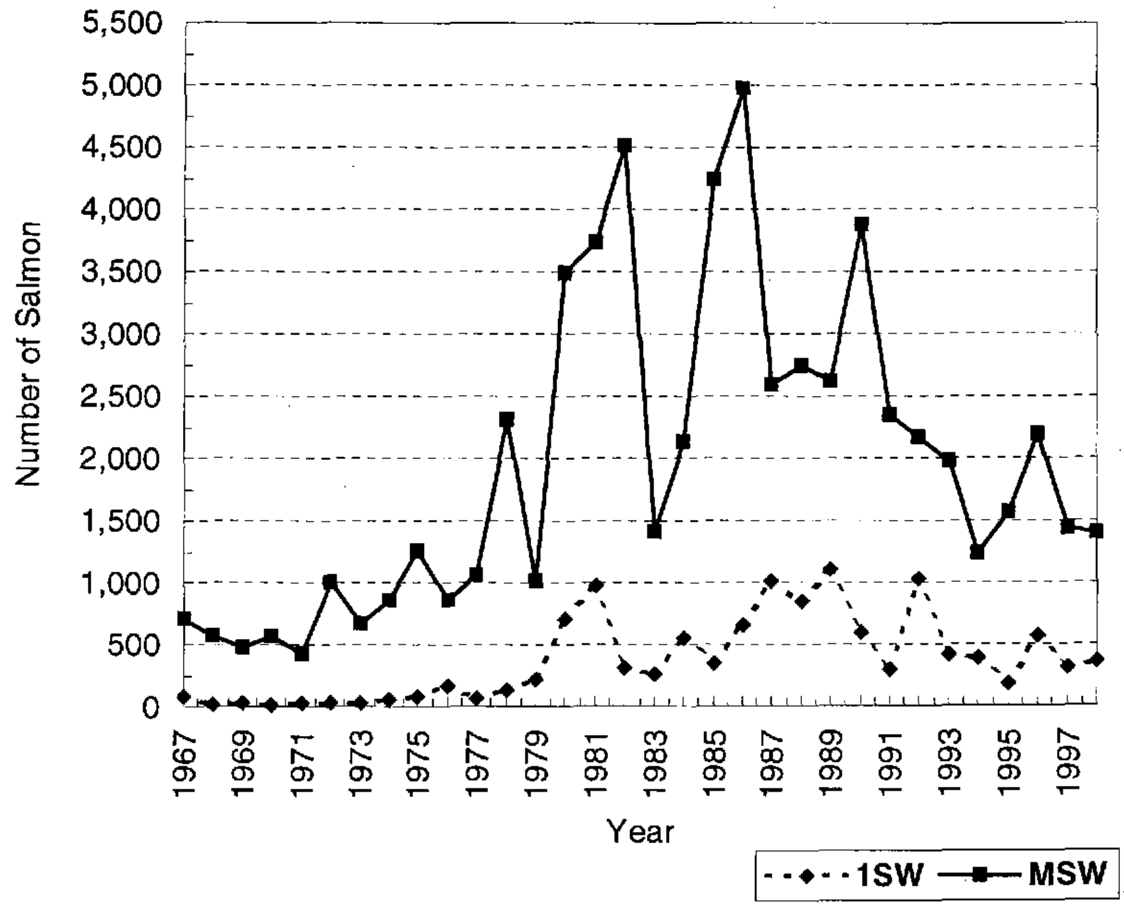


Figure 4.2.1.4. Rivers with smolt and juvenile monitoring programs in eastern Canada and U.S. used in the analysis.

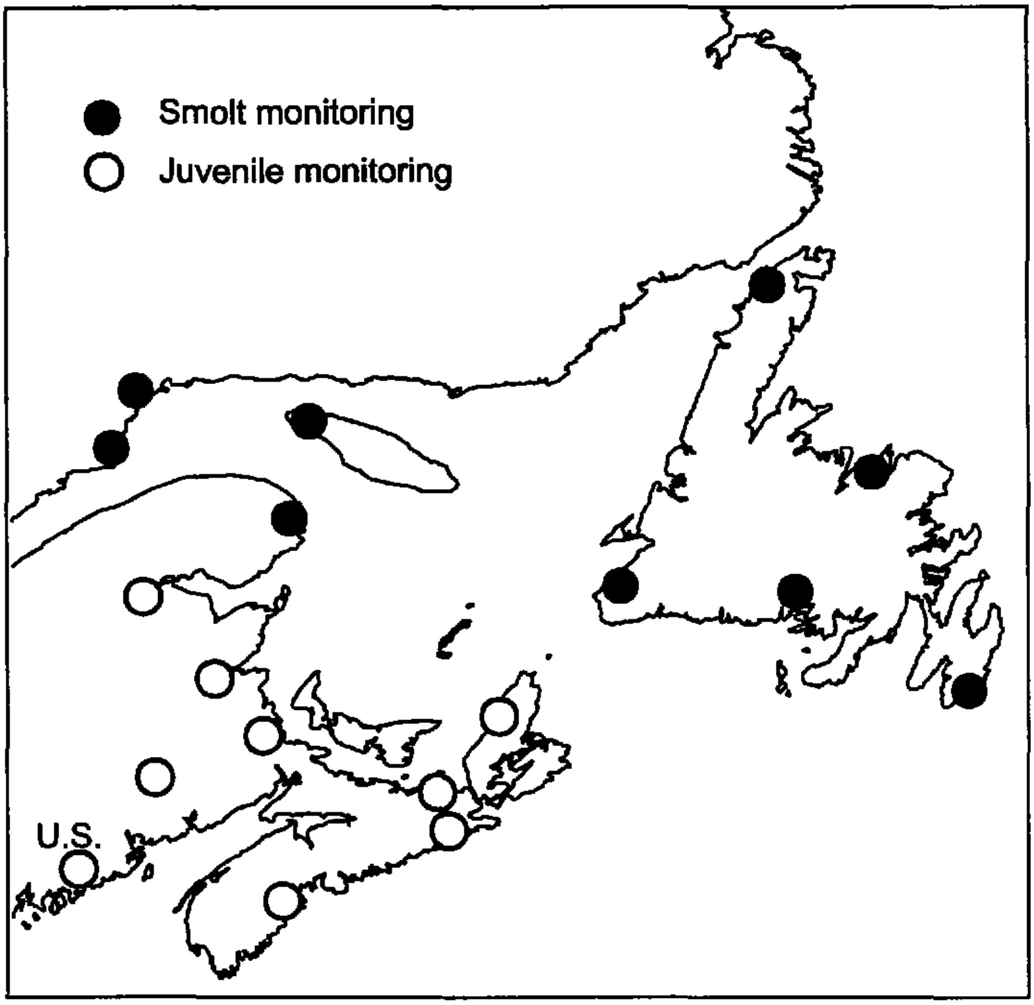


Figure 4.2.1.5. Variability in the wild smolt output from nine rivers of eastern Canada in 1971 to 1998 relative to the average smolt output (by individual river) for the 1990 to 1995 period.

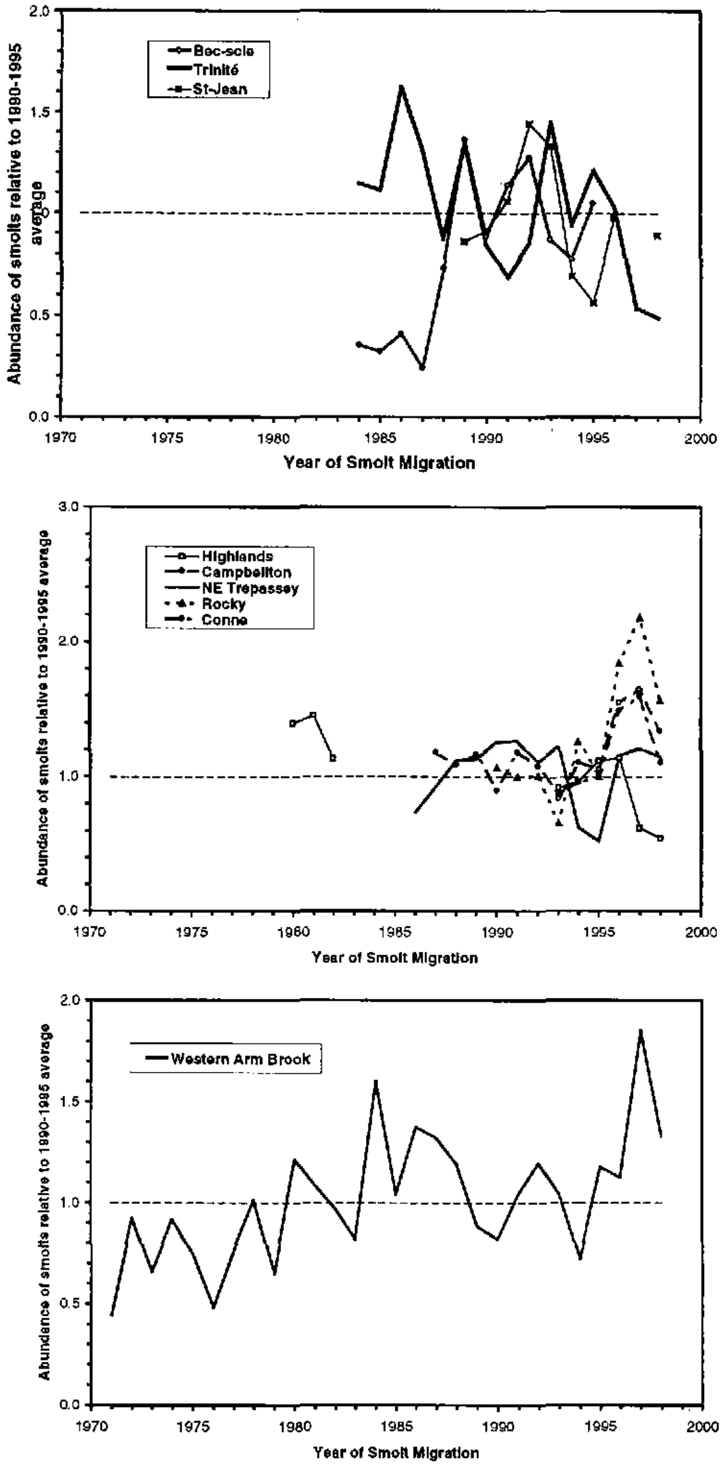
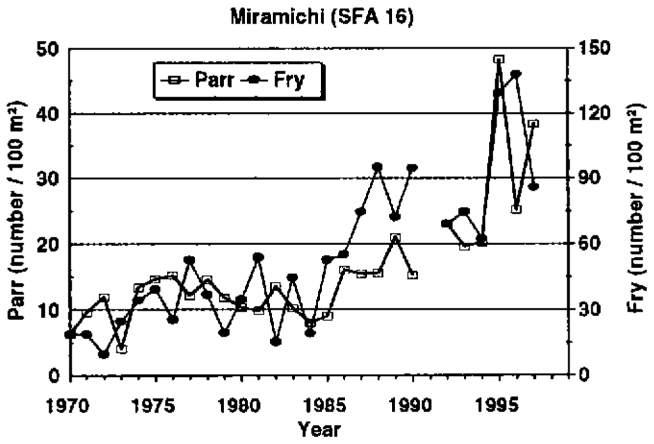
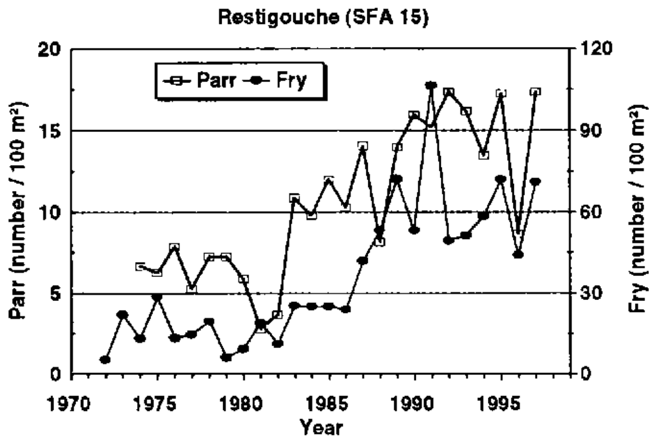


Figure 4.2.1.6. Mean juvenile Atlantic salmon densities in the Miramichi River (SFA 16), Restigouche River (SFA 15) and the Stewiacke River (SFA 22), Canada based on sampling at standard index sites in each river.





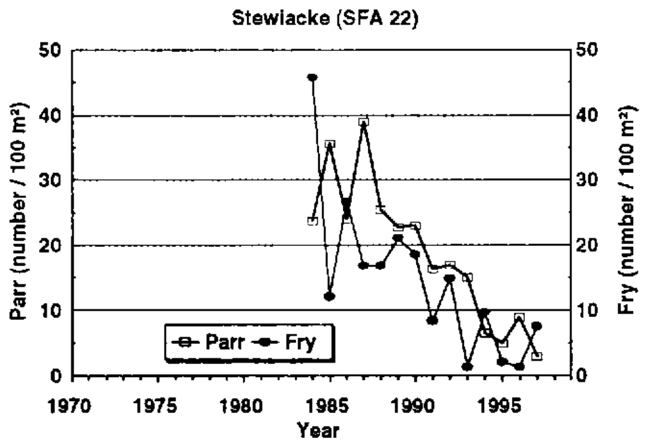
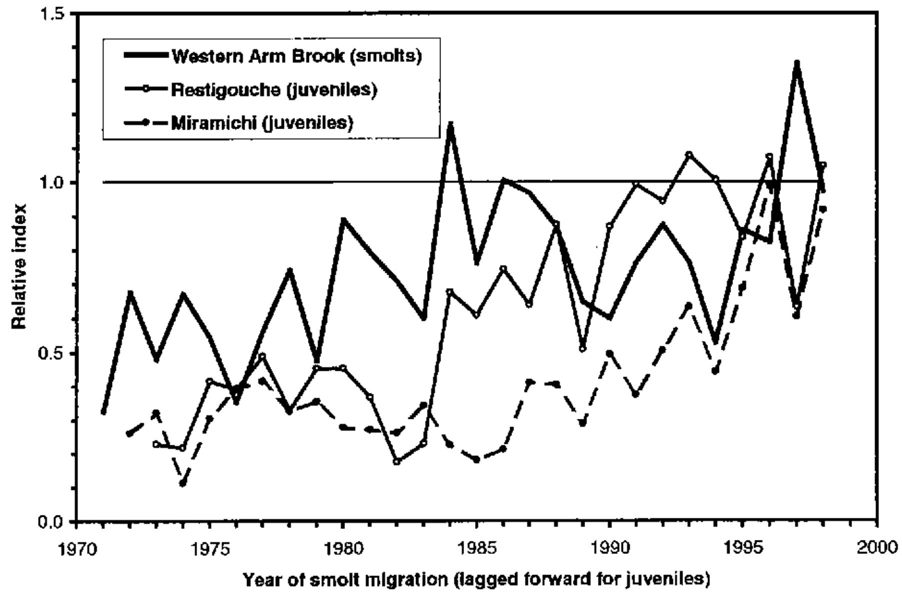


Figure 4.2.1.7. Relative index of smolt production in the three longest time series of smolt and juveniles in eastern Canada (upper) and relative index for eastern North America based on weighting factors.



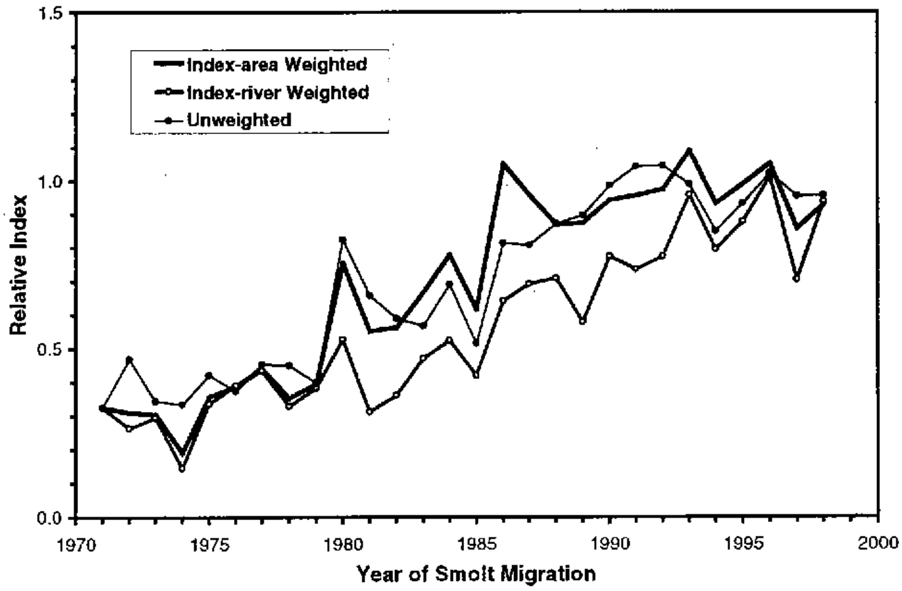


Figure 4.2.1.8. Relative index of smolt production in the three longest time series of smolt and juveniles in eastern Canada.

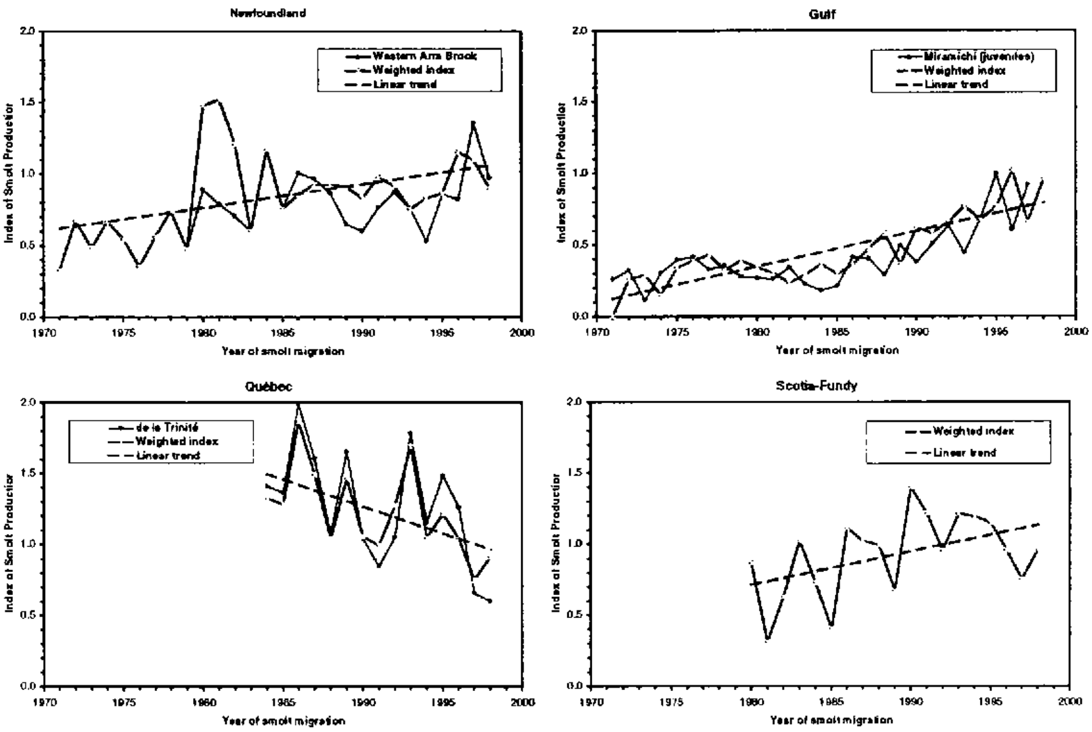


Figure 4.2.2.1 Estimated mid-points of 1SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 1SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 1SW spawners (squares), 1971-98. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23. Labrador data for 1998 is unavailable.

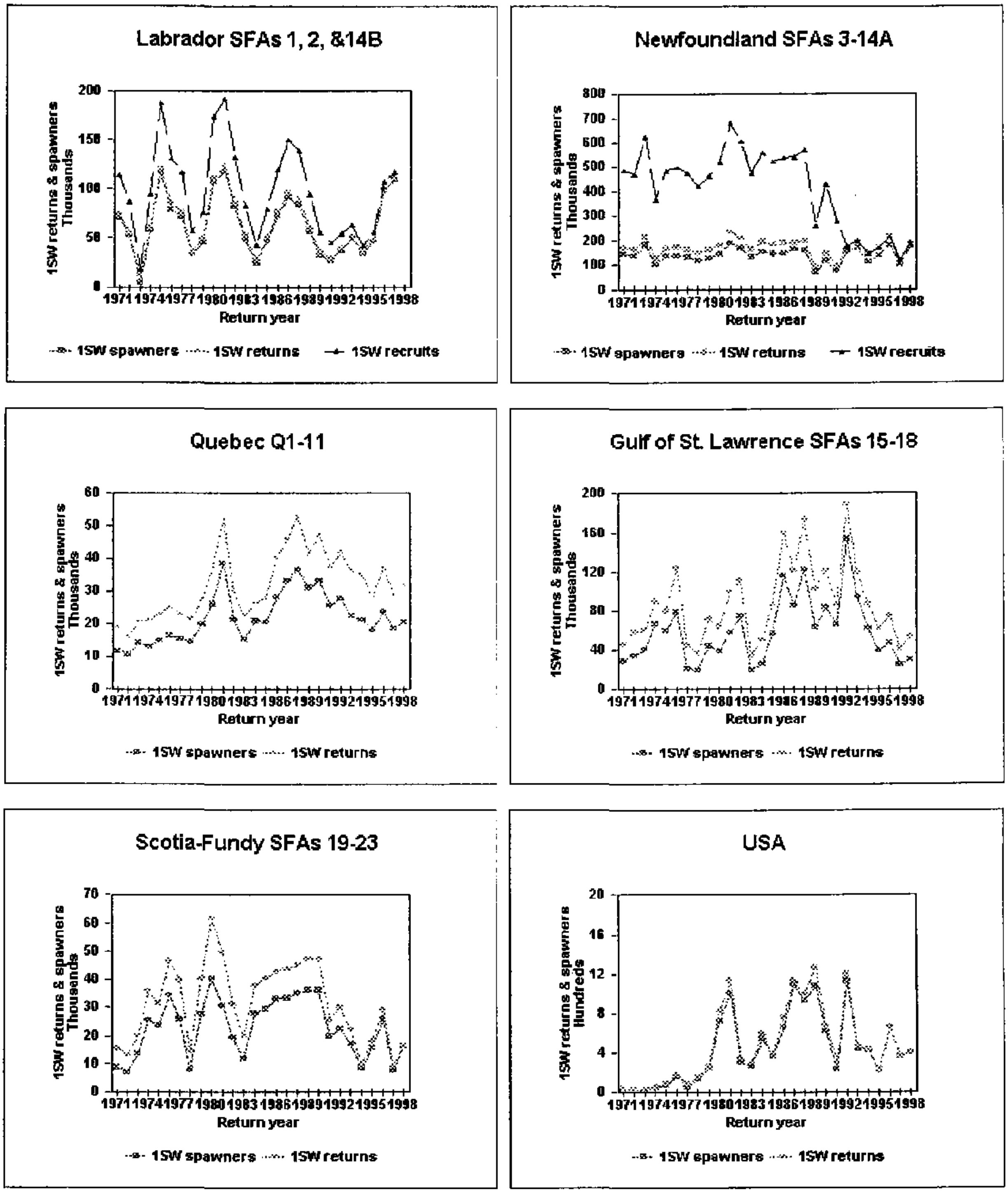


Figure 4.2.2.2 Comparison of estimated mid-points of 2SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 2SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 2SW spawners (squares) and 2SW conservation requirements (triangles) for 1971-98 return years. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23. Estimates for 1998 for Labrador are unavailable.

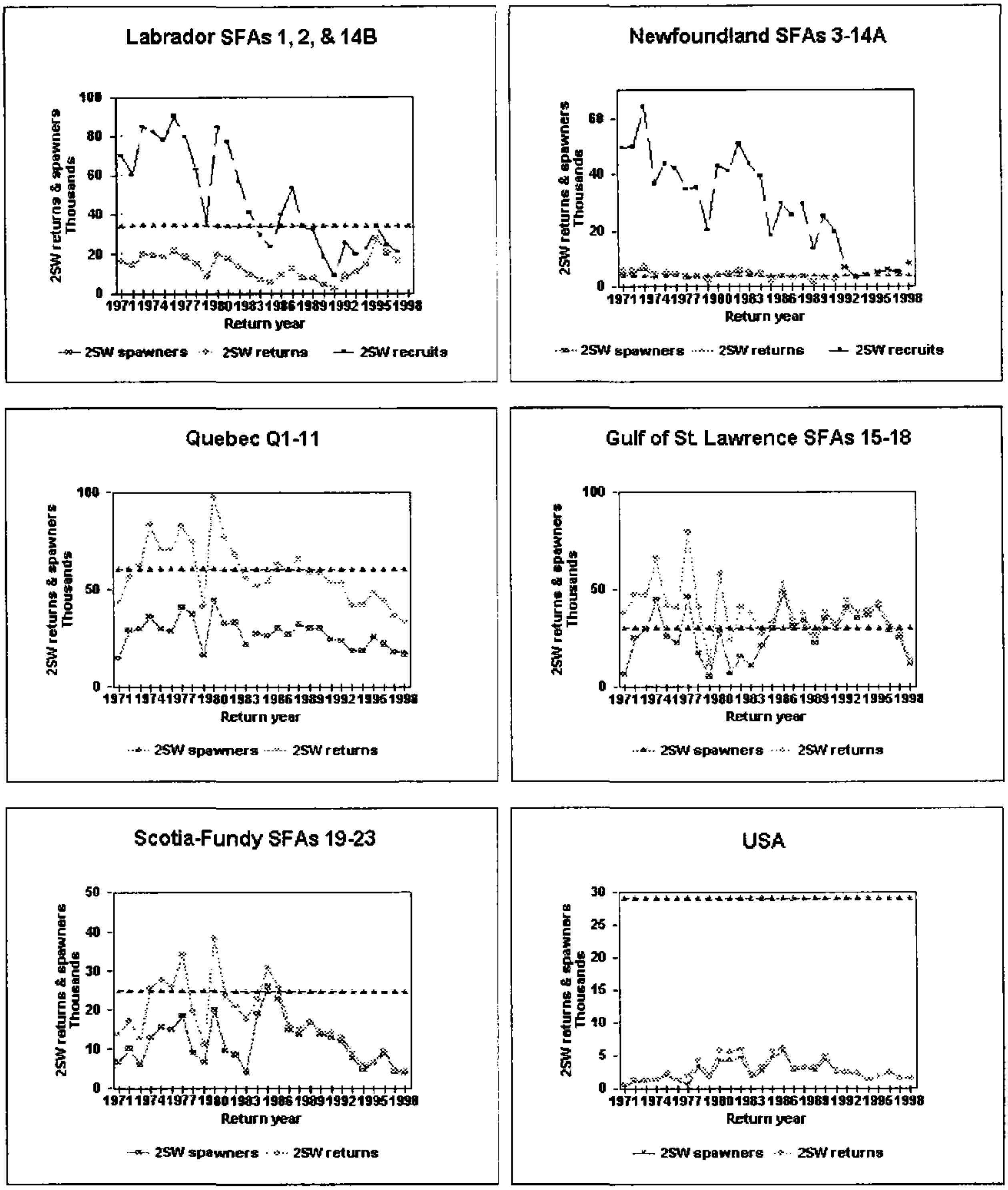


Figure 4.2.3.1. Pre-fishery abundance estimate of maturing and non-maturing salmon in North America (A), and proportion of smolt class maturing after 1SW (B).

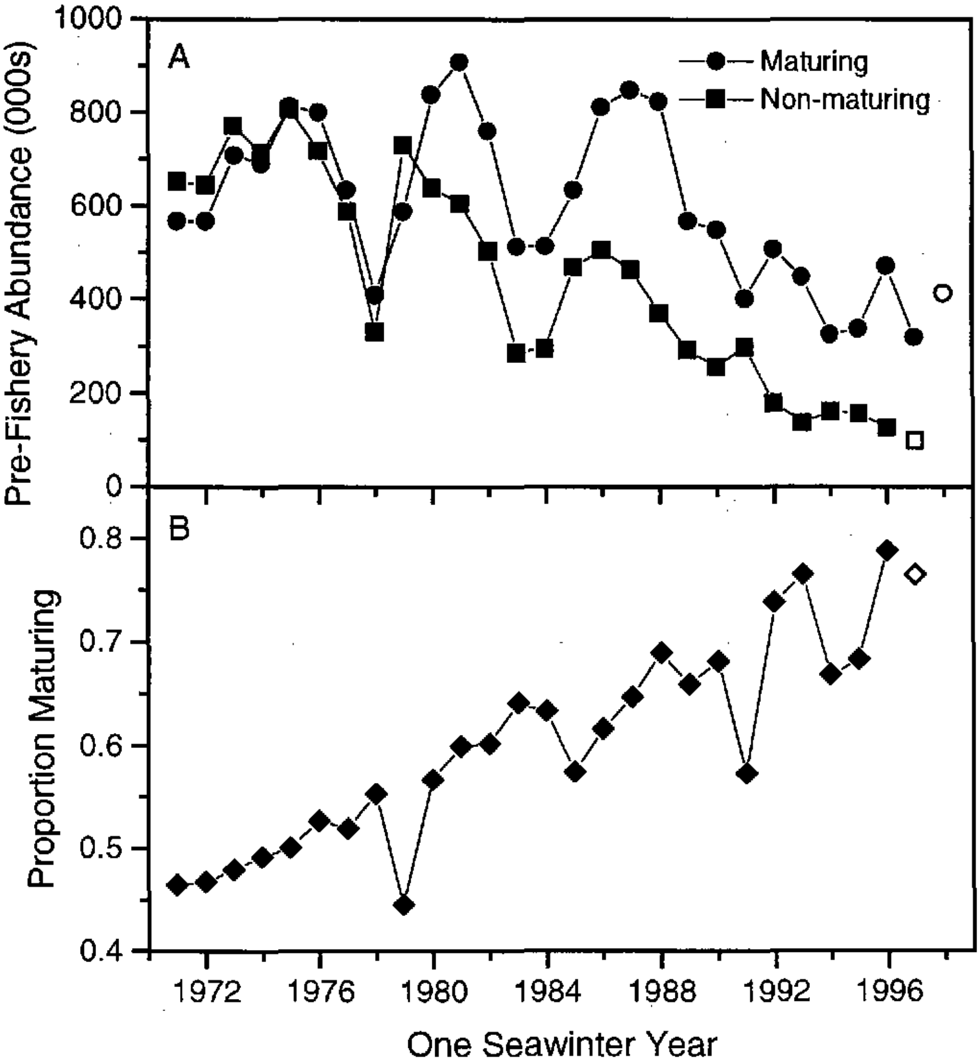


Figure 4.2.3.2. Total 1SW recruits (non-maturing and maturing) originating in North America.

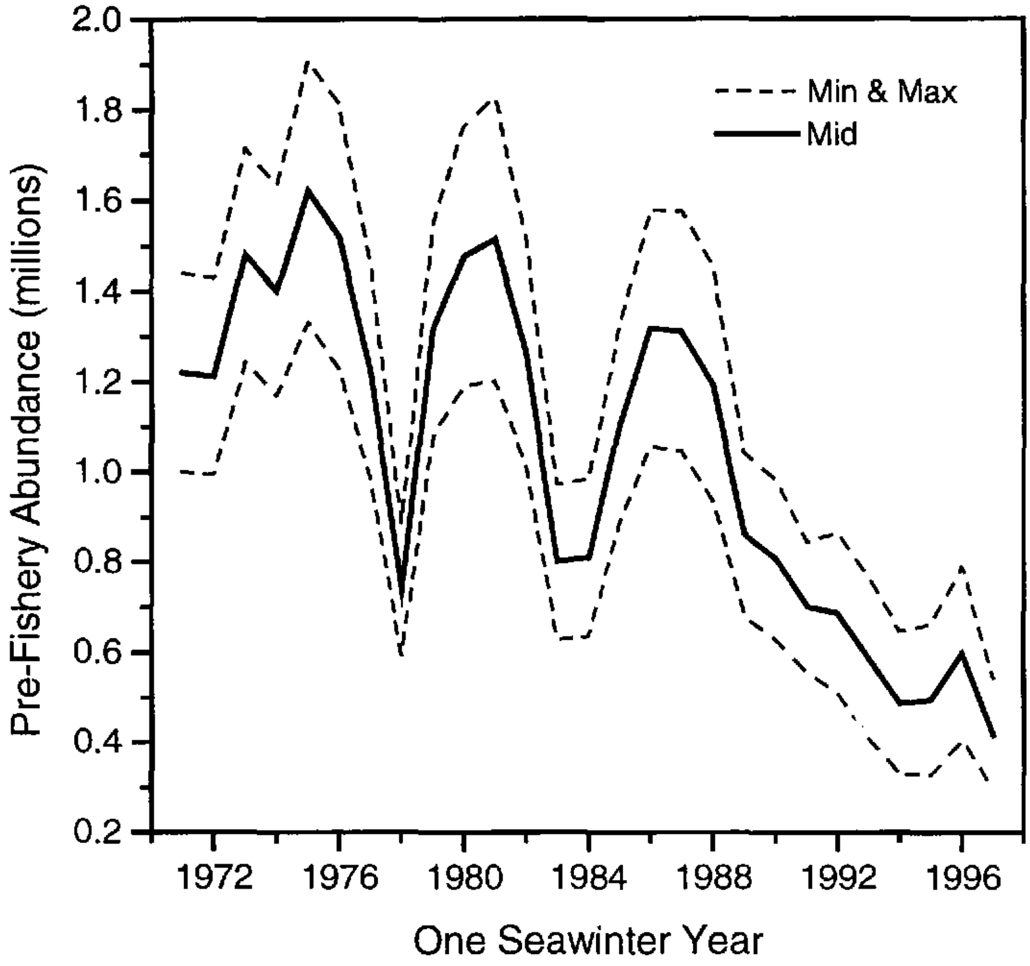


Figure 4.2.4.1. Egg depositions in 1998 relative to conservation requirements in 71 rivers (upper map) and for 19 rivers of eastern Canada and five rivers of U.S. under colonization or rehabilitation (lower map). The black slice represents the proportion of the conservation requirement achieved in 1998. A solid black circle indicates the egg deposition requirement was attained or exceeded.

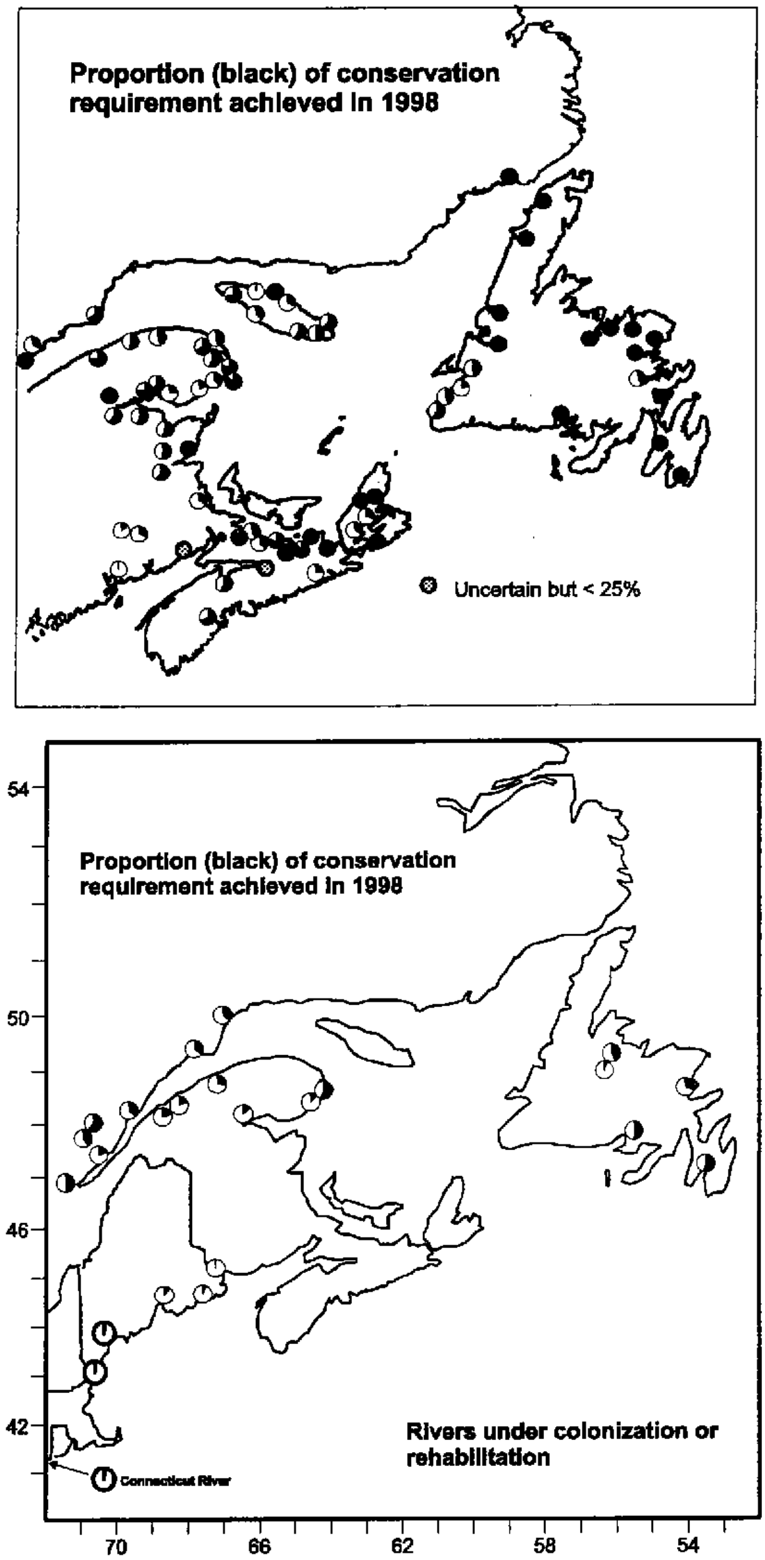


Figure 4.2.4.2. Proportion of the conservation requirements met in monitored rivers in four geographic area of eastern Canada, 1984 to 1998. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion and the number above the vertical line is the number of rivers included in the annual summary. The horizontal line defines the location of 100% of conservation requirements.

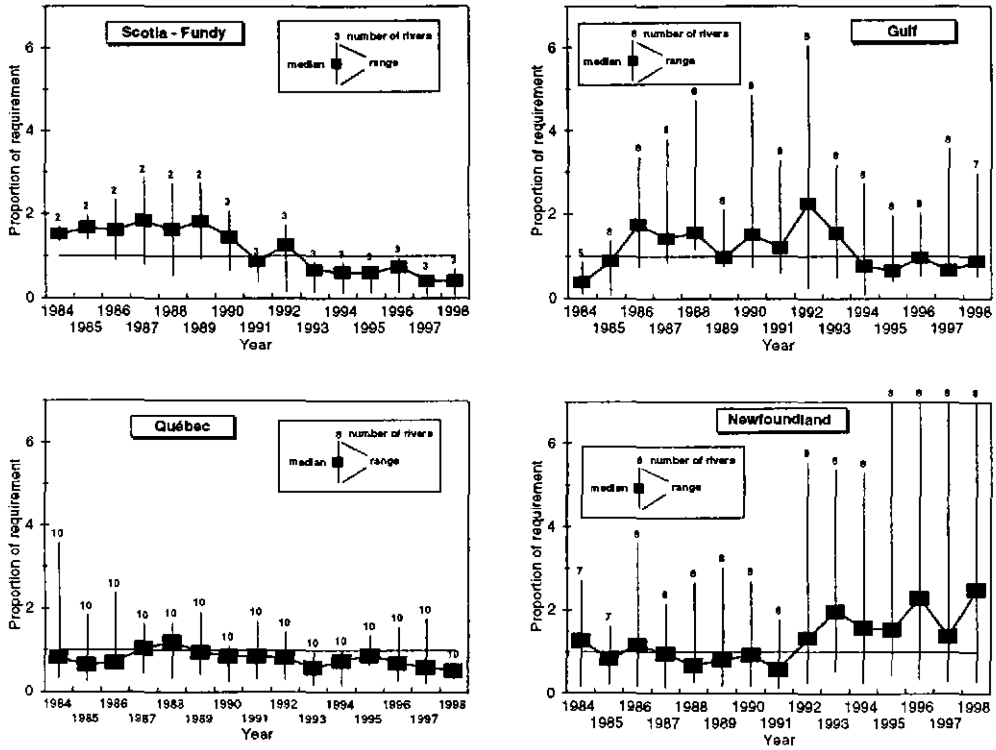
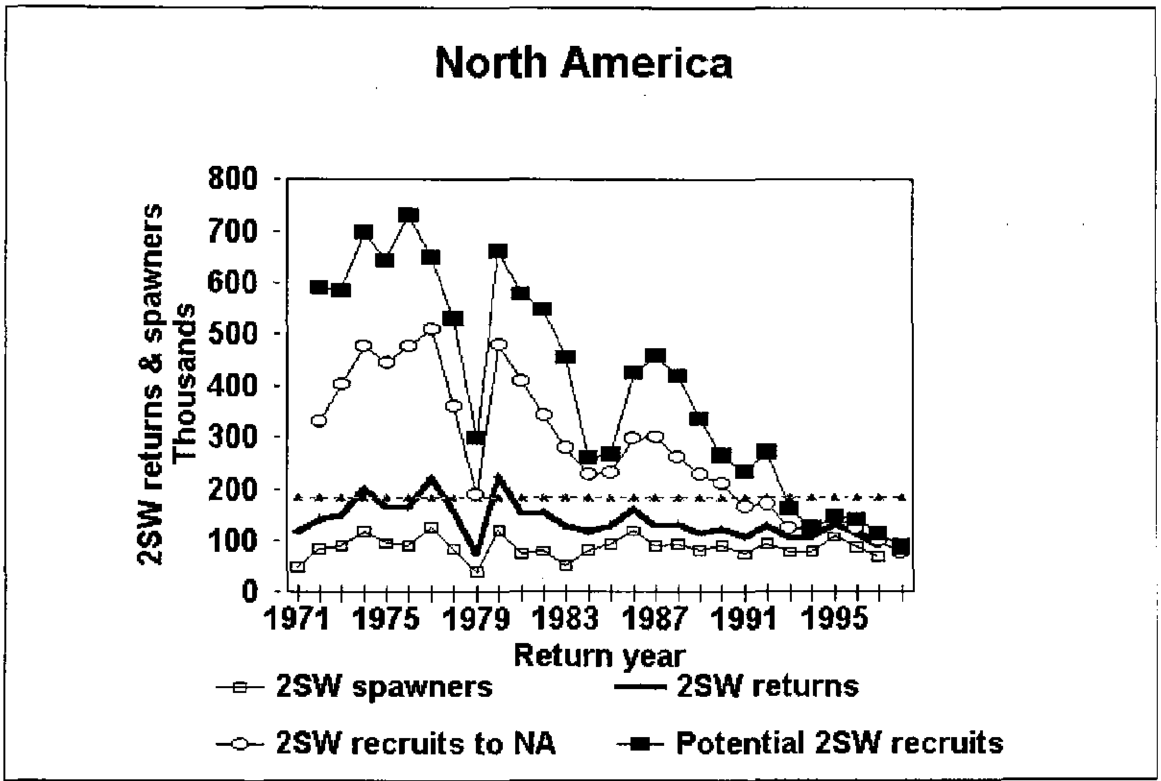


Figure 4.2.4.3 Top panel: comparison of estimated of potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971-98 and 2SW returns and spawners for 1971-97, as 1998 data for Labrador are unavailable. Triangles indicate the 2SW spawner threshold. Bottom panel: comparison of potential maturing 1SW recruits, 1971-98 and returns a 1SW spawners for 1971-97 return years as Labrador data for 1998 are unavailable.



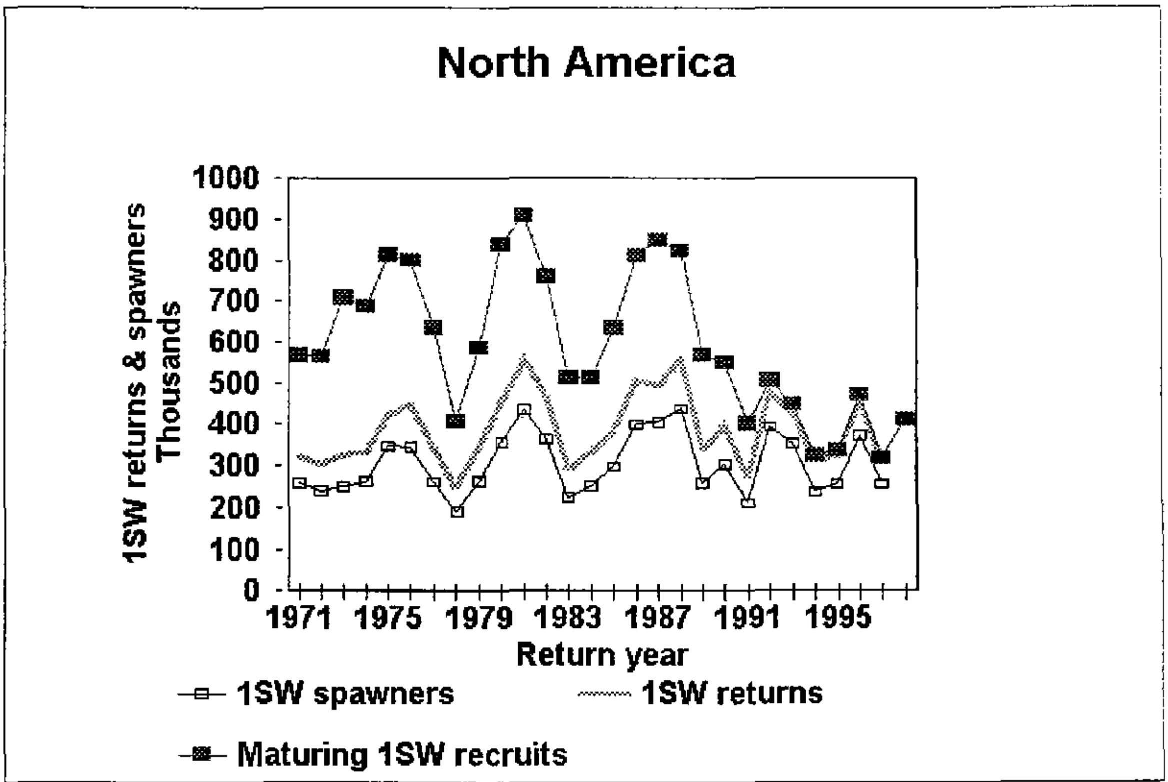


Figure 4.2.4.4. Lagged spawner contributions (mid-points) to potential recruitment in the given year for six geographic areas of North America. The horizontal line represents the spawning requirement (in terms of 2SW fish) in each geographic area.

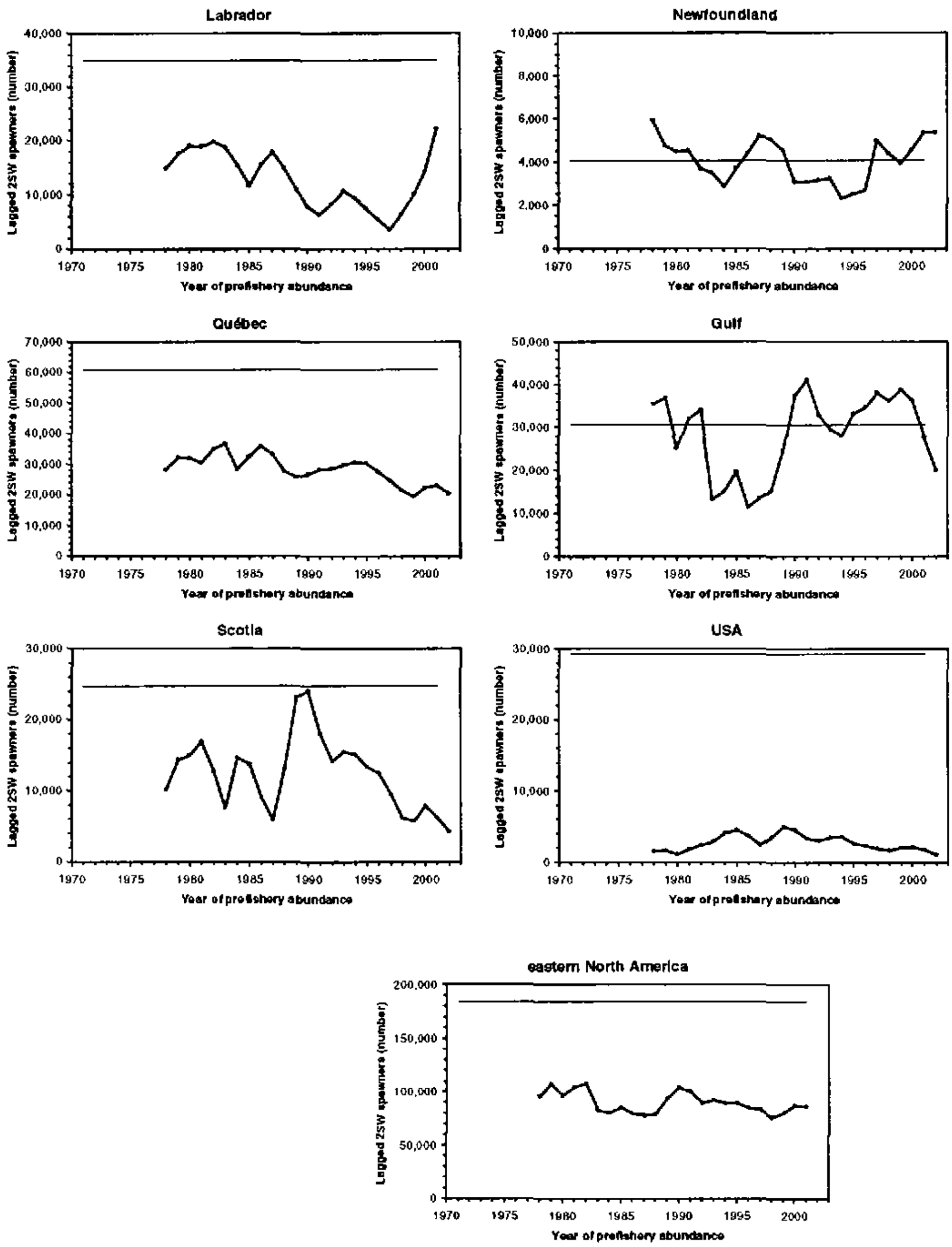


Figure 4.2.4.5. Proportion of lagged spawners (mid-points) in the six geographic areas of North America relative to the total lagged spawner escapement contributing to the year of prefishery abundance. The horizontal line represents the theoretical spawner proportions for each area based on the 2SW spawner requirement for North America.

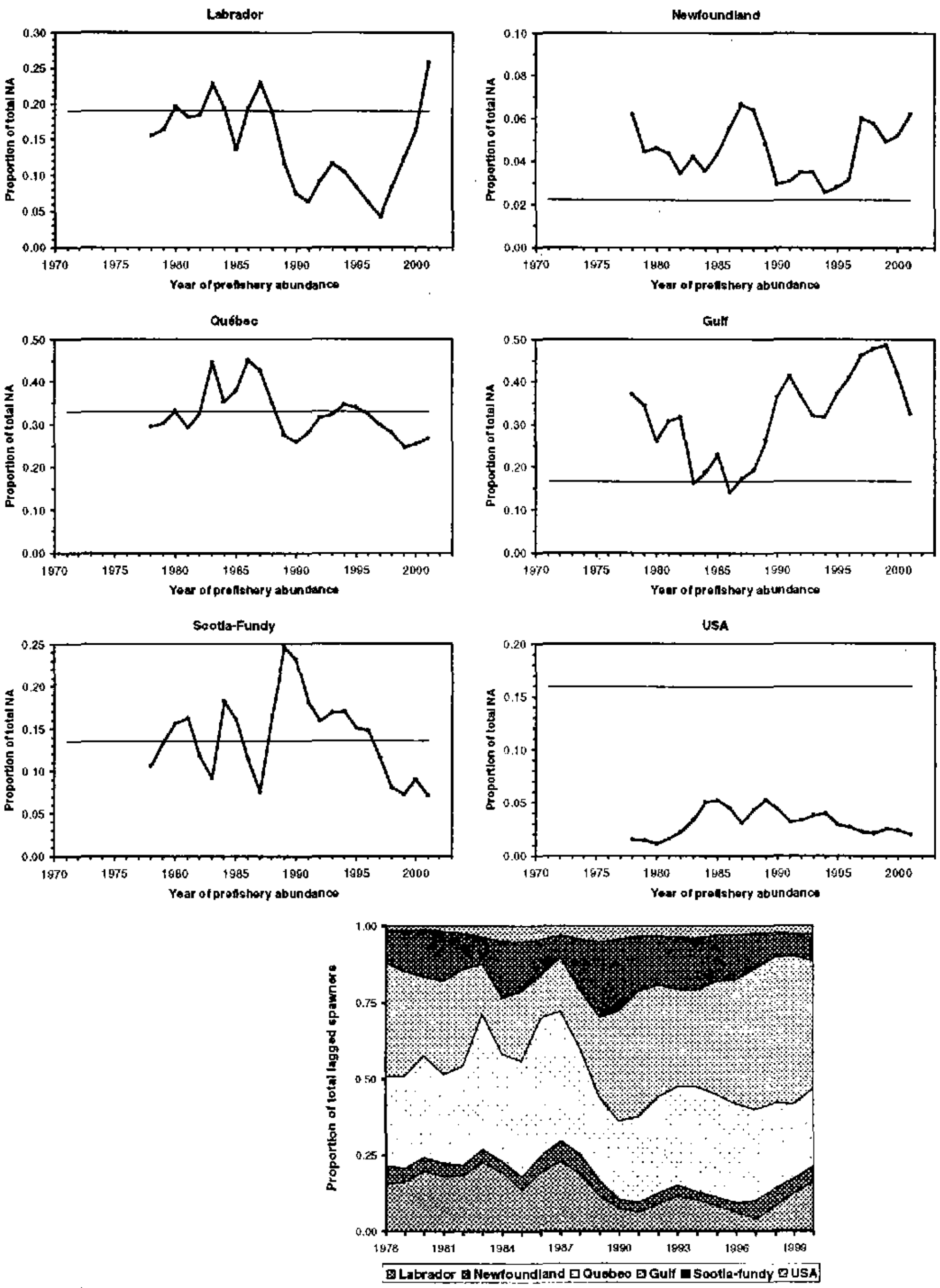


Figure 4.2.5.1. Trends in survival rates (%) of hatchery released smolts from the Saint John River (SFA 23), LaHave River (SFA 21), Liscomb River (SFA 20), and aux Rocher River (Q7) as 1SW, 2SW returns to the river.

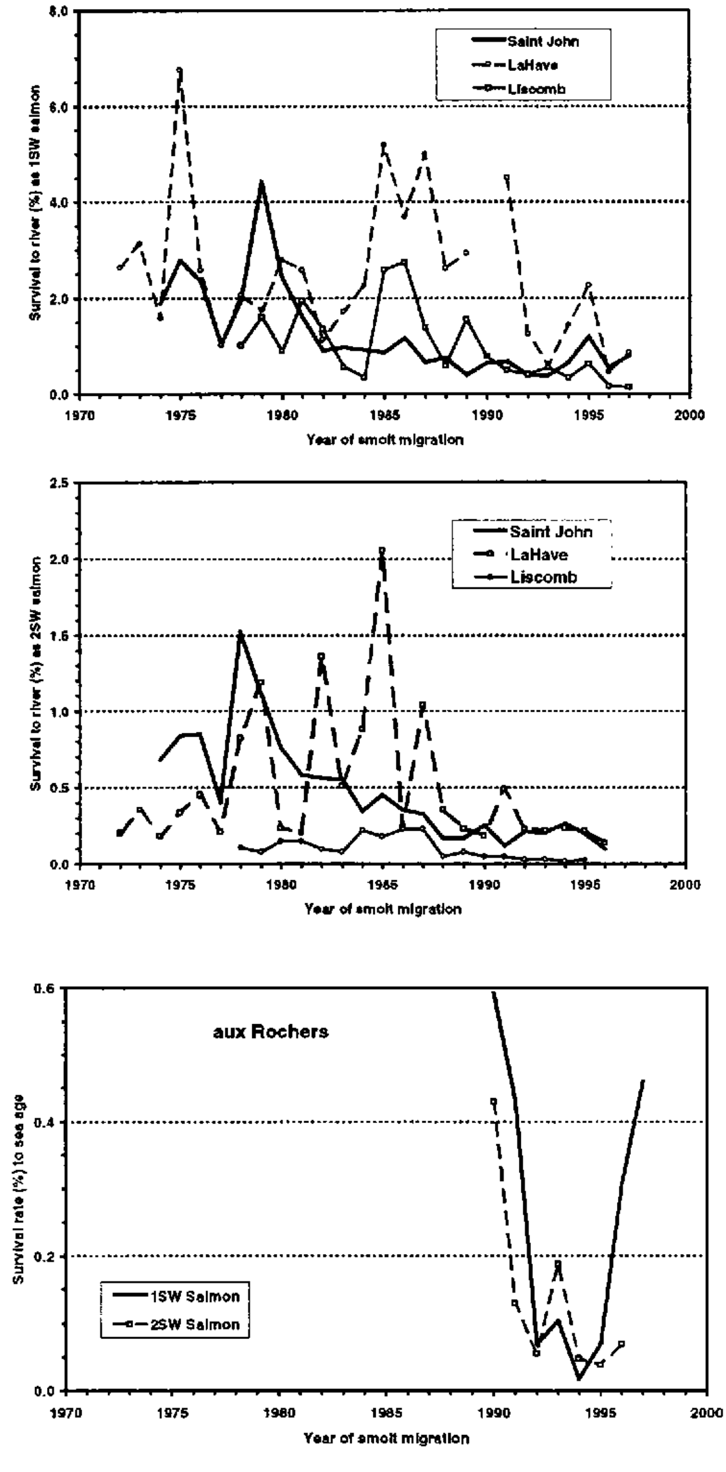
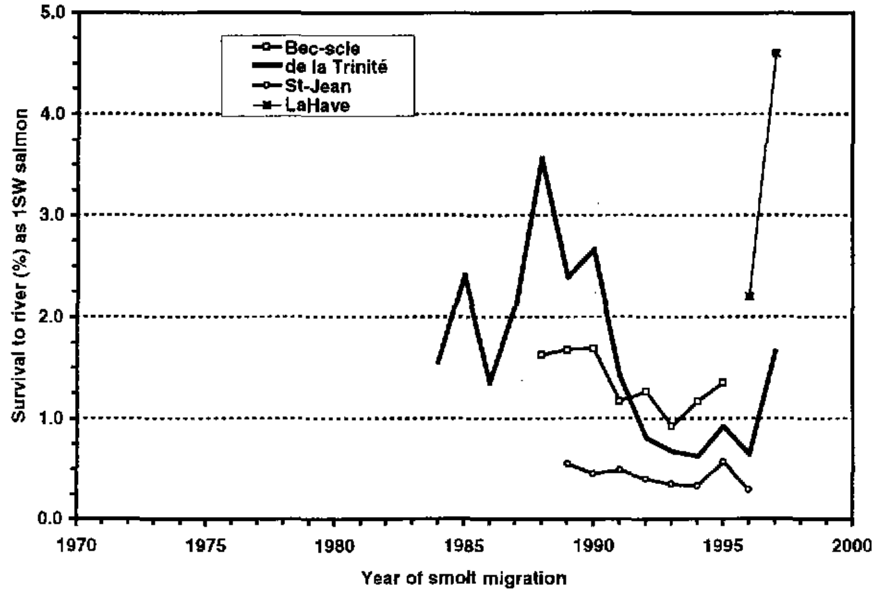


Figure 4.2.5.2. Trends in survival rates (%) of wild smolts as 1SW and 2SW salmon from the rivers in Nova Scotia (LaHave, SFA 21) and Quebec (Saint-Jean, Q2; de la Trinité, Q7; Bec-scie, Q10).



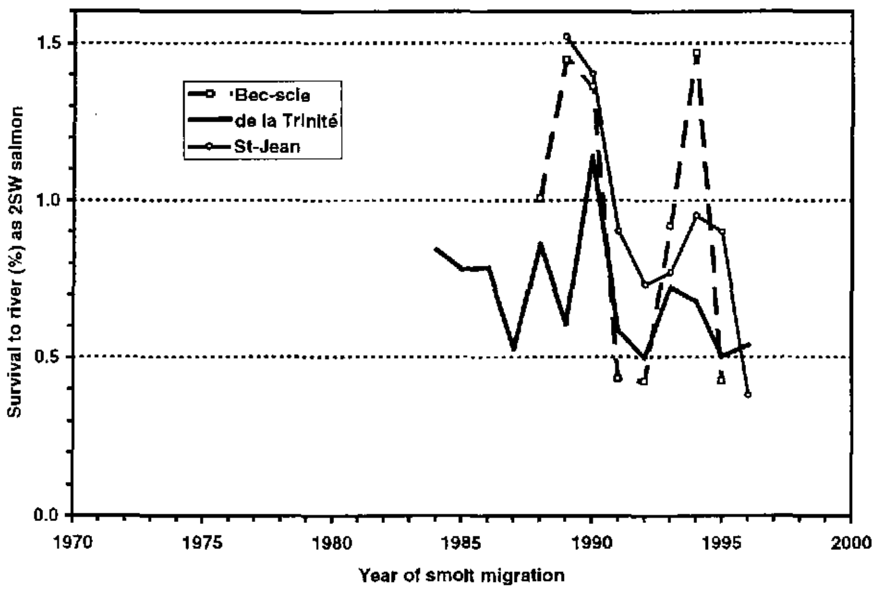
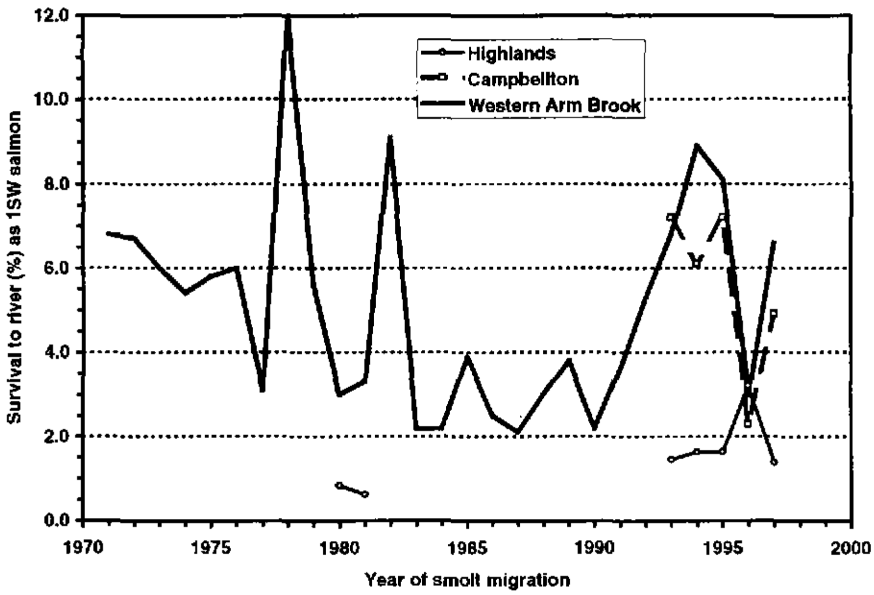


Figure 4.2.5.3. Trends in survival rates (%) of wild smolts as 1SW salmon from the rivers in Newfoundland (Campbellton, SFA 4; NE Trepassey, SFA 9; Rocky, SFA 9; Conne, SFA 10; and Highlands, SFA 13).



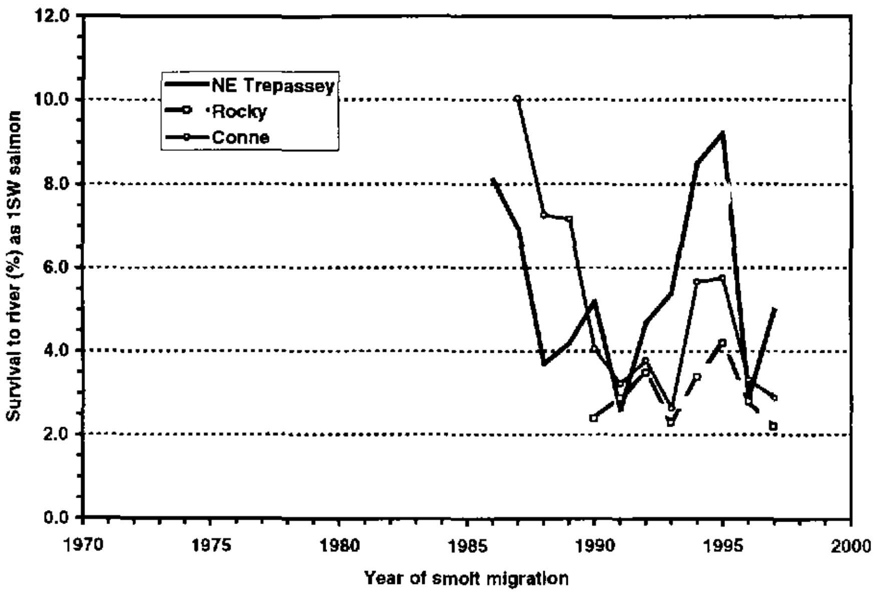
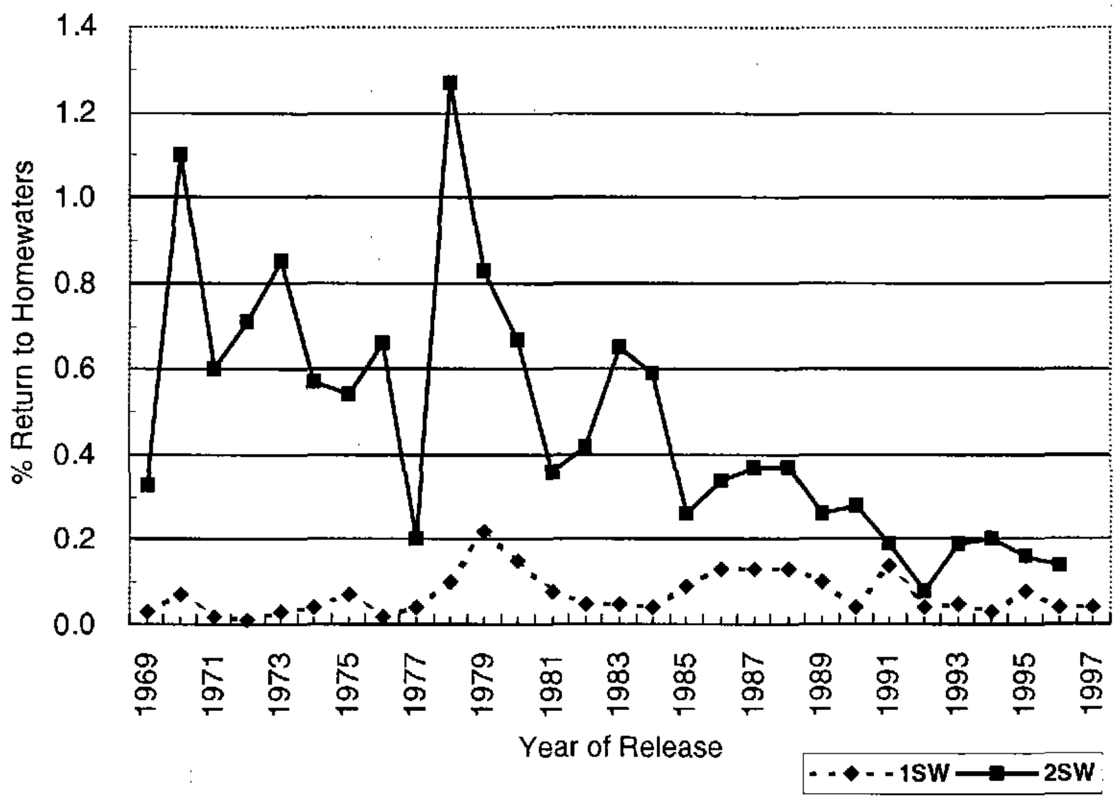


Figure 4.2.5.4. Marine survival of hatchery-reared Atlantic salmon smolts released into the Penobscot River, Maine, USA



5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION AREA

5.1 Description of Fishery at West Greenland

5.1.1 Catch and effort in 1998

At its annual meeting in 1998 the West Greenland Commission of NASCO agreed that the catch at West Greenland should be restricted to that amount used for internal consumption in Greenland, which in the past has been estimated at 20 t. The Greenland authorities subsequently set this amount as total allowable catch.

The fishery was opened on August 16, and the season lasted to the end of the year. The total nominal catches amounted to 11 t (Table 5.1.1.1) of which a substantial part was taken late in the season. The geographical distribution of the nominal catches by Greenland vessels is given in Table 5.1.1.2 for the years 1977-98.

According to the regulations in force all catches, including landings to local markets, privately purchased salmon, and salmon caught by food fishermen, are reported on a daily basis to the Fishery Licence Office. In 1998 no landings to fish plants were permitted. Licences for the salmon fishery have been issued to fishermen fishing for the local markets, hotels, hospitals etc., while fishing for personal use was permitted without licence for residents of Greenland. In total, 321 licences were issued, however only 49 of these reported landings to local markets and private sales. Landings to local markets and salmon caught by food fishermen account for the largest part of the reported amount. Twenty-one persons were identified as food fishermen. Due to the new reporting system, the fishermen being personally responsible for reporting their catches, and due to the extremely scattered fishery a relatively large part of the total catches is considered to remain unreported. The unreported catches are estimated to be approximately 11 t in 1998.

5.1.2 Origin of catches at West Greenland

The Working Group examined the composition and origin of Atlantic salmon caught at West Greenland in 1998 based on discriminant analysis of characteristics from 532 samples from NAFO Div. 1D (August 17 to 21) and 8 samples from Div. 1E (August 12). Within the limited spatial and temporal scope of catch sampling, a randomised sampling design was used to obtain samples from salmon landed by fishing vessels in these areas during the local food fishery. The Working Group noted that samples were collected over a five-day period and only at two sites, one in NAFO Div. 1D and the other in 1E. While the Working Group recognized the difficulties with sampling a fishery with very small catches potentially well spread out in time and space, it was felt that the spatial and temporal distribution of the samples were not adequate to well define the characteristics of salmon in the local consumption fishery. Nevertheless, the samples are valid for defining biological characteristics and proportions of North American/European origin within the time and geographical scale from which they were collected.

Since 1969, discriminant analysis of scale characters from scales taken from salmon caught in the commercial fishery has been used to determine the proportions of the two continental stock groups in this fishery. The technique has proven to be a reliable method for discriminating and identifying salmon caught in this fishery (Lear and Sandeman 1980; Reddin 1986; Reddin *et al.* 1988; Reddin *et al.* 1990). Beginning in 1986, a combined genotypic/phenotypic approach was used whereby a subset of the samples obtained from the Greenland fishery was also sampled for liver and muscle tissue, from which continent of origin was determined using genetic protein polymorphisms (Reddin *et al.* 1990). The scale characters from this subset were used as a database for discriminant analysis to determine the proportions of North American and European salmon in all of the samples from this fishery. In 1995, the genetic technique was changed from protein polymorphisms to nuclear and mitochondrial DNA, which have been shown to provide a more reliable identification to continent of origin. This combined genotypic/phenotypic approach was used again in 1998 to develop a database to determine the proportions of North American and European salmon at Greenland.

Samples of muscle tissue were taken from salmon landed in Nuuk, Greenland during the 1998 sampling programme at Greenland. Samples were identified to continental origin based on microsatellites. In total, there were 121 North American and 35 European samples collected with nuclear DNA (microsatellites) and scale character information. Because of the low number of European samples the discriminant analysis was done by bootstrap. Samples of 35 North American and 35 European were randomly selected from the overall database and were used to classify the 540 samples of unknown origin from the fishery samples. This procedure was repeated 1,000 times outputting the probabilities of group membership which were then averaged to provide the final classifications to North American or European groups. The results of a cross-validation procedure indicated misclassification rates of 16% and error rates of ±1%. This is an acceptable level of error. The method of Pella and Robertson (1979) was used to correct for misclassifications and gave an overall percent North American origin of 79% and European origin of 21 % (Table 5.1.2.1). Continent of origin was also determined in the samples collected for DNA analysis. In these samples, the overall percent North American was 78%, a difference of 1 % from the samples determined by scale analysis.

Applying the results of the above analysis to the reported catch indicated that 8.6 t (3,100 salmon) of North American origin and 2.6 t (900 salmon) of European origin were landed in West Greenland in 1998. This indicates that the numbers of North American salmon landed at West Greenland is reduced by 9,800 (75%) from 1997, while the numbers of European salmon caught is reduced by 7,400 (89 %). The data for 1982 to 1998 (no data for 1993-94) are summarised in Table 5.1.2.2, Figure 5.1.2.1.

The results of DNA analysis have also become available for the years 1995-97. These samples allow for the recalculation of the proportion of North American and European salmon using within year samples of known origin. This is a previous recommendation of the Working Group as it is felt that this type of analysis will allow for better classifications with lower error rates. A similar procedure was followed to that described above for 1998 with a bootstrap procedure used to classify individual salmon. The results of this analysis and comparison of the results from the scale technique gave the following:

	North American %		European %	
Year	**DNA**	**Scales**	**DNA**	**Scales**
1998	78	79	22	21
1997	72	77	28	23
1996	67	73	33	27
1995	89	68	11	32

This comparison of the results from DNA and scales demonstrates the good correspondence between the two techniques. While the two series of North American and European are not directly comparable because the scale samples have much higher sample sizes in some years, the correspondence is best when samples are most similar, i.e. 1996-98. Scale determination of continent of origin in 1995 came from over 2,000 samples while the DNA came from only 122 collected over a much shorter time scale. Also, it indicates that the proportion of North American salmon in the local food fishery in 1998 and previously in the commercial fishery, 1995-97, has been quite high. Because the biological characteristics from the salmon in the above analysis were not immediately available, the Working Group recommended that the new proportions not be considered until next year.

5.1.3 Biological characteristics of the catches

Biological characteristics (length, weight, and age) were recorded from 540 samples of catches from NAFO Div. 1C and 1E in 1998 using the results of discriminant analysis to divide samples into North American and European components. The data for 1998 are compared with those for previous years in Tables 5.1.3.1 to 5.1.3.3.

The downward trend in mean length of both European and North American 1SW salmon since 1969 changed in 1996, as mean lengths increased. From 1996 to 1998 the mean lengths decreased only slightly, being almost equal to the mean lengths observed since 1989 (Table 5.1.3.1).

Distribution of the catch by river age in 1968-98 as determined from scale samples is shown in Table 5.1.3.2. The proportion of the European origin salmon that were river-age three fish increased through 1995-97 to 37.8% in 1997, which is much greater than the overall mean of 17.4%. In 1998 a low proportion of 7.6% of river-age three was observed, the lowest on record. During the last two years the proportions of river-age two of North American origin salmon have declined appreciably from the 1968-95 mean of 36.5% to 20.4%, however with a slight increase from 1997 to 1998.

The sea-age composition of the samples collected from the West Greenland fishery showed a slight decrease in proportion in the North American component of 1SW fish from 1997 (98.0%) to 1998 (96.8%) (Table 5.1.3.3), these values being among the highest in the time series. The proportion of 1SW salmon in the European component in 1998 remained at the high level observed in 1997 (changed from 99.7% to 99.4%). Both components exhibit the highest recorded proportion of 1SW fish since 1969.

5.2 Status of the stocks in the West Greenland area

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

For the Northeast Commission area, a run-reconstruction model was used to update the estimates of pre-fishery abundance of non-maturing 1SW salmon (Table 3.6.2.4). The main contributor to the abundance of the European component of the West Greenland stock complex is non-maturing 1SW salmon from the southern areas of Europe. These stocks appear to have been more volatile, with large fluctuations occurring in the first half of the time series. Over the past 12 years, however, there has been a steady decline in non-maturing 1SW salmon from Southern European stocks.

Conservation limits and the time series of spawners have been provided for 16 rivers in the NEAC area. Only six of the 16 rivers had egg depositions above their conservation limits in the later years. There were no significant trends noted in the spawner attainment over the last ten years for all stocks combined, but a significant trend towards lower egg deposition was noted over the most recent 5-year period (Section 3.4). No category of rivers with an increasing trend could be identified, but 1998 represented an improvement over 1997 for 12 out of the 16 rivers.

In most parts of the NEAC area, marine survival was lower than the previous 5-year mean. However, analysis showed no significant trends in marine survival for the last 5- and 10-year periods. Marine survival rates for six hatchery stocks showed a downward trend in survival to homewaters for 1SW and 2SW salmon for the past 10-year period, but no significant trend was observed for the past 5-year period.

In general, there has been no significant change in smolt production in the Northeast Atlantic. Returns of salmon to most European rivers showed a significant downward trend for the last five years but no trend for the last 10 years.

For the North American Commission area, the North American run-reconstruction model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971-97. The 1997 estimate of pre-fishery abundance of non-maturing 1SW salmon was the lowest on record. Pre-fishery abundance in 1997 has declined by 23% from the 1996 value (Section 4.2.3, Figure 4.2.3.1). In addition to the steady decline in total recruits (both maturing and non-maturing 1SW salmon) over the last ten years, maturing 1SW salmon (grilse) have become an increasingly large percentage of the North American stock complex. This percentage has risen from about 45% at the beginning of the 1970s, to around 70% in 1992-95 to almost 80% in 1997-98.

The estimate of the total number of 2SW salmon returning to Newfoundland rivers and coastal waters of other areas of North America in 1998 is 19% lower than the estimate for 1997 and lower than the average of the previous years (1971-96). It is the lowest observed in the past 10 years and second lowest in the 28 year time series, 1971-98 (Table 4.2.2.2). The estimates of returns are quite variable over the time series with no trends indicated. Returns have declined from a peak of 226,000 in 1980.

In most regions apart from Newfoundland, the returns of 2SW fish in 1998 are near the lower end of the twenty-seven year time series. However, returns of 2SW salmon to Labrador in 1995 and 1996 were the best in the time series. The estimated returns decreased again in 1997. No estimate is given for 1998 from this area, there being no commercial fishery, which was the basis for the return and spawner model for Labrador.

The majority of the USA returns were recorded in the rivers of Maine. The estimated 2SW returns and spawners to USA rivers in 1998 was only 5% below the 1997 estimate, but was 18% and 41% below the previous 5-year and 10-year averages, respectively. Returns to most USA rivers are hatchery-dependent. Spawning escapements remained at low levels (5%) compared to conservation requirements.

Egg depositions exceeded or equalled the specific conservation requirements in 21 of the 71 rivers (30%) that were assessed in Canada and were less than 50% of requirements in 24 other rivers (34%). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where eight of the 12 rivers assessed (67%) had egg depositions that were less than 50% of conservation requirements (Figure 4.2.4.1).

North American salmon stocks remain at low levels relative in the 1970s. The 1SW non-maturing component continues to be depressed with river returns and total production amongst the lowest recorded. In addition, returns in 1998 of maturing 1SW salmon (grilse) to North American rivers were among the lowest in the 28-year time series. This being the case, improvement in 2SW salmon returns and spawners is unlikely in 1999. Only Newfoundland achieved its spawning requirements for 2SW salmon in 1998, where 2SW salmon comprise only a small proportion of salmon production. The next highest was the Gulf of St. Lawrence, where 2SW salmon are a high proportion of production and very important in terms of their contribution to both North American and Greenland fisheries (Section 4.2.6).

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

5.3 Evaluation of the Effects on European and North American Stocks of the West Greenland Management Measures since 1993

There have been two significant changes in the management regime at West Greenland since 1993. First, NASCO adopted a new management model based upon ICES' assessment of the PFA of non-maturing 1SW North American salmon and the spawner escapement requirements for these stocks. This resulted in a substantial reduction in the TAC agreed to by NASCO from 840 t in 1991 to 258 t in 1993, and further reductions in subsequent years. The second change in management was the suspension of fishing in 1993 and 1994 following the agreement of compensation payments by the North Atlantic Salmon Fund. Due to the closure of the fishery in the two years no sampling could be carried out in Greenland, and no information on the biological characteristics was thus obtained. To calculate a possible TAC for those years according to the agreed quota allocation model (Anon. 1993) biological parameters from sampling in 1992 were used (Table 5.3.1). The mean weights, proportions of NA fish, and age correction factors in the Table are those used for projection purposes by the Working Group.

The numbers of fish spared by the closure are shown in Table 5.3.2. The potential catches in the two years of 89 and 137t, respectively, correspond to the TACs calculated in accordance with the quota allocation computation model that was agreed by NASCO at its annual meeting in 1993. For the successive years nominal catch figures are used. The Table shows the number of salmon returning to home waters provided no fishing of the given magnitude took place in Greenland. The biological parameters given in the Table represent the annual sampling data.

The mean number for 1993-98 of potentially returning fish per ton caught at Greenland is calculated to 176 and 131 salmon, respectively.

In the years 1972-92 exploitation rates in Greenland of the North American component of the salmon stock fluctuated between 10 and 45% around an average of 30% (Figure 5.3.1). The management measures in force since 1993 resulted in an average exploitation rate of this component of 13%, about one-third of its previous level, for the period 1995-97, after reopening of the fishery in 1995.

5.4 Changes to the 'Model' Used to Provide Catch Advice and Impacts of Changes on the Calculated Quota

5.4.1 Changes from the 1998 assessment

The models used to predict pre-fishery abundance of the North American non-maturing stock complex and subsequent quota levels for West Greenland were unchanged from the 1998 assessment. The same independent variables used previously were found to provide an improved fit over last year's model. However, some of the input data streams were modified to reflect new information available to the Working Group. These included: improvement of the catch reporting system in the Province of Newfoundland and Labrador by inclusion of catch statistics from Aboriginal fisheries in northern Labrador; and another year of data was added to all data series. Changes from ICES 1998/ACFM:15 in the data used to estimate pre-fisheries abundance resulted in only a very small change in the pre-fishery abundance estimates for most years or no change at all. In addition to the changes discussed above, we also note that the 1998 catch advice of 0 t would not have been different if the 1998 assessment had been done with the revised input data from this year. Although not completely appropriate, an assessment of what the forecast value would have been is 108,700 (Table 5.6.1.1).

5.4.2 Impact of changes on the catch advice

Modifications and improvement to the data streams used to predict pre-fishery abundance would impact the quota in various ways. Modifications to the data that increase the estimated pre-fishery abundance will tend to increase the quota by potentially providing more fish to the surplus portion of the populations. The opposite is also true. Since the updates made in the database resulted in a fit that was only slightly different than in the 1997 assessment, we can conclude no change would have occurred to the 1998 forecast.

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

Sampling of the fishery at West Greenland (Table 5.1.3.3) since 1985 has shown that both European and North American stocks harvested there are primarily (greater than 90%) 1SW non-maturing salmon that would mature as either 2 or 3 SW salmon, if surviving to spawn. Usually less than 1% of the harvest are salmon which have previously spawned and a few percent are 2 SW salmon which would mature as 3SW or older salmon, if surviving to spawn. In 1998, 96.8 of the sampled catch was North American origin and 99.4% of the sampled catch was 1SW salmon of European origin. For this reason, conservation limits defined previously for North American stocks have been limited to this cohort (2SW salmon on their return to homewaters) that may have been at Greenland as 1SW non-maturing fish. These numbers have been documented previously by the Working Group and are revised this year in Section 4.4. From Table 4.4.1, the 2SW spawning requirements of salmon stocks from North America which may be present in the West Greenland Commission Area total 183,852 fish, with 154,653 and 29,199 required in Canadian and USA rivers, respectively.

The Working Group revised their estimates of provisional conservation limits for MSW salmon in Europe based on the methods developed in 1998 (ICES 1998/ACFM:15) and the improvements outlined in Section 3.7.1 (Table 3.7.2.1). The conservation limits were split into 1SW and MSW componennts on the basis of the average age composition of catches in the past ten years. The stocks have also been partitioned into northern and southern groups, and tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern group. The provisional conservation limit for southern European MSW stocks is approximately 470,000 fish (Table 3.7.1.1).

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

5.6.1 Overview of provision of catch advice

The Working Group was asked to advise on catch levels based upon maintaining adequate spawning escapements sufficient to achieve conservation limits. Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed stock fisheries are still relevant. In principle, adjustments in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mean mortality on the contributing populations. However, benefits that might result for particular stocks would be difficult to demonstrate, in the same way that damage to individual stocks are difficult to identify.

In 1993, the Working Group considered how the predictive measures of abundance could be used to give annual catch advice (ICES 1993/Assess:10; Sections 5.3 and 5.4). The aim of management would be to limit catches to a level that would facilitate achieving overall spawning escapement equivalent to the sum of spawning requirements in individual North American and European rivers (when the latter have been defined). In order to achieve the desired level of exploitation for a given level of predicted abundance, a TAC could be fixed or some form of effort adjustment introduced.

The advice for any given year is dependent on obtaining a reliable predictor of the abundance of non-maturing 1SW North American stocks prior to the start of the fishery in Greenland. Gill net fisheries in Greenland and Labrador harvest one-sea-winter (1SW) salmon about one year before they mature and return to spawn in North American rivers. This component is also harvested on their return as 2SW salmon in commercial fisheries in Québec, angling and native fisheries throughout eastern Canada and angling fisheries in the northeastern USA. The fishery in Greenland harvests salmon which would not mature until the following year while the fishery in Labrador (closed in 1998) harvests a mix from the non-maturing component as well as maturing 1SW and MSW salmon. The commercial fishery in Québec harvests maturing 1SW and MSW salmon.

The Working Group has advocated models based on thermal habitat in the northwest Atlantic to forecast pre-fishery abundance in order to provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, the models themselves have varied slightly over the years. The changes have been made to these models in attempts to improve the prediction and add more biological reality. The models of previous years included using the following predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; 1995 -thermal habitat in January, February, and March; and 1996-97 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada.

North American run-reconstruction model
The Working Group has used the North American run-reconstruction model to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West Greenland fishery (See Section 4.2.3). Region-specific estimates of 2SW returns are listed in Table 4.2.2.2. Estimates of 2SW returns prior to 1998 in Labrador are derived from estimated 2SW catches in the fishery using a range of assumptions regarding exploitation rates and origin of the catch. With the closure of the Labrador fishery, 1998 returns were estimated as a proportion of the total for other areas based on historical data.

Update of thermal habitat
The Working Group has been using the relationship between marine habitat, 2SW spawners and pre-fishery abundance to forecast pre-fishery abundance (ICES 1993/Assess:10; 1994/Assess:16; 1995/Assess:14; 1996/Assess:11, 1997/Assess:10; and 1998/ACFM:15). Marine habitat is measured as a relative index of the area suitable for salmon at sea, termed thermal habitat, and was derived from sea surface temperature (SST) data obtained from the National Meteorological Center of the National Ocean & Atmospheric Administration and previously published catch rates for salmon from research vessels fishing in the northwest Atlantic (Reddin *et al.* 1993 and ICES 1995/Assess:14). The SST data were determined by optimally interpolating SSTs from ships of opportunity, earth observation satellites (AVHRR), and sea ice cover data. The area used to determine available salmon habitat encompassed the northwest Atlantic north of 41°N latitude and west of 29°W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland.

Thermal habitat has been updated to include 1998 data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 5.6.1.1 and Figure 5.6.1.1). Available habitat for February was reduced in 1999 below the 1998 level from 1849 to 1741, a decline of approximately 6%. The 1999 February value is still well above the long-term mean.

5.6.2 Forecast model for pre-fishery abundance of North America 2SW salmon

The 1999 forecast of pre-fishery abundance was based on regression analysis to predict the pre-fishery abundance of non-maturing 1SW fish prior to the start of the Greenland fishery. This makes the fourth consecutive year the same model has been used in the forecasting procedure. The basis for the model is two predictor variables: thermal habitat for February (term H2) and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Quebec, term SLNQ) (ICES 1996/Assess:11). This was justified on the basis of studies showing that salmon stocks over wide geographic areas tend to have synchronous survival rates and that the winter period may be the critical stage for post-smolt survival and maturation (Scarnecchia 1989; Reddin and Shearer 1987; Friedland *et al.* 1993; Friedland *et al.* 1998). Consequently, the model used in 1997 was updated to reflect the inclusion of the additional value and the refinement of other parameters to the time series of pre-fishery abundance estimates and then the 1999 pre-fishery abundance was forecasted.

The linear fit to the 1999 model of pre-fishery abundance versus February thermal habitat and lagged spawners (SLNQ) produced a significant relationship between observed and predicted values ($F_{2,17}$ =37.4) and all model parameters were significant at less than the 5% level (Table 5.6.2.1). Individually, the two predictor variables used are also significantly related to pre-fishery abundance (Figure 5.6.2.1).

The contribution of the two variables to the model fit has changed compared to what was previously the case, where SLNQ spawners contributed much less than February habitat. In the current analysis, February habitat accounted for 54% of the total sum of squares by itself but with SLNQ spawners included, the contribution of February habitat was only 15% of the overall variability while the contribution of SNLQ spawners was 28% (Table 5.6.2.1). The jackknife and simulated predicted values for pre-fishery abundance for 1978-99 are shown in Table 5.6.1.1 and Figure 5.6.2.2. The predicted values are shown to fit the observed data quite well except during the period of low abundance in 1978 and in the late 1980s and 90s when abundance was low. The high correlation between the observed and jackknife predictions (r=+0.859) can be seen in Figure 5.6.2.3A. The residual pattern for the model shows a positive relationship with observed values (r=+0.430) and there are low positive residuals at the end of the time series (Figure 5.6.2.3B). The forecasted estimate by simulation of pre-fishery abundance for 1999 using the February thermal habitat and lagged spawner model is about 79,500 at the 50% probability level (Table 5.6.1.1). Using the current model to estimate the 1998 pre-fishery abundance yields a value of 108,890, which is similar to the previously reported value of 113,899. It should be noted that deterministic and simulated forecast values will show differences due to the method of calculation.

The model continues to be influenced primarily by the spawning stock level in the predictive relationship for pre-fishery abundance (Table 5.6.2.1). Thus, the prediction of pre-fishery abundance would be moderated during periods of high levels of habitat and low levels of spawning stock. The alternate case would be an increase in predicted pre-fishery abundance when spawning stocks were high and thermal habitat was low. The former has occurred with the predicted values for 1998 and 1999, as thermal habitat has increased considerably, the predicted pre-fishery abundance in recent years is low due to the large decline in spawners producing them (Figure 5.6.1.1). Two-sea-winter spawners contributing to returns will not improve until the year 2000.

Stochastic Analyses
Although the exact error bounds for the estimates of NN1(i) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods, implemented in the software package SAS (SAS Institute, 1996), were used to generate the probability density function of NN1(i). This was done as a six-step procedure as follows:

1. Annual values (1978–97) of pre-fishery abundance (NN1) were generated assuming a uniform distribution of the minimum to maximum values of input parameters NC1, NC2, and NR2.

2. The parameter values of the regression model of pre-fishery abundance on the February thermal habitat (H2) variable and the lagged spawners (SLNQ) variable were estimated from the data set generated in step 1.

3. A single pre-fishery forecast value for 1988 was obtained by drawing at random from a normal distribution defined by the mean forecast value and the mean square error of the estimate (for a single prediction) from the regression statistics. The normal distribution was used because the error structure of the regression is assumed to be normal.

4. Step 3 was repeated 1,000 times to generate a vector of forecast values from an individual regression fit.

5. Steps 1 to 4 were repeated 1,000 times to generate 1,000,000 predictions (1,000 times 1,000) of pre-fishery abundance. This resampling incorporates the uncertainty of the input parameters (step 1) and the unexplained variance in pre-fishery abundance from the regression (step 4).

6. The probability profile of these stochastic forecasts (in 5% intervals) of the pre-fishery abundance forecast was generated from the vector of pre-fishery abundance forecast values obtained in step 5 (Table 5.6.2.2).

These estimates can be used to quantify the probability that the actual stock is above the relative probabilities of attaining spawning requirements for the stock under different allocation schemes. Managers may also use this information to determine the relative risks borne by the stock (i.e., not meeting spawning requirements) versus the fishery (e.g., reduced short-term catches).

5.6.3 Development of catch options for 1999

Development of catch advice
Atlantic salmon are managed on the basis of ensuring adequate numbers of spawners in individual rivers. A composite spawning requirement for the North American 2SW stock complex was developed by summing the spawning requirements of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawning requirements are provided in (ICES 1996/Assess:11) and in Section 4.4 of this report. With these data, it is possible to compute an allowable harvest. This procedure is unchanged from the previous assessment and is shown in Appendix 7. Previously, NASCO considered all salmon above the conservation requirement as being available for harvest.

Catch advice for 1998
The fishery allocation for West Greenland is for 1SW fisheries in 1999, whereas the allocation for North America can be harvested in fisheries on 1SW salmon in 1999 and/or in fisheries on 2SW salmon in 2000. To achieve spawning requirements, a pool of fish must be set aside prior to fishery allocation in order to meet spawning requirements and allow for natural mortality in the intervening months between the fishery and return to river. In last year's report, a spawning requirement of 183,852 fish was reported for all North American rivers (ICES 1998/ACFM:15). Thus,

205,230 pre-fishery abundance fish must be reserved (183,852/exp(-.01*11)) to ensure achievement of the requirement after natural mortality.

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

Quota computation for the 1999 fishery requires an estimate of pre-fishery abundance [NN1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea-age composition of the total landings [ACF]. Exponential smoothing model forecasts utilising data collected during the 1997 fishery and using interpolated values for 1993 and 1994, with approximate 50% confidence limits, are summarised below.

Parameter	Forecast	Minus 1SE	Plus 1SE
PropNA	0.584	0.503	0.667
WT1SWNA	2.62	2.47	2.78
WT1SWE	2.74	2.56	2.92
ACF	1.118	1.018	1.21

The Working Group recommends that as these parameters have changed in the past, they should be updated with new data from sampling programs to ensure the greatest possible accuracy in the quota calculation. However, the absence of an adequate sample from the 1998 fishery precludes a new analysis.
Greenland quota levels for H2-SLNQ forecast of pre-fishery abundance were computed. The quota values based on this forecast between interquartile limits of the probability density function are presented in Table 5.6.3.1. For the point estimate level and the stochastic regression estimate using NN1, the quota options are all 0 t, regardless of the proportion allocated to West Greenland (FNA) or selection of a probability level between 25% and 75%.

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

The Working Group concludes that it is evident from both the indicators of stock status that the North American stock complex is in tenuous condition. If the forecast is accurate then pre-fishery abundance in 1999 will be lower than any other pre-fishery abundance value previously estimated despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below requirement spawning escapements for 2SW salmon, and the low marine survival rates for some monitored stocks. The increasing advantage associated with each additional spawner in under-seeded river systems makes a strong case for a conservative management strategy.

5.6.4 Risk assessment of catch options

The provision of catch advice in a risk framework involves the incorporation of the uncertainty in all the factors used to develop the catch options. The ranges in the uncertainties of all the factors will result in assessments of differing levels of precision. The precision of the assessment has a potential effect on the risk approach used by managers. One approach considers the catch options relative to a 50% chance of the undesirable event occurring and ignores the uncertainty in the stock assessment. The reliability of the assessment has very different and profound consequences on the catch options for risk-averse compared to risk-prone approaches (Figure 5.6.4.1). In a theoretical example, two assessments provide the same point estimate (50% probability value) but the precisions are very different. Under a risk-prone management approach, the allowed catch would be greater for the imprecise assessment: at a 70% risk level, the advised catch under the precise assessment would be 500 t but the uncertain assessment would provide for a catch of 800 t (Figure 5.6.4.1). The risk-averse management approach would advise for lower catch options for the imprecise assessment: at a 20% risk level, the precise assessment would provide a catch option of about 400 t but for the imprecise assessment, no catch is advised. Under precautionary management principles (Section 2.7), a risk-averse approach would be favoured for imprecise assessments.

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

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

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

The risk analysis plots are calculated for consideration of the 1999 fishery in West Greenland.

Spawner requirement risk analysis
The derivation of the spawning requirement risk plot for North America was similar to the method presented in ICES 1997/Assess:10. Briefly, North America is divided into six stock areas which correspond to the areas used to estimate returns and spawning escapements (Table 4.4.1). The annual variability in the proportion female in each stock area was described in terms of a uniform distribution corresponding to values for each stock area. A total of 1,000 simulations were run for each spawning escapement level. The sex ratio varied independently in each stock for each simulation. The risk plots were expressed as the probability of meeting or exceeding the spawning requirements concurrently in all six stock areas. In addition, plots of the probability of meeting or exceeding lower proportions of the spawning requirements were derived as an indication of the magnitude of under-escapement which would be expected for different levels of escapement to North American rivers.

Under the assumption of equal production from all stock areas (i.e., recruitment in direct proportion to the spawner requirement) just over 200,000 fish should escape to North America as spawners to achieve the spawner requirement in all six stock areas at a 50% probability level. This value is higher than the point estimate for the North American stock complex (183,852 2SW salmon, Table 4.4.1) because it includes the annual variation in proportion female.

Pre-fishery forecast abundance uncertainty
Model fitting and the confidence intervals for the pre-fishery abundance of non-maturing North American origin salmon are described in Section 5.6.2. The required elements for the risk analysis are the distributions of pre-fishery abundance and their associated probabilities (Figure 5.6.4.2).

Uncertainty in the biological characteristics and predicted catches of North American origin salmon
The catch options table (Table 5.6.3.1) is calculated using the probability density function of the pre-fishery abundance forecasts and point estimates for the remaining parameters including: the spawner reserve for North America, proportion of the 1SW catch which would be of North American origin, weight of 1SW North American and European fish, and the age correction factor. The predicted stock characteristics for 1999 and their associated errors were the same as those of 1998 (Section 5.6.3). In the risk analysis, the biological characteristics were modelled assuming a normal distribution with a mean and standard error generated from the exponential smoothing function for the 1998 characteristics (Section 5.6.3). The only exception was for the age correction factor (ACF) for which the lower bound was trimmed to unity. The resultant distributions from 1,000 iterations appropriately represented the initial input parameters with the exception of the ACF distribution (Figure 5.6.4.3). An alternative to the normal error distribution for the ACF parameter was not explored at this meeting.

Using the biological characteristics and the catch options, the total returns to North America after the Greenland fishery were calculated by subtracting the catch of North American 1SW origin salmon from the pre-fishery abundance forecast and discounting for the 11 months of natural mortality between the time of the Greenland fishery and return to homewaters. An example of the distribution of harvest (numbers) of North American origin salmon for a quota of 100 t at West Greenland, which incorporated the uncertainty in the biological characteristics, is shown in the middle panel of Figure 5.6.4.2. The distribution of returns to North America after harvest at Greenland, which incorporates the uncertainty in the pre-fishery abundance forecast and the uncertainty in harvest numbers, is shown in the bottom panel of Figure 5.6.4.2.

Catch options and risk summary for 1999
The final step in the risk analysis of the catch options involves combining the cumulative risk plots from the conservation requirement calculation with the probability distribution of the returns to North America for different catch options. The sum of the products of the cumulative distribution of spawner requirements and the probability distribution of the corresponding returns to North America equals the probability of meeting the conservation requirements. The risk of not meeting the conservation requirement in at least one of the six stock areas is obtained by subtracting from unity the probability of meeting the requirements in all the areas. An analysis of the risk of the severity of the underescapement (for example, the risk of not attaining 50% of the conservation requirement in at least one of the six stock areas) was derived in exactly the same way by substituting the cumulative distribution for a different conservation requirement proportion.

The pre-fishery abundance of salmon in 1999 is expected to be low (Figure 5.6.4.2). There is a high risk (85% probability) that the returns of 2SW salmon to North America in 2000 will be below the conservation requirement in at least one of the six stock areas, even in the absence of any fisheries-induced mortality on this age group in Greenland in 1999 and North America in 2000 (Figure 5.6.4.4). There is a high probability (55% chance) that at least one of the six stock areas will be severely underescaped (by 50%). The risk profile is shallow over the range of catch options illustrated (0 to 1000 t) which reflects the degree of uncertainty in the expected abundance relative to the catch options considered.

The impact of the combined Greenland and North American fisheries must also be considered. The fisheries exploitation rates in North America in the last few years were estimated to be between 0.15 and 0.25 (Section 4.1.4). Assuming that fisheries management in North America in 2000 would be similar to recent years, then it would be expected that, at most, 15 to 25% of the 2SW returns to North America would be removed prior to spawning. Exploitation rates on 2SW salmon have declined in Canada as a result of the closure/reduction of the commercial fisheries and closure of many angling fisheries (Section 4.1). The impact of such a fishing scenario in North America on the salmon returning to homewaters in 2000, in the absence of any fishery at Greenland in 1999, results in a high risk (92%) of not meeting the conservation requirements in at least one of the six stock areas (Figure 5.6.4.4 lower panel). This assumes that salmon will return to each geographic area in proportion to the relative conservation requirements in each area and that the exploitation rates in each of the six stock areas are similar. Although this is not true (see Section 4.1.4, 4.2.2), it was the only scenario considered by the Working Group at this meeting. Under further reduced exploitation rates in North America, there is no less than an 85% chance that conservation requirements will not be met.

The cumulative consequences of fisheries at Greenland (1999) and in North America (2000) on the potential spawning escapements to North American stock areas increases the risk of severe underescapement (50% of conservation requirements) in North America. There is a 55% risk of severe underescapement with no fisheries and the risk rises to greater than 61% at a Greenland catch option of 50 t and exploitation rates between 0.15 and 0.25 in North America (Figure 5.6.4.4). Considering the uncertainty in the assessment of the abundance of North American salmon in West Greenland in 1999, precautionary approach principles in managing the both the Greenland and North American salmon fisheries are advised.

5.7 Critical examination of the Confidence Limits on the Output of, and Assumptions in, the 'Model' Used to Provide Catch Advice

5.7.1 Introduction

This is the second year that the Working Group considered this request. This is because there was neither a "workshop", as proposed in the Terms of Reference adopted at the 1998 Statuatory Meeting (C.Res. 1998/2:4: "Comment on the Report of the Workshop on Peer Review of ICES Salmon Model") nor a report on which to comment. In the absence of same and in recognition of the weaknesses of the existing models the Working Group focused on several initiatives.

Brief description of the 'model'
The Greenland pre-fishery abundance estimate (PFA) is generated as described in previous reports (ICES 1998/ACFM:15, section 5.5). First, the 2SW returns of salmon to specific regions in North America (Labrador, Newfoundland, Québec, Gulf of St. Lawrence, Scotia-Fundy and the USA) are estimated by various means (counting fences, catches, mark-recapture estimates, etc.), and the numbers for returns and catches are entered into the

continental run reconstruction model for North America. This model looks backward in time, after all fisheries and spawning runs are complete, to provide a final estimate of what the prefishery abundances were in the preceding year, and what mortalities resulted from the various fisheries.

To forecast PFAs for the upcoming year, a second model is employed which incorporates terms for February sea surface temperatures (SSTs) in the ocean area where salmon are believed to be residing, and a "lagged spawner" estimate (derived from the run reconstruction model) as a surrogate for the number of smolts which would have previously migrated to sea and which should be contributing to the upcoming year's fishery. Both of these variables have been shown to have a significant relationship with the PFAs, and it is these relationships that permit the working group to provide PFA forecasts.

Confidence limits
Currently, estimates of pre-fishery abundance forecast error in the model to forecast salmon in the Northwest Atlantic are based on a series of empirically derived confidence intervals developed for some, but not all of the variables included in the regression model. The Working Group considered an alternate estimation procedure that utilizes the error structure from the base regression model residuals to develop a bootstrap sample of forecasts. The resultant probability density function from the bootstrap sample was compared to the current assessment results. The bootstrap sample appeared to contain bias, a feature not uncommon for this class of models. The probability density distribution of the bootstrap sample was close to the one generated by both the current re-sampling procedure, and to the confidence interval resulting from the base regression itself. This convergence of techniques was noted by the Working Group; however, it was felt to be premature to apply the bootstrapping approach until this bias could be better understood and a correction procedure appropriate to the data could be developed. The Working Group encourages further work on the bootstrapping approach.

5.7.2 Impact of measurement errors on 1999 PFA forecast

The forecast of the North American PFA is based on a two variable linear model: the lagged spawners and the February habitat. Twenty years of data are available to fit the model (1978 to 1997) and a prediction is derived for 1999 based on the observations of the independent variables collected for that year. This linear regression can be treated under a Bayesian approach (Gelman *et al.* 1995). The posterior predictive distribution of the 1999 PFA forecast is a Student-t centered on the point estimates that would be obtained under classical least squares fitting. The posterior uncertainty of this prediction is shown in Figure 5.7.2.1. Negative values are excluded as *a priori* impossibilities.

Measurement errors can have disruptive effects on model fitting and on the uncertainty of the predictions. An analysis was conducted to assess the potential effect of measurement errors on the PFA and the lagged spawners, because both are derived from estimation procedures and are not readily observable. In contrast, the habitat variable was regarded as an actual measure without errors, because it is derived from a collection of "field" temperature measurements. Accounting for the measurement errors reflects that the information introduced in the PFA estimation procedure (the first twenty years of data plus the independent variables for 1999) are less informative than the point estimates of the variables would tend to suggest. As a consequence, the uncertainty of the 1999 prediction should increase.

Accounting for measurement errors under the Bayesian framework is equivalent to generating data sets under a probabilistic description of their error structure and averaging the resulting posterior distributions of interest (the 1999 PFA prediction) over all possible data sets. This can be easily carried out by Monte-Carlo simulation. For the purpose of the analysis presented here, measurement errors were assumed to be independent between years and between variables. The structure of the errors was defined as triangular distributions with a mode located at the point estimates currently used and ranging between a minimum and maximum representing -/+ X% of the point estimates. Three levels of error were considered: -/+ 10%, -/+ 25% and -/+ 50%. The same level of error was assigned to both the PFA and the lagged spawners as a preliminary approach. A total of 5,000 simulations were conducted for each level of error. It should be noted that accounting for measurement errors is different from considering autocorrelation in the data series which was not addressed in this analysis.

The results are summarized in Figure 5.7.2.1. Measurement errors can have major disruptive effects on the 1999 PFA forecast. As measurement errors increase, not only does the uncertainty of the prediction increase but also the most probable value. This is because the data are less informative about the variability in PFA than is assumed when no measurement errors are taken into account. As the predictive variables become less informative about PFA, the most probable value of the PFA approaches the mean. In a least squares regression sense, the slope of the relationship would decrease and the intercept would become more significant. If the independent variables were above their average level, which would lead to a high PFA forecast, the effect of the inclusion of measurement errors would be opposite. In both cases the accounting for measurement errors displaces the mode toward the average of the PFA series with increased uncertainty.

Part of the range of values of the PFA given in Figure 5.7.2.1 might be considered impossible given complimentary information available, such as observations of returns in homewaters over the last years. This can readily be introduced in the Bayesian analysis by means of a prior distribution of the PFA which would put a null probability *a priori* on implausible values. Even within a narrower range of possible values, it is impossible to assign contrasting levels of credibility to the PFA predicted values.

1. It is recommended that the extent of the measurement error inherent in the run-reconstruction model should be estimated to describe the potential bias in the mode and the description of uncertainty associated with the forecast.
2. The inclusion of the measurement error in the forecast model increases the uncertainty of the forecast and under increased uncertainty, alternative risk levels to the 50% point should be considered, consistent with the precautionary approach.
3. Other indices of adult salmon abundance should be examined and used as prior information to constrain the plausible range of abundance levels.
4. Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses,) to provide some index of plausibility of the quantitative forecasts.

5.7.3 Alternative models for characterizing salmon abundance

Two explanatory variables are presently used to model the prefishery abundance (PFA) of non-maturing 1SW salmon in the Northwest Atlantic before the Greenland fishery: spawning stock and environment (Section 5.6). The coefficients of the explanatory variables indicate that PFA is positively correlated with both the spawning stock size and the environmental signal. PFA would be expected to decline as spawning stock and/or environment declines. In 1996 to 1998, PFA has declined, consistent with the decline in spawning stock but despite an improved environmental signal.

The spawning stock variable used in the model excludes the spawners from the Gulf and USA and therefore only considers part of the spawners contributing to PFA in the Northwest Atlantic. Also, the spawning stock variable only considers 2SW spawners while other age groups (1SW, 3SW and previous spawners) also contribute to egg depositions and undoubtedly salmon maturing as 2SW fish. Inclusion of all the spawning stock component from eastern North America is not a significant explanatory variable of PFA variability. The Gulf spawning stock has remained well above its area conservation requirement during the 1990s in contrast to other areas where spawning stock has declined.

A more useful variable for characterizing salmon abundance in the ocean would be an estimate of the annual smolt output from rivers of North America. If smolt output is known, factors determining mortality at sea could be explored directly using a standard survival relationship (Ricker 1975):

$$N_t/N_o = e^{-Z}$$

where N_t = population size at time t (for example PFA before West Greenland fishery)
N_o = population size at an earlier time (for example smolt output)
Z = instantaneous mortality rate

When stocks are exploited in fisheries, Z can be described in terms of the mortality due to the fishery (F) and due to natural mortality (M), i.e. $Z = F + M$. In the absence of fisheries (as is almost the case in the Northwest Atlantic for Atlantic salmon), Z is essentially equal to M.

Some of the factors contributing to natural mortality could be characterized by an environment signal (as in the currently used model) and predation (Section 2.4.6). The survival model with these two variables could be written (Hilborn and Walters 1992):

$$N_t/N_o = e^{-(\alpha Pred + \beta Env + c)}$$

where N_t and N_o are as previously defined
Pred = variable measuring predator abundance (absolute or relative)
Env = variable describing the environmental factor (absolute or relative)
α = coefficient of the relative instantaneous mortality per unit predator
β = coefficient of the relative instantaneous mortality per unit of environment

c = constant proportional mortality

This formulation differs from the model currently used because the variables are considered to have a proportional effect on instantaneous mortality. For both variables, the relative instantaneous mortality is constant and independent of size of the salmon. But overall mortality is a function of relative levels of the variables. For example, as relative predator abundance increases, the overall mortality increases. But the relative change in mortality rates would decline as the variables increase. The relative change in mortality is always less than the relative change in the variables. In the absence of any predator or environment effect modifying survival, then survival is proportional to abundance.

The coefficients of the parameters could be estimated under a linear model assumption after transformation:

$$\ln(N_t/N_o) = -(c + \alpha Pred + \beta Env) + \varepsilon$$

where ln( ) refers to a natural logarithm transformation

ε is the residual error, assumed $N(0, \sigma)$

A preliminary exploration of this model was undertaken using the data derived in other sections of the report. Since there are no estimates of total smolt production for the North American Commission area, a relative index of smolt production was determined using the smolt counts and juvenile surveys from the rivers in eastern Canada and USA (Section 4.2.1). Since 1971, the relative index of smolt production from eastern North America has increased by a factor of three with relative smolt production generally constant since 1986 (Figure 4.2.1.7).

PFA was considered as the sum of the maturing and non-maturing components to eastern North America (Table 4.2.3.3, 4.2.3.4). The predator index was the population size of harp seals in the Northwest Atlantic (Section 2.4.10). The environmental variable was the February habitat index in the Northwest Atlantic as described in Section 5.6.1 (Table 5.6.1.1).

PFA abundance is negatively associated with the index of relative smolt production from North America (Figure 5.7.3.1). Both February habitat index and predators are significantly correlated with the relative survival: habitat is positively associated whereas predators are negatively correlated (Figure 5.7.3.2). When both the habitat and predator variables are included, the habitat variable becomes non-significant ($P > 0.5$). The year variable is also negatively correlated with the relative survival which should not be surprising since both the habitat index and the predator index are also significantly correlated whereas the relative smolt index is positively correlated (Figure 5.7.3.2). The absence of contrasting states in the variables examined inhibits the testing of alternative hypotheses to describe the observed declines in Atlantic salmon survival rates.

From this preliminary analysis, it can be concluded that:

1. the increased relative smolt production from North America has been insufficient to compensate for the increased mortality factors on Atlantic salmon;
2. the observed decline in relative survival associated with the increased relative smolt production is not sufficient to draw any conclusions on the nature of the mortality function, i.e., density dependent or density independent; and
3. in the absence of evidence for density-dependent mortality of Atlantic salmon at sea, the objective of achieving conservation in all salmon rivers of eastern North America remains valid.

5.8 Data Deficiencies and Research Needs in the WGC area

5.8.1 Progress on data deficiencies and research needs in the WGC area

Some progress was made on the recommendations for resolving data deficiencies and research requirements made in the 1998 report. First, the catch reporting system was improved for records of local sales and food fishermen over previous years. In order to improve the recording of local sales and food catches, individual fishermen were required to directly report their catches. However, in spite of these improvements, a relatively high proportion of the total food fishery catch is thought to be have been unreported. Second, as the food fishery was spatially and temporally more diverse than the commercial fishery had been, the sampling programme in 1998 did not adequately cover the landings. The Working Group felt that further improvements in both catch statistics and sampling are required and accordingly reiterates last year's recommendations.

5.8.2 Recommendations for 1999

1. The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme, which occurred in 1995-98, be continued and improved to spatially and temporally cover as much of the landings as possible.

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

3. The catch options for the West Greenland fishery are based almost entirely upon data derived from North American stocks (with the current exclusion of Labrador, see Section 4.6). In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible.

4. The bootstrapping approach to improve confidence intervals for the pre-fishery abundance forecast error estimates shows promise, and should be explored further.

5. The Working Group recommends that an evaluation be conducted on the present reliability of the PFA estimate. An initial approach is to determine what fraction of the PFA estimate is directly based on catches and assessed returns (hard data), and what fraction results from less certain information such as scaling factors for potential productive habitat.

6. It is recommended that the extent of the measurement error inherent in the run-reconstruction model should be estimated to describe the potential bias in the mode and the description of uncertainty associated with the forecast.

7. The inclusion of measurement error in the forecast model increases the uncertainty of the forecast and under increased uncertainty, alternative risk levels to the 50% point should be considered, consistent with the precautionary approach.

8. Other indices of adult salmon abundance should be examined and used as prior information to constrain the plausible range of abundance levels.

9. Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses) to provide some index of plausibility of the quantitative forecasts.

Table 5.1.1.1. Nominal catches of salmon, West Greenland 1960-98 (metric tons round fresh weight).

Year	Norway	Faroes	Sweden	Denmark	Greenland[1]	Total	Quota[2]
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1539	1539	-
1965	-[3]	36	-	-	825	861	-
1966	32	87	-	-	1251	1370	-
1967	78	155	-	85	1283	1601	-
1968	138	134	4	272	579	1127	-
1969	250	215	30	355	1360	2210	-
1970	270	259	8	358	1244	2146[4]	-
1971	340	255	-	645	1449	2689	-
1972	158	144	-	401	1410	2113	1100
1973	200	171	-	385	1585	2341	1100
1974	140	110	-	505	1162	1917	1191
1975	217	260	-	382	1171	2030	1191
1976	-	-	-	-	1175	1175	1191
1977	-	-	-	-	1420	1420	1191
1978	-	-	-	-	984	984	1191
1979	-	-	-	-	1395	1395	1191
1980	-	-	-	-	1194	1194	1191
1981	-	-	-	-	1264	1264	1265[6]
1982	-	-	-	-	1077	1077	1253[6]
1983	-	-	-	-	310	310	1191
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	-[7]
1989	-	-	-	-	337	337	-[7]
1990	-	-	-	-	274	274	-[7]
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237	237	258[8]
1993	-	-	-	-	0[5]	0[5]	89[9]
1994	-	-	-	-	0[5]	0[5]	137[9]
1995	-	-	-	-	83	83	77
1996	-	-	-	-	92	92	174[8]
1997	-	-	-	-	58	58	57
1998	-	-	-	-	11	11	20[10]

[1] For Greenland vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non-Greenland catches 1969-75 were taken with drift nets.

[2] Quota figures apply to Greenland fishery only.

[3] Figures not available, but catch is known to be less than Faroese catch.

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

[5] The fishery was suspended.

[6] Quota corresponding to specific opening dates of the fishery.

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

[8] Set by Greenland authorities.

[9] Quotas were bought out.

[10] Fishery restricted to catches used for internal consumption in Greenland.

Table 5.1.1.2. Distribution of nominal catches (metric tons), Greenland vessels.

Year	NAFO Division							Total	East	Total
	1A	1B	1C	1D	1E	1F	NK	Westgrl.	Greenland 6	**Greenland**
1977	201	393	336	207	237	46	-	1420	6	1426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1395	+	1395
1980	52	275	404	231	158	74	-	1194	+	1194
1981	105	403	348	203	153	32	20	1264	+	1264
1982	111	330	239	136	167	76	18	1077	+	1077
1983	14	77	93	41	55	30	-	310	+	310
1984	33	116	64	4	43	32	5	297	+	297
1985	85	124	198	207	147	103	-	864	7	871
1986	46	73	128	203	233	277	-	960	19	979
1987	48	114	229	205	261	109	-	966	+	966
1988	24	100	213	191	198	167	-	893	4	897
1989	9	28	81	73	75	71	-	337	-	337
1990	4	20	132	54	16	48	-	274	-	274
1991	12	36	120	38	108	158	-	472	4	476
1992	-	4	23	5	75	130	-	237	5	242
1993[1]	-	-	-	-	-	-	-	-	-	-
1994[1]	-	-	-	-	-	-	-	-	-	-
1995	+	10	28	17	22	5	-	83	2	85
1996	+	+	50	8	23	10	-	92	+	92
1997	1	5	15	4	16	17	-	58	1	59
1998	1	2	2	4	1	2	-	11	-	11

[1]) The fishery was suspended
+) Small catches <0.5 t
-) No commercial landings

Table 5.1.2.1. Size of biological samples and percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82), from commercial samples (1978-92 and 1995-97), and from local consumption samples (1998).

		Sample size		Continent of origin (%)			
Source	Year	Length	Scales	NA	(95%CI)[1]	E	(95%CI)[1]
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(75,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3488	3488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977	-	-	45	-	55	-
	1978[2]	606	606	38	(41,34)	62	(66,59)
	1978[3]	49	49	55	(69,41)	45	(59,31)
	1979	328	328	47	(52,41)	53	(59,48)
	1980	617	617	58	(62,54)	42	(46,38)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1653	1653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4570	1930	59	(61,58)	41	(42,39)
	1982	1949	414	62	(64,60)	38	(40,36)
	1983	4896	1815	40	(41,38)	60	(62,59)
	1984	7282	2720	50	(53,47)	50	(53,47)
	1985	13272	2917	50	(53,46)	50	(54,47)
	1986	20394	3509	57	(66,48)	43	(52,34)
	1987	13425	2960	59	(63,54)	41	(46,37)
	1988	11047	2562	43	(49,38)	57	(62,51)
	1989	9366	2227	56	(60,52)	44	(48,40)
	1990	4897	1208	75	(79,70)	25	(30,21)
	1991	5005	1347	65	(69,61)	35	(39,31)
	1992	6348	1648	54	(57,50)	46	(50,43)
	1995	2045	2045	65	(69,61)	35	(39,31)
	1996	3341	1297	55	(67,42)	45	(58,33)
	1997	794	282	60	(66,55)	40	(45,34)
Local cons.	1998	540	406	79	(84,73)	21	(27,16)

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

[2] During Fishery.

[3] Research samples after fishery closed.

Table 5.1.2.2. The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-98. Numbers are rounded to the nearest hundred fish.

Year	Proportion weighted by catch in number		Numbers of Salmon caught	
	NA	E	NA	E
1982	57	43	192200	143800
1983	40	60	39500	60500
1984	54	46	48800	41200
1985	47	53	143500	161500
1986	59	41	188300	131900
1987	59	41	171900	126400
1988	43	57	125500	168800
1989	55	45	65000	52700
1990	74	26	62400	21700
1991	63	37	111700	65400
1992	45	55	46900	38500
1993	-	-	-	-
1994	-	-	-	-
1995	65	35	20700	11200
1996	53	47	16800	15200
1997	61	39	13000	8300
1998	78	22	3100	900

Table 5.1.3.1. Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-92 and 1995-98. Fork length (cm); whole weight (kg). NA = North America; E = Europe.

	Whole weight (kg)									Fork length (cm)					
	Sea age & origin									Sea age & origin					
	1SW		2SW		PS		All sea ages		TOTAL	1SW		2SW		PS	
Year	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.69	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.42	2.54	5.82	6.23	5.15	5.09	2.57	2.79	2.65	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.54	2.66	6.49	6.01	4.09	5.28	2.86	2.74	2.81	62.3	63.2	83.4	81.1	77.4	82.7
1995	2.42	2.62	6.45	5.30	3.80	3.96	2.51	2.70	2.58	61.2	62.6	82.1	78.5	71.5	72.8
1996	2.67	2.75	6.56	6.20	5.19	4.94	2.94	2.83	2.88	63.0	63.4	81.3	81.6	78.2	77.0
1997	2.62	2.74	7.49	-	5.63	3.55	2.70	2.74	2.72	62.6	63.1	85.3	-	84.2	69.0
1998	2.72	2.83	6.44	-	3.28	4.77	2.76	2.84	2.78	62.0	62.7	84.0	-	66.3	76.0

Table 5.1.3.2. River age distribution (%) for all North American and European origin salmon caught at West Greenland, 1968-92 and 1995-98.

	River age							
Year	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0.0
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0.0
1992	6.7	36.7	34.1	19.1	3.2	0.3	0.0	0.0
1995	5.3	29.1	35.2	20.2	8.4	1.9	0.0	0.0
1996	7.4	23.8	35.2	21.9	10.7	0.9	0.2	0.0
1997	2.0	18.7	45.3	16.7	16.0	1.3	0.0	0.0
1998	0.4	20.4	50.4	22.9	2.9	2.5	0.4	0.0
Mean	4.3	36.2	35.9	16.2	6.1	1.1	0.1	0.0
European								
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0
1988	18.4	61.6	17.3	2.3	0.5	0.0	0.0	0.0
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0
1990	15.9	56.3	23.0	4.4	0.2	0.2	0.0	0.0
1991	20.9	47.4	26.3	4.2	1.2	0.0	0.0	0.0
1992	11.8	38.2	42.8	6.5	0.6	0.0	0.0	0.0
1995	14.7	54.9	27.5	3.0	0.0	0.0	0.0	0.0
1996	7.6	49.2	31.5	10.2	1.3	0.2	0.0	0.0
1997	3.6	55.0	37.8	2.7	0.9	0.0	0.0	0.0
1998	28.6	60.0	7.6	2.9	0.0	1.0	0.0	0.0
Mean	19.6	59.8	17.4	2.9	0.4	0.0	0.0	0.0

Table 5.1.3.3. Sea-age composition (%) of samples from commercial catches at West Greenland, 1985-98.

Year	North American			European		
	1SW	2SW	Previous Spawners	1SW	2SW	Previous spawners
1985	92.5	7.2	0.3	95.0	4.7	0.4
1986	95.1	3.9	1.0	97.5	1.9	0.6
1987	96.3	2.3	1.4	98.0	1.7	0.3
1988	96.7	2.0	1.2	98.1	1.3	0.5
1989	92.3	5.2	2.4	95.5	3.8	0.6
1990	95.7	3.4	0.9	96.3	3.0	0.7
1991	95.6	4.1	0.4	93.4	6.5	0.2
1992	91.9	8.0	0.1	97.5	2.1	0.4
1993	-	-	-	-	-	-
1994	-	-	-	-	-	-
1995	97.3	1.3	1.4	96.0	2.5	1.6
1996	92.1	5.4	2.5	97.1	1.7	1.2
1997	98.0	0.9	1.1	99.7	0.5	0.8
1998[1]	96.8	0.5	2.7	99.4	0.0	0.6

[1] Catches for local consumption only.

Table 5.3.1 Parameters used for calculating TACs for Greenland according to the salmon quota allocation computation model, agreed by NASCO in 1993.

	1993	1994	1995	1996	1997	1998
NA spawning target:	193741	193741	186486	180495	180495	183852
M per month:	0.01	0.01	0.01	0.01	0.01	0.01
No. of months	11	11	11	11	11	11
M (in migration period):	0.11	0.11	0.11	0.11	0.11	0.11
Sp. target reserve (NA):	216269	216269	208170	201483	201483	205230
Pre-fishery abundance (PFA):	257828	280250	244000	190000	196858	113899
f_NA:	0.4	0.4	0.4	0.4	0.4	0.4
WT1SWNA:	2.525	2.525	2.525	2.420	2.647	2.623
WT1SWE:	2.660	2.660	2.660	2.620	2.750	2.740
PropNA:	0.540	0.540	0.540	0.592	0.557	0.584
ACF:	1.121	1.121	1.121	1.133	1.133	1.118
Max allow. harvest (MAH), NA-fish:	41559	63981	35830	-11483	-4625	-91331
Surplus for harvest in Grl. of NA1SW:	16624	25592	14332	-4593	-1850	-36532
Surplus of harvest in Grl. of E1SW:	14161	21801	12209	-3162	-1472	-25980
TAC in Greenland (numbers):	**30785**	**47393**	**26541**	**0**	**0**	**0**
TAC (tons):	**89**	**137**	**77**	**0**	**0**	**0**

Table 5.3.2 Calculated numbers of salmon returning to home waters provided no fishing took place in Greenland. Average number of potentially returning salmon per ton caught in Greenland is also given.

Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Catch at Greenland (tons):	89	137	83	92	58	11
Proportion of NA fish in catch (PropNA):	0.540	0.540	0.650	0.550	0.600	0.790
Proportion of EU fish in catch (PropEU):	0.460	0.460	0.350	0.450	0.400	0.210
Mean weight, NA fish, all sea ages (kg):	2.860	2.860	2.510	2.940	2.700	2.760
Mean weight, EU fish, all sea ages (kg):	2.740	2.740	2.700	2.830	2.740	2.840
Mean weight of all sea ages (NA+EU fish):	2.805	2.805	2.577	2.891	2.716	2.777
Proportion of 1SW fish in catch:	0.919	0.919	0.969	0.921	0.980	0.968
Catch of 1SW NA fish:	15492	23850	20828	15851	12631	3048
Catch of 1SW EU fish:	13774	21206	10426	13473	8298	787
Natural mortality during migration:	0.10	0.10	0.10	0.10	0.10	0.10
Additional fish if no fishery at Greenland:						
2SW fish returning to NA (numbers):	**14017**	**21580**	**18846**	**14343**	**11429**	**2758**
2SW fish returning to EU (numbers):	**12464**	**19188**	**9434**	**12191**	**7508**	**712**

Average number of salmon potentially returning to home waters per ton caught in Greenland:	
2SW fish returning to NA (numbers per ton, average of 1993-1998):	**176**
2SW fish returning to EU (numbers per ton, average of 1993-1998):	**131**

Table 5.6.1.1. Pre-Fishery abundance estimates, thermal habitat index for February based on sea surface temperature, lagged spawner index for North America excluding Gulf and US spawners (SNLQ), results of a jackknife cross-validation of the forecast model, and simulated forecasts.

	Pre-Fishery Abundance			Thermal Habitat	Lagged Spawners			Jackknife Cross-Validation	
Year	Low	High	Mid	February	Low	High	Mid	Prediction	Residuals
1971	578,955	726,699	652,827	2,011					
1972	557,789	733,183	645,486	1,990					
1973	672,662	867,737	770,200	1,708					
1974	623,993	800,812	712,403	1,862					
1975	710,244	904,537	807,391	1,827					
1976	610,837	826,772	718,805	1,676					
1977	506,934	667,717	587,326	1,915					
1978	288,809	371,345	330,077	1,951	35,441	81,978	58,710	495,467	-165,390
1979	630,107	831,343	730,725	2,058	42,640	94,840	68,740	602,969	127,755
1980	549,070	729,314	639,192	1,823	43,222	97,219	70,221	568,465	70,726
1981	527,385	684,484	605,935	1,912	43,287	97,645	70,466	612,907	-6,972
1982	439,899	567,062	503,481	1,703	43,393	98,396	70,895	553,105	-49,624
1983	236,421	337,375	286,898	1,416	40,425	91,991	66,208	396,013	-109,115
1984	245,428	347,472	296,450	1,257	37,658	84,098	60,878	237,111	59,338
1985	399,013	538,538	468,776	1,410	39,305	83,265	61,285	267,981	200,794
1986	435,092	575,040	505,066	1,688	39,891	89,038	64,464	442,924	62,141
1987	398,157	527,749	462,953	1,627	36,298	87,453	61,875	383,103	79,849
1988	317,617	423,435	370,526	1,698	37,061	83,602	60,331	389,013	-18,487
1989	241,038	345,076	293,057	1,642	41,944	86,394	64,169	442,898	-149,841
1990	218,194	295,743	256,969	1,503	40,952	81,826	61,389	342,161	-85,192
1991	249,702	348,471	299,086	1,357	37,575	73,152	55,364	185,746	113,339
1992	143,913	215,597	179,755	1,381	35,591	71,572	53,582	179,741	13
1993	95,337	178,931	137,134	1,252	38,381	79,473	58,927	228,371	-91,237
1994	109,491	212,937	161,214	1,329	38,395	75,957	57,176	220,273	-59,059
1995	117,379	195,601	156,490	1,311	36,738	70,104	53,421	153,143	3,346
1996	97,740	155,435	126,588	1,470	33,488	61,737	47,612	120,414	6,173
1997	69,710	126,088	97,899	1,594	29,823	55,178	42,500	81,919	15,979
1998				1,849	25,593	50,477	38,035	*99,956* 1	
1999				1,741	25,587	52,506	39,047	*79,450* 1	

1. Simulated forecast values.

Table 5.6.2.1 Results of analysis of prefishery abundance (NN1) on February thermal habitat (H2) and North American spawners (SLNQ), 1978-97.

General Linear Models Procedure

Dependent Variable: NN1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	530671065624	265335532812	37.44	0.0001
Error	17	120469105657	7086417980		
Corrected Total	19	651140171281			

R-Square	C.V.	Root MSE	NN1 Mean
0.814987	24.37104	84180.865	345413.55

Source	DF	Type I SS	Mean Square	F Value	Pr > F
H2	1	351184699546	351184699546	49.56	0.0001
G_US	1	179486366078	179486366078	25.33	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
H2	1	97115957923	97115957923	13.70	0.0018
G_US	1	179486366078	179486366078	25.33	0.0001

Regression statistics

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-1087783.498	-6.50	0.0001	167284.3934
H2	341.585	3.70	0.0018	92.2713
G_US	14.852	5.03	0.0001	2.9511

Summary of Stepwise Procedure for Dependent Variable NN1

Step	Variable Entered	Variable Removed	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	G_US		1	0.6658	0.6658	14.7045	35.8664	0.0001
2	H2		2	0.1491	0.8150	3.0000	13.7045	0.0018

Table 5.6.2.2 Estimate of pre-fishery abundance in 1999. forecasted by H2-SNLQ regression model of probability levels between 25 and 75%.

Cumulative Density Function %	Forecast
25	795
30	18,398
35	34,579
40	49,917
45	64,810
50	79,450
55	94,097
60	108,959
65	124,344
70	140,537
75	158,302

Table 5.6.3.1 Quota options (mt) for 1999 at West Greenland based on H2-SNLQ regression forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0

Sp. res =	205,230
Prop NA =	0.5844
WT1SWNA =	2.623
WT1SWE =	2.740
ACF =	1.118

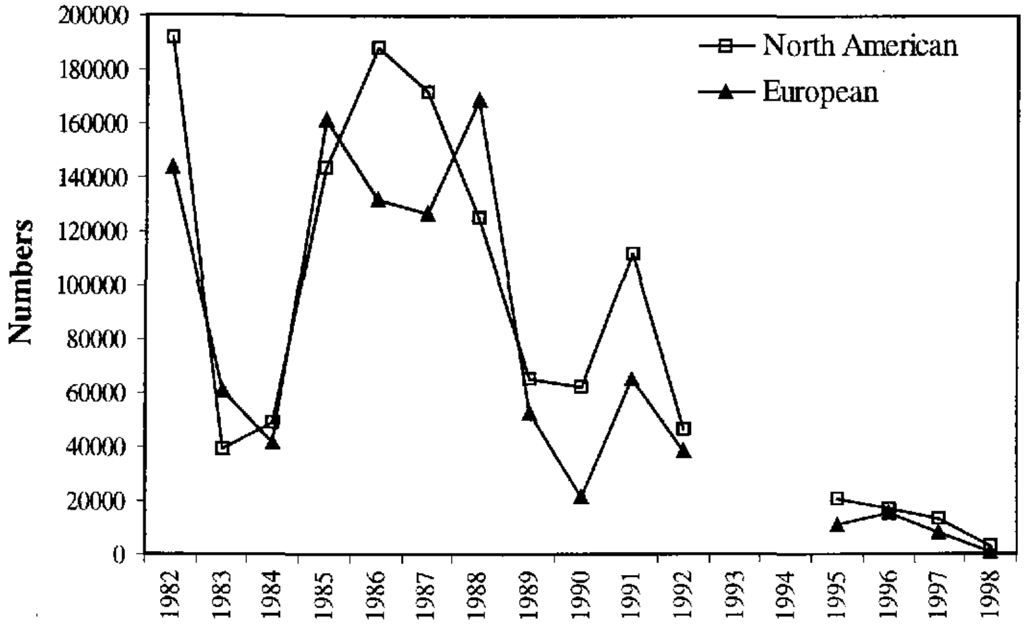


Figure 5.1.2.1 Numbers of North American and European Atlantic salmon caught at West Greenland 1982-92 and 1995-98.

Figure 5.3.1. Extant exploitation of the non-maturing component of North American salmon as 1SW salmon in North America and Greenland from the run reconstruction statistics.

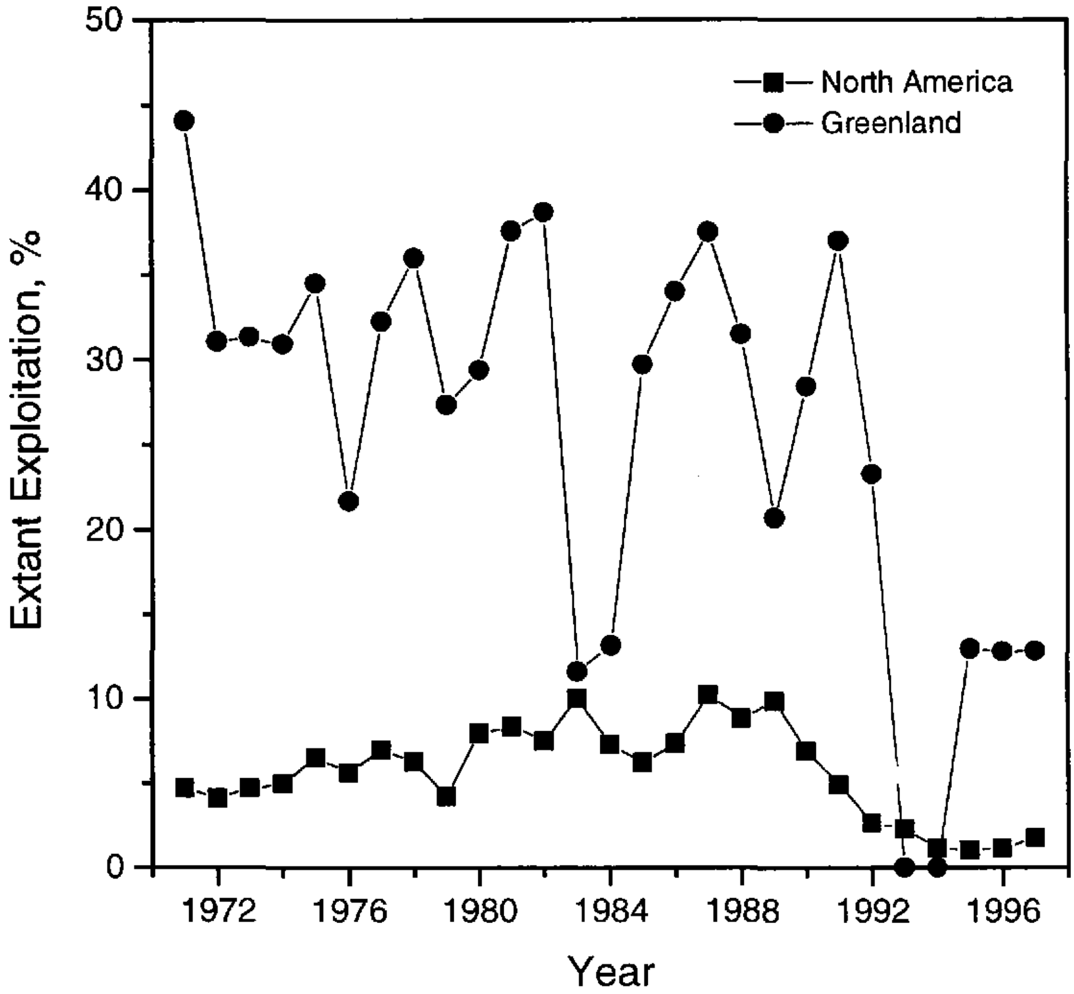


Figure 5.6.1.1 Thermal habitat index for February and lagged spawners (SNLQ).

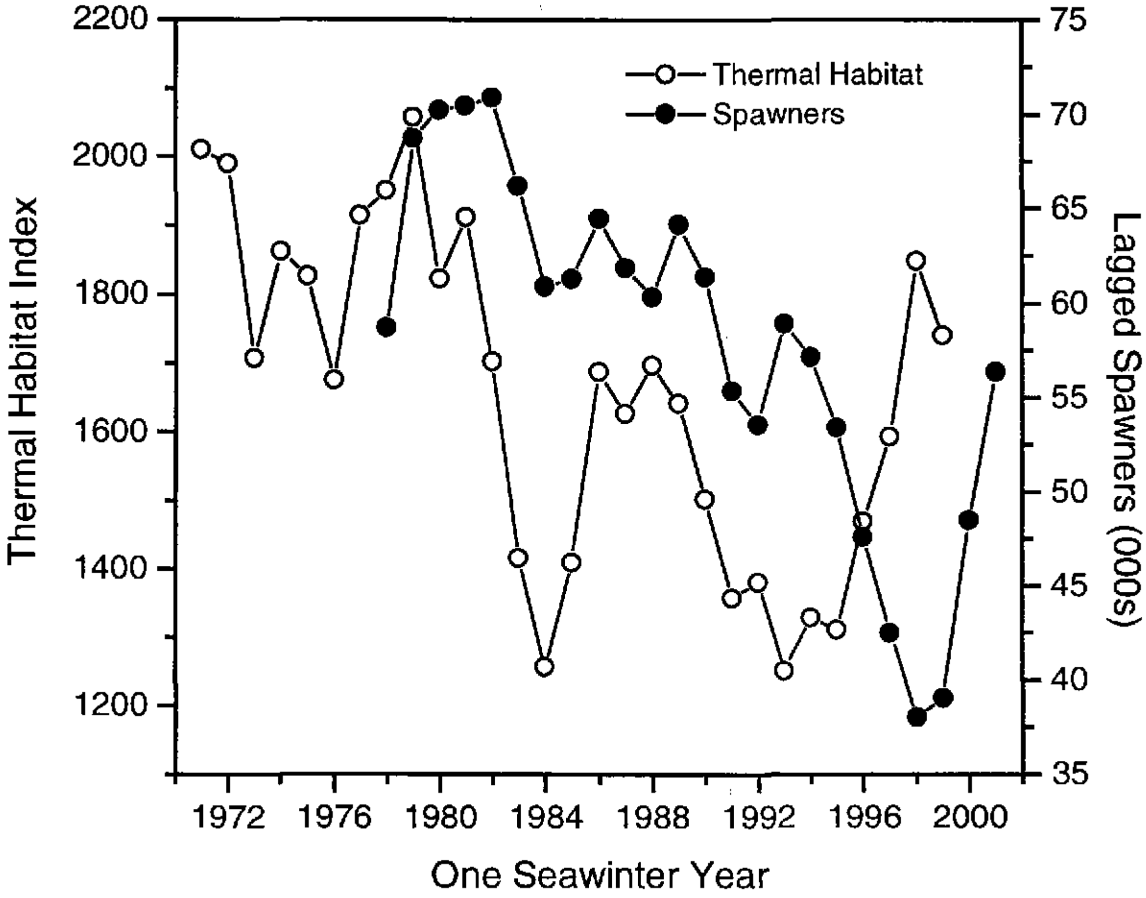


Figure 5.6.2.1. Bivariate relationships between independant variables lagged spawners (A) and thermal habitat (B) used in forecast model and pre-fishery abundance of non-maturing fish. Open symbol are for 1997 PFA.

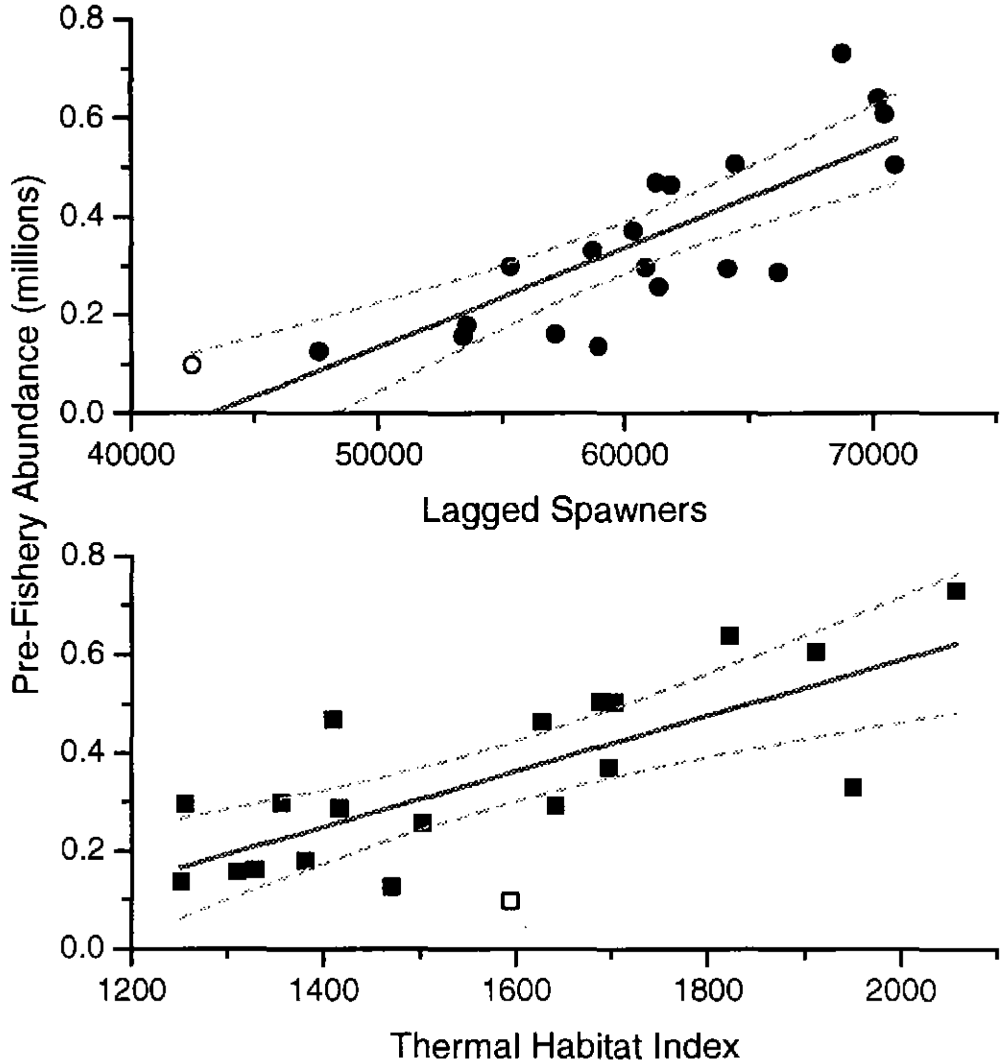


Figure 5.6.2.2. Observed estimates, jackknifed historical predictions, and deterministic forecasts (A) of pre-fishery abundance. Residual pattern from jackknifed predictions (B).

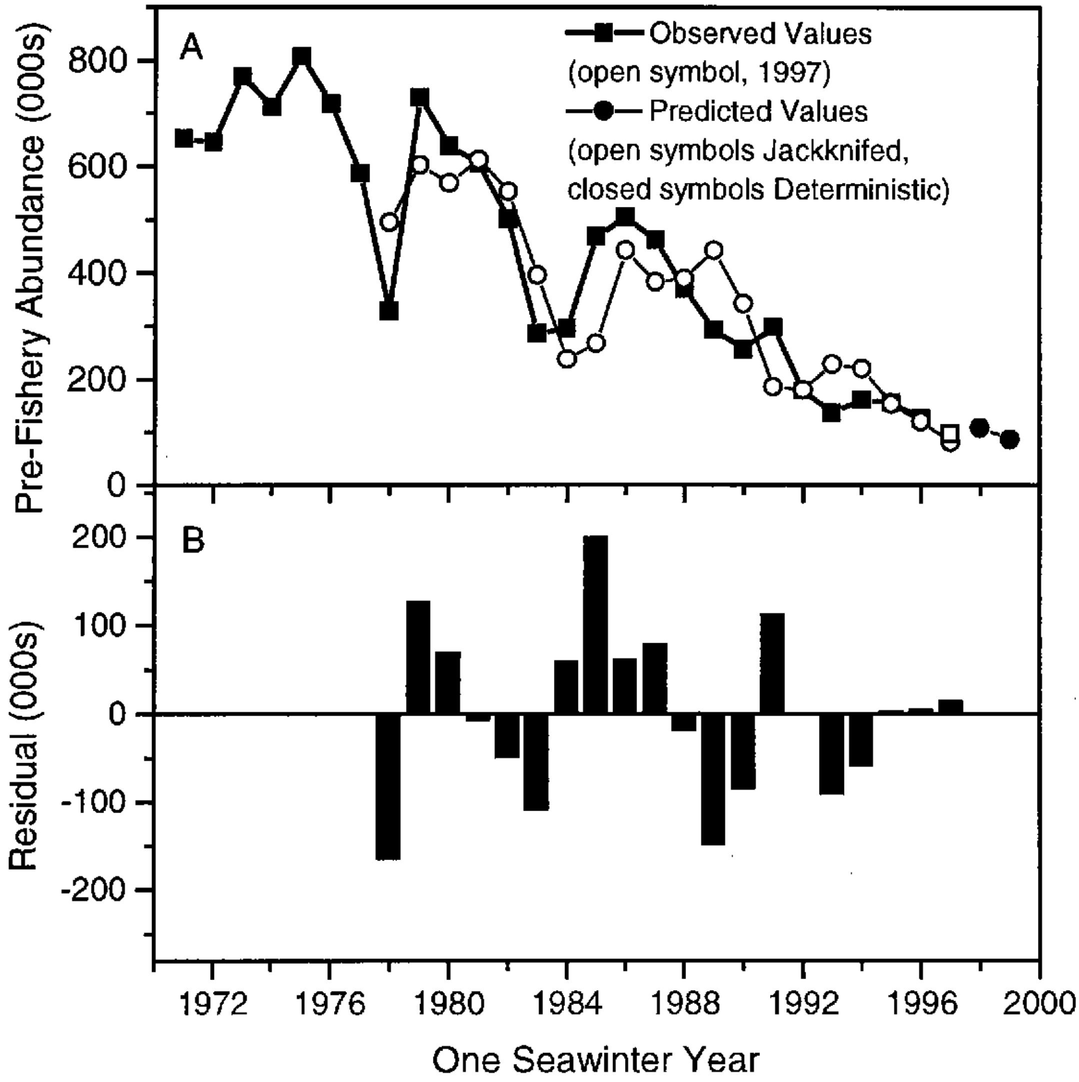


Figure 5.6.2.3. Jackknifed predictions versus observed (A) and residuals versus observed (B) pre-fishery abundance. Open symbols, 1997.

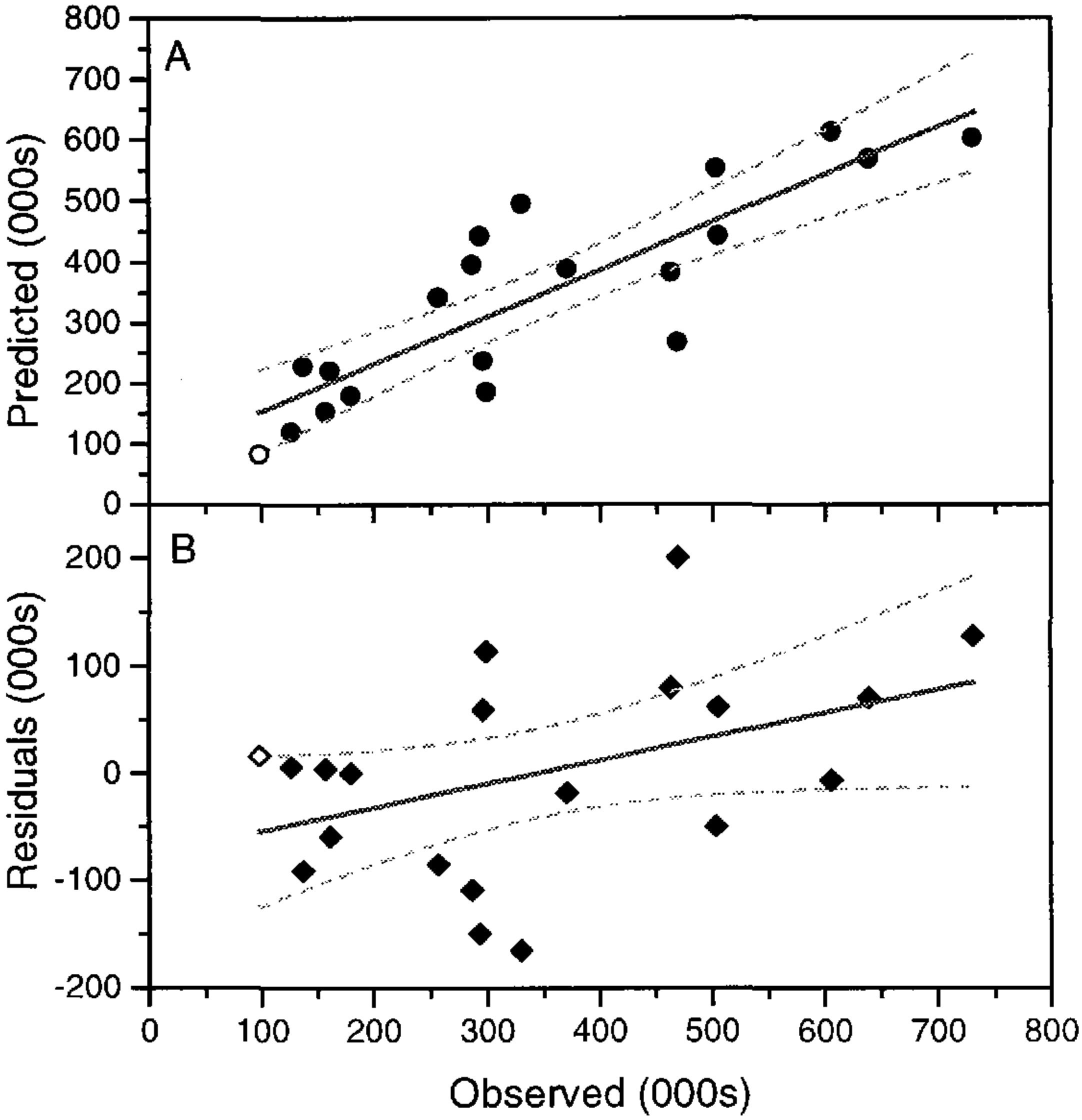


Figure 5.6.4.1. Theoretical risk analysis plots showing the risk-prone and risk-averse zones relative to the uncertainty of the stock assessment.

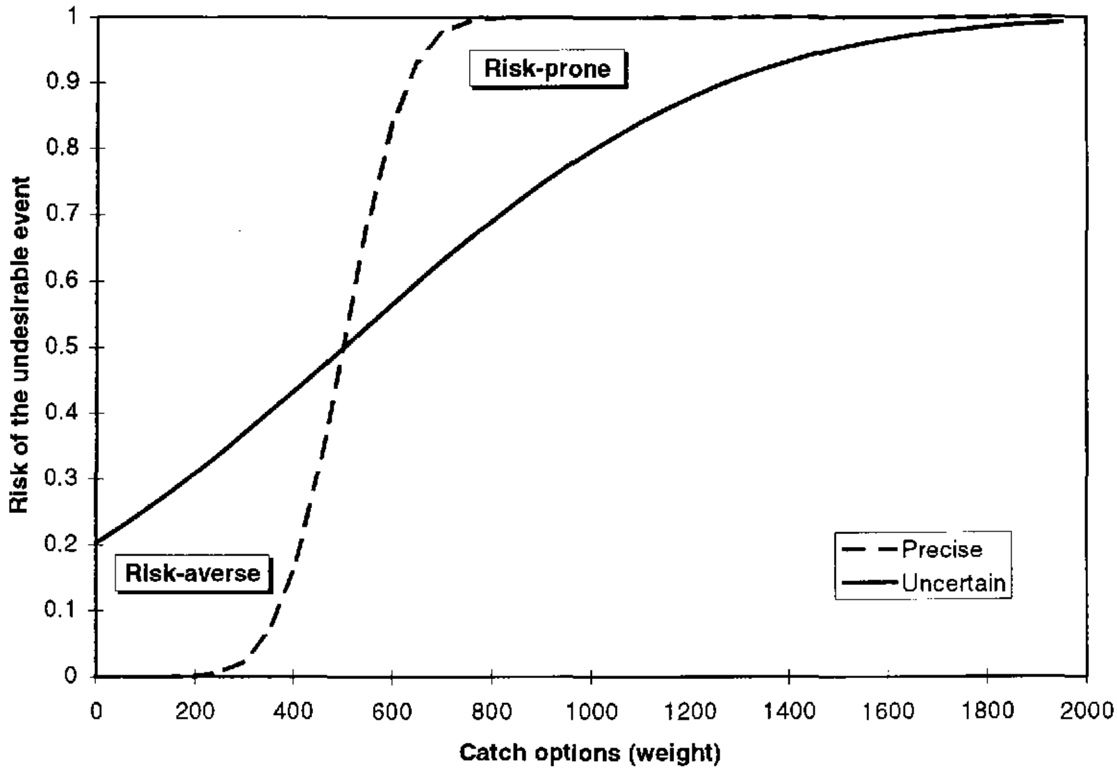


Figure 5.6.4.2. Distributions and probabilities of prefishery abundance forecasts for 1999 (upper panel), number of North American origin salmon captured in a 100 t fishery at West Greenland in 1999 (middle panel) and the post-fishery returns to North America in 2000 (bottom panel).

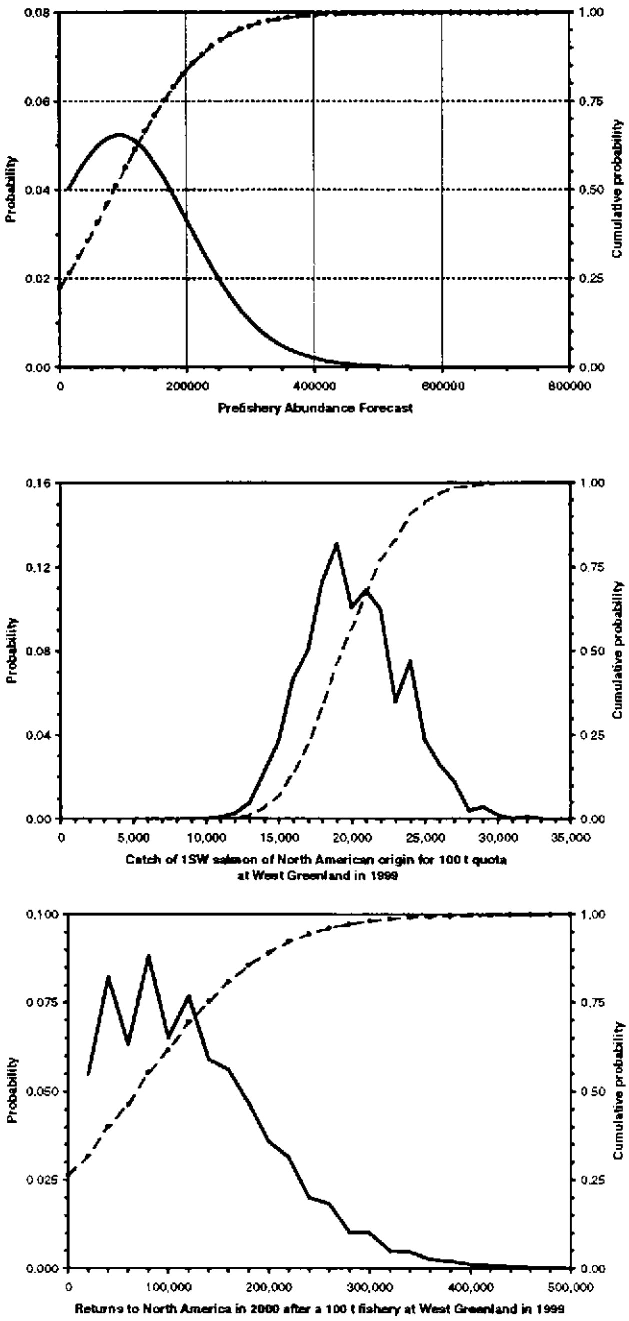


Figure 5.6.4.3. Summary of the distributions of the predicted biological characteristics of Atlantic salmon at West Greenland in 1999 generated from 1000 resampling events. The distribution of the weight of 1SW salmon of European origin is similar to the middle panel.

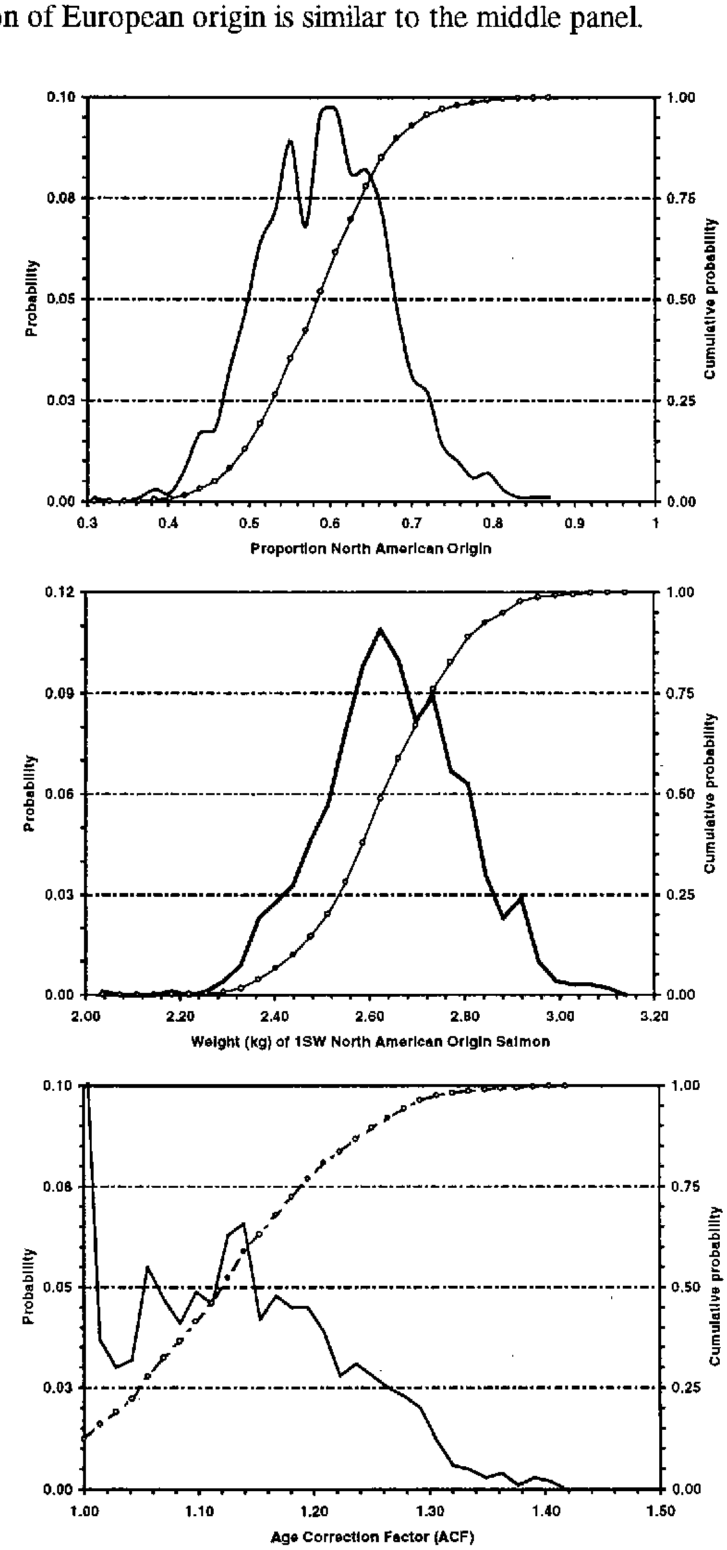
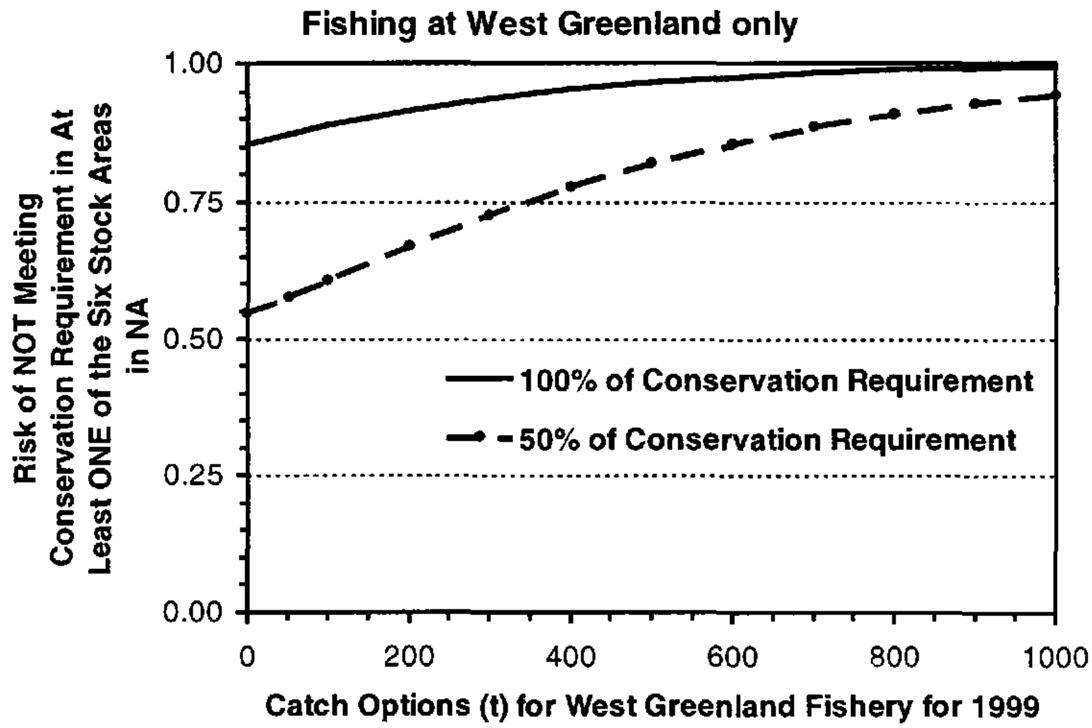


Figure 5.6.4.4. Risk analysis (probability of not meeting the conservation requirement in at least one of the six stock areas in North America) of catch options on the prefishery 1SW non-maturing salmon component in 1999. Risk is expressed relative to catch options at West Greenland in 1999 without fisheries in North America in 2000 (upper panel) and for combined fisheries at West Greenland in 1999 and North America in 2000 (lower panel). Exploitation rates in North America are based on levels varying between 0.15 and 0.25 on the returning large salmon (Section 4.1.4).



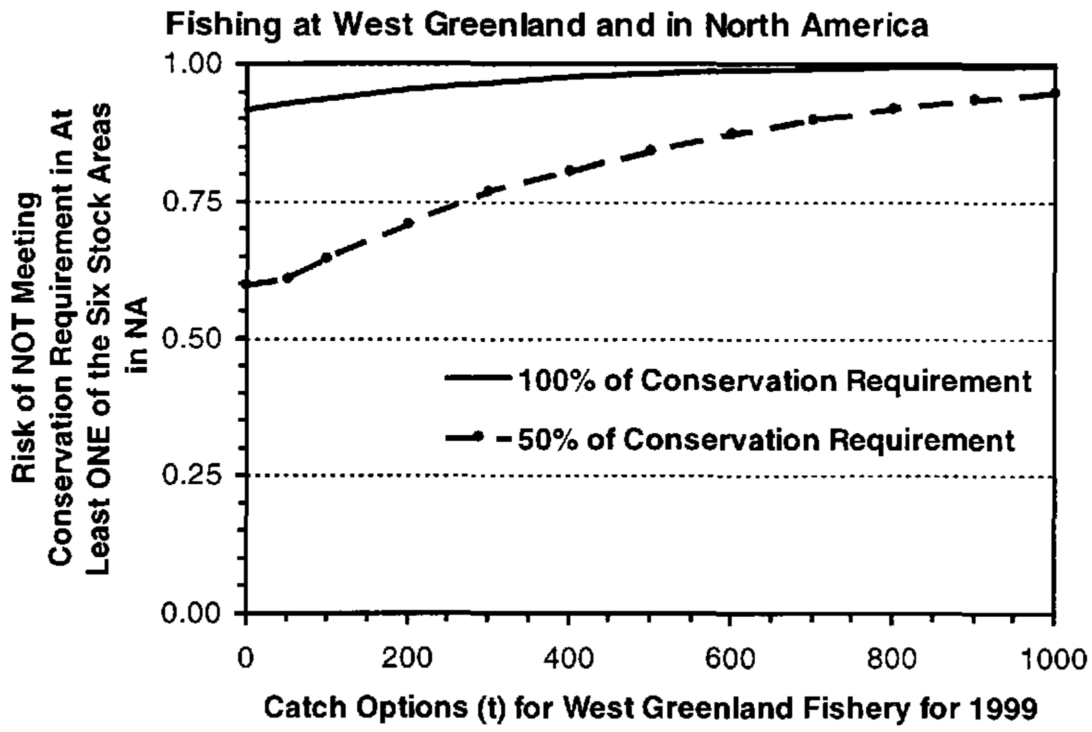


Figure 5.7.2.1. Approximate posterior predictive distributions (5000 Monte Carlo simulations) of the 1999 PFA under varying levels of measurement errors in the PFA and lagged spawner variables. The point estimate without error refers to the mode of the posterior predictive distribution.

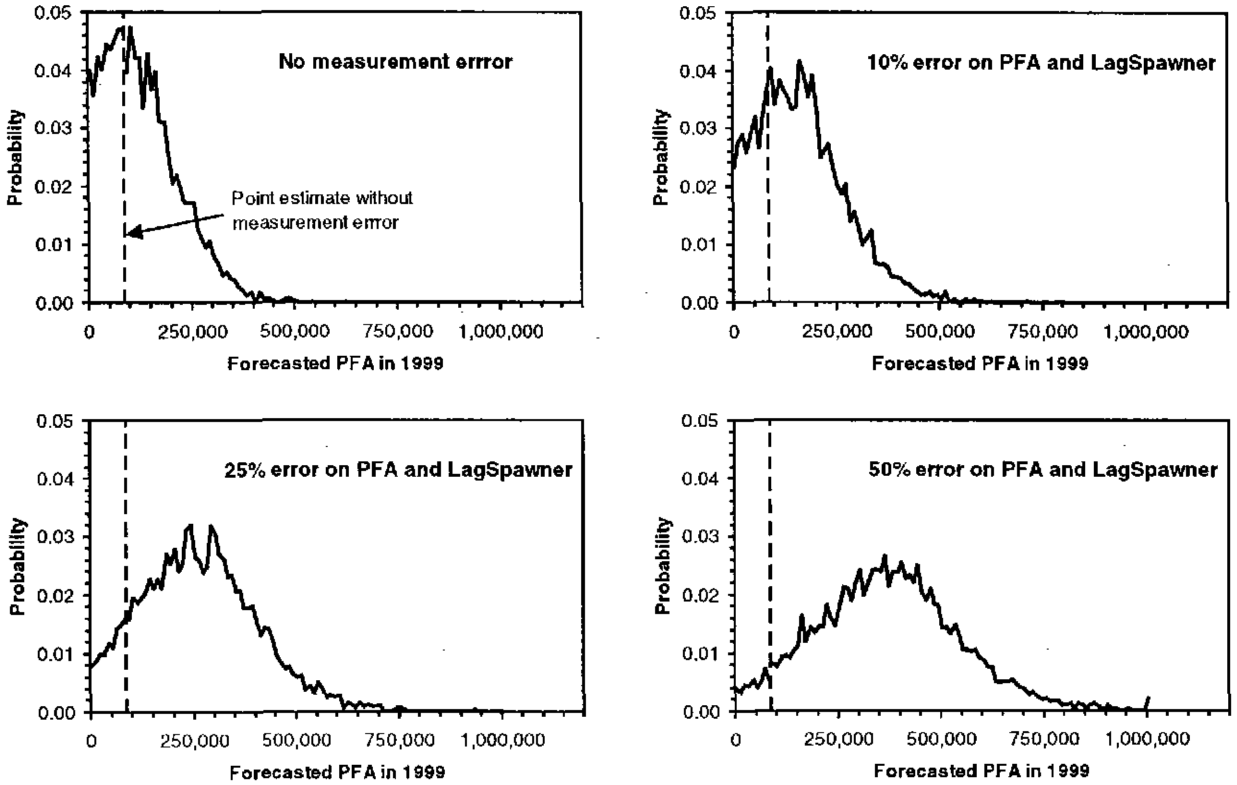


Figure 5.7.3.1. Relationship between estimated PFA of maturing and non-maturing 1SW salmon relative to the index of smolt production from North America (1972 to 1997).

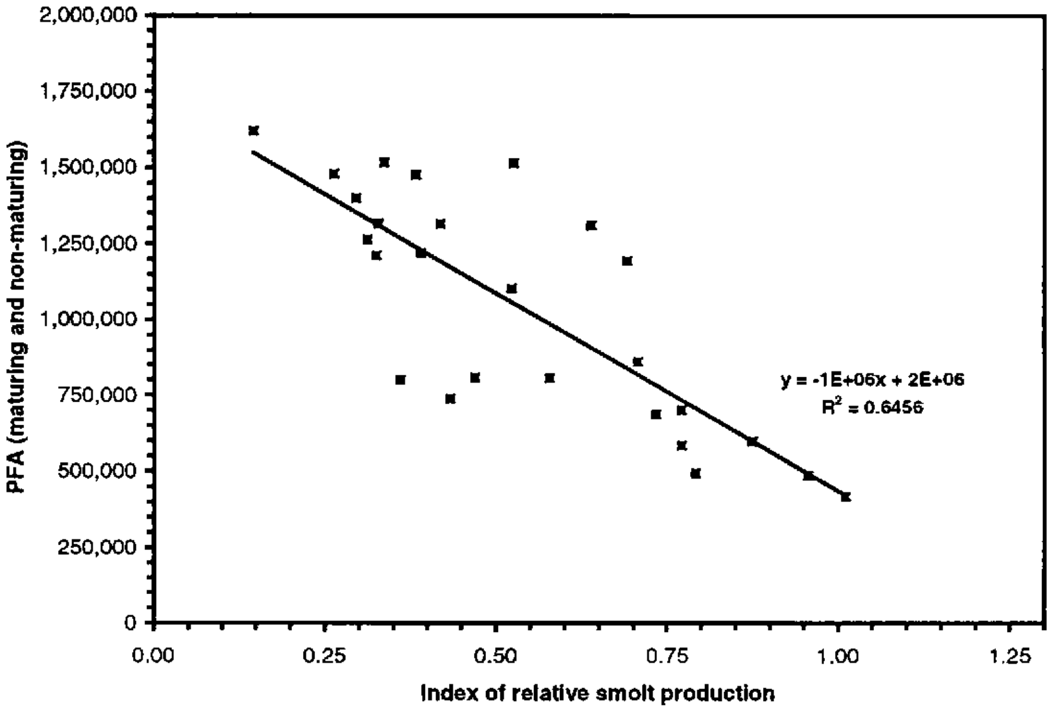
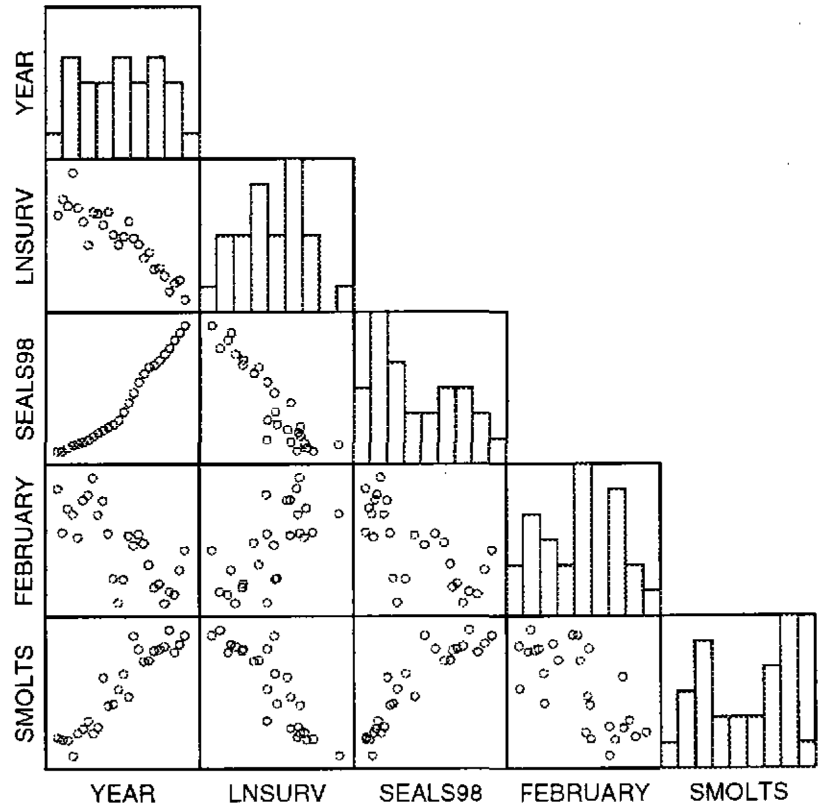


Figure 5.7.3.2. Bivariate scatter plots of variables explored in the North American Atlantic salmon survival model. Variables are: LNSURV = ln(maturing and non-maturing prefishery abundance relative to the area-weighted smolt index), FEBRUARY = index of habitat in February, SEALS98 = index of predator abundance based on harp seal population size, SMOLTS = area-weighted relative smolt index.



6 RECOMMENDATIONS

6.1 Meetings

The Working Group recommends that it should meet in 2000 to address questions posed by ACFM, including those posed by NASCO to ICES. To provide catch advice for West Greenland, the Working Group relies upon sea-surface temperature data which are complete by April 4. Therefore the Working Group should convene at ICES Headquarters on April 11.

6.2 Data Deficiencies and Research Needs

1. More research into the biology of salmon in the early marine phase is required and extension of recent research on the biology of post-smolts is recommended. Competitive interactions with other marine species should be explored. Additionally, by-catches of post-smolts in marine fisheries for other species should be monitored and estimates of mortality from this source should be derived. There is a continuing requirement to monitor trends in marine mortality for a wider range of stocks than at present, and to identify causes for current low levels of marine survival. In the latter context, it is noteworthy that an ICES Workshop on the Usefulness of Scale Growth Analyses and Other Measures of Condition in Salmon will be held in Amherst, USA in July, 1999.

2. It is recommended that a research fishery at Faroes should be continued and that material gained during previous study should continue to be worked-up.

3. The quality of data used to set conservation limits should continue to be improved and the PFA model should continue development. More and better input data should be obtained from a greater range of sources. Data collection should be targeted at finer scales. New ways of handling data, including GIS applications, and particularly new methods for grouping sub-divisions (eg., populations, or alternative divisions based on biological characteristics such as sea-age or run-timing) should continue to be explored, developed and validated. In particular, sensitivity analyses are essential to assess the confidence with which data derived from the theoretical models can be used in an applied management context.

4. Assessment methods for juvenile salmon and for freshwater habitat parameters should continue to be developed. Attempts should be made to couple these parameters with adult return parameters, via life-history models of appropriate scale. Habitat and life-history variables should be used together to examine the extent to which stock-recruitment relationships from a limited range of index rivers are transferable to other rivers.

5. The status of southern and central European rivers with respect to Gyrodactylus species, and particularly *G. salaris*, should be established without delay. Monitoring of the spread and occurrence of *G. salaris* should be encouraged in salmon-producing countries, and in other countries that are possible sources for transfer of the parasite.

6. There is an urgent need to monitor salmon returns and develop habitat-based spawner requirements in Labrador and Ungava regions of Québec.

7. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks, and total recruits prior to fisheries. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA.

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

9. Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates.

10. The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme, which occurred in 1995-98, be continued and improved to spatially and temporally cover as much of the landings as possible.

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

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

13. The bootstrapping approach to improve confidence intervals for the pre-fishery abundance forecast error estimates shows promise, and should be explored further.

14. The Working Group recommends that an evaluation be conducted on the present reliability of the PFA estimate. An initial approach is to determine what fraction of the PFA estimate is directly based on catches and assessed returns (hard data), and what fraction results from less certain information such as scaling factors for potential productive habitat.

15. It is recommended that the extent of the measurement error inherent in the run-reconstruction model should be estimated to describe the potential bias in the mode and the description of uncertainty associated with the forecast.

16. The inclusion of measurement error in the forecast model increases the uncertainty of the forecast and under increased uncertainty, alternative risk levels to the 50% point should be considered, consistent with the precautionary approach.

17. Other indices of adult salmon abundance should be examined and used as prior information to constrain the plausible range of abundance levels.

18. Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses) to provide some index of plausibility of the quantitative forecasts.

APPENDIX 1

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP ON NORTH ATLANTIC SALMON, 1999

Doc. No. 1 Friedland, K. and R. Brown. Forecast estimate of North American stock abundance using bootstrapping techniques.

Doc. No. 2 Friedland, K.D. and D.G. Reddin. Production patterns and thermal conditions in Atlantic salmon post-smolt nurseries in the northwest Atlantic area.

Doc. No. 3 Reddin, D.G., J.B. Dempson, P. Downton, C.C. Mullins and K.D. Friedland. Migration of Atlantic salmon kelts (*Salmo salar*) in relation to sea water temperature in Newfoundland, 1998.

Doc. No. 4 Reddin, D.G. Return and spawner estimates Atlantic salmon for insular Newfoundland.

Doc. No. 5 Reddin, D.G., Estimation of the Labrador component of prefishery abundance of North American Atlantic salmon (*Salmo salar*) in 1998.

Doc. No. 6 Reddin, D.G., P.B. Short, K.D. Friedland and P. Kanneworff. Identification and characteristics of North Atlantic and European Atlantic salmon (*Salmon salar* L.) caught at West Greenland in 1998.

Doc. No. 7 Reddin, D.G., P.B. Short, T. King and P. Kanneworff. Identification of North American and European salmon (*Salmo salar* L.) caught at West Greenland in 1995-97.

Doc. No. 8 Gudbergsson, G. National report for Iceland the 1998 salmon season.

Doc. No. 9 Insulander, C. National report, Sweden.

Doc. No. 10 Insulander, C. The spawning run in the River Dalalven, Bothnian Sea, Baltic.

Doc. No. 11 Erkinaro, J. and M. Lansman. National report for Finland – salmon fishing season in 1998.

Doc. No. 12 Erkinaro, J., M. Kaukoranta, N. Popov, A. Lupandin, J. Pautamo, P. Karppinen, P. Heinimaa, T. Makinen and H. Erkinaro. Salmon stock restoration project in the River Tuloma.

Doc. No. 13 Hansen, L.P., A. J. Jensen, P. Fiske, and N.A. Hvidsten. Atlantic salmon; national report for Norway 1998.

Doc. No. 14 Hansen, L.P., J.C. Holst, A.J. Jensen and B.O. Johnsen. Norwegian spring spawning herring and Atlantic salmon: do they interact?

Doc. No. 15 Erikstad, L., S.-E. Sloreid and L.P. Hansen. A first approach to estimate Atlantic salmon smolt production in Norwegian rivers using geographic information systems.

Doc. No. 16 Hansen, L.P. Regional catches of 1SW salmon in Norway.

Doc. No. 17 Shelton, R.G.J. Post-smolt sampling by FRV *Clupea* – cruise report.

Doc. No. 18 MacLean, J.C. National report for UK (Scotland).

Doc. No. 19 MacLean, J.C., G.W. smith and B.D.M. Whyte. Description of marine growth checks observed on the scales of salmon returning to Scottish homewaters in 1997.

Doc. No. 20 Prévost, É. Stock status of Atlantic salmon (*Salmo salar*) in the Scorff R. (southern Brittany, France) in 1998: smolt production, adult returns, escapement, exploitation and survival rates.

Doc. No. 21 Porcher, J.-P. Salmon fisheries and status of stocks in France: national report for 1998.

Doc. No. 22 Anon. Salmon stocks and fisheries in England and Wales, 1998. Preliminary assessment prepared for ICES, April 1999.

Doc. No. 23 Potter, E.C.E. What is a "Stock rebuilding programme"?

Doc. No. 24 Potter, E.C.E. Improving 'PFA' and 'CL' estimates for NEAC area salmon.

Doc. No. 25 Crozier, W.W. Summary of salmon fisheries and status of stocks in UK (Northern Ireland) for 1988.

Doc. No. 26 Ó Maoiléidigh, N., J. Browne, A.Cullen, T. McDermott, N. Bond, D. McLaughlin, and G. Rogan. National report for Ireland – the 1998 salmon season.

Doc. No. 27 Amiro, P.G. and C.J. Harvie. Recruitment of the North American stock of Atlantic salmon (*Salmo salar*) estimated from an index of smolt production and either the North American salmon habitat index or the abundance of Harp seals.

Doc. No. 28 Cairns, D.K. and D.G. Reddin. Potential impact of seal and seabird predation on North American Atlantic salmon populations.

Doc. No. 29 Montevecchi,W.A., D.K. Cairns and R.A. Myers. Gannet Predation on salmon in the northwest Atlantic.

Doc. No. 30 Caron, F. and P.-M. Fontaine. Spawner and return numbers in Québec, 1969-1998.

Doc. No. 31 Picard, S.-E. and F. Caron. Determination of the salmon-rearing potential of a salmon river using a habitat suitability index (HIS).

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Doc. No. 33 Fontaine, P-M, F. Caron. Stock-recruitment relationships to define a conservation threshold and targets for Québec Atlantic salmon rivers.

Doc. No. 34 Kanneworff, P. The salmon fishery in Greenland 1998.

Doc. No. 35 Meerburg, D. Catch, catch-and-released, and unrepoted catch estimates for Atlantic salmon in Canada

Doc. No. 36 Withdrawn.

Doc. No. 37 Baum, E. 1998 USA Atlantic salmon stock status report.

Doc. No. 38 Holm, M., J.C Holst and L.P. Hansen. Spatial distribution of post-smolts 1990 – 98 in the Norwegian Sea and adjacent areas in relation to hydrological parameters.

Doc. No. 39 Jacobsen, J.A. Status of the fisheries for Atlantic salmon and production of farmed salmon in 1998 by Faroe Islands

Doc. No. 40 Prusov, S., B.F. Prischepa, S.S. Krylova, V.P. Antonova, and V.F. Bugaev. Atlantic salmon fisheries and status of stocks in Russia. National report for 1998.

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Doc. No. 42 de la Hoz, J. Salmon fisheries and status of stocks in Spain (Asturias). National report for 1998.

Doc. No. 43 Marshall, T.L. Updated estimates of returns and spawners to Salmon Fishing Area (SFA) 18, Gulf of St. Lawrence and SFAs 19-21 and 23, Scotia-Fundy, Canada.

Doc. No. 44 Short, P.B., R. Johnson and D.G. Reddin. 1998 Atlantic salmon survey, Labrador Sea.

Doc. No. 45 Kanneworff, P. Effects on North American and European stocks of the West Greenland management measures since 1993.

APPENDIX 2

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APPENDIX 3

LIST OF PARTICIPANTS

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Appendix 4. Eggs taken and juvenile Atlantic salmon and eggs stocked (excluding private commercial sea ranching).

Blank fields indicate data not available.

Estimated number (nearest 1,000) of eggs spawned by artificial methods from (Year) sea-run adults in autumn/winter period of Year / Year +1).

Example = eggs artificially spawned and recorded for 1997 were spawned during the fall/winter period of 1997/1998

Belgium

Country / Year	Total Eggs Artificially Spawned	Eggs Stocked (rounded to nearest 1,000)			No. Fry Stocked (rounded to nearest 1,000)			No. Parr Stocked (rounded to nearest 100)				No. Smolts (rounded to nearest 100)		
		Green	Eyed	All	Unfed	Fed	All	0+	1 & 1+	2 or >	All	1	2 or more	All
Total	0	0	59000	59000				763400	0	0	763400	10400	0	10400
1990	0	0	15000	15000				51400	0	0	51400	500	0	500
1991	0	0	0	0				55900	0	0	55900	500	0	500
1992	0	0	25000	25000				71500	0	0	71500	700	0	700
1993	0	0	5000	5000				42000	0	0	42000	400	0	400
1994	0	0	14000	14000				57400	0	0	57400	1100	0	1100
1995	0	0	0	0				59400	0	0	59400	1800	0	1800
1996	0	0	0	0				111200	0	0	111200	900	0	900
1997	0	0	0	0				120700	0	0	120700	0	0	0
1998	0	0	0	0				193900	0	0	193900	4500	0	4500

Comments:

(1) All eggs and juveniles stocked are obtained from foreign eggs (french, irish, scottish) which are reared in hatchery in Belgium

(2) Parr stocked : parr 0+ from 50 to 100 mm, with a majority of 50 mm

Canada

Country / Year	Total Eggs Artificially Spawned	Green	Eyed	All	Unfed	Fed	All	0+	1 & 1+	2 or >	All	1	2 or more	All
Total	29616000	872000	710000	1582000	28113000	7496000	27947000	14787700	2091900	179100	17058700	7274700	1563000	8837700
1990	6742000	0	0	0	6752000	910000	7662000	2237500	62200	1400	2301100	803000	229600	1032600
1991	2734000	0	0	0	5687000	689000	6376000	1953400	55500	2600	2011500	802600	177900	980500
1992	2604000	0	0	0	3151000	948000	4099000	1743800	174200	2900	1920900	775600	211600	987200
1993	1088000	0	0	0	3578000	680000	4258000	1395900	157300	15700	1568900	804000	148500	952500
1994	1749000	0	0	0	2923000	930000	3853000	1269200	55900	14200	1339300	721200	156100	877300
1995	1279000	0	0	0	1183000	617000	1800000	1396700	152100	106000	1654800	796300	293000	1089300
1996	1190000	0	0	0	1963000	855000	2818000	1720200	45400	0	1765600	871500	44000	915500
1997	6996000	870000	550000	1420000	1573000	1535000	3108000	1578600	343300	25500	1947400	1061000	183900	1244900
1998	5234000	2000	160000	162000	1303000	332000	1635000	1492400	1046000	10800	2549200	639500	118400	757900

Comments:

(1) Total eggs artificially spawned includes some egg collections from captive sea run kelts.

(2) Eggs artificially spawned, 1990-1996, incomplete; eggs and unfed fry in 1997 are provisional.

Denmark

Total						154600	154600	368000	2218300		2586300	864500	104100	968600
1990						50100	50100	10900	139900		150800	25900	0	25900
1991						7600	7600	8800	131800		140600	120300	0	120300
1992						7300	7300	9500	139700		149200	135700	0	135700
1993						5800	5800	36000	105700		141700	109300	30800	140100
1994						11800	11800	28900	178400		207300	70100	46600	116700
1995						0	0	10300	395000		405300	85200	6000	91200
1996						4000	4000	0	450700		450700	116100	0	116100
1997						0	0	0	464600		464600	106400	0	106400
1998						68000	68000	263600	212500		476100	95500	20700	116200

Finland

Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0

France

Total		0	296000	296000	1952000	12074000	14026000	3885900	717400	0	4603300	1498400	129100	1627500
1990		0	0	0	334000	377000	711000	406400	100700	0	507100	44000	23500	67500
1991		0	0	0	58000	570000	628000	903400	1100	0	904500	103200	72500	175700
1992		0	0	0	113000	657000	770000	289100	111300	0	400400	114600	9400	124000
1993		0	94000	94000	352000	709000	1061000	320100	131600	0	451700	189200	13100	202300
1994		0	0	0	58000	568000	626000	342500	85900	0	428400	207200	6500	213700
1995		0	0	0	119000	2441000	2560000	468200	77700	0	545900	277100	800	277900
1996		0	0	0	310000	2416000	2726000	477900	120600	0	598500	248500	0	248500
1997		0	52000	52000	420000	2108000	2528000	264000	48000	0	312000	163700	0	163700
1998		0	150000	150000	188000	2228000	2416000	414300	40500	0	454800	150900	3300	154200

Iceland

Total		0	0	0	1365000	4631000	5996000	1173500	0	0	1173500	3798400	71600	3870000
1990		0	0	0	307000	660000	967000	97000	0	0	97000	259500	5400	264900
1991		0	0	0	109000	687000	796000	110600	0	0	110600	331700	0	331700
1992		0	0	0	25000	688000	713000	134100	0	0	134100	427800	0	427800
1993		0	0	0	97000	547000	644000	33400	0	0	33400	362300	0	362300
1994		0	0	0	240000	525000	765000	51500	0	0	51500	304400	2000	306400
1995		0	0	0	287000	436000	723000	112300	0	0	112300	334300	5000	339300
1996		0	0	0	91000	458000	549000	263100	0	0	263100	645000	3500	648500
1997		0	0	0	129000	341000	470000	118400	0	0	118400	617800	11000	628800
1998		0	0	0	80000	289000	369000	253100	0	0	253100	515600	44700	560300

Ireland

Total	32853000	0	1637000	1637000	11420000	4395000	15815000	1476200	0	0	1476200	1776100	100	1776200
1990														
1991														
1992														
1993														
1994														
1995	6751000		113000	113000	464000	3032000	3496000	488500			488500	295200		295200
1996	7322000		186000	186000	3209000	217000	3426000	307200			307200	520200		520200
1997	8189000	0	226000	226000	3588000	644000	4232000	331600	0	0	331600	500400	100	500500
1998	10591000		1112000	1112000	4159000	502000	4661000	348900			348900	460300		460300

Norway

Total				597000	10565000	3573000	14138000	5184800	623900	206100	6014800	0	0	1704900
1990														
1991														
1992					327000	254000	581000	745900	17100	59700	822700			65600
1993					2230000	523000	2753000	1043800	47200	75000	1166000			277400
1994					1788000	783000	2571000	909900	126400	0	1036300			320200
1995				42000	2287000	490000	2777000	975500	232000	59400	1266900			333600
1996				98000	2651000	1009000	3660000	776200	30300	7800	814300			345700
1997				457000	1282000	514000	1796000	733500	170900	4200	908600			362400
1998														

Comments

(1) 1992 data are incomplete

(2) 1990, 1991, and 1998 data are currently unavailable.

(3) In addition, 195300, 73733, 22000, and 150 Atlantic salmon of unspecified life stages were released from 1993 to 1996, respectively.

Russia

Total	23361000	0	0	0	0	0	0	267800	127000	787600	1182400	0	5744600	5744600
1990	5431000	0	0	0	0	0	0			130700	130700	0	621000	621000
1991	3492000	0	0	0	0	0	0			143000	143000	0	778800	778800
1992	2535000	0	0	0	0	0	0			57900	57900	0	773600	773600
1993	1780000	0	0	0	0	0	0			250000	250000	0	600900	600900
1994	2291000	0	0	0	0	0	0			151000	151000	0	360000	360000
1995	2183000	0	0	0	0	0	0	217000	34000	55000	306000	0	270800	270800
1996	2067000	0	0	0	0	0	0	0	40000	0	40000	0	836300	836300
1997	1676000	0	0	0	0	0	0	50800	20000	0	70800	0	669000	669000
1998	1906000	0	0	0	0	0	0	0	33000	0	33000	0	834200	834200

Spain

Total	2515000							1556500	485300	0	2041800	285500	0	285500
1990	25000							539500	0	0	539500	17500	0	17500
1991	40000							426000	18000	0	444000	6100	0	6100
1992	80000							0	0	0	0	28900	0	28900
1993	40000							0	10900	0	10900	42200	0	42200
1994	230000							0	28100	0	28100	6000	0	6000
1995	200000							74000	100000	0	174000	27000	0	27000
1996	270000							0	114800	0	114800	71500	0	71500
1997	680000							85000	106000	0	191000	52800	0	52800
1998	950000							432000	107500	0	539500	33500	0	33500

Sweden

Total		0	0	0	8000	0	8000	107500	300	0	107800	601400	875300	1476700
1990		0	0	0	0	0	0	107500	0	0	107500	77100	141600	218700
1991		0	0	0	0	0	0	0	0	0	0	17800	155800	173600
1992		0	0	0	0	0	0		300		300	73300	99600	172900
1993		0	0	0	0	0	0	0	0	0	0	71900	60700	132600
1994		0	0	0	8000		8000	0	0	0	0	63000	120800	183800
1995		0	0	0	0	0	0	0	0	0	0	88400	79400	167800
1996		0	0	0	0	0	0	0	0	0	0	61200	99000	160200
1997		0	0	0	0	0	0	0	0	0	0	56400	72700	129100
1998		0	0	0	0	0	0	0	0	0	0	92300	45700	138000

UK - (England & Wales)

Total	28059000	0	706000	706000	1701000	17511000	19212000	7518500	1825500	0	9344000	1442400	0	1442400
1990	5025000	0	20000	20000	109000	1812000	1921000	331700	201400	0	533100	121200	0	121200
1991	5103000	0	12000	12000	373000	1561000	1934000	1186700	216600	0	1403300	126000	0	126000
1992	3587000	0	220000	220000	171000	1830000	2001000	1203300	391000	0	1594300	183000	0	183000
1993	5130000	0	0	0	172000	1248000	1420000	872000	173700	0	1045700	218700	0	218700
1994	3590000	0	48000	48000	688000	2024000	2712000	812300	199100	0	1011400	152500	0	152500
1995	3209000	0	379000	379000	139000	1386000	1525000	578900	143100	0	722000	203800	0	203800
1996	2415000	0	25000	25000	49000	7200000	7249000	1127800	143200	0	1271000	127300	0	127300
1997		0	0	0	0	277000	277000	1141000	199200	0	1340200	185400	0	185400
1998		0	2000	2000	0	173000	173000	264800	158200	0	423000	124500	0	124500

Comments:

(1) Total eggs artificially spawned is estimated by backcalculating from egg and juvenile releases.

UK - (Northern Ireland)

Total	0	2595000	0	1830000	714000	0	714000	0	0	0	0	38000	12000	50000
1990														
1991														
1992														
1993														
1994														
1995														
1996														
1997		850000	0	85000	229000	0	229000	0	0	0	0	1000	10000	11000
1998		1745000	0	1745000	485000	0	485000	0	0	0	0	37000	2000	39000

UK - (Scotland)

Total		316000	1393000	1709000	7525000	4039000	11564000	0	182100	0	182100	0	31200	31200
1990														
1991														
1992														
1993														
1994														
1995														
1996														
1997		296000	263000	559000	3854000	1781000	5635000	0	59000	0	59000	0	24000	24000
1998		20000	1130000	1150000	3671000	2258000	5929000	0	123100	0	123100	0	7200	7200

USA

Total	41516000	0	0	0	59383000	19918000	79301000	5869400	933900	0	6803300	8661600	137700	8799300
1990	4117000	0	0	0	1788000	1288000	3076000	799900	387300	0	1187200	1244500	33100	1277600
1991	4488000	0	0	0	2713000	1467000	4180000	948900	168900	0	1117800	1226100	88300	1314400
1992	5005000	0	0	0	2437000	2114000	4551000	918400	152400	0	1070800	1301400	8100	1309500
1993	3369000	0	0	0	5481000	1981000	7462000	825900	73200	0	899100	1099700	0	1099700
1994	3455000	0	0	0	8111000	2784000	10895000	347900	25400	0	373300	1113600	0	1113600
1995	5292000	0	0	0	9113000	2325000	11438000	493600	18300	0	511900	665000	0	665000
1996	5353000	0	0	0	7990000	3072000	11062000	562100	35400	0	597500	654300	2800	657100
1997	5662000	0	0	0	9849000	4040000	13889000	510600	30200	0	540800	666500	5400	671900
1998	4775000	0	0	0	11901000	847000	12748000	462100	42800	0	504900	690500	0	690500

Comments:

(1) Total Eggs Artificially Spawned include only eggs collected from sea-run fish. Significant numbers of eggs are also collected from captive/broodstock and captive sea-run kelts.

Summary

1990	21340000	0	35000	35000	9290000	5097100	14387100	4581800	891500	132100	5605400	2593200	1054200	3647400
1991	15857000	0	12000	12000	8940000	4981600	13921600	5593700	591900	145600	6331200	2734300	1273300	4007600
1992	13811000	0	245000	245000	6224000	6498300	12722300	5115600	986000	120500	6222100	3041000	1102300	4143300
1993	11407000	0	99000	99000	11910000	5693800	17603800	4569100	699600	340700	5609400	2897700	854000	3751700
1994	11315000	0	62000	62000	13816000	7625800	21441800	3819600	699200	165200	4684000	2639100	692000	3331100
1995	18914000	0	492000	492000	13592000	10727000	24319000	4874400	1152200	220400	6247000	2774100	655000	3429100
1996	18617000	0	211000	211000	16263000	15231000	31494000	5345700	980400	7800	6333900	3316500	985600	4302100
1997	23203000	2016000	1091000	3107000	20924000	11240000	32164000	4934200	1441200	29700	6405100	3411400	976100	4387500
1998	23456000	1767000	2554000	4321000	21787000	6697000	28484000	4125100	1763600	10800	5899500	2844100	1076200	3920300
Grand Total	157920000	3783000	4801000	8584000	122746000	73791600	196537600	42959200	9205600	1172800	53337600	26251400	8668700	34920100

Comments:

(1) Summary table is incomplete due to missing data for some countries.

APPENDIX 5

SAS program to calculate Atlantic salmon pre-fishery abundance with an estimate of precision based on empirically derived distributions of observed patterns of pre-fishery abundance.

```
FILENAME CATCH DDE 'EXCEL | Years78-99 ! R4C1:R25C14';

OPTIONS NOCENTER LINESIZE = 80;

*... DATA FOR CATCH ADVICE FOR 1999 FROM RISKVAR99.XLS ;

*<><><><><><><><><><  don't forget to update columns by one in FILENAME STATEMENT <><><>;

DATA CATCH;
   INFILE CATCH;
   INPUT YEAR NG1 NC1_L NC1_H NC2_L NC2_H NR2_L NR2_H NN1_L NN1_H NN1_M H2 GUS_L GUS_H ;
GUS_M=(GUS_L+GUS_H)/2;

PROC PRINT;

PROC REG;
  MODEL NN1_M = H2 GUS_M/P R;

DATA D2;  SET CATCH;
    SEED = 0;

DO SIM = 1 TO 1000;
 RAN_C1  = NC1_L + ((NC1_H - NC1_L) * RANUNI(SEED));
 RAN_C2  = NC2_L + ((NC2_H - NC2_L) * RANUNI(SEED));
 RAN_R2  = NR2_L + ((NR2_H - NR2_L) * RANUNI(SEED));
 RAN_PFA = (((RAN_R2/.99005) + RAN_C2)/.90483) + RAN_C1 + NG1;
* RAN_SP  = GUS_L + ((GUS_H - GUS_L) * RANUNI(SEED));

OUTPUT;

END;

PROC SORT; BY SIM;

PROC REG NOPRINT;
 BY SIM;
 ID YEAR;
 MODEL RAN_PFA = H2 GUS_M/ P R;
 output out=predic p=pran_pfa stdi=stdi_pfa;

*<><><><><><  REMEMBER TO CHANGE THE YEAR   <><><><><><>;

data univ;
  set predic;
  if year=1999;
  do i=1 to 1000;
    new_pfa=pran_pfa+((stdi_pfa)*rannor(0));
    output;
  end;

run;


PROC UNIVARIATE  DATA = UNIV;
    VAR NEW_PFA;
    OUTPUT OUT=D4 PCTLNAME=
   MEAN=M STD=S
   PCTLPRE=PFA
       PCTLPTS=5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95;

proc print;

run;
```

Appendix 6(i). Estimated numbers of 1SW salmon recruits, returns and spawners for Labrador.

Year	Commercial catches of small salmon			Labrador origin small recruits before commercial fishery in Labrador						Labrador grilse recruits prior to commercial fishery						Grilse Recruits		Grilse to rivers		Labrador grilse spawners Angling catch subtracted	
	SFA 1	SFA 2	SFA 14B	SFA 1		SFA 2		SFA 14B		SFA 1		SFA 2		SFA 14B		SFA 1,2&14B+Nfld		SFA 1,2&14B		SFA 1,2&14B	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
*1969	10774	21627	6321	12929	28730	25952	57672	7585	16856	10343	25857	20762	51905	6068	15171	48912	122280	18587	65053	15476	61942
*1970	14666	29441	8605	17600	39110	35329	78509	10326	22947	14080	35199	28263	70658	8261	20652	66584	166459	25302	88556	21289	84543
*1971	19109	38359	11212	22931	50958	46031	102291	13454	29898	18345	45862	36825	92062	10763	26908	86754	216884	32966	115382	29032	111448
*1972	14303	28711	8392	17164	38141	34454	76563	10070	22378	13731	34327	27563	68907	8056	20140	64934	162335	24675	86362	21728	83415
*1973	3130	6282	1836	3756	8346	7539	16753	2203	4896	3004	7511	6031	15077	1763	4407	14208	35520	5399	18897	0	11405
1974	9848	37145	9328	11818	26261	44574	99053	11194	24875	9454	23635	35659	89148	8955	22387	71142	177856	27034	94619	24533	92118
1975	34937	57560	19294	41924	93165	69072	153493	23153	51451	33540	83849	55258	138144	18522	46306	141210	353024	53660	187809	49688	183837
1976	17589	47468	13152	21107	46904	56962	126581	15782	35072	16885	42214	45569	113923	12626	31565	98790	246976	37540	131391	31814	125665
1977	17796	40539	11267	21355	47456	48647	108104	13520	30045	17084	42710	38917	97294	10816	27041	87918	219796	33409	116931	28815	112337
1978	17095	12535	4026	20514	45587	15042	33427	4831	10736	16411	41028	12034	30084	3865	9662	42513	106282	16155	56542	13464	53851
1979	9712	26808	7194	11654	25899	34570	76821	8633	19184	9324	23309	27656	69139	6906	17266	57744	144360	21943	76800	17825	72682
1980	22501	72485	8493	27001	60003	86982	193293	10192	22648	21601	54002	69586	173964	8153	20383	130710	326776	49670	173845	45870	170045
1981	21596	86426	6658	25915	57589	103711	230469	7990	17755	20732	51830	82969	207422	6392	15979	144859	362147	55046	192662	49855	187471
1982	18478	53592	7379	22174	49275	64310	142912	8855	19677	17739	44347	51448	128621	7084	17710	100357	250892	38136	133474	34032	129370
1983	15964	30185	3292	19157	42571	36222	80493	3950	8779	15325	38314	28978	72444	3160	7901	62452	156129	23732	83061	19360	78689
1984	11474	11695	2421	13769	30597	14034	31187	2905	6456	11015	27538	11227	28068	2324	5810	32324	80811	12283	42991	9348	40056
1985	15400	24499	7460	18480	41067	29399	65331	8952	19893	14784	36960	23519	58798	7162	17904	59822	149555	22732	79563	19631	76462
1986	17779	45321	8296	21335	47411	54385	120856	9955	22123	17068	42670	43508	108770	7964	19910	90184	225461	34270	119945	30806	116481
1987	13714	64351	11389	16457	36571	77221	171603	13667	30371	13165	32914	61777	154442	10933	27334	112995	282486	42938	150283	37572	144917
1988	19641	56381	7087	23569	52376	67657	150349	8504	18899	18855	47138	54126	135314	6804	17009	104980	262449	39892	139623	34369	134100
1989	13233	34200	9053	15880	35288	41040	91200	10864	24141	12704	31759	32832	82080	8691	21727	71351	178377	27113	94896	22429	90212
1990	8736	20699	3592	10483	23296	24839	55197	4310	9579	8387	20966	19871	49678	3448	8621	41718	104296	15853	55485	12544	52176
1991	1410	20055	5303	1692	3760	24066	53480	6364	14141	1354	3384	19253	48132	5091	12727	33812	84531	12849	44970	10526	42647
1992	9588	13336	1325	14646	34950	20371	48613	2024	4830	11716	31455	16296	43751	1619	4347	29632	79554	17993	62094	15229	59331
1993	3893	12037	1144	9514	23619	29417	73030	2796	6941	7611	21257	23534	65727	2237	6247	33382	93231	25186	80938	22499	78251
1994	3303	4535	802	10659	26807	14635	36805	2588	6509	8527	24126	11708	33125	2071	5858	22306	63109	18159	56888	15228	53958
1995	3202	4561	217	14471	36647	20613	52201	981	2484	11577	32982	16491	46981	785	2235	28852	82199	25022	76453	22144	73575
1996	1676	5308	865	14849	37772	47029	119627	7664	19495	11880	33995	37623	107664	6131	17545	55634	159204	51867	153553	48362	150048
**1997	1728	8025														72138	162610	66812	155963	64049	153200

Estimates are based on:

EST SMALL RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE PROP SFAs1,2&14B=.6-.8, SFA 1:0.36-0.42&SFA 2:0.75-0.85(97) EXP RATE-SFAs1,2&14B=.3-.5(69-91),.22-.39(92),.13-.25(93), -.10-.19(94),.07-.13(95),.04-.07(96), SFA 1 0.07-0.14&SFA 2:0.04-0.07 (97)

EST GRILSE RETURNS CORRECTED FOR NON-MATURING 1SW - (SMALL RET*PROP GRILSE), PROP GRILSE SFAs1,2&14B=0.8-0.9

EST RET TO FRESHWATER - (EST GRILSE RET-GRILSE CATCHES)

EST GRILSE SPAWNERS = EST GRILSE RETURNS TO FRESHWATER - GRILSE ANGLING CATCHES

*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78

Furthermore small catches in 1973 were adjusted by ratio of large:small in 1972&74 (SFA 1-1.4591, SFA 2-2.2225, SFA 14B-1.5506).

**Preliminary values adjusted for change in size category

Appendix 6(ii). Estimated numbers of 2SW salmon recruits, returns and spawners for Labrador salmon stocks including west Greenland.

	Commercial catches of large salmon			Labrador Origin Large returns before commercial fishery						Labrador 2SW Recruits prior to commercial fishery						Labrador 2SW Recruits,NF & Greenland SFAs 1,2 &14B		Labrador salmon Labrador at Greenland	Total+NF+WG		Labrador 2SW to rivers SFAs 1,2 &14B		Labrador 2SW spawners SFAs 1,2 &14B Angling catch subtracted	
Year	SFA 1	SFA 2	SFA 14B	SFA 1		SFA 2		SFA 14B		SFA 1		SFA 2		SFA 14B										
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
*1969	18929	48822	10300	12620	16826	32548	55797	6867	11772	8634	15144	19529	44637	4120	9418	32483	69198	34280	80636	133032	3248	20760	2890	20287
*1970	17633	45479	9595	11755	20152	30319	51976	6397	10963	8229	18137	18191	41581	3838	8773	30258	68490	56379	99561	154121	3026	20547	2676	20085
*1971	25127	64806	13673	16751	28716	43204	74064	9115	15626	11726	25845	25922	59251	5469	12501	43117	97596	24299	85831	163577	4312	29279	4012	28882
*1972	21599	55708	11753	14399	24685	37138	63666	7835	13432	10080	22216	22283	50933	4701	10746	37064	83895	59202	112096	178927	3706	25168	3435	24812
*1973	30204	77902	16436	20136	34519	51935	89031	10957	18784	14095	31067	31161	71225	6574	15027	51830	117319	22348	96314	189771	5183	35196	4565	34376
1974	13866	93036	15863	9244	15847	62024	106327	10575	18129	6471	14262	37214	85061	6345	14503	50030	113827	38035	109433	200476	5003	54148	4490	33475
1975	28601	71168	14752	19067	32687	47445	81335	9835	16859	13347	29418	28467	65068	5901	13488	47715	107974	40919	109012	195006	4772	32392	4564	32119
1976	38555	77796	15189	25703	44063	51864	88910	10126	17359	17992	39657	31118	71128	6076	13887	55186	124671	67730	146485	245646	5519	37401	4984	36701
1977	28158	70158	18664	18772	32181	46772	80181	12443	21330	13140	28963	28063	64144	7466	17064	48669	110171	28482	97937	185706	4867	33051	4042	31969
1978	30824	48934	11715	20549	35227	32623	55925	7810	13389	14385	31705	19574	44740	4686	10711	38644	87155	32668	87816	157045	3864	26147	3361	25490
1979	21291	27073	.3874	14194	24333	18049	30941	2583	4427	9936	21899	10829	24752	1550	3542	22315	50194	18636	50481	90267	2231	15058	1823	14528
1980	28750	87067	9138	19167	32857	58045	99505	6092	10443	13417	29571	34827	79604	3655	8355	51899	117530	21426	95490	189152	5190	35259	4633	34525
1981	36147	68581	7606	24098	41311	45721	78378	5071	8693	16869	37180	27432	62703	3042	6954	47343	106836	32768	100331	185233	4734	32051	4403	31615
1982	24192	53085	5966	16128	27648	35390	60669	3977	6818	11290	24883	21234	48535	2386	5455	34910	78873	43678	93497	156236	3491	23662	3080	23127
1983	19403	33320	7489	12935	22175	22213	38080	4993	8559	9055	19957	13328	30464	2996	6847	25378	57268	30804	67021	112531	2538	17181	2267	16824
1984	11726	25258	6218	7817	13401	16839	28866	4145	7106	5472	12061	10103	23093	2487	5685	18063	40859	4026	29802	62306	1806	12252	1478	11822
1985	13252	16789	3954	8835	15145	11193	19187	2636	4519	6184	13631	6716	15350	1582	3615	14481	32596	3977	24644	50494	1448	9779	1258	9530
1986	19152	34071	5342	12768	21888	22714	38938	3561	6105	8938	19699	13628	31151	2137	4884	24703	55734	17738	52991	97275	2470	16720	2177	16334
1987	18257	49799	11114	12171	20865	33199	56913	7409	12702	8520	18779	19920	45531	4446	10161	32885	74471	29695	76625	135970	3289	22341	2895	21821
1988	12621	32386	4591	8414	14424	21591	37013	3061	5247	5890	12982	12954	29610	1836	4197	20681	46739	27842	57355	94614	2068	14037	1625	13452
1989	16261	26836	4646	10841	18584	17891	30670	3097	5310	7588	16726	10734	24536	1858	4248	20181	45509	26728	55528	91673	2018	13653	1727	13270
1990	7313	17316	2858	4875	8358	11544	19790	1905	3263	3413	7522	6926	15832	1143	2613	11482	25967	9771	26158	46828	1148	7790	923	7493
1991	1369	7679	4417	913	1565	5119	8776	2945	5048	639	1408	3072	7021	1767	4038	5477	12467	7779	15596	25571	548	3740	491	3665
1992	9981	19608	2752	7219	13760	14182	27032	1990	3794	5053	12384	8509	21626	1194	3035	14756	37045	13713	28469	50758	2515	15548	2012	14889
1993	3825	9651	3620	3682	8021	9290	20238	3485	7591	2577	7219	5574	16190	2091	6073	10242	29482	6592	16834	36074	3858	18234	3624	17922
1994	3464	11056	857	4124	9453	13162	30170	1020	2339	2887	8507	7897	24136	612	1871	11396	34514	0	11396	34514	5653	24396	5339	23981
1995	2150	8714	312	5132	12100	20801	49043	745	1756	3593	10890	12481	39235	447	1405	16520	51530	0	16520	51530	12368	44205	12006	43726
1996	1375	5479	418	3609	8664	14382	34523	1097	2634	2526	7798	8629	27619	658	2107	11814	37523	4312	16126	41835	9113	32759	8838	32395
**1997	1393	5550														13167	28647	3806	16973	32453	9384	23833	9221	23646

Estimates are based on:

EST LARGE RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1 2&14B= 6- 8,SFA 1 0.64-0 72 & SFA 2 0 88-0.95 (97); EXP RATE-SFAs1,2&14B= 7- 9(69-91), 58- 83(92), 38- 62(93),.29- 50(94), 15-.26(95), .13-.23(96),

- SFA 1 0 22-0 40, SFA 2. 0 16-0 28 (97)

EST 2SW RETURNS - (EST LARGE RETURNS*PROP 2SW), PROP 2SW SFA 1= 7-.9,SFAs 2&14B=.6-.8

WG - are North American 1SW salmon of river age 4 and older of which 70% are Labrador origin

EST RET TO FRESHWATER - (EST 2SW RET-2SW CATCHES)

EST 2SW SPAWNERS = EST 2SW RETURNS TO FRESHWATER - 2SW ANGLING CATCHES

*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

**1997 Preliminary values adjusted for size category

Appendix 6(iii). Atlantic salmon returns to freshwater, total recruits prior to the commercial fishery and spawners summed for Salmon Fishing Area 3-14A, insular Newfoundland, 1969-1998.
Ret. = retained fish; Rel. = released fish.

	Small catch	Small returns to river		Small recruits		Small spawners		Large returns to river		Large recruits		Large catch	Large spawners		2SW returns to river		2SW spawners		2SW recruits	
Year	Retained	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Min	Max	Min	Max	Min	Max	Min	Max
1969	34944	108807	217349	217613	724497	73863	182405	10484	26767	34946	267666	2310	8174	24457	2245	9324	1408	8054	7483	93240
1970	30437	139570	279594	279139	931980	109133	249157	12627	30508	42091	305081	2138	10490	28371	3184	11851	2384	10642	10613	118509
1971	26666	112266	224994	224532	749980	85600	198328	9857	24146	32856	241462	1602	8255	22544	2385	9104	1810	8230	7951	91039
1972	24402	108509	217092	217018	723640	84107	192690	10046	23996	33485	239955	1380	8666	22616	2494	9129	1985	8358	8314	91288
1973	35482	143729	287832	287457	959438	108247	252350	13292	33061	44308	330613	1923	11369	31138	2995	11808	2275	10720	9982	118082
1974	26485	84667	169103	169335	563676	58182	142618	10821	21662	36069	216616	1213	9608	20449	1968	6702	1534	6043	6559	67021
1975	33390	111847	223890	223694	746300	78457	190500	12222	24478	40741	244782	1241	10981	23237	2382	8002	1959	7355	7940	80018
1976	34463	114787	229853	229573	766175	80324	195390	10756	21550	35855	215501	1051	9705	20499	2327	7663	2003	7160	7758	76630
1977	34352	109649	219106	219299	730354	75297	184754	9750	19493	32499	194933	2755	6995	16738	1880	6309	1134	5131	6267	63094
1978	28619	97070	194133	194141	647109	68451	165514	7873	15786	26243	157860	1563	6310	14223	2005	6419	1564	5728	6682	64194
1979	31169	106791	213327	213582	711091	75622	182158	5549	11113	18496	111128	561	4988	10552	1103	3691	992	3506	3677	36906
1980	35849	120355	240449	240709	801497	84506	204600	9325	18691	31084	186909	1922	7403	16769	2447	7794	1894	6928	8157	77936
1981	46670	156541	312697	313083	1042325	109871	266027	9553	19144	31845	191442	1369	8184	17775	2317	7475	1935	6874	7723	74746
1982	41871	139951	279115	279902	930383	98080	237244	9528	19097	31758	190971	1248	8280	17849	2975	9228	2635	8691	9915	92276
1983	32420	109378	218548	218756	728495	76958	186128	8911	17871	29703	178711	1382	7529	16489	2511	7915	2167	7364	8372	79148
1984	39331	129235	257256	258469	857521	89904	217925	8007	15995	26691	159955	511	7496	15484	2273	7117	2082	6829	7576	71166
1985	36552	120816	240985	241633	803283	84264	204433	3612	7680	12041	76800	0	3581	7649	961	3319	949	3300	3205	33186
1986	37496	124547	248688	249094	828961	87051	211192	6850	14103	22832	141030	0	6770	14023	1592	5402	1560	5354	5308	54020
1987	24482	125116	249856	250232	832852	100634	225374	6357	13068	21190	130684	0	6316	13027	1338	4629	1322	4605	4461	46293
1988	39841	132059	263363	264119	877877	92218	223522	6369	13330	21231	133299	0	6309	13270	1553	5346	1529	5310	5177	53459
1989	18462	59793	119261	119587	397537	41331	100799	3260	6752	10865	67518	0	3241	6733	704	2452	697	2441	2347	24517
1990	29967	98830	197276	197659	657588	68863	167309	5751	11868	19170	118675	0	5701	11817	1341	4562	1321	4532	4470	45620
1991	20529	64016	127698	128032	425661	43487	107169	4449	9173	14831	91734	0	4416	9140	1057	3577	1044	3557	3524	35771
1992	23118	116116	231954	116116	231954	92434	208272	15797	31897	15797	31897	0	15656	31756	3024	10354	2968	10270	3024	10354
1993	24693	131045	261721	131045	261721	104712	235387	7955	16227	7955	16227	0	7791	16063	1487	5217	1437	5139	1487	5217
1994	28959	95487	190655	95487	190655	65691	160859	7915	16099	7915	16099	0	7709	15894	1889	6255	1825	6156	1889	6255
1995	29055	111889	223758	111889	223758	81877	193746	8972	18182	8972	18182	0	8753	17963	2296	7462	2223	7350	2296	7462
1996	36715	141232	287587	141232	287587	102657	249011	11844	24487	11844	24487	0	11580	24223	2606	9007	2519	8874	2606	9007
1997	17388	86230	146833	86230	146833	68519	129122	12072	20872	12072	20872	0	11943	20743	2837	7213	2809	7167	2837	7213
1998	15207	119033	255093	119033	255093	102827	238887	19121	37273	19121	37273	0	18920	37072	4327	11735	4278	11656	4327	11735

SRR (Small returns to river) are the sum of Bay St. George small returns (Reddin & Mullins 1996) plus Humber R small returns (Mullins & Reddin 1996) plus small returns in SFAs 3-12 & 14A.
SSR (Small recruits) = SRR/(1-Exploitation rate commercial (ERC)) where ERC=0.5-0.7, 1969-91 & ERC=0, 1992-98.
SS (Small spawners) = SSR-(SC+(SR*0.1))
SC = small salmon catch retained
SR = small salmon catch released with assumed mortalities at 10%
RL (RATIO large:small) are from counting facilities in SFAs 3-11, 13 & 14A, angling catches in SFA 12.
LRR (Large returns to river) = SRR * RL
LR (Large recruits) = LRR*(1-Exploitation rate large (ERL)), where ERL=0.7-0.9, 1969-91; & ERL=0, 1992-98.
LS (Large spawners) = LRR-large catch retained (LC)-(0.1*large catch released)
2SW-RR (2SW returns to river)= LRR*proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-S (2SW spawners) = LS * proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-R (2SW recruits) = LR * proportion 2SW of 0.4-0.6 for SFAs 12-14A& 0.1-0.2 for SFAs 3-11.

Appendix 6(iv). Small, large and 2SW return and spawner estimates for SFA 15.

Year	Small salmon				Large salmon				Proportion of 2SW in large salmon	2SW salmon			
	Returns		Spawners		Returns		Spawners			Returns		Spawners	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
1970	3513	7505	1497	4418	24955	36452	1917	5548	0.65	16221	23694	1246	3606
1971	2629	5566	1116	3246	12096	17412	846	2335	0.65	7863	11318	550	1518
1972	2603	5537	1092	3235	10621	21963	4323	12085	0.59	6266	12958	2550	7130
1973	5146	9852	1589	4720	10588	21653	4184	11686	0.74	7835	16023	3096	8648
1974	2869	6007	1159	3422	13102	27353	5345	15221	0.73	9564	19968	3902	11112
1975	3150	6567	1262	3717	7229	13894	2413	6660	0.79	5711	10976	1906	5261
1976	11884	20582	2619	7647	12318	25396	5005	14313	0.76	9362	19301	3804	10878
1977	7438	14652	2606	7527	14011	28399	5728	15988	0.83	11629	23571	4754	13270
1978	5215	9595	1477	4244	9716	19224	3768	9917	0.75	7287	14418	2826	7437
1979	5451	11163	2223	6260	3655	6267	1114	2602	0.51	1864	3196	568	1327
1980	9692	18781	3164	9285	11473	22537	4577	11997	0.81	9294	18255	3708	9717
1981	11367	21188	3362	9669	12078	21265	3163	8305	0.47	5677	9995	1487	3903
1982	8889	16834	2736	7978	9431	15011	1810	4599	0.59	5565	8856	1068	2713
1983	3621	6207	799	2268	9281	14864	1654	4489	0.59	5476	8770	976	2648
1984	11861	18589	1646	4732	6924	12237	3603	7403	0.79	5470	9667	2847	5848
1985	8525	18272	3639	10801	9802	20224	7600	16096	0.63	6175	12741	4788	10140
1986	12895	27635	5490	16311	13324	27128	10333	21470	0.76	10126	20617	7853	16317
1987	11708	24768	4930	14408	9627	19058	6932	14401	0.64	6161	12197	4437	9217
1988	16037	34159	6796	20027	12796	26222	9932	20804	0.72	9213	18880	7151	14979
1989	7673	16088	3185	9249	9905	19797	7319	15185	0.57	5646	11284	4172	8655
1990	9527	19902	3975	11418	8125	16280	6066	12636	0.68	5525	11070	4125	8592
1991	5276	10962	2219	6270	6185	12207	4621	9388	0.50	3092	6104	2311	4694
1992	10529	22220	4462	12930	9530	19257	7125	14911	0.54	5146	10399	3848	8052
1993	6578	13541	2739	7643	4407	8742	3156	6647	0.40	1763	3497	1262	2659
1994	10446	21861	4390	12580	8493	17143	6379	13317	0.60	5096	10286	3828	7990
1995	3310	6832	1344	3830	5590	10880	3977	8132	0.65	3636	7077	2587	5290
1996	7468	15529	3259	9043	7796	15745	5902	12275	0.65	5067	10234	3836	7979
1997	7666	16238	3572	9898	5302	10602	4008	8295	0.65	3446	6891	2605	5392
1998	7657	18381	3710	12036	2871	7562	600	3976	0.65	1866	4916	390	2584

Return and spawner estimates for SFA 15 are based on Restigouche River data, scaled up for SFA 15 using angling data.
Restigouche stock assessment is based on angling catch with assumed exploitation rates between 50% (min.) and 30% (max).
The proportion of 2SW in large salmon numbers is based on aged scale samples from angling, trapnets, and broodstock.
No scale samples were available for 1970-71, 1995-96; the mean value of 0.65 is used here.
Salmon in the Quebec portions of the Restigouche River were subtracted from the total for the watershed.
The returns and spawners estimates thus derived for the SFA 15 portion of the Restigouche were then multiplied by the minumum (1.117) and maximum (1.465) ratios of angling catch in SFA15:SFA 15 portion of Restigouche catch to obtain estimates for SFA 15.

Appendix 6(v a). Returns and escapement of large salmon to SFA 16.

Year	2SW returns to SFA 16 Min.	Max.	Returns to the Miramichi River: Large returns	0.8 Min.	1.33 Max.	Prop. 2SW	2SW Returns to Miramichi Min	Max	Returns of large salmon to SFA 16 Min	Max
1971	19697	32746	24407	19526	32461	0.918	17924	29799	21457	35672
1972	24645	40972	29049	23239	38635	0.965	22427	37284	25538	42456
1973	22896	38065	27192	21754	36165	0.958	20835	34639	23905	39742
1974	33999	56523	42592	34074	56647	0.908	30939	51436	37444	62250
1975	21990	36558	28817	23054	38327	0.868	20011	33267	25334	42117
1976	17118	28459	22801	18241	30325	0.854	15578	25898	20045	33325
1977	43160	71753	51842	41474	68950	0.947	39275	65296	45575	75769
1978	18539	30822	24493	19594	32576	0.861	16871	28048	21532	35797
1979	5484	9117	9054	7243	12042	0.689	4991	8297	7960	13233
1980	30332	50426	36318	29054	48303	0.95	27602	45888	31928	53080
1981	9489	15775	16182	12946	21522	0.667	8635	14355	14226	23651
1982	21875	36368	30758	24606	40908	0.809	19907	33095	27040	44954
1983	19762	32854	27924	22339	37139	0.805	17983	29897	24549	40812
1984	12562	20884	15137	12110	20132	0.944	11431	19005	13307	22123
1985	15861	26369	20738	16590	27582	0.87	14434	23996	18231	30309
1986	23460	39003	31285	25028	41609	0.853	21349	35493	27503	45724
1987	13590	22594	19421	15537	25830	0.796	12367	20561	17073	28385
1988	15599	25933	21745	17396	28921	0.816	14195	23599	19116	31781
1989	9880	16426	17211	13769	22891	0.653	8991	14948	15131	25155
1990	15474	25725	28574	22859	38003	0.616	14081	23410	25120	41762
1991	15929	26482	29949	23959	39832	0.605	14495	24098	26329	43772
1992	19191	31905	37000	29600	49210	0.590	17464	29034	32527	54077
1993	21662	36012	35200	28160	46816	0.7	19712	32771	30945	51446
1994	14582	37515	27450	18278	47023	0.726	13270	34139	20086	51674
1995	18879	48135	32627	19747	50348	0.87	17180	43803	21700	55327
1996	13034	24328	24812	17443	32557	0.68	11861	22139	19168	35777
1997	10957	20049	18422	14183	25953	0.703	9971	18245	15586	28520
1998	4129	6882	9500	7500	12500	0.501	3758	6263	8242	13736

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.

For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.

For 1994 to 1997, min and max are 5th and 95th percentiles from the assessment.

Prop. 2SW are from scale ageing.

Miramichi makes up 91% of total rearing area of SFA 16.

Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 2SW returns to Miramichi / 0.91

Same procedure for escapements as used to calculate returns.

Year	Escapement of 2SW to SFA 16 Min	Max	Escapements to the Miramichi River: Large	0.8 Min.	1.33 Max.	Prop. 2SW	Escapement of 2SW Min	Max	Escapement of large salmon to SFA 16 Min	Max
1971	3508	5832	4347	3478	5782	0.918	3192	5307	3822	6353
1972	14992	24924	17671	14137	23502	0.965	13643	22681	15535	25827
1973	17134	28486	20349	16279	27064	0.958	15592	25922	17889	29741
1974	27495	45711	34445	27556	45812	0.908	25021	41597	30281	50343
1975	16366	27209	21448	17158	28526	0.868	14893	24760	18855	31347
1976	10760	17889	14332	11466	19062	0.854	9792	16279	12600	20947
1977	27404	45560	32917	26334	43780	0.947	24938	41459	28938	48109
1978	8197	13627	10829	8663	14403	0.861	7459	12401	9520	15827
1979	2751	4573	4541	3633	6040	0.689	2503	4161	3992	6637
1980	15762	26204	18873	15098	25101	0.95	14343	23846	16592	27584
1981	2702	4492	4608	3686	6129	0.667	2459	4088	4051	6735
1982	9429	15676	13258	10606	17633	0.809	8581	14265	11655	19377
1983	5986	9951	8458	6766	11249	0.805	5447	9056	7436	12362
1984	12189	20264	14687	11750	19534	0.944	11092	18440	12912	21466
1985	15390	25586	20122	16098	26762	0.87	14005	23283	17690	29409
1986	22659	37670	30216	24173	40187	0.853	20619	34280	26564	44162
1987	12635	21006	18056	14445	24014	0.796	11498	19116	15873	26390
1988	15050	25021	20980	16784	27903	0.816	13696	22769	18444	30663
1989	8921	14831	15540	12432	20668	0.653	8118	13496	13662	22712
1990	14940	24838	27588	22070	36692	0.616	13595	22602	24253	40321
1991	15472	25721	29089	23271	38688	0.605	14079	23406	25573	42515
1992	18984	27603	35927	29281	42573	0.590	17275	25118	32176	46784
1993	21755	31632	34702	28282	41122	0.7	19797	28785	31079	45189
1994	14207	37140	27147	17808	46553	0.726	12929	33797	19569	51157
1995	18345	47600	32093	19188	49789	0.87	16694	43316	21086	54713
1996	12510	23804	23478	16741	31855	0.68	11384	21661	18397	35005
1997	10319	19411	17596	13357	25127	0.703	9390	17664	14678	27612
1998	3923	6725	9000	7000	12000	0.51	3570	6120	7692	13187

Appendix 6(v b). Returns and escapements of small salmon to SFA 16.

	1SW returns to SFA 16		Returns to the Miramichi River			Prop. 1SW Returns to Miramichi		
				0.8	1.33	1SW	0.97	1.00
Year	Min.	Max.	Small	Min.	Max.		Min	Max
1971	30420	52137	35673	28538	47445		27682	47445
1972	39461	67633	46275	37020	61546		35909	61546
1973	37986	65104	44545	35636	59245		34567	59245
1974	62607	107303	73418	58734	97646		56972	97646
1975	55345	94857	64902	51922	86320		50364	86320
1976	78095	133848	91580	73264	121801		71066	121801
1977	23658	40547	27743	22194	36898		21529	36898
1978	20711	35496	24287	19430	32302		18847	32302
1979	43460	74487	50965	40772	67783		39549	67783
1980	35464	60782	41588	33270	55312		32272	55312
1981	55661	95399	65273	52218	86813		50652	86813
1982	68543	117477	80379	64303	106904		62374	106904
1983	21476	36807	25184	20147	33495		19543	33495
1984	25333	43418	29707	23766	39510		23053	39510
1985	51847	88862	60800	48640	80864		47181	80864
1986	100240	171802	117549	94039	156340		91218	156340
1987	72327	123962	84816	67853	112805		65817	112805
1988	103966	178189	121919	97535	162152		94609	162152
1989	64153	109953	75231	60185	100057		58379	100057
1990	71160	121962	83448	66758	110986		64756	110986
1991	51906	88962	60869	48695	80956		47234	80956
1992	132610	198777	152647	124407	180887		120675	180887
1993	80271	120323	92400	75306	109494		73047	109494
1994	44288	92257	56929	41549	83954		40303	83954
1995	20998	85127	54145	19699	77466		19108	77466
1996	40133	73318	44377	37651	66719		36521	66719
1997	18980	33143	22565	17806	30160		17272	30160
1998	29313	45055	33000	27500	41000		26675	41000

Returns to the Miramichi are from the assessment. Min. and max values are based on capture efficiencies of Millbank trapnet which gave a lower CI of -20% of estimate and upper CI of 33% of estimate.
For 1992 and 1993, lower and upper CI are based on estimate bounds of -18.5% to +18.5%.
For 1994 to 1997, min and max are 5th and 95th percentiles from the assessment.
Prop. 1SW are from scale ageing. Proportions vary from 0.97 to 1.00. Ref. Moore et al. 1995.
Miramichi makes up 91% of total rearing area of SFA 16.
Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 1SW returns to Miramichi / 0.91
Same procedure for escapements as used to calculate returns.

	Escapement of 1SW to SFA 16		Escapement to the Miramichi				Escapement of 1SW	
				0.8	1.33	Prop.	Min	Max
Year	Min	Max	Small	Min.	Max.	1SW	0.97	1
1971	18714	32075	21946	17557	29188		17030	29188
1972	23139	39659	27135	21708	36090		21057	36090
1973	26169	44852	30688	24550	40815		23814	40815
1974	47060	80656	55186	44149	73397		42824	73397
1975	41332	70839	48469	38775	64464		37612	64464
1976	53194	91171	62380	49904	82965		48407	82965
1977	11296	19361	13247	10598	17619		10280	17619
1978	12239	20977	14353	11482	19089		11138	19089
1979	26306	45086	30848	24678	41028		23938	41028
1980	22934	39307	26894	21515	35769		20870	35769
1981	34049	58358	39929	31943	53106		30985	53106
1982	47754	81846	56000	44800	74480		43456	74480
1983	12662	21702	14849	11879	19749		11523	19749
1984	16142	27665	18929	15143	25176		14689	25176
1985	35658	61114	41815	33452	55614		32448	55614
1986	76234	130659	89398	71518	118899		69373	118899
1987	53533	91751	62777	50222	83493		48715	83493
1988	76984	131945	90278	72222	120070		70056	120070
1989	41260	70717	48385	38708	64352		37547	64352
1990	50759	86997	59524	47619	79167		46191	79167
1991	41161	70547	48269	38615	64198		37457	64198
1992	112317	168359	129288	105370	153206		102209	153206
1993	66385	99509	76416	62279	90553		60411	90553
1994	27829	75289	42479	26108	68513		25325	68513
1995	13079	53561	34084	12270	48740		11902	48740
1996	19278	51818	24812	18086	47154		17543	47154
1997	8762	22609	12979	8220	20574		7973	20574
1998	11725	26923	16500	11000	24500		10670	24500

Appendix 6(vi). Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1970-98. Ret. = retained fish, Rel. = released fish.

Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1955-1998. Ret. = retained fish; Rel. = released fish.

Year	Small (<63 cm)			Large (>= 63 cm)			Total (Small + Large)			Percent	Small recruits		Small spawners		Large recruits		Large spawners		2SW recruits		2SW spawners	
	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	small	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1970	0	.	.	13	.	.	13	.	.	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	.	.	0	.	.	0	.	.		0	0	0	0	0	0	0	0	0	0	0	0
1972	0	.	.	7	.	.	7	.	.	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	2	.	.	0	.	.	2	.	.	100	5	9	3	7	0	0	0	0	0	0	0	0
1974	0	.	.	2	.	.	2	.	.	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	.	.	0	.	.	0	.	.		0	0	0	0	0	0	0	0	0	0	0	0
1976	6	.	.	1	.	.	7	.	.	86	14	28	8	22	2	5	1	4	2	5	1	4
1977	0	.	.	0	.	.	0	.	.		0	0	0	0	0	0	0	0	0	0	0	0
1978	0	.	.	0	.	.	0	.	.		0	0	0	0	0	0	0	0	0	0	0	0
1979	1	.	.	2	.	.	3	.	.	33	2	5	1	4	5	9	3	7	5	9	3	7
1980	5	.	.	1	.	.	6	.	.	83	12	23	7	18	2	5	1	4	2	5	1	4
1981	108	.	.	4	.	.	112	.	.	87	259	498	151	390	40	77	36	73	40	77	36	73
1982	73	.	.	8	.	.	81	.	.	92	175	336	102	263	16	31	8	23	16	31	8	23
1983	7	.	.	2	.	.	9	.	.	50	17	32	10	25	17	32	15	30	17	32	15	30
1984	7	.	.	0	.	.	7	.	.	56	17	32	10	25	13	26	13	26	13	26	13	26
1985	47	.	.	0	.	.	47	.	.	93	113	217	66	170	8	15	8	15	8	15	8	15
1986	236	.	.	0	.	.	236	.	.	99	566	1088	330	852	5	11	5	11	5	11	5	11
1987	476	.	.	0	.	.	476	.	.	94	1141	2194	665	1718	66	128	66	128	66	128	66	128
1988	643	.	.	0	.	.	643	.	.	94	1542	2963	899	2320	96	185	96	185	96	185	96	185
1989	167	.	.	0	.	.	167	.	.	73	400	770	233	603	149	287	149	287	149	287	149	287
1990	768	.	.	0	.	.	768	.	.	87	1842	3539	1074	2771	284	545	284	545	284	545	284	545
1991	657	1033	1690	0	164	164	657	1197	1854	89	1576	3028	919	2371	188	361	188	361	188	361	188	361
1992	781	.	.	0	.	.	781	.	.	95	1873	3599	1092	2818	95	183	95	183	95	183	95	183
1993	533	.	.	0	.	.	533	.	.	98	1277	2454	745	1922	22	43	22	43	22	43	22	43
1994	92	111	203	3	99	102	95	210	305	55	209	383	117	291	168	309	165	306	168	309	165	306
1995	473	146	595	4	95	99	477	241	718	93	1058	1915	585	1442	85	154	81	150	85	154	81	150
1996	422	270	692	4	150	154	426	420	846	88	1159	2573	737	2151	158	351	154	347	158	351	154	347
1997	202	92	294	1	36	37	203	128	331	94	484	931	282	729	31	59	30	58	31	59	30	58
1998	269	135	404	2	69	71	271	204	475	89	645	1240	376	971	80	153	78	151	80	153	78	151
55-88 X̄	85			2			87			64	203	391	119	306	14	27	13	27	14	27	13	27
89-98 X̄	436	298	646	1	102	105	438	400	755	86	1052	2043	616	1607	126	245	125	243	126	245	125	243

Notes

CPUE is retained catch per rod-day.

In the above table a period indicates no data.

Retained fish include native harvest and estimated hook-and-released mortality

Size of angled salmon was not recorded in 1955-1969. Numbers of small and large salmon for these years are estimated from the overall small:large ratio for 1970-1980.

Number of small retained salmon in 1993 was not recorded. The number given is the mean for 1986-1992

For 1959-1969, percent small is the percent measured in 1970-1980. For 1970-1980, percent small is calculated from numbers of small and large salmon in the retained catch in each year. For 1981-1997, percent small is calculated from numbers of small and large salmon taken at the Leard's Pond trap. For 1998, percent small is taken from seining catches at Mooneys Pool.

Small recruits are calculated as small retained salmon/exploitation rate. Angler exploitation was calculated as 0.34, 0.347, and 0.264 of estimated returns in 1994, 1995, and 1996, respectively. For other years the mean of these values is used. The min and max numbers of small recruits are calculated using max numbers of small recruits are calculated using exploitation + or - 0.1; e.g. 0.34 + or - 0.1 gives 0.24 and 0.44.

Small spawners = number of small recruits - number of small retained

Large recruits = (number of small recruits/(0.01*percent small))-number of small recruits

Large spawners = number of large recruits - number of large retained

It is asssumed that large salmon and 2SW salmon are equivalent

Appendix 6(viia). Total 2SW returns and spawners to SFA 18, 1970-1998.

	LARGE RETURNS						Commercial catches			TOTAL 2SW		SPAWNERS				TOTAL	
	Margaree		SFA 18		2SW RETURNS			2SW ctch		RETURNS		Margaree		SFA 18		SPAWNERS	
	Large salmon		1.24	2.15	0.77	0.87	Zone 6	0.77	0.87	(inc. comm.)				1.24	2.15	0.77	0.87
Year	Min	Max	Min	Max	Min	Max	(kg)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1970	581	1,000	723	2,151	556	1,871	30,440	4,262	4,815	4,818	6,686	657	1,145	817	2,462	629	2,142
1971	254	437	316	940	243	818	12,001	1,680	1,898	1,923	2,716	256	446	318	959	245	834
1972	284	488	353	1,050	272	914	31,840	4,458	5,037	4,729	5,950	272	474	338	1,019	261	887
1973	316	544	393	1,170	303	1,018	27,694	3,877	4,381	4,180	5,399	287	499	356	1,074	274	934
1974	289	498	360	1,070	277	931	37,437	5,241	5,922	5,518	6,853	318	554	396	1,191	305	1,036
1975	173	298	215	641	166	558	23,631	3,308	3,738	3,474	4,296	214	372	266	800	205	696
1976	222	381	276	819	213	713	18,361	2,571	2,904	2,783	3,617	267	465	332	1,000	256	870
1977	378	651	470	1,400	362	1,218	26,221	3,671	4,148	4,033	5,366	393	683	488	1,469	376	1,278
1978	427	735	531	1,581	409	1,375	30,216	4,230	4,780	4,639	6,155	510	888	635	1,909	489	1,661
1979	219	377	272	811	210	705	7,917	1,108	1,252	1,318	1,958	265	461	330	991	254	863
1980	378	651	470	1,400	362	1,218	24,412	3,418	3,862	3,780	5,080	497	865	618	1,860	476	1,618
1981	375	647	466	1,391	359	1,211	15,562	2,179	2,462	2,538	3,672	451	785	561	1,688	432	1,469
1982	484	833	602	1,791	463	1,559	26,664	3,733	4,218	4,196	5,776	555	965	690	2,076	531	1,806
1983	402	693	500	1,490	385	1,297	24,280	3,399	3,841	3,784	5,137	480	834	596	1,794	459	1,561
1984	327	583	407	1,254	313	1,091	15,140	2,120	2,395	2,433	3,486	296	532	368	1,144	283	995
1985	1,109	2,217	1,379	4,768	1,062	4,148		0	0	1,062	4,148	1,025	2,133	1,275	4,587	981	3,991
1986	2,738	5,680	3,405	12,216	2,622	10,628		0	0	2,622	10,628	2,583	5,525	3,212	11,882	2,473	10,338
1987	2,976	6,540	3,701	14,065	2,850	12,237		0	0	2,850	12,237	2,860	6,424	3,557	13,816	2,739	12,020
1988	1,286	2,494	1,599	5,364	1,231	4,666		0	0	1,231	4,666	1,143	2,351	1,421	5,056	1,094	4,399
1989	1,708	3,693	2,124	7,942	1,635	6,910		0	0	1,635	6,910	1,583	3,568	1,969	7,673	1,516	6,676
1990	3,481	7,933	4,329	17,061	3,333	14,843		0	0	3,333	14,843	3,347	7,799	4,162	16,773	3,205	14,592
1991	1,853	5,785	2,304	12,441	1,774	10,824		0	0	1,774	10,824	1,692	5,624	2,104	12,095	1,620	10,523
1992	4,875	9,375	6,062	20,162	4,668	17,541		0	0	4,668	17,541	4,722	9,222	5,872	19,833	4,522	17,255
1993	2,408	6,158	2,995	13,244	2,306	11,522		0	0	2,306	11,522	2,274	6,024	2,828	12,955	2,177	11,271
1994	2,350	4,500	2,922	9,678	2,250	8,420		0	0	2,250	8,420	2,209	4,359	2,747	9,375	2,115	8,156
1995	1,750	3,815	2,176	8,205	1,676	7,138		0	0	1,676	7,138	1,693	3,758	2,105	8,082	1,621	7,031
1996	2,214	4,050	2,753	8,710	2,120	7,578		0	0	2,120	7,578	2,001	3,837	2,488	8,252	1,916	7,179
1997	3,268	5,435	4,064	11,689	3,129	10,169		0	0	3,129	10,169	3,006	5,173	3,738	11,125	2,878	9,679
1998	2,283	3,798	2,839	8,168	2,186	7,106		0	0	2,186	7,106	2,107	3,622	2,620	7,790	2,018	6,777

Yr	SFA 18	Marg-aree	Ratio
84	449	305	1.47
85	1706	1215	1.40
86	4448	2636	1.69
87	3012	1857	1.62
88	3078	1932	1.59
89	3206	1570	2.04
90	2391	1507	1.59
91	3470	1757	1.97
92	3315	1938	1.71
93	2370	1102	2.15
94	2043	1479	1.38
95	1633	1040	1.57
96	3921	1864	2.10
97	2609	2098	1.24
98	2318	1466	1.58
		Min	1.244
		Max	2.151

Margaree returns, 1970-84, equal catch /min (0.215) or max (0.37) exploitation rate.

Return of large salmon (MIN) and (MAX)to all SFA 18 equals Margaree returns * ratio Margaree catch to SFA 18 catch.

Margaree returns 1984-1998 based on various Margaree CAFSAC , DFO Atl. Res and CSAS Res Docs.

Margaree catch to SFA 18 catch; MIN _MAX 2SW based on the ratio 0.77-0.87 2SW fish among MSW fish.

Margaree escapements 1970-1983 = returns minus removals; 1984-1996 from various Margaree CAFSAC, DFO Atl. Fish. and CSAS Res.

Docs e.g., Marshall et al. (MS 1998) 2SW equal 0.77-0.87 of MSW fish; Margaree raised to SFA by respective ratios in sport catch

Appendix 6(viib). Total 1SW returns and spawners to SFA 18, 1970-1998.

	RETURNS				SPAWNERS			
	Margaree		SFA 18		Margaree		SFA 18	
	0.37	0.21	1.214	2.378			1.214	2.378
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	230	395	279	940	145	310	176	738
1971	57	98	69	232	36	77	43	182
1972	114	195	138	465	72	153	87	365
1973	449	772	545	1,836	283	606	343	1,441
1974	162	279	197	664	102	219	124	521
1975	97	167	118	398	61	131	74	313
1976	259	447	315	1,062	163	351	198	834
1977	186	321	226	763	117	252	143	599
1978	68	116	82	277	43	91	52	217
1979	1,614	2,777	1,959	6,604	1,017	2,180	1,234	5,184
1980	451	777	548	1,847	284	610	345	1,450
1981	2,430	4,181	2,950	9,944	1,531	3,282	1,859	7,806
1982	1,868	3,214	2,267	7,643	1,177	2,523	1,429	6,000
1983	184	316	223	752	116	248	141	590
1984	400	688	486	1,636	158	446	192	1,061
1985	634	1,167	770	2,775	125	658	152	1,565
1986	838	1,420	1,017	3,377	56	638	68	1,517
1987	1,143	1,865	1,388	4,435	166	888	202	2,112
1988	1,674	2,911	2,032	6,923	795	2,032	965	4,832
1989	591	977	718	2,323	30	416	36	989
1990	940	5,077	1,141	12,074	291	4,428	353	10,530
1991	794	3,891	964	9,253	42	3,139	51	7,465
1992	1,258	2,419	1,527	5,753	701	1,862	851	4,428
1993	1,489	3,851	1,808	9,158	906	3,268	1,100	7,772
1994	573	1,101	696	2,618	259	787	314	1,872
1995	538	1,083	653	2,576	329	874	399	2,079
1996	1,277	2,960	1,550	7,039	935	2,618	1,135	6,226
1997	316	1,517	384	3,608	74	1,299	90	3,089
1998	357	1,625	433	3,864	132	1,400	160	3,329

Recreational ctch:

Year	SFA 18	Marg-aree	Ratio
1984	298	242	1.23
1985	618	509	1.21
1986	1,180	782	1.51
1987	1,289	977	1.32
1988	1,349	879	1.53
1989	928	561	1.65
1990	1,206	649	1.86
1991	1,262	752	1.68
1992	1,242	678	1.83
1993	1,218	777	1.57
1994	659	429	1.54
1995	710	333	2.13
1996	2,021	918	2.20
1997	558	316	1.77
1998	849	357	2.38
		Min	1.214
		Max	2.378

Margaree returns, 1970-83, equal catch divided by MIN (0.215) and MAX (0.37) exploitation rate.
Return of small salmon to all SFA 18 equals Margaree returns * MIN and MAX ratio of
Margaree catch to SFA 18 catch. Margaree returns, 1984-1998, based on annual assessments
in CAFSAC and DFO Atl. Fish. and Can. Sec. Assess.Stocks Res. Docs, eg., Marshall et al. (MS 1998).
Spawners for 1970-1983 equal returns minus removals; 1984-1996 from various Margaree CAFSAC,
Atl. Res. and CSAS Res Doc. series, eg., Marshall et al. (MS 1998).

ppendix 6(viii). Total 1SW returns and spawners, SFAs 19, 20, 21 and 23, 1970-1998.

Year	RETURNS: River returns SFA 19-21 MIN	RETURNS: River returns SFA 19-21 MAX	RETURNS: Commercial 19-21	RETURNS: SFA 23 Wild MIN	RETURNS: SFA 23 Wild MAX	RETURNS: SFA 23 Hatch	TOTAL RETURNS SFAs 19,20,21,23 MIN	TOTAL RETURNS SFAs 19,20,21,23 MAX	SPAWNERS: angled 19-21	SPAWNERS: Spawners 19-21 MIN	SPAWNERS: Spawners 19-21 MAX	SPAWNERS: SFA 23 H+W rtns MIN	SPAWNERS: SFA 23 H+W rtns MAX	SPAWNERS: SFA 23 Harvest	TOTAL SPAWNERS 19,20,21,23 MIN	TOTAL SPAWNERS 19,20,21,23 MAX
1970	8,236	16,868	3,189	5,206	7,421	100	16,731	27,578	3,609	4,627	13,259	5,306	7,521	1,420	8,513	19,360
1971	6,345	13,062	1,922	2,883	4,176	365	11,515	19,525	2,761	3,584	10,301	3,248	4,541	2,032	4,800	12,810
1972	6,636	13,354	1,055	1,546	2,221	285	9,522	16,915	2,917	3,719	10,437	1,831	2,506	2,558	2,992	10,385
1973	8,225	16,744	1,067	3,509	5,047	1,965	14,766	24,823	3,604	4,621	13,140	5,474	7,012	1,437	8,658	18,715
1974	14,478	29,385	2,050	6,204	8,910	3,991	26,723	44,336	6,340	8,138	23,045	10,195	12,901	2,124	16,209	33,822
1975	5,096	10,393	2,822	11,648	16,727	6,374	25,940	36,316	2,227	2,869	8,166	18,022	23,101	2,659	18,232	28,608
1976	12,421	25,398	1,675	13,761	19,790	9,074	36,931	55,937	5,404	7,017	19,994	22,835	28,864	5,263	24,589	43,595
1977	13,349	27,943	3,773	6,746	9,679	6,992	30,860	48,387	5,841	7,508	22,102	13,738	16,671	4,542	16,704	34,231
1978	2,535	5,241	3,651	3,227	4,651	3,044	12,457	16,587	1,113	1,422	4,128	6,271	7,695	2,015	5,678	9,808
1979	12,365	25,381	3,154	11,529	16,690	3,827	30,875	49,052	5,428	6,937	19,953	15,356	20,517	3,716	18,577	36,754
1980	16,534	33,825	8,252	14,346	20,690	10,793	49,925	73,560	7,253	9,281	26,572	25,139	31,483	5,542	28,878	52,513
1981	18,594	38,329	1,951	11,199	16,176	5,627	37,371	62,083	8,163	10,431	30,166	16,826	21,803	9,021	18,236	42,948
1982	10,008	20,552	2,020	8,773	12,598	3,038	23,839	38,208	4,361	5,647	16,191	11,811	15,636	5,279	12,179	26,548
1983	4,662	9,562	1,621	7,706	11,028	1,564	15,553	23,775	2,047	2,615	7,515	9,270	12,592	4,138	7,747	15,969
1984	12,398	25,815	0	14,105	20,227	1,451	27,954	47,493	4,724	7,674	21,091	15,556	21,678	5,266	17,964	37,503
1985	16,354	34,055	0	11,038	15,910	2,018	29,410	51,983	6,360	9,994	27,695	13,056	17,928	4,892	18,158	40,731
1986	16,661	34,495	0	13,412	19,321	862	30,935	54,678	6,182	10,479	28,313	14,274	20,183	3,549	21,204	44,947
1987	18,368	37,902	0	10,030	14,334	3,328	31,746	55,564	7,056	11,332	30,846	13,358	17,662	3,101	21,589	45,407
1988	16,611	33,851	0	15,131	21,834	1,250	32,992	56,935	6,384	10,227	27,467	16,381	23,084	3,320	23,288	47,231
1989	17,378	35,141	0	16,240	23,182	1,339	34,957	59,662	6,629	10,749	28,512	17,579	24,521	4,455	23,873	48,578
1990	20,119	41,652	0	12,287	17,643	1,533	33,939	60,828	7,391	12,728	34,261	13,820	19,176	3,795	22,753	49,642
1991	6,718	13,870	0	10,602	15,246	2,439	19,759	31,555	2,399	4,319	11,471	13,041	17,685	3,546	13,814	25,610
1992	9,269	18,936	0	11,340	16,181	2,223	22,832	37,340	3,629	5,640	15,307	13,563	18,404	4,078	15,125	29,633
1993	9,104	18,711	0	7,610	8,828	foot-	16,714	27,539	3,327	5,777	15,384	5,762	6,868	foot-	11,539	22,252
1994	2,446	4,973	0	5,770	6,610	note:"a"	8,216	11,583	493	1,953	4,480	4,965	5,738	note:"a"	6,918	10,218
1995	5,974	12,364	0	8,265	9,458		14,239	21,822	1,885	4,089	10,479	8,025	9,218		12,114	19,697
1996	9,888	20,791	0	12,907	15,256		22,795	36,047	2,211	7,677	18,580	11,576	13,892		19,253	32,472
1997	2,665	5,488	0	4,508	4,979		7,173	10,467	493	2,172	4,995	3,971	4,433		6,143	9,428
1998	4,308	9,025	0	9,203	10,801		13,511	19,826	0	4,308	9,025	8,775	10,348		13,083	19,373

SFAs 19,20,21: Returns estimated as run size (1SW recreational catch / expl. rate [0 2 t0 0 45]; where MIN and MAX selected as 5th and 95th percentiles values from 1,000 monte carlo estimates) + estimated 1SW fish in commercial landings 1970-1983 (Cutting et al. MS 1985).

SFA 22: Inner Fundy stocks and inner-Fundy SFA 23 (primarily 1SW fish) do not go to the North Atlantic.

SFA 23. Similar approach as for SFAs 19-21 except that estimated wild 1SW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch and estimated proportions that production above Mactaquac is of the total (0.4-0 6) river replaced exploitataion rates, Marshall (MS 1992) (commercial harvest, bi-catch etc., incl. in estimated returns); hatchery returns attributed to above Mactaquac only; 1SW production in rest of SFA (outer Fundy) omitted.

a- Revision of method, SFA 23, 1993-1998, estimated returns to Nashwaak fence raised by proportion of area below Mactaquac (0 21-0.30) and added to total estimated returns originating upriver of Mactaquac (Marshall et al. 1998b); MIN and MAX removals below Mactaquac based on Nashwaak losses, Mactaquac losses are a single value and together summed and removed from returns to establish estimate of spawners

SFAs 19-21, estimate of returns for 1998 based on regression of Lal lave wild counts on MIN and MAX estimates of total SFA 19-21 returns, 1984-1997, because there was no angling in SFAs 20-21 in1998.

Values in SFAs 19-21, revised from previous year using final estimates of recreational catch for 1997.

Appendix 6(ixa). Total 2SW returns to SFAs 19, 20, 21 and 23, 1970-1998.

Year	***SFA 19*** MIN	MAX	***SFA 20*** MIN	MAX	***SFA 21*** MIN	MAX	Total Comm-ercial 19-21	***SFA 23*** Wild MIN	Wild MAX	Htch MIN	Htch MAX	***TOTAL SFAs 19,20,21,23*** MIN	MAX
	2SW=0.7-0.9 Exp. rate=0.2-0.45		2SW=0.6-0.9 Exp. rate=0.2-0.45		2SW=0.5-0.9 Exp. rate=0.2-0.45			2SW= 0.85-0.95 p. abv= 0.4-0.6		2SW= 0.85-0.95			
1970	1,170	2,537	658	1,535	597	1,525	2,644	8,540	12,674	0	0	13,609	20,915
1971	600	1,266	344	802	481	1,199	2,607	7,089	10,463	66	73	11,187	16,410
1972	735	1,614	421	1,002	454	1,198	4,549	7,362	10,809	507	559	14,028	19,731
1973	726	1,571	665	1,532	546	1,437	4,217	3,773	5,559	432	477	10,359	14,793
1974	1,035	2,225	691	1,588	548	1,397	8,873	8,766	12,790	1,989	2,198	21,902	29,071
1975	376	824	149	343	882	2,321	9,430	11,217	16,490	1,890	2,088	23,944	31,496
1976	791	1,672	346	822	441	1,146	5,916	12,304	18,106	1,970	2,175	21,768	29,837
1977	999	2,152	660	1,509	873	2,354	9,205	14,539	21,420	2,330	2,575	28,606	39,215
1978	810	1,739	429	995	655	1,706	6,827	6,059	8,903	2,166	2,391	16,946	22,561
1979	532	1,169	431	978	508	1,288	2,326	4,149	6,084	1,016	1,123	8,962	12,968
1980	1,408	3,051	746	1,714	1,483	3,989	9,204	16,500	24,041	2,556	2,824	31,897	44,823
1981	886	1,856	926	2,133	1,754	4,475	4,438	8,696	12,690	2,330	2,577	19,030	28,169
1982	917	1,990	316	746	682	1,756	5,819	8,266	12,198	1,516	1,673	17,516	24,182
1983	477	1,030	641	1,475	552	1,434	2,978	8,718	12,793	944	1,043	14,310	20,753
1984	828	1,768	638	1,500	766	2,004	0	14,753	21,573	953	1,054	17,938	27,899
1985	1,495	3,132	2,703	6,355	2,102	5,469	0	15,793	23,002	748	826	22,841	38,784
1986	3,500	7,541	2,561	5,987	2,150	5,312	0	9,210	13,507	681	754	18,102	33,101
1987	2,427	5,237	1,066	2,527	1,114	2,872	0	6,512	9,590	410	453	11,529	20,679
1988	2,635	5,724	1,914	4,464	1,105	2,945	0	3,936	5,836	780	861	10,370	19,830
1989	2,236	4,810	1,512	3,485	1,631	4,086	0	6,159	8,994	401	443	11,939	21,818
1990	2,406	5,178	1,085	2,515	1,271	3,260	0	4,994	7,375	492	543	10,248	18,871
1991	1,890	4,050	965	2,200	421	1,071	0	6,739	9,902	598	661	10,613	17,884
1992	1,788	3,923	631	1,488	480	1,236	0	6,213	9,074	665	735	9,777	16,456
1993	876	1,897	1,006	2,321	564	1,498	0	4,318	5,371	foot-		6,764	11,087
1994	833	1,845	242	561	305	773	0	2,999	3,729	note "a"		4,379	6,908
1995	759	1,582	666	1,565	518	1,339	0	3,042	3,831			4,985	8,317
1996	1,231	2,692	604	1,404	894	2,293	0	4,498	5,665			7,227	12,054
1997	607	1,299	170	387	301	1,026	0	2,567	3,210			3,645	5,922
1998	>>>>>>>>>.>>>>>		1,103	3,888	<<<<<<<<<<<<<<<		0	1,625	2,115			2,728	6,003

SFAs 19,20,21: Returns estimated as run size (MSW recreational catch * prop. 2SW [range of values]/ expl. rate [range of values]; where MIN and MAX selected as 5th and 95th percentile values from 1,000 monte carlo estimates) + estimated 2SW fish in commercial landings 1970-1983 (cutting et al. MS 1985)

SFA 22: Inner Fundy stocks do not go to north Atlantic.

SFA 23: Similar approach as for SFAs 19-21 except that estimated wild MSW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch; and estimated proportions that production above Mactaquac is of the total river replaced exploitation rates. Marshall (MS 1992) (commercial harvest, bi-catch etc., incl. in estimated returns) + est. 0.85-0.95* MSW hatchery returns to Mactaquac; 2SW production in rest of SFA ignored.

a- Revsion of method, SFA 23, 1993-1998, estimated MSW returns to Nashwaak fence raised by proportion of area below Mactaquac (0.21-0.30) * proportion 2SW (0.7-0.9) and added to estimated MSW hatchery and wild returns * (Marshall et al. MS 1998) (0.85-0.95; 2SW) originating upriver of Mactaquac.

SFAs 19-21, estimate of returns for 1998 based on regression of LaHave wild counts on MIN and MAX estimates of total SFA 19-21 MSW returns, 1984-1997 because there was no angling in SFAs 20-21 in1998.

Values in SFAs 19-21, revised from previous year using final estimates of recreational catch for 1997.

Appendix 6(ixb). Total 2SW spawners in SFAs 19, 20, 21 and 23, 1970-1998.

	RETURNS						**REMOVALS**		**SPAWNERS**		**SFA 23**				**TOTAL**	
	SFA 19		**SFA 20**		**SFA 21**		angled (19-21)		SFAs (19-21)		**RETURNS**		**REMOVALS**		**SPAWNERS**	
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	941	1,375	1,485	4,222	8,540	12,674	7,004	7,828	3,021	9,068
1971	600	1,266	344	802	481	1,199	541	812	884	2,455	7,155	10,536	3,543	3,960	4,496	9,032
1972	735	1,614	421	1,002	454	1,198	623	922	987	2,892	7,869	11,368	1,397	1,562	7,459	12,699
1973	726	1,571	665	1,532	546	1,437	740	1,108	1,197	3,432	4,205	6,036	1,454	1,625	3,949	7,844
1974	1,035	2,225	691	1,588	548	1,397	871	1,277	1,404	3,933	10,755	14,988	2,632	2,942	9,526	15,979
1975	376	824	149	343	882	2,321	534	867	874	2,621	13,107	18,578	2,120	2,369	11,861	18,830
1976	791	1,672	346	822	441	1,146	603	887	975	2,754	14,274	20,281	4,203	4,698	11,045	18,337
1977	999	2,152	660	1,509	873	2,354	967	1,463	1,565	4,552	16,869	23,995	4,856	5,427	13,578	23,119
1978	810	1,739	429	995	655	1,706	723	1,088	1,171	3,352	8,225	11,294	2,879	3,218	6,517	11,428
1979	532	1,169	431	978	508	1,288	560	851	911	2,585	5,165	7,207	1,393	1,557	4,683	8,234
1980	1,408	3,051	746	1,714	1,483	3,989	1,390	2,131	2,247	6,623	19,056	26,865	7,033	7,860	14,270	25,628
1981	886	1,856	926	2,133	1,754	4,475	1,338	2,125	2,228	6,339	11,026	15,267	7,384	8,253	5,870	13,353
1982	917	1,990	316	746	682	1,756	734	1,096	1,181	3,396	9,782	13,871	5,307	5,932	5,656	11,335
1983	477	1,030	641	1,475	552	1,434	633	971	1,037	2,968	9,662	13,836	9,194	10,275	1,505	6,529
1984	828	1,768	638	1,500	766	2,004	267	419	1,965	4,853	15,706	22,627	3,426	3,829	14,245	23,650
1985	1,495	3,132	2,703	6,355	2,102	5,469			6,300	14,956	16,541	23,828	4,656	5,204	18,185	33,580
1986	3,500	7,541	2,561	5,987	2,150	5,312			8,211	18,840	9,891	14,261	2,667	2,981	15,435	30,120
1987	2,427	5,237	1,066	2,527	1,114	2,872			4,607	10,636	6,922	10,043	1,294	1,446	10,235	19,233
1988	2,635	5,724	1,914	4,464	1,105	2,945			5,654	13,133	4,716	6,697	1,296	1,449	9,074	18,381
1989	2,236	4,810	1,512	3,485	1,631	4,086			5,379	12,381	6,560	9,437	250	279	11,689	21,539
1990	2,406	5,178	1,085	2,515	1,271	3,260			4,762	10,953	5,486	7,918	560	626	9,688	18,245
1991	1,890	4,050	965	2,200	421	1,071			3,276	7,321	7,337	10,563	1,257	1,405	9,356	16,479
1992	1,788	3,923	631	1,488	480	1,236			2,899	6,647	6,878	9,809	1,052	1,176	8,725	15,280
1993	876	1,897	1,006	2,321	564	1,498			2,446	5,716	4,318	5,371	1,054	1,166	5,710	9,921
1994	833	1,845	242	561	305	773			1,380	3,179	2,999	3,729	697	815	3,682	6,093
1995	759	1,582	666	1,565	518	1,339			1,943	4,486	3,042	3,831	313	346	4,672	7,971
1996	1,231	2,692	604	1,404	894	2,293			2,729	6,389	4,498	5,665	720	812	6,507	11,242
1997	607	1,299	170	387	301	1,026			1,078	2,712	2,567	3,210	550	611	3,095	5,311
1998	>>>>>>>>>>>>>		1,103	3,888	<<<<<<<<<<<<<				1,103	3,888	1,625	2,115	304	340	2,424	5,663

Spawners = returns minus removals where:

"returns" are from App.5(xa), where revisions to methods for SFAs 19-21, 1998, and SFA 23 1993-1998 are outlined (1997 values for SFAs 19-21 revised on basis of final estimate of recreational catch).

removals" of 2SW fish in SFAs 19-21have been few, largely illegal and unascribed since the catch-and-release angling regulations in 1985; removals in SFA 23 1985-1997 had been in total the assessed losses to stocks originating above Mactaquac. The revised method (App 5(ixa)), 1993-1998 incorporates 5th and 95th percentile values for losses noted on the Nashwaak raised to the total production area downstream of Mactaquac and the previously assessed and used values for stocks upstream of Mactaquac.

Appendix 6 x. Global evaluation of the number of recruits and spawners for all the Quebec's river, 1969-1998.

Year	Recruits of small salmon			Recruits of large salmon			Spawners of small salmon			Spawners of large salmon		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
1969	25,355	31,694	38,032	74,653	93,316	111,979	16,313	20,392	24,470	25,532	31,915	38,299
1970	18,904	23,630	28,356	82,680	103,350	124,020	11,045	13,806	16,568	31,292	39,115	46,937
1971	14,969	18,711	22,453	47,354	59,192	71,031	9,338	11,672	14,007	16,194	20,243	24,292
1972	12,470	15,587	18,704	61,773	77,217	92,660	8,213	10,267	12,320	31,727	39,658	47,590
1973	16,585	20,731	24,877	68,171	85,214	102,256	10,987	13,734	16,480	32,279	40,349	48,419
1974	16,791	20,988	25,186	91,455	114,319	137,182	10,067	12,583	15,100	39,256	49,070	58,884
1975	18,071	22,589	27,106	77,664	97,080	116,497	11,606	14,507	17,409	32,627	40,784	48,940
1976	19,959	24,948	29,938	77,212	96,515	115,818	12,979	16,224	19,469	31,032	38,790	46,548
1977	18,190	22,737	27,285	91,017	113,771	136,525	12,004	15,005	18,006	44,660	55,825	66,990
1978	16,971	21,214	25,456	81,953	102,441	122,930	11,447	14,309	17,170	40,944	51,180	61,416
1979	21,683	27,103	32,524	45,197	56,497	67,796	15,863	19,829	23,795	17,543	21,929	26,315
1980	29,791	37,239	44,686	107,461	134,327	161,192	20,817	26,021	31,226	48,758	60,948	73,137
1981	41,667	52,084	62,501	84,428	105,535	126,642	30,952	38,690	46,428	35,798	44,747	53,697
1982	23,699	29,624	35,549	74,870	93,587	112,305	16,877	21,096	25,316	36,290	45,363	54,435
1983	17,987	22,484	26,981	61,488	76,860	92,232	12,030	15,038	18,045	23,710	29,638	35,565
1984	21,566	26,230	30,894	61,180	71,110	81,041	16,316	20,636	24,957	30,610	37,674	44,739
1985	22,771	28,016	33,262	62,899	73,545	84,192	15,608	20,374	25,140	28,312	35,897	43,482
1986	33,758	40,347	46,937	75,561	87,479	99,397	22,230	28,042	33,855	32,997	41,114	49,232
1987	37,816	45,925	54,034	72,190	82,920	93,650	25,789	33,135	40,481	29,758	36,610	43,462
1988	43,943	53,068	62,193	77,904	90,587	103,269	28,582	36,699	44,815	34,781	43,653	52,524
1989	34,568	41,488	48,407	70,762	81,316	91,871	24,710	31,015	37,319	34,268	41,727	49,185
1990	39,962	47,377	54,792	68,851	79,872	90,893	26,594	33,210	39,826	33,454	41,535	49,615
1991	31,488	37,121	42,755	64,166	73,675	83,184	20,582	25,508	30,433	27,341	33,569	39,797
1992	35,257	42,000	48,742	64,271	74,112	83,953	21,754	27,668	33,583	26,489	32,993	39,497
1993	30,645	36,400	42,156	50,717	57,197	63,677	17,493	22,469	27,444	21,609	25,481	29,353
1994	29,667	34,918	40,170	51,649	58,139	64,630	16,758	21,200	25,642	21,413	25,191	28,968
1995	23,851	28,109	32,368	59,939	67,083	74,227	14,409	17,978	21,548	30,925	35,122	39,320
1996	32,008	37,283	42,558	53,990	61,136	68,282	18,923	23,364	27,805	26,042	30,433	34,824
1997	24,300	28,659	33,018	44,442	50,315	56,187	14,724	18,467	22,210	21,275	24,871	28,466
1998	26,588	31,568	36,547	40,373	46,117	51,862	16,152	20,477	24,801	19,729	23,299	26,869

APPENDIX 7

COMPUTATION OF CATCH ADVICE FOR WEST GREENLAND

The North American Spawning Target (SpT) for 2SW salmon has been revised to 180,495 fish in 1996.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. $SpR = SpT * (exp(11*M)$ (where $M = 0.01$)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. $MAH = PFA - SpR$

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. $NA1SW = f_{NA} * MAH$

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] [1]. Thus:

Eq. 4. $E1SW = (NA1SW / PropNA) - NA1SW$

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric tonnes, it is necessary to incorporate the mean weights (kg) of salmon for North America [WT1SWNA][1] and Europe [WT1SWE][1] and age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon [ACF][1]. The quota (in tonnes) at Greenland is then estimated as

Eq. 5. $Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000$

[1] New sampling data from the 1995 fishery at West Greenland were used to update the forecast values of the proportion of North American salmon in the catch (PropNA), mean weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF] in 1996.

Appendix 8a Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FINLAND

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	3,114	3,156	20	30	20	30	30	70	30	70
1972	4,865	4,932	20	30	20	30	30	70	30	70
1973	7,395	7,496	20	30	20	30	30	70	30	70
1974	6,803	7,253	20	30	20	30	30	70	30	70
1975	6,732	7,178	20	30	20	30	30	70	30	70
1976	5,817	6,202	20	30	20	30	30	70	30	70
1977	5,238	5,584	20	30	20	30	30	70	30	70
1978	3,832	3,481	20	30	20	30	30	70	30	70
1979	3,982	2,298	20	30	20	30	30	70	30	70
1980	3,920	3,093	20	30	20	30	30	70	30	70
1981	3,617	4,874	20	30	20	30	30	70	30	70
1982	2,598	5,408	20	30	20	30	30	70	30	70
1983	3,916	6,050	20	30	20	30	30	70	30	70
1984	4,899	4,726	20	30	20	30	30	70	30	70
1985	6,201	4,912	20	30	20	30	30	70	30	70
1986	6,131	3,244	20	30	20	30	30	70	30	70
1987	8,696	4,520	20	30	20	30	30	70	30	70
1988	5,926	3,495	20	30	20	30	30	70	30	70
1989	10,395	5,332	20	30	20	30	30	80	30	80
1990	10,084	5,600	20	30	20	30	30	80	30	80
1991	9,213	6,298	20	30	20	30	30	80	30	80
1992	15,017	6,284	20	30	20	30	30	80	30	80
1993	11,157	8,180	20	30	20	30	30	80	30	80
1994	7,493	6,230	20	30	20	30	30	80	30	80
1995	7,786	5,344	20	30	20	30	30	80	30	80
1996	10,726	2,717	20	30	20	30	30	70	30	70
1997	9,469	4,272	20	30	20	30	30	70	30	70
1998	11,410	3,749	20	30	20	30	30	70	30	70
1999	0	0	20	30	20	30	30	70	30	70
2000	0	0	20	30	20	30	30	70	30	70

M(min)= 0.005 Return time (m)= 1SW(min) 6 MSW(min) 18
M(max)= 0.015 1SW(max) 8 MSW(max) 20

Appendix 8b Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FRANCE

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
			Non-reporting included in exploitation rates							
1971	1,740	4,060	0	0	0	0	8	15	22	37
1972	3,480	8,120	0	0	0	0	8	15	22	37
1973	2,130	4,970	0	0	0	0	8	15	22	37
1974	990	2,310	0	0	0	0	8	15	22	37
1975	1,980	4,620	0	0	0	0	8	15	20	35
1976	1,820	3,380	0	0	0	0	8	15	20	35
1977	1,400	2,600	0	0	0	0	8	15	20	35
1978	1,435	2,665	0	0	0	0	8	15	20	35
1979	1,645	3,055	0	0	0	0	8	15	20	35
1980	3,430	6,370	0	0	0	0	8	15	20	35
1981	2,720	4,080	0	0	0	0	8	15	20	35
1982	1,680	2,520	0	0	0	0	8	15	20	35
1983	1,800	2,700	0	0	0	0	8	15	20	35
1984	2,960	4,440	0	0	0	0	8	15	20	35
1985	1,100	3,330	0	0	0	0	8	15	20	35
1986	3,400	3,400	0	0	0	0	8	15	20	35
1987	6,000	1,800	0	0	0	0	8	15	20	35
1988	2,100	5,000	0	0	0	0	8	15	20	35
1989	1,100	2,300	0	0	0	0	8	15	20	35
1990	1,900	2,300	0	0	0	0	8	15	20	35
1991	1,400	2,100	0	0	0	0	7	12	20	35
1992	2,500	2,700	0	0	0	0	7	12	20	35
1993	3,600	1,300	0	0	0	0	8	15	20	35
1994	2,800	2,300	0	0	0	0	8	15	20	35
1995	1,669	1,095	0	0	0	0	8	15	20	35
1996	2,063	1,942	0	0	0	0	8	15	20	35
1997	1,060	1,001	0	0	0	0	8	15	20	35
1998	2,065	846	0	0	0	0	8	15	20	35
1999	0	0	0	0	0	0	8	15	20	35
2000	0	0	0	0	0	0	8	15	20	35

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	17

Appendix 8c Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - ICELAND

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	21,403	13,083	0	0	0	0	40	60	50	70
1972	19,588	21,134	0	0	0	0	40	60	50	70
1973	20,052	18,021	0	0	0	0	40	60	50	70
1974	14,204	14,325	0	0	0	0	40	60	50	70
1975	20,328	18,032	0	0	0	0	40	60	50	70
1976	17,349	13,874	0	0	0	0	40	60	50	70
1977	19,454	17,419	0	0	0	0	40	60	50	70
1978	24,120	22,884	0	0	0	0	40	60	50	70
1979	23,759	15,981	0	0	0	0	40	60	50	70
1980	7,649	20,158	0	0	0	0	40	60	50	70
1981	15,543	9,516	0	0	0	0	40	60	50	70
1982	11,872	9,478	0	0	0	0	40	60	50	70
1983	16,031	11,483	0	0	0	0	40	60	50	70
1984	9,988	11,929	0	0	0	0	40	60	50	70
1985	20,064	6,882	0	0	0	0	40	60	50	70
1986	30,769	12,521	0	0	0	0	40	60	50	70
1987	20,392	12,898	0	0	0	0	40	60	50	70
1988	37,561	10,516	0	0	0	0	40	60	50	70
1989	20,366	9,399	0	0	0	0	40	60	50	70
1990	18,956	10,327	0	0	0	0	40	60	50	70
1991	22,878	8,614	0	0	0	0	40	60	50	70
1992	30,676	11,633	0	0	0	0	40	60	50	70
1993	29,360	9,665	0	0	0	0	40	60	50	70
1994	17,562	10,480	0	0	0	0	40	60	50	70
1995	25,552	8,689	0	0	0	0	40	60	50	70
1996	21,624	7,812	0	0	0	0	40	60	50	70
1997	21,476	7,164	0	0	0	0	40	60	50	70
1998	35,537	7,791	0	0	0	0	40	60	50	70
1999	0	0	0	0	0	0	40	60	50	70
2000	0	0	0	0	0	0	40	60	50	70

M(min)= 0.005 Return time (m)= 1SW(min) 6 MSW(min) 17
M(max)= 0.015 1SW(max) 8 MSW(max) 19

Appendix 8d Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - IRELAND

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
			Non-reporting included in exploitation rates							
1971	475,839	52,871	0	0	0	0	54	63	47	55
1972	523,742	58,194	0	0	0	0	54	63	47	55
1973	560,323	62,258	0	0	0	0	54	63	47	55
1974	617,806	68,645	0	0	0	0	54	63	47	55
1975	643,355	71,484	0	0	0	0	54	63	47	55
1976	453,194	50,355	0	0	0	0	54	63	47	55
1977	398,323	44,258	0	0	0	0	54	63	47	55
1978	357,097	39,677	0	0	0	0	54	63	47	55
1979	318,484	35,387	0	0	0	0	54	63	47	55
1980	248,333	39,608	0	0	0	0	54	63	47	55
1981	173,667	32,159	0	0	0	0	62	72	47	55
1982	310,000	12,353	0	0	0	0	61	72	43	51
1983	502,000	29,411	0	0	0	0	54	63	46	54
1984	242,666	19,804	0	0	0	0	59	70	36	42
1985	498,333	19,608	0	0	0	0	66	77	38	45
1986	498,125	28,335	0	0	0	0	63	74	51	61
1987	358,842	27,609	0	0	0	0	60	70	35	41
1988	559,297	30,599	0	0	0	0	45	54	43	50
1989	305,667	24,891	0	0	0	0	60	70	48	56
1990	180,118	14,667	0	0	0	0	46	54	59	70
1991	125,389	10,211	0	0	0	0	40	47	49	57
1992	217,446	17,707	0	0	0	0	47	55	45	53
1993	186,901	15,220	0	0	0	0	46	54	71	83
1994	268,839	21,892	0	0	0	0	47	55	43	50
1995	237,773	19,362	0	0	0	0	51	60	43	50
1996	230,826	18,797	0	0	0	0	50	52	60	75
1997	194,187	15,813	0	0	0	0	30	45	40	50
1998	219,767	17,896	0	0	0	0	30	40	40	50
1999	0	0	0	0	0	0	30	45	40	50
2000	0	0	0	0	0	0	30	45	40	50

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	17
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 8e Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	213,595	135,247	40	60	40	60	70	90	70	90
1972	279,249	176,818	40	60	40	60	70	90	70	90
1973	305,439	193,402	40	60	40	60	70	90	70	90
1974	288,982	182,981	40	60	40	60	70	90	70	90
1975	271,993	172,224	40	60	40	60	70	90	70	90
1976	270,754	171,439	40	60	40	60	70	90	70	90
1977	263,322	166,733	40	60	40	60	70	90	70	90
1978	185,812	117,655	40	60	40	60	70	90	70	90
1979	324,020	205,167	40	60	40	60	70	90	70	90
1980	323,843	205,055	40	60	40	60	70	90	70	90
1981	221,566	213,943	40	60	40	60	70	90	70	90
1982	163,120	174,229	40	60	40	60	70	90	70	90
1983	278,061	171,361	40	60	40	60	70	90	70	90
1984	294,365	176,716	40	60	40	60	70	90	70	90
1985	299,037	162,403	40	60	40	60	70	90	70	90
1986	264,849	191,524	40	60	40	60	70	90	70	90
1987	235,703	153,534	40	60	40	60	70	90	70	90
1988	217,617	120,367	40	60	40	60	70	90	70	90
1989	220,170	80,880	40	60	40	60	50	70	50	70
1990	192,500	91,437	40	60	40	60	50	70	50	70
1991	177,041	92,214	40	60	40	60	50	70	50	70
1992	150,580	97,586	40	60	40	60	50	70	50	70
1993	151,291	92,717	30	50	30	50	50	70	50	70
1994	153,412	99,519	30	50	30	50	50	70	50	70
1995	134,341	98,656	30	50	30	50	50	70	50	70
1996	110,085	96,656	30	50	30	50	50	70	50	70
1997	124,387	69,290	25	45	25	45	45	65	45	65
1998	162,185	82,335	25	45	25	45	45	65	45	65
1999	0	0	25	45	25	45	45	65	45	65
2000	0	0	25	45	25	45	45	65	45	65

M(min)= 0.005 Return time (m)= 1SW(min) 5 MSW(min) 17
M(max)= 0.015 1SW(max) 7 MSW(max) 18

Appendix 8f Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - RUSSIA

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	48,312	80,841	11	25	11	25	25	45	25	45
1972	53,525	67,407	11	25	11	25	25	45	25	45
1973	89,440	112,636	11	25	11	25	25	45	25	45
1974	82,141	103,444	11	25	11	25	25	45	25	45
1975	87,944	129,896	11	25	11	25	25	45	25	45
1976	66,447	110,756	11	25	11	25	25	45	25	45
1977	55,463	83,195	11	25	11	25	25	45	25	45
1978	60,737	57,564	11	25	11	25	25	45	25	45
1979	69,423	63,844	11	25	11	25	25	45	25	45
1980	45,673	96,795	11	25	11	25	25	45	25	45
1981	32,611	52,528	11	25	11	25	20	40	20	40
1982	39,702	42,471	11	25	11	25	20	40	20	40
1983	57,870	68,396	11	25	11	25	20	40	20	40
1984	54,991	72,228	11	25	11	25	20	40	20	40
1985	72,803	80,292	11	25	11	25	20	40	20	40
1986	63,926	89,465	11	25	11	25	20	40	20	40
1987	97,242	41,769	11	25	11	25	20	40	20	40
1988	53,158	46,848	11	25	11	25	20	40	20	40
1989	78,023	29,454	11	25	11	25	20	40	20	40
1990	70,595	25,663	11	25	11	25	20	40	20	40
1991	40,603	17,543	33	47	33	47	10	25	10	25
1992	34,021	13,431	45	55	45	55	10	25	10	25
1993	28,100	17,907	50	60	50	60	10	25	10	25
1994	30,877	13,668	55	65	55	65	10	25	10	25
1995	27,775	10,023	55	65	55	65	10	25	10	25
1996	33,878	8,708	55	65	65	75	10	25	10	25
1997	31,857	7,107	55	65	65	75	10	25	10	25
1998	34,870	7,024	55	65	65	75	10	25	10	25
1999	0	0	55	65	65	75	10	25	10	25
2000	0	0	55	65	65	75	10	25	10	25

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 16

M(max)= 0.015 1SW(max) 9 MSW(max) 18

Appendix 8g Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - SWEDEN

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	6,330	420	20	50	20	50	70	95	55	100
1972	5,005	295	20	50	20	50	70	95	55	100
1973	6,210	1,025	20	50	20	50	70	95	55	100
1974	8,935	660	20	50	20	50	70	95	55	100
1975	9,620	160	20	50	20	50	70	95	55	100
1976	5,420	480	20	50	20	50	70	95	55	100
1977	2,555	360	20	50	20	50	70	95	55	100
1978	2,917	275	20	50	20	50	70	95	55	100
1979	3,080	800	20	50	20	50	70	95	55	100
1980	3,920	1,400	20	50	20	50	70	95	55	100
1981	7,095	407	20	50	20	50	70	95	55	100
1982	6,230	1,460	20	50	20	50	70	95	55	100
1983	8,290	1,005	20	50	20	50	70	95	55	100
1984	11,680	1,410	20	50	20	50	70	95	55	100
1985	13,890	590	20	50	20	50	70	95	55	100
1986	14,635	570	20	50	20	50	70	95	55	100
1987	11,860	1,700	20	50	20	50	70	95	55	100
1988	9,930	1,650	20	50	20	50	70	95	55	100
1989	3,180	4,610	20	50	20	50	70	95	55	100
1990	7,430	3,135	20	50	20	50	70	95	55	100
1991	8,990	3,620	20	50	20	50	70	95	55	100
1992	9,850	4,655	20	50	20	50	70	95	55	100
1993	10,540	6,370	20	50	20	50	70	95	55	100
1994	8,035	4,660	20	50	20	50	60	85	55	100
1995	9,761	2,770	20	50	20	50	50	75	[illegible]	90
1996	6,008	3,542	20	50	20	50	50	75	55	90
1997	2,747	2,307	20	50	20	50	50	75	55	90
1998	2,421	1,702	5	25	5	25	60	85	55	90
1999	0	0	20	50	20	50	50	75	55	90
2000	0	0	20	50	20	50	50	75	55	90

M(min)=	0.005	Return time (m)=	1SW(min)	6	MSW(min)	17
M(max)=	0.015		1SW(max)	8	MSW(max)	18

Appendix 8h Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(ENGLAND & WALES)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	32,905	17,718	25	50	25	50	30	60	30	60
1972	40,468	21,315	25	50	25	50	30	60	30	60
1973	40,076	20,645	25	50	25	50	30	60	30	60
1974	41,715	21,014	25	50	25	50	30	60	30	60
1975	49,238	24,252	25	50	25	50	30	60	30	60
1976	29,842	14,369	25	50	25	50	31	51	31	51
1977	34,675	16,317	25	50	25	50	32	52	32	52
1978	39,117	17,988	25	50	25	50	33	53	33	53
1979	27,881	12,526	25	50	25	50	34	54	34	54
1980	36,451	15,997	25	50	25	50	39	59	39	59
1981	48,057	20,596	25	50	25	50	40	60	40	60
1982	29,791	12,466	25	50	25	50	41	61	41	61
1983	39,105	15,972	25	50	25	50	42	62	42	62
1984	35,539	14,166	25	50	25	50	44	64	44	64
1985	36,236	14,092	25	50	25	50	45	65	45	65
1986	48,023	18,215	25	50	25	50	45	65	45	65
1987	42,017	15,540	25	50	25	50	45	65	45	65
1988	56,248	20,280	25	50	25	50	45	65	45	65
1989	45,346	15,932	25	50	25	50	48	68	48	68
1990	42,802	14,651	25	50	25	50	50	70	50	70
1991	23,767	7,922	25	50	25	50	48	68	48	68
1992	21,801	7,075	25	50	25	50	47	67	47	67
1993	30,484	7,151	30	60	30	60	41	61	41	61
1994	41,792	12,483	30	60	30	60	40	60	40	60
1995	27,006	10,502	15	25	15	25	39	59	39	59
1996	22,400	12,062	15	25	15	25	33	53	33	53
1997	19,687	7,281	15	25	15	25	25	45	25	45
1998	22,893	4,689	15	25	15	25	25	45	25	45
1999	0	0	15	25	15	25	25	45	25	45
2000	0	0	15	25	15	25	25	45	25	45

M(min)= 0.005 Return time (m)= 1SW(min) 7 MSW(min) 17
M(max)= 0.015 1SW(max) 9 MSW(max) 19

Appendix 8i Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(NORTHERN IRELAND)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	70,760	9,375	10	33	10	33	62	76	41	51
1972	63,502	8,413	10	33	10	33	62	76	41	51
1973	55,035	7,291	10	33	10	33	62	76	41	51
1974	55,640	7,371	10	33	10	33	62	76	41	51
1975	49,592	6,570	10	33	10	33	62	76	41	51
1976	34,170	4,527	10	33	10	33	62	76	41	51
1977	33,263	4,407	10	33	10	33	62	76	41	51
1978	44,754	5,929	10	33	10	33	62	76	41	51
1979	29,937	3,966	10	33	10	33	62	76	41	51
1980	36,892	4,888	10	33	10	33	62	76	41	51
1981	30,542	4,046	10	33	10	33	62	76	41	51
1982	39,916	5,289	10	33	10	33	62	76	41	51
1983	56,548	7,492	10	33	10	33	62	76	41	51
1984	23,586	3,125	10	33	10	33	62	76	41	51
1985	29,634	3,926	10	33	10	33	62	76	41	51
1986	32,961	4,367	10	33	10	33	62	76	41	51
1987	16,934	2,243	10	33	10	33	62	76	41	51
1988	34,473	4,567	10	33	10	33	58	71	32	40
1989	42,940	5,689	10	37	10	37	80	98	54	66
1990	28,425	3,766	10	17	10	17	56	68	34	42
1991	16,631	2,203	10	17	10	17	58	71	39	47
1992	27,518	3,646	10	23	10	23	50	62	30	36
1993	25,098	3,325	10	17	10	17	37	45	11	13
1994	27,519	3,646	10	28	10	28	63	77	36	44
1995	26,904	3,565	10	17	10	17	60	74	38	46
1996	23,343	3,093	10	20	10	20	47	67	24	44
1997	29,360	3,890	5	15	5	15	50	70	24	44
1998	26,539	3,517	5	15	5	15	30	40	20	35
1999	0	0	5	15	5	15	30	40	20	35
2000	0	0	5	15	5	15	30	40	20	35

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.015		1SW(max)	9	MSW(max)	18

Appendix 8j Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(SCOTLAND)

Year	Catch (numbers)		Catch of Scottish fish in England	Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	(% 1SW)	min	max	min	max	min	max	min	max
			70%								
1971	262,160	161,601	57,335	20	40	20	40	20	40	30	50
1972	251,465	218,023	49,097	20	40	20	40	20	40	30	50
1973	293,090	237,920	59,700	20	40	20	40	20	40	30	50
1974	289,416	188,357	50,118	20	40	20	40	20	40	30	50
1975	222,345	207,978	50,778	20	40	20	40	20	40	30	50
1976	188,492	114,582	14,759	20	40	20	40	20	40	25	45
1977	194,264	138,987	49,186	20	40	20	40	20	40	25	45
1978	204,470	162,954	47,500	20	40	20	40	20	40	25	45
1979	187,236	132,509	39,552	20	40	20	40	20	40	25	45
1980	121,441	172,588	41,202	15	30	15	30	15	35	25	45
1981	150,738	174,721	61,511	15	30	15	30	15	35	20	40
1982	208,061	128,242	44,147	15	30	15	30	15	35	20	40
1983	209,617	145,961	67,231	15	30	15	30	15	35	20	40
1984	213,079	107,213	50,994	15	30	15	30	15	35	20	40
1985	158,012	114,648	48,753	15	30	15	30	15	35	20	40
1986	202,855	148,397	53,277	15	30	15	30	15	35	15	35
1987	164,785	103,994	29,999	15	30	15	30	15	35	15	35
1988	149,098	112,162	41,696	15	30	15	30	15	35	15	35
1989	174,941	103,886	33,577	10	20	10	20	10	30	15	35
1990	81,094	87,924	41,224	10	20	10	20	10	30	15	35
1991	73,608	65,193	20,343	10	20	10	20	10	30	10	30
1992	101,676	82,841	16,115	10	20	10	20	10	30	10	30
1993	94,517	71,726	33,440	10	20	10	20	10	30	10	30
1994	99,459	85,404	37,243	10	20	10	20	10	30	10	30
1995	89,921	78,452	42,568	10	20	10	20	10	30	10	30
1996	66,413	57,920	14,865	10	20	10	20	8	25	8	25
1997	46,526	40,316	17,538	10	20	10	20	8	25	8	25
1998	51,398	35,913	14,612	10	20	10	20	8	30	8	25
1999	0	0	0	10	20	10	20	8	25	8	25
2000	0	0	0	10	20	10	20	8	25	8	25

M(min)= 0.005
M(max)= 0.015

Return time (m)= 1SW(min) 7 MSW(min) 17
1SW(max) 8 MSW(max) 18

Appendix 8k Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FAROES

Year n/n+1	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	2620	105796	5	15	0	0	100	100	100	100
1972	2754	111187	5	15	0	0	100	100	100	100
1973	3121	126012	5	15	0	0	100	100	100	100
1974	2186	88276	5	15	0	0	100	100	100	100
1975	2798	112984	5	15	0	0	100	100	100	100
1976	1830	73900	5	15	0	0	100	100	100	100
1977	1291	52112	5	15	0	0	100	100	100	100
1978	974	39309	5	15	0	0	100	100	100	100
1979	1736	70082	5	15	0	0	100	100	100	100
1980	4523	182616	5	15	0	0	100	100	100	100
1981	7443	300542	5	15	0	0	100	100	100	100
1982	6859	276957	5	15	0	0	100	100	100	100
1983	15861	215349	5	15	0	0	100	100	100	100
1984	5534	138227	5	15	0	0	100	100	100	100
1985	378	158103	5	15	0	0	100	100	100	100
1986	1979	180934	5	15	0	0	100	100	100	100
1987	90	166244	5	15	0	0	100	100	100	100
1988	8637	87629	5	15	0	0	100	100	100	100
1989	1788	121965	5	15	0	0	100	100	100	100
1990	1989	140054	5	15	0	0	100	100	100	100
1991	943	84935	5	15	0	0	100	100	100	100
1992	68	35700	5	15	0	0	100	100	100	100
1993	6	30023	5	15	0	0	100	100	100	100
1994	15	31672	5	15	0	0	100	100	100	100
1995	18	34662	5	15	0	0	100	100	100	100
1996	101	28381	5	15	0	0	100	100	100	100
1997	339	1,424	10	20	0	0	100	100	100	100
1998	0	0	5	15	0	0	100	100	100	100
1999	0	0	5	15	0	0	100	100	100	100
2000	0	0	5	15	0	0	100	100	100	100

M(min)= 0.005 Return time (m)= 1SW(min) 0 MSW(min) 1
M(max)= 0.015 1SW(max) 1 MSW(max) 2

Appendix 8I Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - WEST GREENLAND

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	439111	0	0	5	15	100	100	100	100
1972	0	345051	0	0	5	15	100	100	100	100
1973	0	382283	0	0	5	15	100	100	100	100
1974	0	292402	0	0	5	15	100	100	100	100
1975	0	354886	0	0	5	15	100	100	100	100
1976	0	198413	0	0	5	15	100	100	100	100
1977	0	251475	0	0	5	15	100	100	100	100
1978	0	145265	0	0	5	15	100	100	100	100
1979	0	244519	0	0	5	15	100	100	100	100
1980	0	166716	0	0	5	15	100	100	100	100
1981	0	246704	0	0	5	15	100	100	100	100
1982	0	143800	0	0	5	15	100	100	100	100
1983	0	60500	0	0	5	15	100	100	100	100
1984	0	41200	0	0	5	15	100	100	100	100
1985	0	161500	0	0	5	15	100	100	100	100
1986	0	131900	0	0	5	15	100	100	100	100
1987	0	126400	0	0	5	15	100	100	100	100
1988	0	168800	0	0	5	15	100	100	100	100
1989	0	52700	0	0	5	15	100	100	100	100
1990	0	21700	0	0	5	15	100	100	100	100
1991	0	65400	0	0	5	15	100	100	100	100
1992	0	39500	0	0	5	15	100	100	100	100
1993	0	2000	0	0	5	15	100	100	100	100
1994	0	2000	0	0	5	15	100	100	100	100
1995	0	11200	0	0	5	15	100	100	100	100
1996	0	15200	0	0	5	15	100	100	100	100
1997	0	8300	0	0	5	15	100	100	100	100
1998	0	1700	0	0	5	15	100	100	100	100
1999	0	0	0	0	5	15	100	100	100	100
2000	0	0	0	0	5	15	100	100	100	100

M(min)=	0.005	Return time (m)=	1SW(min)	7	MSW(min)	8
M(max)=	0.015		1SW(max)	8	MSW(max)	10

Appendix 9a Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis
FINLAND

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	4,139	2.7E+04	4,227	3.5E-12	8,675	5.4E+06	8,839	5.7E+06	9,434	6.25E+06	16,710	1.86E+07	4,536	2,326	4,612	2,398
1972	6,466	5.7E+04	6,582	0.0E+00	13,459	1.1E+07	13,555	1.1E+07	14,591	1.28E+07	26,210	5.02E+07	6,993	3,269	6,973	3,376
1973	9,860	1.5E+05	10,012	7.1E-12	20,979	2.4E+07	21,489	3.2E+07	22,679	2.85E+07	25,193	3.42E+07	11,119	4,892	11,477	5,679
1974	9,056	1.1E+05	9,629	8.8E-13	19,114	2.4E+07	20,683	2.5E+07	20,617	2.83E+07	22,950	3.24E+07	10,058	4,924	11,054	5,035
1975	8,948	1.1E+05	9,541	3.5E-12	19,278	2.6E+07	18,911	2.3E+07	20,806	2.96E+07	22,381	3.45E+07	10,330	5,110	9,370	4,753
1976	7,806	9.3E+04	8,288	3.5E-12	16,141	1.5E+07	18,200	1.9E+07	17,402	1.74E+07	19,715	2.36E+07	8,336	3,863	9,912	4,365
1977	7,022	7.3E+04	7,436	5.9E-13	14,064	1.1E+07	16,169	1.6E+07	15,158	1.30E+07	12,438	1.04E+07	7,042	3,321	8,733	3,982
1978	5,091	3.7E+04	4,627	5.9E-13	10,514	8.3E+06	10,098	6.1E+06	11,327	9.51E+06	8,344	4.99E+06	5,423	2,868	5,471	2,478
1979	5,342	4.4E+04	3,065	2.9E-12	11,236	8.4E+06	6,790	3.0E+06	12,136	9.50E+06	10,567	6.62E+06	5,893	2,887	3,725	1,722
1980	5,207	4.0E+04	4,125	4.7E-12	11,278	7.3E+06	8,543	4.2E+06	12,339	8.53E+06	16,949	1.72E+07	6,071	2,699	4,418	2,054
1981	4,815	3.5E+04	6,507	3.5E-12	10,482	6.0E+06	13,865	1.1E+07	11,617	7.42E+06	18,697	2.20E+07	5,667	2,450	7,358	3,389
1982	3,468	1.9E+04	7,228	1.8E-12	7,473	3.5E+06	15,341	1.4E+07	8,344	4.08E+06	21,113	3.07E+07	4,005	1,872	8,114	3,735
1983	5,236	4.3E+04	8,086	1.2E-12	10,958	7.4E+06	17,372	2.0E+07	12,152	8.75E+06	16,112	1.57E+07	5,722	2,710	9,285	4,483
1984	6,538	6.0E+04	6,310	4.7E-12	13,186	1.2E+07	13,245	9.9E+06	14,339	1.35E+07	17,143	1.64E+07	6,648	3,412	6,935	3,139
1985	8,279	1.1E+05	6,575	1.2E-12	18,654	2.0E+07	14,146	1.1E+07	20,157	2.35E+07	11,041	8.33E+06	10,375	4,465	7,570	3,352
1986	8,174	9.5E+04	4,315	0.0E+00	17,141	1.9E+07	9,032	5.4E+06	18,592	2.29E+07	15,608	1.50E+07	8,967	4,396	4,718	2,326
1987	11,630	2.0E+05	6,024	2.9E-13	24,184	3.6E+07	12,806	9.2E+06	26,099	4.13E+07	11,722	9.86E+06	12,554	5,983	6,782	3,025
1988	7,894	8.0E+04	4,658	2.4E-12	17,074	1.8E+07	9,612	6.2E+06	18,501	2.14E+07	16,743	2.33E+07	9,180	4,240	4,954	2,497
1989	13,930	3.1E+05	7,137	1.2E-12	27,508	6.5E+07	13,735	1.6E+07	29,642	7.59E+07	17,612	3.19E+07	13,579	8,034	6,597	3,976
1990	13,470	2.7E+05	7,517	1.5E-12	26,029	5.5E+07	14,520	2.1E+07	28,012	6.36E+07	19,670	3.50E+07	12,560	7,410	7,003	4,636
1991	12,251	2.1E+05	8,368	1.2E-12	24,757	5.3E+07	16,191	2.1E+07	26,614	6.12E+07	19,258	2.82E+07	12,507	7,246	7,823	4,618
1992	19,996	5.5E+05	8,311	5.9E-13	39,384	1.4E+08	15,857	1.8E+07	42,190	1.52E+08	25,702	6.31E+07	19,388	11,710	7,546	4,239
1993	14,866	2.6E+05	10,896	4.4E-13	29,044	7.1E+07	21,208	4.3E+07	31,149	8.04E+07	19,385	2.78E+07	14,177	8,424	10,312	6,540
1994	9,971	1.4E+05	8,318	1.2E-12	19,567	3.6E+07	15,989	1.8E+07	21,024	4.23E+07	17,902	2.84E+07	9,596	6,009	7,672	4,246
1995	10,329	1.5E+05	7,092	2.2E-13	19,989	3.8E+07	14,726	1.7E+07	21,478	4.42E+07	9,475	6.41E+06	9,660	6,162	7,634	4,170
1996	14,281	3.5E+05	3,631	5.9E-13	31,644	6.2E+07	7,793	3.7E+06	33,989	7.36E+07	14,244	1.49E+07	17,362	7,854	4,162	1,932
1997	12,572	2.4E+05	5,688	1.5E-13	27,930	4.3E+07	11,730	9.4E+06	29,955	4.94E+07	13,100	8.58E+06	15,358	6,564	6,042	3,066
1998	15,275	3.2E+05	5,061	0.0E+00	33,326	6.7E+07	10,822	5.9E+06	35,745	7.74E+07	1	2.13E+00	18,051	8,157	5,762	2,436
1999	0	0.0E+00	0	3.4E-23	0	0.0E+00	0	5.2E-07	0	0.00E+00	0	8.56E-07	0	0	0	0
2000	0	0.0E+00	0	2.0E-25	0	0.0E+00	0	5.5E-07	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9b Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis
FRANCE

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	1,740	2.94E-13	4,060	3.53E-12	15,572	8.70E+06	14,141	4.35E+06	17,022	1.05E+07	40,496	3.58E+07	13,832	2,950	10,081	2,085
1972	3,480	1.18E-12	8,120	0.00E+00	30,669	2.83E+07	28,156	1.83E+07	33,410	3.43E+07	24,664	1.23E+07	27,189	5,321	20,036	4,275
1973	2,130	1.18E-12	4,970	7.06E-12	19,124	1.02E+07	17,370	5.91E+06	20,917	1.28E+07	15,137	6.17E+06	16,994	3,200	12,400	2,431
1974	990	1.47E-13	2,310	8.82E-13	8,564	2.61E+06	7,991	1.50E+06	9,392	2.96E+06	22,870	1.33E+07	7,574	1,617	5,681	1,225
1975	1,980	5.88E-13	4,620	3.53E-12	17,405	1.09E+07	17,311	7.72E+06	19,019	1.31E+07	21,053	1.15E+07	15,425	3,294	12,691	2,778
1976	1,820	5.88E-13	3,380	3.53E-12	16,063	7.63E+06	12,523	4.14E+06	17,494	8.50E+06	15,758	6.47E+06	14,243	2,763	9,143	2,034
1977	1,400	5.88E-13	2,600	5.88E-13	13,021	5.75E+06	9,930	2.58E+06	14,192	6.92E+06	16,099	6.53E+06	11,621	2,398	7,330	1,608
1978	1,435	4.41E-13	2,665	5.88E-13	13,104	5.23E+06	9,561	2.49E+06	14,259	6.12E+06	15,967	6.76E+06	11,669	2,286	6,896	1,579
1979	1,645	2.94E-13	3,055	2.94E-12	14,708	7.59E+06	11,285	3.60E+06	16,032	8.64E+06	34,308	2.66E+07	13,063	2,754	8,230	1,897
1980	3,430	0.00E+00	6,370	4.70E-12	29,818	3.33E+07	24,086	1.37E+07	32,567	3.82E+07	22,278	1.03E+07	26,388	5,772	17,716	3,704
1981	2,720	1.76E-12	4,080	3.53E-12	24,901	2.20E+07	15,316	6.60E+06	27,371	2.65E+07	13,572	4.58E+06	22,181	4,694	11,236	2,569
1982	1,680	1.18E-12	2,520	1.76E-12	14,708	6.97E+06	9,216	2.05E+06	16,281	8.07E+06	13,685	4.92E+06	13,028	2,641	6,696	1,430
1983	1,800	5.88E-13	2,700	1.18E-12	16,172	9.00E+06	10,058	3.00E+06	17,925	1.06E+07	20,502	8.65E+06	14,372	3,000	7,358	1,733
1984	2,960	3.53E-12	4,440	4.70E-12	26,273	2.07E+07	16,342	5.84E+06	28,706	2.59E+07	15,422	6.59E+06	23,313	4,555	11,902	2,416
1985	1,100	4.41E-13	3,330	1.18E-12	9,830	3.43E+06	12,482	4.30E+06	10,805	4.19E+06	17,597	6.02E+06	8,730	1,853	9,152	2,073
1986	3,400	2.35E-12	3,400	0.00E+00	30,561	3.24E+07	12,613	2.98E+06	33,363	4.01E+07	9,612	1.96E+06	27,161	5,692	9,213	1,727
1987	6,000	2.35E-12	1,800	2.94E-13	54,027	8.01E+07	6,567	9.63E+05	58,826	1.04E+08	23,737	1.41E+07	48,027	8,951	4,767	981
1988	2,100	5.88E-13	5,000	2.35E-12	19,339	1.27E+07	18,638	9.20E+06	21,151	1.53E+07	13,457	4.11E+06	17,239	3,568	13,638	3,033
1989	1,100	1.47E-13	2,300	1.18E-12	10,323	3.19E+06	8,731	2.16E+06	11,327	4.04E+06	11,229	3.36E+06	9,223	1,787	6,431	1,469
1990	1,900	2.94E-13	2,300	1.47E-12	17,196	9.32E+06	8,855	2.11E+06	18,735	1.10E+07	9,519	2.40E+06	15,296	3,053	6,555	1,454
1991	1,400	7.35E-13	2,100	1.18E-12	15,237	5.50E+06	7,907	1.64E+06	16,585	6.82E+06	12,455	4.53E+06	13,837	2,346	5,807	1,282
1992	2,500	1.18E-12	2,700	5.88E-13	26,887	1.42E+07	9,889	2.65E+06	29,177	1.65E+07	6,299	9.01E+05	24,387	3,769	7,189	1,628
1993	3,600	0.00E+00	1,300	4.41E-13	33,475	3.59E+07	4,826	5.76E+05	36,330	4.29E+07	10,215	3.45E+06	29,875	5,996	3,526	759
1994	2,800	4.12E-12	2,300	1.18E-12	24,905	1.99E+07	8,621	2.27E+06	27,055	2.49E+07	4,895	6.90E+05	22,105	4,465	6,321	1,508
1995	1,669	2.94E-13	1,095	2.20E-13	14,994	8.59E+06	4,121	4.54E+05	16,305	1.07E+07	8,843	2.79E+06	13,325	2,931	3,026	674
1996	2,063	1.18E-12	1,942	5.88E-13	18,958	1.06E+07	7,362	1.67E+06	20,571	1.21E+07	4,690	4.69E+05	16,895	3,253	5,420	1,293
1997	1,060	7.35E-14	1,001	1.47E-13	9,554	2.78E+06	3,783	3.33E+05	10,369	3.36E+06	3,883	4.18E+05	8,494	1,667	2,782	577
1998	2,065	0.00E+00	846	0.00E+00	18,313	9.91E+06	3,184	2.21E+05	19,866	1.20E+07	15	5.74E+01	16,248	3,148	2,338	470
1999	0	0.00E+00	0	3.42E-23	0	0.00E+00	0	3.71E-05	0	0.00E+00	0	6.19E-07	0	0	0	0
2000	0	0.00E+00	0	2.01E-25	0	0.00E+00	0	3.55E-07	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9c Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis ICELAND

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	21,403	0	13,083	0	43,618	2.3E+07	22,034	4.6E+06	46,735	2.69E+07	42,968	2.25E+07	22,215	4,810	8,951	2,149
1972	19,588	0	21,134	0	39,103	1.7E+07	35,038	1.1E+07	41,903	2.06E+07	36,891	1.35E+07	19,515	4,141	13,904	3,291
1973	20,052	0	18,021	0	40,588	2.3E+07	30,005	7.4E+06	43,485	2.60E+07	30,150	1.18E+07	20,535	4,747	11,984	2,728
1974	14,204	0	14,325	0	28,017	1.1E+07	24,498	6.2E+06	30,030	1.37E+07	36,888	1.66E+07	13,813	3,335	10,173	2,483
1975	20,328	0	18,032	0	40,101	2.3E+07	30,121	9.0E+06	42,985	2.78E+07	28,350	1.06E+07	19,773	4,748	12,089	3,003
1976	17,349	0	13,874	0	35,014	1.7E+07	23,065	5.9E+06	37,535	2.18E+07	35,641	1.60E+07	17,665	4,166	9,191	2,421
1977	19,454	0	17,419	0	40,073	2.2E+07	29,334	7.8E+06	42,952	2.77E+07	45,840	2.34E+07	20,619	4,743	11,914	2,786
1978	24,120	0	22,884	0	48,960	3.5E+07	37,909	1.2E+07	52,447	4.00E+07	33,207	1.33E+07	24,839	5,944	15,025	3,420
1979	23,759	0	15,981	0	47,412	3.4E+07	27,284	7.2E+06	50,796	3.99E+07	42,345	2.35E+07	23,653	5,870	11,303	2,693
1980	7,649	0	20,158	0	15,422	3.0E+06	34,213	1.2E+07	16,523	3.42E+06	21,046	5.30E+06	7,773	1,720	14,055	3,464
1981	15,543	0	9,516	0	31,968	1.3E+07	15,819	2.4E+06	34,244	1.48E+07	21,085	5.92E+06	16,424	3,625	6,303	1,550
1982	11,872	0	9,478	0	23,429	7.3E+06	16,010	3.0E+06	25,110	8.87E+06	24,189	6.65E+06	11,557	2,708	6,532	1,735
1983	16,031	0	11,483	0	32,301	1.4E+07	18,948	3.2E+06	34,616	1.72E+07	25,051	8.61E+06	16,270	3,774	7,465	1,777
1984	9,988	0	11,929	0	20,187	5.5E+06	20,042	4.2E+06	21,627	6.38E+06	15,158	3.23E+06	10,199	2,356	8,113	2,038
1985	20,064	0	6,882	0	41,303	2.2E+07	11,784	1.5E+06	44,259	2.57E+07	26,871	8.43E+06	21,239	4,645	4,902	1,225
1986	30,769	0	12,521	0	63,457	5.5E+07	21,447	3.7E+06	68,015	6.71E+07	27,238	9.86E+06	32,688	7,392	8,926	1,932
1987	20,392	0	12,898	0	41,701	2.6E+07	21,799	4.9E+06	44,664	2.95E+07	21,992	5.47E+06	21,309	5,138	8,901	2,218
1988	37,561	0	10,516	0	76,619	8.2E+07	17,823	2.8E+06	82,094	9.58E+07	19,545	4.69E+06	39,058	9,068	7,307	1,658
1989	20,366	0	9,399	0	41,334	2.9E+07	15,584	2.2E+06	44,277	3.28E+07	21,794	6.29E+06	20,967	5,374	6,185	1,491
1990	18,956	0	10,327	0	38,537	2.5E+07	17,544	3.3E+06	41,284	2.80E+07	17,856	4.10E+06	19,581	4,965	7,217	1,806
1991	22,878	0	8,614	0	46,763	3.1E+07	14,633	1.9E+06	50,107	3.67E+07	23,296	6.68E+06	23,885	5,601	6,019	1,391
1992	30,676	0	11,633	0	61,195	5.5E+07	19,316	3.4E+06	65,549	6.21E+07	19,320	3.84E+06	30,519	7,422	7,683	1,857
1993	29,360	0	9,665	0	58,808	4.4E+07	16,023	2.2E+06	62,994	4.89E+07	21,482	6.06E+06	29,448	6,617	6,358	1,488
1994	17,562	0	10,480	0	35,781	1.8E+07	17,817	3.1E+06	38,348	2.21E+07	18,073	4.72E+06	18,219	4,250	7,337	1,755
1995	25,552	0	8,689	0	50,770	4.0E+07	14,946	2.3E+06	54,415	4.95E+07	15,992	3.47E+06	25,218	6,355	6,257	1,504
1996	21,624	0	7,812	0	43,121	2.5E+07	13,223	1.8E+06	46,223	3.16E+07	14,618	2.11E+06	21,497	5,021	5,411	1,341
1997	21,476	0	7,164	0	42,983	2.6E+07	12,199	1.3E+06	46,033	2.80E+07	15,574	3.04E+06	21,507	5,066	5,035	1,136
1998	35,537	0	7,791	0	71,304	6.7E+07	13,003	1.6E+06	76,391	7.73E+07	1	2.13E+00	35,767	8,200	5,212	1,278
1999	0	0	0	0	0	0.0E+00	0	2.6E-04	0	0.00E+00	0	4.78E-04	0	0	0	0
2000	0	0	0	0	0	0.0E+00	0	2.5E-04	0	0.00E+00	0	0.00E+00	0	0	0	0

ppendix 9d Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis
IRELAND

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	475,841	1.77E+00	52,871	2.05E-02	820,291	1.56E+09	103,756	2.19E+07	889,893	2.28E+09	183,290	1.26E+08	344,450	39,490	50,884	4,677
1972	523,744	2.56E+00	58,194	2.55E-02	897,076	1.98E+09	114,582	3.05E+07	973,497	3.48E+09	177,196	1.06E+08	373,332	44,522	56,389	5,523
1973	560,326	2.75E+00	62,258	2.88E-02	966,827	2.50E+09	122,734	2.98E+07	1,049,016	3.86E+09	197,899	1.52E+08	406,501	50,038	60,476	5,459
1974	617,810	3.03E+00	68,645	3.84E-02	1,064,073	2.86E+09	134,590	3.93E+07	1,154,105	3.80E+09	188,525	1.54E+08	446,263	53,442	65,944	6,271
1975	643,358	2.95E+00	71,484	4.72E-02	1,109,097	2.64E+09	140,683	3.89E+07	1,203,223	4.17E+09	157,620	9.18E+07	465,739	51,417	69,199	6,239
1976	453,196	2.03E+00	50,355	1.98E-02	779,163	1.49E+09	99,165	2.10E+07	845,158	2.09E+09	129,896	6.36E+07	325,967	38,573	48,810	4,581
1977	398,324	1.19E+00	44,258	1.62E-02	688,131	9.79E+08	87,405	1.54E+07	746,454	1.50E+09	122,846	5.64E+07	289,807	31,287	43,146	3,926
1978	357,098	9.51E-01	39,678	1.40E-02	618,716	7.90E+08	78,637	1.18E+07	671,081	1.15E+09	101,579	3.51E+07	261,618	28,114	38,959	3,433
1979	318,485	7.99E-01	35,387	1.19E-02	547,698	6.95E+08	69,378	9.85E+06	594,351	1.22E+09	136,361	6.86E+07	229,212	26,357	33,991	3,138
1980	248,334	6.00E-01	39,608	1.24E-02	426,906	4.03E+08	78,210	1.48E+07	463,418	5.39E+08	117,472	3.65E+07	178,572	20,085	38,602	3,851
1981	173,668	2.33E-01	32,159	1.01E-02	259,379	1.45E+08	63,580	7.96E+06	282,054	2.28E+08	63,219	1.45E+07	85,711	12,042	31,421	2,821
1982	310,001	6.71E-01	12,353	1.16E-03	470,158	5.12E+08	26,271	1.55E+06	510,651	8.27E+08	93,654	2.65E+07	160,157	22,630	13,918	1,244
1983	502,002	2.02E+00	29,411	7.23E-03	858,358	1.56E+09	58,700	8.07E+06	931,689	2.30E+09	77,909	2.09E+07	356,355	39,468	29,289	2,840
1984	242,667	5.63E-01	19,804	3.32E-03	379,292	3.09E+08	51,728	6.55E+06	411,758	4.68E+08	69,693	1.58E+07	136,625	17,576	31,924	2,560
1985	498,335	2.28E+00	19,608	3.28E-03	702,963	1.06E+09	47,161	5.44E+06	762,829	1.83E+09	85,816	2.40E+07	204,628	32,519	27,553	2,331
1986	498,128	1.86E+00	28,335	6.01E-03	728,167	1.01E+09	50,976	5.38E+06	790,174	1.64E+09	107,162	3.71E+07	230,040	31,794	22,641	2,320
1987	358,844	1.08E+00	27,609	6.01E-03	559,275	6.61E+08	72,712	1.13E+07	606,877	9.88E+08	94,687	2.87E+07	200,432	25,712	45,103	3,365
1988	559,300	2.47E+00	30,599	7.50E-03	1,128,528	3.33E+09	66,664	9.27E+06	1,224,476	5.26E+09	81,730	1.98E+07	569,228	57,745	36,065	3,045
1989	305,668	8.22E-01	24,891	5.01E-03	469,599	5.34E+08	47,933	5.35E+06	509,618	8.63E+08	38,646	3.89E+06	163,931	23,109	23,042	2,313
1990	180,119	2.59E-01	14,667	1.74E-03	365,342	2.92E+08	22,860	1.25E+06	396,352	3.93E+08	26,883	2.78E+06	185,224	17,081	8,192	1,118
1991	125,390	1.39E-01	10,211	8.56E-04	290,602	1.81E+08	19,119	6.85E+05	315,285	2.79E+08	48,525	9.63E+06	165,212	13,446	8,909	828
1992	217,447	5.22E-01	17,707	3.02E-03	426,569	3.58E+08	35,998	2.86E+06	462,674	5.42E+08	28,061	3.26E+06	209,122	18,912	18,291	1,693
1993	186,902	2.31E-01	15,220	1.93E-03	375,253	3.16E+08	19,737	9.09E+05	407,020	4.72E+08	57,936	1.55E+07	188,351	17,781	4,517	953
1994	268,840	6.13E-01	21,892	4.01E-03	530,417	6.09E+08	47,139	4.98E+06	575,304	9.12E+08	51,823	1.16E+07	261,577	24,677	25,247	2,232
1995	237,774	4.57E-01	19,362	2.86E-03	424,826	4.21E+08	41,895	4.39E+06	460,833	6.54E+08	35,583	6.89E+06	187,052	20,530	22,532	2,095
1996	230,827	4.36E-01	18,797	3.15E-03	451,037	3.57E+07	27,946	3.02E+06	489,214	1.87E+08	43,287	9.28E+06	220,210	5,974	9,149	1,737
1997	194,188	3.25E-01	15,813	2.26E-03	533,969	4.34E+09	35,044	5.28E+06	579,349	5.53E+09	48,730	1.56E+07	339,781	65,861	19,231	2,299
1998	219,768	3.47E-01	17,896	2.91E-03	634,682	2.68E+09	40,182	6.52E+06	688,211	3.28E+09	82	3.13E+02	414,914	51,787	22,286	2,554
1999	0	0.00E+00	0	7.68E-18	0	0.00E+00	0	1.99E-08	0	0.00E+00	0	5.17E-08	0	0	0	0
2000	0	0.00E+00	0	9.15E-18	0	0.00E+00	0	2.15E-08	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9e Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis NORWAY

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Estimated number 1SW returns	Variance	Estimated number MSW returns	Variance	Estimated maturing 1SW recruits	Variance	Est. non-mat. 1SW recruits	Variance	Est. 1SW spawners	SD	Est MSW spawners	SD
1971	439,846	2.73E+09	274,382	9.38E+08	554,111	5.88E+09	343,231	2.25E+09	589,592	6.71E+09	591,498	6.86E+09	114,265	56,134	68,850	36,282
1972	567,311	5.03E+09	359,001	2.02E+09	715,537	1.04E+10	449,756	4.42E+09	761,222	1.20E+10	648,693	8.48E+09	148,226	73,569	90,755	49,060
1973	624,796	5.58E+09	389,332	2.46E+09	784,514	1.19E+10	495,198	5.22E+09	834,724	1.38E+10	612,745	7.35E+09	159,719	79,376	105,865	52,535
1974	587,847	5.69E+09	378,952	2.06E+09	737,511	1.04E+10	475,653	4.43E+09	784,628	1.24E+10	566,180	5.86E+09	149,663	68,571	96,701	48,671
1975	547,541	4.67E+09	347,667	1.41E+09	695,371	9.77E+09	432,157	3.55E+09	739,402	1.06E+10	562,964	5.88E+09	147,830	71,364	84,490	46,199
1976	546,327	4.19E+09	346,306	1.65E+09	695,837	8.82E+09	438,916	3.54E+09	739,758	9.82E+09	524,694	5.12E+09	149,510	68,040	92,610	43,489
1977	534,618	4.21E+09	332,838	1.61E+09	670,254	8.18E+09	417,251	3.09E+09	712,315	8.90E+09	380,071	3.18E+09	135,636	63,017	84,413	38,455
1978	375,331	1.89E+09	240,345	9.68E+08	469,594	4.45E+09	299,856	1.85E+09	499,344	5.15E+09	660,398	8.04E+09	94,263	50,595	59,511	29,695
1979	649,400	6.43E+09	414,528	2.25E+09	807,887	1.34E+10	526,868	4.51E+09	859,198	1.56E+10	712,733	8.01E+09	158,488	83,700	112,339	47,538
1980	638,857	6.12E+09	421,154	2.49E+09	791,931	1.19E+10	529,435	4.86E+09	843,138	1.40E+10	782,779	1.05E+10	153,074	75,980	108,280	48,778
1981	451,268	3.02E+09	433,045	2.69E+09	569,950	6.77E+09	546,021	6.57E+09	607,914	7.83E+09	643,275	5.77E+09	118,682	61,262	112,976	62,234
1982	331,762	1.59E+09	348,334	1.55E+09	416,960	3.40E+09	437,430	3.69E+09	445,192	3.99E+09	615,273	4.91E+09	85,198	42,487	89,096	46,234
1983	562,976	4.24E+09	344,596	1.42E+09	703,695	9.95E+09	435,781	3.23E+09	750,128	1.14E+10	605,976	5.73E+09	140,719	75,572	91,185	42,472
1984	600,649	5.19E+09	364,410	1.80E+09	751,198	1.01E+10	452,341	3.52E+09	799,418	1.15E+10	559,794	5.74E+09	150,549	69,732	87,931	41,440
1985	612,712	6.08E+09	327,136	1.43E+09	775,190	1.36E+10	413,434	3.64E+09	824,792	1.59E+10	651,477	7.73E+09	162,478	86,467	86,298	47,027
1986	545,597	4.02E+09	385,094	2.04E+09	694,785	9.68E+09	484,474	4.40E+09	739,342	1.09E+10	532,558	5.89E+09	149,188	75,260	99,380	48,596
1987	473,385	3.28E+09	308,886	1.29E+09	595,915	7.20E+09	386,778	3.65E+09	634,336	8.34E+09	402,356	2.55E+09	122,531	62,570	77,893	48,512
1988	445,637	2.84E+09	242,921	7.97E+08	555,098	6.13E+09	303,600	1.52E+09	590,807	6.92E+09	388,613	3.23E+09	109,461	57,358	60,678	26,825
1989	444,590	3.03E+09	166,243	4.17E+08	759,687	1.49E+10	281,516	2.09E+09	808,081	1.71E+10	411,865	3.55E+09	315,097	109,102	115,273	40,848
1990	388,087	2.23E+09	180,754	3.99E+08	655,456	1.08E+10	303,138	2.16E+09	697,164	1.25E+10	402,726	3.56E+09	267,369	92,787	122,384	41,903
1991	366,006	1.95E+09	187,830	4.71E+08	628,644	8.83E+09	320,293	2.27E+09	668,670	1.07E+10	411,050	3.87E+09	262,638	82,970	132,464	42,446
1992	306,831	1.31E+09	200,110	4.87E+08	509,807	4.92E+09	336,695	2.50E+09	541,775	5.52E+09	316,503	2.70E+09	202,976	60,105	136,585	44,853
1993	259,812	6.93E+08	154,235	2.29E+08	434,152	3.81E+09	257,931	1.49E+09	461,421	4.30E+09	351,870	2.74E+09	174,340	55,847	103,696	35,462
1994	255,126	6.31E+08	169,433	2.57E+08	436,896	3.37E+09	287,295	1.67E+09	464,324	3.77E+09	350,360	1.95E+09	181,770	52,330	117,862	37,580
1995	223,959	5.04E+08	167,045	2.12E+08	371,712	2.83E+09	285,304	1.31E+09	395,047	3.13E+09	328,647	2.34E+09	147,753	48,221	118,259	33,146
1996	183,470	3.37E+08	157,998	2.30E+08	307,603	1.74E+09	267,100	1.32E+09	327,135	2.10E+09	243,906	1.37E+09	124,133	37,520	109,103	33,037
1997	194,059	2.75E+08	108,494	9.36E+07	360,454	2.20E+09	203,492	7.89E+08	383,228	2.66E+09	278,691	1.74E+09	166,395	43,835	94,998	26,364
1998	252,680	5.44E+08	128,782	1.19E+08	467,801	3.91E+09	233,575	1.02E+09	497,208	4.64E+09	15	5.74E+01	215,121	58,037	104,793	30,033
1999	0	0.00E+00	0	1.81E-08	0	0.00E+00	0	1.24E-07	0	0.00E+00	0	2.80E-07	0	0	0	0
2000	0	0.00E+00	0	2.02E-08	0	0.00E+00	0	1.73E-07	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9f Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis RUSSIA

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Estimated number 1SW returns mean	Variance	Estimated number MSW returns mean	Variance	Estimated maturing 1SW recruits Mean	Variance	Est. non-mat. 1SW recruits mran	Variance	Est. 1SW spawners	SD	Est MSW spawners	SD
1971	58,982	0.00E+00	98,508	2.47E+07	172,536	7.90E+08	287,089	2.70E+09	186,643	9.79E+08	305,786	2.63E+09	113,554	28,101	188,581	51,687
1972	64,732	9.33E+06	82,403	1.53E+07	190,675	1.25E+09	240,096	1.82E+09	206,116	1.46E+09	508,691	7.65E+09	125,943	35,271	157,693	42,539
1973	108,134	2.57E+07	138,091	4.12E+07	319,477	3.52E+09	409,396	5.25E+09	345,354	4.22E+09	447,555	6.44E+09	211,343	59,081	271,305	72,159
1974	100,227	2.71E+07	124,669	3.89E+07	299,420	2.76E+09	363,356	4.40E+09	323,443	3.24E+09	562,506	9.83E+09	199,193	52,298	238,687	66,004
1975	107,987	2.67E+07	158,102	6.27E+07	316,749	3.69E+09	457,407	6.67E+09	342,139	4.26E+09	495,601	7.81E+09	208,761	60,489	299,306	81,315
1976	133,328	1.32E-08	135,225	4.72E+07	237,445	1.71E+09	406,821	5.59E+09	256,594	2.06E+09	365,192	4.80E+09	104,117	41,324	271,596	74,483
1977	67,851	9.69E+06	101,665	2.46E+07	185,963	7.96E+08	299,321	2.76E+09	200,887	9.29E+08	258,178	2.36E+09	118,113	28,037	197,656	52,255
1978	74,440	1.30E+07	70,464	1.22E+07	216,633	1.52E+09	211,674	1.62E+09	234,067	1.84E+09	278,161	2.37E+09	142,193	38,834	141,210	40,070
1979	84,687	1.81E+07	77,885	1.35E+07	246,014	1.87E+09	223,941	1.62E+09	265,943	2.32E+09	443,112	6.45E+09	161,327	43,035	146,057	40,116
1980	56,129	7.22E+06	118,589	3.53E+07	163,299	9.09E+08	345,649	4.49E+09	176,855	1.10E+09	320,411	2.68E+09	107,170	30,033	227,060	66,716
1981	39,778	3.49E+06	64,357	1.09E+07	137,327	8.64E+08	221,891	2.07E+09	148,995	1.02E+09	261,904	1.86E+09	97,549	29,339	157,535	45,391
1982	48,728	5.50E+06	51,777	5.63E+06	172,114	1.38E+09	175,028	1.29E+09	186,357	1.58E+09	387,878	4.98E+09	123,386	37,020	123,251	35,853
1983	71,100	1.18E+07	83,751	1.64E+07	247,607	2.56E+09	291,395	3.33E+09	268,278	3.15E+09	413,403	6.04E+09	176,507	50,529	207,644	57,597
1984	66,944	1.11E+07	88,462	2.03E+07	227,195	2.15E+09	324,205	3.95E+09	245,611	2.51E+09	442,731	8.64E+09	160,251	46,291	235,743	62,697
1985	88,909	1.94E+07	99,231	2.06E+07	307,529	4.31E+09	348,458	5.64E+09	332,466	5.18E+09	472,910	7.73E+09	218,620	65,474	249,227	74,992
1986	78,257	1.78E+07	108,958	2.69E+07	266,212	2.93E+09	372,528	5.22E+09	287,647	3.33E+09	246,465	1.98E+09	187,955	53,961	263,569	72,030
1987	118,898	3.50E+07	50,977	6.19E+06	412,601	7.28E+09	181,462	1.38E+09	445,922	8.66E+09	258,989	2.92E+09	293,704	85,135	130,486	37,034
1988	65,206	1.02E+07	57,199	8.82E+06	221,545	2.32E+09	203,869	1.89E+09	239,519	2.74E+09	169,038	9.05E+08	156,339	48,059	146,670	43,327
1989	95,643	2.18E+07	35,871	2.99E+06	336,554	4.87E+09	123,342	5.67E+08	363,672	5.83E+09	152,772	7.57E+08	240,910	69,618	87,471	23,741
1990	86,525	1.69E+07	31,499	2.12E+06	298,102	4.02E+09	109,955	5.25E+08	322,157	4.82E+09	223,178	3.35E+09	211,576	63,303	78,457	22,870
1991	67,285	2.15E+07	29,600	3.83E+06	414,014	1.16E+10	180,854	2.36E+09	446,581	1.31E+10	206,167	3.44E+09	346,730	107,780	151,254	48,498
1992	68,488	1.59E+07	26,796	2.48E+06	420,552	1.20E+10	171,132	2.48E+09	454,405	1.46E+10	286,113	7.54E+09	352,064	109,691	144,336	49,750
1993	62,280	1.62E+07	39,541	7.41E+06	372,700	1.02E+10	238,401	4.88E+09	402,921	1.24E+10	252,210	4.06E+09	310,420	101,058	198,859	69,787
1994	78,374	3.10E+07	34,087	5.35E+06	475,605	1.74E+10	209,975	2.85E+09	512,855	1.94E+10	195,757	2.74E+09	397,231	131,829	175,888	53,311
1995	70,789	2.69E+07	24,888	3.34E+06	441,461	1.50E+10	161,298	1.80E+09	476,734	1.75E+10	209,154	3.66E+09	370,672	122,316	136,410	42,349
1996	84,320	3.91E+07	29,094	8.04E+06	508,739	2.05E+10	173,332	2.58E+09	549,842	2.46E+10	173,145	2.63E+09	424,419	142,887	144,238	50,745
1997	80,913	3.82E+07	23,874	5.37E+06	501,861	1.84E+10	146,187	1.82E+09	542,145	2.19E+10	168,354	2.42E+09	420,947	135,449	122,313	42,619
1998	87,745	4.95E+07	23,613	5.44E+06	514,736	1.93E+10	142,394	1.66E+09	554,900	2.15E+10	0	4.83E-05	426,991	138,769	118,781	40,682
1999	0	0.00E+00	0	1.15E-07	0	0.00E+00	0	3.24E-05	0	0.00E+00	0	4.80E-05	0	0	0	0
2000	0	0.00E+00	0	1.14E-07	0	0.00E+00	0	3.45E-05	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9g Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis - SWEDEN

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	9,740	1.69E+06	636	6.09E+03	11,887	4.05E+06	850	3.06E+04	12,843	4.78E+06	4,309	7.99E+05	2,147	1,535	214	157
1972	7,828	1.21E+06	462	4.01E+03	9,599	3.07E+06	588	1.37E+04	10,404	3.52E+06	6,285	7.70E+05	1,771	1,367	125	99
1973	9,880	1.64E+06	1,640	4.42E+04	12,001	3.60E+06	2,236	2.31E+05	12,990	4.10E+06	4,652	7.55E+05	2,121	1,399	596	432
1974	14,091	3.83E+06	1,035	1.90E+04	17,292	8.75E+06	1,430	1.05E+05	18,605	1.04E+07	3,489	2.00E+05	3,201	2,218	394	294
1975	15,201	4.40E+06	250	1.18E+03	18,437	9.75E+06	337	5.24E+03	19,854	1.15E+07	3,840	8.16E+05	3,236	2,312	87	64
1976	8,494	1.33E+06	758	1.16E+04	10,457	2.92E+06	1,005	5.28E+04	11,272	3.49E+06	2,704	3.63E+05	1,963	1,262	247	203
1977	3,983	3.01E+05	570	5.73E+03	4,920	6.45E+05	755	2.35E+04	5,328	7.52E+05	2,250	3.61E+05	937	587	185	133
1978	4,624	4.36E+05	435	2.97E+03	5,731	1.13E+06	581	1.55E+04	6,177	1.30E+06	4,023	3.50E+05	1,106	831	146	112
1979	4,862	4.51E+05	1,268	3.27E+04	5,948	1.03E+06	1,698	1.34E+05	6,450	1.20E+06	8,464	1.37E+06	1,086	763	430	318
1980	6,308	8.40E+05	2,150	9.62E+04	7,649	1.73E+06	2,868	4.68E+05	8,421	2.08E+06	8,912	8.12E+05	1,342	945	718	610
1981	11,178	2.44E+06	637	8.03E+03	13,456	5.07E+06	863	3.44E+04	14,749	5.98E+06	10,814	1.96E+06	2,278	1,620	226	162
1982	9,763	2.00E+06	2,289	1.20E+05	12,075	4.10E+06	3,020	4.14E+05	13,252	5.02E+06	8,125	1.17E+06	2,311	1,448	731	543
1983	13,268	2.95E+06	1,569	4.21E+04	16,182	6.98E+06	2,062	2.09E+05	17,708	8.68E+06	7,311	1.27E+06	2,914	2,008	493	408
1984	18,118	6.80E+06	2,169	7.46E+04	22,086	1.44E+07	2,844	4.22E+05	23,816	1.70E+07	5,394	3.58E+05	3,968	2,766	675	589
1985	21,302	8.08E+06	944	1.60E+04	25,873	1.79E+07	1,224	7.45E+04	27,821	2.16E+07	5,846	4.90E+05	4,571	3,140	281	242
1986	23,165	9.07E+06	926	1.58E+04	28,493	2.16E+07	1,201	7.02E+04	30,677	2.59E+07	8,363	1.41E+06	5,328	3,535	276	233
1987	18,671	6.40E+06	2,641	1.21E+05	22,441	1.23E+07	3,468	6.20E+05	24,148	1.39E+07	6,416	1.23E+06	3,770	2,429	827	706
1988	15,284	3.56E+06	2,486	9.88E+04	19,044	9.27E+06	3,352	5.76E+05	20,523	1.02E+07	14,786	7.41E+06	3,760	2,390	866	691
1989	4,914	4.39E+05	7,281	9.26E+05	5,984	9.42E+05	9,742	5.00E+06	6,523	1.15E+06	10,663	2.75E+06	1,070	710	2,461	2,019
1990	11,867	2.80E+06	5,015	4.39E+05	14,648	5.46E+06	6,507	1.82E+06	15,753	6.42E+06	10,358	5.52E+06	2,781	1,631	1,492	1,174
1991	14,161	3.73E+06	5,793	6.71E+05	17,462	8.21E+06	7,690	3.35E+06	18,721	9.43E+06	12,136	5.75E+06	3,301	2,115	1,896	1,637
1992	15,563	3.85E+06	7,452	9.66E+05	18,955	7.90E+06	9,741	4.10E+06	20,303	9.66E+06	16,277	1.45E+07	3,391	2,012	2,289	1,770
1993	16,334	4.79E+06	9,993	2.01E+06	19,965	9.75E+06	13,289	9.42E+06	21,358	1.07E+07	12,482	7.93E+06	3,631	2,226	3,296	2,721
1994	12,418	2.49E+06	7,355	9.45E+05	17,443	7.90E+06	10,063	4.92E+06	18,675	9.23E+06	8,004	2.50E+06	5,025	2,324	2,707	1,994
1995	15,510	4.74E+06	4,417	3.68E+05	25,517	2.53E+07	6,239	1.68E+06	27,328	3.02E+07	9,517	3.56E+06	10,006	4,537	1,822	1,144
1996	9,447	1.84E+06	5,464	4.98E+05	15,420	7.89E+06	7,543	2.47E+06	16,510	9.10E+06	6,087	1.42E+06	5,973	2,459	2,079	1,403
1997	4,246	3.79E+05	3,590	2.20E+05	6,889	1.94E+06	5,074	9.88E+05	7,370	2.25E+06	3,455	3.17E+05	2,643	1,249	1,484	877
1998	2,841	3.32E+04	2,011	2.10E+04	3,956	2.17E+05	2,904	2.21E+05	4,229	2.58E+05	2	6.38E+00	1,115	429	893	447
1999	0	0.00E+00	0	4.24E-08	0	0.00E+00	0	1.55E-07	0	0.00E+00	0	3.43E-07	0	0	0	0
2000	0	0.00E+00	0	5.17E-08	0	0.00E+00	0	2.26E-07	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9h Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis - UK(E&W)

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD	
1971	52,731	3.45E+07	28,758	1.24E+07	122,919	7.71E+08	67,846	2.37E+08	133,700	9.24E+08	140,368	4.98E+08	70,188	27,144	39,088
1972	66,409	6.59E+07	34,727	1.41E+07	159,544	1.61E+09	81,484	3.01E+08	173,454	1.92E+09	122,393	6.11E+08	93,135	39,242	46,757
1973	64,546	6.08E+07	33,655	1.49E+07	148,788	1.56E+09	80,168	3.64E+08	161,656	1.79E+09	128,373	5.26E+08	84,243	38,714	46,513
1974	66,995	6.22E+07	33,730	1.54E+07	163,564	1.49E+09	78,699	3.15E+08	177,712	1.76E+09	126,866	7.34E+08	96,569	37,775	44,969
1975	79,398	1.07E+08	38,784	1.94E+07	174,603	1.64E+09	92,400	5.11E+08	190,017	2.08E+09	107,097	2.33E+08	95,206	39,133	53,616
1976	48,770	3.53E+07	22,734	7.77E+06	123,598	5.43E+08	58,833	1.38E+08	134,313	6.47E+08	99,799	2.61E+08	74,828	22,530	36,099
1977	56,228	4.42E+07	26,237	8.88E+06	135,681	7.38E+08	63,486	1.58E+08	147,301	8.42E+08	111,692	2.82E+08	79,453	26,341	37,250
1978	63,971	4.69E+07	29,220	1.08E+07	151,043	6.69E+08	70,052	1.66E+08	164,111	8.20E+08	73,731	1.42E+08	87,072	24,939	40,832
1979	45,694	2.69E+07	20,602	6.75E+06	105,569	3.31E+08	47,900	8.58E+07	114,771	4.02E+08	98,988	1.68E+08	59,875	17,433	27,298
1980	58,331	4.37E+07	25,366	8.16E+06	123,943	4.60E+08	51,903	9.08E+07	134,974	5.43E+08	110,669	1.83E+08	65,612	20,399	26,537
1981	79,691	9.07E+07	32,756	1.33E+07	165,004	9.09E+08	66,559	1.06E+08	179,833	1.10E+09	71,432	8.93E+07	85,313	28,601	33,803
1982	49,644	3.11E+07	20,382	6.00E+06	98,141	2.80E+08	41,357	4.85E+07	107,176	3.32E+08	76,751	1.38E+08	48,497	15,768	20,975
1983	63,979	6.95E+07	25,890	1.07E+07	127,709	4.93E+08	50,987	8.00E+07	139,402	5.93E+08	62,292	1.00E+08	63,729	20,566	25,097
1984	56,924	4.93E+07	23,053	7.63E+06	106,972	2.91E+08	43,144	6.02E+07	116,559	3.64E+08	57,094	6.91E+07	50,049	15,547	20,090
1985	59,379	4.52E+07	22,707	7.37E+06	108,864	2.55E+08	41,262	4.55E+07	118,484	3.18E+08	83,863	1.26E+08	49,484	14,486	18,555
1986	76,231	8.26E+07	29,787	1.34E+07	140,001	4.51E+08	54,115	7.89E+07	152,413	5.67E+08	70,057	1.03E+08	63,770	19,184	24,328
1987	67,360	7.15E+07	25,482	8.03E+06	122,836	3.83E+08	46,460	6.58E+07	133,553	4.28E+08	85,594	1.41E+08	55,476	17,654	20,979
1988	91,393	1.09E+08	33,160	1.71E+07	172,298	7.03E+08	61,579	9.42E+07	187,347	8.49E+08	74,886	9.11E+07	80,905	24,391	28,419
1989	73,551	8.51E+07	26,076	1.23E+07	126,376	4.11E+08	45,409	5.10E+07	137,401	4.92E+08	55,485	6.18E+07	52,825	18,066	19,333
1990	70,534	7.71E+07	23,658	7.30E+06	119,395	3.09E+08	40,276	3.71E+07	129,755	3.71E+08	28,832	2.00E+07	48,861	15,237	16,618
1991	38,912	2.01E+07	12,927	2.76E+06	68,448	1.09E+08	22,153	1.20E+07	74,387	1.30E+08	29,631	1.65E+07	29,536	9,438	9,226
1992	35,860	1.57E+07	11,440	1.46E+06	63,476	7.95E+07	20,776	1.05E+07	68,916	9.44E+07	34,400	4.99E+07	27,616	7,987	9,336
1993	55,265	7.51E+07	12,903	5.21E+06	108,205	4.10E+08	25,462	3.03E+07	117,550	5.14E+08	58,388	1.59E+08	52,940	18,312	12,559
1994	78,462	1.62E+08	23,523	1.35E+07	154,845	9.13E+08	47,996	9.95E+07	168,106	1.09E+09	33,748	2.34E+07	76,384	27,396	24,473
1995	34,005	1.60E+06	13,066	2.42E+05	71,747	8.78E+07	27,438	1.33E+07	77,957	1.12E+08	44,728	3.63E+07	37,742	9,286	14,372
1996	28,041	1.04E+06	15,095	2.99E+05	65,375	7.47E+07	36,172	2.22E+07	71,022	9.42E+07	33,934	4.12E+07	37,334	8,581	21,077
1997	24,539	6.97E+05	9,115	1.24E+05	71,921	1.58E+08	27,149	2.51E+07	78,048	1.85E+08	21,318	1.53E+07	47,381	12,541	18,035
1998	28,679	1.03E+06	5,873	4.66E+04	83,118	2.41E+08	17,233	9.67E+06	90,234	2.92E+08	83	3.17E+02	54,439	15,484	11,360
1999	0	0.00E+00	0	1.77E-07	0	0.00E+00	0	4.63E-05	0	0.00E+00	0	7.33E-05	0	0	0
2000	0	0.00E+00	0	2.39E-07	0	0.00E+00	0	4.75E-05	0	0.00E+00	0	0.00E+00	0	0	0

Appendix 9i Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis - UK(N IRELAND)

Year	Estimated total catch 1SW		Estimated total catch MSW		Estimated number 1SW returns		Estimated number MSW returns		Estimated maturing 1SW recruits		Est. non-mat. 1SW recruits		Est. 1SW spawners		Est MSW spawners	
		Variance		Variance	mean	Variance	mean	Variance	Mean	Variance	mran	Variance		SD		SD
1971	89,673	5.16E+07	12,176	0.00E+00	130,291	1.61E+08	27,089	6.18E+06	141,109	2.16E+08	27,798	1.05E+07	40,618	10,442	14,913	2,486
1972	81,249	5.30E+07	10,713	0.00E+00	118,801	1.69E+08	23,494	6.66E+06	128,618	2.02E+08	24,216	7.39E+06	37,552	10,767	12,781	2,581
1973	70,354	3.53E+07	9,412	0.00E+00	102,374	1.00E+08	20,470	4.62E+06	110,950	1.39E+08	24,858	7.58E+06	32,019	8,065	11,058	2,149
1974	71,556	3.77E+07	9,560	0.00E+00	103,291	1.07E+08	21,000	4.27E+06	111,848	1.38E+08	21,675	6.81E+06	31,736	8,345	11,440	2,067
1975	62,500	2.72E+07	8,446	0.00E+00	90,278	8.50E+07	18,311	3.98E+06	97,780	1.06E+08	15,046	2.85E+06	27,778	7,603	9,865	1,995
1976	43,219	1.31E+07	5,814	0.00E+00	63,139	4.93E+07	12,705	1.51E+06	68,418	6.65E+07	14,413	2.93E+06	19,920	6,013	6,892	1,228
1977	43,043	1.42E+07	5,605	0.00E+00	63,428	4.38E+07	12,180	1.83E+06	68,690	5.70E+07	19,512	4.89E+06	20,385	5,440	6,575	1,354
1978	57,121	2.47E+07	7,563	0.00E+00	83,447	7.33E+07	16,481	2.74E+06	90,300	8.94E+07	13,133	2.03E+06	26,327	6,972	8,919	1,654
1979	38,267	1.08E+07	5,074	0.00E+00	55,712	3.17E+07	11,099	1.23E+06	60,334	3.73E+07	16,285	4.02E+06	17,445	4,572	6,025	1,109
1980	47,282	1.86E+07	6,281	0.00E+00	68,541	5.61E+07	13,757	2.39E+06	74,407	7.35E+07	13,325	2.72E+06	21,259	6,123	7,476	1,544
1981	39,580	1.19E+07	5,168	0.00E+00	57,359	3.83E+07	11,246	1.35E+06	62,413	4.86E+07	17,251	3.85E+06	17,779	5,137	6,079	1,163
1982	50,929	1.90E+07	6,712	0.00E+00	74,358	5.83E+07	14,576	2.27E+06	80,781	7.60E+07	24,858	7.58E+06	23,429	6,268	7,864	1,507
1983	72,472	3.66E+07	9,641	0.00E+00	106,869	1.02E+08	20,999	4.17E+06	115,953	1.22E+08	10,374	1.51E+06	34,396	8,109	11,358	2,041
1984	30,715	6.13E+06	4,005	0.00E+00	44,868	2.45E+07	8,757	7.87E+05	48,740	3.18E+07	13,301	2.64E+06	14,154	4,280	4,752	887
1985	37,822	9.83E+06	5,142	0.00E+00	55,018	3.04E+07	11,229	1.35E+06	59,653	3.80E+07	14,488	3.04E+06	17,196	4,533	6,087	1,160
1986	42,820	1.30E+07	5,613	0.00E+00	62,191	3.79E+07	12,239	1.81E+06	67,455	4.60E+07	7,329	6.63E+05	19,371	4,987	6,626	1,345
1987	21,674	2.67E+06	2,847	0.00E+00	31,327	7.94E+06	6,193	3.97E+05	34,041	9.71E+06	19,385	6.31E+06	9,653	2,295	3,346	630
1988	44,876	1.32E+07	5,865	0.00E+00	69,539	4.04E+07	16,359	3.26E+06	75,378	4.89E+07	14,715	3.35E+06	24,663	5,217	10,494	1,806
1989	57,373	3.84E+07	7,389	0.00E+00	64,322	6.10E+07	12,433	2.02E+06	69,659	7.00E+07	13,615	1.27E+06	6,949	4,750	5,044	1,422
1990	32,966	5.34E+05	4,344	0.00E+00	53,326	1.13E+07	11,499	5.10E+05	57,766	1.52E+07	7,022	2.81E+05	20,360	3,282	7,155	714
1991	19,250	2.15E+05	2,549	0.00E+00	30,095	3.56E+06	5,932	1.04E+05	32,595	4.34E+06	15,704	2.29E+06	10,845	1,830	3,384	323
1992	33,064	2.37E+06	4,386	0.00E+00	58,738	2.42E+07	13,259	9.83E+05	63,562	3.21E+07	37,991	1.02E+07	25,674	4,671	8,874	991
1993	29,030	4.05E+05	3,840	0.00E+00	71,651	1.96E+07	32,075	3.36E+06	77,542	2.98E+07	13,628	1.89E+06	42,621	4,382	28,235	1,834
1994	34,568	4.72E+06	4,554	0.00E+00	50,050	1.68E+07	11,517	1.09E+06	54,166	2.27E+07	11,707	9.51E+05	15,482	3,481	6,963	1,045
1995	31,258	4.74E+05	4,135	0.00E+00	46,845	7.23E+06	9,888	3.82E+05	50,707	1.11E+07	12,831	5.63E+06	15,587	2,599	5,752	618
1996	27,502	7.41E+05	3,639	0.00E+00	48,987	2.42E+07	10,844	3.86E+06	53,014	3.08E+07	15,297	1.04E+07	21,485	4,842	7,206	1,965
1997	32,449	1.03E+06	4,302	0.00E+00	54,698	3.48E+07	12,907	6.49E+06	59,186	4.54E+07	16,890	6.52E+06	22,249	5,815	8,605	2,547
1998	29,573	8.66E+05	3,907	0.00E+00	84,320	5.42E+07	14,286	4.62E+06	91,194	6.72E+07	0	7.46E-05	54,747	7,304	10,379	2,150
1999	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	5.29E-05	0	0.00E+00	0	5.77E-05	0	0	0	0
2000	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	4.05E-05	0	0.00E+00	0	0.00E+00	0	0	0	0

Appendix 9j Estimated numbers of fish killed, returning, spawning and recruits from Monto Carlo simulation analysis - UK(SCOTLAND)

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Estimated number 1SW returns mean	Variance	Estimated number MSW returns mean	Variance	Estimated maturing 1SW recruits Mean	Variance	Est. non-mat. 1SW recruits mran	Variance	Est. 1SW spawners	SD	Est MSW spawners
1971	375,532	1.13E+09	235,136	0.00E+00	1,306,300	7.29E+10	609,204	1.14E+10	1,409,926	8.48E+10	1,156,474	3.30E+10	930,768	267,879	374,068
1972	369,183	9.59E+08	309,396	0.00E+00	1,332,102	8.08E+10	803,129	1.90E+10	1,438,145	9.44E+10	1,192,570	3.94E+10	962,920	282,618	493,733
1973	421,053	1.35E+09	342,971	0.00E+00	1,571,368	1.21E+11	892,875	2.44E+10	1,696,471	1.42E+11	1,000,952	1.98E+10	1,150,315	345,405	549,903
1974	412,591	1.07E+09	270,915	0.00E+00	1,427,414	8.89E+10	708,240	1.32E+10	1,541,013	1.04E+11	999,728	1.72E+10	1,014,823	296,365	437,325
1975	319,400	7.06E+08	304,227	0.00E+00	1,184,116	6.68E+10	769,346	1.11E+10	1,278,337	7.79E+10	767,055	1.49E+10	864,717	257,139	465,119
1976	269,557	4.84E+08	165,464	0.00E+00	929,808	4.79E+10	502,541	8.87E+09	1,003,792	5.63E+10	816,463	1.93E+10	660,251	217,694	337,077
1977	281,052	5.74E+08	198,061	0.00E+00	985,213	4.58E+10	593,438	1.26E+10	1,064,428	5.59E+10	971,666	3.10E+10	704,161	212,710	395,377
1978	291,259	5.71E+08	236,560	0.00E+00	1,039,931	4.04E+10	708,932	1.85E+10	1,121,590	4.55E+10	761,143	1.72E+10	748,671	199,617	472,372
1979	269,808	4.80E+08	193,092	0.00E+00	958,334	4.17E+10	572,611	1.11E+10	1,034,993	5.00E+10	966,357	2.19E+10	688,526	203,138	379,519
1980	156,764	7.34E+07	223,752	0.00E+00	706,149	3.11E+10	661,072	1.37E+10	763,488	3.70E+10	1,120,309	3.58E+10	549,385	176,141	437,320
1981	196,028	1.17E+08	227,863	0.00E+00	870,713	4.30E+10	801,909	2.47E+10	941,381	5.11E+10	840,063	2.76E+10	674,685	207,195	574,047
1982	269,182	2.13E+08	165,569	0.00E+00	1,211,260	1.00E+11	599,623	1.62E+10	1,308,484	1.17E+11	899,121	4.01E+10	942,077	316,127	434,054
1983	270,524	2.03E+08	189,020	0.00E+00	1,201,000	7.61E+10	676,435	2.39E+10	1,299,056	9.27E+10	643,834	1.67E+10	930,475	275,407	487,416
1984	276,154	2.88E+08	140,265	0.00E+00	1,185,696	8.95E+10	487,570	1.05E+10	1,280,693	1.05E+11	666,780	1.77E+10	909,542	298,717	347,305
1985	204,826	1.37E+08	149,097	0.00E+00	875,380	3.98E+10	517,018	1.08E+10	945,999	4.81E+10	1,097,088	6.13E+10	670,554	199,195	367,922
1986	260,748	2.12E+08	191,412	0.00E+00	1,152,834	7.92E+10	836,160	4.18E+10	1,245,306	9.35E+10	772,132	3.12E+10	892,086	281,107	644,747
1987	213,958	1.51E+08	135,252	0.00E+00	937,996	5.69E+10	580,236	2.01E+10	1,012,610	6.57E+10	793,826	2.76E+10	724,038	238,323	444,983
1988	192,214	1.23E+08	145,055	0.00E+00	852,272	3.84E+10	614,340	1.80E+10	919,709	4.34E+10	741,753	2.59E+10	660,058	195,654	469,284
1989	205,581	4.57E+07	122,176	0.00E+00	1,154,350	1.45E+11	536,726	1.62E+10	1,246,791	1.71E+11	574,820	1.76E+10	948,768	380,541	414,550
1990	96,082	1.15E+07	103,918	0.00E+00	543,102	3.26E+10	445,517	1.17E+10	585,782	3.72E+10	523,299	2.97E+10	447,021	180,575	341,599
1991	86,848	8.94E+06	76,641	0.00E+00	505,561	2.74E+10	425,729	2.00E+10	545,843	3.20E+10	655,328	4.21E+10	418,713	165,540	349,088
1992	119,792	1.74E+07	96,956	0.00E+00	662,806	4.10E+10	529,226	2.81E+10	715,770	4.87E+10	576,126	3.27E+10	543,014	202,410	432,270
1993	110,999	1.47E+07	83,985	0.00E+00	616,781	3.45E+10	466,526	2.18E+10	666,575	4.17E+10	668,655	4.68E+10	505,782	185,805	382,541
1994	117,197	1.58E+07	100,882	0.00E+00	658,341	3.94E+10	553,823	2.95E+10	710,237	4.48E+10	651,465	4.79E+10	541,144	198,371	452,941
1995	106,306	1.39E+07	92,177	0.00E+00	597,915	3.53E+10	538,905	3.10E+10	645,518	4.12E+10	557,380	3.49E+10	491,608	187,835	446,728
1996	78,154	7.39E+06	68,255	0.00E+00	540,775	2.95E+10	459,232	2.29E+10	584,001	3.47E+10	390,298	1.46E+10	462,621	171,784	390,977
1997	54,933	3.17E+06	47,430	0.00E+00	377,212	1.68E+10	322,831	1.08E+10	407,481	2.01E+10	354,951	1.24E+10	322,280	129,786	275,401
1998	60,308	3.92E+06	42,095	0.00E+00	392,796	2.68E+10	295,435	8.82E+09	424,530	3.20E+10	361	1.37E+03	332,488	163,570	253,340
1999	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	6.56E-04	0	0.00E+00	0	1.14E-03	0	0	0
2000	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	7.67E-04	0	0.00E+00	0	0.00E+00	0	0	0

Appendix 9k Estimated numbers of fish killed and recruits from Monto Carlo simulation analysis - FAROES

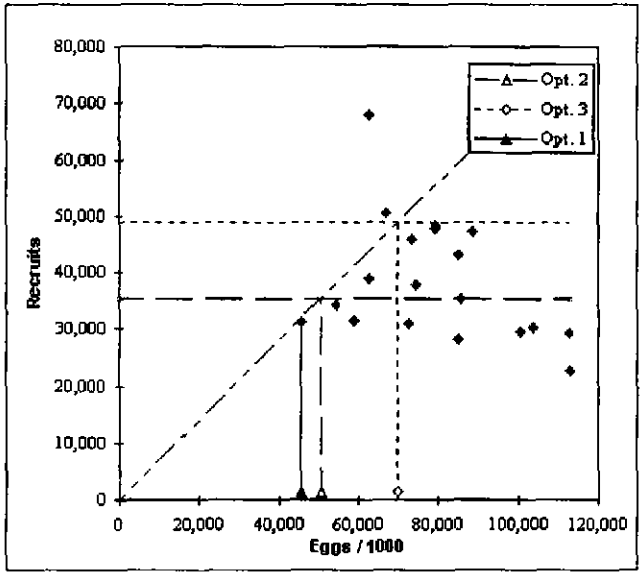
Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Est. mat. 1SW recruits mean	Variance	Est. non-mat. 1SW recruits mran	Variance	Total 1SW recruits means	SD	Prop'n wild	Stock composition	1SW	MSW
1971	11,932	8.77E+06	105,796	8.21E-04	2,611	5.27E+05	122,355	6.24E+06	124,966	2,601	1.00	**France**	0.05	0
1972	12,918	1.16E+07	111,187	9.59E-04	2,835	7.50E+05	138,184	8.16E+06	141,019	2,985	1.00	**Finland**	0.05	0
1973	4,558	1.37E+06	126,012	1.21E-03	3,246	8.69E+05	101,275	8.09E+06	104,522	2,993	1.00	**Iceland**		0.006
1974	14,753	1.23E+07	88,276	7.38E-04	2,236	3.98E+05	122,790	4.30E+06	125,025	2,167	1.00	**Ireland**	0.1	0.057
1975	8,290	4.40E+06	112,984	9.95E-04	2,744	5.50E+05	84,958	5.92E+06	87,702	2,543	1.00	**Norway**	0.3	0.396
1976	10,174	5.93E+06	73,900	4.42E-04	1,756	2.28E+05	59,249	2.43E+06	61,005	1,632	1.00	**Russia**	0.1	0.183
1977	22,149	3.24E+07	52,112	1.88E-04	1,347	1.59E+05	44,742	1.38E+06	46,089	1,241	1.00	**Sweden**	0.05	0.023
1978	12,551	8.95E+06	39,309	1.53E-04	1,000	8.55E+04	74,789	1.00E+06	75,788	1,043	1.00	**UK(E&W)**	0.1	0.023
1979	6,119	2.37E+06	70,082	3.77E-04	1,814	2.52E+05	192,070	3.51E+06	193,884	1,939	1.00	**UK(NI)**	0.05	0
1980	34,009	8.01E+07	182,617	2.86E-03	4,870	2.07E+06	322,762	2.45E+07	327,632	5,154	1.00	**UK(Sc)**	0.2	0.192
1981	8,017	3.72E+06	300,542	7.83E-03	7,457	4.89E+06	308,128	5.36E+07	315,585	7,649	0.98			
1982	31,274	5.67E+07	276,957	6.45E-03	6,878	3.95E+06	243,362	3.60E+07	250,240	6,323	0.98	**Other**		0.122
1983	36,670	4.63E+07	215,350	3.66E-03	8,023	3.23E+06	169,275	2.87E+07	177,298	5,655	0.98			
1984	18,600	1.64E+07	138,227	1.53E-03	4,073	1.06E+06	175,261	1.08E+07	179,334	3,441	0.96	**Total**	1	1.002
1985	14,129	2.10E+07	158,103	2.28E-03	3,105	1.26E+06	194,936	1.33E+07	198,041	3,815	0.92			
1986	18,463	2.64E+07	180,934	2.85E-03	4,054	1.65E+06	183,417	1.81E+07	187,471	4,447	0.96			
1987	15,272	1.96E+07	166,244	2.16E-03	3,348	1.10E+06	101,035	1.25E+07	104,383	3,689	0.97			
1988	17,275	7.09E+06	87,629	7.33E-04	3,791	6.52E+05	137,494	4.86E+06	141,285	2,348	0.92			
1989	13,677	1.28E+07	121,965	1.11E-03	3,000	7.80E+05	153,050	8.49E+06	156,051	3,044	0.82			
1990	15,109	1.70E+07	140,054	1.74E-03	3,302	9.51E+05	98,182	1.13E+07	101,484	3,498	0.54			
1991	8,674	5.72E+06	84,935	6.15E-04	1,907	3.61E+05	43,083	3.59E+06	44,990	1,987	0.54			
1992	3,301	9.12E+05	35,700	1.19E-04	722	5.23E+04	33,100	5.77E+05	33,823	793	0.62			
1993	2,882	6.83E+05	30,023	7.43E-05	630	3.77E+04	34,447	4.54E+05	35,078	701	0.69			
1994	2,827	8.13E+05	31,672	8.71E-05	621	4.94E+04	37,439	5.76E+05	38,060	791	0.72			
1995	3,251	8.67E+05	34,662	9.53E-05	713	5.23E+04	31,391	6.14E+05	32,104	816	0.80			
1996	2,524	6.74E+05	28,381	7.35E-05	554	3.83E+04	3,429	4.20E+05	3,983	677	0.75			
1997	593	2.93E+03	1,424	1.56E-07	130	3.95E+02	466	2.22E+03	596	51	0.80			
1998	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80			
1999	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80			
2000	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0	0.80			

Appendix 9I Estimated numbers of fish killed and recruits from Monto Carlo simulation analysis - WEST GREENLAND

Year	Estimated total catch 1SW	Variance	Estimated total catch MSW	Variance	Estimated number 1SW recruits mean	Variance	Est. non-mat. 1SW recruits mean	Variance	Prop'n EU	European stock composition	MSW
1971	0	0.00E+00	486,483	2.53E+08	0	0.00E+00	532,319	4.22E+08	**0.50**	**France**	0.027
1972	0	0.00E+00	385,062	1.64E+08	0	0.00E+00	304,664	1.48E+08	**0.50**	**Finland**	0.001
1973	0	0.00E+00	423,586	1.64E+08	0	0.00E+00	421,353	2.79E+08	**0.50**	**Iceland**	0.001
1974	0	0.00E+00	324,974	9.58E+07	0	0.00E+00	177,402	6.23E+07	**0.50**	**Ireland**	0.147
1975	0	0.00E+00	395,274	1.54E+08	0	0.00E+00	463,615	3.99E+08	**0.50**	**Norway**	0.027
1976	0	0.00E+00	220,747	5.51E+07	0	0.00E+00	297,625	1.81E+08	**0.50**	**Russia**	0.000
1977	0	0.00E+00	278,405	7.67E+07	0	0.00E+00	355,645	2.05E+08	**0.50**	**Sweden**	0.003
1978	0	0.00E+00	162,083	2.68E+07	0	0.00E+00	202,219	8.32E+07	0.48	**UK(E&W)**	0.149
1979	0	0.00E+00	271,913	7.40E+07	0	0.00E+00	432,659	3.86E+08	0.50	**UK(NI)**	0.000
1980	0	0.00E+00	184,771	4.19E+07	0	0.00E+00	300,396	1.30E+08	0.52	**UK(Sc)**	0.645
1981	0	0.00E+00	274,521	7.25E+07	0	0.00E+00	241,605	1.19E+08	0.41		
1982	0	0.00E+00	160,351	2.22E+07	0	0.00E+00	175,485	4.84E+07	0.38	**Other**	
1983	0	0.00E+00	67,675	4.57E+06	0	0.00E+00	74,070	1.05E+07	0.60		
1984	0	0.00E+00	45,395	1.91E+06	0	0.00E+00	49,681	4.25E+06	0.50	**Total**	1.000
1985	0	0.00E+00	180,957	3.14E+07	0	0.00E+00	198,034	6.47E+07	0.50		
1986	0	0.00E+00	145,814	2.01E+07	0	0.00E+00	159,579	4.28E+07	0.43		
1987	0	0.00E+00	141,293	2.31E+07	0	0.00E+00	154,626	4.41E+07	0.41		
1988	0	0.00E+00	187,100	2.90E+07	0	0.00E+00	204,779	7.29E+07	0.57		
1989	0	0.00E+00	58,460	3.21E+06	0	0.00E+00	63,980	6.98E+06	0.44		
1990	0	0.00E+00	24,119	6.79E+05	0	0.00E+00	26,396	1.34E+06	0.25		
1991	0	0.00E+00	72,812	5.81E+06	0	0.00E+00	79,685	1.16E+07	0.35		
1992	0	0.00E+00	44,023	2.03E+06	0	0.00E+00	48,181	4.33E+06	0.46		
1993	0	0.00E+00	2,240	4.23E+03	0	0.00E+00	2,451	9.35E+03	**0.4**		
1994	0	0.00E+00	2,208	4.25E+03	0	0.00E+00	2,416	8.77E+03	**0.4**		
1995	0	0.00E+00	12,408	1.67E+05	0	0.00E+00	13,578	3.17E+05	0.35		
1996	0	0.00E+00	16,838	2.77E+05	0	0.00E+00	18,427	5.77E+05	0.45		
1997	0	0.00E+00	9,317	9.40E+04	0	0.00E+00	10,197	1.98E+05	0.40		
1998	0	0.00E+00	1,895	3.83E+03	0	0.00E+00	2,074	7.88E+03	0.27		
1999	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00			
2000	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00			

Appendix 10a Lagged egg deposition analysis and estimation of conservation limit options - FINLAND

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	6000	13000	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	12%	77%		0.00	0.00	0.26	0.59	0.14	0.01	egg x 10^{-3}		
1971	4,536	4,612	48,889							n/a	26,144	
1972	6,993	6,973	73,993							n/a	40,802	
1973	11,119	11,477	121,559							n/a	47,872	
1974	10,058	11,054	116,688	0						n/a	43,568	
1975	10,330	9,370	99,991	0	0					n/a	43,187	
1976	8,336	9,912	104,225	0	0	12,711				n/a	37,116	
1977	7,042	8,733	91,642	0	0	19,238	28,844			n/a	27,596	
1978	5,423	5,471	58,023	0	0	31,605	43,656	6,844		n/a	19,672	
1979	5,893	3,725	40,827	0	0	30,339	71,720	10,359	489	112,907	22,703	0.20
1980	6,071	4,418	47,865	0	0	25,998	68,846	17,018	740	112,602	29,288	0.26
1981	5,667	7,358	77,054	0	0	27,099	58,994	16,336	1,216	103,645	30,314	0.29
1982	4,005	8,114	83,621	0	0	23,827	61,493	13,999	1,167	100,485	29,457	0.29
1983	5,722	9,285	96,378	0	0	15,086	54,069	14,592	1,000	84,746	28,264	0.33
1984	6,648	6,935	73,412	0	0	10,615	34,234	12,830	1,042	58,721	31,482	0.54
1985	10,375	7,570	82,005	0	0	12,445	24,088	8,123	916	45,572	31,198	0.68
1986	8,967	4,718	52,605	0	0	20,034	28,240	5,716	580	54,570	34,200	0.63
1987	12,554	6,782	75,425	0	0	21,742	45,462	6,701	408	74,313	37,821	0.51
1988	9,180	4,954	55,099	0	0	25,058	49,337	10,788	479	85,661	35,244	0.41
1989	13,579	6,597	74,186	0	0	19,087	56,863	11,707	771	88,428	47,254	0.53
1990	12,560	7,003	77,634	0	0	21,321	43,313	13,493	836	78,964	47,682	0.60
1991	12,507	7,823	86,808	0	0	13,677	48,383	10,278	964	73,302	45,872	0.63
1992	19,388	7,546	87,166	0	0	19,610	31,037	11,481	734	62,862	67,891	1.08
1993	14,177	10,312	111,733	0	0	14,326	44,501	7,365	820	67,011	50,534	0.75
1994	9,596	7,672	82,550	0	0	19,288	32,509	10,559	526	62,882	38,925	0.62
1995	9,660	7,634	82,213	0	0	20,185	43,770	7,714	754	72,423	30,953	0.43
1996	17,362	4,162	52,076	0	0	22,310	45,804	10,386	551	79,051	48,233	0.61
1997	15,358	6,042	69,693	0	0	22,663	50,626	10,869	742	84,900	43,055	0.51
1998	18,051	5,762	68,503	0	0	29,050	51,428	12,013	776	93,268	-	-
1999	0	0	0	0	0	21,463	65,922	12,203	858	100,447	0	0.00
2000	0	0	0	0	0	21,375	48,704	15,643	872	86,594	0	0.00



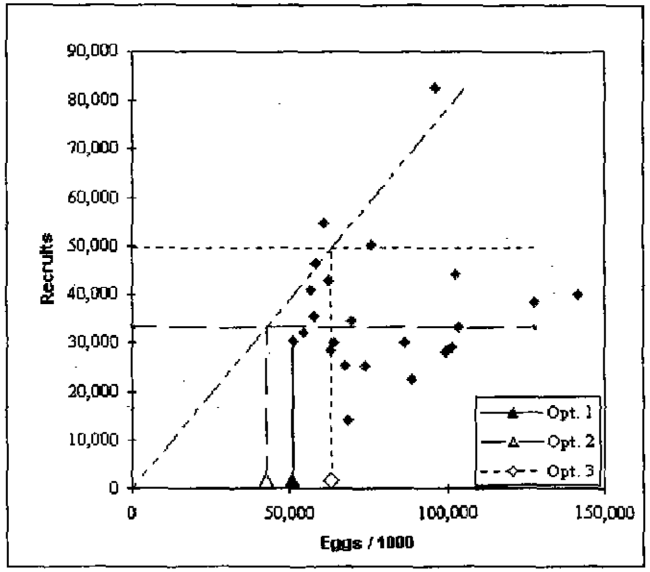
Median recruits	35,244
90%ile recruits	48,693
90%ile Rec./L	0.70

Conservation limits		**Eggs**	**1SW**	**MSW**	**Total.**
Option 1	(Min Leg. eggs)	45,572	8,189	4,062	12,251
Option 2	(Med R./90%L)	50,457	9,067	4,497	13,564
Option 3	90%Rec/90%L	69,712	12,527	6,213	18,740

	1SW	**MSW**	**Tot.**
10yr av. #	14,224	7,056	21,279
10yr av.%	67%	33%	
eggsx10^{-3}	8,534	70,622	79,156

Appendix 10b Lagged egg deposition analysis and estimation of conservation limit options - FRANCE

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition 1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	3450	5900										
Fem	45%	80%		85%	15%	0%	0%	0%	0%			
1971	13,832	10,081	77,123							n/a	57,518	
1972	27,189	20,036	152,813							n/a	58,073	
1973	16,994	12,400	94,833							n/a	36,053	
1974	7,574	5,681	43,119	65555						n/a	32,262	
1975	15,425	12,691	94,002	129891	11569					141,459	40,072	0.28
1976	14,243	9,143	72,581	80608	22922	0				103,530	33,252	0.32
1977	11,621	7,330	58,503	36651	14225	0	0			50,876	30,291	0.60
1978	11,669	6,896	56,179	79902	6468	0	0	0		86,370	30,226	0.35
1979	13,063	8,230	65,711	61694	14100	0	0	0	0	75,794	50,339	0.66
1980	26,388	17,716	138,762	49728	10887	0	0	0	0	60,615	54,845	0.90
1981	22,181	11,236	96,461	47752	8775	0	0	0	0	56,527	40,943	0.72
1982	13,028	6,696	57,186	55854	8427	0	0	0	0	64,281	29,965	0.47
1983	14,372	7,358	62,927	117947	9857	0	0	0	0	127,804	38,427	0.30
1984	23,313	11,902	101,891	81992	20814	0	0	0	0	102,806	44,128	0.43
1985	8,730	9,152	64,072	48608	14469	0	0	0	0	63,077	28,402	0.45
1986	27,161	9,213	93,025	53488	8578	0	0	0	0	62,066	42,975	0.69
1987	48,027	4,767	100,875	86607	9439	0	0	0	0	96,046	82,563	0.86
1988	17,239	13,638	102,048	54461	15284	0	0	0	0	69,745	34,608	0.50
1989	9,223	6,431	49,820	79071	9611	0	0	0	0	88,682	22,556	0.25
1990	15,296	6,565	59,933	85744	13954	0	0	0	0	99,697	28,254	0.28
1991	13,837	5,807	53,536	86741	15131	0	0	0	0	101,872	29,040	0.29
1992	24,387	7,169	77,545	42347	15307	0	0	0	0	57,654	35,476	0.62
1993	29,875	3,526	65,844	50943	7473	0	0	0	0	58,416	46,545	0.80
1994	22,105	6,321	69,208	45505	8990	0	0	0	0	54,495	31,950	0.59
1995	13,325	3,026	37,390	65913	8030	0	0	0	0	73,943	25,148	0.34
1996	16,895	5,420	56,151	55967	11632	0	0	0	0	67,599	25,261	0.37
1997	8,494	2,782	28,545	58827	9877	0	0	0	0	68,703	14,251	0.21
1998	16,248	2,338	38,130	31781	10381	0	0	0	0	42,163	-	-
1999	0	0	0	47728	5608	0	0	0	0	53,337	0	0.00
2000	0	0	0	24263	8423	0	0	0	0	32,686	0	0.00



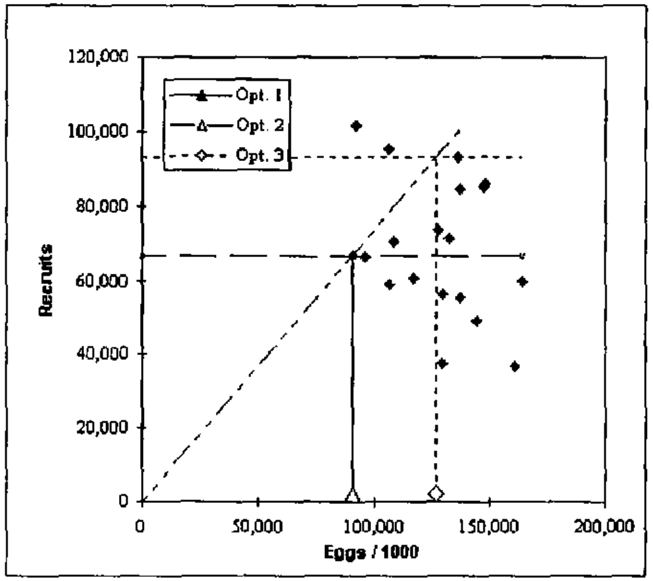
Median recruits	33,252
90%ile recruits	49,581
90%ile Rec./L	0.78

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	50,876	16,103	4,688	20,791
Option 2	(Med R./90%L)	42,506	13,454	3,916	17,370
Option 3	90%Rec/90%L	63,376	20,060	5,840	25,900

	1SW	MSW	Tot.
10yr av. #	16,968	4,940	21,908
10yr av.%	77%	23%	
eggsx10^{-3}	26,343	27,267	53,610

Appendix 10c Lagged egg deposition analysis and estimation of conservation limit options - ICELAND

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	5800	10800	egg x 10^3	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	47%	72%		0%	20%	40%	40%	0%	0%	egg x 10^{-3}		
1971	22,215	8,951	130,163							n/a	89,702	
1972	19,515	13,904	161,315							n/a	78,795	
1973	20,535	11,984	149,164							n/a	73,635	
1974	13,813	10,173	116,758	0						n/a	66,918	
1975	19,773	12,089	147,903	0	26033					n/a	71,335	
1976	17,665	9,191	119,622	0	32263	52065				n/a	73,176	
1977	20,619	11,914	148,854	0	29833	64526	52065			146,424	88,792	0.61
1978	24,839	15,025	184,549	0	23352	59666	64526	0		147,543	85,654	0.58
1979	23,653	11,303	152,369	0	29581	46703	59666	0	0	135,949	93,141	0.69
1980	7,773	14,055	130,480	0	23924	59161	46703	0	0	129,789	37,569	0.29
1981	16,424	6,303	93,783	0	29771	47849	59161	0	0	136,781	55,329	0.40
1982	11,557	6,532	82,299	0	36910	59542	47849	0	0	144,301	49,300	0.34
1983	16,270	7,465	102,397	0	30474	73820	59542	0	0	163,835	59,667	0.36
1984	10,199	8,113	90,885	0	26096	60948	73820	0	0	160,863	36,786	0.23
1985	21,239	4,902	96,013	0	18757	52192	60948	0	0	131,896	71,130	0.54
1986	32,688	8,926	158,516	0	16460	37513	52192	0	0	106,165	95,254	0.90
1987	21,309	8,901	127,302	0	20479	32919	37513	0	0	90,912	66,656	0.73
1988	39,058	7,307	163,290	0	18177	40959	32919	0	0	92,055	101,638	1.10
1989	20,967	6,185	105,254	0	19203	36354	40959	0	0	96,516	66,071	0.68
1990	19,581	7,217	109,493	0	31703	38405	36354	0	0	106,463	59,140	0.56
1991	23,885	6,019	111,914	0	25460	63407	38405	0	0	127,272	73,403	0.58
1992	30,519	7,683	142,938	0	32658	50921	63407	0	0	146,985	84,869	0.58
1993	29,448	6,358	129,716	0	21051	65316	50921	0	0	137,288	84,475	0.62
1994	18,219	7,337	106,717	0	21899	42102	65316	0	0	129,316	56,421	0.44
1995	25,218	6,257	117,401	0	22383	43797	42102	0	0	108,282	70,407	0.65
1996	21,497	5,411	100,676	0	28588	44766	43797	0	0	117,151	60,841	0.52
1997	21,507	5,035	97,779	0	25943	57175	44766	0	0	127,884	61,608	0.48
1998	35,767	5,212	138,032	0	21343	51887	57175	0	0	130,405	-	-
1999	0	0	1	0	23480	42687	51887	0	0	118,054	0	0.00
2000	0	0	1	0	20135	46961	42687	0	0	109,783	0	0.00



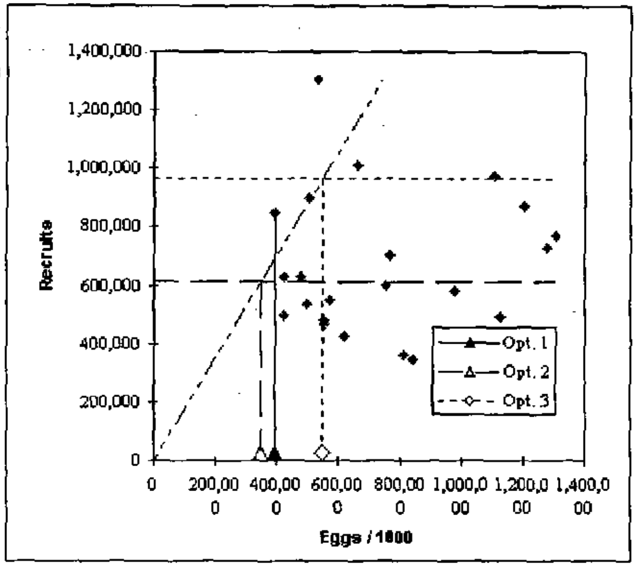
Median recruits	66,656
90%ile recruits	93,141
90%ile Rec./L	0.73

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	90,912	19,329	4,915	24,244
Option 2	(Med R./90%L)	90,912	19,329	4,915	24,244
Option 3	90%Rec/90%L	127,034	27,008	6,868	33,877

	1SW	MSW	Tot.
10yr av. #	24,661	6,271	30,932
10yr av.%	80%	20%	
eggx10^{-3}	67,225	48,767	115,992

Appendix 10d Lagged egg deposition analysis and estimation of conservation limit options - IRELAND

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	3400	7000	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	60%	85%		0	1	0	0	0	0	egg x 10^{-3}		
1971	344,450	50,884	1,005,440							n/a	1,073,183	
1972	373,332	56,389	1,097,109							n/a	1,150,693	
1973	406,501	60,476	1,189,092							n/a	1,246,915	
1974	446,263	65,944	1,302,745	201,088						n/a	1,342,630	
1975	465,739	69,199	1,361,843	219,422	703,808					n/a	1,360,843	
1976	325,967	48,810	955,389	237,818	767,976	100,544				1,106,339	975,054	0.88
1977	289,807	43,146	847,926	260,549	832,364	109,711	0			1,202,624	869,300	0.72
1978	261,618	38,959	765,506	272,369	911,921	118,909	0	0		1,303,199	772,659	0.59
1979	229,212	33,991	669,841	191,078	953,290	130,274	0	0	0	1,274,643	730,712	0.57
1980	178,572	38,602	593,966	169,585	668,772	136,184	0	0	0	974,542	580,890	0.60
1981	85,711	31,421	361,807	153,101	593,548	95,539	0	0	0	842,188	345,273	0.41
1982	160,157	13,918	409,534	133,968	535,854	84,793	0	0	0	754,615	604,305	0.80
1983	356,355	29,289	901,232	118,793	468,889	76,551	0	0	0	664,232	1,009,599	1.52
1984	136,625	31,924	468,662	72,361	415,776	66,984	0	0	0	565,122	481,451	0.87
1985	204,628	27,553	581,381	81,907	253,265	59,397	0	0	0	394,568	848,645	2.15
1986	230,040	22,641	603,992	180,246	286,673	36,181	0	0	0	503,101	897,336	1.78
1987	200,432	45,103	677,242	93,732	630,862	40,953	0	0	0	765,548	701,564	0.92
1988	569,228	36,065	1,375,810	116,276	328,063	90,123	0	0	0	534,463	1,306,206	2.44
1989	163,931	23,042	471,518	120,798	406,967	46,866	0	0	0	574,632	548,264	0.95
1990	165,224	8,192	426,599	135,448	422,795	58,138	0	0	0	616,381	423,236	0.69
1991	165,212	8,909	390,040	275,162	474,069	60,399	0	0	0	809,631	363,810	0.45
1992	209,122	18,291	536,442	94,304	963,067	67,724	0	0	0	1,125,095	490,735	0.44
1993	188,351	4,517	411,113	85,320	330,063	137,581	0	0	0	552,964	464,956	0.84
1994	261,577	25,247	683,836	78,008	298,619	47,152	0	0	0	423,779	627,127	1.48
1995	187,052	22,532	515,653	107,088	273,028	42,660	0	0	0	422,777	496,416	1.17
1996	220,210	9,149	503,666	82,223	374,809	39,004	0	0	0	496,036	532,501	1.07
1997	339,781	19,231	807,579	136,767	287,779	53,544	0	0	0	478,090	628,079	1.31
1998	414,914	22,286	979,023	103,131	478,685	41,111	0	0	0	622,927	-	-
1999	0	0	0	100,733	360,957	68,384	0	0	0	530,074	0	0.00
2000	0	0	0	161,516	352,566	51,565	0	0	0	565,647	0	0.00



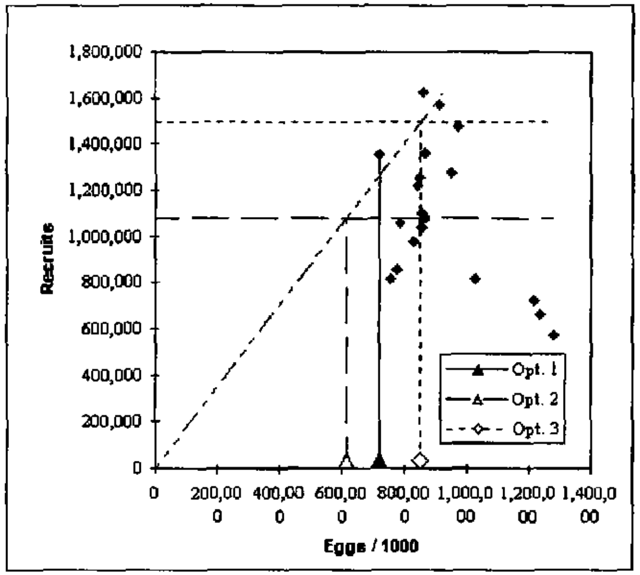
Median recruits	615,716
90%ile recruits	967,282
90%ile Rec./L	1.76

Conservation limits		**Eggs**	**1SW**	**MSW**	**Total.**
Option 1	(Min Lag. eggs)	394,568	160,969	11,124	172,094
Option 2	(Med R./90%L)	350,387	142,945	9,879	152,824
Option 3	90%Rec/90%L	550,454	224,565	15,520	240,085

	1SW	**MSW**	**Tot.**
10yr av. #	233,537	16,140	249,677
10yr av.%	94%	6%	
eggsx10^{-3}	476,416	96,031	572,447

Appendix 10e Lagged egg deposition analysis and estimation of conservation limit options - NORWAY

	Est. 1SW spawners	Est MSW spawners	Egg deposition egg x 10^{-3}	Smolt age composition						Lagged egg dep. S egg x 10^{-3}	Total 1SW recruits R	R/S
Egg	3600	9000		1 yr	2 yr	3 yr	4 yr	5 yr	6 yr			
Fem	40%	60%		0.00	0.16	0.48	0.29	0.07	1%			
1971	114,265	68,850	655,688							n/a	1,181,089	
1972	148,226	90,755	860,954							n/a	1,409,915	
1973	159,719	105,865	985,836							n/a	1,447,469	
1974	149,663	96,701	905,778	0						n/a	1,350,808	
1975	147,830	84,490	815,291	0	99665					n/a	1,302,367	
1976	149,510	92,610	876,110	0	130865	313419				n/a	1,264,452	
1977	135,636	84,413	797,662	0	149847	411536	192117			n/a	1,092,386	
1978	94,263	59,511	560,449	0	137678	471230	252260	44587		n/a	1,159,742	
1979	158,488	112,339	1,030,727	0	123924	432962	288650	58545	3278	907,559	1,571,930	1.73
1980	153,074	108,280	993,920	0	133169	389709	265393	67037	4305	859,612	1,625,917	1.89
1981	118,682	112,976	979,583	0	121245	418780	238880	61593	4929	845,427	1,251,189	1.48
1982	85,198	89,096	760,766	0	85188	381282	256700	55440	4529	783,139	1,060,464	1.35
1983	140,719	91,185	853,541	0	156670	267895	233715	59575	4076	721,932	1,356,104	1.88
1984	150,549	87,931	843,871	0	151076	492687	164212	54241	4381	866,596	1,359,212	1.57
1985	162,478	86,298	848,818	0	148897	475094	302003	38111	3988	968,092	1,476,269	1.52
1986	149,188	99,380	924,401	0	115636	468241	291219	70089	2802	947,988	1,271,900	1.34
1987	122,531	77,893	732,370	0	129738	363646	287018	67587	5154	853,143	1,036,693	1.22
1988	109,461	60,678	590,128	0	128268	407993	222905	66612	4970	830,747	979,420	1.18
1989	315,097	115,273	1,271,104	0	129020	403371	250088	51732	4898	839,108	1,219,945	1.45
1990	267,369	122,384	1,255,479	0	140509	405735	247254	58041	3804	855,343	1,099,890	1.29
1991	262,638	132,464	1,321,432	0	111320	441864	248704	57383	4268	863,539	1,079,720	1.25
1992	202,976	136,585	1,267,581	0	89699	350073	270850	57720	4219	772,561	858,278	1.11
1993	174,340	103,696	990,685	0	193208	282081	214585	62859	4244	756,977	813,290	1.07
1994	181,770	117,862	1,103,085	0	190833	607588	172908	49801	4622	1,025,751	814,684	0.79
1995	147,753	118,259	1,058,318	0	200858	600119	372433	40129	3662	1,217,201	723,694	0.59
1996	124,133	109,103	959,326	0	192672	631645	367855	86435	2951	1,281,558	571,041	0.45
1997	166,395	94,998	916,941	0	150584	605904	387180	85373	6356	1,235,396	661,919	0.54
1998	215,121	104,793	1,055,681	0	167669	473547	371401	89857	6277	1,108,752	-	-
1999	0	0	0	0	160864	527275	290271	86196	6607	1,071,212	0	0.00
2000	0	0	0	0	145818	505876	323204	67367	6338	1,048,602	0	0.00



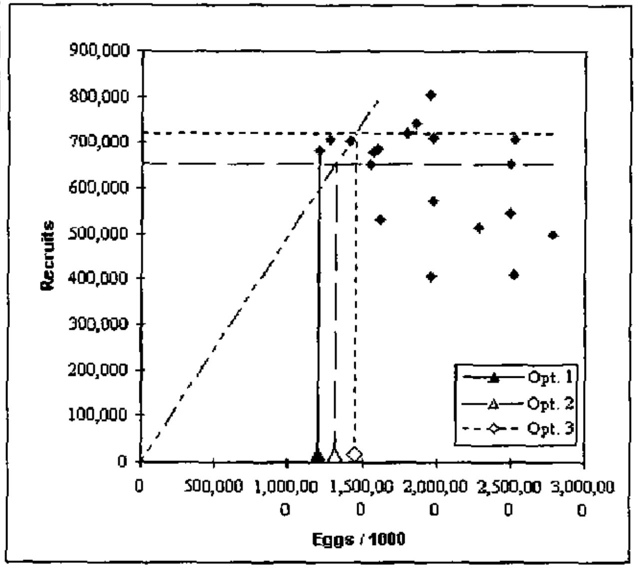
Median recruits	1,079,720
90%ile recruits	1,495,401
90%ile Rec./L	1.76

Conservation limits		**Eggs**	**1SW**	**MSW**	**Total.**
Option 1	(Min Lag. eggs)	721,932	132,633	74,479	207,112
Option 2	(Med R./90%L)	613,017	112,623	63,242	175,866
Option 3	90%Rec/90%L	849,023	155,982	87,590	243,572

	1SW	**MSW**	**Tot.**
10yr av. #	205,759	115,542	321,301
10yr av.%	64%	36%	
eggsx10^{-3}	288,063	831,901	1,119,963

Appendix 10f Lagged egg deposition analysis and estimation of conservation limit options - RUSSIA

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	4500	10500	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	45%	80%		0.00	0.10	0.70	0.20	0.00	0.00	egg x 10^{-3}		
1971	113,554	188,581	1,814,027							n/a	492,429	
1972	125,943	157,693	1,579,658							n/a	714,807	
1973	211,343	271,305	2,706,933							n/a	792,909	
1974	199,193	238,687	2,408,339	0						n/a	885,949	
1975	208,761	299,306	2,936,908	0	181,403					n/a	837,740	
1976	104,117	271,596	2,492,243	0	157,966	1,269,819				n/a	621,786	
1977	118,113	197,656	1,899,491	0	270,693	1,105,761	362,805			1,739,260	459,065	0.26
1978	142,193	141,210	1,474,104	0	240,834	1,894,853	315,932	0		2,451,618	512,228	0.21
1979	161,327	146,057	1,553,564	0	293,691	1,685,838	541,387	0	0	2,520,915	709,055	0.28
1980	107,170	227,060	2,124,324	0	249,224	2,055,836	481,668	0	0	2,786,728	497,265	0.18
1981	97,549	157,535	1,520,830	0	189,949	1,744,570	587,382	0	0	2,521,901	410,900	0.16
1982	123,386	123,251	1,285,168	0	147,410	1,329,644	498,449	0	0	1,975,503	574,235	0.29
1983	176,507	207,644	2,101,635	0	155,356	1,031,873	379,898	0	0	1,567,128	681,681	0.43
1984	160,251	235,743	2,304,752	0	212,432	1,087,495	294,821	0	0	1,594,748	688,341	0.43
1985	218,620	249,227	2,536,210	0	152,083	1,487,027	310,713	0	0	1,949,823	805,376	0.41
1986	187,955	263,569	2,594,591	0	128,517	1,064,581	424,865	0	0	1,617,962	534,112	0.33
1987	293,704	130,486	1,690,830	0	210,164	899,618	304,166	0	0	1,413,947	704,911	0.50
1988	156,339	146,670	1,548,614	0	230,475	1,471,145	257,034	0	0	1,958,654	408,557	0.21
1989	240,910	87,471	1,222,600	0	253,621	1,613,327	420,327	0	0	2,287,275	516,444	0.23
1990	211,576	78,457	1,087,478	0	259,459	1,775,347	460,950	0	0	2,495,757	545,336	0.22
1991	346,730	151,254	1,972,657	0	169,083	1,816,214	507,242	0	0	2,492,539	652,747	0.26
1992	352,064	144,336	1,925,353	0	154,861	1,183,581	518,918	0	0	1,857,361	740,517	0.40
1993	310,420	198,859	2,299,020	0	122,260	1,084,029	338,166	0	0	1,544,456	655,131	0.42
1994	397,231	175,888	2,281,849	0	108,748	855,820	309,723	0	0	1,274,290	708,612	0.56
1995	370,672	136,410	1,896,453	0	197,266	761,234	244,520	0	0	1,203,020	685,888	0.57
1996	424,419	144,238	2,071,049	0	192,535	1,380,860	217,496	0	0	1,790,891	722,987	0.40
1997	420,947	122,313	1,879,849	0	229,902	1,347,747	394,531	0	0	1,972,180	710,499	0.36
1998	426,991	118,781	1,862,414	0	228,185	1,609,314	385,071	0	0	2,222,569	-	-
1999	0	0	0	0	189,645	1,597,295	459,804	0	0	2,246,744	0	0.00
2000	0	0	0	0	207,105	1,327,517	456,370	0	0	1,990,992	0	0.00



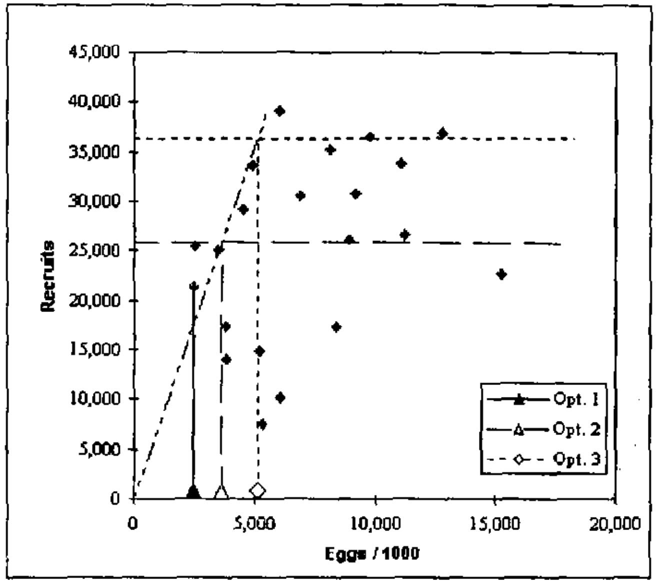
Median recruits	655,131
90%ile recruits	722,987
90%ile Rec./L	0.50

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	1,203,020	227,742	88,315	316,056
Option 2	(Med R /90%L)	1,314,096	248,769	96,469	345,238
Option 3	90%Rec/90%L	1,450,205	274,536	106,461	380,996

	1SW	MSW	Tot.
10yr av. #	350,196	135,801	485,997
10yr av.%	72%	28%	
eggsx10^{-3}	709,147	1,140,725	1,849,872

Appendix 10g Lagged egg deposition analysis and estimation of conservation limit options - SWEDEN

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	3000	6000	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	50%	70%		0	1	0	0	0	0	egg x 10^{-3}		
1971	2,147	214	4,120							n/a	17,152	
1972	1,771	125	3,183							n/a	16,689	
1973	2,121	596	5,683							n/a	17,642	
1974	3,201	394	6,458	824						n/a	22,094	
1975	3,236	87	5,220	637	2,472					n/a	23,694	
1976	1,963	247	3,981	1,137	1,910	824				3,870	13,976	3.61
1977	937	185	2,183	1,292	3,410	637	0			5,338	7,578	1.42
1978	1,106	146	2,272	1,044	3,875	1,137	0	0		6,055	10,200	1.68
1979	1,086	430	3,434	796	3,132	1,292	0	0	0	5,220	14,915	2.86
1980	1,342	718	5,028	437	2,389	1,044	0	0	0	3,869	17,333	4.48
1981	2,278	226	4,368	454	1,310	796	0	0	0	2,560	25,564	9.98
1982	2,311	731	6,539	687	1,363	437	0	0	0	2,486	21,377	8.60
1983	2,914	493	6,441	1,006	2,060	454	0	0	0	3,520	25,019	7.11
1984	3,968	675	8,788	874	3,017	687	0	0	0	4,577	29,210	6.38
1985	4,571	281	8,035	1,308	2,621	1,006	0	0	0	4,934	33,667	6.82
1986	5,328	276	9,149	1,288	3,923	874	0	0	0	6,085	39,040	6.42
1987	3,770	827	9,129	1,758	3,865	1,308	0	0	0	6,930	30,564	4.41
1988	3,760	866	9,276	1,607	5,273	1,288	0	0	0	8,168	35,309	4.32
1989	1,070	2,461	11,941	1,830	4,821	1,758	0	0	0	8,409	17,186	2.04
1990	2,781	1,492	10,437	1,826	5,489	1,607	0	0	0	8,922	26,111	2.93
1991	3,301	1,896	12,915	1,855	5,477	1,830	0	0	0	9,162	30,857	3.37
1992	3,391	2,289	14,702	2,388	5,566	1,826	0	0	0	9,780	36,580	3.74
1993	3,631	3,296	19,290	2,087	7,165	1,855	0	0	0	11,107	33,840	3.05
1994	5,025	2,707	18,909	2,583	6,262	2,388	0	0	0	11,234	26,679	2.37
1995	10,006	1,822	22,660	2,940	7,749	2,087	0	0	0	12,777	36,846	2.88
1996	5,973	2,079	17,690	3,858	8,821	2,583	0	0	0	15,262	22,596	1.48
1997	2,643	1,484	10,197	3,782	11,574	2,940	0	0	0	18,296	10,825	0.59
1998	1,115	893	5,424	4,532	11,345	3,858	0	0	0	19,735	-	-
1999	0	0	0	3,538	13,596	3,782	0	0	0	20,916	0	0.00
2000	0	0	0	2,039	10,614	4,532	0	0	0	17,185	0	0.00



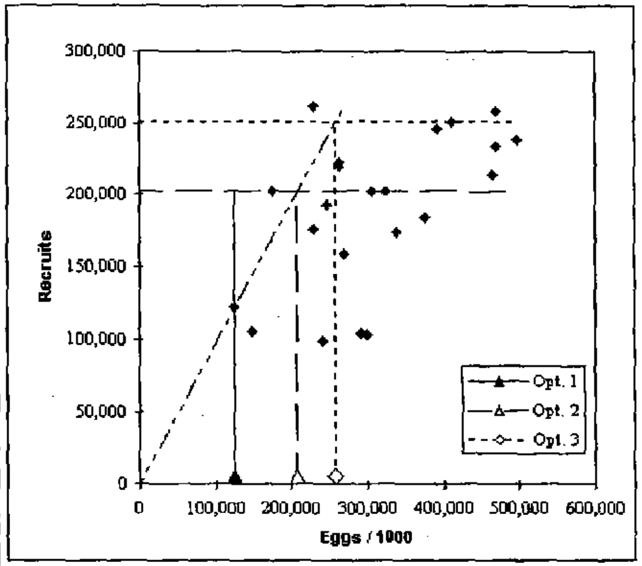
Median recruits	25,837
90%ile recruits	36,453
90%ile Rec./L	7.08

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	2,486	671	352	1,024
Option 2	(Med R./90%L)	3,650	986	517	1,503
Option 3	90%Rec/90%L	5,150	1,391	729	2,120

	1SW	MSW	Tot.
10yr av. #	3,894	2,042	5,936
10yr av.%	66%	34%	
eggsx10^{-3}	5,840	8,576	14,417

Appendix 10h Lagged egg deposition analysis and estimation of conservation limit options - UK(ENGLAND & WALES)

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	4930	7900	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	60%	70%		0.40	0.55	0.05	0.00	0.00	0.00	egg x 10^{-3}		
1971	70,188	39,088	384,609							n/a	274,068	
1972	93,135	46,757	482,089							n/a	295,847	
1973	84,243	46,513	459,398							n/a	290,029	
1974	96,569	44,969	480,447	153,843						n/a	304,577	
1975	95,206	53,616	524,991	192,835	211,535					n/a	297,114	
1976	74,828	36,099	379,217	183,759	265,149	19,230				468,138	234,111	0.50
1977	79,453	37,250	396,678	192,179	252,669	24,104	0			468,952	258,993	0.55
1978	87,072	40,832	434,775	209,996	264,246	22,970	0	0		497,212	237,842	0.48
1979	59,875	27,298	294,660	151,687	288,745	24,022	0	0	0	464,454	213,759	0.46
1980	65,612	26,537	304,217	158,671	208,569	26,250	0	0	0	393,490	245,642	0.62
1981	85,313	33,803	391,681	173,910	218,173	18,961	0	0	0	411,044	251,264	0.61
1982	48,497	20,975	232,382	117,864	239,126	19,834	0	0	0	376,824	183,927	0.49
1983	63,729	25,097	291,736	121,687	162,063	21,739	0	0	0	305,488	201,694	0.66
1984	50,049	20,090	231,216	156,673	167,319	14,733	0	0	0	338,725	173,653	0.51
1985	49,484	18,555	221,372	92,953	215,425	15,211	0	0	0	323,588	202,347	0.63
1986	63,770	24,328	287,580	116,694	127,610	19,584	0	0	0	264,088	222,471	0.84
1987	55,476	20,979	249,155	92,486	160,455	11,619	0	0	0	264,560	219,147	0.83
1988	80,905	28,419	351,330	88,549	127,169	14,587	0	0	0	230,304	262,233	1.14
1989	52,825	19,333	233,692	115,032	121,754	11,561	0	0	0	248,347	192,885	0.78
1990	48,861	16,618	209,164	99,662	158,169	11,069	0	0	0	268,900	158,587	0.59
1991	29,536	9,226	121,906	140,532	137,035	14,379	0	0	0	291,947	104,018	0.36
1992	27,616	9,336	117,905	93,477	193,232	12,458	0	0	0	299,166	103,316	0.35
1993	52,940	12,559	196,507	83,666	128,531	17,567	0	0	0	229,763	175,938	0.77
1994	76,384	24,473	318,656	48,763	115,040	11,685	0	0	0	175,488	201,854	1.15
1995	37,742	14,372	170,057	47,162	67,049	10,458	0	0	0	124,669	122,685	0.98
1996	37,334	21,077	206,156	78,603	64,848	6,095	0	0	0	149,546	104,956	0.70
1997	47,381	18,035	213,447	127,462	108,079	5,895	0	0	0	241,436	99,366	0.41
1998	54,439	11,360	193,476	68,023	175,261	9,825	0	0	0	253,109	-	-
1999	0	0	0	82,462	93,531	15,933	0	0	0	191,927	0	0.00
2000	0	0	0	85,379	113,386	8,503	0	0	0	207,268	0	0.00



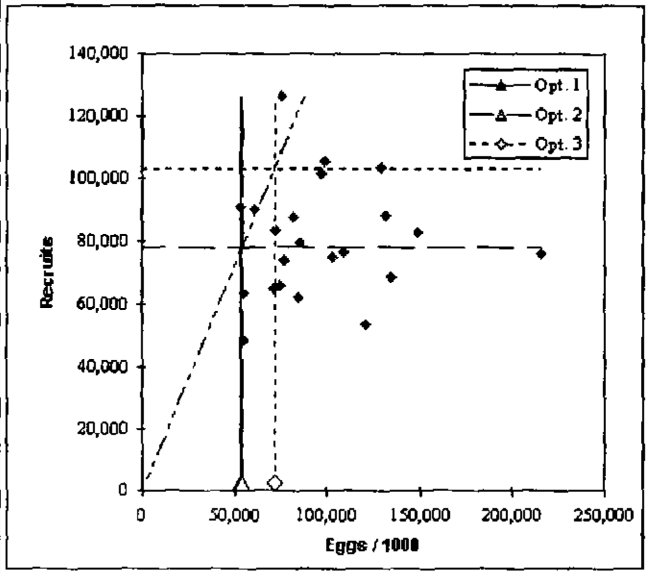
Median recruits	201,774
90%ile recruits	250,702
90%ile Rec./L	0.97

Conservation limits		**Eggs**	**1SW**	**MSW**	**Total.**
Option 1	(Min Lag. eggs)	124,669	29,268	9,842	39,110
Option 2	(Med R./90%L)	208,032	48,838	16,423	65,261
Option 3	90%Rec/90%L	258,478	60,681	20,406	81,087

	1SW	**MSW**	**Tot.**
10yr av. #	46,506	15,639	62,145
10yr av.%	75%	25%	
eggsx10^{-3}	111,614	86,483	198,097

Appendix 10i Lagged egg deposition analysis and estimation of conservation limit options - UK(N IRELAND)

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	3400	7000	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	S	R	R/S
Fem	60%	85%		20%	78%	2%	0%	0%	0%	egg x 10^{-3}		
1971	40,618	14,913	171,595							n/a	168,907	
1972	37,552	12,781	152,652							n/a	152,834	
1973	32,019	11,058	131,113							n/a	135,809	
1974	31,736	11,440	132,811	34,319						n/a	133,523	
1975	27,778	9,865	115,361	30,530	133,844					n/a	112,826	
1976	19,920	6,892	81,643	26,223	119,068	3,432				148,723	82,831	0.56
1977	20,385	6,575	80,705	26,562	102,268	3,053	0			131,884	88,202	0.67
1978	26,327	8,919	106,772	23,072	103,593	2,622	0	0		129,287	103,433	0.80
1979	17,445	6,025	71,437	16,329	89,982	2,656	0	0	0	108,967	76,619	0.70
1980	21,259	7,476	87,852	16,141	63,682	2,307	0	0	0	82,130	87,732	1.07
1981	17,779	6,079	72,438	21,354	62,950	1,633	0	0	0	85,937	79,664	0.93
1982	23,429	7,864	94,584	14,287	83,282	1,614	0	0	0	99,184	105,639	1.07
1983	34,396	11,358	137,748	17,570	55,721	2,135	0	0	0	75,427	126,327	1.67
1984	14,154	4,752	57,150	14,488	68,524	1,429	0	0	0	84,441	62,041	0.73
1985	17,196	6,087	71,298	18,917	56,502	1,757	0	0	0	77,176	74,141	0.96
1986	19,371	6,626	78,941	27,550	73,776	1,449	0	0	0	102,774	74,784	0.73
1987	9,653	3,346	39,598	11,430	107,443	1,892	0	0	0	120,765	53,427	0.44
1988	24,663	10,494	112,752	14,260	44,577	2,755	0	0	0	61,592	90,093	1.46
1989	6,949	5,044	44,188	15,788	55,612	1,143	0	0	0	72,543	83,274	1.15
1990	20,360	7,155	84,110	7,920	61,574	1,426	0	0	0	70,920	64,788	0.91
1991	10,845	3,384	42,256	22,550	30,887	1,579	0	0	0	55,016	48,299	0.88
1992	25,674	8,874	105,172	8,838	87,947	792	0	0	0	97,576	101,553	1.04
1993	42,621	28,235	254,944	16,822	34,467	2,255	0	0	0	53,544	91,169	1.70
1994	15,482	6,963	73,015	8,451	65,605	884	0	0	0	74,940	65,873	0.88
1995	15,587	5,752	66,025	21,034	32,960	1,682	0	0	0	55,676	63,538	1.14
1996	21,485	7,206	86,703	50,989	82,034	845	0	0	0	133,868	68,311	0.51
1997	22,249	8,605	96,588	14,603	198,856	2,103	0	0	0	215,563	76,076	0.35
1998	54,747	10,379	173,438	13,205	56,952	5,099	0	0	0	75,256	-	-
1999	0	0	0	17,341	51,499	1,460	0	0	0	70,300	0	0.00
2000	0	0	0	19,318	67,628	1,320	0	0	0	88,266	0	0.00



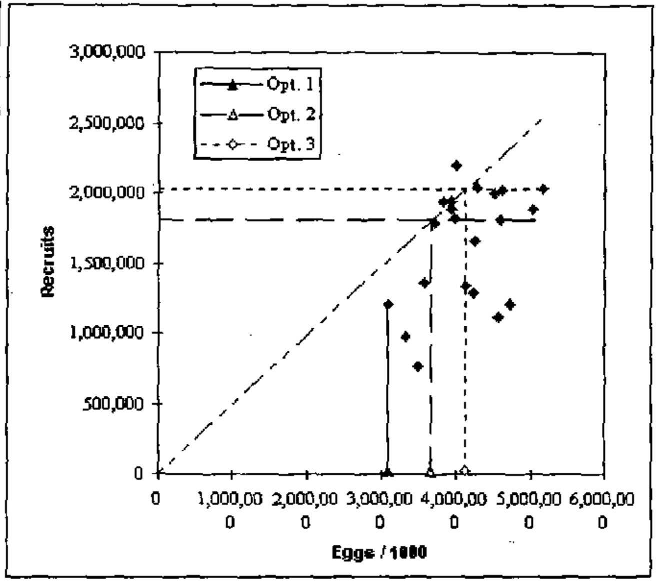
Median recruits	78,142
90%ile recruits	103,245
90%ile Rec./L	1.43

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	53,544	12,311	4,778	17,089
Option 2	(Med R./90%L)	54,596	12,553	4,872	17,425
Option 3	90%Rec/90%L	72,136	16,585	6,437	23,023

	1SW	MSW	Tot.
10yr av. #	23,600	9,160	32,760
10yr av.%	72%	28%	
eggsx10^{-3}	48,144	54,500	102,644

Appendix 10j Lagged egg deposition analysis and estimation of conservation limit options - UK(SCOTLAND)

	Est. 1SW spawners	Est MSW spawners	Egg deposition	Smolt age composition						Lagged egg dep.	Total 1SW recruits	
Egg	5000	10000	egg x 10^{-3}	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	L	R	R/L
Fem	40%	60%		10%	45%	40%	5%	0%	0%	egg x 10^{-3}		
1971	930,768	374,068	4,105,941							n/a	2,566,399	
1972	962,920	493,733	4,888,237							n/a	2,630,714	
1973	1,150,315	549,903	5,600,049							n/a	2,697,423	
1974	1,014,823	437,325	4,653,599	410,594						n/a	2,540,741	
1975	864,717	465,119	4,520,146	488,824	1,847,674					n/a	2,045,391	
1976	660,251	337,077	3,342,963	560,005	2,199,707	1,642,376				n/a	1,820,256	
1977	704,161	395,377	3,780,583	465,360	2,520,022	1,955,295	205,297			5,145,974	2,036,094	0.40
1978	748,671	472,372	4,331,573	452,015	2,094,120	2,240,020	244,412	0		5,030,566	1,882,733	0.37
1979	688,526	379,519	3,654,169	334,296	2,034,066	1,861,440	280,002	0	0	4,509,804	2,001,350	0.44
1980	549,385	437,320	3,722,692	378,058	1,504,333	1,808,058	232,680	0	0	3,923,130	1,883,797	0.48
1981	674,685	574,047	4,793,650	433,157	1,701,262	1,337,185	226,007	0	0	3,697,612	1,781,445	0.48
1982	942,077	434,054	4,488,481	365,417	1,949,208	1,512,233	167,148	0	0	3,994,006	2,207,605	0.55
1983	930,475	487,416	4,785,445	372,269	1,644,376	1,732,629	189,029	0	0	3,938,304	1,942,890	0.49
1984	909,542	347,305	3,902,912	479,365	1,675,211	1,461,668	216,579	0	0	3,832,823	1,947,473	0.51
1985	670,554	367,922	3,548,637	448,848	2,157,142	1,489,077	182,708	0	0	4,277,776	2,043,087	0.48
1986	892,086	644,747	5,652,656	478,544	2,019,816	1,917,460	186,135	0	0	4,601,955	2,017,438	0.44
1987	724,038	444,983	4,117,977	390,291	2,153,450	1,795,392	239,682	0	0	4,578,816	1,806,436	0.39
1988	660,058	469,284	4,135,821	354,864	1,756,310	1,914,178	224,424	0	0	4,249,776	1,661,462	0.39
1989	948,768	414,550	4,384,837	565,266	1,596,887	1,561,165	239,272	0	0	3,962,590	1,821,610	0.46
1990	447,021	341,599	2,943,637	411,798	2,543,695	1,419,455	195,146	0	0	4,570,094	1,109,080	0.24
1991	418,713	349,088	2,931,954	413,582	1,853,090	2,261,063	177,432	0	0	4,705,166	1,201,171	0.26
1992	543,014	432,270	3,679,645	438,484	1,861,120	1,647,191	282,633	0	0	4,229,427	1,291,896	0.31
1993	505,782	382,541	3,306,810	294,364	1,973,177	1,654,329	205,899	0	0	4,127,768	1,335,230	0.32
1994	541,144	452,941	3,799,936	293,195	1,324,636	1,753,935	206,791	0	0	3,578,558	1,361,702	0.38
1995	491,608	446,728	3,663,582	367,964	1,319,379	1,177,455	219,242	0	0	3,084,040	1,202,899	0.39
1996	462,621	390,977	3,271,107	330,681	1,655,840	1,172,782	147,182	0	0	3,306,485	974,299	0.29
1997	322,280	275,401	2,296,964	379,994	1,488,064	1,471,858	146,598	0	0	3,486,514	762,432	0.22
1998	332,488	253,340	2,185,018	366,358	1,709,971	1,322,724	183,982	0	0	3,583,035	-	-
1999	0	0	0	327,111	1,648,612	1,519,974	165,340	0	0	3,661,037	0	0.00
2000	0	0	0	229,696	1,471,998	1,465,433	189,997	0	0	3,357,124	0	0.00



Median recruits	1,806,436
90%ile recruits	2,036,094
90%ile Rec./L	0.49

Conservation limits		Eggs	1SW	MSW	Total.
Option 1	(Min Lag. eggs)	3,084,040	476,278	355,247	831,525
Option 2	(Med R /90%L)	3,661,705	565,489	421,788	987,277
Option 3	90%Rec/90%L	4,127,231	637,381	475,411	1,112,793

	1SW	MSW	Tot.
10yr av. #	501,344	373,944	875,287
10yr av.%	57%	43%	
eggsx10^{-3}	1,002,688	2,243,661	3,246,349